Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2523862 C 2009/06/23

(11)(21) 2 523 862

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 2004/04/15
(87) Date publication PCT/PCT Publication Date: 2004/11/04
(45) Date de délivrance/Issue Date: 2009/06/23
(85) Entrée phase nationale/National Entry: 2005/10/27
(86) N° demande PCT/PCT Application No.: US 2004/011973
(87) N° publication PCT/PCT Publication No.: 2004/094766
(30) Priorité/Priority: 2003/04/17 (US60/463,586)

(51) Cl.Int./Int.Cl. *E21B 29/00* (2006.01),
E21B 23/01 (2006.01)

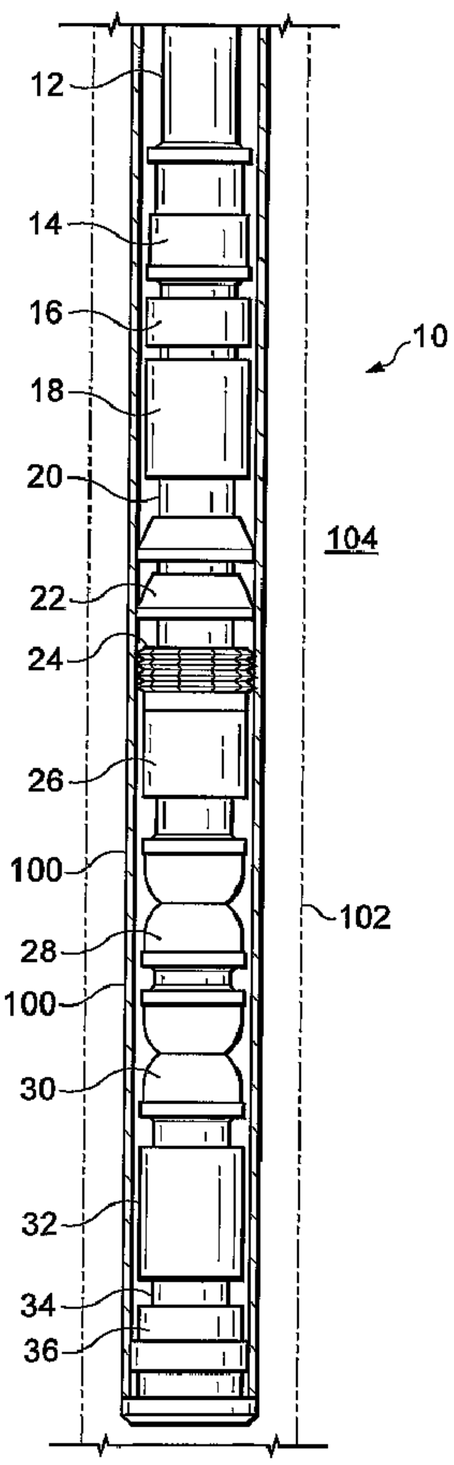
(72) Inventeurs/Inventors:
BRISCO, DAVID PAUL, US;
WATSON, BROCK WAYNE, US;
TREECE, HAROLD, US

(73) Propriétaire/Owner:
ENVENTURE GLOBAL TECHNOLOGY, US

(74) Agent: KIRBY EADES GALE BAKER

(54) Titre : APPAREIL SERVANT A ETENDRE RADIALEMENT ET DEFORMER PLASTIQUEMENT UN ELEMENT TUBULAIRE

(54) Title: APPARATUS FOR RADIALLY EXPANDING AND PLASTICALLY DEFORMING A TUBULAR MEMBER



(57) Abrégé/Abstract:
An apparatus for radially expanding and plastically deforming a tubular (100).

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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 November 2004 (04.11.2004)

PCT

(10) International Publication Number
WO 2004/094766 A3

(51) International Patent Classification[7]: E21B 23/01

(21) International Application Number:
PCT/US2004/011973

(22) International Filing Date: 15 April 2004 (15.04.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/463,586 17 April 2003 (17.04.2003) US

(71) Applicant *(for all designated States except US)*: **ENVENTURE GLOBAL TECHNOLOGY** [US/US]; 16200 A. Park Row, Houston, TX 77084 (US).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **BRISCO, David, Paul** [US/US]; 405 Westridge Drive, Duncan, OK 73533 (US). **WATSON, Brock, Wayne** [US/US]; 2535 Marsh Lane #1004, Carrollton, TX 75006 (US). **TREECE, Harold** [US/US]; 213 Ridgecrest Drive, Duncan, OK 73533 (US).

(74) Agent: **MATTINGLY, Todd**; Haynes and Boone, LLP, 901 Main Street, Suite 3100, Dallas, TX 75202 (US).

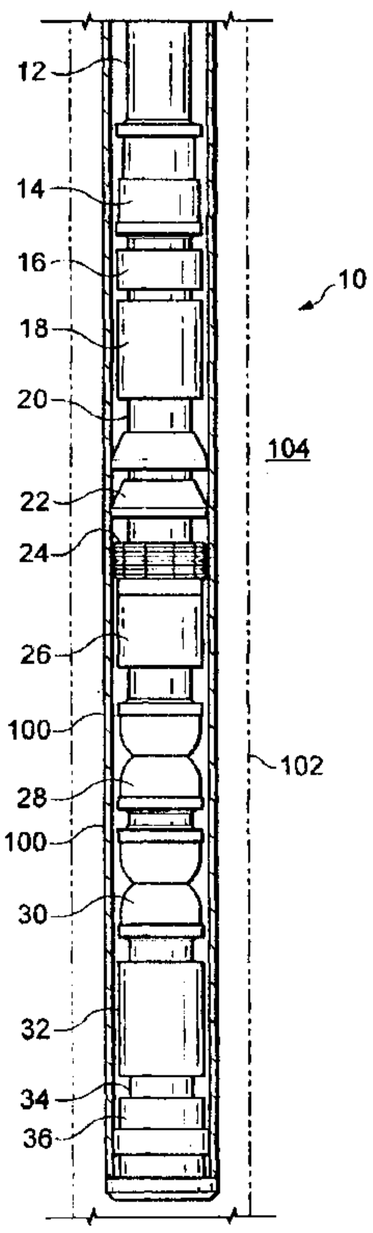
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: APPARATUS FOR RADIALLY EXPANDING AND PLASTICALLY DEFORMING A TUBULAR MEMBER

(57) Abstract: An apparatus for radially expanding and plastically deforming a tubular (100).



WO 2004/094766 A3

WO 2004/094766 A3

Declaration under Rule 4.17:
— *of inventorship (Rule 4.17(iv)) for US only*

Published:
— *with international search report*
— *with amended claims*

(88) Date of publication of the international search report:
17 November 2005

Date of publication of the amended claims: 16 March 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2004/094766 PCT/US2004/011973

APPARATUS FOR RADIALLY EXPANDING AND PLASTICALLY DEFORMING A TUBULAR MEMBER

Background of the Invention

[0004] This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

Summary Of The Invention

[0005] According to one aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a support member, a cutting device for cutting the tubular member coupled to the support member, and an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member.

[0006] According to another aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a support member, an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member, and an actuator coupled to the support member for displacing the expansion device relative to the support member.

[0007] According to another aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a support member; an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; and a sealing assembly for sealing an annulus defined between the support member and the tubular member.

[0008] According to another aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a support member; a first expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; and a second expansion device for radially expanding and plastically deforming the tubular member coupled to the support

member.

[0009] According to another aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a support member; an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; and a packer coupled to the support member.

[0010] According to another aspect of the present invention, an apparatus for radially expanding and plastically deforming an expandable tubular member is provided that includes a support member; a cutting device for cutting the tubular member coupled to the support member; a gripping device for gripping the tubular member coupled to the support member; a sealing device for sealing an interface with the tubular member coupled to the support member; a locking device for locking the position of the tubular member relative to the support member; a first adjustable expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; a second adjustable expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; a packer coupled to the support member; and an actuator for displacing one or more of the sealing assembly, first and second adjustable expansion devices, and packer relative to the support member.

[0011] According to another aspect of the present invention, an apparatus for cutting a tubular member is provided that includes a support member; and a plurality of movable cutting elements coupled to the support member.

[0012] According to another aspect of the present invention, an apparatus for engaging a tubular member is provided that includes a support member; and a plurality of movable elements coupled to the support member.

[0013] According to another aspect of the present invention, an apparatus for gripping a tubular member is provided that includes a plurality of movable gripping elements.

[0014] According to another aspect of the present invention, an actuator is provided that includes a tubular housing; a tubular piston rod movably coupled to and at least partially positioned within the housing; a plurality of annular piston chambers defined by the tubular housing and the tubular piston rod; and a plurality of tubular pistons coupled to the tubular piston rod, each tubular piston movably positioned within a corresponding annular piston chamber.

[0015] According to another aspect of the present invention, an apparatus for controlling a packer is provided that includes a tubular support member; one or more drag blocks releasably coupled to the tubular support member; and a tubular stinger coupled to the tubular support member for engaging the packer.

[0016] According to another aspect of the present invention, a packer is provided that

includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support member.

[0017] According to another aspect of the present invention, a method of radially expanding and plastically deforming an expandable tubular member within a borehole having a preexisting wellbore casing is provided that includes positioning the tubular member within the borehole in overlapping relation to the wellbore casing; radially expanding and plastically deforming a portion of the tubular member to form a bell section; and radially expanding and plastically deforming a portion of the tubular member above the bell section comprising a portion of the tubular member that overlaps with the wellbore casing; wherein the inside diameter of the bell section is greater than the inside diameter of the radially expanded and plastically deformed portion of the tubular member above the bell section.

[0018] According to another aspect of the present invention, a method for forming a mono diameter wellbore casing is provided that includes positioning an adjustable expansion device within a first expandable tubular member; supporting the first expandable tubular member and the adjustable expansion device within a borehole; lowering the adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the adjustable expansion device; displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; positioning the adjustable expansion device within a second expandable tubular member; supporting the second expandable tubular member and the adjustable expansion device within the borehole in overlapping relation to the first expandable tubular member; lowering the adjustable expansion device out of the second expandable tubular member; increasing the outside dimension of the adjustable expansion device; and displacing the adjustable expansion device upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole.

[0019] According to another aspect of the present invention, a method for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes positioning an adjustable expansion device within the expandable tubular member; supporting the expandable tubular member and the adjustable expansion device within the borehole; lowering the adjustable expansion device out of the expandable tubular member; increasing the outside dimension of the adjustable expansion device; displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable

tubular member within the borehole; and pressurizing an interior region of the expandable tubular member above the adjustable expansion device during the radial expansion and plastic deformation of the expandable tubular member within the borehole.

[0020] According to another aspect of the present invention, a method for forming a mono diameter wellbore casing is provided that includes positioning an adjustable expansion device within a first expandable tubular member; supporting the first expandable tubular member and the adjustable expansion device within a borehole; lowering the adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the adjustable expansion device; displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; pressurizing an interior region of the first expandable tubular member above the adjustable expansion device during the radial expansion and plastic deformation of the first expandable tubular member within the borehole; positioning the adjustable expansion mandrel within a second expandable tubular member; supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member; lowering the adjustable expansion mandrel out of the second expandable tubular member; increasing the outside dimension of the adjustable expansion mandrel; displacing the adjustable expansion mandrel upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole; and pressurizing an interior region of the second expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the second expandable tubular member within the borehole.

[0021] According to another aspect of the present invention, a method for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes positioning first and second adjustable expansion devices within the expandable tubular member; supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; lowering the first adjustable expansion device out of the expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the

expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0022] According to another aspect of the present invention, a method for forming a mono diameter wellbore casing is provided that includes positioning first and second adjustable expansion devices within a first expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; lowering the first adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; positioning first and second adjustable expansion devices within a second expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; lowering the first adjustable expansion device out of the second expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; and displacing the second adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0023] According to another aspect of the present invention, a method for radially expanding and plastically deforming an expandable tubular member within a borehole is

provided that includes positioning first and second adjustable expansion devices within the expandable tubular member; supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; lowering the first adjustable expansion device out of the expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; pressurizing an interior region of the expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the expandable tubular member by the first adjustable expansion device; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member; and pressurizing an interior region of the expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the expandable tubular member above the lower portion of the expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0024] According to another aspect of the present invention, a method for forming a mono diameter wellbore casing is provided that includes positioning first and second adjustable expansion devices within a first expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; lowering the first adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; pressurizing an interior region of the first expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the first expandable tubular member by the first adjustable expansion device; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically

deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; pressurizing an interior region of the first expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the first expandable tubular member above the lower portion of the first expandable tubular member by the second adjustable expansion device; positioning first and second adjustable expansion devices within a second expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; lowering the first adjustable expansion device out of the second expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; pressurizing an interior region of the second expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the second expandable tubular member by the first adjustable expansion device; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; and pressurizing an interior region of the second expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the second expandable tubular member above the lower portion of the second expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0025] According to another aspect of the present invention, a method for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; increasing the size of the adjustable expansion device; and displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member.

[0026] According to another aspect of the present invention, a method for forming a mono diameter wellbore casing within a borehole that includes a preexisting wellbore casing

is provided that includes supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; increasing the size of the adjustable expansion device; displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member; and displacing the adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform the remaining portion of the expandable tubular member and a portion of the preexisting wellbore casing that overlaps with an end of the remaining portion of the expandable tubular member.

[0027] According to another aspect of the present invention, a method of radially expanding and plastically deforming a tubular member is provided that includes positioning the tubular member within a preexisting structure; radially expanding and plastically deforming a lower portion of the tubular member to form a bell section; and radially expanding and plastically deforming a portion of the tubular member above the bell section.

[0028] According to another aspect of the present invention, a method of radially expanding and plastically deforming a tubular member is provided that includes applying internal pressure to the inside surface of the tubular member at a plurality of discrete location separated from one another.

[0029] According to another aspect of the present invention, a system for radially expanding and plastically deforming an expandable tubular member within a borehole having a preexisting wellbore casing is provided that includes means for positioning the tubular member within the borehole in overlapping relation to the wellbore casing; means for radially expanding and plastically deforming a portion of the tubular member to form a bell section; and means for radially expanding and plastically deforming a portion of the tubular member above the bell section comprising a portion of the tubular member that overlaps with the wellbore casing; wherein the inside diameter of the bell section is greater than the inside diameter of the radially expanded and plastically deformed portion of the tubular member above the bell section.

[0030] According to another aspect of the present invention, a system for forming a mono diameter wellbore casing is provided that includes means for positioning an adjustable expansion device within a first expandable tubular member; means for supporting the first expandable tubular member and the adjustable expansion device within a borehole; means for lowering the adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; means for positioning the adjustable expansion device

within a second expandable tubular member; means for supporting the second expandable tubular member and the adjustable expansion device within the borehole in overlapping relation to the first expandable tubular member; means for lowering the adjustable expansion device out of the second expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; and means for displacing the adjustable expansion device upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole.

[0031] According to another aspect of the present invention, a system for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes means for positioning an adjustable expansion device within the expandable tubular member; means for supporting the expandable tubular member and the adjustable expansion device within the borehole; means for lowering the adjustable expansion device out of the expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; means for displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member within the borehole; and means for pressurizing an interior region of the expandable tubular member above the adjustable expansion device during the radial expansion and plastic deformation of the expandable tubular member within the borehole.

[0032] According to another aspect of the present invention, a system for forming a mono diameter wellbore casing is provided that includes means for positioning an adjustable expansion device within a first expandable tubular member; means for supporting the first expandable tubular member and the adjustable expansion device within a borehole; means for lowering the adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; means for pressurizing an interior region of the first expandable tubular member above the adjustable expansion device during the radial expansion and plastic deformation of the first expandable tubular member within the borehole; means for positioning the adjustable expansion mandrel within a second expandable tubular member; means for supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member; means for lowering the adjustable expansion mandrel out of the second expandable tubular member; means for increasing the outside dimension of the adjustable expansion mandrel; means for displacing the adjustable expansion mandrel

upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole; and means for pressurizing an interior region of the second expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the second expandable tubular member within the borehole.

[0033] According to another aspect of the present invention, a system for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes means for positioning first and second adjustable expansion devices within the expandable tubular member; means for supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; means for lowering the first adjustable expansion device out of the expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0034] According to another aspect of the present invention, a system for forming a mono diameter wellbore casing is provided that includes means for positioning first and second adjustable expansion devices within a first expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; means for lowering the first adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to

radially expand and plastically deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; means for positioning first and second adjustable expansion devices within a second expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; means for lowering the first adjustable expansion device out of the second expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; and means for displacing the second adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0035] According to another aspect of the present invention, a system for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes means for positioning first and second adjustable expansion devices within the expandable tubular member; means for supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; means for lowering the first adjustable expansion device out of the expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; means for pressurizing an interior region of the expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the expandable tubular member by the first adjustable expansion device; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of

the expandable tubular member; and means for pressurizing an interior region of the expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the expandable tubular member above the lower portion of the expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0036] According to another aspect of the present invention, a system for forming a mono diameter wellbore casing is provided that includes means for positioning first and second adjustable expansion devices within a first expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; means for lowering the first adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; means for pressurizing an interior region of the first expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the first expandable tubular member by the first adjustable expansion device; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; means for pressurizing an interior region of the first expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the first expandable tubular member above the lower portion of the first expandable tubular member by the second adjustable expansion device; means for positioning first and second adjustable expansion devices within a second expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; means for lowering the first adjustable expansion device out of the second expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; means for pressurizing an interior region of the second

expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the second expandable tubular member by the first adjustable expansion device; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; and means for pressurizing an interior region of the second expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the second expandable tubular member above the lower portion of the second expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[0037] According to another aspect of the present invention, a system for radially expanding and plastically deforming an expandable tubular member within a borehole is provided that includes means for supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; means for increasing the size of the adjustable expansion device; and means for displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member.

[0038] According to another aspect of the present invention, a system for forming a mono diameter wellbore casing within a borehole that includes a preexisting wellbore casing is provided that includes means for supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; means for increasing the size of the adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member; and means for displacing the adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform the remaining portion of the expandable tubular member and a portion of the preexisting wellbore casing that overlaps with an end of the remaining portion of the expandable tubular member.

[0039] According to another aspect of the present invention, a system for radially expanding and plastically deforming a tubular member is provided that includes means for positioning the tubular member within a preexisting structure; means for radially expanding and plastically deforming a lower portion of the tubular member to form a bell section; and

means for radially expanding and plastically deforming a portion of the tubular member above the bell section.

[0040] According to another aspect of the present invention, a system of radially expanding and plastically deforming a tubular member is provided that includes a support member; and means for applying internal pressure to the inside surface of the tubular member at a plurality of discrete location separated from one another coupled to the support member.

[0041] According to another aspect of the present invention, a method of cutting a tubular member is provided that includes positioning a plurality of cutting elements within the tubular member; and bringing the cutting elements into engagement with the tubular member.

[0042] According to another aspect of the present invention, a method of gripping a tubular member is provided that includes positioning a plurality of gripping elements within the tubular member; bringing the gripping elements into engagement with the tubular member. In an exemplary embodiment, bringing the gripping elements into engagement with the tubular member includes displacing the gripping elements in an axial direction; and displacing the gripping elements in a radial direction.

[0043] According to another aspect of the present invention, a method of operating an actuator is provided that includes pressurizing a plurality of pressure chamber.

[0044] According to another aspect of the present invention, a method of injecting a hardenable fluidic sealing material into an annulus between a tubular member and a preexisting structure is provided that includes positioning the tubular member into the preexisting structure; sealing off an end of the tubular member; operating a valve within the end of the tubular member; and injecting a hardenable fluidic sealing material through the valve into the annulus between the tubular member and the preexisting structure.

[0045] According to another aspect of the present invention, a system for cutting a tubular member is provided that includes means for positioning a plurality of cutting elements within the tubular member; and means for bringing the cutting elements into engagement with the tubular member.

[0046] According to another aspect of the present invention, a system for gripping a tubular member is provided that includes means for positioning a plurality of gripping elements within the tubular member; and means for bringing the gripping elements into engagement with the tubular member.

[0047] According to another aspect of the present invention, an actuator system is provided that includes a support member; and means for pressurizing a plurality of pressure chambers coupled to the support member. In an exemplary embodiment, the system further includes means for transmitting torsional loads.

[0048] According to another aspect of the present invention, a system for injecting a hardenable fluidic sealing material into an annulus between a tubular member and a preexisting structure is provided that includes means for positioning the tubular member into the preexisting structure; means for sealing off an end of the tubular member; means for operating a valve within the end of the tubular member; and means for injecting a hardenable fluidic sealing material through the valve into the annulus between the tubular member and the preexisting structure.

[0049] According to another aspect of the present invention, a method of engaging a tubular member is provided that includes positioning a plurality of elements within the tubular member; and bringing the elements into engagement with the tubular member.

[0050] According to another aspect of the present invention, a system for engaging a tubular member is provided that includes means for positioning a plurality of elements within the tubular member; and means for bringing the elements into engagement with the tubular member. In an exemplary embodiment, the elements include a first group of elements; and a second group of elements; wherein the first group of elements are interleaved with the second group of elements.

[0051] According to another aspect of the present invention, a locking device for locking a tubular member to a support member is provided that includes a plurality of circumferentially spaced apart locking elements coupled to the support member for engaging an interior surface of the tubular member; a plurality of spring elements coupled to the support member for biasing corresponding locking elements out of engagement with the interior surface of the tubular member; a releasable retaining element releasably coupled to the support member for releasably retaining the locking elements in engagement with the interior surface of the tubular member; an actuator coupled to the support member for controllably displacing the retaining element relative to the locking elements; and a sensor coupled to the support member for sensing an operating condition within the tubular member for controllably displacing the retaining element relative to the locking elements.

[0052] According to another aspect of the present invention, a method of locking a tubular member to a support member is provided that includes engaging the interior surface of the tubular member at a plurality of circumferentially spaced apart locations using one or more engagement members; and disengaging the engagement members from the interior surface of the tubular member if an operating condition within the tubular member exceeds a predetermined amount; wherein the engagement members are biased out of engagement with the tubular member.

[0053] According to another aspect of the present invention, a system for locking a tubular member to a support member is provided that includes means for engaging the interior surface of the tubular member at a plurality of circumferentially spaced apart

locations using one or more engagement members; and means for disengaging the engagement members from the interior surface of the tubular member if an operating condition within the tubular member exceeds a predetermined amount; wherein the engagement members are biased out of engagement with the tubular member.

Brief Description of the Drawings

[0054] Fig. 1 is a fragmentary cross-sectional illustration of an embodiment of a system for radially expanding and plastically deforming wellbore casing, including a tubular support member, a casing cutter, a ball gripper for gripping a wellbore casing, a force multiplier tension actuator, a safety sub, a cup sub, a casing lock, an extension actuator, a bell section adjustable expansion cone assembly, a casing section adjustable expansion cone assembly, a packer setting tool, a packer, a stinger, and an expandable wellbore casing, during the placement of the system within a wellbore.

[0055] Fig. 2 is a fragmentary cross-sectional illustration of the system of Fig. 1 during the subsequent displacement of the bell section adjustable expansion cone assembly, the casing section adjustable expansion cone assembly, the packer setting tool, the packer, and the stinger downwardly out of the end of the expandable wellbore casing and the expansion of the size of the bell section adjustable expansion cone assembly and the casing section adjustable expansion cone assembly.

[0056] Fig. 3 is a fragmentary cross-sectional illustration of the system of Fig. 2 during the subsequent operation of the tension actuator to displace the bell section adjustable expansion cone assembly upwardly into the end of the expandable wellbore casing to form a bell section in the end of the expandable wellbore casing.

[0057] Fig. 4 is a fragmentary cross-sectional illustration of the system of Fig. 3 during the subsequent reduction of the bell section adjustable expansion cone assembly.

[0058] Fig. 5 is a fragmentary cross-sectional illustration of the system of Fig. 4 during the subsequent upward displacement of the expanded casing section adjustable expansion cone assembly to radially expand the expandable wellbore casing.

[0059] Fig. 6 is a fragmentary cross-sectional illustration of the system of Fig. 5 during the subsequent lowering of the tubular support member, casing cutter, ball gripper, a force multiplier tension actuator, safety sub, cup sub, casing lock, extension actuator, bell section adjustable expansion cone assembly, casing section adjustable expansion cone assembly, packer setting tool, packer, and stinger and subsequent setting of the packer within the expandable wellbore casing above the bell section.

[0060] Fig. 7 is a fragmentary cross-sectional illustration of the system of Fig. 6 during the subsequent injection of fluidic materials into the system to displace the expanded casing section adjustable expansion cone assembly upwardly through the expandable wellbore casing to radially expand and plastically deform the expandable wellbore casing.

[0061] Fig. 8 is a fragmentary cross-sectional illustration of the system of Fig. 7 during the subsequent injection of fluidic materials into the system to displace the expanded casing section adjustable expansion cone assembly upwardly through the expandable wellbore casing and a surrounding preexisting wellbore casing to radially expand and plastically deform the overlapping expandable wellbore casing and the surrounding preexisting wellbore casing.

[0062] Fig. 9 is a fragmentary cross-sectional illustration of the system of Fig. 8 during the subsequent operation of the casing cutter to cut off an end of the expandable wellbore casing.

[0063] Fig. 10 is a fragmentary cross-sectional illustration of the system of Fig. 9 during the subsequent removal of the cut off end of the expandable wellbore casing.

[0064] Figs. 11-1 and 11-2, 11A1 to 11A2, 11B1 to 11B2, 11C, 11D, 11E, 11F, 11G, 11H, 11I, 11j, 11K, 11L, 11M, 11N, 11O, 11P, 11Q, 11R, 11S, 11T, 11U, 11V, 11W, 11X, 11Y, 11Z1 to 11Z4, 11AA1 to 11AA4, 11AB1 to 11AB4, 11AC1 to 11AC4, 11AD, and 11AE are fragmentary cross-sectional and perspective illustrations of an exemplary embodiment of a casing cutter assembly.

[0065] Figs. 12A1 to 12A4 and 12C1 to 12C4 are fragmentary cross-sectional illustrations of an exemplary embodiment of a ball gripper assembly.

[0066] Fig. 12B is a top view of a portion of the ball gripper assembly of Figs. 12A1 to 12A4 and 12C1 to 12C4.

[0067] Figs. 13A1 to 13A8 and 13B1 to 13B7 are fragmentary cross-sectional illustrations of an exemplary embodiment of a tension actuator assembly.

[0068] Fig. 14A is a fragmentary cross-sectional illustrations of an exemplary embodiment of a safety sub assembly.

[0069] Figs. 14A, 14B and 14C are fragmentary cross-sectional and perspective illustrations of an exemplary embodiment of a cup seal assembly.

[0070] Figs. 15-1, 15-2, 15A1, 15A2, 15B1, 15B2, 15C1, 15C2, 15D, 15E1 to 15E5, 15F1 to 15F5, and 15G1 to 15G5 are fragmentary cross sectional illustrations of an exemplary embodiment of an extension actuator and casing lock assembly.

[0071] Figs. 16-1 and 16-2, 16A1 to 16A2, 16B1 to 16B2, 16C, 16D, 16E, 16F, 16G, 16H, 16I, 16j, 16K, 16L, 16M, 16N, 16O, 16P, 16R, 16S, 16T, 16U, 16V, 16W, 16X, 16Y, 16Z1 to 16Z4, 16AA1 to 16AA4, 16AB1 to 16AB4, 16AC1 to 16AC4, 16AD, and 16AE are fragmentary cross-sectional and perspective illustrations of an exemplary embodiment of an adjustable bell section expansion cone assembly.

[0072] Figs. 17-1 and 17-2, 17A1 to 17A2, 17B1 to 17B2, 17C, 17D, 17E, 17F, 17G, 17H, 17I, 17j, 17K, 17L, 17M, 17N, 17O, 17P, 17R, 17S, 17T, 17U, 17V, 17W, 17X, 17Y, 17Z1-17Z4, 17AA1 to 17AA4, 17AB1 to 17AB4, 17AC1 to 17AC4, 17AD, and 17AE are

fragmentary cross-sectional and perspective illustrations of an exemplary embodiment of an adjustable casing expansion cone assembly.

[0073] Figs. 18A to 18C is a fragmentary cross-sectional illustration of an exemplary embodiment of a packer setting tool assembly.

[0074] Figs. 19-1 to 19-5 is a fragmentary cross-sectional illustration of an exemplary embodiment of a packer assembly.

[0075] Figs. 20A1 to 20A5, 20B1 to 20B5, 20C1 to 20C5, 20D1 to 20D5, 20E1 to 20E6, 20F1 to 20F6, 20G1 to 20G6, and 20H1 to 20H5, are fragmentary cross-sectional illustrations of an exemplary embodiment of the operation of the packer setting tool and the packer assembly of Figs. 18A to 18C and 19-1 to 19-5.

[0076] Figs. 21 and 21A to 21AX are fragmentary perspective and cross-sectional illustrations of an alternative embodiment of the packer assembly.

Detailed Description of the Illustrative Embodiments

[0077] Referring initially to Figs. 1-10, an exemplary embodiment of a system 10 for radially expanding and plastically deforming a wellbore casing includes a conventional tubular support 12 having an end that is coupled to an end of a casing cutter assembly 14. In an exemplary embodiment, the casing cutter assembly 14 may be, or may include elements, of one or more conventional commercially available casing cutters for cutting wellbore casing, or equivalents thereof.

[0078] An end of a ball gripper assembly 16 is coupled to another end of the casing cutter assembly 14. In an exemplary embodiment, the ball gripper assembly 14 may be, or may include elements, of one or more conventional commercially available ball grippers, or other types of gripping devices, for gripping wellbore casing, or equivalents thereof.

[0079] An end of a tension actuator assembly 18 is coupled to another end of the ball gripper assembly 16. In an exemplary embodiment, the tension actuator assembly 18 may be, or may include elements, of one or more conventional commercially actuators, or equivalents thereof.

[0080] An end of a safety sub assembly 20 is coupled to another end of the tension actuator assembly 18. In an exemplary embodiment, the safety sub assembly 20 may be, or may include elements, of one or more conventional apparatus that provide quick connection and/or disconnection of tubular members, or equivalents thereof.

[0081] An end of a sealing cup assembly 22 is coupled to another end of the safety sub assembly 20. In an exemplary embodiment, the sealing cup assembly 22 may be, or may include elements, of one or more conventional sealing cup assemblies, or other types of sealing assemblies, that sealingly engage the interior surfaces of surrounding tubular members, or equivalents thereof.

[0082] An end of a casing lock assembly 24 is coupled to another end of the sealing cup

assembly 22. In an exemplary embodiment, the casing lock assembly 24 may be, or may include elements, of one or more conventional casing lock assemblies that lock the position of wellbore casing, or equivalents thereof.

[0083] An end of an extension actuator assembly 26 is coupled to another end of the casing lock assembly 24. In an exemplary embodiment, the extension actuator assembly 26 may be, or may include elements, of one or more conventional actuators, or equivalents thereof.

[0084] An end of an adjustable bell section expansion cone assembly 28 is coupled to another end of the extension actuator assembly 26. In an exemplary embodiment, the adjustable bell section expansion cone assembly 28 may be, or may include elements, of one or more conventional adjustable expansion devices for radially expanding and plastically deforming wellbore casing, or equivalents thereof.

[0085] An end of an adjustable casing expansion cone assembly 30 is coupled to another end of the adjustable bell section expansion cone assembly 28. In an exemplary embodiment, the adjustable casing expansion cone assembly 30 may be, or may include elements, of one or more conventional adjustable expansion devices for radially expanding and plastically deforming wellbore casing, or equivalents thereof.

[0086] An end of a packer setting tool assembly 32 is coupled to another end of the adjustable casing expansion cone assembly 30. In an exemplary embodiment, the packer setting tool assembly 32 may be, or may include elements, of one or more conventional adjustable expansion devices for controlling the operation of a conventional packer, or equivalents thereof.

[0087] An end of a stinger assembly 34 is coupled to another end of the packer setting tool assembly 32. In an exemplary embodiment, the stinger assembly 34 may be, or may include elements, of one or more conventional devices for engaging a conventional packer, or equivalents thereof.

[0088] An end of a packer assembly 36 is coupled to another end of the stinger assembly 34. In an exemplary embodiment, the packer assembly 36 may be, or may include elements, of one or more conventional packers.

[0089] In an exemplary embodiment, one or more of the elements of the system 10 may be omitted, at least in part, and/or combined, at least in part, with one or more of the other elements of the system.

[0090] As illustrated in Fig. 1, in an exemplary embodiment, during operation of the system 10, an expandable wellbore casing 100 is coupled to and supported by the casing lock assembly 24 of the system. The system 10 is then positioned within a wellbore 102 that traverses a subterranean formation 104 and includes a preexisting wellbore casing 106.

[0091] As illustrated in Fig. 2, in an exemplary embodiment, the extension actuator

assembly 26 is then operated to move the adjustable bell section expansion cone assembly 28, adjustable casing expansion cone assembly 30, packer setting tool assembly 32, stinger assembly 34, packer assembly 36 downwardly in a direction 108 and out of an end of the expandable wellbore casing 100. After the adjustable bell section expansion cone assembly 28 and adjustable casing expansion cone assembly 30 have been moved to a position out of the end of the expandable wellbore casing 100, the adjustable bell section expansion cone assembly and adjustable casing expansion cone assembly are then operated to increase the outside diameters of the expansion cone assemblies. In an exemplary embodiment, the increased outside diameter of the adjustable bell section expansion cone assembly 28 is greater than the increased outside diameter of the adjustable casing expansion cone assembly 30.

[0092] As illustrated in Fig. 3, in an exemplary embodiment, the ball gripper assembly 16 is then operated to engage and hold the position of the expandable tubular member 100 stationary relative to the tubular support member 12. The tension actuator assembly 18 is then operated to move the adjustable bell section expansion cone assembly 28, adjustable casing expansion cone assembly 30, packer setting tool assembly 32, stinger assembly 34, packer assembly 36 upwardly in a direction 110 into and through the end of the expandable wellbore casing 100. As a result, the end of the expandable wellbore casing 100 is radially expanded and plastically deformed by the adjustable bell section expansion cone assembly 28 to form a bell section 112. In an exemplary embodiment, during the operation of the system 10 described above with reference to Fig. 3, the casing lock assembly 24 may or may not be coupled to the expandable wellbore casing 100.

[0093] In an exemplary embodiment, the length of the end of the expandable wellbore casing 100 that is radially expanded and plastically deformed by the adjustable bell section expansion cone assembly 28 is limited by the stroke length of the tension actuator assembly 18. In an exemplary embodiment, once the tension actuator assembly 18 completes a stroke, the ball gripper assembly 16 is operated to release the expandable tubular member 100, and the tubular support 12 is moved upwardly to permit the tension actuator assembly to be re-set. In this manner, the length of the bell section 112 can be further extended by continuing to stroke and then re-set the position of the tension actuator assembly 18. Note, that, during the upward movement of the tubular support 12 to re-set the position of the tension actuator assembly 18, the expandable tubular wellbore casing 100 is supported by the expansion surfaces of the adjustable bell section expansion cone assembly 28.

[0094] As illustrated in Fig. 4, in an exemplary embodiment, the casing lock assembly 24 is then operated to engage and maintain the position of the expandable wellbore casing 100 stationary relative to the tubular support 12. The adjustable bell section expansion cone assembly 28, adjustable casing expansion cone assembly 30, packer setting tool assembly

32, stinger assembly 34, and packer assembly 36 are displaced downwardly into the bell section 112 in a direction 114 relative to the expandable wellbore casing 100 by operating the extension actuator 26 and/or by displacing the system 10 downwardly in the direction 114 relative to the expandable wellbore casing. After the adjustable bell section expansion cone assembly 28 and adjustable casing expansion cone assembly 30 have been moved downwardly in the direction 114 into the bell section 112 of the expandable wellbore casing 100, the adjustable bell section expansion cone assembly is then operated to decrease the outside diameter of the adjustable bell section expansion cone assembly. In an exemplary embodiment, the decreased outside diameter of the adjustable bell section expansion cone assembly 28 is less than the increased outside diameter of the adjustable casing expansion cone assembly 30. In an exemplary embodiment, during the operation of the system illustrated and described above with reference to Fig. 4, the ball gripper 16 may or may not be operated to engage the expandable wellbore casing 100.

[0095] As illustrated in Fig. 5, in an exemplary embodiment, the casing lock assembly 24 is then disengaged from the expandable wellbore casing 100 and fluidic material 116 is then injected into the system 10 through the tubular support 12 to thereby pressurize an annulus 118 defined within the expandable wellbore casing below the cup sub assembly 22. As a result, a pressure differential is created across the cup seal assembly 22 that causes the cup seal assembly to apply a tensile force in the direction 120 to the system 10. As a result, the system 10 is displaced upwardly in the direction 120 relative to the expandable wellbore casing 100 thereby pulling the adjustable casing expansion cone assembly 30 upwardly in the direction 120 through the expandable wellbore casing thereby radially expanding and plastically deforming the expandable wellbore casing.

[0096] In an exemplary embodiment, the tension actuator assembly 16 may also be operated during the injection of the fluidic material 116 to displace the adjustable casing expansion cone assembly 30 upwardly relative to the tubular support 12. As a result, additional expansion forces may be applied to the expandable wellbore casing 100.

[0097] As illustrated in Fig. 6, in an exemplary embodiment, the radial expansion and plastic deformation of the expandable wellbore casing using the adjustable casing expansion cone assembly 30 continues until the packer assembly 36 is positioned within a portion of the expandable tubular member above the bell section 112. The packer assembly 36 may then be operated to engage the interior surface of the expandable wellbore casing 100 above the bell section 112.

[0098] In an exemplary embodiment, after the packer assembly 36 is operated to engage the interior surface of the expandable wellbore casing 100 above the bell section 112, a hardenable fluidic sealing material 122 may then be injected into the system 10 through the tubular support 12 and then out of the system through the packer assembly to

thereby permit the annulus between the expandable wellbore casing and the wellbore 102 to be filled with the hardenable fluidic sealing material. The hardenable fluidic sealing material 122 may then be allowed to cure to form a fluid tight annulus between the expandable wellbore casing 100 and the wellbore 102, before, during, or after the completion of the radial expansion and plastic deformation of the expandable wellbore casing.

[0099] As illustrated in Fig. 7, in an exemplary embodiment, the fluidic material 116 is then re-injected into the system 10 through the tubular support 12 to thereby re-pressurize the annulus 118 defined within the expandable wellbore casing below the cup sub assembly 22. As a result, a pressure differential is once again created across the cup seal assembly 22 that causes the cup seal assembly to once again apply a tensile force in the direction 120 to the system 10. As a result, the system 10 is displaced upwardly in the direction 120 relative to the expandable wellbore casing 100 thereby pulling the adjustable casing expansion cone assembly 30 upwardly in the direction 120 through the expandable wellbore casing thereby radially expanding and plastically deforming the expandable wellbore casing and disengaging the stinger assembly 34 from the packer assembly 36. In an exemplary embodiment, during this operational mode, the packer assembly 36 prevents the flow of fluidic materials out of the expandable wellbore casing 100. As a result, the pressurization of the annulus 118 is rapid and efficient thereby enhancing the operational efficiency of the subsequent radial expansion and plastic deformation of the expandable wellbore casing 100.

[00100] In an exemplary embodiment, the tension actuator assembly 16 may also be operated during the re-injection of the fluidic material 116 to displace the adjustable casing expansion cone assembly 30 upwardly relative to the tubular support 12. As a result, additional expansion forces may be applied to the expandable wellbore casing 100.

[00101] As illustrated in Fig. 8, in an exemplary embodiment, the radial expansion and plastic deformation of the expandable wellbore casing using the adjustable casing expansion cone assembly 30 continues until the adjustable casing expansion cone assembly 30 reaches the portion 124 of the expandable wellbore casing 100 that overlaps with the preexisting wellbore casing 106. At which point, the system 10 may radially expand the portion 124 of the expandable wellbore casing 100 that overlaps with the preexisting wellbore casing 106 and the surrounding portion of the preexisting wellbore casing. Consequently, in an exemplary embodiment, during the radial expansion of the portion 124 of the expandable wellbore casing 100 that overlaps with the preexisting wellbore casing 106, the tension actuator assembly 16 is also operated to displace the adjustable casing expansion cone assembly 30 upwardly relative to the tubular support 12. As a result, additional expansion forces may be applied to the expandable wellbore casing 100 and the preexisting wellbore casing 106 during the radial expansion of the portion 124 of the expandable wellbore casing that overlaps with the preexisting wellbore casing.

[00102] As illustrated in Fig. 9, in an exemplary embodiment, the entire length of the portion 124 of the expandable wellbore casing 100 that overlaps with the preexisting wellbore casing 106 is not radially expanded and plastically deformed. Rather, only part of the portion 124 of the expandable wellbore casing 100 that overlaps with the preexisting wellbore casing 106 is radially expanded and plastically deformed. The remaining part of the portion 124 of the expandable wellbore casing 100 that overlaps with the preexisting wellbore casing 106 is then cut away by operating the casing cutter assembly 14.

[00103] As illustrated in Fig. 10, the remaining part of the portion 124 of the expandable wellbore casing 100 that overlaps with the preexisting wellbore casing 106 that is cut away by operating the casing cutter assembly 14 is then also carried out of the wellbore 102 using the casing cutter assembly.

[00104] Furthermore, in an exemplary embodiment, the inside diameter of the expandable wellbore casing 100 above the bell section 112 is equal to the inside diameter of the portion of the preexisting wellbore casing 106 that does not overlap with the expandable wellbore casing 100. As a result, a wellbore casing is constructed that includes overlapping wellbore casings that together define an internal passage having a constant cross-sectional area.

[00105] In an exemplary embodiment, one or more of the operational elements of the system 10 may be omitted, at least in part, and/or combined, at least in part, with one or more of the other operational elements of the system.

[00010] In several exemplary embodiments, the system 10 includes one or more of the methods and apparatus disclosed in one or more of the following:

U.S. Patent Nos. 6,968,618; 6,559,821; 6,557,460; 6,604,763; 6,575,240; 6,966,370; 6,712,154; 6,640,903; 6,725,919; 6,892,819; 6,328,113; 6,823,937; 6,568,471; 6,739,392; 6,745,845; 6,758,278; 6,857,473; 6,497,289; 7,011,161; 7,021,390; 6,604,763; 6,564,875; 6,695,012; 7,048,067; 7,100,684; 7,172,024; 7,185,710; 7,100,685; 6,470,966; 6,521,227; 6,631,760; 7,240,728; 6,634,431; 6,705,395; 6,631,759; 6,631,769; 7,063,142; 6,684,947; 7,055,608; 7,044,221; 7,040,396; 7,048,062; 7,086,475; 7,077,213; 7,036,582; 7,044,218; 7,159,665; 7,108,061; 7,108,072; 7,121,352; 6,550,821; U.S. Publication Nos. 2004/0244968; 2002/0100595; 2003/0107217; 2004/0123988; 2003/0192705; 2003/0222455; and WO 01/04535; WO 02/66783; WO 03/23178; WO 03/16669; WO 03/29607; WO 03/04819; WO 03/23179; WO 03/58022; WO 03/71086; WO 03/42486; WO 03/42487; WO 03/102365; WO 04/03337; WO 03/086675; WO 03/078785; WO 03/089161; WO 04/010039; WO 03/093623; WO 03/059549; WO 03/104601; WO 03/106130; WO 04/11776; WO 04/09950; WO 04/20895.

[00106] In an exemplary embodiment, the casing cutter assembly 14 is provided and operates substantially, at least in part, as disclosed in one or more of the following: WO 04/027204 and WO 04/081346.

[00107] In an exemplary embodiment, as illustrated in Figs. 11-1 and 11-2, 11A1 to 11A2, 11B1 to 11B2, 11C, 11D, 11E, 11F, 11G, 11H, 11I, 11j, 11K, 11L, 11M, 11N, 11O, 11P, 11Q, 11R, 11S, 11T, 11U, 11V, 11W, 11X, 11Y, 11Z1 to 11Z4, 11AA1 to 11AA4, 11AB1 to 11AB4, 11AC1 to 11AC4, 11AD, and 11AE, the casing cutter assembly 14 includes an upper tubular tool joint 14002 that defines a longitudinal passage 14002a and mounting holes, 14002b and 14002c, and includes an internal threaded connection 14002d, an inner annular recess 14002e, an inner annular recess 14002f, and an internal threaded connection 14002g. A tubular torque plate 14004 that defines a longitudinal passage 14004a and includes circumferentially spaced apart teeth 14004b is received within, mates with, and is coupled to the internal annular recess 14002e of the upper tubular tool joint 14002.

[00108] Circumferentially spaced apart teeth 14006a of an end of a tubular lower mandrel 14006 that defines a longitudinal passage 14006b, a radial passage 14006ba, and a radial passage 14006bb and includes an external threaded connection 14006c, an external flange 14006d, an external annular recess 14006e having a step 14006f at one end, an external annular recess 14006g, external teeth 14006h, an external threaded connection 14006i, and an external annular recess 14006j engage the circumferentially spaced apart teeth 14004b of the tubular torque plate 14004. An internal threaded connection 14008a of an end of a tubular toggle bushing 14008 that defines a longitudinal passage 14008b, an upper

longitudinal slot 14008c , a lower longitudinal slot 14008d, mounting holes, 14008e, 14008f, 14008g, 14008h, 14008i, 14008j, 14008k, 14008l, 14008m, 14008n, 14008o, 14008p, 14008q, 14008r, 14008s, 14008t, 14008u, 14008v, 14008w, 14008x, 14008xa, and 14008xb, and includes an external annular recess 14008y, internal annular recess 14008z, external annular recess 14008aa, and an external annular recess 14008ab receives and is coupled to the external threaded connection 14006c of the tubular lower mandrel 14006.

[00109] A sealing element 14010 is received within the external annular recess 14008y of the tubular toggle bushing 14008 for sealing the interface between the tubular toggle bushing and the upper tubular tool joint 14002. A sealing element 14012 is received within the internal annular recess 14008z of the tubular toggle bushing 14008 for sealing the interface between the tubular toggle bushing and the tubular lower mandrel 14006.

[00110] Mounting screws, 14014a and 14014b, mounted within and coupled to the mounting holes, 14008w and 14008x, respectively, of the tubular toggle bushing 14008 are also received within the mounting holes, 14002b and 14002c, of the upper tubular tool joint 14002. Mounting pins, 14016a, 14016b, 14016c, 14016d, and 14016e, are mounted within the mounting holes, 14008e, 14008f, 14008g, 14008h, and 14008i, respectively. Mounting pins, 14018a, 14018b, 14018c, 14018d, and 14018e, are mounted within the mounting holes, 14008t, 14008s, 14008r, 14008q, and 14008p, respectively. Mounting screws, 14020a and 14020b, are mounted within the mounting holes, 14008u and 14008v, respectively.

[00111] A first upper toggle link 14022 defines mounting holes, 14022a and 14022b, for receiving the mounting pins, 14016a and 14016b, and includes a mounting pin 14022c at one end. A first lower toggle link 14024 defines mounting holes, 14024a, 14024b, and 14024c, for receiving the mounting pins, 14022c, 14016c, and 14016d, respectively and includes an engagement arm 14024d. A first trigger 14026 defines a mounting hole 14026a for receiving the mounting pin 14016e and includes an engagement arm 14026b at one end, an engagement member 14026c, and an engagement arm 14026d at another end.

[00112] A second upper toggle link 14028 defines mounting holes, 14028a and 14028b, for receiving the mounting pins, 14018a and 14018b, and includes a mounting pin 14028c at one end. A second lower toggle link 14030 defines mounting holes, 14030a, 14030b, and 14030c, for receiving the mounting pins, 14028c, 14018c, and 14018d, respectively and includes an engagement arm 14030d. A second trigger 14032 defines a mounting hole 14032a for receiving the mounting pin 14018e and includes an engagement arm 14032b at one end, an engagement member 14032c, and an engagement arm 14032d at another end.

[00113] An end of a tubular spring housing 14034 that defines a longitudinal passage 14034a, mounting holes, 14034b and 14034c, and mounting holes, 14034ba and 14034ca, and includes an internal flange 14034d and an internal annular recess 14034e at one end,

and an internal flange 14034f, an internal annular recess 14034g, an internal annular recess 14034h, and an external threaded connection 14034i at another end receives and mates with the end of the tubular toggle bushing 14008. Mounting screws, 14035a and 14035b, are mounted within and coupled to the mounting holes, 14008xb and 14008xa, respectively, of the tubular toggle bushing 14008 and are received within the mounting holes, 14034ba and 14034ca, respectively, of the tubular spring housing 14034.

[00114] A tubular retracting spring ring 14036 that defines mounting holes, 14036a and 14036b, receives and mates with a portion of the tubular lower mandrel 14006 and is received within and mates with a portion of the tubular spring housing 14034. Mounting screws, 14038a and 14038b, are mounted within and coupled to the mounting holes, 14036a and 14036b, respectively, of the tubular retracting spring ring 14036 and extend into the mounting holes, 14034b and 14034c, respectively, of the tubular spring housing 14034.

[00115] Casing diameter sensor springs, 14040a and 14040b, are positioned within the longitudinal slots, 14008c and 1408d, respectively, of the tubular toggle bushing 14008 that engage the engagement members, 14026c and 14032c, and engagement arms,14026d and 14032d, of the first and second triggers, 14026 and 14032, respectively. An inner flange 14042a of an end of a tubular spring washer 14042 mates with and receives a portion of the tubular lower mandrel 14006 and an end face of the inner flange of the tubular spring washer is positioned proximate and end face of the external flange 14006d of the tubular lower mandrel. The tubular spring washer 14042 is further received within the longitudinal passage 14034a of the tubular spring housing 14034.

[00116] An end of a retracting spring 14044 that receives the tubular lower mandrel 14006 is positioned within the tubular spring washer 14042 in contact with the internal flange 14042a of the tubular spring washer and the other end of the retracting spring is positioned in contact with an end face of the tubular retracting spring ring 14036.

[00117] A sealing element 14046 is received within the external annular recess 14006j of the tubular lower mandrel 14006 for sealing the interface between the tubular lower mandrel and the tubular spring housing 14034. A sealing element 14048 is received within the internal annular recess 14034h of the tubular spring housing 14034 for sealing the interface between the tubular spring housing and the tubular lower mandrel 14006.

[00118] An internal threaded connection 14050a of an end of a tubular upper hinge sleeve 14050 that includes an internal flange 14050b and an internal pivot 14050c receives and is coupled to the external threaded connection 14034i of the end of the tubular spring housing 14034.

[00119] An external flange 14052a of a base member 14052b of an upper cam assembly 14052, that is mounted upon and receives the lower tubular mandrel 14006, that includes an internal flange 14052c that is received within the external annular recess 14006e of the

lower tubular mandrel 14006 and a plurality of circumferentially spaced apart cam arms 14052d extending from the base member mates with and is received within the tubular upper hinge sleeve 14050. The base member 14052b of the upper cam assembly 14052 further includes a plurality of circumferentially spaced apart teeth 14052f that mate with and are received within a plurality of circumferentially spaced apart teeth 14034j provided on the end face of the tubular spring housing 14034 and an end face of the external flange 14052a of the base member of the upper cam assembly is positioned in opposing relation to an end face of the internal flange 14050b of the tubular upper hinge sleeve 14050. Each of the cam arms 14052d of the upper cam assembly 14052 include external cam surfaces 14052e. In an exemplary embodiment, the teeth 14052f of the base member 14052b of the upper cam assembly 14052 and the teeth 14034j provided on the end face of the tubular spring housing 14034 permit torsional loads to be transmitted between the tubular spring housing and the upper cam assembly.

[00120] A plurality of circumferentially spaced apart upper casing cutter segments 14054 are mounted upon and receive the lower tubular mandrel 14006 and each include an external pivot recess 14054a for mating with and receiving the internal pivot 14050c of the tubular upper hinge sleeve 14050 and an external flange 14054b and are pivotally mounted within the tubular upper hinge sleeve and are interleaved with the circumferentially spaced apart cam arms 14052d of the upper cam assembly 14052. A casing cutter element 14056 is coupled to and supported by the upper surface of each upper casing cutter segments 14054 proximate the external flange 14054b.

[00121] A plurality of circumferentially spaced apart lower casing cutter segments 14058 are mounted upon and receive the lower tubular mandrel 14006, are interleaved among the upper casing cutter segments 14054, are oriented in the opposite direction to the upper casing cutter segments 14054, each include an external pivot recess 14058a, and are positioned in opposing relation to corresponding circumferentially spaced apart cam arms 14052d of the upper cam assembly 14052.

[00122] A lower cam assembly 14060 is mounted upon and receives the lower tubular mandrel 14006 that includes a base member 14060a having an external flange 14060b, a plurality of circumferentially spaced apart cam arms 14060d that extend from the base member that each include external cam surfaces 14060e and define mounting holes 14060f and 14060g. The base member 14060a of the lower cam assembly 14060 further includes a plurality of circumferentially spaced apart teeth 14060h. The circumferentially spaced apart cam arms 14060d of the lower cam assembly 14060 are interleaved among the lower casing cutter segments 14058 and the circumferentially spaced apart cam arms 14052d of the upper cam assembly 14052 and positioned in opposing relation to corresponding upper casing cutter segments 14054.

[00123] Mounting screws, 14062a, 14062b, 14062c, and 14062e, are mounted within the corresponding mounting holes, 14060f and 14060g, of the lower cam assembly 14060 and are received within the external annular recess 14006g of the lower cam assembly 14060.

[00124] A tubular lower hinge sleeve 14064 that receives the lower casing cutter segments 14058 and the lower cam assembly 14060 includes an internal flange 14064a for engaging the external flange 14060b of the base member of the lower cam assembly 14060, an internal pivot 14064b for engaging and receiving the external pivot recess 14058a of the lower casing cutter segments 14058 thereby pivotally mounting the lower casing cutter segments within the tubular lower hinge sleeve, and an internal threaded connection 14064c.

[00125] An external threaded connection 14066a of an end of a tubular sleeve 14066 that defines mounting holes, 14066b and 14066c, and includes an internal annular recess 14066d having a shoulder 14066e, an internal flange 14066f, and an internal threaded connection 14066g at another end is received within and coupled to the internal threaded connection 14064c of the tubular lower hinge sleeve 14064. An external threaded connection 14068a of an end of a tubular member 14068 that defines a longitudinal passage 14068b and mounting holes, 14068c and 14068d, and includes an external annular recess 14068e, and an external threaded connection 14068f at another end is received within and is coupled to the internal threaded connection 14066g of the tubular sleeve 14066.

[00126] Mounting screws, 14070a and 14070b, are mounted in and coupled to the mounting holes, 14068c and 14068d, respectively, of the tubular member 14068 that also extend into the mounting holes, 14066b and 14066c, respectively, of the tubular sleeve 14066. A sealing element 14072 is received within the external annular recess 14068e of the tubular member 14068 for sealing the interface between the tubular member and the tubular sleeve 14066.

[00127] An internal threaded connection 14074a of a tubular retracting piston 14074 that defines a longitudinal passage 14074b and includes an internal annular recess 14074c and an external annular recess 14074d receives and is coupled to the external threaded connection 14006i of the tubular lower mandrel 14006. A sealing element 14076 is received within the external annular recess 14074d of the tubular retracting piston 14074 for sealing the interface between the tubular retracting piston and the tubular sleeve 14066. A sealing element 14078 is received within the internal annular recess 14074c of the tubular retracting piston 14074 for sealing the interface between the tubular retracting piston and the tubular lower mandrel 14006.

[00128] Locking dogs 14080 mate with and receive the external teeth 14006h of the tubular lower mandrel 14006. A spacer ring 14082 is positioned between an end face of the locking dogs 14080 and an end face of the lower cam assembly 14060. A release piston

14084 mounted upon the tubular lower mandrel 14006 defines a radial passage 14084a for mounting a burst disk 14086 includes sealing elements, 14084b, 14084c, and 14084d. The sealing elements, 14084b and 14084d, sealing the interface between the release piston 14084 and the tubular lower mandrel 14006. An end face of the release piston 14084 is positioned in opposing relation to an end face of the locking dogs 14080.

[00129] A release sleeve 14088 that receives and is mounted upon the locking dogs 14080 and the release piston 14084 includes an internal flange 14088a at one end that sealingly engages the tubular lower mandrel 14006. A bypass sleeve 14090 that receives and is mounted upon the release sleeve 14088 includes an internal flange 14090a at one end.

[00130] In an exemplary embodiment, during operation of the casing cutter assembly 14, the retracting spring 14044 is compressed and thereby applies a biasing spring force in a direction 14092 from the lower tubular mandrel 14006 to the tubular spring housing 14034 that, in the absence of other forces, moves and/or maintains the upper cam assembly 14052 and the upper casing cutter segments 14054 out of engagement with the lower casing cutter segments 14058 and the lower cam assembly 14060. In an exemplary embodiment, during operation of the casing cutter assembly 14, an external threaded connection 12a of an end of the tubular support member 12 is coupled to the internal threaded connection 14002d of the upper tubular tool joint 14002 and an internal threaded connection 16a of an end of the ball gripper assembly 16 is coupled to the external threaded connection 14068f of the tubular member 14068.

[00131] The upper cam assembly 14052 and the upper casing cutter segments 14054 may be brought into engagement with the lower casing cutter segments 14058 and the lower cam assembly 14060 by pressurizing an annulus 14094 defined between the lower tubular mandrel 14006 and the tubular spring housing 14034. In particular, injection of fluidic materials into the cam cutter assembly 14 through the longitudinal passage 14006b of the lower tubular mandrel 14006 and into the radial passage 14006ba may pressurize the annulus 14094 thereby creating sufficient operating pressure to generate a force in a direction 14096 sufficient to overcome the biasing force of the retracting spring 14044. As a result, the spring housing 14034 may be displaced in the direction 14096 relative to the lower tubular mandrel 14006 thereby displacing the tubular upper hinge sleeve 14050, upper cam assembly 14052 , and upper casing cutter segments 14054 in the direction 14096.

[00132] In an exemplary embodiment, as illustrated in Figs. 11P, 11Q and 11R, the displacement of the upper cam assembly 14052 and upper casing cutter segments 14054 in the direction 14096 will cause the lower casing cutter segments 14058 to ride up the cam surfaces of the cam arms of the upper cam assembly 14052 while also pivoting about the lower tubular hinge segment 14064, and will also cause the upper casing cutter segments

14054 to ride up the cam surfaces of the cam arms of the lower cam assembly 14060 while also pivoting about the upper tubular hinge segment 14050.

[00133] In an exemplary embodiment, during the operation of the casing cutter assembly 14, when the upper and lower casing cutter segments, 14054 and 14058, brought into axial alignment in a radially expanded position, the casing cutter elements of the casing cutter segments are brought into intimate contact with the interior surface of a pre-selected portion of the expandable wellbore casing 100. The casing cutter assembly 14 may then be rotated to thereby cause the casing cutter elements to cut through the expandable wellbore casing. The portion of the expandable wellbore casing 100 cut away from the remaining portion on the expandable wellbore casing may then be carried out of the wellbore 102 with the cut away portion of the expandable wellbore casing supported by the casing cutter elements.

[00134] In an exemplary embodiment, the upper cam assembly 14052 and the upper casing cutter segments 14054 may be moved out of engagement with the lower casing cutter segments 14058 and the lower cam assembly 14060 by reducing the operating pressure within the annulus 14094.

[00135] In an alternative embodiment, as illustrated in Figs. 11S, 11T, 11U and 11V, during operation of the casing cutter assembly 14, the upper cam assembly 14052 and the upper casing cutter segments 14054 may also be moved out of engagement with the lower casing cutter segments 14058 and the lower cam assembly 14060 by sensing the operating pressure within the longitudinal passage 14006b of the lower tubular mandrel 14006. In particular, as illustrated in Fig. 11T, if the operating pressure within the longitudinal passage 14006b and radial passage 14006bb of the lower tubular mandrel 14006 exceeds a predetermined value, the burst disc 14086 will open the passage 14084a thereby pressurizing the interior of the tubular release sleeve 14088 thereby displacing the tubular release sleeve 14088 downwardly in a direction 14092 away from engagement with the locking dogs 14080.

[00136] As a result, as illustrated in Fig. 11U, the locking dogs 14080 are displaced outwardly in the radial directed and thereby released from engagement with the lower tubular mandrel 14006 thereby permitting the lower casing cutter segments 14058 and the lower cam assembly 14060 to be displaced downwardly relative to the lower tubular mandrel.

[00137] As a result, as illustrated in Fig. 11V, the operating pressure within the lower tubular mandrel 14066 may then cause the lower tubular mandrel to be displaced downwardly in the direction 14094 relative to the tubular lower mandrel 14006 and the retracting piston 14074. As a result, the lower tubular mandrel 14066, the lower casing cutter segments 14058, the lower cam assembly 14060, and tubular lower hinge sleeve 14064 are displaced downwardly in the direction 14094 relative to the tubular spring housing

14034 thereby moving the lower casing cutter segments 14058 and the lower cam assembly 14060 out of engagement with the upper cam assembly 14052 and the upper casing cutter segments 14054.

[00138] In an exemplary embodiment, as illustrated in Figs. 11W, 11X, and 11Y, during operation of the casing cutter assembly 14, the casing cutter assembly 14 senses the diameter of the expandable wellbore casing 100 using the upper toggle links, 14022 and 14028, lower toggle links, 14024 and 14030, and triggers, 14026 and 14032, and then prevents the engagement of the upper cam assembly 14052 and the upper casing cutter segments 14054 with the lower casing cutter segments 14058 and the lower cam assembly 14060.

[00139] In particular, as illustrated in Fig. 11W, anytime the upper toggle links, 14022 and 14028, and lower toggle links, 14024 and 14030, are positioned within a portion of the expandable wellbore casing 100 that has been radially expanded and plastically deformed by the system 10, the triggers, 14026 and 14032, will be pivoted by the engagement arms, 14024d and 14030d, of the lower toggle links, 14024 and 14030, to a position in which the triggers will no longer engage the internal flange 14034d of the end of the tubular spring housing 14034 thereby permitting the displacement of the tubular spring housing in the direction 14096. As a result, the upper cam assembly 14052 and the upper casing cutter segments 14054 can be brought into engagement with the lower casing cutter segments 14058 and the lower cam assembly 14060. In an exemplary embodiment, the upper toggle links, 14022 and 14028, and the lower toggle links, 14024 and 14030, are spring biased towards the position illustrated in Fig. 11W.

[00140] Conversely, as illustrated in Fig. 11X, anytime the upper toggle links, 14022 and 14028, and lower toggle links, 14024 and 14030, are positioned within a portion of the expandable wellbore casing 100 that has not been radially expanded and plastically deformed by the system 10, the triggers, 14026 and 14032, will be maintained in a position in which the triggers will engage the internal flange 14034d of the end of the tubular spring housing 14034 thereby preventing the displacement of the tubular spring housing in the direction 14096. As a result, the upper cam assembly 14052 and the upper casing cutter segments 14054 cannot be brought into engagement with the lower casing cutter segments 14058 and the lower cam assembly 14060. In an exemplary embodiment, the triggers, 14026 and 14032, are spring biased towards the position illustrated in Fig. 11X.

[00141] In an exemplary embodiment, as illustrated in Fig. 11Y, the tubular spring housing 14034 may be displaced upwardly in the direction 14098 even if the upper toggle links, 14022 and 14028, and lower toggle links, 14024 and 14030, are positioned within a portion of the expandable wellbore casing 100 that has not been radially expanded and plastically deformed by the system 10.

[00142] In an exemplary embodiment, as illustrated in Figs. 11Z1 to 11Z4, 11AA1 to 11AA4, 11AB1 to 11AB4, 11AC1 to 11AC4, 11AD, and 11AE, the tubular spring housing 14034 of the casing cutter assembly 14 defines internal annular recesses 14034k and 14034l, spaced apart by an internal flange 14034m, the tubular toggle bushing 14008 defines an external annular recess 14008ac, and the casing cutter assembly further includes pins, 14100a and 14100b and 14102a and 14102b, mounted in holes 14008j and 14008o and 14008k and 14008n, respectively, of the tubular toggle bushing, and a one-shot deactivation device 14104 mounted on the tubular toggle bushing between the pins, 14100a and 14100b and 14102a and 14102b.

[00143] The one-shot deactivation device 14104 includes a tubular body 14104a that defines radial holes, 14104b and 14014c, and includes an external annular recess 14104d at one end, a centrally positioned external flange 14104e, a centrally positioned internal annular recess 14104f, and an external annular recess 14104g at another end. An engagement member 14106 that includes a base member 14106a having a tapered end 14106b and a key member 14106c having a tapered end 14106d is received within a portion of the internal annular recess 14104f of the tubular body 14104a and an engagement member 14108 that includes a base member 14108a having a tapered end 14108b and a key member 14108c having a tapered end 14108d is received within an opposite portion of the internal annular recess 14104f of the tubular body 14104a. Spring members, 14110 and 14112, are received within the annular recess 14104f of the tubular body 14104a for biasing the base members, base member 14106a and 14108a, of the engagement members, 14106 and 14108, respectively, radially inwardly relative to the tubular body 14104a.

[00144] In an exemplary embodiment, during operation of the casing cutter assembly 14, as illustrated in Figs. 11Z1 to 11Z4, the one-shot deactivation device 14104 are positioned proximate and in intimate contact with the pins, 14102a and 14102b, with the tapered ends, 14106b and 14108b, of the base members, 14106a and 14108a, of the engagement members, 14106 and 14108, received within the external annular recess 14008ac of the tubular toggle bushing 14008. When the one-shot deactivation device 14104 is positioned as illustrated in Fig. 11Z, the external annular recess 14104d of the tubular body 14104a of the one-shot deactivation device is moved out of engagement with the engagement arms, 14026d and 14032d, of the triggers, 14026 and 14032, respectively. As a result, the triggers, 14026 and 14032, may operate normally as described above with reference to Figs. 11W, 11X, and 11Y.

[00145] Conversely, in an exemplary embodiment, during operation of the casing cutter assembly 14, as illustrated in Figs. 11AA1 to 11AA4, the one-shot deactivation device 14104 are positioned proximate and in intimate contact with the pins, 14100a and 14100b, with the tapered ends, 14106b and 14108b, of the base members, 14106a and 14108a, of

the engagement members, 14106 and 14108, not received within the external annular recess 14008ac of the tubular toggle bushing 14008. When the one-shot deactivation device 14104 is positioned as illustrated in Figs. 11AA1 to 11AA4, the external annular recess 14104d of the tubular body 14104a of the one-shot deactivation device is moved into engagement with the engagement arms, 14026d and 14032d, of the triggers, 14026 and 14032, respectively. As a result, the triggers, 14026 and 14032, are deactivated and may not operate normally as described above with reference to Figs. 11W, 11X, and 11Y.

[00146] In an alternative embodiment, the elements of the casing cutter assembly 14 that sense the diameter of the expandable wellbore casing 100 may be disabled or omitted or adjusted to sense any pre-selected internal diameter of the expandable wellbore casing.

[00147] In an exemplary embodiment, the ball gripper assembly 16 is provided and operates substantially, at least in part, as disclosed in one or more of the following: WO 04/027205; WO 03/093623 and WO 04/081346.

[00148] In an exemplary embodiment, as illustrated in Figs. 12A1 to 12A4, 12B and 12C1 to 12C4, the ball gripper assembly 16 includes an upper mandrel 1602 that defines a longitudinal passage 1602a and a radial passage 1602b and includes an internal threaded connection 1602c at one end, an external flange 1602d at an intermediate portion that includes an external annular recess 1602e having a shoulder 1602f and an external radial hole 1602g, an external annular recess 1602h, an external annular recess 1602i, an external annular recess 1602j having a tapered end 1602k including an external annular recess 1602ka, an external annular recess 1602l, and an external annular recess 1602m, and an external annular recess 1602n, an external radial hole 1602o, an external annular recess 1602p, and an external annular recess 1602q at another end.

[00149] An upper tubular bushing 1604 defines an internally threaded radial opening 1604a and includes an external flange 1604b having an external annular recess 1604c and an internal annular recess 1604d mates with and receives the external flange 1602d of the upper mandrel 1602. In particular, the internal annular recess 1604d of the upper tubular

bushing 1604 mates with the shoulder 1602f of the external annular recess 1602e of the upper mandrel 1602. A screw 1606 that is threadably coupled to the internally threaded radial opening 1604a of the upper tubular bushing 1604 extends into the external radial hole 1602g of the external flange 1602d of the upper mandrel 1602.

[00150] A deactivation tubular sleeve 1608 defines a radial passage 1608a and includes an internal annular recess 1608b that mates with and receives an end of the external annular recess 1604c of the external flange 1604b of the upper tubular bushing 1604, an internal annular recess 1608c that mates with and receives the external flange 1602d of the upper mandrel 1602, an internal annular recess 1608d, an internal annular recess 1608e, and an internal annular recess 1608f. A deactivation spring 1610 is received within an annulus 1612 defined between the internal annular recess 1608b of the deactivation tubular sleeve 1608, an end face of the external annular recess 1604c of the external flange 1604b of the upper tubular bushing 1604, and the external annular recess 1602h of the external flange 1602d of the upper mandrel 1602.

[00151] A sealing member 1614 is received with the external annular recess 1602i of the external flange 1602d of the upper mandrel 1602 for sealing the interface between the upper mandrel and the deactivation tubular sleeve 1608. An annular spacer element 1616 is received within the external annular recess 1602ka of the tapered end 1602k of the external annular recess 1602j of the upper mandrel 1602.

[00152] One or more inner engagement elements 1618a of a tubular coglet 1618 engage and are received within the external annular recess 1602ka of the tapered end 1602k of the external annular recess 1602j of the upper mandrel 1602 and one or more outer engagement elements 1618b of the coglet engage and are received within the internal annular recess 1608d of the deactivation tubular sleeve 1608.

[00153] An external annular recess 1620a of an end of a tubular coglet prop 1620 that includes an inner flange 1620b receives and mates with the inner surfaces of the outer engagement elements 1618b of the coglet 1618. The end of the tubular coglet prop 1620 further receives and mates with the external annular recess 1602j of the external flange 1602d of the upper mandrel 1602. A sealing element 1622 is received within the external annular recess 1602l of the upper mandrel 1602 for sealing the interface between the upper mandrel and the tubular coglet prop 1620.

[00154] An end of a tubular bumper sleeve 1624 that includes internal and external flanges, 1624a and 1624b, and a hole 1624c at another end mates with and receives the external annular recess 1602m of the external flange 1602d of the upper mandrel 1602. A coglet spring 1626 is received within an annulus 1628 defined between the external annular recess 1602m of the external flange 1602d of the upper mandrel 1602, the tubular coglet prop 1620, the inner flange 1620b of the tubular coglet prop, an end face of the tubular

bumper sleeve 1624, and the internal annular recess 1608c of the deactivation tubular sleeve 1608.

[00155] A tubular ball race 1628 that defines a plurality of tapered annular recesses 1628a and an internally threaded radial opening 1628b and includes one or more axial engagement elements 1628c at one end and one or more axial engagement elements 1628d at another end receives and mates with the other end of the upper mandrel 1602. In an exemplary embodiment, the axial engagement elements 1628c of the tubular ball race 1628 are received within and are coupled to the hole 1624c of the tubular bumper sleeve 1624. An end of a tubular activation sleeve 1630 that defines a plurality of radial openings 1630a, a radial opening 1630b, a radial opening 1630c, and includes an internal annular recess 1630d receives and mates with the tubular ball race 1628. In an exemplary embodiment, an end face of an end of the tubular activation sleeve 1630 is positioned proximate and in opposing relation to an end face of an end of the deactivation sleeve 1608. In an exemplary embodiment, the radial openings 1630a are aligned with and positioned in opposing relation to corresponding of tapered annular recesses 1628a of the tubular ball race 1628, and the radial openings are also narrowed in cross section in the radial direction for reasons to be described.

[00156] Balls 1632 are received within each of the of tapered annular recesses 1628a and corresponding radial openings 1630a of the tubular ball race 1628 and tubular activation sleeve 1630, respectively. In an exemplary embodiment, the narrowed cross sections of the radial openings 1630a of the tubular activation sleeve 1630 will permit the balls 1632 to be displaced outwardly in the radial direction until at least a portion of the balls extends beyond the outer perimeter of the tubular activation sleeve to thereby permit engagement of the balls with an outer structure such as, for example, a wellbore casing.

[00157] A lower mandrel 1634 that defines a longitudinal passage 1634a and an internally threaded radial passage 1634b at one end and includes internal annular recesses, 1634c and 1634d, for receiving and mating with the external annular recesses, 1602p and 1602q, of the upper mandrel 1602, an internal annular recess 1634e, an external flange 1634f, and an externally threaded connection 1634g at another end. In an exemplary embodiment, as illustrated in Fig. 12B, the end of the lower mandrel 1634 further includes longitudinal recesses 1634h for receiving and mating with corresponding axial engagement elements 1628d of the tubular ball race 1628. A sealing element 1635 is received within the internal annular recess 1634d of the lower mandrel 1634 for sealing an interface between the lower mandrel and the external annular recess 1602p of the upper mandrel 1602.

[00158] A tubular spring retainer 1636 that defines a radial passage 1636a and includes an external annular recess 1636b at one end mates with and receives the end of the lower mandrel 1634 and is positioned proximate an end face of the external flange 1634f

of the lower mandrel. A tubular spring retainer 1638 receives and mates with the end of the lower mandrel 1634 and is received and mates with the internal annular recess 1630d of the tubular activation sleeve 1630.

[00159] An activation spring 1640 is received within an annulus 1642 defined an end face of the tubular spring retainer 1638, an end face of the spring retainer 1636, the internal annular recess 1630d of the tubular activation sleeve 1630, and the end of the lower mandrel 1634. A retainer screw 1642 is received within and is threadably coupled to the internally threaded radial opening 1634b of the lower mandrel 1634 that also extends into the external radial hole 1602o of the upper mandrel 1602.

[00160] During operation of the ball gripper assembly 16, in an exemplary embodiment, as illustrated in Figs. 12A1 to 12A4, the ball gripper assembly may be positioned within the expandable wellbore casing 100 and the internally threaded connection 1602c of the upper mandrel 1602 may be coupled to an externally threaded connection 14a of an end of the casing cutter assembly 14 and the externally threaded connection 1634g of the lower mandrel 1634 may be coupled to an internally threaded connection 18a of an end of the tension actuator assembly 18.

[00161] In an alternative embodiment, the internally threaded connection 1602c of the upper mandrel 1602 may be coupled to an externally threaded connection of an end of the tension actuator assembly 18 and the externally threaded connection 1634g of the lower mandrel 1634 may be coupled to an internally threaded connection of an end of casing cutter assembly 14.

[00162] In an exemplary embodiment, the deactivation spring 1610 has a greater spring rate than the activation spring 1640. As a result, in an initial operating mode, as illustrated in Figs. 12A1 to 12A4, a biasing spring force is applied to the deactivation sleeve 1608 and activation sleeve 1630 in a direction 1644 that maintains the activation sleeve in a position relative to the tubular ball race 1628 that maintains the balls 1632 within the radially inward portions of the corresponding tapered annular recesses 1628a of the tubular ball race such that the balls do not extend beyond the perimeter of the activation sleeve to engage the expandable wellbore casing 100.

[00163] As illustrated in Figs. 12C1 to 12C4, in an exemplary embodiment, the ball gripper 16 may be operated to engage the interior surface of the expandable wellbore casing 100 by injecting a fluidic material 1650 into the ball gripper assembly through the longitudinal passages 1602a and 1634aa, of the upper and lower mandrels, 1602 and 1634, respectively.

[00164] In particular, when the longitudinal and radial passages, 1602a and 1602b, respectively, of the upper mandrel 1602 are pressurized by the injection of the fluidic material 1650, the internal annular recess 1608c of the deactivation tubular sleeve 1608 is

pressurized. When the operating pressure of the fluidic material 1650 within the internal annular recess 1608c of the deactivation tubular sleeve 1608 is sufficient to overcome the biasing spring force of the deactivation spring 1610, the deactivation tubular sleeve is displaced in a direction 1652. As a result, the spring force provided by the activation spring 1640 then may displace the activation tubular sleeve 1630 in the direction 1652 thereby moving the balls 1632 on the corresponding tapered annular recesses 1628a of the tubular ball race 1628 outwardly in a radial direction into engagement with the interior surface of the expandable wellbore casing 100. In an exemplary embodiment, the operating pressure of the fluidic material 1650 sufficient to overcome the biasing spring force of the deactivation spring 1610 was about 100 psi.

[00165] In an exemplary embodiment, when the operating pressure of the fluidic material 1650 is reduced, the operating pressure of the fluidic material 1650 within the internal annular recess 1608c of the deactivation tubular sleeve 1608 is no longer sufficient to overcome the biasing spring force of the deactivation spring 1610, and the deactivation tubular sleeve and the activation tubular sleeve 1630 are displaced in a direction opposite to the direction 1652 thereby moving the balls 1632 radially inwardly and out of engagement with the interior surface of the expandable wellbore casing 100.

[00166] In an exemplary embodiment, the ball gripper assembly 16 is operated to engage the interior surface of the expandable wellbore casing 100 in combination with the operation of the tension actuator assembly 18 to apply an upward tensile force to one or more elements of the system 10 coupled to and positioned below the tension actuator assembly. As a result, a reaction force comprising a downward tensile force is applied to the lower mandrel 1634 of the ball gripper assembly 16 in a direction opposite to the direction 1652 during the operation of the tension actuator assembly 18. Consequently, due to the geometry of the tapered 1628a of the tubular ball race 1628, the balls 1632 are driven up the tapered annular recesses 1628a of the tubular ball race 1628 with increased force and the contact force between the balls 1632 and the interior surface of the expandable wellbore casing 100 is significantly increased thereby correspondingly increasing the gripping force and effect of the ball gripper assembly.

[00167] In an exemplary embodiment, the ball gripper assembly 16 may be operated to radially expand and plastically deform discrete portions of the expandable wellbore casing 100 by controlling the amount of contact force applied to the interior surface of the expandable wellbore casing by the balls 1632 of the ball gripper assembly. In an experimental test of an exemplary embodiment of the ball gripper assembly 16, an expandable wellbore casing was radially expanded and plastically deformed. This was an unexpected result.

[00168] In an exemplary embodiment, the tension actuator assembly 18 operates and is

provided substantially, at least in part, as disclosed in one or more of the following: WO 03/042487; WO 04/027205; WO 03/093623; WO 04/027200 and WO 04/081346.

[00169] In an exemplary embodiment, as illustrated in Figs. 13A1 to 13A8 and 13B1 to 13B7, the tension actuator assembly 18 includes an upper tubular support member 18002 that defines a longitudinal passage 18002a, and external internally threaded radial openings, 18002b and 18002c, and an external annular recess 18002d and includes an internally threaded connection 18002e at one end and an external flange 18002f, an external annular recess 18002g having an externally threaded connection, and an internal annular recess 18002h having an internally threaded connection at another end. An end of a tubular actuator barrel 18004 that defines radial passages, 18004a and 18004b, at one end and radial passages, 18004c and 18004d, includes an internally threaded connection 18004e at one end that mates with, receives, and is threadably coupled to the external annular recess 18002g of the upper tubular support member 18002 and abuts and end face of the external flange 18002f of the upper tubular support member and an internally threaded connection 18004f at another end.

[00170] Torsional locking pins, 18006a and 18006b, are coupled to and mounted within the external radial mounting holes, 18002b and 18002c, respectively, of the upper tubular support member and received within the radial passages, 18004a and 18004b, of the end of the tubular actuator barrel 18004. The other end of the tubular actuator barrel 18004 receives and is threadably coupled to an end of a tubular barrel connector 18008 that defines an internal annular recess 18008a, external radial mounting holes, 18008b and 18008c, radial passages, 18008d and 18008e, and external radial mounting holes, 18008f and 18008g and includes circumferentially spaced apart teeth 18008h at one end. A sealing cartridge 18010 is received within and coupled to the internal annular recess 18008a of the

tubular barrel connector 18008 for fluidicly sealing the interface between the tubular barrel connector and the sealing cartridge. Torsional locking pins, 18012a and 18012b, are coupled to and mounted within the external radial mounting holes, 18008b and 18008c, respectively, of the tubular barrel connector 18008 and received within the radial passages, 18004c and 18004d, of the tubular actuator barrel 18004.

[00171] A tubular member 18014 that defines a longitudinal passage 18014a having one or more internal splines 18014b at one end and circumferentially spaced apart teeth 18014c at another end for engaging the circumferentially spaced apart teeth 18008h of the tubular barrel connector 18008 mates with and is received within the actuator barrel 18004 and the one end of the tubular member abuts an end face of the other end of the upper tubular support member 18002 and at another end abuts and end face of the tubular barrel connector 18008. A tubular guide member 18016 that defines a longitudinal passage 18016a having a tapered opening 18016aa, and radial passages, 18016b and 18016c, includes an external flange 18016d having an externally threaded connection at one end that is received within and coupled to the internal annular recess 18002h of the upper tubular support member 18002.

[00172] The other end of the tubular barrel connector 18008 is threadably coupled to and is received within an end of a tubular actuator barrel 18018 that defines a longitudinal passage 18018a, radial passages, 18018b and 18018c, and radial passages, 18018d and 18018e. Torsional locking pins, 18020a and 18020b, are coupled to and mounted within the external radial mounting holes, 18008f and 18008g, respectively, of the tubular barrel connector 18008 and received within the radial passages, 18018b and 18018c, of the tubular actuator barrel 18018. The other end of the tubular actuator barrel 18018 receives and is threadably coupled to an end of a tubular barrel connector 18022 that defines an internal annular recess 18022a, external radial mounting holes, 18022b and 18022c, radial passages, 18022d and 18022e, and external radial mounting holes, 18022f and 18022g. A sealing cartridge 18024 is received within and coupled to the internal annular recess 18022a of the tubular barrel connector 18022 for fluidicly sealing the interface between the tubular barrel connector and the sealing cartridge. Torsional locking pins, 18024a and 18024b, are coupled to and mounted within the external radial mounting holes, 18022b and 18022c, respectively, of the barrel connector 18022 and received within the radial passages, 18018d and 18018e, of the tubular actuator barrel 18018.

[00173] The other end of the tubular barrel connector 18022 is threadably coupled to and is received within an end of a tubular actuator barrel 18026 that defines a longitudinal passage 18026a, radial passages, 18026b and 18026c, and radial passages, 18026d and 18026e. Torsional locking pins, 18028a and 18028b, are coupled to and mounted within the external radial mounting holes, 18022f and 18022g, respectively, of the tubular barrel

connector 18022 and received within the radial passages, 18026b and 18026c, of the tubular actuator barrel 18026. The other end of the tubular actuator barrel 18026 receives and is threadably coupled to an end of a tubular barrel connector 18030 that defines an internal annular recess 18030a, external radial mounting holes, 18030b and 18030c, radial passages, 18030d and 18030e, and external radial mounting holes, 18030f and 18030g. A sealing cartridge 18032 is received within and coupled to the internal annular recess 18030a of the tubular barrel connector 18030 for fluidicly sealing the interface between the tubular barrel connector and the sealing cartridge. Torsional locking pins, 18034a and 18034b, are coupled to and mounted within the external radial mounting holes, 18030b and 18030c, respectively, of the tubular barrel connector 18030 and received within the radial passages, 18026d and 18026e, of the tubular actuator barrel 18026.

[00174] The other end of the tubular barrel connector 18030 is threadably coupled to and is received within an end of a tubular actuator barrel 18036 that defines a longitudinal passage 18036a, radial passages, 18036b and 18036c, and radial passages, 18036d and 18036e. Torsional locking pins, 18038a and 18038b, are coupled to and mounted within the external radial mounting holes, 18030f and 18030g, respectively, of the tubular barrel connector 18030 and received within the radial passages, 18036b and 18036c, of the tubular actuator barrel 18036. The other end of the tubular actuator barrel 18036 receives and is threadably coupled to an end of a tubular barrel connector 18040 that defines an internal annular recess 18040a, external radial mounting holes, 18040b and 18040c, radial passages, 18040d and 18040e, and external radial mounting holes, 18040f and 18040g. A sealing cartridge 18042 is received within and coupled to the internal annular recess 18040a of the tubular barrel connector 18040 for fluidicly sealing the interface between the tubular barrel connector and the sealing cartridge. Torsional locking pins, 18044a and 18044b, are coupled to and mounted within the external radial mounting holes, 18040b and 18040c, respectively, of the tubular barrel connector 18040 and received within the radial passages, 18036d and 18036e, of the tubular actuator barrel 18036.

[00175] The other end of the tubular barrel connector 18040 is threadably coupled to and is received within an end of a tubular actuator barrel 18046 that defines a longitudinal passage 18046a, radial passages, 18046b and 18046c, and radial passages, 18046d and 18046e. Torsional locking pins, 18048a and 18048b, are coupled to and mounted within the external radial mounting holes, 18040f and 18040g, respectively, of the tubular barrel connector 18040 and received within the radial passages, 18046b and 18046c, of the tubular actuator barrel 18046. The other end of the tubular actuator barrel 18046 receives and is threadably coupled to an end of a tubular barrel connector 18050 that defines an internal annular recess 18050a, external radial mounting holes, 18050b and 18050c, radial passages, 18050d and 18050e, and external radial mounting holes, 18050f and 18050g. A

sealing cartridge 18052 is received within and coupled to the internal annular recess 18050a of the tubular barrel connector 18050 for fluidicly sealing the interface between the tubular barrel connector and the sealing cartridge. Torsional locking pins, 18054a and 18054b, are coupled to and mounted within the external radial mounting holes, 18050b and 18050c, respectively, of the tubular barrel connector 18050 and received within the radial passages, 18046d and 18046e, of the tubular actuator barrel 18046.

[00176] The other end of the tubular barrel connector 18050 is threadably coupled to and is received within an end of a tubular actuator barrel 18056 that defines a longitudinal passage 18056a, radial passages, 18056b and 18056c, and radial passages, 18056d and 18056e. Torsional locking pins, 18058a and 18058b, are coupled to and mounted within the external radial mounting holes, 18050f and 18050g, respectively, of the tubular barrel connector 18050 and received within the radial passages, 18056b and 18056c, of the tubular actuator barrel 18056. The other end of the tubular actuator barrel 18056 receives and is threadably coupled to an end of a tubular lower stop 18060 that defines an internal annular recess 18060a, external radial mounting holes, 18060b and 18060c, and an internal annular recess 18060d that includes one or more circumferentially spaced apart locking teeth 18060e at one end and one or more circumferentially spaced apart locking teeth 18060f at the other end. A sealing cartridge 18062 is received within and coupled to the internal annular recess 18060a of the tubular lower stop 18060 for fluidicly sealing the interface between the tubular lower stop and the sealing cartridge. Torsional locking pins, 18064a and 18064b, are coupled to and mounted within the external radial mounting holes, 18060b and 18060c, respectively, of the tubular lower stop 18060 and received within the radial passages, 18056d and 18056e, of the tubular actuator barrel 18056.

[00177] A connector tube 18066 that defines a longitudinal passage 18066a and radial mounting holes, 18066b and 18066c, and includes external splines 18066d at one end for engaging the internal splines 18014b of the tubular member 18014 and radial mounting holes, 18066e and 18066f, at another end is received within and sealingly and movably engages the interior surface of the sealing cartridge 18010 mounted within the annular recess 18008a of the tubular barrel connector 18008. In this manner, during longitudinal displacement of the connector tube 18066 relative to the tubular barrel connector 18008, a fluidic seal is maintained between the exterior surface of the connector tube and the interior surface of the tubular barrel connector. An end of the connector tube 18066 also receives and mates with the other end of the tubular guide member 18016. Mounting screws, 18068a and 18068b, are coupled to and received within the radial mounting holes, 18066b and 18066c, respectively of the connector tube 18066.

[00178] The other end of the connector tube 18066 is received within and threadably coupled to an end of a tubular piston 18070 that defines a longitudinal passage 18070a,

radial mounting holes, 18070b and 18070c, radial passages, 18070d and 18070e, and radial mounting holes, 18070f and 18070g, that includes a flange 18070h at one end. A sealing cartridge 18072 is mounted onto and sealingly coupled to the exterior of the tubular piston 18070 proximate the flange 18070h. The sealing cartridge 18072 also mates with and sealingly engages the interior surface of the tubular actuator barrel 18018. In this manner, during longitudinal displacement of the tubular piston 18070 relative to the actuator barrel 18018, a fluidic seal is maintained between the exterior surface of the piston and the interior surface of the actuator barrel. Mounting screws, 18074a and 18074b, are coupled to and mounted within the external radial mounting holes, 18070b and 18070c, respectively, of the tubular piston 18070 and received within the radial passages, 18066e and 18066f, of the connector tube 18066.

[00179] The other end of the tubular piston 18070 receives and is threadably coupled to an end of a connector tube 18076 that defines a longitudinal passage 18076a, radial mounting holes, 18076b and 18076c, at one end and radial mounting holes, 18076d and 18076e, at another end. The connector tube 18076 is received within and sealingly and movably engages the interior surface of the sealing cartridge 18024 mounted within the annular recess 18022a of the tubular barrel connector 18022. In this manner, during longitudinal displacement of the connector tube 18076 relative to the tubular barrel connector 18022, a fluidic seal is maintained between the exterior surface of the connector tube and the interior surface of the barrel connector. Mounting screws, 18078a and 18078b, are coupled to and mounted within the external radial mounting holes, 18070f and 18070g, respectively, of the tubular piston 18070 and received within the radial passages, 18076b and 18076c, of the connector tube 18076.

[00180] The other end of the connector tube 18076 is received within and threadably coupled to an end of a tubular piston 18080 that defines a longitudinal passage 18080a, radial mounting holes, 18080b and 18080c, radial passages, 18080d and 18080e, and radial mounting holes, 18080f and 18080g, that includes a flange 18080h at one end. A sealing cartridge 18082 is mounted onto and sealingly coupled to the exterior of the tubular piston 18080 proximate the flange 18080h. The sealing cartridge 18082 also mates with and sealingly engages the interior surface of the tubular actuator barrel 18026. In this manner, during longitudinal displacement of the tubular piston 18080 relative to the tubular actuator barrel 18026, a fluidic seal is maintained between the exterior surface of the piston and the interior surface of the actuator barrel. Mounting screws, 18084a and 18084b, are coupled to and mounted within the external radial mounting holes, 18080b and 18080c, respectively, of the tubular piston 18080 and received within the radial passages, 18076e and 18076f, of the connector tube 18076.

[00181] The other end of the tubular piston 18080 receives and is threadably coupled

to an end of a connector tube 18086 that defines a longitudinal passage 18086a, radial mounting holes, 18086b and 18086c, at one end and radial mounting holes, 18086d and 18086e, at another end. The connector tube 18086 is received within and sealingly and movably engages the interior surface of the sealing cartridge 18032 mounted within the annular recess 18030a of the tubular barrel connector 18030. In this manner, during longitudinal displacement of the connector tube 18086 relative to the tubular barrel connector 18030, a fluidic seal is maintained between the exterior surface of the connector tube and the interior surface of the barrel connector. Mounting screws, 18088a and 18088b, are coupled to and mounted within the external radial mounting holes, 18080f and 18080g, respectively, of the tubular piston 18080 and received within the radial passages, 18086b and 18086c, of the connector tube 18086.

[00182] The other end of the connector tube 18086 is received within and threadably coupled to an end of a tubular piston 18090 that defines a longitudinal passage 18090a, radial mounting holes, 18090b and 18090c, radial passages, 18090d and 18090e, and radial mounting holes, 18090f and 18090g, that includes a flange 18090h at one end. A sealing cartridge 18092 is mounted onto and sealingly coupled to the exterior of the tubular piston 18090 proximate the flange 18090h. The sealing cartridge 18092 also mates with and sealingly engages the interior surface of the tubular actuator barrel 18036. In this manner, during longitudinal displacement of the tubular piston 18090 relative to the tubular actuator barrel 18036, a fluidic seal is maintained between the exterior surface of the piston and the interior surface of the actuator barrel. Mounting screws, 18094a and 18094b, are coupled to and mounted within the external radial mounting holes, 18090b and 18090c, respectively, of the tubular piston 18090 and received within the radial passages, 18086e and 18086f, of the connector tube 18086.

[00183] The other end of the tubular piston 18090 receives and is threadably coupled to an end of a connector tube 18096 that defines a longitudinal passage 18096a, radial mounting holes, 18096b and 18096c, at one end and radial mounting holes, 18096d and 18096e, at another end. The connector tube 18096 is received within and sealingly and movably engages the interior surface of the sealing cartridge 18042 mounted within the annular recess 18040a of the tubular barrel connector 18040. In this manner, during longitudinal displacement of the connector tube 18096 relative to the tubular barrel connector 18040, a fluidic seal is maintained between the exterior surface of the connector tube and the interior surface of the barrel connector. Mounting screws, 18098a and 18098b, are coupled to and mounted within the external radial mounting holes, 18090f and 18090g, respectively, of the tubular piston 18090 and received within the radial passages, 18096b and 18096c, of the connector tube 18096.

[00184] The other end of the connector tube 18096 is received within and threadably

coupled to an end of a tubular piston 18100 that defines a longitudinal passage 18100a, radial mounting holes, 18100b and 18100c, radial passages, 18100d and 18100e, and radial mounting holes, 18100f and 18100g, that includes a flange 18100h at one end. A sealing cartridge 18102 is mounted onto and sealingly coupled to the exterior of the tubular piston 18100 proximate the flange 18100h. The sealing cartridge 18102 also mates with and sealingly engages the interior surface of the tubular actuator barrel 18046. In this manner, during longitudinal displacement of the tubular piston 18100 relative to the tubular actuator barrel 18046, a fluidic seal is maintained between the exterior surface of the piston and the interior surface of the actuator barrel. Mounting screws, 18104a and 18104b, are coupled to and mounted within the external radial mounting holes, 18100b and 18100c, respectively, of the tubular piston 18100 and received within the radial passages, 18096e and 18096f, of the connector tube 18096.

[00185] The other end of the tubular piston 18100 receives and is threadably coupled to an end of a connector tube 18106 that defines a longitudinal passage 18106a, radial mounting holes, 18106b and 18106c, at one end and radial mounting holes, 18106d and 18106e, at another end. The connector tube 18106 is received within and sealingly and movably engages the interior surface of the sealing cartridge 18052 mounted within the annular recess 18050a of the tubular barrel connector 18050. In this manner, during longitudinal displacement of the connector tube 18106 relative to the tubular barrel connector 18050, a fluidic seal is maintained between the exterior surface of the connector tube and the interior surface of the barrel connector. Mounting screws, 18108a and 18108b, are coupled to and mounted within the external radial mounting holes, 18100f and 18100g, respectively, of the tubular piston 18100 and received within the radial passages, 18106b and 18106c, of the connector tube 18106.

[00186] The other end of the connector tube 18106 is received within and threadably coupled to an end of a tubular piston 18110 that defines a longitudinal passage 18110a, radial mounting holes, 18110b and 18110c, radial passages, 18110d and 18110e, radial mounting holes, 18110f and 18110g, that includes a flange 18110h at one end and circumferentially spaced teeth 18110i at another end for engaging the one or more circumferentially spaced apart locking teeth 18060e of the tubular lower stop 18060. A sealing cartridge 18112 is mounted onto and sealingly coupled to the exterior of the tubular piston 18110 proximate the flange 18110h. The sealing cartridge 18112 also mates with and sealingly engages the interior surface of the actuator barrel 18056. In this manner, during longitudinal displacement of the tubular piston 18110 relative to the actuator barrel 18056, a fluidic seal is maintained between the exterior surface of the piston and the interior surface of the actuator barrel. Mounting screws, 18114a and 18114b, are coupled to and mounted within the external radial mounting holes, 18110b and 18110c, respectively, of the tubular

piston 18110 and received within the radial passages, 18106d and 18106e, of the connector tube 18106.

[00187] The other end of the tubular piston 18110 receives and is threadably coupled to an end of a connector tube 18116 that defines a longitudinal passage 18116a, radial mounting holes, 18116b and 18116c, at one end and radial mounting holes, 18116d and 18116e, at another end that includes an external flange 18116f that includes circumferentially spaced apart teeth 18116g that extend from an end face of the external flange for engaging the teeth 18060f of the tubular lower stop 18060, and an externally threaded connection 18116h at another end. The connector tube 18116 is received within and sealingly and movably engages the interior surface of the sealing cartridge 18062 mounted within the annular recess 18060a of the lower tubular stop 18060. In this manner, during longitudinal displacement of the connector tube 18116 relative to the lower tubular stop 18060, a fluidic seal is maintained between the exterior surface of the connector tube and the interior surface of the lower tubular stop. Mounting screws, 18118a and 18118b, are coupled to and mounted within the external radial mounting holes, 18110f and 18110g, respectively, of the tubular piston 18110 and received within the radial passages, 18116b and 18116c, of the connector tube 18116.

[00188] In an exemplary embodiment, as illustrated in Figs. 13A1 to 13A8, the internally threaded connection 18002e of the upper tubular support member 18002 receives and is coupled to the externally threaded connection 1234g of the lower mandrel 1234 of the ball grabber assembly 16 and the externally threaded connection 18116h of the connector tube 18116 is received within and is coupled to an internally threaded connection 20a of an end of the safety sub assembly 20.

[00189] In an exemplary embodiment, as illustrated in Figs. 13A1 to 13A8, during operation of the tension actuator assembly 18, the tension actuator assembly is positioned within the expandable wellbore casing 100 and fluidic material 18200 is injected into the tension actuator assembly through the passages 18002a, 18016a, 18066a, 18070a, 18076a, 18080a, 18086a, 18090a, 18096a, 18100a, 18106a, 18110a, and 18116a. The injected fluidic material 18200 will also pass through the radial passages, 18070d and 18070e, 18080d and 18080e, 18090d and 18090e, 18100d and 18100e, 18110d and 18110e, of the tubular pistons, 18070, 18080, 18090, 18100, and 18110, respectively, into annular piston chambers, 18202, 18204, 18206, 18208, 18208, and 18210.

[00190] As illustrated in Figs. 13B1 to 13B7, the operating pressure of the fluidic material 18200 may then be increased by, for example, controllably blocking or limiting the flow of the fluidic material through the passage 18116a and/or increasing the operating pressure of the outlet of a pumping device for injecting the fluidic material 18200 into the tension actuator assembly 18. As a result, of the increased operating pressure of the fluidic

material 18200 within the tension actuator assembly 18, the operating pressures of the annular piston chambers, 18202, 18204, 18206, 18208, 18208, and 18210, will be increased sufficiently to displace the tubular pistons, 18070, 18080, 18090, 18100, and 18110, upwardly in the direction 18212 thereby also displacing the connector tube 18116. As a result, a upward tensile force is applied to all elements of the system 10 coupled to and positioned below the connector tube 18116. In an exemplary embodiment, during the upward displacement of the tubular pistons, 18070, 18080, 18090, 18100, and 18110, fluidic materials displaced by the tubular pistons within discharge annular chambers, 18214, 18216, 18218, 18220, and 18222 are exhausted out of the tension actuator assembly 18 through the radial passages, 18008d and 18008e, 18022d and 18022e, 18030d and 18030e, 18040d and 18040e, 18050d and 18050e, respectively. Furthermore, in an exemplary embodiment, the upward displacement of the tubular pistons, 18070, 18080, 18090, 18100, and 18110, further causes the external splines 18066d of the connector tube 18066 to engage the internal splines 18014b of the tubular member 18014 and the circumferentially spaced apart teeth 18116g of the connector tube 18116 to engage the circumferentially spaced teeth 18060f of the tubular lower stop 18060. As a result of the interaction of the external splines 18066d of the connector tube 18066 to engage the internal splines 18014b of the tubular member 18014 and the circumferentially spaced apart teeth 18116g of the connector tube 18116 to engage the circumferentially spaced teeth 18060f of the tubular lower stop 18060, torsional loads may be transmitted through the tension actuator assembly 18.

[00191] In an exemplary embodiment, as illustrated in Fig. 14A, the safety sub assembly 20 includes a tubular body 200a that defines a longitudinal passage 200b and includes an external flange 200c and an internal annular recess 200d at one end, and external annular recesses, 200e, 200f, 200g, and 200h at another end. A sealing member 202 is positioned within the external annular recess 200h at the other end of the tubular body 200a.

[00192] In an exemplary embodiment, as illustrated in Figs. 14A, 14B and 14C, the sealing cup assembly 22 includes an upper tubular mandrel 2202 that defines a longitudinal passage 2202a and internally threaded radial mounting holes, 2202b and 2202c, and includes an internal annular recess 2202d at one end, an internal annular recess 2202e, an internal annular recess 2202f, an internal annular recess 2202g, and an internally threaded internal annular recess 2202h and an external flange 2202i at another end. The internal annular recesses, 2202d, 2202e, and 2202f, of the upper tubular mandrel 2202 of the sealing cup assembly 22 receive, mate with, and are coupled to the other end of the tubular body 200a of the safety sub assembly 20.

[00193] An externally threaded end of a lower tubular mandrel 2204 that defines a longitudinal passage 2204a and includes an external annular recess 2204b at one end, an

external annular recess 2204c, an external flange 2204d, an external annular recess 2204e, an externally threaded external flange 2204f, and an external annular recess 2204g at another end mates with, is received within, and is coupled to the internal annular recesses, 2202g and 2202h, of the other end of the upper tubular mandrel 2202.

[00194] Mounting screws, 2250a and 2205b, are received within and coupled to the mounting holes, 2202c and 2202b, respectively, of the tubular mandrel 2202 that extend into and engage the external annular recess 2204c of the lower tubular mandrel 2204.

[00195] A tubular cup seal spacer 2206 receives and is mounted upon the lower tubular mandrel 2204 proximate the external flange 2202i of the upper tubular mandrel 2202. A tubular cup seal retainer 2208 that includes an internal flange 2208a at one end receives and is mounted upon the lower tubular mandrel 2204 proximate the tubular cup seal spacer 2206. A tubular cup seal retainer 2210 that includes an internal flange 2210a at one end receives and is mounted upon the lower tubular mandrel 2204 proximate the other end of the tubular cup seal retainer 2208. In an exemplary embodiment, the tubular cup seal retainer 2210 is nested within the other end of the tubular cup seal retainer 2208. A tubular cup seal 2212 that includes an internal flange 2212a at one end receives and is mounted upon the lower tubular mandrel 2204 proximate the other end of the tubular cup seal retainer 2210. In an exemplary embodiment, the tubular cup seal 2212 is nested within the other end of the tubular cup seal retainer 2210.

[00196] A sealing member 2211 is received within the external annular recess 2204b of the lower tubular mandrel 2204 for sealing the interface between the lower tubular mandrel and the upper tubular mandrel 2202.

[00197] A tubular spacer 2214 receives and is mounted upon the lower tubular mandrel 2204 proximate the other end of the tubular cup seal 2212.

[00198] A tubular cup seal spacer 2216 receives and is mounted upon the lower tubular mandrel 2204 proximate the other end of the tubular spacer 2214. A tubular cup seal retainer 2218 that includes an internal flange 2218a at one end receives and is mounted upon the lower tubular mandrel 2204 proximate the other end of the tubular cup seal spacer 2216. A tubular cup seal retainer 2220 that includes an internal flange 2220a at one end receives and is mounted upon the lower tubular mandrel 2204 proximate the other end of the tubular cup seal retainer 2218. In an exemplary embodiment, the tubular cup seal retainer 2220 is nested within the other end of the tubular cup seal retainer 2218. A tubular cup seal 2222 that includes an internal flange 2222a at one end receives and is mounted upon the lower tubular mandrel 2204 proximate the other end of the tubular cup seal retainer 2220. In an exemplary embodiment, the tubular cup seal 2222 is nested within the other end of the tubular cup seal retainer 2220.

[00199] A tubular spacer 2224 receives and is mounted upon the lower tubular

mandrel 2204 proximate the other end of the tubular cup seal 2222 at one end and proximate the external flange 2204d of the lower tubular mandrel at another end. A retaining ring 2226 receives and is mounted upon the other end of the tubular spacer 2224 proximate the external flange 2204d of the lower tubular mandrel 2204.

[00200] In an exemplary embodiment, during operation of the system 10, the end of the tubular body 200a of the safety sub assembly 20 is coupled to and receives and is coupled to an end of the tension actuator assembly 18 and the other end of the lower tubular mandrel 2204 of the sealing cup assembly 22 is received within and is coupled to an end of the casing lock assembly 24.

[00201] In an exemplary embodiment, during operation of the system 10, the tubular cup seals, 2212 and/or 2222, sealingly engage the interior surface of the expandable tubular member 100. In this manner, when an annulus defined between the system 10 and the expandable wellbore casing 10, below the tubular cup seals, 2212 and/or 2222, is pressurized, the resulting pressure differential across the tubular cup seals applies an upward tensile force to the system thereby pulling the adjustable bell section expansion cone assembly 28 and/or the adjustable casing expansion cone assembly 30 through the expandable wellbore casing. In this manner, the adjustable bell section expansion cone assembly 28 and/or the adjustable casing expansion cone assembly 30, if either or both are adjusted to an outside diameter suitable for a radial expansion operation, may radially expand and plastically deform the expandable wellbore casing 100.

[00202] In an exemplary embodiment, the sealing cup assembly 22 operates and is provided substantially, at least in part, as disclosed in one or more of the following: WO 03/042486; WO 03/042487; WO 03/078785; WO 04/027205; WO 03/093623; WO 03/106130 and WO 04/081346.

[00203] In an exemplary embodiment, the casing lock assembly 24 operates and is provided substantially, at least in part, as disclosed in one or more of the following: WO 03/042487; WO 04/027205; WO 03/093623 and WO 04/081346.

[00204] In an exemplary embodiment, the extension actuator assembly 26 operates and is provided substantially, at least in part, as disclosed in one or more of the following: WO 03/042487; WO 04/027205; WO 04/081346; WO 04/027200 and WO 04/081346.

[00205] In an exemplary embodiment, as illustrated in Figs. 15-1, 15-2, 15A1, 15A2, 15B1, 15B2, 15C1, 15C2, 15D, 15E1 to 15E5, 15F1 to 15F5, and 15G1 to 15G5, the extension actuator assembly 26, combines the functionality of the casing lock assembly 24 with the functionality of the extension actuator assembly, and includes a tubular upper tool

joint 26002 that defines a longitudinal passage 26002a and mounting holes, 26002b and 26002c, and includes an internal threaded connection 26002d at one end, an external flange 26002e, an external recess 26002f having an external threaded connection, a tapered recess 26002g, and an external recess 26002h and an internal recess 26002i at another end. An end of an upper pull-nut tube 26004 that defines a longitudinal passage 26004a and includes an external recess 26004b and an internally threaded internal recess 26004c at another end is received within and mates with the longitudinal passage 26002a of the tubular upper tool joint 26002.

[0100] An externally threaded end of a tubular inner mandrel 26006 that defines a longitudinal passage 26006a and radial passages, 26006b, 26006c, 26006d, and 26006e, and includes an externally threaded connection 26006f at another end mates with, is received within, and is coupled to the internally threaded recess 26004c of the upper pull-nut tube 26004. An internally threaded end of an lower pull-nut tube 26008 that defines a longitudinal passage 26008a and includes an external recess 26008b receives, mates with, and is coupled to externally threaded connection 26006f of the tubular inner mandrel 26006.

[0101] An internal flange 26010a of an end of a tubular lock mandrel 26010 that defines a longitudinal passage 26010b, radial passages, 26010c and 26010d, a radial passage 26010e, and a radial passage 26010f having an internal annular recess 26016fa and includes an external flange 26010g that mates with and is received within the internal recess 26002i of the tubular upper tool joint 26002, an external annular recess 26010h, an external flange 26010i, an external flange 26010j, an external flange 26010k, an external flange 26010l, an external flange 26010m that includes an external annular recess 26010ma, an external flange 26010n that defines mounting holes, 26010o and 26010p, an external annular recess 26010q, an external annular recess 26010r, and a tapered annular recess 26010s at another end receives and mates with the tubular inner mandrel 26006. Internal flanges, 26012a and 26012b, of a first locking dog 26012 that defines a radial passage 26012c and includes spring arms, 26012d and 26012e, and an external flange 26012f including external teeth 26012g are positioned upon the external flanges, 26010i and 26010j, of the tubular lock mandrel 26010. Internal flanges, 26014a and 26014b, of a second locking dog 26014 that defines a radial passage 26014c and includes spring arms, 26014d and 26014e, and an external flange 26014f including external teeth 26014g are positioned upon the external flanges, 26010i and 26010j, of the tubular lock mandrel 26010.

[0102] An internally threaded end of a tubular retainer sleeve 26016 that defines a longitudinal passage 26016a, radial passages, 26016b and 26016c, at one end, radial passages, 26016d and 26016e, for receiving and mating with the external flanges, 26012f and 26014f, respectively, of the first and second locking dogs, 26012 and 26014, respectively, and radial passages, 26016f and 26016g, at another end and includes a

tapered internal flange 26016h, a tapered internal recess 26016i that receives and mates with the spring arms, 26012d and 26014d, and ends of the first and second locking dogs, respectively, a tapered internal recess 26016j that receives and mates with the springs arms, 26012e and 26014e, and other ends of the first and second locking dogs, respectively, a tapered internal flange 26016k, and an internal threaded connection 26016l at another end receives, mates with, and is coupled to the externally threaded connection 26002f of the end of the tubular upper tool joint 26002. The ends of the spring arms, 26012d and 26014d, of the first and second locking dogs, 26012 and 26014, respectively, are held between the internal surface of the end of the tapered internal recess 26016i of the tubular retainer sleeve 26016 and the external surface of the end of the tapered external annular recess 26002h of the tubular upper tool joint 26002.

[0103] An externally threaded connection 26018a of an end of a tubular connector 26018 that defines mounting holes, 26018a and 26018b, and mounting holes, 26018c and 26018d, and includes a tapered external annular recess 26018e at one end, an external annular recess 26018f and an external annular recess 26018g at another end is received within, mates with, and is coupled to the internal threaded connection 26016l of the end of the tubular retainer sleeve 26016. The ends of the spring arms, 26012e and 26014e, of the first and second locking dogs, 26012 and 26014, respectively, are held between the internal surface of the end of the tapered internal recess 26016j of the tubular retainer sleeve 26016 and the external surface of the end of the tapered external annular recess 26018e of the tubular connector 26018.

[0104] A sealing member 26020 is received within the external annular recess 26010h of the tubular lock mandrel 26010 for sealing the interface between the tubular lock mandrel and the tubular upper tool joint 26002. A sealing member 26022 is received within the external annular recess 26010q of the tubular lock mandrel 26010 for sealing the interface between the tubular lock mandrel and the tubular connector 26018.

[0105] A tubular face seal 26024, tubular face seal back-up 26026, a spring 26028, and a plunger 26030 are mounted upon and retained upon the external annular recess 26018g of the tubular connector 26018 by a snap ring 26032 that is coupled to the external annular recess of the tubular connector. A burst disk 26034 and tubular burst disk bushing 26036 are mounted within the radial passage 26010f of the tubular lock mandrel 26010, and a sealing member 26038 is received within the internal annular recess 26010fa of the radial passage of the tubular lock mandrel for sealing the interface between the tubular burst disk bushing and the tubular lock mandrel.

[0106] An internally threaded end 26040a of a tubular release body 26040 that defines a longitudinal passage 26040b, radial passages, 26040c and 26040d, radial mounting holes, 26040e and 26040f, radial mounting holes, 26040g and 26040h, and includes an internal

flange 26040i that mates with and receives the external flange 26010n of the tubular lock mandrel 26010, an internal flange 26040j that mates with and receives the tubular lock mandrel receives, and an external annular recess 26040k mates with, and is coupled to an externally threaded end 26018h of the tubular connector 26018. A sealing member 26042 received within the external annular recess 26018f of the tubular connector 26018 seals the interface between the tubular connector and the tubular release body 26040. A sealing member 26044 received within the external annular recess 26010ma of the tubular lock mandrel 26010 seals the interface between the tubular lock mandrel and the tubular release body 26040. Shear pins, 26046a and 26046b, are received within and coupled to the radial mounting holes, 26010o and 26040e, and 26010p and 26040f, respectively, of the tubular lock mandrel 26010 and tubular release body 26040, respectively. Torque pins, 26048a and 26048b, are received within and coupled to the radial mounting holes, 26018c and 26018d, respectively, of the tubular connector 26018 that also extend into the radial passages, 26040c and 26040d, respectively, of the tubular release body 26040. A sealing member 26050 received within the external annular recess 26010r of the tubular lock mandrel 26010 seals the interface between the tubular lock mandrel and the internal flange 26040j of the tubular release body 26040.

[0107] An internally threaded end 26052a of a tubular extender barrel 26052 that defines a longitudinal passage 26052b, radial passages, 26052c and 26052d, and radial passages, 26052e and 26052f, and includes receives, mates with, and is coupled to an external threaded connection 26040l of the tubular release body 26040. A sealing member 26054 received within the external annular recess 26040k of the tubular release body 26040 seals the interface between the tubular release body and the tubular extender barrel 26052.

[0108] An external threaded connection 26056a of an end of a tubular lower bushing 26056 that defines a longitudinal passage 26056b and mounting holes, 26056c and 26056d, and includes an internal annular recess 26056e, an internal annular recess 26056f, a plurality of circumferentially spaced apart teeth 26056g at one end, a plurality of circumferentially spaced apart teeth 26056h at another end, and an external annular recess 26056i is received within, mates with, and is coupled to an internal threaded connection 26052m of the tubular extender barrel 26052. Torque pins, 26058a and 26058b, are mounted within and coupled to the mounting holes, 26056c and 26056d, respectively, of the tubular lower bushing 26056 that also extend into the radial passages, 26052e and 26052f, respectively, of the tubular extender barrel 26052.

[0109] A tubular connecting rod 26060 that defines a longitudinal passage 26060a that receives and mates with the lower pull-nut tube 26008, radial passages, 26060b and 26060c, and radial mounting holes, 26060d and 26060e, and includes an external threaded connection 26060f at one end, and an external threaded connection 26060g at another end

is slidably received within the longitudinal passage 25056b of the tubular lower bushing 26056. An internal threaded connection 26062a of an inner mandrel tubular piston 26062 that defines mounting holes, 26062b and 26062c, and includes an internal flange 26062d at one end that receives and mates with the tubular inner mandrel 26006, an external annular recess 26062e, and a plurality of circumferentially spaced apart teeth 26062f at another end receives, mates with, and is coupled to the external threaded connection 26060f of the tubular connecting rod 26060.

[0110] Torque screws, 26064a and 26064b, are mounted within and coupled to the mounting holes, 26062b and 26062c, respectively, of the inner mandrel tubular piston 26062 that also extend into the radial passages, 26060b and 26060c, of the tubular connecting rod 26060. A sealing member 26066 positioned within the external annular recess 26062e of the inner mandrel tubular piston 26062 seals the interface between the inner tubular piston and the tubular extender barrel 26052. A sealing member 26068 positioned within the external annular recess 26056i of the tubular lower bushing 26056 seals the interface between the tubular lower bushing and the tubular extender barrel 26052.

[0111] A packing sealing element 26070 is received within the internal annular recess 25056f of the tubular lower bushing 26056, and a packing retainer 26072 is received within the internal annular recess 26056e of the tubular lower bushing for sealing the interface between the tubular lower bushing and the tubular connecting rod 26060. The packing sealing element 26070 and the packing retainer 26072 are retained within the internal annular recess 25056f of the tubular lower bushing 26056 and internal annular recess 26056e of the tubular lower bushing, respectively, by a snap ring 26074 that is coupled to the tubular connecting rod 26060.

[0112] An internally threaded connection 26076a of a tubular lower tool joint 26076 that defines a longitudinal passage 26076b, radial mounting holes, 26076c and 26076d, and radial mounting holes, 26076e and 26076f, and includes an internal annular recess 26076g and an external annular recess 26076h receives, mates with, and is coupled to an external threaded connection 26060g of the tubular connecting rod 26060. Torque screws, 26078a and 26078b, are mounted within and coupled to the mounting holes, 26076c and 26076d, respectively, of the tubular lower tool joint 26076 that also extend into the radial passages, 26060d and 26060e, of the tubular connecting rod 26060. A sealing member 26080 is received within the internal annular recess 26076g of the tubular lower tool joint 26076 for sealing the interface between the tubular lower tool joint and the tubular connecting rod 26060.

[0113] In an exemplary embodiment, during operation of the extension actuator assembly 26, as illustrated in Figs. 15E1 to 15E5, the extension actuator assembly is positioned within the wellbore 102, the internal threaded connection 26002d of the tubular

upper tool joint 26002 receives, mates with, and is coupled to an end of the sealing cup assembly 22, and the end of the tubular lower tool joint 26076 is received within, mates with, and is coupled to an end of the adjustable bell section expansion cone assembly 28. In an exemplary embodiment, a portion 100a of the expandable wellbore casing 100 includes internal teeth 100b that engage with, and are coupled to, the external teeth, 26012g and 26014g, of the first and second locking dogs, 26012 and 26014, respectively. In this manner, the expandable wellbore casing 100 is locked to the extension actuator assembly 26 of the system 10.

[0114] In an exemplary embodiment, during the operation of the extension actuator assembly 26, a fluidic material 26100 may then be injected into the extension actuator assembly through the longitudinal passages 26004a, 26006a, and 26008a of the upper pull-nut tube 26004, tubular inner mandrel 26006, and lower pull-nut tube 26008, respectively, thereby pressurizing the longitudinal passages of the upper pull-nut tube, tubular inner mandrel, and lower pull-nut tube. As a result, the fluidic material 26100 is also conveyed through the radial passage 26006c of the tubular inner mandrel 26006 into and through an annulus 26102 defined between the tubular inner mandrel and the tubular lock mandrel 26010. The fluidic material 26100 is then conveyed into an annulus 26104 defined between the tubular inner mandrel 26006 and the tubular extender barrel 26052 proximate an end face of the inner mandrel tubular piston 26062.

[0115] In an exemplary embodiment, as illustrated in Figs. 15F1 to 15F5, the continued injection of the fluidic material 26100 into the extension actuator assembly 26 will then displace the inner mandrel tubular piston 26062 downwardly in a direction 26106. As a result, the tubular connecting rod 26060 and the tubular lower tool joint 26076 are also displaced downwardly in the direction 26106.

[0116] In an exemplary embodiment, as illustrated in Figs. 15G1 to 15G5, the continued injection of the fluidic material 26100 into the extension actuator assembly 26 will then further displace the inner mandrel tubular piston 26062 downwardly in the direction 26106 until an end face of the inner flange 26062d of the inner mandrel tubular piston engages an end face of the lower pull-nut tube 26008. As a result, the lower pull-nut tube 26008, the tubular inner mandrel 26006, the upper pull-nut tube 26004, and the tubular lock mandrel 26010 are also displaced downwardly in the direction 26106 thereby shearing the shear pins, 26064a and 26064b, and disengaging the tubular lock mandrel from the tubular release body 26040.

[0117] The continued injection of the fluidic material 26100 into the extension actuator assembly 26 will then further displace the tubular lock mandrel 26010 downwardly in the direction 26106 thereby displacing the external flanges, 26010i and 26010j, of the tubular lock mandrel out of engagement with the internal flanges, 26012a and 26012b, and 26014a

and 26014b, of the first and second locking dogs, 26012 and 26014, respectively. As a result, a spring bias force in an inner radial direction is applied by the spring arms, 26012d and 26012e, and 26014d and 26014e, of the first and second locking dogs, 26012 and 26014, respectively, to the first and second locking dogs thereby displacing the first and second locking dogs in an inner radial direction out of engagement with the portion 100a of the expandable wellbore casing 100. As a result, the expandable wellbore casing 100 is no longer locked to the first and second locking dogs, 26012 and 26014, of the extension actuator assembly 26.

[0118] In an exemplary embodiment, during operation of the extension actuator assembly 26, the expandable wellbore casing 100 may also be un-locked from engagement with the first and second locking dogs, 26012 and 26014, of the extension actuator assembly by increasing the operating pressure of the fluidic material 26100 above a predetermined level sufficient to rupture the burst disk 26034. As a result, the fluidic material 26100 will enter an annulus 26108 defined between the tubular lock mandrel 26010 and the tubular release body 26040. As a result, the tubular lock mandrel 26010 will be displaced downwardly in the direction 26106 thereby displacing the external flanges, 26010i and 26010j, of the tubular lock mandrel out of engagement with the internal flanges, 26012a and 26012b, and 26014a and 26014b, of the first and second locking dogs, 26012 and 26014, respectively. As a result, a spring bias force in an inner radial direction is applied by the spring arms, 26012d and 26012e, and 26014d and 26014e, of the first and second locking dogs, 26012 and 26014, respectively, to the first and second locking dogs thereby displacing the first and second locking dogs in an inner radial direction out of engagement with the portion 100a of the expandable wellbore casing 100. As a result, the expandable wellbore casing 100 is no longer locked to the first and second locking dogs, 26012 and 26014, of the extension actuator assembly 26. In an exemplary embodiment, the predetermined operating pressure of the fluidic material 26100 sufficient to rupture the burst disk 26034 is selected to provide a release of the expandable wellbore casing 100 from engagement with the first and second locking dogs, 26012 and 26104, in the event of an emergency operating condition during the operation of the system 10.

[0119] In an exemplary embodiment, the pressurization of the longitudinal passages 26004a, 26006a, and 26008a of the upper pull-nut tube 26004, tubular inner mandrel 26006, and lower pull-nut tube 26008, respectively, caused by the injection of the fluidic material 26100 may be further enhanced by blocking the flow of the fluidic material to those portions of the system 10 downstream from the extension actuator assembly 26 by, for example, blocking flow through a flow restriction defined in one or more of the elements of the system downstream of the extension actuator assembly by placing a ball or plug in one or more of those flow restrictions.

[00206] In an exemplary embodiment, the adjustable bell section expansion cone assembly 28 operates and is provided substantially, at least in part, as disclosed in one or more of the following: WO 03/042486; WO 03/042487; WO 03/078785; WO 04/027205; WO 03/093623; WO 03/106130 and WO 04/081346.

[00207] In an exemplary embodiment, as illustrated in Figs. 16-1 and 16-2, 16A1 to 16A2, 16B1 to 16B2, 16C, 16D, 16E, 16F, 16G, 16H, 16I, 16j, 16K, 16L, 16M, 16N, 16O, 16P, 16R, 16S, 16T, 16U, 16V, 16W, 16X, 16Y, 16Z1 to 16Z4, 16AA1 to 16AA4, 16AB1 to 16AB4, 16AC1 to 16AC4, 16AD, and 16AE, the adjustable bell section expansion cone assembly 28 includes an upper tubular tool joint 28002 that defines a longitudinal passage 28002a and mounting holes, 28002b and 28002c, and includes an internal threaded connection 28002d, an inner annular recess 28002e, an inner annular recess 28002f, and an internal threaded connection 28002g. A tubular torque plate 28004 that defines a longitudinal passage 28004a and includes circumferentially spaced apart teeth 28004b is received within, mates with, and is coupled to the internal annular recess 28002e of the upper tubular tool joint 28002.

[00208] Circumferentially spaced apart teeth 28006a of an end of a tubular lower mandrel 28006 that defines a longitudinal passage 28006b, a radial passage 28006ba, and a radial passage 28006bb and includes an external threaded connection 28006c, an external flange 28006d, an external annular recess 28006e having a step 28006f at one end, an external annular recess 28006g, external teeth 28006h, an external threaded connection 28006i, and an external annular recess 28006j engage the circumferentially spaced apart teeth 28004b of the tubular torque plate 28004. An internal threaded connection 28008a of an end of a

tubular toggle bushing 28008 that defines a longitudinal passage 28008b, an upper longitudinal slot 28008c , a lower longitudinal slot 28008d, mounting holes, 28008e, 28008f, 28008g, 28008h, 28008i, 28008j, 28008k, 28008l, 28008m, 28008n, 28008o, 28008p, 28008q, 28008r, 28008s, 28008t, 28008u, 28008v, 28008w, 28008x, 28008xa, and 28008xb, and includes an external annular recess 28008y, internal annular recess 28008z, external annular recess 28008aa, and an external annular recess 28008ab receives and is coupled to the external threaded connection 28006c of the tubular lower mandrel 28006.

[00209] A sealing element 28010 is received within the external annular recess 28008y of the tubular toggle bushing 28008 for sealing the interface between the tubular toggle bushing and the upper tubular tool joint 28002. A sealing element 28012 is received within the internal annular recess 28008z of the tubular toggle bushing 28008 for sealing the interface between the tubular toggle bushing and the tubular lower mandrel 28006.

[00210] Mounting screws, 28014a and 28014b, mounted within and coupled to the mounting holes, 28008w and 28008x, respectively, of the tubular toggle bushing 28008 are also received within the mounting holes, 28002b and 28002c, of the upper tubular tool joint 28002. Mounting pins, 28016a, 28016b, 28016c, 28016d, and 28016e, are mounted within the mounting holes, 28008e, 28008f, 28008g, 28008h, and 28008i, respectively. Mounting pins, 28018a, 28018b, 28018c, 28018d, and 28018e, are mounted within the mounting holes, 28008t, 28008s, 28008r, 28008q, and 28008p, respectively. Mounting screws, 28020a and 28020b, are mounted within the mounting holes, 28008u and 28008v, respectively.

[00211] A first upper toggle link 28022 defines mounting holes, 28022a and 28022b, for receiving the mounting pins, 28016a and 28016b, and includes a mounting pin 28022c at one end. A first lower toggle link 28024 defines mounting holes, 28024a, 28024b, and 28024c, for receiving the mounting pins, 28022c, 28016c, and 28016d, respectively and includes an engagement arm 28024d. A first trigger 28026 defines a mounting hole 28026a for receiving the mounting pin 28016e and includes an engagement arm 28026b at one end, an engagement member 28026c, and an engagement arm 28026d at another end.

[00212] A second upper toggle link 28028 defines mounting holes, 28028a and 28028b, for receiving the mounting pins, 28018a and 28018b, and includes a mounting pin 28028c at one end. A second lower toggle link 28030 defines mounting holes, 28030a, 28030b, and 28030c, for receiving the mounting pins, 28028c, 28018c, and 28018d, respectively and includes an engagement arm 28030d. A second trigger 28032 defines a mounting hole 28032a for receiving the mounting pin 28018e and includes an engagement arm 28032b at one end, an engagement member 28032c, and an engagement arm 28032d at another end.

[00213] An end of a tubular spring housing 28034 that defines a longitudinal passage

28034a, mounting holes, 28034b and 28034c, and mounting holes, 28034ba and 28034ca, and includes an internal flange 28034d and an internal annular recess 28034e at one end, and an internal flange 28034f, an internal annular recess 28034g, an internal annular recess 28034h, and an external threaded connection 28034i at another end receives and mates with the end of the tubular toggle bushing 28008. Mounting screws, 28035a and 28035b, are mounted within and coupled to the mounting holes, 28008xb and 28008xa, respectively, of the tubular toggle bushing 28008 and are received within the mounting holes, 28034ba and 28034ca, respectively, of the tubular spring housing 28034.

[00214] A tubular retracting spring ring 28036 that defines mounting holes, 28036a and 28036b, receives and mates with a portion of the tubular lower mandrel 28006 and is received within and mates with a portion of the tubular spring housing 28034. Mounting screws, 28038a and 28038b, are mounted within and coupled to the mounting holes, 28036a and 28036b, respectively, of the tubular retracting spring ring 28036 and extend into the mounting holes, 28034b and 28034c, respectively, of the tubular spring housing 28034.

[00215] Casing diameter sensor springs, 28040a and 28040b, are positioned within the longitudinal slots, 28008c and 2808d, respectively, of the tubular toggle bushing 28008 that engage the engagement members, 28026c and 28032c, and engagement arms,28026d and 28032d, of the first and second triggers, 28026 and 28032, respectively. An inner flange 28042a of an end of a tubular spring washer 28042 mates with and receives a portion of the tubular lower mandrel 28006 and an end face of the inner flange of the tubular spring washer is positioned proximate and end face of the external flange 28006d of the tubular lower mandrel. The tubular spring washer 28042 is further received within the longitudinal passage 28034a of the tubular spring housing 28034.

[00216] An end of a retracting spring 28044 that receives the tubular lower mandrel 28006 is positioned within the tubular spring washer 28042 in contact with the internal flange 28042a of the tubular spring washer and the other end of the retracting spring is positioned in contact with an end face of the tubular retracting spring ring 28036.

[00217] A sealing element 28046 is received within the external annular recess 28006j of the tubular lower mandrel 28006 for sealing the interface between the tubular lower mandrel and the tubular spring housing 28034. A sealing element 28048 is received within the internal annular recess 28034h of the tubular spring housing 28034 for sealing the interface between the tubular spring housing and the tubular lower mandrel 28006.

[00218] An internal threaded connection 28050a of an end of a tubular upper hinge sleeve 28050 that includes an internal flange 28050b and an internal pivot 28050c receives and is coupled to the external threaded connection 28034i of the end of the tubular spring housing 28034.

[00219] An external flange 28052a of a base member 28052b of an upper cam

assembly 28052, that is mounted upon and receives the lower tubular mandrel 28006, that includes an internal flange 28052c that is received within the external annular recess 28006e of the lower tubular mandrel 28006 and a plurality of circumferentially spaced apart tapered cam arms 28052d extending from the base member mates with and is received within the tubular upper hinge sleeve 28050. The base member 28052b of the upper cam assembly 28052 further includes a plurality of circumferentially spaced apart teeth 28052f that mate with and are received within a plurality of circumferentially spaced apart teeth 28034j provided on the end face of the tubular spring housing 28034 and an end face of the external flange 28052a of the base member of the upper cam assembly is positioned in opposing relation to an end face of the internal flange 28050b of the tubular upper hinge sleeve 28050. Each of the cam arms 28052d of the upper cam assembly 28052 include external cam surfaces 28052e. In an exemplary embodiment, the teeth 28052f of the base member 28052b of the upper cam assembly 28052 and the teeth 28034j provided on the end face of the tubular spring housing 28034 permit torsional loads to be transmitted between the tubular spring housing and the upper cam assembly.

[00220] A plurality of circumferentially spaced apart upper expansion segments 28054 are mounted upon and receive the lower tubular mandrel 28006 and each include an external pivot recess 28054a at one end for mating with and receiving the internal pivot 28050c of the tubular upper hinge sleeve 28050 and an external tapered expansion surface 28054b at another end and are pivotally mounted within the tubular upper hinge sleeve and are interleaved with the circumferentially spaced apart cam arms 28052d of the upper cam assembly 28052. The upper expansion segments 28054 are interleaved among the cam arms 28052d of the upper cam assembly 28052.

[00221] A plurality of circumferentially spaced apart lower expansion segments 28058 are mounted upon and receive the lower tubular mandrel 28006, are interleaved among the upper expansion segments 28054, are oriented in the opposite direction to the upper expansion segments 28054, each include an external pivot recess 28058a at one end and an external tapered expansion surface 28054b at another end and are positioned in opposing relation to corresponding circumferentially spaced apart cam arms 28052d of the upper cam assembly 28052.

[00222] A lower cam assembly 28060 is mounted upon and receives the lower tubular mandrel 28006 that includes a base member 28060a having an external flange 28060b, a plurality of circumferentially spaced apart cam arms 28060d that extend from the base member that each include external cam surfaces 28060e and define mounting holes 28060f and 28060g. The base member 28060a of the lower cam assembly 28060 further includes a plurality of circumferentially spaced apart teeth 28060h. The circumferentially spaced apart cam arms 28060d of the lower cam assembly 28060 are interleaved among the lower

expansion segments 28058 and the circumferentially spaced apart cam arms 28052d of the upper cam assembly 28052 and positioned in opposing relation to corresponding upper expansion segments 28054.

[00223] Mounting screws, 28062a, 28062b, 28062c, and 28062e, are mounted within the corresponding mounting holes, 28060f and 28060g, of the lower cam assembly 28060 and are received within the external annular recess 28006g of the lower cam assembly 28060.

[00224] A tubular lower hinge sleeve 28064 that receives the lower expansion segments 28058 and the lower cam assembly 28060 includes an internal flange 28064a for engaging the external flange 28060b of the base member of the lower cam assembly 28060, an internal pivot 28064b for engaging and receiving the external pivot recess 28058a of the lower expansion segments 28058 thereby pivotally mounting the lower expansion segments within the tubular lower hinge sleeve, and an internal threaded connection 28064c.

[00225] An external threaded connection 28066a of an end of a tubular sleeve 28066 that defines mounting holes, 28066b and 28066c, and includes an internal annular recess 28066d having a shoulder 28066e, an internal flange 28066f, and an internal threaded connection 28066g at another end is received within and coupled to the internal threaded connection 28064c of the tubular lower hinge sleeve 28064. An external threaded connection 28068a of an end of a tubular member 28068 that defines a longitudinal passage 28068b and mounting holes, 28068c and 28068d, and includes an external annular recess 28068e, and an external threaded connection 28068f at another end is received within and is coupled to the internal threaded connection 28066g of the tubular sleeve 28066.

[00226] Mounting screws, 28070a and 28070b, are mounted in and coupled to the mounting holes, 28068c and 28068d, respectively, of the tubular member 28068 that also extend into the mounting holes, 28066b and 28066c, respectively, of the tubular sleeve 28066. A sealing element 28072 is received within the external annular recess 28068e of the tubular member 28068 for sealing the interface between the tubular member and the tubular sleeve 28066.

[00227] An internal threaded connection 28074a of a tubular retracting piston 28074 that defines a longitudinal passage 28074b and includes an internal annular recess 28074c and an external annular recess 28074d receives and is coupled to the external threaded connection 28006i of the tubular lower mandrel 28006. A sealing element 28076 is received within the external annular recess 28074d of the tubular retracting piston 28074 for sealing the interface between the tubular retracting piston and the tubular sleeve 28066. A sealing element 28078 is received within the internal annular recess 28074c of the tubular retracting piston 28074 for sealing the interface between the tubular retracting piston and the tubular lower mandrel 28006.

[00228] Locking dogs 28080 mate with and receive the external teeth 28006h of the tubular lower mandrel 28006. A spacer ring 28082 is positioned between an end face of the locking dogs 28080 and an end face of the lower cam assembly 28060. A release piston 28084 mounted upon the tubular lower mandrel 28006 defines a radial passage 28084a for mounting a burst disk 28086 includes sealing elements, 28084b, 28084c, and 28084d. The sealing elements, 28084b and 28084d, sealing the interface between the release piston 28084 and the tubular lower mandrel 28006. An end face of the release piston 28084 is positioned in opposing relation to an end face of the locking dogs 28080.

[00229] A release sleeve 28088 that receives and is mounted upon the locking dogs 28080 and the release piston 28084 includes an internal flange 28088a at one end that sealingly engages the tubular lower mandrel 28006. A bypass sleeve 28090 that receives and is mounted upon the release sleeve 28088 includes an internal flange 28090a at one end.

[00230] In an exemplary embodiment, during operation of the adjustable bell section expansion cone assembly 28, the retracting spring 28044 is compressed and thereby applies a biasing spring force in a direction 28092 from the lower tubular mandrel 28006 to the tubular spring housing 28034 that, in the absence of other forces, moves and/or maintains the upper cam assembly 28052 and the upper expansion segments 28054 out of engagement with the lower expansion segments 28058 and the lower cam assembly 28060. In an exemplary embodiment, during operation of the adjustable bell section expansion cone assembly 28, an external threaded connection 26a of an end of the extension actuator assembly 26 is coupled to the internal threaded connection 28002d of the upper tubular tool joint 28002 and an internal threaded connection 30a of an end of the adjustable casing expansion cone assembly 30 is coupled to the external threaded connection 28068f of the tubular member 28068.

[00231] The upper cam assembly 28052 and the upper expansion segments 28054 may be brought into engagement with the lower expansion segments 28058 and the lower cam assembly 28060 by pressurizing an annulus 28094 defined between the lower tubular mandrel 28006 and the tubular spring housing 28034. In particular, injection of fluidic materials into the adjustable bell section expansion cone assembly 28 through the longitudinal passage 28006b of the lower tubular mandrel 28006 and into the radial passage 28006ba may pressurize the annulus 28094 thereby creating sufficient operating pressure to generate a force in a direction 28096 sufficient to overcome the biasing force of the retracting spring 28044. As a result, the spring housing 28034 may be displaced in the direction 28096 relative to the lower tubular mandrel 28006 thereby displacing the tubular upper hinge sleeve 28050, upper cam assembly 28052 , and upper expansion segments 28054 in the direction 28096.

[00232] In an exemplary embodiment, as illustrated in Figs. 16P and 16R, the displacement of the upper cam assembly 28052 and upper expansion segments 28054 in the direction 28096 will cause the lower expansion segments 28058 to ride up the cam surfaces 28052e of the cam arms 28052d of the upper cam assembly 28052 while also pivoting about the lower tubular hinge segment 28064, and will also cause the upper expansion segments 28054 to ride up the cam surfaces 28060e of the cam arms 28060d of the lower cam assembly 28060 while also pivoting about the upper tubular hinge segment 28050. In an exemplary embodiment, when the upper and lower expansion segments, 28054 and 28058, are brought into axial alignment, they define an outer expansion surface that is approximately contiguous in a circumferential direction and which provides an outer expansion surface that at least approximates a conical surface.

[00233] In an exemplary embodiment, during the operation of the adjustable bell section expansion cone assembly 28, when the upper and lower expansion segments, 28054 and 28058, brought into axial alignment into a radially expanded position, the upper and lower expansion segments, 28054 and 28058, are displaced relative to the expandable wellbore casing 100 to thereby radially expand and plastically deform at least a portion of the expandable wellbore casing. In an exemplary embodiment, during the radial expansion and plastic deformation of the expandable wellbore casing 100, the adjustable bell section expansion cone assembly 28 may then be rotated relative to the expandable wellbore casing to enhance and/or modify the rate at which the expandable wellbore casing is radially expanded and plastically deformed.

[00234] In an exemplary embodiment, the upper cam assembly 28052 and the upper expansion segments 28054 may be moved out of engagement with the lower expansion segments 28058 and the lower cam assembly 28060 by reducing the operating pressure within the annulus 28094.

[00235] In an alternative embodiment, as illustrated in Figs. 16S, 16T, 16U and 16V, during operation of the adjustable bell section expansion cone assembly 28, the upper cam assembly 28052 and the upper expansion segments 28054 may also be moved out of engagement with the lower expansion segments 28058 and the lower cam assembly 28060 by sensing the operating pressure within the longitudinal passage 28006b of the lower tubular mandrel 28006. In particular, as illustrated in Fig. 16T, if the operating pressure within the longitudinal passage 28006b and radial passage 28006bb of the lower tubular mandrel 28006 exceeds a predetermined value, the burst disc 28086 will open the passage 28084a thereby pressurizing the interior of the tubular release sleeve 28088 thereby displacing the tubular release sleeve 28088 downwardly in a direction 28092 away from engagement with the locking dogs 28080.

[00236] As a result, as illustrated in Fig. 16U, the locking dogs 28080 are displaced

outwardly in the radial directed and thereby released from engagement with the lower tubular mandrel 28006 thereby permitting the lower expansion segments 28058 and the lower cam assembly 28060 to be displaced downwardly relative to the lower tubular mandrel.

[00237] As a result, as illustrated in Fig. 16V, the operating pressure within the lower tubular mandrel 28066 may then cause the lower tubular mandrel to be displaced downwardly in the direction 28094 relative to the tubular lower mandrel 28006 and the retracting piston 28074. As a result, the lower tubular mandrel 28066, the lower expansion segments 28058, the lower cam assembly 28060, and tubular lower hinge sleeve 28064 are displaced downwardly in the direction 28094 relative to the tubular spring housing 28034 thereby moving the lower expansion segments 28058 and the lower cam assembly 28060 out of engagement with the upper cam assembly 28052 and the upper expansion segments 28054.

[00238] In an exemplary embodiment, as illustrated in Figs. 16W, 16X, and 16Y, during operation of the adjustable bell section expansion cone assembly 28, the adjustable bell section expansion cone assembly senses the diameter of the expandable wellbore casing 100 using the upper toggle links, 28022 and 28028, lower toggle links, 28024 and 28030, and triggers, 28026 and 28032, and then prevents the engagement of the upper cam assembly 28052 and the upper expansion segments 28054 with the lower expansion segments 28058 and the lower cam assembly 28060.

[00239] In particular, as illustrated in Fig. 16W, anytime the upper toggle links, 28022 and 28028, and lower toggle links, 28024 and 28030, are positioned within a portion of the expandable wellbore casing 100 that has been radially expanded and plastically deformed by the system 10, the triggers, 28026 and 28032, will be pivoted by the engagement arms, 28024d and 28030d, of the lower toggle links, 28024 and 28030, to a position in which the triggers will no longer engage the internal flange 28034d of the end of the tubular spring housing 28034 thereby permitting the displacement of the tubular spring housing in the direction 28096. As a result, the upper cam assembly 28052 and the upper expansion segments 28054 can be brought into engagement with the lower expansion segments 28058 and the lower cam assembly 28060. In an exemplary embodiment, the upper toggle links, 28022 and 28028, and the lower toggle links, 28024 and 28030, are spring biased towards the position illustrated in Fig. 16W.

[00240] Conversely, as illustrated in Fig. 16X, anytime the upper toggle links, 28022 and 28028, and lower toggle links, 28024 and 28030, are positioned within a portion of the expandable wellbore casing 100 that has not been radially expanded and plastically deformed by the system 10, the triggers, 28026 and 28032, will be maintained in a position in which the triggers will engage the internal flange 28034d of the end of the tubular spring

housing 28034 thereby preventing the displacement of the tubular spring housing in the direction 28096. As a result, the upper cam assembly 28052 and the upper expansion segments 28054 cannot be brought into engagement with the lower expansion segments 28058 and the lower cam assembly 28060. In an exemplary embodiment, the triggers, 28026 and 28032, are spring biased towards the position illustrated in Fig. 16X.

[00241] In an exemplary embodiment, as illustrated in Fig. 16Y, the tubular spring housing 28034 may be displaced upwardly in the direction 28098 even if the upper toggle links, 28022 and 28028, and lower toggle links, 28024 and 28030, are positioned within a portion of the expandable wellbore casing 100 that has not been radially expanded and plastically deformed by the system 10.

[00242] In an exemplary embodiment, as illustrated in Figs. 16Z1 to 16Z4, 16AA1 to 16AA4, 16AB1 to 16AB4, 16AC1 to 16AC4, 16AD, and 16AE, the tubular spring housing 28034 of the adjustable bell section expansion cone assembly 28 defines internal annular recesses 28034k and 28034l, spaced apart by an internal flange 28034m, the tubular toggle bushing 28008 defines an external annular recess 28008ac, and the adjustable bell section expansion cone assembly further includes pins, 28100a and 28100b and 28102a and 28102b, mounted in holes 28008j and 28008o and 28008k and 28008n, respectively, of the tubular toggle bushing, and a one-shot deactivation device 28104 mounted on the tubular toggle bushing between the pins, 28100a and 28100b and 28102a and 28102b.

[00243] The one-shot deactivation device 28104 includes a tubular body 28104a that defines radial holes, 28104b and 28014c, and includes an external annular recess 28104d at one end, a centrally positioned external flange 28104e, a centrally positioned internal annular recess 28104f, and an external annular recess 28104g at another end. An engagement member 28106 that includes a base member 28106a having a tapered end 28106b and a key member 28106c having a tapered end 28106d is received within a portion of the internal annular recess 28104f of the tubular body 28104a and an engagement member 28108 that includes a base member 28108a having a tapered end 28108b and a key member 28108c having a tapered end 28108d is received within an opposite portion of the internal annular recess 28104f of the tubular body 28104a. Spring members, 28110 and 28112, are received within the annular recess 28104f of the tubular body 28104a for biasing the base members, base member 28106a and 28108a, of the engagement members, 28106 and 28108, respectively, radially inwardly relative to the tubular body 28104a.

[00244] In an exemplary embodiment, during operation of the adjustable bell section expansion cone assembly 28, as illustrated in Figs. 16Z1 to 16Z4, the one-shot deactivation device 28104 are positioned proximate and in intimate contact with the pins, 28102a and 28102b, with the tapered ends, 28106b and 28108b, of the base members, 28106a and 28108a, of the engagement members, 28106 and 28108, received within the external

annular recess 28008ac of the tubular toggle bushing 28008. When the one-shot deactivation device 28104 is positioned as illustrated in Figs. 16Z1 to 16Z4, the external annular recess 28104d of the tubular body 28104a of the one-shot deactivation device is moved out of engagement with the engagement arms, 28026d and 28032d, of the triggers, 28026 and 28032, respectively. As a result, the triggers, 28026 and 28032, may operate normally as described above with reference to Figs. 16W, 16X, and 16Y.

[00245] Conversely, in an exemplary embodiment, during operation of the adjustable bell section expansion cone assembly 28, as illustrated in Figs. 16AA1 to 16AA4, the one-shot deactivation device 28104 are positioned proximate and in intimate contact with the pins, 28100a and 28100b, with the tapered ends, 28106b and 28108b, of the base members, 28106a and 28108a, of the engagement members, 28106 and 28108, not received within the external annular recess 28008ac of the tubular toggle bushing 28008. When the one-shot deactivation device 28104 is positioned as illustrated in Fig. 16AA, the external annular recess 28104d of the tubular body 28104a of the one-shot deactivation device is moved into engagement with the engagement arms, 28026d and 28032d, of the triggers, 28026 and 28032, respectively. As a result, the triggers, 28026 and 28032, are deactivated and may not operate normally as described above with reference to Figs. 16W, 16X, and 16Y.

[00246] In an alternative embodiment, the elements of the adjustable bell section expansion cone assembly 28 that sense the diameter of the expandable wellbore casing 100 may be disabled or omitted or adjusted to sense any pre-selected internal diameter of the expandable wellbore casing.

[00247] In an exemplary embodiment, the adjustable casing expansion cone assembly 30 operates and is provided substantially, at least in part, as disclosed in one or more of the following: WO 03/042486; WO 03/042487; WO 03/078785; WO 04/027205; WO 03/093623; WO 03/106130 and WO 04/081346.

[00248] In an exemplary embodiment, as illustrated in Figs. 17-1 and 17-2, 17A1 to 17A2, 17B1 to 17B2, 17C, 17D, 17E, 17F, 17G, 17H, 17I, 17j, 17K, 17L, 17M, 17N, 17O, 17P, 17R, 17S, 17T, 17U, 17V, 17W, 17X, 17Y, 17Z1-17Z4, 17AA1 to 17AA4, 17AB1 to 17AB4, 17AC1 to 17AC4, 17AD, and 17AE, the adjustable casing expansion cone assembly 30 includes an upper tubular tool joint 30002 that defines a longitudinal passage 30002a and mounting holes, 30002b and 30002c, and includes an internal threaded connection 30002d, an inner annular recess 30002e, an inner annular recess 30002f, and an internal threaded connection 30002g. A tubular torque plate 30004 that defines a longitudinal passage 30004a and includes circumferentially spaced apart teeth 30004b is received within, mates with, and is coupled to the internal annular recess 30002e of the upper tubular tool joint 30002.

[00249] Circumferentially spaced apart teeth 30006a of an end of a tubular lower mandrel 30006 that defines a longitudinal passage 30006b, a radial passage 30006ba, and a radial passage 30006bb and includes an external threaded connection 30006c, an external flange 30006d, an external annular recess 30006e having a step 30006f at one end, an external annular recess 30006g, external teeth 30006h, an external threaded connection 30006i, and an external annular recess 30006j engage the circumferentially spaced apart teeth 30004b of the tubular torque plate 30004. An internal threaded connection 30008a of an end of a tubular toggle bushing 30008 that defines a longitudinal passage 30008b, an upper longitudinal slot 30008c , a lower longitudinal slot 30008d, mounting holes, 30008e, 30008f, 30008g, 30008h, 30008i, 30008j, 30008k, 30008l, 30008m, 30008n, 30008o, 30008p, 30008q, 30008r, 30008s, 30008t, 30008u, 30008v, 30008w, 30008x, 30008xa, and 30008xb, and includes an external annular recess 30008y, internal annular recess 30008z, external annular recess 30008aa, and an external annular recess 30008ab receives and is coupled to the external threaded connection 30006c of the tubular lower mandrel 30006.

[00250] A sealing element 30010 is received within the external annular recess 30008y of the tubular toggle bushing 30008 for sealing the interface between the tubular toggle bushing and the upper tubular tool joint 30002. A sealing element 30012 is received within the internal annular recess 30008z of the tubular toggle bushing 30008 for sealing the interface between the tubular toggle bushing and the tubular lower mandrel 30006.

[00251] Mounting screws, 30014a and 30014b, mounted within and coupled to the mounting holes, 30008w and 30008x, respectively, of the tubular toggle bushing 30008 are also received within the mounting holes, 30002b and 30002c, of the upper tubular tool joint

30002. Mounting pins, 30016a, 30016b, 30016c, 30016d, and 30016e, are mounted within the mounting holes, 30008e, 30008f, 30008g, 30008h, and 30008i, respectively. Mounting pins, 30018a, 30018b, 30018c, 30018d, and 30018e, are mounted within the mounting holes, 30008t, 30008s, 30008r, 30008q, and 30008p, respectively. Mounting screws, 30020a and 30020b, are mounted within the mounting holes, 30008u and 30008v, respectively.

[00252] A first upper toggle link 30022 defines mounting holes, 30022a and 30022b, for receiving the mounting pins, 30016a and 30016b, and includes a mounting pin 30022c at one end. A first lower toggle link 30024 defines mounting holes, 30024a, 30024b, and 30024c, for receiving the mounting pins, 30022c, 30016c, and 30016d, respectively and includes an engagement arm 30024d. A first trigger 30026 defines a mounting hole 30026a for receiving the mounting pin 30016e and includes an engagement arm 30026b at one end, an engagement member 30026c, and an engagement arm 30026d at another end.

[00253] A second upper toggle link 30028 defines mounting holes, 30028a and 30028b, for receiving the mounting pins, 30018a and 30018b, and includes a mounting pin 30028c at one end. A second lower toggle link 30030 defines mounting holes, 30030a, 30030b, and 30030c, for receiving the mounting pins, 30028c, 30018c, and 30018d, respectively and includes an engagement arm 30030d. A second trigger 30032 defines a mounting hole 30032a for receiving the mounting pin 30018e and includes an engagement arm 30032b at one end, an engagement member 30032c, and an engagement arm 30032d at another end.

[00254] An end of a tubular spring housing 30034 that defines a longitudinal passage 30034a, mounting holes, 30034b and 30034c, and mounting holes, 30034ba and 30034ca, and includes an internal flange 30034d and an internal annular recess 30034e at one end, and an internal flange 30034f, an internal annular recess 30034g, an internal annular recess 30034h, and an external threaded connection 30034i at another end receives and mates with the end of the tubular toggle bushing 30008. Mounting screws, 30035a and 30035b, are mounted within and coupled to the mounting holes, 30008xb and 30008xa, respectively, of the tubular toggle bushing 30008 and are received within the mounting holes, 30034ba and 30034ca, respectively, of the tubular spring housing 30034.

[00255] A tubular retracting spring ring 30036 that defines mounting holes, 30036a and 30036b, receives and mates with a portion of the tubular lower mandrel 30006 and is received within and mates with a portion of the tubular spring housing 30034. Mounting screws, 30038a and 30038b, are mounted within and coupled to the mounting holes, 30036a and 30036b, respectively, of the tubular retracting spring ring 30036 and extend into the mounting holes, 30034b and 30034c, respectively, of the tubular spring housing 30034.

[00256] Casing diameter sensor springs, 30040a and 30040b, are positioned within

the longitudinal slots, 30008c and 3008d, respectively, of the tubular toggle bushing 30008 that engage the engagement members, 30026c and 30032c, and engagement arms,30026d and 30032d, of the first and second triggers, 30026 and 30032, respectively. An inner flange 30042a of an end of a tubular spring washer 30042 mates with and receives a portion of the tubular lower mandrel 30006 and an end face of the inner flange of the tubular spring washer is positioned proximate and end face of the external flange 30006d of the tubular lower mandrel. The tubular spring washer 30042 is further received within the longitudinal passage 30034a of the tubular spring housing 30034.

[00257] An end of a retracting spring 30044 that receives the tubular lower mandrel 30006 is positioned within the tubular spring washer 30042 in contact with the internal flange 30042a of the tubular spring washer and the other end of the retracting spring is positioned in contact with an end face of the tubular retracting spring ring 30036.

[00258] A sealing element 30046 is received within the external annular recess 30006j of the tubular lower mandrel 30006 for sealing the interface between the tubular lower mandrel and the tubular spring housing 30034. A sealing element 30048 is received within the internal annular recess 30034h of the tubular spring housing 30034 for sealing the interface between the tubular spring housing and the tubular lower mandrel 30006.

[00259] An internal threaded connection 30050a of an end of a tubular upper hinge sleeve 30050 that includes an internal flange 30050b and an internal pivot 30050c receives and is coupled to the external threaded connection 30034i of the end of the tubular spring housing 30034.

[00260] An external flange 30052a of a base member 30052b of an upper cam assembly 30052, that is mounted upon and receives the lower tubular mandrel 30006, that includes an internal flange 30052c that is received within the external annular recess 30006e of the lower tubular mandrel 30006 and a plurality of circumferentially spaced apart tapered cam arms 30052d extending from the base member mates with and is received within the tubular upper hinge sleeve 30050. The base member 30052b of the upper cam assembly 30052 further includes a plurality of circumferentially spaced apart teeth 30052f that mate with and are received within a plurality of circumferentially spaced apart teeth 30034j provided on the end face of the tubular spring housing 30034 and an end face of the external flange 30052a of the base member of the upper cam assembly is positioned in opposing relation to an end face of the internal flange 30050b of the tubular upper hinge sleeve 30050. Each of the cam arms 30052d of the upper cam assembly 30052 include external cam surfaces 30052e. In an exemplary embodiment, the teeth 30052f of the base member 30052b of the upper cam assembly 30052 and the teeth 30034j provided on the end face of the tubular spring housing 30034 permit torsional loads to be transmitted between the tubular spring housing and the upper cam assembly.

[00261] A plurality of circumferentially spaced apart upper expansion segments 30054 are mounted upon and receive the lower tubular mandrel 30006 and each include an external pivot recess 30054a at one end for mating with and receiving the internal pivot 30050c of the tubular upper hinge sleeve 30050 and an external tapered expansion surface 30054b at another end and are pivotally mounted within the tubular upper hinge sleeve and are interleaved with the circumferentially spaced apart cam arms 30052d of the upper cam assembly 30052. The upper expansion segments 30054 are interleaved among the cam arms 30052d of the upper cam assembly 30052.

[00262] A plurality of circumferentially spaced apart lower expansion segments 30058 are mounted upon and receive the lower tubular mandrel 30006, are interleaved among the upper expansion segments 30054, are oriented in the opposite direction to the upper expansion segments 30054, each include an external pivot recess 30058a at one end and an external tapered expansion surface 30054b at another end and are positioned in opposing relation to corresponding circumferentially spaced apart cam arms 30052d of the upper cam assembly 30052.

[00263] A lower cam assembly 30060 is mounted upon and receives the lower tubular mandrel 30006 that includes a base member 30060a having an external flange 30060b, a plurality of circumferentially spaced apart cam arms 30060d that extend from the base member that each include external cam surfaces 30060e and define mounting holes 30060f and 30060g. The base member 30060a of the lower cam assembly 30060 further includes a plurality of circumferentially spaced apart teeth 30060h. The circumferentially spaced apart cam arms 30060d of the lower cam assembly 30060 are interleaved among the lower expansion segments 30058 and the circumferentially spaced apart cam arms 30052d of the upper cam assembly 30052 and positioned in opposing relation to corresponding upper expansion segments 30054.

[00264] Mounting screws, 30062a, 30062b, 30062c, and 30062e, are mounted within the corresponding mounting holes, 30060f and 30060g, of the lower cam assembly 30060 and are received within the external annular recess 30006g of the lower cam assembly 30060.

[00265] A tubular lower hinge sleeve 30064 that receives the lower expansion segments 30058 and the lower cam assembly 30060 includes an internal flange 30064a for engaging the external flange 30060b of the base member of the lower cam assembly 30060, an internal pivot 30064b for engaging and receiving the external pivot recess 30058a of the lower expansion segments 30058 thereby pivotally mounting the lower expansion segments within the tubular lower hinge sleeve, and an internal threaded connection 30064c.

[00266] An external threaded connection 30066a of an end of a tubular sleeve 30066 that defines mounting holes, 30066b and 30066c, and includes an internal annular recess

30066d having a shoulder 30066e, an internal flange 30066f, and an internal threaded connection 30066g at another end is received within and coupled to the internal threaded connection 30064c of the tubular lower hinge sleeve 30064. An external threaded connection 30068a of an end of a tubular member 30068 that defines a longitudinal passage 30068b and mounting holes, 30068c and 30068d, and includes an external annular recess 30068e, and an external threaded connection 30068f at another end is received within and is coupled to the internal threaded connection 30066g of the tubular sleeve 30066.

[00267] Mounting screws, 30070a and 30070b, are mounted in and coupled to the mounting holes, 30068c and 30068d, respectively, of the tubular member 30068 that also extend into the mounting holes, 30066b and 30066c, respectively, of the tubular sleeve 30066. A sealing element 30072 is received within the external annular recess 30068e of the tubular member 30068 for sealing the interface between the tubular member and the tubular sleeve 30066.

[00268] An internal threaded connection 30074a of a tubular retracting piston 30074 that defines a longitudinal passage 30074b and includes an internal annular recess 30074c and an external annular recess 30074d receives and is coupled to the external threaded connection 30006i of the tubular lower mandrel 30006. A sealing element 30076 is received within the external annular recess 30074d of the tubular retracting piston 30074 for sealing the interface between the tubular retracting piston and the tubular sleeve 30066. A sealing element 30078 is received within the internal annular recess 30074c of the tubular retracting piston 30074 for sealing the interface between the tubular retracting piston and the tubular lower mandrel 30006.

[00269] Locking dogs 30080 mate with and receive the external teeth 30006h of the tubular lower mandrel 30006. A spacer ring 30082 is positioned between an end face of the locking dogs 30080 and an end face of the lower cam assembly 30060. A release piston 30084 mounted upon the tubular lower mandrel 30006 defines a radial passage 30084a for mounting a burst disk 30086 includes sealing elements, 30084b, 30084c, and 30084d. The sealing elements, 30084b and 30084d, sealing the interface between the release piston 30084 and the tubular lower mandrel 30006. An end face of the release piston 30084 is positioned in opposing relation to an end face of the locking dogs 30080.

[00270] A release sleeve 30088 that receives and is mounted upon the locking dogs 30080 and the release piston 30084 includes an internal flange 30088a at one end that sealingly engages the tubular lower mandrel 30006. A bypass sleeve 30090 that receives and is mounted upon the release sleeve 30088 includes an internal flange 30090a at one end.

[00271] In an exemplary embodiment, during operation of the adjustable casing expansion cone assembly 30, the retracting spring 30044 is compressed and thereby

applies a biasing spring force in a direction 30092 from the lower tubular mandrel 30006 to the tubular spring housing 30034 that, in the absence of other forces, moves and/or maintains the upper cam assembly 30052 and the upper expansion segments 30054 out of engagement with the lower expansion segments 30058 and the lower cam assembly 30060. In an exemplary embodiment, during operation of the adjustable bell section expansion cone assembly 28, an external threaded connection 20a of an end of the sealing cup assembly 20 is coupled to the internal threaded connection 30002d of the upper tubular tool joint 30002 and an internal threaded connection 30a of an end of the adjustable casing expansion cone assembly 30 is coupled to the external threaded connection 30068f of the tubular member 30068.

[00272] The upper cam assembly 30052 and the upper expansion segments 30054 may be brought into engagement with the lower expansion segments 30058 and the lower cam assembly 30060 by pressurizing an annulus 30094 defined between the lower tubular mandrel 30006 and the tubular spring housing 30034. In particular, injection of fluidic materials into the adjustable casing expansion cone assembly 30 through the longitudinal passage 30006b of the lower tubular mandrel 30006 and into the radial passage 30006ba may pressurize the annulus 30094 thereby creating sufficient operating pressure to generate a force in a direction 30096 sufficient to overcome the biasing force of the retracting spring 30044. As a result, the spring housing 30034 may be displaced in the direction 30096 relative to the lower tubular mandrel 30006 thereby displacing the tubular upper hinge sleeve 30050, upper cam assembly 30052 , and upper expansion segments 30054 in the direction 30096.

[00273] In an exemplary embodiment, as illustrated in Figs. 17P, 17Q, and 17R, the displacement of the upper cam assembly 30052 and upper expansion segments 30054 in the direction 30096 will cause the lower expansion segments 30058 to ride up the cam surfaces 30052e of the cam arms 30052d of the upper cam assembly 30052 while also pivoting about the lower tubular hinge segment 30064, and will also cause the upper expansion segments 30054 to ride up the cam surfaces 30060e of the cam arms 30060d of the lower cam assembly 30060 while also pivoting about the upper tubular hinge segment 30050. In an exemplary embodiment, when the upper and lower expansion segments, 30054 and 30058, are brought into axial alignment, they define an outer expansion surface that is approximately contiguous in a circumferential direction and which provides an outer expansion surface that at least approximates a conical surface.

[00274] In an exemplary embodiment, during the operation of the adjustable casing expansion cone assembly 30, when the upper and lower expansion segments, 30054 and 30058, brought into axial alignment into a radially expanded position, the upper and lower expansion segments, 30054 and 30058, are displaced relative to the expandable wellbore

casing 100 to thereby radially expand and plastically deform at least a portion of the expandable wellbore casing. In an exemplary embodiment, during the radial expansion and plastic deformation of the expandable wellbore casing 100, the adjustable casing expansion cone assembly 30 may then be rotated relative to the expandable wellbore casing to enhance and/or modify the rate at which the expandable wellbore casing is radially expanded and plastically deformed.

[00275] In an exemplary embodiment, the upper cam assembly 30052 and the upper expansion segments 30054 may be moved out of engagement with the lower expansion segments 30058 and the lower cam assembly 30060 by reducing the operating pressure within the annulus 30094.

[00276] In an alternative embodiment, as illustrated in Figs. 17S, 17T, 17U and 17V, during operation of the adjustable casing expansion cone assembly 30, the upper cam assembly 30052 and the upper expansion segments 30054 may also be moved out of engagement with the lower expansion segments 30058 and the lower cam assembly 30060 by sensing the operating pressure within the longitudinal passage 30006b of the lower tubular mandrel 30006. In particular, as illustrated in Fig. 17T, if the operating pressure within the longitudinal passage 30006b and radial passage 30006bb of the lower tubular mandrel 30006 exceeds a predetermined value, the burst disc 30086 will open the passage 30084a thereby pressurizing the interior of the tubular release sleeve 30088 thereby displacing the tubular release sleeve 30088 downwardly in a direction 30092 away from engagement with the locking dogs 30080.

[00277] As a result, as illustrated in Fig. 17U, the locking dogs 30080 are displaced outwardly in the radial directed and thereby released from engagement with the lower tubular mandrel 30006 thereby permitting the lower expansion segments 30058 and the lower cam assembly 30060 to be displaced downwardly relative to the lower tubular mandrel.

[00278] As a result, as illustrated in Fig. 17V, the operating pressure within the lower tubular mandrel 30066 may then cause the lower tubular mandrel to be displaced downwardly in the direction 30094 relative to the tubular lower mandrel 30006 and the retracting piston 30074. As a result, the lower tubular mandrel 30066, the lower expansion segments 30058, the lower cam assembly 30060, and tubular lower hinge sleeve 30064 are displaced downwardly in the direction 30094 relative to the tubular spring housing 30034 thereby moving the lower expansion segments 30058 and the lower cam assembly 30060 out of engagement with the upper cam assembly 30052 and the upper expansion segments 30054.

[00279] In an exemplary embodiment, as illustrated in Figs. 17W, 17X, and 17Y, during operation of the adjustable casing expansion cone assembly 30, the adjustable

casing expansion cone assembly senses the diameter of the expandable wellbore casing 100 using the upper toggle links, 30022 and 30028, lower toggle links, 30024 and 30030, and triggers, 30026 and 30032, and then prevents the engagement of the upper cam assembly 30052 and the upper expansion segments 30054 with the lower expansion segments 30058 and the lower cam assembly 30060.

[00280] In particular, as illustrated in Fig. 17W, anytime the upper toggle links, 30022 and 30028, and lower toggle links, 30024 and 30030, are positioned within a portion of the expandable wellbore casing 100 that has been radially expanded and plastically deformed by the system 10, the triggers, 30026 and 30032, will be pivoted by the engagement arms, 30024d and 30030d, of the lower toggle links, 30024 and 30030, to a position in which the triggers will no longer engage the internal flange 30034d of the end of the tubular spring housing 30034 thereby permitting the displacement of the tubular spring housing in the direction 30096. As a result, the upper cam assembly 30052 and the upper expansion segments 30054 can be brought into engagement with the lower expansion segments 30058 and the lower cam assembly 30060. In an exemplary embodiment, the upper toggle links, 30022 and 30028, and the lower toggle links, 30024 and 30030, are spring biased towards the position illustrated in Fig. 17W.

[00281] Conversely, as illustrated in Fig. 17X, anytime the upper toggle links, 30022 and 30028, and lower toggle links, 30024 and 30030, are positioned within a portion of the expandable wellbore casing 100 that has not been radially expanded and plastically deformed by the system 10, the triggers, 30026 and 30032, will be maintained in a position in which the triggers will engage the internal flange 30034d of the end of the tubular spring housing 30034 thereby preventing the displacement of the tubular spring housing in the direction 30096. As a result, the upper cam assembly 30052 and the upper expansion segments 30054 cannot be brought into engagement with the lower expansion segments 30058 and the lower cam assembly 30060. In an exemplary embodiment, the triggers, 30026 and 30032, are spring biased towards the position illustrated in Fig. 17X.

[00282] In an exemplary embodiment, as illustrated in Fig. 17Y, the tubular spring housing 30034 may be displaced upwardly in the direction 30098 even if the upper toggle links, 30022 and 30028, and lower toggle links, 30024 and 30030, are positioned within a portion of the expandable wellbore casing 100 that has not been radially expanded and plastically deformed by the system 10.

[00283] In an exemplary embodiment, as illustrated in Figs. 17Z1 to 17Z4, 17AA1 to 17AA4, 17AB1 to 17AB4, 17AC1 to 17AC4, 17AD, and 17AE, the tubular spring housing 30034 of the adjustable casing expansion cone assembly 30 defines internal annular recesses 30034k and 30034l, spaced apart by an internal flange 30034m, the tubular toggle bushing 30008 defines an external annular recess 30008ac, and the adjustable casing

expansion cone assembly further includes pins, 30100a and 30100b and 30102a and 30102b, mounted in holes 30008j and 30008o and 30008k and 30008n, respectively, of the tubular toggle bushing, and a one-shot deactivation device 30104 mounted on the tubular toggle bushing between the pins, 30100a and 30100b and 30102a and 30102b.

[00284] The one-shot deactivation device 30104 includes a tubular body 30104a that defines radial holes, 30104b and 30014c, and includes an external annular recess 30104d at one end, a centrally positioned external flange 30104e, a centrally positioned internal annular recess 30104f, and an external annular recess 30104g at another end. An engagement member 30106 that includes a base member 30106a having a tapered end 30106b and a key member 30106c having a tapered end 30106d is received within a portion of the internal annular recess 30104f of the tubular body 30104a and an engagement member 30108 that includes a base member 30108a having a tapered end 30108b and a key member 30108c having a tapered end 30108d is received within an opposite portion of the internal annular recess 30104f of the tubular body 30104a. Spring members, 30110 and 30112, are received within the annular recess 30104f of the tubular body 30104a for biasing the base members, base member 30106a and 30108a, of the engagement members, 30106 and 30108, respectively, radially inwardly relative to the tubular body 30104a.

[00285] In an exemplary embodiment, during operation of the adjustable bell section expansion cone assembly 28, as illustrated in Fig. 17Z, the one-shot deactivation device 30104 are positioned proximate and in intimate contact with the pins, 30102a and 30102b, with the tapered ends, 30106b and 30108b, of the base members, 30106a and 30108a, of the engagement members, 30106 and 30108, received within the external annular recess 30008ac of the tubular toggle bushing 30008. When the one-shot deactivation device 30104 is positioned as illustrated in Fig. 17Z, the external annular recess 30104d of the tubular body 30104a of the one-shot deactivation device is moved out of engagement with the engagement arms, 30026d and 30032d, of the triggers, 30026 and 30032, respectively. As a result, the triggers, 30026 and 30032, may operate normally as described above with reference to Figs. 17W, 17X, and 17Y.

[00286] Conversely, in an exemplary embodiment, during operation of the adjustable casing expansion cone assembly 30, as illustrated in Figs. 17AA1 to 17AA4, the one-shot deactivation device 30104 are positioned proximate and in intimate contact with the pins, 30100a and 30100b, with the tapered ends, 30106b and 30108b, of the base members, 30106a and 30108a, of the engagement members, 30106 and 30108, not received within the external annular recess 30008ac of the tubular toggle bushing 30008. When the one-shot deactivation device 30104 is positioned as illustrated in Figs. 17AA1 to 17AA4, the external annular recess 30104d of the tubular body 30104a of the one-shot deactivation device is moved into engagement with the engagement arms, 30026d and 30032d, of the

triggers, 30026 and 30032, respectively. As a result, the triggers, 30026 and 30032, are deactivated and may not operate normally as described above with reference to Figs. 17W, 17X, and 17Y.

[00287] In an alternative embodiment, the elements of the adjustable casing expansion cone assembly 30 that sense the diameter of the expandable wellbore casing 100 may be disabled or omitted or adjusted to sense any pre-selected internal diameter of the expandable wellbore casing.

[00288] In an exemplary embodiment, as illustrated in 18A to 18C, the packer setting tool assembly 32 includes a tubular adaptor 3202 that defines a longitudinal passage 3202a, radial external mounting holes, 3202b and 3202c, radial passages, 3202d and 3202e, and includes an external threaded connection 3202f at one end and an internal annular recess 3202g having an internal threaded connection at another end. An external threaded connection 3204a of an end of a tubular upper mandrel 3204 that defines a longitudinal passage 3204b, internally threaded external mounting holes, 3204c and 3204d, and includes an external annular recess 3204e, external annular recess 3204f, external annular recess 3204g, external flange 3204h, external splines 3204i, and an internal threaded connection 3204j at another end is received within and is coupled to the internally threaded connection of the internal annular recess 3202g of the other end of the tubular adaptor 3202. Mounting screws, 3205a and 3205b, are received within and coupled to the mounting holes, 3204c and 3204d, of the tubular upper mandrel 3204 that also extend into the radial passages, 3202d and 3202e, of the tubular adaptor 3202.

[00289] An external threaded connection 3206a of an end of a mandrel 3206 that defines a longitudinal passage 3206b and includes an external annular recess 3206c and an external annular recess 3206d having an external threaded connection is received within and is coupled to the internal threaded connection 3204j of the tubular upper mandrel 3204. An internal threaded connection 3208a of a tubular stinger 3208 that defines a longitudinal passage 3208b and includes an external annular recess 3208c, and an external tapered annular recess 3208d and an engagement shoulder 3208e at another end receives and is coupled to the external threaded connection of the external annular recess 3206d of the mandrel 3206. A sealing member 3210 is mounted upon and coupled to the external annular recess 3206d of the mandrel 3206.

[00290] An internal flange 3212a of a tubular key 3212 that includes an external annular recess 3212b at one end and an internal annular recess 3212c at another end is movably received within and engages the external annular recess 3204f of the tubular upper mandrel 3204. A garter spring 3214 is received within and engages the external annular recess 3212b of the tubular key 3212.

[00291] An end of a tubular bushing 3216 that defines a longitudinal passage 3216a

for receiving and mating with the upper mandrel 3204, and radial passages, 3216b and 3216c, and includes an external threaded connection 3216d at an intermediate portion, and an external flange 3216e, an internal annular recess 3216f, circumferentially spaced apart teeth 3216g, and external flanges, 3216h and 3216i, at another end is received within and mates with the internal annular recess 3212c of the tubular key 3212. An internal threaded connection 3218a of a tubular drag block body 3218 that defines a longitudinal passage 3218b for receiving the tubular bushing 3216, mounting holes, 3218c and 3218d, mounting holes, 3218e and 3218f, and includes an internal threaded connection 3218g at one end, a centrally positioned external annular recess 3218h, and an external threaded connection 3218i at another end is received within and coupled to the external threaded connection 3216d of the tubular bushing 3216.

[00292] A first tubular keeper 3220 that defines mounting holes, 3220a and 3220b, is coupled to an end of the tubular drag block body 3218 by mounting screws, 3222a and 3222b, that are received within and are coupled to the mounting holes, 3218c and 3218d, of the tubular drag block body. A second tubular keeper 3224 that defines mounting holes, 3224a and 3224b, is coupled to an end of the tubular drag block body 3218 by mounting screws, 3226a and 3226b, that are received within and are coupled to the mounting holes, 3218e and 3218f, of the tubular drag block body.

[00293] Drag blocks, 3228 and 3230, that are received within the external annular recess 3218h of the tubular drag block body 3218, include ends that mate with and are received within the end of the first tubular keeper 3220, and other ends that mate with and are received within the end of the second tubular keeper 3224. The drag blocks, 3228 and 3230, further include internal annular recesses, 3228a and 3230a, respectively, that receive and mate with ends of springs, 3232 and 3234, respectively. The springs, 3232 and 3234, also receive and mate with the external annular recess 3218h of the tubular drag block body 3218.

[00294] An external threaded connection 3236a of an end of a tubular releasing cap extension 3236 that defines a longitudinal passage 3236b and includes an internal annular recess 3236c and an internal threaded connection 3236d at another end is received within and is coupled to the internal threaded connection 3218g of the tubular drag block body 3218. An external threaded connection 3238a of an end of a tubular releasing cap 3238 that defines a longitudinal passage 3238b and includes an internal annular recess 3238c is received within and coupled to the internal threaded connection 3236d of the tubular releasing cap extension 3236. A sealing element 3240 is received within the internal annular recess 3238c of the tubular releasing cap 3238 for fluidicly sealing the interface between the tubular releasing cap and the upper mandrel 3204.

[00295] An internal threaded connection 3242a of an end of a tubular setting sleeve

3242 that defines a longitudinal passage 3242b, radial passage 3242c, radial passages, 3242d and 3242e, radial passage 3242f, and includes an internal flange 3242g at another end receives the external threaded connection 3218i of the tubular drag block body 3218. An internal flange 3244a of a tubular coupling ring 3244 that defines a longitudinal passage 3244b and radial passages, 3244c and 3244d, receives and mates with the external flange 3216h of the tubular bushing 3216 and an end face of the internal flange of the tubular coupling ring is positioned proximate and in opposing relation to an end face of the external flange 3216i of the tubular bushing.

[00296] An internal flange 3246a of a tubular retaining collet 3246 that includes a plurality of axially extending collet fingers 3246b, each having internal flanges 3246c at an end of each collet finger, for engaging and receiving the tubular coupling ring 3244 receives and mates with external flange 3216e of the tubular bushing 3216 and an end face of the internal flange of the tubular retaining collet is positioned proximate and in opposing relation to an end face of the external flange 3216h of the tubular bushing.

[00297] In an exemplary embodiment, the packer assembly 36 operates and is provided substantially, at least in part, as disclosed in one or more of the following: WO 03/093623; WO 04/027200 and WO 04/081346.

[00298] In an exemplary embodiment, as illustrated in Figs. 19-1 to 19-5, the packer assembly 36 includes a tubular upper adaptor 3602 that defines a longitudinal passage 3602a having a tapered opening 3602b and mounting holes, 3602c and 3602d, that includes a plurality of circumferentially spaced apart teeth 3602e at one end, an external flange 3602f, and an internal threaded connection 3602g at another end. In an exemplary embodiment, the tubular upper adaptor 3602 is fabricated from aluminum. An external threaded connection 3604a of an end of a tubular upper mandrel 3604 that defines a longitudinal passage 3604b, mounting holes, 3604c and 3604d, mounting holes, 3604e and 3604f, and mounting holes, 3604g and 3604h, and includes an external flange 3604i, an internal annular recess 3604j, and an internal threaded connection 3604k at another end is

received within and coupled to the internal threaded connection 3602g of the tubular upper adaptor 3602. In an exemplary embodiment, the tubular upper mandrel 3604 is fabricated from aluminum.

[00299] An upper tubular spacer ring 3606 that defines mounting holes, 3606a and 3606b, receives and mates with the end of the tubular upper mandrel 3604 and includes an angled end face 3606c and another end face that is positioned proximate to an end face of the tubular upper adaptor 3602 is coupled to the tubular upper mandrel by shear pins, 3608a and 3608b, that are mounted within and coupled to the mounting holes, 3604c and 3606a, and, 3604d and 3606b, respectively, of the tubular upper mandrel and upper tubular spacer ring, respectively. A lower tubular spacer ring 3610 that includes an angled end face 3610a receives, mates, and is coupled to the other end of the tubular upper mandrel 3604 and includes another end face that is positioned proximate to an end face of the external flange 3604i of the tubular upper mandrel 3604. In an exemplary embodiment, the upper and tubular spacer rings, 3606 and 3610, are fabricated from a composite material.

[00300] An upper tubular slip 3612 that receives and is movably mounted upon the tubular upper mandrel 3604 defines a longitudinal passage 3612a having a tapered opening 3612b and includes external annular recesses, 3612c, 3612d, 3612e, 3612f, and 3612g, and an angled end face 3612h that mates with and is positioned proximate the angled end face 3606c of the upper tubular spacer ring 3606. Slip retaining bands, 3614a, 3614b, 3614c, 3614d, and 3614e, are received within and coupled to the external annular recesses, 3612c, 3612d, 3612e, 3612f, and 3612g, of the upper tubular slip 3612. A lower tubular slip 3616 that receives and is movably mounted upon the tubular upper mandrel 3604 defines a longitudinal passage 3616a having a tapered opening 3616b and includes external annular recesses, 3616c, 3616d, 3616e, 3616f, and 3616g, and an angled end face 3616h that mates with and is positioned proximate the angled end face 3610a of the lower tubular spacer ring 3610. Slip retaining bands, 3618a, 3618b, 3618c, 3618d, and 3618e, are received within and coupled to the external annular recesses, 3616c, 3616d, 3616e, 3616f, and 3616g, of the lower tubular slip 3616. In an exemplary embodiment, the upper and lower tubular slips, 3612 and 3616, are fabricated from composite materials, and at least some of the slip retaining bands, 3614a, 3614b, 3614c, 3614d, 3614e, 3618a, 3618b, 3618c, 3618d, and 3618e are fabricated from carbide insert materials.

[00301] An upper tubular wedge 3620 that defines an longitudinal passage 3620a for receiving the tubular upper mandrel 3604 and mounting holes, 3620b and 3620c, and includes an angled end face 3620d at one end that is received within and mates with the tapered opening 3612b of the upper tubular slip 3612, and an angled end face 3620e at another end is coupled to the tubular upper mandrel by shear pins, 3622a and 3622b, mounted within and coupled to the mounting holes, 3604e and 3620b, and, 3604f and

3620c, respectively, of the tubular upper mandrel and upper tubular wedge, respectively. A lower tubular wedge 3624 that defines an longitudinal passage 3624a for receiving the tubular upper mandrel 3604 and mounting holes, 3624b and 3624c, and includes an angled end face 3624d at one end that is received within and mates with the tapered opening 3616b of the lower tubular slip 3616, and an angled end face 3624e at another end is coupled to the tubular upper mandrel by shear pins, 3626a and 3626b, mounted within and coupled to the mounting holes, 3604g and 3624b, and, 3604h and 3624c, respectively, of the tubular upper mandrel and lower tubular wedge, respectively. In an exemplary embodiment, the upper and lower tubular wedges, 3620 and 3624, are fabricated from composite materials.

[00302] An upper tubular extrusion limiter 3628 that defines a longitudinal passage 3628a for receiving the tubular upper mandrel 3604 includes an angled end face 3628b at one end that mates with the angled end face 3620e of the upper tubular wedge 3620, an angled end face 3628c at another end having recesses 3628d, and external annular recesses, 3628e, 3628f and 3628g. Retaining bands, 3630a, 3630b, and 3630c, are mounted within and coupled to the external annular recesses, 3628e, 3628f and 3628g, respectively, of the upper tubular extrusion limiter 3628. Circular disc-shaped extrusion preventers 3632 are coupled and mounted within the recesses 3628d. A lower tubular extrusion limiter 3634 that defines a longitudinal passage 3634a for receiving the tubular upper mandrel 3604 includes an angled end face 3634b at one end that mates with the angled end face 3624e of the lower tubular wedge 3624, an angled end face 3634c at another end having recesses 3634d, and external annular recesses, 3634e, 3634f and 3634g. Retaining bands, 3636a, 3636b, and 3636c, are mounted within and coupled to the external annular recesses, 3634e, 3634f and 3634g, respectively, of the lower tubular extrusion limiter 3634. Circular disc-shaped extrusion preventers 3638 are coupled and mounted within the recesses 3634d. In an exemplary embodiment, the upper and lower extrusion limiters, 3628 and 3634, are fabricated from composite materials.

[00303] An upper tubular elastomeric packer element 3640 that defines a longitudinal passage 3640a for receiving the tubular upper mandrel 3604 includes an angled end face 3640b at one end that mates with and is positioned proximate the angled end face 3628c of the upper tubular extrusion limiter 3628 and an curved end face 3640c at another end. A lower tubular elastomeric packer element 3642 that defines a longitudinal passage 3642a for receiving the tubular upper mandrel 3604 includes an angled end face 3642b at one end that mates with and is positioned proximate the angled end face 3634c of the lower tubular extrusion limiter 3634 and an curved end face 3642c at another end.

[00304] A central tubular elastomeric packer element 3644 that defines a longitudinal passage 3644a for receiving the tubular upper mandrel 3604 includes a curved outer surface 3644b for mating with and engaging the curved end faces, 3640c and 3642c, of the upper

and lower tubular elastomeric packer elements, 3640 and 3642, respectively.

[00305] An external threaded connection 3646a of a tubular lower mandrel 3646 that defines a longitudinal passage 3646b having throat passages, 3646c and 3646d, and flow ports, 3646e and 3646f, and a mounting hole 3646g, and includes an internal annular recess 3646h at one end, and an external flange 3646i, internal annular recess 3646j, and internal threaded connection 3646k at another end. In an exemplary embodiment, the tubular lower mandrel 3646 is fabricated from aluminum. A sealing element 3648 is received within the inner annular recess 3604j of the other end of the tubular upper mandrel 3604 for sealing an interface between the tubular upper mandrel and the tubular lower mandrel 3646.

[00306] A tubular sliding sleeve valve 3650 that defines a longitudinal passage 3650a and radial flow ports, 3650b and 3650c, and includes collet fingers 3650d at one end for engaging the internal annular recess 3646h of the lower tubular mandrel 3646, an external annular recess 3650e, an external annular recess 3650f, an external annular recess 3650g, and circumferentially spaced apart teeth 3650h at another end is received within and is slidably coupled to the longitudinal passage 3646b of the tubular lower mandrel 3646. In an exemplary embodiment, the tubular sliding sleeve valve 3650 is fabricated from aluminum. A set screw 3652 is mounted within and coupled to the mounting hole 3646g of the tubular lower mandrel 3646 that is received within the external annular recess 3650e of the tubular sliding sleeve 3650. Sealing elements, 3654 and 3656, are mounted within the external annular recesses, 3650f and 3650g, respectively, of the tubular sliding sleeve valve 3650 for sealing an interface between the tubular sliding sleeve valve and the tubular lower mandrel 3646.

[00307] An end of a tubular outer sleeve 3658 that defines a longitudinal passage 3658a, radial passages, 3658b and 3658c, upper flow ports, 3658d and 3658e, lower flow ports, 3658f and 3658g, and radial passages, 3658h and 3658i, receives, mates with, and is coupled to the other end of the tubular upper mandrel 3604 and an end face of the end of the tubular outer sleeve is positioned proximate and end face of the lower tubular spacer ring 3610. The other end of the tubular outer sleeve 3658 receives, mates with, and is coupled to the other end of the tubular lower mandrel 3646.

[00308] An external threaded connection 3660a of an end of a tubular bypass mandrel 3660 that defines a longitudinal passage 3660b, upper flow ports, 3660c and 3660d, lower flow ports, 3660e and 3660f, and a mounting hole 3660g and includes an internal annular recess 3660h and an external threaded connection 3660i at another end is received within and coupled to the internal threaded connection 3646k of the tubular lower mandrel 3646. A sealing element 3662 is received within the internal annular recess 3646j of the tubular lower mandrel 3646 for sealing an interface between the tubular lower mandrel and the tubular bypass mandrel 3660.

[00309] A tubular plug seat 3664 that defines a longitudinal passage 3664a having a tapered opening 3664b at one end, and flow ports, 3664c and 3664d, and includes an external annular recess 3664e, an external annular recess 3664f, an external annular recess 3664g, an external annular recess 3664h, and an external annular recess 3664i having an external threaded connection at another end is received within and is movably coupled to the longitudinal passage 3660b of the tubular bypass mandrel 3660. A tubular nose 3666 is threadably coupled to and mounted upon the external annular recess 3664i of the tubular plug seat 3664. In an exemplary embodiment, the tubular plug seat 3664 is fabricated from aluminum. Sealing elements, 3668, 3670, and 3672, are received within the external annular recesses, 3664e, 3664g, and 3664h, respectively, of the tubular plug seat 3664 for sealing an interface between the tubular plug seat and the tubular bypass mandrel 3660. A set screw 3674 is mounted within and coupled to the mounting hole 3660g of the tubular bypass mandrel 3660 that is received within the external annular recess 3664f of the tubular plug seat 3664.

[00310] An end of a tubular bypass sleeve 3676 that defines a longitudinal passage 3676a and includes an internal annular recess 3676b at one end and an internal threaded connection 3676c at another end is coupled to the other end of the tubular outer sleeve 3658 and mates with and receives the tubular bypass mandrel 3660. In an exemplary embodiment, the tubular bypass sleeve 3676 is fabricated from aluminum.

[00311] An external threaded connection 3678a of a tubular valve seat 3678 that defines a longitudinal passage 3678b including a valve seat 3678c and up-jet flow ports, 3678d and 3678e, and includes a spring retainer 3678f and an external annular recess 3678g is received within and is coupled to the internal threaded connection 3676c of the tubular bypass sleeve 3676. In an exemplary embodiment, the tubular valve seat 3678 is fabricated from aluminum. A sealing element 3680 is received within the external annular recess 3678g of the tubular valve seat 3678 for fluidicly sealing an interface between the tubular valve seat and the tubular bypass sleeve 3676.

[00312] A poppet valve 3682 mates with and is positioned within the valve seat 3678c of the tubular valve seat 3678. An end of the poppet valve 3682 is coupled to an end of a stem bolt 3684 that is slidingly supported for longitudinal displacement by the spring retainer 3678f A valve spring 3686 that surrounds a portion of the stem bolt 3684 is positioned in opposing relation to the head of the stem bolt and a support 3678fa of the spring retainer 3678f.for biasing the poppet valve 3682 into engagement with the valve seat 3678c of the tubular valve seat 3678.

[00313] An end of a composite nose 3688 that defines a longitudinal passage 3688a and mounting holes, 3688b and 3688c, and includes an internal threaded connection 3688d at another end receives, mates with, and is coupled to the other end of the tubular valve seat

3678. A tubular nose sleeve 3690 that defines mounting holes, 3690a and 3690b, is coupled to the composite nose 3688 by shear pins, 3692a and 3692b, that are mounted in and coupled to the mounting holes, 3688b and 3690a, and, 3688c and 3690b, respectively, of the composite nose and tubular nose sleeve, respectively.

[00314] An external threaded connection 3694a of a baffle nose 3694 that defines longitudinal passages, 3694b and 3694c, is received within and is coupled to the internal threaded connection internal threaded connection 3688d of the composite nose 3688.

[00315] In an exemplary embodiment, as illustrated in Figs. 19A1 to 19A5, during the operation of the packer setting tool assembly 32 and packer assembly 36, the packer setting tool and packer assembly are coupled to one another by inserting the end of the tubular upper adaptor 3602 into the other end of the tubular coupling ring 3244, bringing the circumferentially spaced teeth 3216g of the other end of the tubular bushing 3216 into engagement with the circumferentially spaced teeth 3602e of the end of the tubular upper adaptor, and mounting shear pins, 36100a and 36100b, within the mounting holes, 3244c and 3602c, and, 3244d and 3602d, respectively, of the tubular coupling ring and tubular upper adaptor, respectively. As a result, the tubular mandrel 3206 and tubular stinger 3208 of the packer setting tool assembly 32 are thereby positioned within the longitudinal passage 3604a of the tubular upper mandrel 3604 with the 3208e of the tubular stinger positioned within the longitudinal passage 3646b of the tubular lower mandrel 3646 proximate the collet fingers 3650d of the tubular sliding sleeve valve 3650.

[00316] Furthermore, in an exemplary embodiment, during the operation of the packer setting tool 32 and packer assembly 36, as illustrated in Figs. 20A1 to 20A5, the packer setting tool and packer assembly are positioned within the expandable wellbore casing 100 and an internal threaded connection 30a of an end of the adjustable casing expansion cone assembly 30 receives and is coupled to the external threaded connection 3202f of the end of the tubular adaptor 3202 of the packer setting tool assembly. Furthermore, shear pins, 36102a and 36102b, mounted within the mounting holes, 3658b and 3658c, of the tubular outer sleeve 3658 couple the tubular outer sleeve to the expandable wellbore casing. As a result, torsion loads may transferred between the tubular outer sleeve 3658 and the expandable wellbore casing 100.

[00317] In an exemplary embodiment, as illustrated in Figs. 20B1 to 20B5, a conventional plug 36104 is then injected into the setting tool assembly 32 and packer assembly 36 by injecting a fluidic material 36106 into the setting tool assembly and packer assembly through the longitudinal passages, 3202a, 3204b, 3206b, 3208b, 3650a, 3646a, 3660b, and 3664a of the tubular adaptor 3202, tubular upper mandrel 3204, tubular mandrel 3206, tubular stinger 3208, tubular sliding sleeve valve 3650, tubular lower mandrel 3646, tubular bypass mandrel 3660, and tubular plug seat 3664, respectively. The plug 36104 is

thereby positioned within the longitudinal passage 3664a of the tubular plug seat 3664. Continued injection of the fluidic material 36106 following the seating of the plug 1606 within the longitudinal passage 3664a of the tubular plug seat 3664 causes the plug and the tubular plug seat to be displaced downwardly in a direction 36108 until further movement of the tubular plug seat is prevented by interaction of the set screw 3674 with the external annular recess 3664f of the tubular plug seat. As a result, the flow ports, 3664c and 3664d, of the tubular plug seat 3664 are moved out of alignment with the upper flow ports, 3660c and 3660d, of the tubular bypass mandrel 3660.

[00318] In an exemplary embodiment, as illustrated in Figs. 20C1 to 20C5, after the expandable wellbore casing 100 has been radially expanded and plastically deformed to form at least the bell section 112 of the expandable wellbore casing 100 thereby shearing the shear pins, 36102a and 36102b, the setting tool assembly 32 and packer assembly 36 are then moved upwardly to a position within the expandable wellbore casing 100 above the bell section. The tubular adaptor 3202 is then rotated, by rotating the tool string of the system 10 above the setting tool assembly 32, to displace and position the drag blocks, 3228 and 3230, into engagement with the interior surface of the expandable wellbore casing 100.

[00319] As a result of the engagement of the drag blocks, 3228 and 3230, with the interior surface of the expandable wellbore casing 100, further rotation of the drag blocks relative to the wellbore casing is prevented. Consequently, due to the operation and interaction of the threaded connections, 3216d and 3218a, of the tubular bushing 3216 and tubular drag block body 3218, respectively, further rotation of the tubular adaptor 3202 causes the tubular drag block body and setting sleeve 3242 to be displaced downwardly in a direction 36112 relative to the remaining elements of the setting tool assembly 32 and packer assembly 36. As a result, the setting sleeve 3242 engages and displaces the upper tubular spacer ring 3606 thereby shearing the shear pins, 3622a and 3622b, and driving the upper tubular slip 3612 onto and up the angled end face 3620d of the upper tubular wedge 3620 and into engagement with the interior surface of the expandable wellbore casing 100. As a result, longitudinal displacement of the upper tubular slip 3612 relative to the expandable wellbore casing 100 is prevented. Furthermore, as a result, the 3246b collet fingers of the tubular retaining collet 3246 are disengaged from the tubular upper adaptor 3602.

[00320] In an alternative embodiment, after the drag blocks, 3228 and 3230, engage the interior surface of the expandable wellbore casing 100, an upward tensile force is applied to the tubular support member 12, and the ball gripper assembly 16 is then operate to engage the interior surface of the expandable wellbore casing. The tension actuator assembly 18 is then operated to apply an upward tensile force to the tubular adaptor 3202

thereby pulling the upper tubular spacer ring 3606, lower tubular spacer ring 3610, upper tubular slip 3612, lower tubular slip 3616, upper tubular wedge 3620, lower tubular wedge 3624, upper tubular extrusion limiter 3628, lower tubular extrusion limiter 3634, and central tubular elastomeric element 3644 upwardly into contact with the 3242 thereby compressing the upper tubular spacer ring, lower tubular spacer ring, upper tubular slip, lower tubular slip, upper tubular wedge, lower tubular wedge, upper tubular extrusion limiter, lower tubular extrusion limiter, and central tubular elastomeric element. As a result, the upper tubular slip 3612, lower tubular slip 3616, and central tubular elastomeric element 3644 engage the interior surface of the expandable wellbore casing 100.

[00321] In an exemplary embodiment, as illustrated in Figs. 20D1 to 20D5, an upward tensile force is then applied to the tubular adaptor 3202 thereby compressing the lower tubular slip 3616, lower tubular wedge 3624, central elastomeric packer element 3644, upper tubular extrusion limiter 3628, and upper tubular wedge 3620 between the lower tubular spacer ring 3610 and the stationary upper tubular slip 3612. As a result, the lower tubular slip 3616 is driven onto and up the angled end face 3624d of the lower tubular wedge 3624 and into engagement with the interior surface of the expandable wellbore casing 100, and the central elastomeric packer element 3644 is compressed radially outwardly into engagement with the interior surface of the expandable tubular member. As a result, further longitudinal displacement of the upper tubular slip 3612, lower tubular slip 3616, and central elastomeric packer element 3644 relative to the expandable wellbore casing 100 is prevented.

[00322] In an exemplary embodiment, as illustrated in Figs. 20E1 to 20E6, continued application of the upward tensile force to tubular adaptor 3202 will then shear the shear pins, 1602a and 1602b, thereby disengaging the setting tool assembly 32 from the packer assembly 36.

[00323] In an exemplary embodiment, as illustrated in Figs. 20F1 to 20F6, with the drag blocks, 3228 and 3230, in engagement with the interior surface of the expandable wellbore casing 100, the tubular adaptor 102 is further rotated thereby causing the tubular drag block body 3218 and setting sleeve 3242 to be displaced further downwardly in the direction 36113 until the tubular drag block body and setting sleeve are disengaged from the tubular stinger 3208. As a result, the tubular stinger 3208 of the setting tool assembly 32 may then be displaced downwardly into complete engagement with the tubular sliding sleeve valve 3650.

[00324] In an exemplary embodiment, as illustrated in Figs. 20G1 to 20G6, a fluidic material 36114 is then injected into the setting tool assembly 32 and the packer assembly 36 through the longitudinal passages 3202a, 3204b, 3206b, 3208b, 3604b, 3650a, and 3646b of the tubular adaptor 3202, tubular upper mandrel 3204, tubular mandrel 3206, tubular

stinger 3208, tubular upper mandrel 3604, tubular sliding sleeve valve 3650, and tubular lower mandrel 3646, respectively. Because, the plug 36104 is seated within and blocks the longitudinal passage 3664a of the tubular plug seat 3664, the longitudinal passages 3604b, 3650a, and 3646b of the tubular upper mandrel 3604, tubular sliding sleeve valve 3650, and tubular lower mandrel 3646 are pressurized thereby displacing the tubular upper adaptor 3602 and tubular upper mandrel 3604 downwardly until the end face of the tubular upper mandrel impacts the end face of the upper tubular spacer ring 3606.

[00325] In an exemplary embodiment, as illustrated in Figs. 20H1 to 20H5, the setting tool assembly 32 is brought back into engagement with the packer assembly 36 until the engagement shoulder 3208e of the other end of the tubular stinger 3208 engages the collet fingers 3650d of the end of the tubular sliding sleeve valve 3650. As a result, further downward displacement of the tubular stinger 3208 displaces the tubular sliding sleeve valve 3650 downwardly until the radial flow ports, 3650b and 3650c, of the tubular sliding sleeve valve are aligned with the flow ports, 3646e and 3646f, of the tubular lower mandrel 3646. A hardenable fluidic sealing material 36116 may then be injected into the setting tool assembly 32 and the packer assembly 36 through the longitudinal passages 3202a, 3204b, 3206b, 3208b, and 3650a of the tubular adaptor 3202, tubular upper mandrel 3204, tubular mandrel 3206, tubular stinger 3208, and tubular sliding sleeve valve 3650, respectively. The hardenable fluidic sealing material may then flow out of the packer assembly 36 through the upper flow ports, 3658d and 3658e, into the annulus between the expandable wellbore casing 100 and the wellbore 102.

[00326] The tubular sliding sleeve valve 3650 may then be returned to its original position, with the radial flow ports, 3650b and 3650c, of the tubular sliding sleeve valve out of alignment with the flow ports, 3646e and 3646f, of the tubular lower mandrel 3646. The hardenable fluidic sealing material 36116 may then be allowed to cure before, during, or after the continued operation of the system 10 to further radially expand and plastically deform the expandable wellbore casing.

[00327] In an alternative embodiment, as illustrated in Figs. 21 and 21A to 21AX, the packer assembly 36 includes an upper tubular spacer ring 36200 receives and mates with the end of the tubular upper mandrel 3604 and includes an angled end face 36200a that includes a plurality of spaced apart radial grooves 36200b and another end face that is positioned proximate to an end face of the tubular upper adaptor 3602 is coupled to the tubular upper mandrel by shear pins, 36202a, 36202b, 36202c, and 36202d. A lower tubular spacer ring 36204 that includes an angled end face 36204a that includes a plurality of spaced apart radial grooves 36204b receives, mates, and is coupled to the other end of the tubular upper mandrel 3604 and includes another end face that is positioned proximate to an end face of the external flange 3604i of the tubular upper mandrel 3604. In an exemplary

embodiment, the upper and tubular spacer rings, 3606 and 3610, are fabricated from a composite material.

[00328] An upper tubular slip assembly 36206 that receives and is movably mounted upon the tubular upper mandrel 3604 includes a plurality of substantially identical slip elements 36206a that each include an exterior arcuate cylindrical surface 36206aa including mounting holes, 36206ab, 36206ac, 36206ad, 36206ae, 36206af, 36206ag, 36206ah, 36206ai, and 36206aj, and grooves, 36206aj and 36206ak, a front end face 36206al, a rear end face 36206am including a mounting hole 36206an, side faces, 36206ao and 36206ap, an interior arcuate cylindrical surface 36206aq that mates with the exterior surface of the tubular upper mandrel 3604, and an interior tapered surface 36206ar including a mounting hole 36206as. Mounting pins 36206at are received within and coupled to the mounting holes 36206an and are received within corresponding radial grooves 36200b of the angled end face 36200a of the upper tubular spacer ring 36200. Retaining pins 36206au are mounted within and coupled to the mounting holes 36206as that include heads 36206av. Slip retaining bands, 36206aw and 36206ax, are received within and coupled to grooves, 36206aj and 36206ak, respectively, of the slip elements 36206a. Slip gripping elements, 36206ay, 36206az, 36206aaa, 36206aab, 36206aac, 36206aad, 36206aae, 36206aaf, and 36206aag, are mounted within, coupled to, and extend out of the mounting holes, 36206ab, 36206ac, 36206ad, 36206ae, 36206af, 36206ag, 36206ah, 36206ai, and 36206aj, respectively. In an exemplary embodiment, the adjacent exterior arcuate cylindrical surfaces 36206aa of the identical slip elements 36206a of the upper tubular slip assembly 36206 together define a substantially contiguous cylindrical surface.

[00329] A lower tubular slip assembly 36208 that receives and is movably mounted upon the tubular upper mandrel 3604 includes a plurality of substantially identical slip elements 36208a that each include an exterior arcuate cylindrical surface 36208aa including mounting holes, 36208ab, 36208ac, 36208ad, 36208ae, 36208af, 36208ag, 36208ah, 36208ai, and 36208aj, and grooves, 36208aj and 36208ak, a front end face 36208al, a rear end face 36208am including a mounting hole 36208an, side faces, 36208ao and 36208ap, an interior arcuate cylindrical surface 36208aq that mates with the exterior surface of the tubular upper mandrel 3604, and an interior tapered surface 36208ar including a mounting hole 36208as. Mounting pins 36208at are received within and coupled to the mounting holes 36208an and are received within corresponding radial grooves 36204b of the angled end face 36204a of the lower tubular spacer ring 36204. Retaining pins 36208au are mounted within and coupled to the mounting holes 36208as that include heads 36208av. Slip retaining bands, 36208aw and 36208ax, are received within and coupled to grooves, 36208aj and 36208ak, respectively, of the slip elements 36208a. Slip gripping elements, 36208ay, 36208az, 36208aaa, 36208aab, 36208aac, 36208aad, 36208aae, 36208aaf, and

36208aag, are mounted within, coupled to, and extend out of the mounting holes, 36208ab, 36208ac, 36208ad, 36208ae, 36208af, 36208ag, 36208ah, 36208ai, and 36208aj, respectively. In an exemplary embodiment, the adjacent exterior arcuate cylindrical surfaces 36208aa of the identical slip elements 36208a of the upper tubular slip assembly 36208 together define a substantially contiguous cylindrical surface.

[00330] An upper tubular wedge 36210 that receives the tubular upper mandrel 3604 includes an angled front end face 36210a including spaced apart radial grooves 36210b, a rear end face 36210c, an exterior cylindrical surface 36210d, a plurality of spaced apart faceted tapered exterior surface segments 36210e that mate with corresponding tapered internal surfaces 36206ar of corresponding slip elements 36206a of the upper tubular slip assembly 36206, and T-shaped exterior grooves 36210f aligned with the midline of corresponding faceted tapered exterior surface segments that extend from the angled end face to the rear end face that receive and mate with corresponding retaining pins 36206au of corresponding slip elements of the upper tubular slip assembly. The upper tubular wedge 36210 is releasably coupled to the tubular upper mandrel 3604 by shear pins 36211.

[00331] A lower tubular wedge 36212 that receives the tubular upper mandrel 3604 includes an angled front end face 36212a including spaced apart radial grooves 36212b, a rear end face 36212c, an exterior cylindrical surface 36212d, a plurality of spaced apart faceted tapered exterior surface segments 36212e that mate with corresponding tapered internal surfaces 36208ar of corresponding slip elements 36208a of the upper tubular slip assembly 36208, and T-shaped exterior grooves 36212f aligned with the midline of corresponding faceted tapered exterior surface segments that extend from the angled end face to the rear end face that receive and mate with corresponding retaining pins 36208au of corresponding slip elements of the lower tubular slip assembly. The lower tubular wedge 36212 is releasably coupled to the tubular upper mandrel 3604 by shear pins 36213.

[00332] An upper tubular extrusion limiter assembly 36214 that receives and is movably mounted upon the tubular upper mandrel 3604 includes a plurality of substantially identical extrusion limiter elements 36214a that each include an angled front end face 36214aa having a recessed portion 36214ab, an angled rear end face 36214ac that defines a mounting hole 36214ad, an interior arcuate cylindrical surface 36214ae that mates with the tubular upper mandrel, and an exterior arcuate cylindrical surface 36214af including grooves, 36214ag, 36214ah, and 36214ai. Disk extrusion preventers 36214aj are mounted within and coupled to the recessed portions 36214ab of adjacent extrusion limiter elements 36214a, and mounting pins 36214ak are mounted within and coupled to mounting holes 36214ad of corresponding extrusion limiter elements 36214a that are received within corresponding radial grooves 36210b of the front end face 36210a of the upper tubular wedge 36210. Retaining bands, 36214al, 36214am, and 36214an, are positioned within and

coupled to the grooves, 36214ai, 36214ah, and 36214ag, respectively, of the extrusion limiter elements 36214a.

[00333] A lower tubular extrusion limiter assembly 36216 that receives and is movably mounted upon the tubular upper mandrel 3604 includes a plurality of substantially identical extrusion limiter elements 36216a that each include an angled front end face 36216aa having a recessed portion 36216ab, an angled rear end face 36216ac that defines a mounting hole 36216ad, an interior arcuate cylindrical surface 36216ae that mates with the tubular upper mandrel, and an exterior arcuate cylindrical surface 36216af including grooves, 36216ag, 36216ah, and 36216ai. Disk extrusion preventers 36216aj are mounted within and coupled to the recessed portions 36216ab of adjacent extrusion limiter elements 36216a, and mounting pins 36216ak are mounted within and coupled to mounting holes 36216ad of corresponding extrusion limiter elements 36216a that are received within corresponding radial grooves 36212b of the front end face 36212a of the lower tubular wedge 36212. Retaining bands, 36216al, 36216am, and 36216an, are positioned within and coupled to the grooves, 36216ag, 36216ah, and 36216ai, of the extrusion limiter elements 36216a.

[00334] The angled end face 3640b of the upper tubular elastomeric packer element 3640 mates with and is positioned proximate the angled end faces 36214aa and disk extrusion preventers 36214aj of the extrusion limiter elements 36214a of the upper tubular extrusion limiter assembly 36214, and the angled end face 3642b of the lower tubular elastomeric packer element 3642 mates with and is positioned proximate the angled end faces 36216aa and disk extrusion preventers 36216aj of the extrusion limiter elements 36216a of the lower tubular extrusion limiter assembly 36216.

[00335] During operation of the alternative embodiment of the packer assembly 36 described above with reference to Figs. 21 and 21A to 21AX, the first step in setting the packer assembly 36 includes pushing the slip elements, 36206a and 36208a, of the upper and lower slip assemblies, 36206 and 36208, respectively, up the upper and lower tubular wedges, 36210 and 36212, respectively, which breaks the retaining rings, 36206aw and 36206ax, and 36208aw and 36208ax, respectively, and moves the slip elements outwardly against the interior surface of the expandable wellbore casing 100. In an exemplary embodiment, during the radial displacement of the slip elements, 36206a and 36208a, the retaining pins, 36206au and 36208au, respectively, and the mounting pins, 36206at and 36208at, respectively, maintain the slip elements in an evenly spaced apart configuration. In an exemplary embodiment, during the operation of the packer assembly 36, the mounting pins, 36214ak and 36216ak, maintain the extrusion limiter elements, 36214a and 36216a, of the upper and lower tubular extrusion limiter assemblies, 36214 and 36216, respectively, in an evenly spaced apart configuration. The operation of the alternative embodiment of the

packer assembly 36 described above with reference to Figs. 21 and 21A to 21AX is otherwise substantially identical to the operation of the packer assembly described above with reference to Figs. 20A1 to 20A5, 20B1 to 20B5, 20C1 to 20C5, 20D1 to 20D5, 20E1 to 20E6, 20F1 to 20F6, 20G1 to 20G6, and 20H1 to 20H5.

[00336] In an exemplary embodiment, the system 10 is provided as illustrated in Appendix A to the present application which corresponds generally to the extension actuator assembly 26 described above with reference to Figs. 15-1, 15-2, 15A1, 15A2, 15B1, 15B2, 15C1, 15C2, 15D, 15E1 to 15E5, 15F1 to 15F5, and 15G1 to 15G5.

[00337] An apparatus for radially expanding and plastically deforming an expandable tubular member has been described that includes a support member, a cutting device for cutting the tubular member coupled to the support member, and an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member. In an exemplary embodiment, the apparatus further includes a gripping device for gripping the tubular member coupled to the support member. In an exemplary embodiment, the gripping device comprises a plurality of movable gripping elements. In an exemplary embodiment, the gripping elements are moveable in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in an axial direction relative to the support member. In an exemplary embodiment, if the tubular member is displaced in a first axial direction, the gripping device grips the tubular member; and, if the tubular member is displaced in a second axial direction, the gripping device does not grip the tubular member.

In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, the gripping elements are biased to remain in the first position. In an exemplary embodiment, the gripping device further includes an actuator for moving the gripping elements from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein the actuator is a fluid powered actuator. In an exemplary embodiment, the apparatus further includes a sealing device for sealing an interface with the tubular member coupled to the support member. In an exemplary embodiment, the sealing device seals an annulus defines between the support member and the tubular member. In an exemplary embodiment, the apparatus further includes a locking device for locking the position of the tubular member relative to the support member. In an exemplary embodiment, the apparatus further includes a packer assembly coupled to the support member. In an exemplary embodiment, the packer assembly includes a packer; and a packer control device for controlling the operation of the packer coupled to the support member. In an exemplary embodiment, the packer includes: a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support member. In an exemplary embodiment, the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the packer. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve positioned within the passage of the support member; and wherein the packer control device includes: a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the sliding sleeve valve. In an exemplary embodiment, the apparatus further includes an actuator for displacing the expansion device relative to the support member. In an exemplary embodiment, the actuator includes a first actuator for pulling the expansion device; and a second actuator for pushing the expansion device. In an exemplary embodiment, the actuator includes means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the first and second actuators include means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the actuator includes a plurality of pistons positioned

within corresponding piston chambers. In an exemplary embodiment, the cutting device includes a support member; and a plurality of movable cutting elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the cutting elements between a first position and a second position; wherein in the first position, the cutting elements do not engage the tubular member; and wherein in the second position, the cutting elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the cutting elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the cutting elements includes a first set of cutting elements; and a second set of cutting elements; wherein the first set of cutting elements are interleaved with the second set of cutting elements. In an exemplary embodiment, in the first position, the first set of cutting elements are not axially aligned with the second set of cutting elements. In an exemplary embodiment, in the second position, the first set of cutting elements are axially aligned with the second set of cutting elements. In an exemplary embodiment, the expansion device includes a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements. In an exemplary embodiment, the expansion device includes an adjustable expansion device. In an exemplary embodiment, the expansion device includes a plurality of expansion devices. In an exemplary embodiment, at least one of the expansion devices includes an adjustable expansion device. In an exemplary embodiment, the adjustable expansion device includes a support member; and a plurality of movable expansion elements coupled to the support

member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements.

[00338] An apparatus for radially expanding and plastically deforming an expandable tubular member has been described that includes a support member, an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member, and an actuator coupled to the support member for displacing the expansion device relative to the support member. In an exemplary embodiment, the apparatus further includes a cutting device coupled to the support member for cutting the tubular member. In an exemplary embodiment, the cutting device includes a support member; and a plurality of movable cutting elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the cutting elements between a first position and a second position; wherein in the first position, the cutting elements do not engage the tubular member; and wherein in the second position, the cutting elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the cutting elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the cutting elements include a first set of cutting elements; and a second set of cutting elements; wherein the first set of cutting elements are interleaved with the second set of cutting elements. In an exemplary embodiment, in the first position, the first set of cutting elements are not axially aligned with the second set of cutting elements. In an exemplary embodiment, in the second position, the first set of cutting elements are axially aligned with the second set of cutting elements. In an exemplary embodiment, the apparatus further

includes a gripping device for gripping the tubular member coupled to the support member. In an exemplary embodiment, the gripping device includes a plurality of movable gripping elements. In an exemplary embodiment, the gripping elements are moveable in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in an axial direction relative to the support member. In an exemplary embodiment, if the tubular member is displaced in a first axial direction, the gripping device grips the tubular member; and wherein, if the tubular member is displaced in a second axial direction, the gripping device does not grip the tubular member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, the gripping elements are biased to remain in the first position. In an exemplary embodiment, the gripping device further includes an actuator for moving the gripping elements from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein the actuator is a fluid powered actuator. In an exemplary embodiment, the apparatus further includes a sealing device for sealing an interface with the tubular member coupled to the support member. In an exemplary embodiment, the sealing device seals an annulus defines between the support member and the tubular member. In an exemplary embodiment, the apparatus further includes a locking device for locking the position of the tubular member

relative to the support member. In an exemplary embodiment, the apparatus further includes a packer assembly coupled to the support member. In an exemplary embodiment, the packer assembly includes a packer; and a packer control device for controlling the operation of the packer coupled to the support member. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support member. In an exemplary embodiment, the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the packer. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve positioned within the passage of the support member; and wherein the packer control device comprises: a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the sliding sleeve valve. In an exemplary embodiment, the expansion device includes a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, the in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements. In an exemplary embodiment, the expansion device includes an adjustable expansion device. In an exemplary embodiment, the expansion device includes a plurality of expansion devices. In an exemplary embodiment, at least one of the expansion devices includes an adjustable expansion device. In an exemplary embodiment, the adjustable expansion device includes a support member; and a plurality of movable

expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements.

[00339] An apparatus for radially expanding and plastically deforming an expandable tubular member has been described that includes a support member; an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; and a sealing assembly for sealing an annulus defined between the support member and the tubular member. In an exemplary embodiment, the apparatus further includes a gripping device for gripping the tubular member coupled to the support member. In an exemplary embodiment, the gripping device includes a plurality of movable gripping elements. In an exemplary embodiment, the gripping elements are moveable in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first

position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in an axial direction relative to the support member. In an exemplary embodiment, the if the tubular member is displaced in a first axial direction, the gripping device grips the tubular member; and wherein, if the tubular member is displaced in a second axial direction, the gripping device does not grip the tubular member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, the gripping elements are biased to remain in the first position. In an exemplary embodiment, the gripping device further includes an actuator for moving the gripping elements from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein the actuator is a fluid powered actuator. In an exemplary embodiment, the apparatus further includes a locking device for locking the position of the tubular member relative to the support member. In an exemplary embodiment, the apparatus further includes a packer assembly coupled to the support member. In an exemplary embodiment, the packer assembly includes a packer; and a packer control device for controlling the operation of the packer coupled to the support member. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support member. In an exemplary embodiment, the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the packer. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve positioned within the passage of the support member; and wherein the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the sliding sleeve valve. In an exemplary embodiment, the apparatus further includes an actuator for displacing the expansion device relative to the support member. In an exemplary embodiment, the actuator includes a first actuator for pulling the expansion device; and a second actuator for pushing the expansion device. In an exemplary embodiment, the actuator includes means

for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the first and second actuators comprise means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the actuator includes a plurality of pistons positioned within corresponding piston chambers. In an exemplary embodiment, the cutting device includes a support member; and a plurality of movable cutting elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the cutting elements between a first position and a second position; wherein in the first position, the cutting elements do not engage the tubular member; and wherein in the second position, the cutting elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the cutting elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the cutting elements include a first set of cutting elements; and a second set of cutting elements; wherein the first set of cutting elements are interleaved with the second set of cutting elements. In an exemplary embodiment, in the first position, the first set of cutting elements are not axially aligned with the second set of cutting elements. In an exemplary embodiment, in the second position, the first set of cutting elements are axially aligned with the second set of cutting elements. In an exemplary embodiment, the expansion device includes a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements includes a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements. In an exemplary embodiment, the expansion device includes an adjustable expansion device. In an

exemplary embodiment, the expansion device includes a plurality of expansion devices. In an exemplary embodiment, at least one of the expansion devices includes an adjustable expansion device. In an exemplary embodiment, the adjustable expansion device includes a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements.

[00340] An apparatus for radially expanding and plastically deforming an expandable tubular member has been described that includes a support member; a first expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; and a second expansion device for radially expanding and plastically deforming the tubular member coupled to the support member. In an exemplary embodiment, the apparatus further includes a gripping device for gripping the tubular member coupled to the support member. In an exemplary embodiment, the gripping device includes a plurality of movable gripping elements. In an exemplary embodiment, the gripping elements are moveable in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the

first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in an axial direction relative to the support member. In an exemplary embodiment, if the tubular member is displaced in a first axial direction, the gripping device grips the tubular member; and wherein, if the tubular member is displaced in a second axial direction, the gripping device does not grip the tubular member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, the gripping elements are biased to remain in the first position. In an exemplary embodiment, the gripping device further includes an actuator for moving the gripping elements from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein the actuator is a fluid powered actuator. In an exemplary embodiment, the apparatus further includes a sealing device for sealing an interface with the tubular member coupled to the support member. In an exemplary embodiment, the sealing device seals an annulus defines between the support member and the tubular member. In an exemplary embodiment, the apparatus further includes a locking device for locking the position of the tubular member relative to the support member. In an exemplary embodiment, the apparatus further includes a packer assembly coupled to the support member. In an exemplary embodiment, the packer assembly includes a packer; and a packer control device for controlling the operation of the packer coupled to the support member. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support member. In an exemplary embodiment, the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the packer. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve

valve positioned within the passage of the support member; and wherein the packer control device comprises: a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the sliding sleeve valve. In an exemplary embodiment, the apparatus further includes an actuator for displacing the expansion device relative to the support member. In an exemplary embodiment, the actuator includes a first actuator for pulling the expansion device; and a second actuator for pushing the expansion device. In an exemplary embodiment, the actuator includes means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the first and second actuators include means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the actuator includes a plurality of pistons positioned within corresponding piston chambers. In an exemplary embodiment, the apparatus further includes a cutting device for cutting the tubular member coupled to the support member. In an exemplary embodiment, the cutting device includes a support member; and a plurality of movable cutting elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the cutting elements between a first position and a second position; wherein in the first position, the cutting elements do not engage the tubular member; and wherein in the second position, the cutting elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the cutting elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the cutting elements include a first set of cutting elements; and a second set of cutting elements; wherein the first set of cutting elements are interleaved with the second set of cutting elements. In an exemplary embodiment, in the first position, the first set of cutting elements are not axially aligned with the second set of cutting elements. In an exemplary embodiment, in the second position, the first set of cutting elements are axially aligned with the second set of cutting elements. In an exemplary embodiment, at least one of the first second expansion devices include a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the

expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements. In an exemplary embodiment, at least one of the first and second expansion devices comprise a plurality of expansion devices. In an exemplary embodiment, at least one of the first and second expansion device comprise an adjustable expansion device. In an exemplary embodiment, the adjustable expansion device includes a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements.

[00341] An apparatus for radially expanding and plastically deforming an expandable tubular member has been described that includes a support member; an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; and a packer coupled to the support member. In an exemplary embodiment, the apparatus further includes a gripping device for gripping the tubular member coupled to the support member. In an exemplary embodiment, the gripping device comprises a plurality of movable gripping elements. In an exemplary embodiment, the gripping elements are moveable in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in a radial and an axial

direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in an axial direction relative to the support member. In an exemplary embodiment, if the tubular member is displaced in a first axial direction, the gripping device grips the tubular member; and wherein, if the tubular member is displaced in a second axial direction, the gripping device does not grip the tubular member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, the gripping elements are biased to remain in the first position. In an exemplary embodiment, the gripping device further includes an actuator for moving the gripping elements from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein the actuator is a fluid powered actuator. In an exemplary embodiment, the apparatus further includes a sealing device for sealing an interface with the tubular member coupled to the support member. In an exemplary embodiment, the sealing device seals an annulus defines between the support member and the tubular member. In an exemplary embodiment, the apparatus further includes a locking device for locking the position of the tubular member relative to the support member. In an exemplary embodiment, the packer assembly includes a packer; and a packer control device for controlling the operation of the packer coupled to the support member. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support

member. In an exemplary embodiment, the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the packer. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve positioned within the passage of the support member; and wherein the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the sliding sleeve valve. In an exemplary embodiment, the apparatus further includes an actuator for displacing the expansion device relative to the support member. In an exemplary embodiment, the actuator includes a first actuator for pulling the expansion device; and a second actuator for pushing the expansion device. In an exemplary embodiment, the actuator includes means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the first and second actuators include means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the actuator includes a plurality of pistons positioned within corresponding piston chambers. In an exemplary embodiment, the apparatus further includes a cutting device coupled to the support member for cutting the tubular member. In an exemplary embodiment, the cutting device includes a support member; and a plurality of movable cutting elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the cutting elements between a first position and a second position; wherein in the first position, the cutting elements do not engage the tubular member; and wherein in the second position, the cutting elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the cutting elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the cutting elements include a first set of cutting elements; and a second set of cutting elements; wherein the first set of cutting elements are interleaved with the second set of cutting elements. In an exemplary embodiment, in the first position, the first set of cutting elements are not axially aligned with the second set of cutting elements. In an exemplary embodiment, in the second position, the first set of cutting elements are axially aligned with the second set of cutting elements. In an exemplary embodiment, the expansion device includes a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for

moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements. In an exemplary embodiment, the expansion device includes an adjustable expansion device. In an exemplary embodiment, the expansion device includes a plurality of expansion devices. In an exemplary embodiment, at least one of the expansion devices comprises an adjustable expansion device. In an exemplary embodiment, the adjustable expansion device includes a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements.

[00342] An apparatus for radially expanding and plastically deforming an expandable tubular member has been described that includes a support member; a cutting device for cutting the tubular member coupled to the support member; a gripping device for gripping the tubular member coupled to the support member; a sealing device for sealing an interface

with the tubular member coupled to the support member; a locking device for locking the position of the tubular member relative to the support member; a first adjustable expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; a second adjustable expansion device for radially expanding and plastically deforming the tubular member coupled to the support member; a packer coupled to the support member; and an actuator for displacing one or more of the sealing assembly, first and second adjustable expansion devices, and packer relative to the support member. In an exemplary embodiment, the gripping device includes a plurality of movable gripping elements. In an exemplary embodiment, the gripping elements are moveable in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial and an axial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial direction relative to the support member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in an axial direction relative to the support member. In an exemplary embodiment, if the tubular member is displaced in a first axial direction, the gripping device grips the tubular member; and wherein, if the tubular member is displaced in a second axial direction, the gripping device does not grip the tubular member. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, the gripping elements are biased to remain in the first position. In an exemplary embodiment, the gripping device further includes an actuator for moving the gripping elements from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the

second position, the gripping elements do engage the tubular member; and wherein the actuator is a fluid powered actuator. In an exemplary embodiment, the sealing device seals an annulus defines between the support member and the tubular member. In an exemplary embodiment, the packer assembly includes a packer; and a packer control device for controlling the operation of the packer coupled to the support member. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support member. In an exemplary embodiment, the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the packer. In an exemplary embodiment, the packer includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve positioned within the passage of the support member; and wherein the packer control device includes a support member; one or more drag blocks releasably coupled to the support member; and a stinger coupled to the support member for engaging the sliding sleeve valve. In an exemplary embodiment, the actuator includes a first actuator for pulling the expansion device; and a second actuator for pushing the expansion device. In an exemplary embodiment, the actuator includes means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the first and second actuators include means for transferring torsional loads between the support member and the expansion device. In an exemplary embodiment, the actuator includes a plurality of pistons positioned within corresponding piston chambers. In an exemplary embodiment, the cutting device includes a support member; and a plurality of movable cutting elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the cutting elements between a first position and a second position; wherein in the first position, the cutting elements do not engage the tubular member; and wherein in the second position, the cutting elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the cutting elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the cutting elements include a first set of cutting elements; and a second set of cutting elements; wherein the first set of cutting elements are interleaved with the second set of cutting elements. In an exemplary embodiment, in the first position, the first set of cutting elements are not axially aligned with

the second set of cutting elements. In an exemplary embodiment, in the second position, the first set of cutting elements are axially aligned with the second set of cutting elements. In an exemplary embodiment, at least one of the adjustable expansion devices include a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements. In an exemplary embodiment, at least one of the adjustable expansion devices comprise a plurality of expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices include a support member; and a plurality of movable expansion elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the expansion elements between a first position and a second position; wherein in the first position, the expansion elements do not engage the tubular member; and wherein in the second position, the expansion elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the expansion elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the expansion elements include a first set of expansion elements; and a second set of expansion elements; wherein the first set of expansion elements are interleaved with the second set of expansion elements. In an exemplary embodiment, in the first position, the first set of expansion elements are not axially aligned with the second set of expansion elements. In an exemplary embodiment, in the second position, the first set of expansion elements are axially aligned with the second set of expansion elements.

[00343] An apparatus for cutting a tubular member has been described that includes a

support member; and a plurality of movable cutting elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the cutting elements between a first position and a second position; wherein in the first position, the cutting elements do not engage the tubular member; and wherein in the second position, the cutting elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the cutting elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the cutting elements include a first set of cutting elements; and a second set of cutting elements; wherein the first set of cutting elements are interleaved with the second set of cutting elements. In an exemplary embodiment, in the first position, the first set of cutting elements are not axially aligned with the second set of cutting elements. In an exemplary embodiment, in the second position, the first set of cutting elements are axially aligned with the second set of cutting elements.

[00344] An apparatus for engaging a tubular member has been described that includes a support member; and a plurality of movable elements coupled to the support member. In an exemplary embodiment, the apparatus further includes an actuator coupled to the support member for moving the elements between a first position and a second position; wherein in the first position, the elements do not engage the tubular member; and wherein in the second position, the elements engage the tubular member. In an exemplary embodiment, the apparatus further includes a sensor coupled to the support member for sensing the internal diameter of the tubular member. In an exemplary embodiment, the sensor prevents the elements from being moved to the second position if the internal diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, the elements include a first set of elements; and a second set of elements; wherein the first set of elements are interleaved with the second set of elements. In an exemplary embodiment, in the first position, the first set of elements are not axially aligned with the second set of elements. In an exemplary embodiment, in the second position, the first set of elements are axially aligned with the second set of elements.

[00345] An apparatus for gripping a tubular member has been described that includes a plurality of movable gripping elements. In an exemplary embodiment, the gripping elements are moveable in a radial direction. In an exemplary embodiment, the gripping elements are moveable in an axial direction. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement

from the first position to the second position, the gripping elements move in a radial and an axial direction. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in a radial direction. In an exemplary embodiment, the gripping elements are moveable from a first position to a second position; wherein in the first position, the gripping elements do not engage the tubular member; wherein in the second position, the gripping elements do engage the tubular member; and wherein, during the movement from the first position to the second position, the gripping elements move in an axial direction. In an exemplary embodiment, in a first axial direction, the gripping device grips the tubular member; and wherein, in a second axial direction, the gripping device does not grip the tubular member. In an exemplary embodiment, the apparatus further includes an actuator for moving the gripping elements. In an exemplary embodiment, the gripping elements include a plurality of separate and distinct gripping elements.

[00346] An actuator has been described that includes a tubular housing; a tubular piston rod movably coupled to and at least partially positioned within the housing; a plurality of annular piston chambers defined by the tubular housing and the tubular piston rod; and a plurality of tubular pistons coupled to the tubular piston rod, each tubular piston movably positioned within a corresponding annular piston chamber. In an exemplary embodiment, the actuator further includes means for transmitting torsional loads between the tubular housing and the tubular piston rod.

[00347] An apparatus for controlling a packer has been described that includes a tubular support member; one or more drag blocks releasably coupled to the tubular support member; and a tubular stinger coupled to the tubular support member for engaging the packer. In an exemplary embodiment, the apparatus further includes a tubular sleeve coupled to the drag blocks. In an exemplary embodiment, the tubular support member includes one or more axially aligned teeth for engaging the packer.

[00348] A packer has been described that includes a support member defining a passage; a shoe comprising a float valve coupled to an end of the support member; one or more compressible packer elements movably coupled to the support member; and a sliding sleeve valve movably positioned within the passage of the support member.

[00349] A method of radially expanding and plastically deforming an expandable tubular member within a borehole having a preexisting wellbore casing has been described that includes positioning the tubular member within the borehole in overlapping relation to the wellbore casing; radially expanding and plastically deforming a portion of the tubular

member to form a bell section; and radially expanding and plastically deforming a portion of the tubular member above the bell section comprising a portion of the tubular member that overlaps with the wellbore casing; wherein the inside diameter of the bell section is greater than the inside diameter of the radially expanded and plastically deformed portion of the tubular member above the bell section. In an exemplary embodiment, radially expanding and plastically deforming a portion of the tubular member to form a bell section includes positioning an adjustable expansion device within the expandable tubular member; supporting the expandable tubular member and the adjustable expansion device within the borehole; lowering the adjustable expansion device out of the expandable tubular member; increasing the outside dimension of the adjustable expansion device; and displacing the adjustable expansion device upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member, wherein n is greater than or equal to 1.

[00350] A method for forming a mono diameter wellbore casing has been described that includes positioning an adjustable expansion device within a first expandable tubular member; supporting the first expandable tubular member and the adjustable expansion device within a borehole; lowering the adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the adjustable expansion device; displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; positioning the adjustable expansion device within a second expandable tubular member; supporting the second expandable tubular member and the adjustable expansion device within the borehole in overlapping relation to the first expandable tubular member; lowering the adjustable expansion device out of the second expandable tubular member; increasing the outside dimension of the adjustable expansion device; and displacing the adjustable expansion device upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole.

[00351] A method for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes positioning an adjustable expansion device within the expandable tubular member; supporting the expandable tubular member and the adjustable expansion device within the borehole; lowering the adjustable expansion device out of the expandable tubular member; increasing the outside dimension of the adjustable expansion device; displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member within the borehole; and pressurizing an interior region of the expandable tubular member above the adjustable expansion device

during the radial expansion and plastic deformation of the expandable tubular member within the borehole.

[00352] A method for forming a mono diameter wellbore casing has been described that includes positioning an adjustable expansion device within a first expandable tubular member; supporting the first expandable tubular member and the adjustable expansion device within a borehole; lowering the adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the adjustable expansion device; displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; pressurizing an interior region of the first expandable tubular member above the adjustable expansion device during the radial expansion and plastic deformation of the first expandable tubular member within the borehole; positioning the adjustable expansion mandrel within a second expandable tubular member; supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member; lowering the adjustable expansion mandrel out of the second expandable tubular member; increasing the outside dimension of the adjustable expansion mandrel; displacing the adjustable expansion mandrel upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole; and pressurizing an interior region of the second expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the second expandable tubular member within the borehole.

[00353] A method for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes positioning first and second adjustable expansion devices within the expandable tubular member; supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; lowering the first adjustable expansion device out of the expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member; wherein the outside dimension of the first adjustable

expansion device is greater than the outside dimension of the second adjustable expansion device.

[00354] A method for forming a mono diameter wellbore casing has been described that includes positioning first and second adjustable expansion devices within a first expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; lowering the first adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; positioning first and second adjustable expansion devices within a second expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; lowering the first adjustable expansion device out of the second expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; and displacing the second adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[00355] A method for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes positioning first and second adjustable expansion devices within the expandable tubular member; supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; lowering the first adjustable expansion device out of the expandable tubular

member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; pressurizing an interior region of the expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the expandable tubular member by the first adjustable expansion device; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member; and pressurizing an interior region of the expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the expandable tubular member above the lower portion of the expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[00356] A method for forming a mono diameter wellbore casing has been described that includes positioning first and second adjustable expansion devices within a first expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; lowering the first adjustable expansion device out of the first expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; pressurizing an interior region of the first expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the first expandable tubular member by the first adjustable expansion device; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; pressurizing an interior region of the first expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the first expandable tubular member above the lower portion of the first expandable tubular member

by the second adjustable expansion device; positioning first and second adjustable expansion devices within a second expandable tubular member; supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; lowering the first adjustable expansion device out of the second expandable tubular member; increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; pressurizing an interior region of the second expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the second expandable tubular member by the first adjustable expansion device; displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; displacing the second adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; and pressurizing an interior region of the second expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the second expandable tubular member above the lower portion of the second expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[00357] A method for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; increasing the size of the adjustable expansion device; and displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member. In an exemplary embodiment, the method further includes reducing the size of the adjustable expansion device after the portion of the expandable tubular member has been radially expanded and plastically deformed. In an exemplary embodiment, the method further includes fluidicly sealing the radially expanded and plastically deformed end of the expandable tubular member after reducing the size of the adjustable expansion device. In an exemplary embodiment, the method further includes permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator after fluidicly sealing the radially expanded and plastically deformed end of the expandable

tubular member. In an exemplary embodiment, the method further includes injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and a preexisting structure after permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator. In an exemplary embodiment, the method further includes increasing the size of the adjustable expansion device after permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator. In an exemplary embodiment, the method further includes displacing the adjustable expansion cone upwardly relative to the expandable tubular member to radially expand and plastically deform another portion of the expandable tubular member. In an exemplary embodiment, the method further includes if the end of the other portion of the expandable tubular member overlaps with a preexisting structure, then not permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator; and displacing the adjustable expansion cone upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform the end of the other portion of the expandable tubular member that overlaps with the preexisting structure.

[00358] A method for forming a mono diameter wellbore casing within a borehole that includes a preexisting wellbore casing has been described that includes supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; increasing the size of the adjustable expansion device; displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member; and displacing the adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform the remaining portion of the expandable tubular member and a portion of the preexisting wellbore casing that overlaps with an end of the remaining portion of the expandable tubular member. In an exemplary embodiment, the method further includes reducing the size of the adjustable expansion device after the portion of the expandable tubular member has been radially expanded and plastically deformed. In an exemplary embodiment, the method further includes fluidicly sealing the radially expanded and plastically deformed end of the expandable tubular member after reducing the size of the adjustable expansion device. In an exemplary embodiment, the method further includes permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator after fluidicly sealing the radially expanded and plastically deformed end of the expandable tubular member. In an exemplary embodiment, the method further includes injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the borehole after permitting the position of the expandable tubular member to float

relative to the position of the hydraulic actuator. In an exemplary embodiment, the method further includes increasing the size of the adjustable expansion device after permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator. In an exemplary embodiment, the method further includes displacing the adjustable expansion cone upwardly relative to the expandable tubular member to radially expand and plastically deform the remaining portion of the expandable tubular member. In an exemplary embodiment, the method further includes not permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator; and displacing the adjustable expansion cone upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform the end of the remaining portion of the expandable tubular member that overlaps with the preexisting wellbore casing after not permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator.

[00359] A method of radially expanding and plastically deforming a tubular member has been described that includes positioning the tubular member within a preexisting structure; radially expanding and plastically deforming a lower portion of the tubular member to form a bell section; and radially expanding and plastically deforming a portion of the tubular member above the bell section. In an exemplary embodiment, positioning the tubular member within a preexisting structure includes locking the tubular member to an expansion device. In an exemplary embodiment, the outside diameter of the expansion device is less than the inside diameter of the tubular member. In an exemplary embodiment, the expansion device is positioned within the tubular member. In an exemplary embodiment, the expansion device includes an adjustable expansion device. In an exemplary embodiment, the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of expansion devices. In an exemplary embodiment, at least one of the expansion devices includes an adjustable expansion device. In an exemplary embodiment, at least one of the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, radially expanding and plastically deforming a lower portion of the tubular member to form a bell section includes lowering an expansion device out of an end of the tubular member; and pulling the expansion device through the end of the tubular member. In an exemplary embodiment, lowering an expansion device out of an end of the tubular member includes lowering the expansion device out of the end of the tubular member; and adjusting the size of the expansion device. In an exemplary embodiment, the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary

embodiment, pulling the expansion device through the end of the tubular member includes gripping the tubular member; and pulling an expansion device through an end of the tubular member. In an exemplary embodiment, gripping the tubular member includes permitting axial displacement of the tubular member in a first direction; and not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, pulling the expansion device through the end of the tubular member includes pulling the expansion device through the end of the tubular member using an actuator. In an exemplary embodiment, radially expanding and plastically deforming a portion of the tubular member above the bell section includes lowering an expansion device out of an end of the tubular member; and pulling the expansion device through the end of the tubular member. In an exemplary embodiment, lowering an expansion device out of an end of the tubular member includes lowering the expansion device out of the end of the tubular member; and adjusting the size of the expansion device. In an exemplary embodiment, the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary embodiment, pulling the expansion device through the end of the tubular member includes gripping the tubular member; and pulling an expansion device through an end of the tubular member. In an exemplary embodiment, gripping the tubular member includes permitting axial displacement of the tubular member in a first direction; and not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, pulling the expansion device through the end of the tubular member includes pulling the expansion device through the end of the tubular member using an actuator. In an exemplary embodiment, pulling the expansion device through the end of the tubular member includes pulling the expansion device through the end of the tubular member using fluid pressure. In an exemplary embodiment, pulling the expansion device through the end of the tubular member using fluid pressure includes pressurizing an annulus within the tubular member above the expansion device. In an exemplary embodiment, radially expanding and plastically deforming a portion of the tubular member above the bell section includes fluidicly sealing an end of the tubular member; and pulling the expansion device through the tubular member. In an exemplary embodiment, the expansion device is adjustable. In an exemplary embodiment, the expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device comprises a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary embodiment, pulling the expansion device through the end of the tubular member includes gripping the tubular member; and pulling an expansion device through an end of the tubular member. In an exemplary embodiment,

gripping the tubular member includes permitting axial displacement of the tubular member in a first direction; and not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, pulling the expansion device through the end of the tubular member includes pulling the expansion device through the end of the tubular member using an actuator. In an exemplary embodiment, pulling the expansion device through the end of the tubular member includes pulling the expansion device through the end of the tubular member using fluid pressure. In an exemplary embodiment, pulling the expansion device through the end of the tubular member using fluid pressure includes pressurizing an annulus within the tubular member above the expansion device. In an exemplary embodiment, radially expanding and plastically deforming a portion of the tubular member above the bell section includes overlapping the portion of the tubular member above the bell section with an end of a preexisting tubular member; and pulling an expansion device through the overlapping portions of the tubular member and the preexisting tubular member. In an exemplary embodiment, the expansion device is adjustable. In an exemplary embodiment, the expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary embodiment, pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member includes gripping the tubular member; and pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member. In an exemplary embodiment, gripping the tubular member includes permitting axial displacement of the tubular member in a first direction; and not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member includes pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member using an actuator. In an exemplary embodiment, pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member includes pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member using fluid pressure. In an exemplary embodiment, pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member using fluid pressure includes pressurizing an annulus within the tubular member above the expansion device. In an exemplary embodiment, the method further includes cutting an end of the portion of the tubular member that overlaps with the preexisting tubular member. In an exemplary embodiment, the method further includes removing the cut off end of the expandable tubular member from the preexisting structure. In an exemplary embodiment,

the method further includes injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the preexisting structure. In an exemplary embodiment, the method further includes cutting off an end of the expandable tubular member. In an exemplary embodiment, the method further includes removing the cut off end of the expandable tubular member from the preexisting structure.

[00360] A method of radially expanding and plastically deforming a tubular member has been described that includes applying internal pressure to the inside surface of the tubular member at a plurality of discrete location separated from one another.

[00361] A system for radially expanding and plastically deforming an expandable tubular member within a borehole having a preexisting wellbore casing has been described that includes means for positioning the tubular member within the borehole in overlapping relation to the wellbore casing; means for radially expanding and plastically deforming a portion of the tubular member to form a bell section; and means for radially expanding and plastically deforming a portion of the tubular member above the bell section comprising a portion of the tubular member that overlaps with the wellbore casing; wherein the inside diameter of the bell section is greater than the inside diameter of the radially expanded and plastically deformed portion of the tubular member above the bell section. In an exemplary embodiment, means for radially expanding and plastically deforming a portion of the tubular member to form a bell section includes means for positioning an adjustable expansion device within the expandable tubular member; means for supporting the expandable tubular member and the adjustable expansion device within the borehole; means for lowering the adjustable expansion device out of the expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; and means for displacing the adjustable expansion device upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member, wherein n is greater than or equal to 1.

[00362] A system for forming a mono diameter wellbore casing has been described that includes means for positioning an adjustable expansion device within a first expandable tubular member; means for supporting the first expandable tubular member and the adjustable expansion device within a borehole; means for lowering the adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; means for positioning the adjustable expansion device within a second expandable tubular member; means for supporting the second expandable tubular member and the adjustable expansion device within the borehole in overlapping relation to the first

expandable tubular member; means for lowering the adjustable expansion device out of the second expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; and means for displacing the adjustable expansion device upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole.

[00363] A system for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes means for positioning an adjustable expansion device within the expandable tubular member; means for supporting the expandable tubular member and the adjustable expansion device within the borehole; means for lowering the adjustable expansion device out of the expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; means for displacing the adjustable expansion mandrel upwardly relative to the expandable tubular member n times to radially expand and plastically deform n portions of the expandable tubular member within the borehole; and means for pressurizing an interior region of the expandable tubular member above the adjustable expansion device during the radial expansion and plastic deformation of the expandable tubular member within the borehole.

[00364] A system for forming a mono diameter wellbore casing has been described that includes means for positioning an adjustable expansion device within a first expandable tubular member; means for supporting the first expandable tubular member and the adjustable expansion device within a borehole; means for lowering the adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the first expandable tubular member m times to radially expand and plastically deform m portions of the first expandable tubular member within the borehole; means for pressurizing an interior region of the first expandable tubular member above the adjustable expansion device during the radial expansion and plastic deformation of the first expandable tubular member within the borehole; means for positioning the adjustable expansion mandrel within a second expandable tubular member; means for supporting the second expandable tubular member and the adjustable expansion mandrel within the borehole in overlapping relation to the first expandable tubular member; means for lowering the adjustable expansion mandrel out of the second expandable tubular member; means for increasing the outside dimension of the adjustable expansion mandrel; means for displacing the adjustable expansion mandrel upwardly relative to the second expandable tubular member n times to radially expand and plastically deform n portions of the second expandable tubular member within the borehole; and means for pressurizing an interior region of the second expandable tubular member above the adjustable expansion mandrel during the radial expansion and plastic deformation of the second expandable

tubular member within the borehole.

[00365] A system for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes means for positioning first and second adjustable expansion devices within the expandable tubular member; means for supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; means for lowering the first adjustable expansion device out of the expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[00366] A system for forming a mono diameter wellbore casing has been described that includes means for positioning first and second adjustable expansion devices within a first expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; means for lowering the first adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; means for positioning first and second adjustable expansion devices within a second expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; means for lowering the first adjustable expansion device out of

the second expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; and means for displacing the second adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[00367] A system for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes means for positioning first and second adjustable expansion devices within the expandable tubular member; means for supporting the expandable tubular member and the first and second adjustable expansion devices within the borehole; means for lowering the first adjustable expansion device out of the expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform a lower portion of the expandable tubular member; means for pressurizing an interior region of the expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the expandable tubular member by the first adjustable expansion device; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform portions of the expandable tubular member above the lower portion of the expandable tubular member; and means for pressurizing an interior region of the expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the expandable tubular member above the lower portion of the expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[00368] A system for forming a mono diameter wellbore casing has been described that includes means for positioning first and second adjustable expansion devices within a first expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within a borehole; means for lowering the first adjustable expansion device out of the first expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform a lower portion of the first expandable tubular member; means for pressurizing an interior region of the first expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the first expandable tubular member by the first adjustable expansion device; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the first expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to the first expandable tubular member to radially expand and plastically deform portions of the first expandable tubular member above the lower portion of the expandable tubular member; means for pressurizing an interior region of the first expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the first expandable tubular member above the lower portion of the first expandable tubular member by the second adjustable expansion device; means for positioning first and second adjustable expansion devices within a second expandable tubular member; means for supporting the first expandable tubular member and the first and second adjustable expansion devices within the borehole in overlapping relation to the first expandable tubular member; means for lowering the first adjustable expansion device out of the second expandable tubular member; means for increasing the outside dimension of the first adjustable expansion device; means for displacing the first adjustable expansion device upwardly relative to the second expandable tubular member to radially expand and plastically deform a lower portion of the second expandable tubular member; means for pressurizing an interior region of the second expandable tubular member above the first adjustable expansion device during the radial expansion of the lower portion of the second expandable tubular member by the first adjustable expansion device; means for displacing the first adjustable expansion device and the second adjustable expansion device downwardly relative to the second expandable tubular member; means for decreasing the outside dimension of the first adjustable expansion device and increasing the outside dimension of the second adjustable expansion device; means for displacing the second adjustable expansion device upwardly relative to

the second expandable tubular member to radially expand and plastically deform portions of the second expandable tubular member above the lower portion of the second expandable tubular member; and means for pressurizing an interior region of the second expandable tubular member above the second adjustable expansion device during the radial expansion of the portions of the second expandable tubular member above the lower portion of the second expandable tubular member by the second adjustable expansion device; wherein the outside dimension of the first adjustable expansion device is greater than the outside dimension of the second adjustable expansion device.

[00369] A system for radially expanding and plastically deforming an expandable tubular member within a borehole has been described that includes means for supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; means for increasing the size of the adjustable expansion device; and means for displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member. In an exemplary embodiment, the system further includes means for reducing the size of the adjustable expansion device after the portion of the expandable tubular member has been radially expanded and plastically deformed. In an exemplary embodiment, the system further includes means for fluidicly sealing the radially expanded and plastically deformed end of the expandable tubular member after reducing the size of the adjustable expansion device. In an exemplary embodiment, the system further includes means for permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator after fluidicly sealing the radially expanded and plastically deformed end of the expandable tubular member. In an exemplary embodiment, the system further includes means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and a preexisting structure after permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator. In an exemplary embodiment, the system further includes means for increasing the size of the adjustable expansion device after permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator. In an exemplary embodiment, system further includes means for displacing the adjustable expansion cone upwardly relative to the expandable tubular member to radially expand and plastically deform another portion of the expandable tubular member. In an exemplary embodiment, the system further includes if the end of the other portion of the expandable tubular member overlaps with a preexisting structure, then means for not permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator; and means for displacing the adjustable expansion cone upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform the

end of the other portion of the expandable tubular member that overlaps with the preexisting structure.

[00370] A system for forming a mono diameter wellbore casing within a borehole that includes a preexisting wellbore casing has been described that includes means for supporting the expandable tubular member, an hydraulic actuator, and an adjustable expansion device within the borehole; means for increasing the size of the adjustable expansion device; means for displacing the adjustable expansion device upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform a portion of the expandable tubular member; and means for displacing the adjustable expansion device upwardly relative to the expandable tubular member to radially expand and plastically deform the remaining portion of the expandable tubular member and a portion of the preexisting wellbore casing that overlaps with an end of the remaining portion of the expandable tubular member. In an exemplary embodiment, the system further includes means for reducing the size of the adjustable expansion device after the portion of the expandable tubular member has been radially expanded and plastically deformed. In an exemplary embodiment, the system further includes means for fluidicly sealing the radially expanded and plastically deformed end of the expandable tubular member after reducing the size of the adjustable expansion device. In an exemplary embodiment, the system further includes means for permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator after fluidicly sealing the radially expanded and plastically deformed end of the expandable tubular member. In an exemplary embodiment, the system further includes means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the borehole after permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator. In an exemplary embodiment, the system further includes means for increasing the size of the adjustable expansion device after permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator. In an exemplary embodiment, the system further includes means for displacing the adjustable expansion cone upwardly relative to the expandable tubular member to radially expand and plastically deform the remaining portion of the expandable tubular member. In an exemplary embodiment, the system further includes means for not permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator; and means for displacing the adjustable expansion cone upwardly relative to the expandable tubular member using the hydraulic actuator to radially expand and plastically deform the end of the remaining portion of the expandable tubular member that overlaps with the preexisting wellbore casing after not permitting the position of the expandable tubular member to float relative to the position of the hydraulic actuator.

[00371] A system for radially expanding and plastically deforming a tubular member has been described that includes means for positioning the tubular member within a preexisting structure; means for radially expanding and plastically deforming a lower portion of the tubular member to form a bell section; and means for radially expanding and plastically deforming a portion of the tubular member above the bell section. In an exemplary embodiment, positioning the tubular member within a preexisting structure includes means for locking the tubular member to an expansion device. In an exemplary embodiment, the outside diameter of the expansion device is less than the inside diameter of the tubular member. In an exemplary embodiment, the expansion device is positioned within the tubular member. In an exemplary embodiment, the expansion device includes an adjustable expansion device. In an exemplary embodiment, the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of expansion devices. In an exemplary embodiment, at least one of the expansion devices includes an adjustable expansion device. In an exemplary embodiment, at least one of the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, means for radially expanding and plastically deforming a lower portion of the tubular member to form a bell section includes means for lowering an expansion device out of an end of the tubular member; and means for pulling the expansion device through the end of the tubular member. In an exemplary embodiment, means for lowering an expansion device out of an end of the tubular member includes means for lowering the expansion device out of the end of the tubular member; and means for adjusting the size of the expansion device. In an exemplary embodiment, the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for gripping the tubular member; and means for pulling an expansion device through an end of the tubular member. In an exemplary embodiment, means for gripping the tubular member includes means for permitting axial displacement of the tubular member in a first direction; and means for not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for pulling the expansion device through the end of the tubular member using an actuator. In an exemplary embodiment, means for radially expanding and plastically deforming a portion of the tubular member above the bell section includes means for lowering an expansion device out of an end of the tubular member; and means for pulling the expansion device through the end of the tubular member. In an exemplary embodiment,

means for lowering an expansion device out of an end of the tubular member includes means for lowering the expansion device out of the end of the tubular member; and means for adjusting the size of the expansion device. In an exemplary embodiment, the adjustable expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device comprises a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for gripping the tubular member; and means for pulling an expansion device through an end of the tubular member. In an exemplary embodiment, means for gripping the tubular member includes means for permitting axial displacement of the tubular member in a first direction; and means for not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for pulling the expansion device through the end of the tubular member using an actuator. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for pulling the expansion device through the end of the tubular member using fluid pressure. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member using fluid pressure includes means for pressurizing an annulus within the tubular member above the expansion device. In an exemplary embodiment, means for radially expanding and plastically deforming a portion of the tubular member above the bell section includes means for fluidicly sealing an end of the tubular member; and means for pulling the expansion device through the tubular member. In an exemplary embodiment, the expansion device is adjustable. In an exemplary embodiment, the expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for gripping the tubular member; and means for pulling an expansion device through an end of the tubular member. In an exemplary embodiment, means for gripping the tubular member includes means for permitting axial displacement of the tubular member in a first direction; and means for not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for pulling the expansion device through the end of the tubular member using an actuator. In an exemplary embodiment, means for pulling the expansion device through the end of the tubular member includes means for pulling the expansion device through the end of the tubular member using fluid pressure. In an

exemplary embodiment, means for pulling the expansion device through the end of the tubular member using fluid pressure includes means for pressurizing an annulus within the tubular member above the expansion device. In an exemplary embodiment, means for radially expanding and plastically deforming a portion of the tubular member above the bell section includes means for overlapping the portion of the tubular member above the bell section with an end of a preexisting tubular member; and means for pulling an expansion device through the overlapping portions of the tubular member and the preexisting tubular member. In an exemplary embodiment, the expansion device is adjustable. In an exemplary embodiment, the expansion device is adjustable to a plurality of sizes. In an exemplary embodiment, the expansion device includes a plurality of adjustable expansion devices. In an exemplary embodiment, at least one of the adjustable expansion devices is adjustable to a plurality of sizes. In an exemplary embodiment, means for pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member includes means for gripping the tubular member; and means for pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member. In an exemplary embodiment, means for gripping the tubular member includes means for permitting axial displacement of the tubular member in a first direction; and means for not permitting axial displacement of the tubular member in a second direction. In an exemplary embodiment, means for pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member includes means for pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member using an actuator. In an exemplary embodiment, means for pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member includes means for pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member using fluid pressure. In an exemplary embodiment, means for pulling the expansion device through the overlapping portions of the tubular member and the preexisting tubular member using fluid pressure includes means for pressurizing an annulus within the tubular member above the expansion device. In an exemplary embodiment, the system further includes means for cutting an end of the portion of the tubular member that overlaps with the preexisting tubular member. In an exemplary embodiment, the system further includes means for removing the cut off end of the expandable tubular member from the preexisting structure. In an exemplary embodiment, the system further includes means for injecting a hardenable fluidic sealing material into an annulus between the expandable tubular member and the preexisting structure. In an exemplary embodiment, the system further includes means for cutting off an end of the expandable tubular member. In an exemplary embodiment, the system further includes means for removing the cut off end of

the expandable tubular member from the preexisting structure.

[00372] A system of radially expanding and plastically deforming a tubular member has been described that includes a support member; and means for applying internal pressure to the inside surface of the tubular member at a plurality of discrete location separated from one another coupled to the support member.

[00373] A method of cutting a tubular member has been described that includes positioning a plurality of cutting elements within the tubular member; and bringing the cutting elements into engagement with the tubular member. In an exemplary embodiment, the cutting elements include a first group of cutting elements; and a second group of cutting elements; wherein the first group of cutting elements are interleaved with the second group of cutting elements. In an exemplary embodiment, bringing the cutting elements into engagement with the tubular member includes bringing the cutting elements into axial alignment. In an exemplary embodiment, bringing the cutting elements into engagement with the tubular member further includes pivoting the cutting elements. In an exemplary embodiment, bringing the cutting elements into engagement with the tubular member further includes translating the cutting elements. In an exemplary embodiment, bringing the cutting elements into engagement with the tubular member further includes pivoting the cutting elements; and translating the cutting elements. In an exemplary embodiment, bringing the cutting elements into engagement with the tubular member includes rotating the cutting elements about a common axis. In an exemplary embodiment, bringing the cutting elements into engagement with the tubular member includes pivoting the cutting elements about corresponding axes; translating the cutting elements; and rotating the cutting elements about a common axis. In an exemplary embodiment, the method further includes preventing the cutting elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, preventing the cutting elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value includes sensing the inside diameter of the tubular member.

[00374] A method of gripping a tubular member has been described that includes positioning a plurality of gripping elements within the tubular member; bringing the gripping elements into engagement with the tubular member. In an exemplary embodiment, bringing the gripping elements into engagement with the tubular member includes displacing the gripping elements in an axial direction; and displacing the gripping elements in a radial direction. In an exemplary embodiment, the method further includes biasing the gripping elements against engagement with the tubular member.

[00375] A method of operating an actuator has been described that includes pressurizing a plurality of pressure chamber. In an exemplary embodiment, the method further includes transmitting torsional loads.

[00376] A method of injecting a hardenable fluidic sealing material into an annulus between a tubular member and a preexisting structure has been described that includes positioning the tubular member into the preexisting structure; sealing off an end of the tubular member; operating a valve within the end of the tubular member; and injecting a hardenable fluidic sealing material through the valve into the annulus between the tubular member and the preexisting structure.

[00377] A system for cutting a tubular member has been described that includes means for positioning a plurality of cutting elements within the tubular member; and means for bringing the cutting elements into engagement with the tubular member. In an exemplary embodiment, the cutting elements include a first group of cutting elements; and a second group of cutting elements; wherein the first group of cutting elements are interleaved with the second group of cutting elements. In an exemplary embodiment, means for bringing the cutting elements into engagement with the tubular member includes means for bringing the cutting elements into axial alignment. In an exemplary embodiment, means for bringing the cutting elements into engagement with the tubular member further includes means for pivoting the cutting elements. In an exemplary embodiment, means for bringing the cutting elements into engagement with the tubular member further includes means for translating the cutting elements. In an exemplary embodiment, means for bringing the cutting elements into engagement with the tubular member further includes means for pivoting the cutting elements; and means for translating the cutting elements. In an exemplary embodiment, means for bringing the cutting elements into engagement with the tubular member includes means for rotating the cutting elements about a common axis. In an exemplary embodiment, means for bringing the cutting elements into engagement with the tubular member includes means for pivoting the cutting elements about corresponding axes; means for translating the cutting elements; and means for rotating the cutting elements about a common axis. In an exemplary embodiment, the system further includes means for preventing the cutting elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, means for preventing the cutting elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value includes means for sensing the inside diameter of the tubular member.

[00378] A system for gripping a tubular member has been described that includes means for positioning a plurality of gripping elements within the tubular member; and means for bringing the gripping elements into engagement with the tubular member. In an

exemplary embodiment, means for bringing the gripping elements into engagement with the tubular member includes means for displacing the gripping elements in an axial direction; and means for displacing the gripping elements in a radial direction. In an exemplary embodiment, the system further includes means for biasing the gripping elements against engagement with the tubular member.

[00379] An actuator system has been described that includes a support member; and means for pressurizing a plurality of pressure chambers coupled to the support member. In an exemplary embodiment, the system further includes means for transmitting torsional loads.

[00380] A system for injecting a hardenable fluidic sealing material into an annulus between a tubular member and a preexisting structure has been described that includes means for positioning the tubular member into the preexisting structure; means for sealing off an end of the tubular member; means for operating a valve within the end of the tubular member; and means for injecting a hardenable fluidic sealing material through the valve into the annulus between the tubular member and the preexisting structure.

[00381] A method of engaging a tubular member has been described that includes positioning a plurality of elements within the tubular member; and bringing the elements into engagement with the tubular member. In an exemplary embodiment, the elements include a first group of elements; and a second group of elements; wherein the first group of elements are interleaved with the second group of elements. In an exemplary embodiment, bringing the elements into engagement with the tubular member includes bringing the elements into axial alignment. In an exemplary embodiment, bringing the elements into engagement with the tubular member further includes pivoting the elements. In an exemplary embodiment, bringing the elements into engagement with the tubular member further includes translating the elements. In an exemplary embodiment, bringing the elements into engagement with the tubular member further includes pivoting the elements; and translating the elements. In an exemplary embodiment, bringing the elements into engagement with the tubular member includes rotating the elements about a common axis. In an exemplary embodiment, bringing the elements into engagement with the tubular member includes pivoting the elements about corresponding axes; translating the elements; and rotating the elements about a common axis. In an exemplary embodiment, the method further includes preventing the elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, preventing the elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value includes sensing the inside diameter of the tubular member.

[00382] A system for engaging a tubular member has been described that includes means for positioning a plurality of elements within the tubular member; and means for bringing the elements into engagement with the tubular member. In an exemplary embodiment, the elements include a first group of elements; and a second group of elements; wherein the first group of elements are interleaved with the second group of elements. In an exemplary embodiment, means for bringing the elements into engagement with the tubular member includes means for bringing the elements into axial alignment. In an exemplary embodiment, means for bringing the elements into engagement with the tubular member further includes means for pivoting the elements. In an exemplary embodiment, means for bringing the elements into engagement with the tubular member further includes means for translating the elements. In an exemplary embodiment, means for bringing the elements into engagement with the tubular member further includes means for pivoting the elements; and means for translating the elements. In an exemplary embodiment, means for bringing the elements into engagement with the tubular member includes means for rotating the elements about a common axis. In an exemplary embodiment, means for bringing the elements into engagement with the tubular member includes means for pivoting the elements about corresponding axes; means for translating the elements; and means for rotating the elements about a common axis. In an exemplary embodiment, the system further includes means for preventing the elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value. In an exemplary embodiment, means for preventing the elements from coming into engagement with the tubular member if the inside diameter of the tubular member is less than a predetermined value includes means for sensing the inside diameter of the tubular member.

[00383] A locking device for locking a tubular member to a support member has been described that includes a plurality of circumferentially spaced apart locking elements coupled to the support member for engaging an interior surface of the tubular member; a plurality of spring elements coupled to the support member for biasing corresponding locking elements out of engagement with the interior surface of the tubular member; a releasable retaining element releasably coupled to the support member for releasably retaining the locking elements in engagement with the interior surface of the tubular member; an actuator coupled to the support member for controllably displacing the retaining element relative to the locking elements; and a sensor coupled to the support member for sensing an operating condition within the tubular member for controllably displacing the retaining element relative to the locking elements.

[00384] A method of locking a tubular member to a support member has been described that includes engaging the interior surface of the tubular member at a plurality of

circumferentially spaced apart locations using one or more engagement members; and disengaging the engagement members from the interior surface of the tubular member if an operating condition within the tubular member exceeds a predetermined amount; wherein the engagement members are biased out of engagement with the tubular member.

[00385] A system for locking a tubular member to a support member has been described that includes means for engaging the interior surface of the tubular member at a plurality of circumferentially spaced apart locations using one or more engagement members; and means for disengaging the engagement members from the interior surface of the tubular member if an operating condition within the tubular member exceeds a predetermined amount; wherein the engagement members are biased out of engagement with the tubular member.

[00386] It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the teachings of the present illustrative embodiments may be used to provide a wellbore casing, a pipeline, or a structural support. Furthermore, the elements and teachings of the various illustrative embodiments may be combined in whole or in part in some or all of the illustrative embodiments. In addition, one or more of the elements and teachings of the various illustrative embodiments may be omitted, at least in part, and/or combined, at least in part, with one or more of the other elements and teachings of the various illustrative embodiments.

[00387] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

1. An apparatus for radially expanding and plastically deforming an expandable tubular member, comprising:

a support member;

an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member;

a sealing assembly for sealing an annulus defined between the support member and the tubular member;

a locking device for locking the position of the tubular member relative to the support member; and

an actuator for displacing the expansion device relative to the support member;

wherein the actuator comprises:

a first actuator for pulling the expansion device; and

a second actuator for pushing the expansion device.

2. An apparatus for radially expanding and plastically deforming an expandable tubular member, comprising:

a support member;

an expansion device for radially expanding and plastically deforming the tubular member coupled to the support member;

a packer coupled to the support member;

a locking device for locking the position of the tubular member relative to the support member; and

an actuator for displacing the expansion device relative to the support member;

wherein the actuator comprises:

a first actuator for pulling the expansion device; and

a second actuator for pushing the expansion device.

3. The apparatus of claim 1, wherein the locking device comprises:

a housing defining a plurality of circumferentially spaced apart openings;

a plurality of circumferentially spaced apart locking elements coupled to the housing that extend into corresponding openings of the housing for engaging an interior surface of the expandable tubular member; and

a plurality of spring elements coupled to the housing for biasing corresponding locking elements out of engagement with the interior surface of the expandable tubular member.

4. The apparatus of claim 3, wherein the locking device further comprises:

a fluid powered actuator coupled to the housing for displacing the locking element retainer relative to the locking elements.

5. The apparatus of claim 3, wherein the locking device further comprises:

a pressure sensor coupled to the locking element retainer for displacing the locking element retainer relative to the locking elements if a sensed operating condition exceeds a predetermined value.

6. The apparatus of claim 1, wherein at least one of the first and second actuators comprise:

a locking device for locking the position of the tubular member relative to the support member;

wherein the locking device comprises:

one or more locking elements for engaging an interior surface of the expandable tubular member; and

one or more spring elements for biasing corresponding locking elements out of engagement with the interior surface of the expandable tubular member.

7. The apparatus of claim 6, wherein the locking device further comprises:

a fluid powered actuator for displacing the locking element retainer relative to the locking elements.

8. The apparatus of claim 6, wherein the locking device further comprises:

a pressure sensor for displacing the locking element retainer relative to the locking elements if a sensed operating condition exceeds a predetermined value.

9. The apparatus of claim 6, wherein the locking device comprises:

a housing defining a plurality of circumferentially spaced apart openings;

a plurality of circumferentially spaced apart locking elements coupled to the housing that extend into corresponding openings of the housing for engaging an interior surface of the expandable tubular member; and

a plurality of spring elements coupled to the housing for biasing corresponding locking elements out of engagement with the interior surface of the expandable tubular member.

10. The apparatus of claim 9, wherein the locking device further comprises:

a fluid powered actuator coupled to the housing for displacing the locking element retainer relative to the locking elements.

11. The apparatus of claim 9, wherein the locking device further comprises:

a pressure sensor coupled to the locking element retainer for displacing the locking element retainer relative to the locking elements if a sensed operating condition exceeds a predetermined value.

12. The apparatus of claim 2, wherein the locking device comprises:

one or more locking elements for engaging an interior surface of the expandable tubular member; and

one or more spring elements for biasing corresponding locking elements out of engagement with the interior surface of the expandable tubular member.

13. The apparatus of claim 12, wherein the locking device further comprises:

a fluid powered actuator for displacing the locking element retainer relative to the locking elements.

14. The apparatus of claim 12, wherein the locking device further comprises:

a pressure sensor for displacing the locking element retainer relative to the locking elements if a sensed operating condition exceeds a predetermined value.

15. The apparatus of claim 2, wherein the locking device comprises:

a housing defining a plurality of circumferentially spaced apart openings;

a plurality of circumferentially spaced apart locking elements coupled to the housing that extend into corresponding openings of the housing for engaging an interior surface of the expandable tubular member; and

a plurality of spring elements coupled to the housing for biasing corresponding locking elements out of engagement with the interior surface of the expandable tubular member.

16. The apparatus of claim 15, wherein the locking device further comprises:

a fluid powered actuator coupled to the housing for displacing the locking element retainer relative to the locking elements.

17. The apparatus of claim 15, wherein the locking device further comprises:

a pressure sensor coupled to the locking element retainer for displacing the locking element retainer relative to the locking elements if a sensed operating condition exceeds a predetermined value.

18. The apparatus of claim 2, wherein at least one of the first and second actuators comprise:

a locking device for locking the position of the tubular member relative to the support member;

wherein the locking device comprises:

one or more locking elements for engaging an interior surface of the expandable tubular member; and

one or more spring elements for biasing corresponding locking elements out of engagement with the interior surface of the expandable tubular member.

19. The apparatus of claim 18, wherein the locking device further comprises:

a fluid powered actuator for displacing the locking element retainer relative to the locking elements.

20. The apparatus of claim 18, wherein the locking device further comprises:

a pressure sensor for displacing the locking element retainer relative to the locking elements if a sensed operating condition exceeds a predetermined value.

21. The apparatus of claim 18, wherein the locking device comprises:

a housing defining a plurality of circumferentially spaced apart openings;

a plurality of circumferentially spaced apart locking elements coupled to the housing that extend into corresponding openings of the housing for engaging an interior surface of the expandable tubular member; and

a plurality of spring elements coupled to the housing for biasing corresponding locking elements out of engagement with the interior surface of the expandable tubular member.

22. The apparatus of claim 21, wherein the locking device further comprises:

a fluid powered actuator coupled to the housing for displacing the locking element retainer relative to the locking elements.

23. The apparatus of claim 21, wherein the locking device further comprises:

a pressure sensor coupled to the locking element retainer for displacing the locking element retainer relative to the locking elements if a sensed operating condition exceeds a predetermined value.

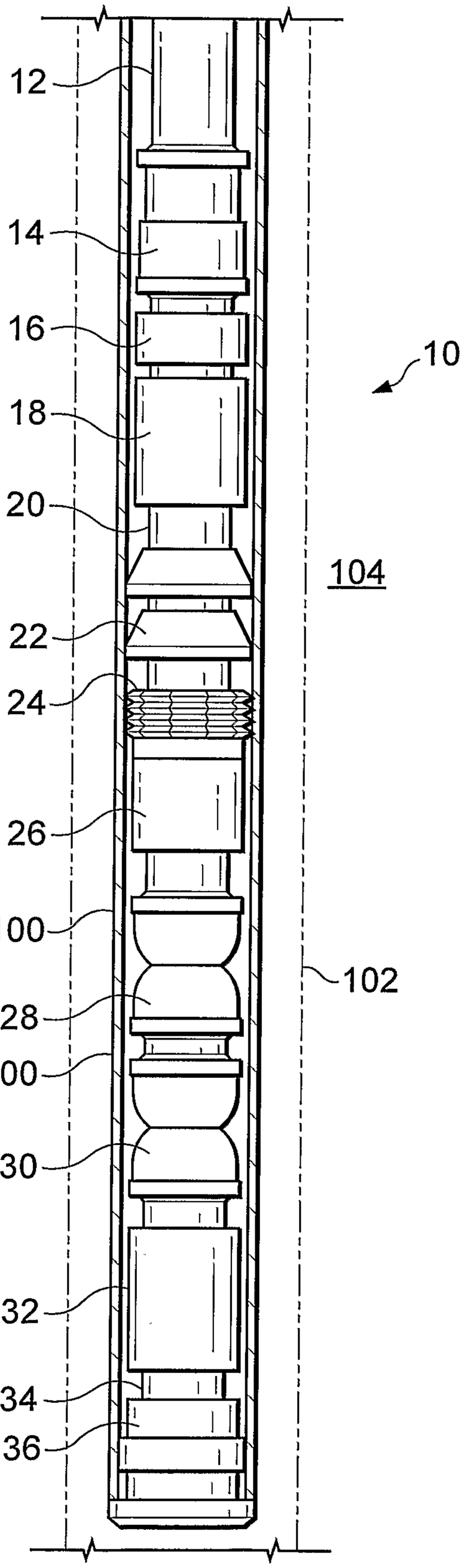

12
14
16
18
20
22
24
26
100
28
100
30
32
34
36
10
104
102

Fig. 1

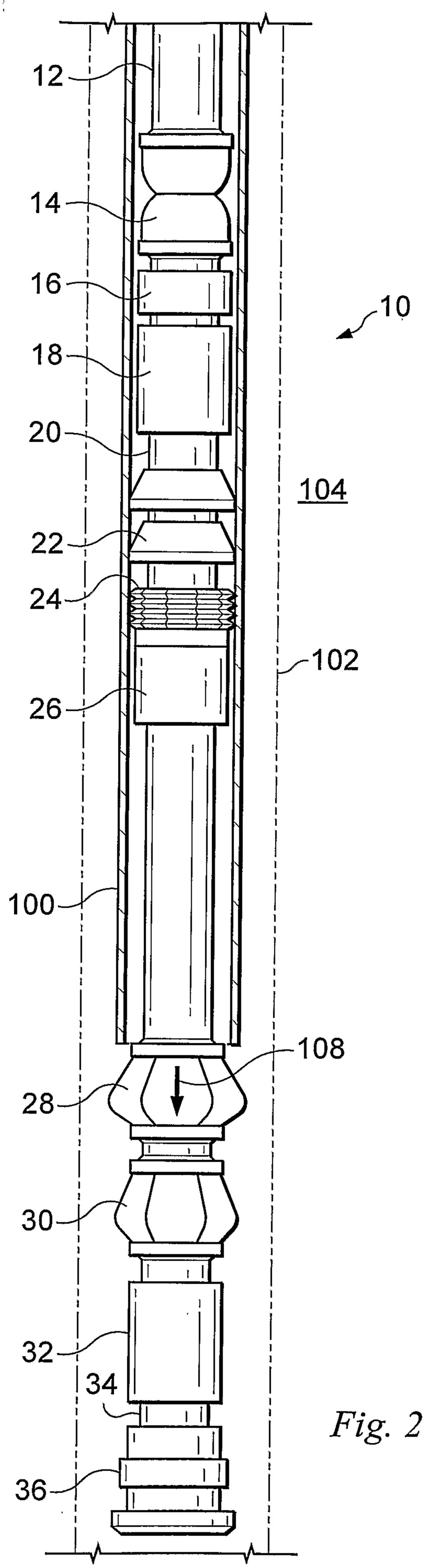

12
14
16
18
20
22
24
26
100
28
108
30
32
34
36
10
104
102

Fig. 2

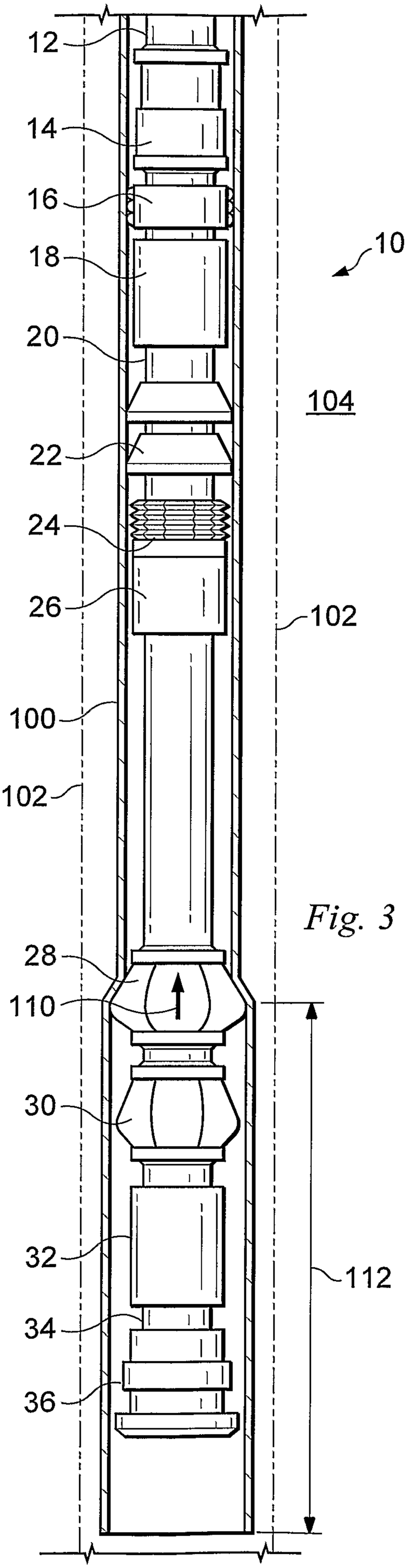


Fig. 3

2/250'

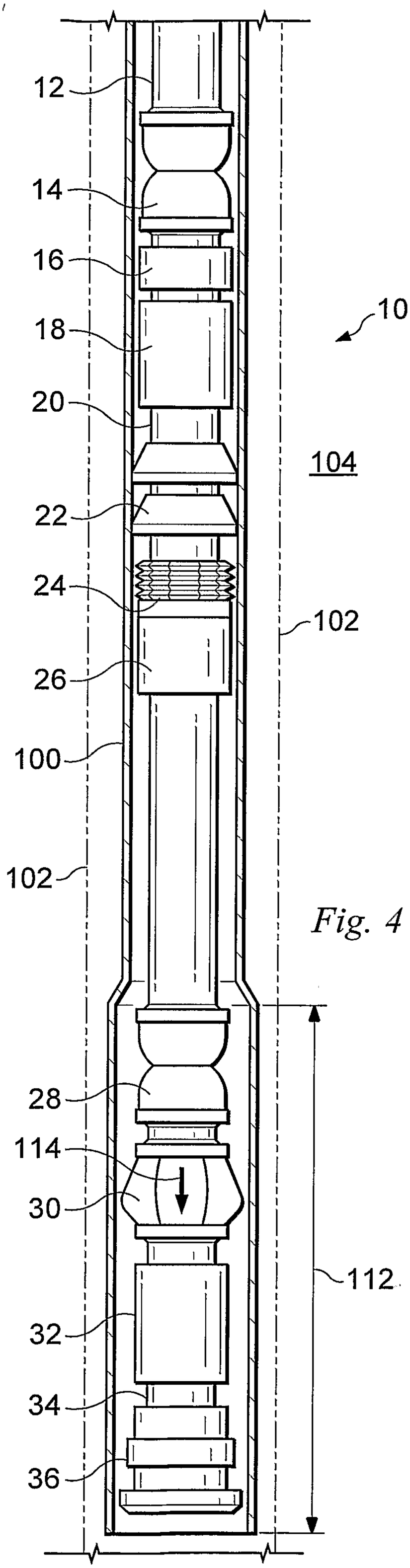


Fig. 4

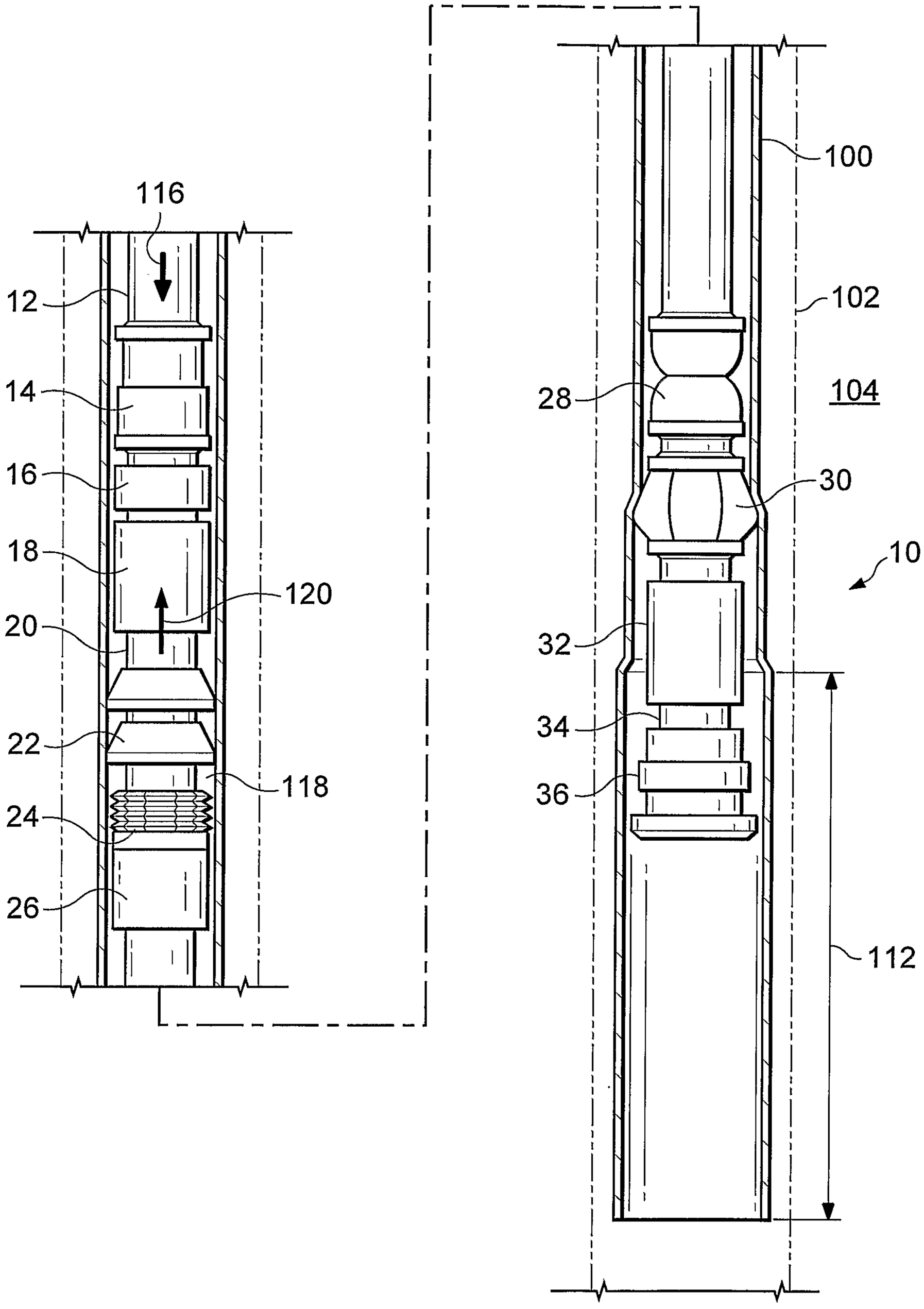


Fig. 5

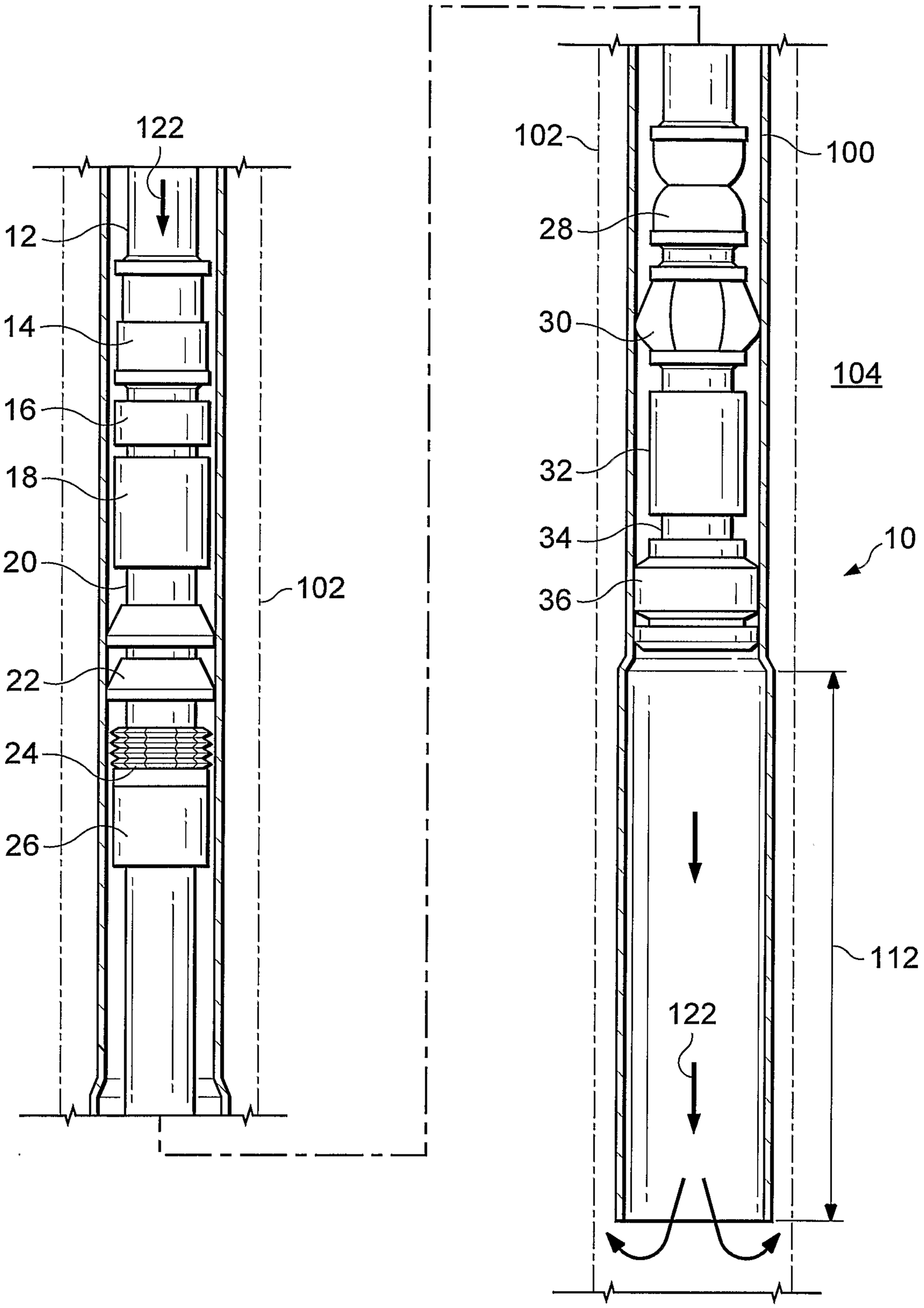


Fig. 6

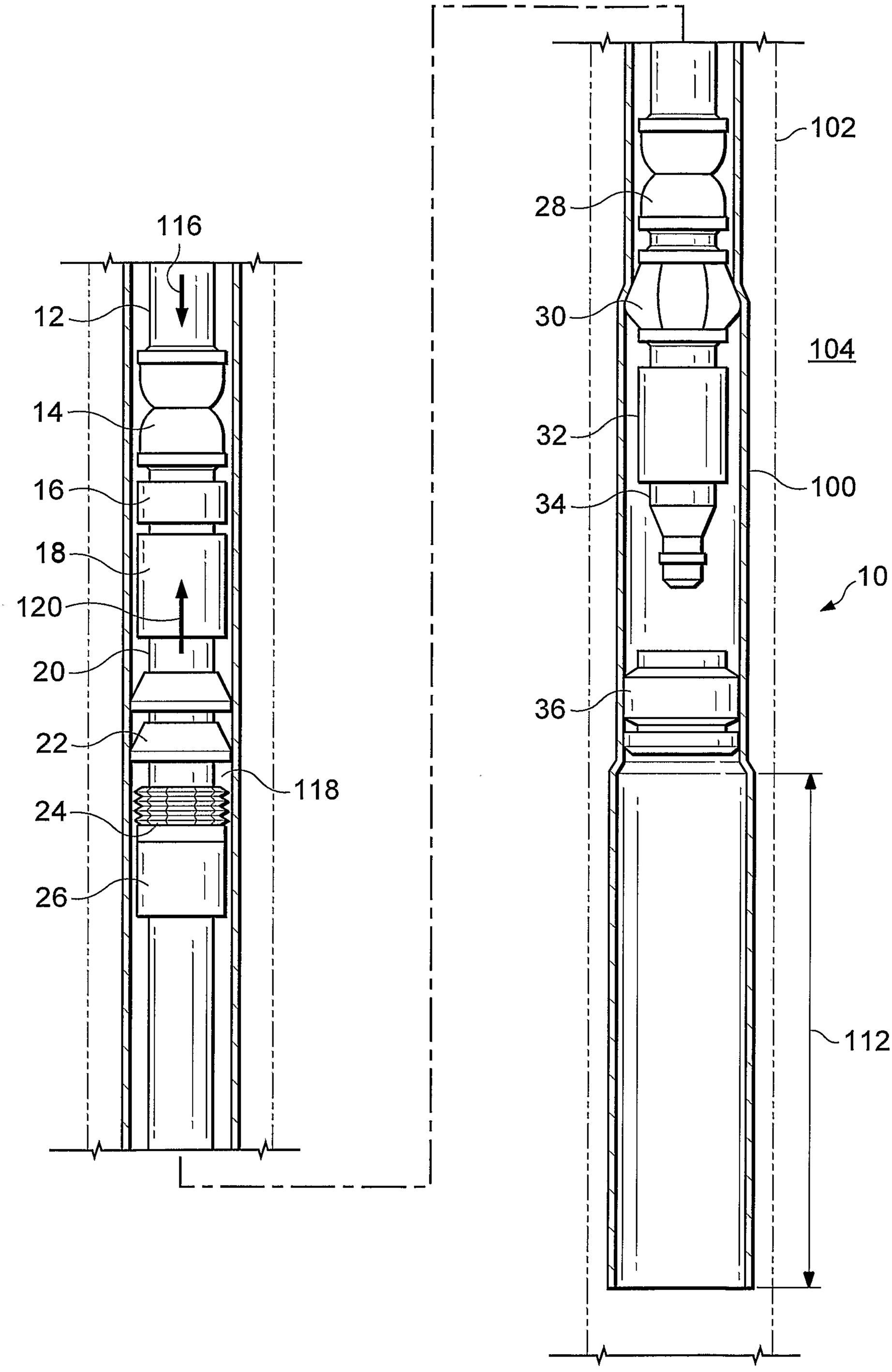
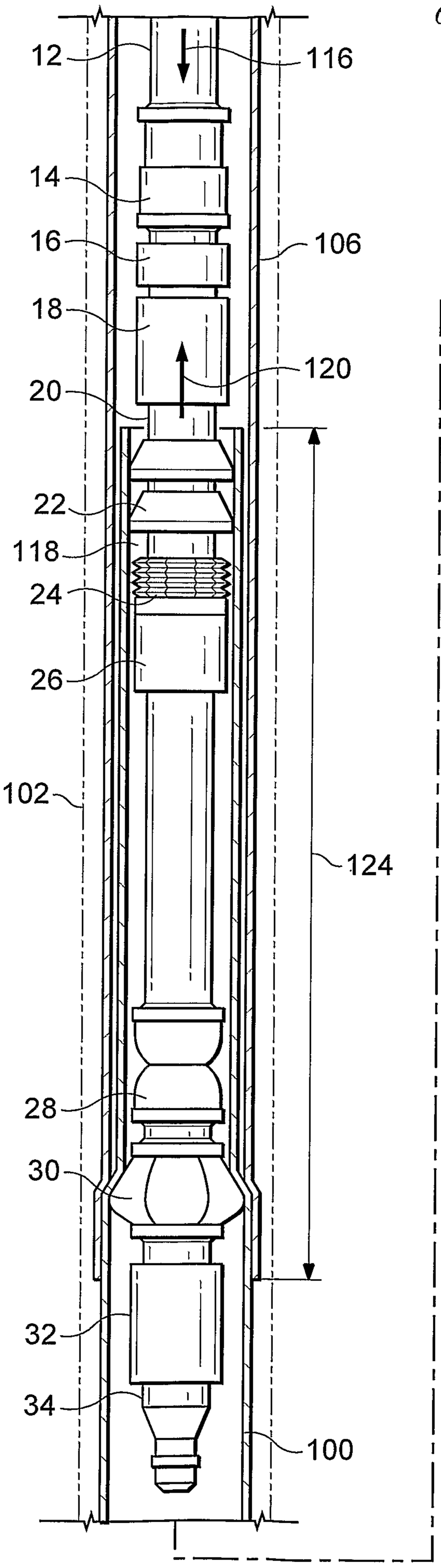


Fig. 7


12
116
14
16
106
18
120
20
22
118
24
26
102
124
28
30
32
34
100

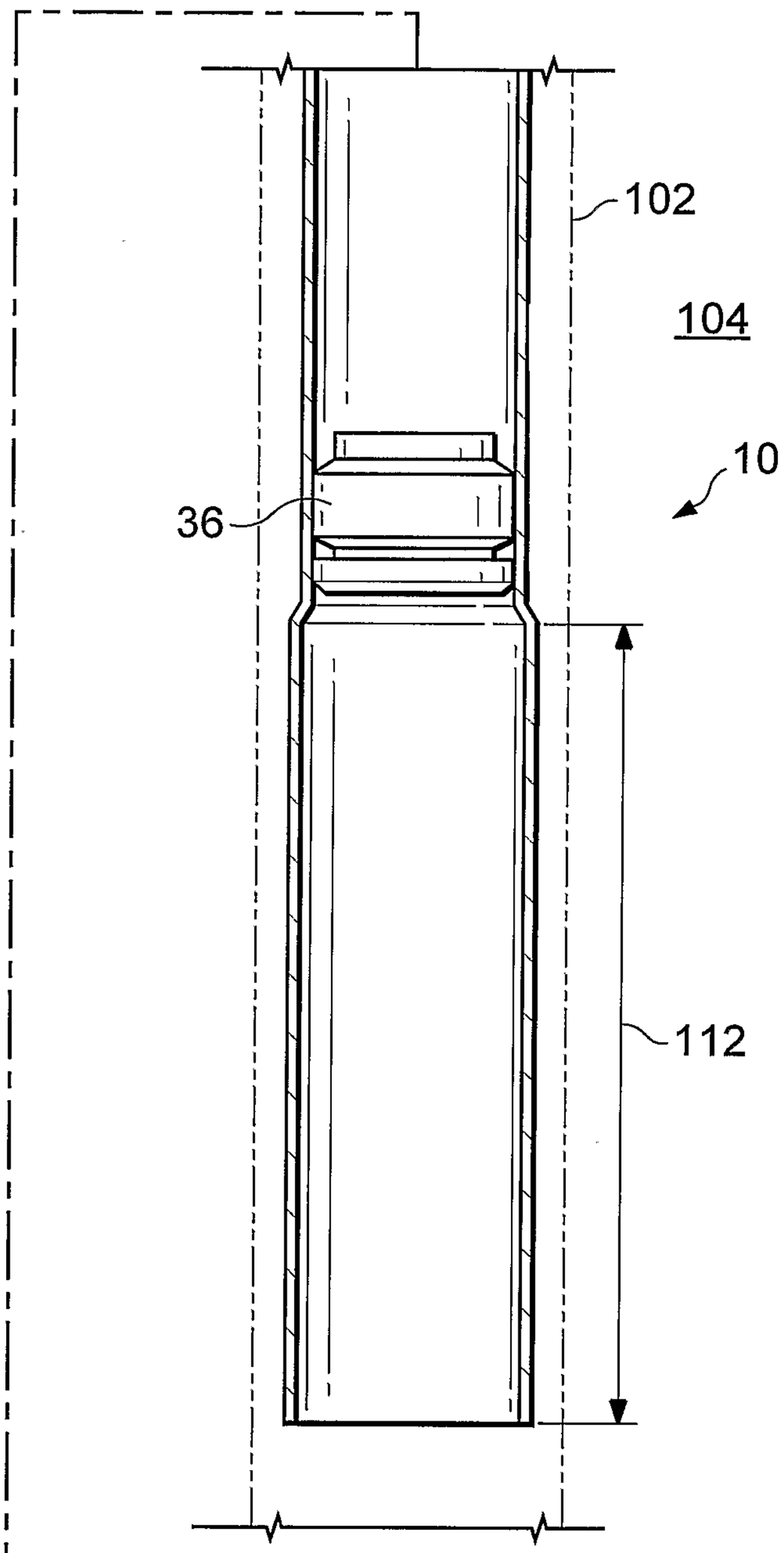
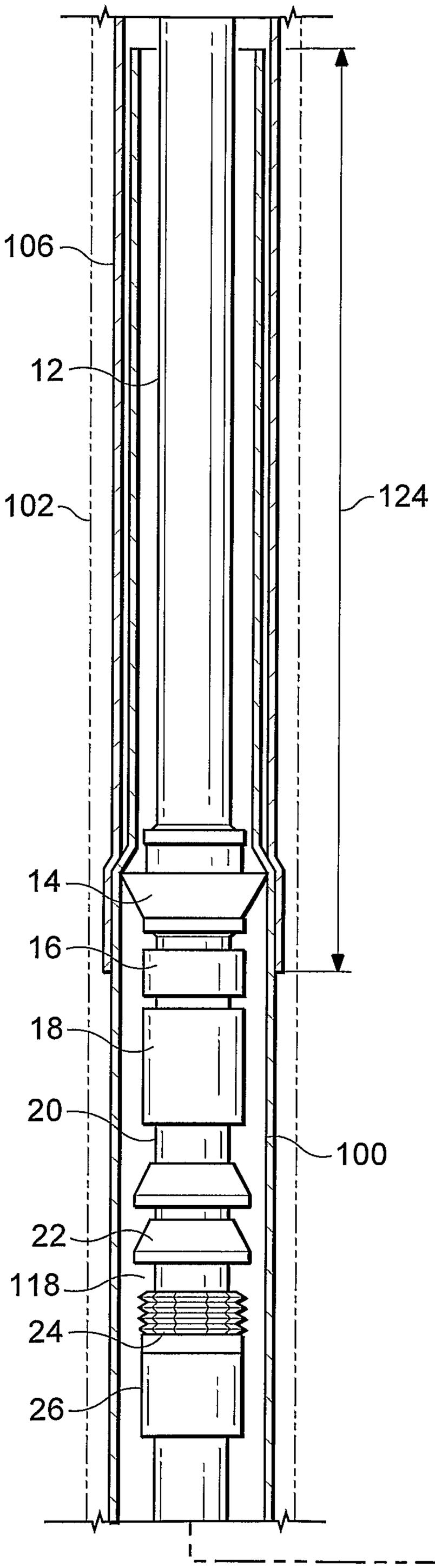

102
104
10
36
112

Fig. 8


106
12
102
124
14
16
18
20
100
22
118
24
26

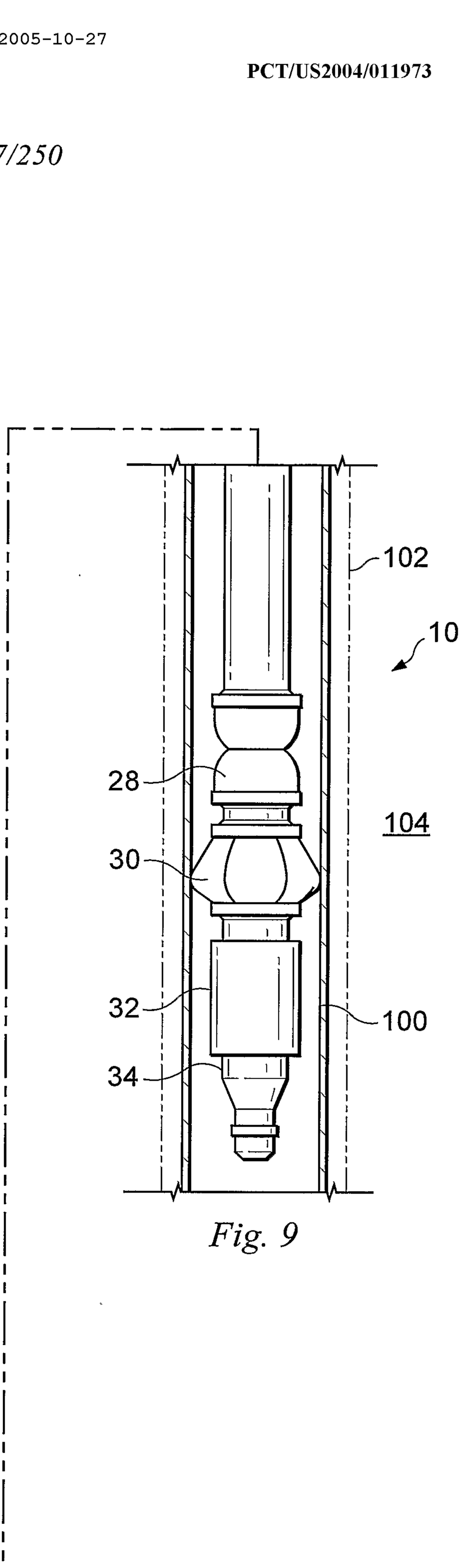

102
10
28
104
30
32
100
34

Fig. 9

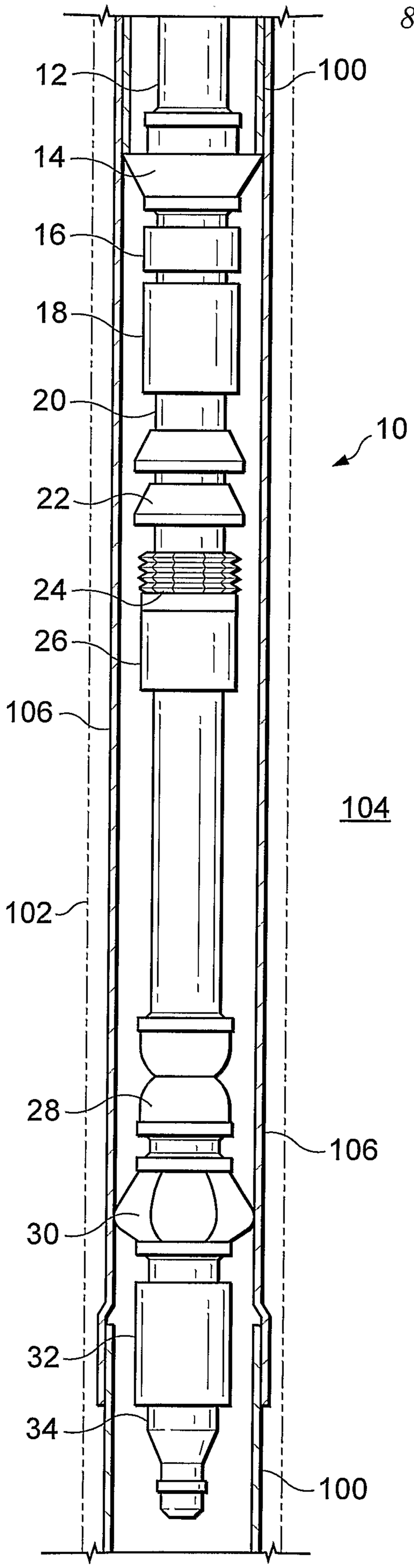


Fig. 10

Fig. 11-1

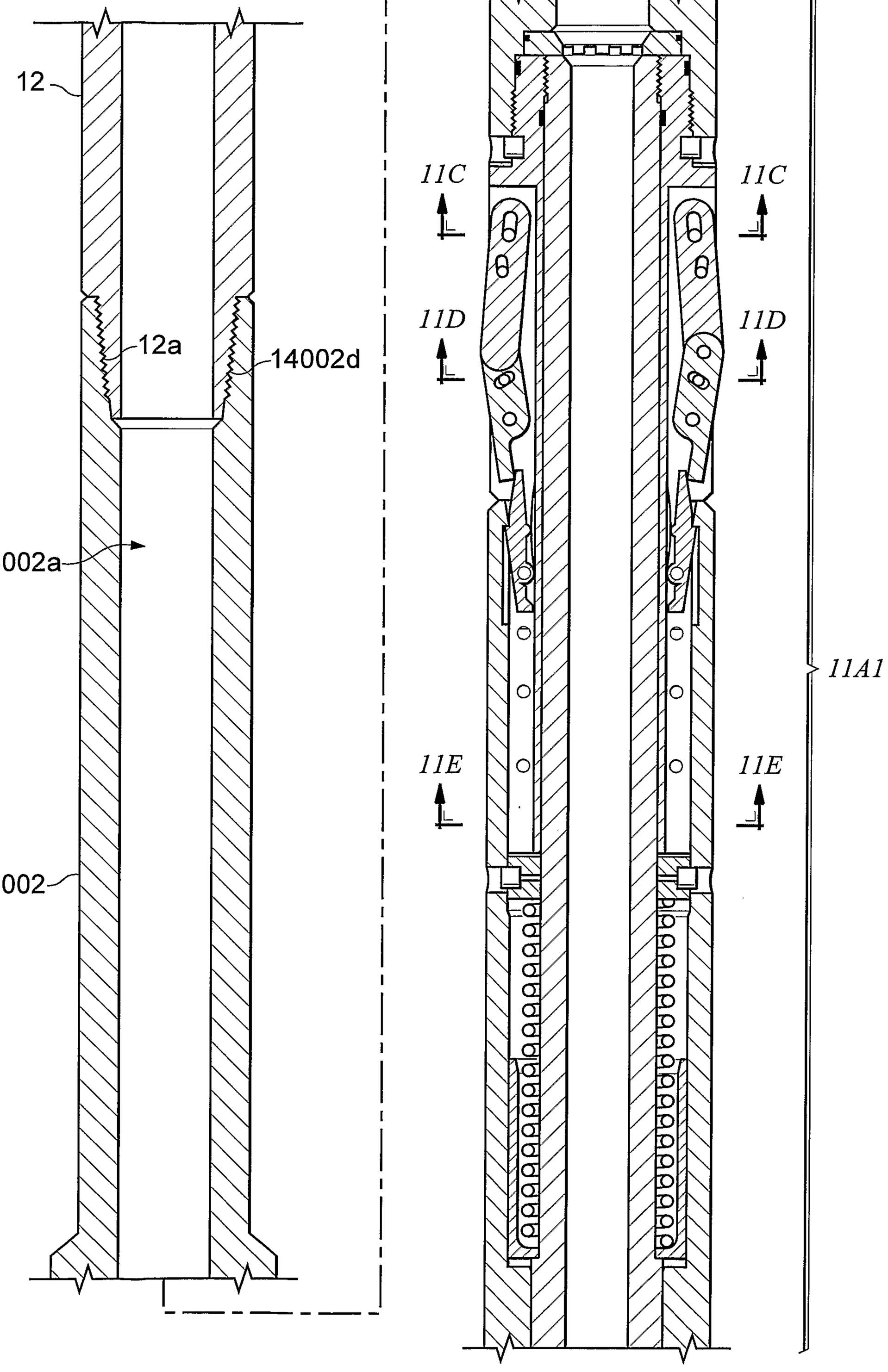

9/250
14
12
12a
14002d
14002a
14002
11C
11C
11D
11D
11E
11E
11A1

Fig. 11-2

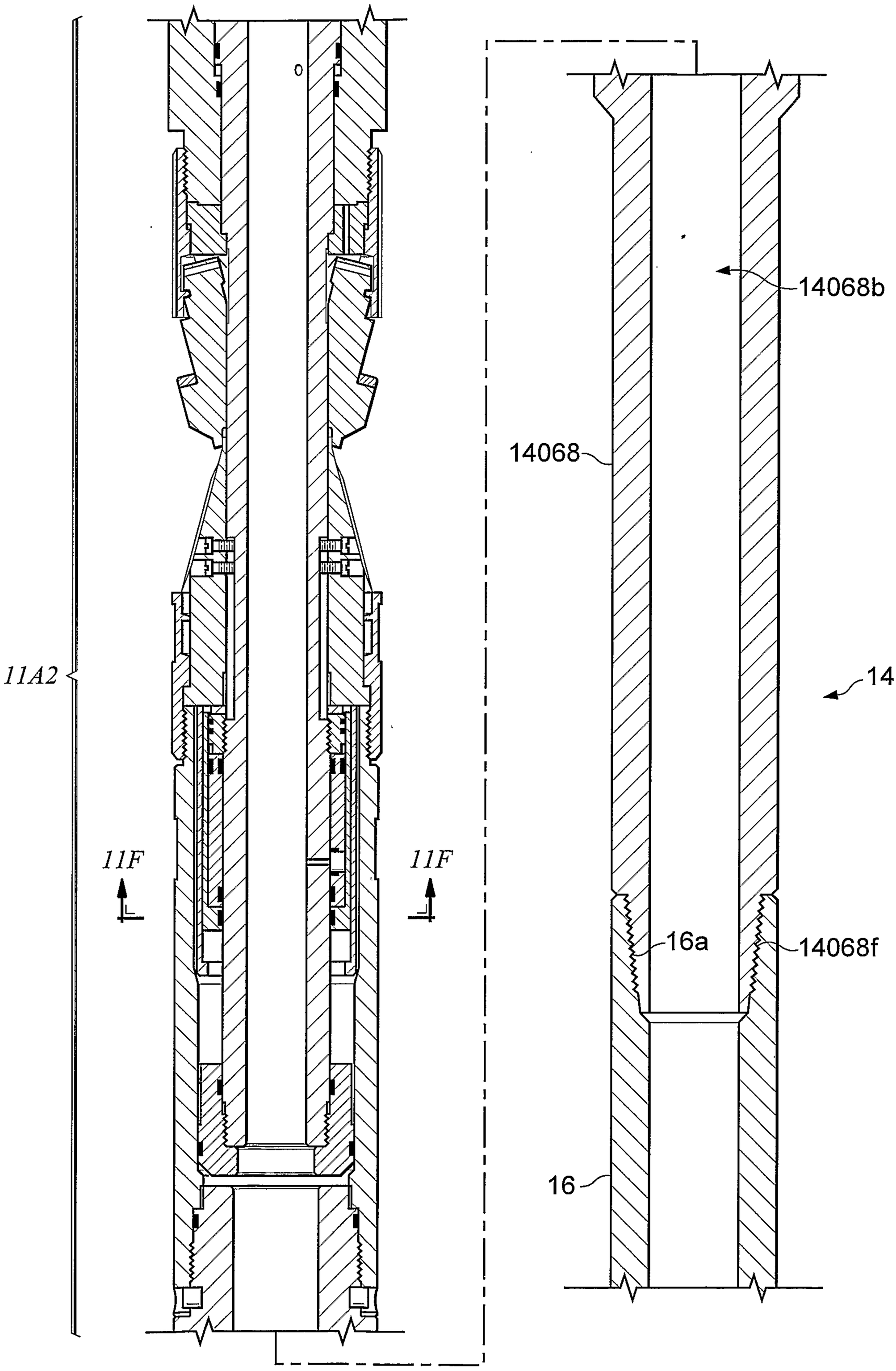
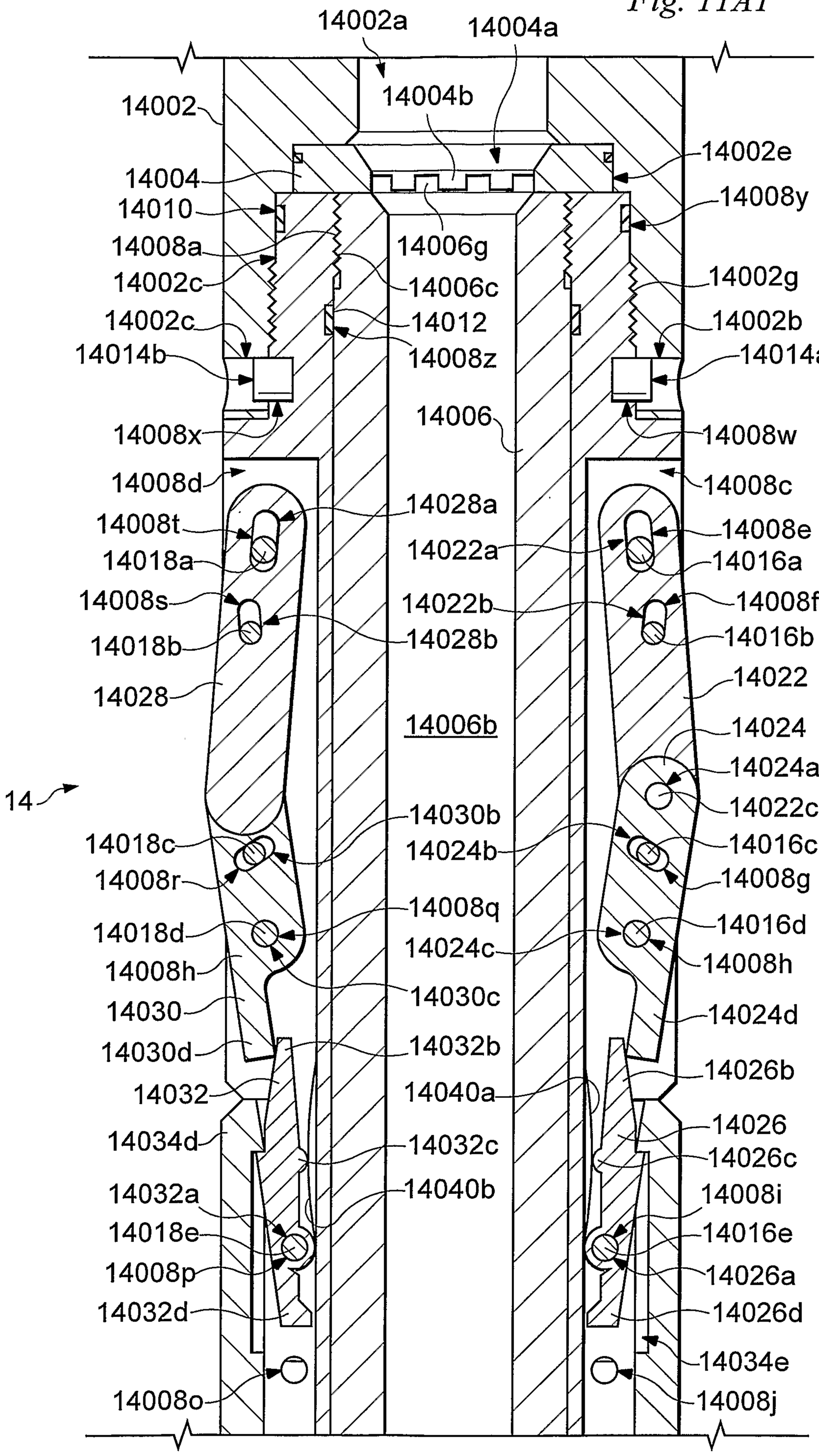


Fig. 11A1


14002a
14004a
14004b
14002
14004
14010
14008a
14002c
14002c
14014b
14008x
14008d
14008t
14018a
14008s
14018b
14028
14
14018c
14008r
14018d
14008h
14030
14030d
14032
14034d
14032a
14018e
14008p
14032d
14008o
14006g
14006c
14012
14008z
14006
14028a
14028b
14006b
14030b
14024b
14008q
14024c
14030c
14032b
14040a
14032c
14040b
14002e
14008y
14002g
14002b
14014a
14008w
14008c
14008e
14016a
14008f
14016b
14022
14024
14024a
14022c
14016c
14008g
14016d
14008h
14024d
14026b
14026
14026c
14008i
14016e
14026a
14026d
14034e
14008j

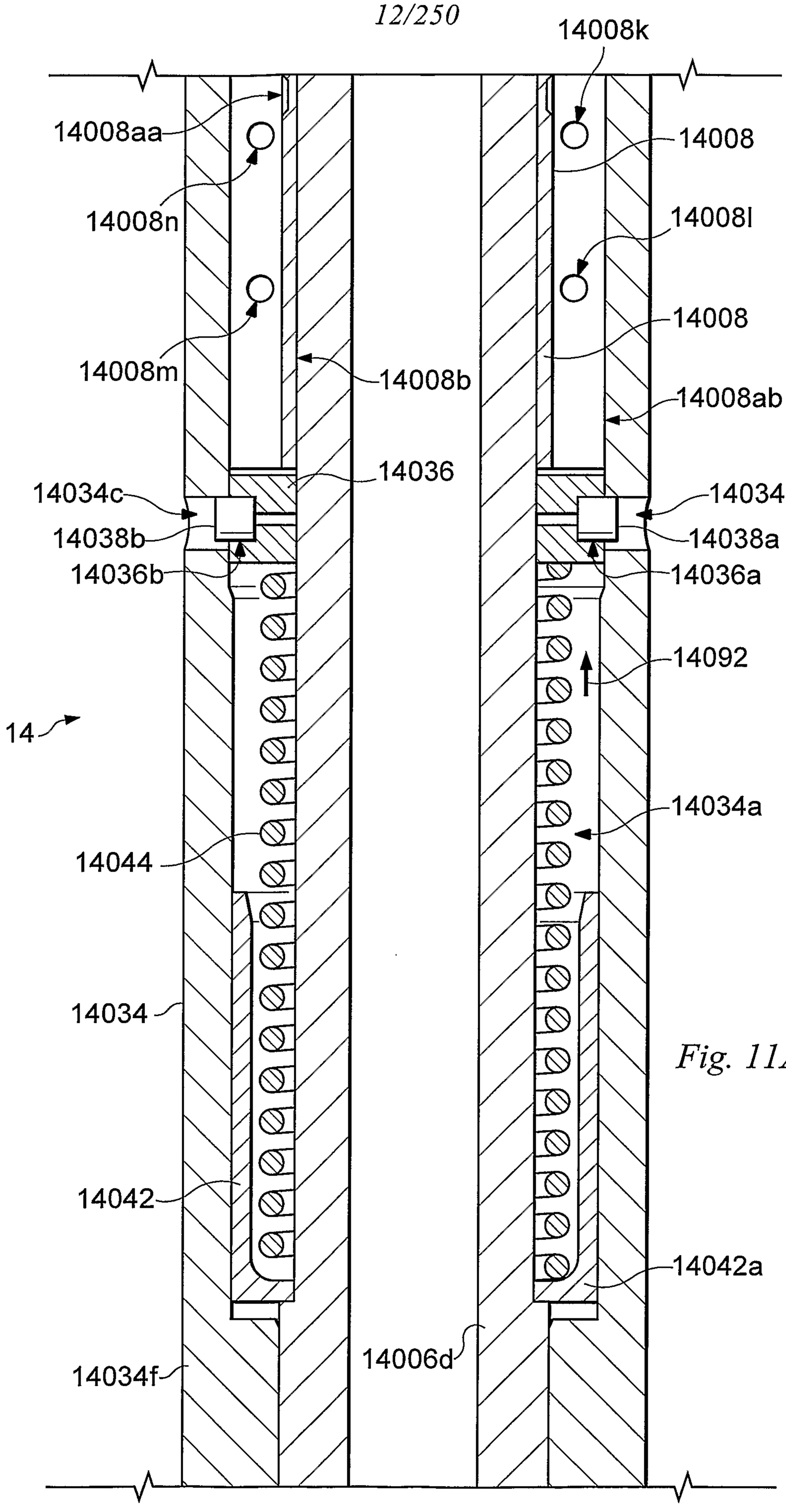

14008k
14008aa
14008
14008n
14008l
14008m
14008b
14008
14008ab
14036
14034c
14034b
14038b
14038a
14036b
14036a
14092
14
14034a
14044
14034
14042
14042a
14034f
14006d

Fig. 11A2

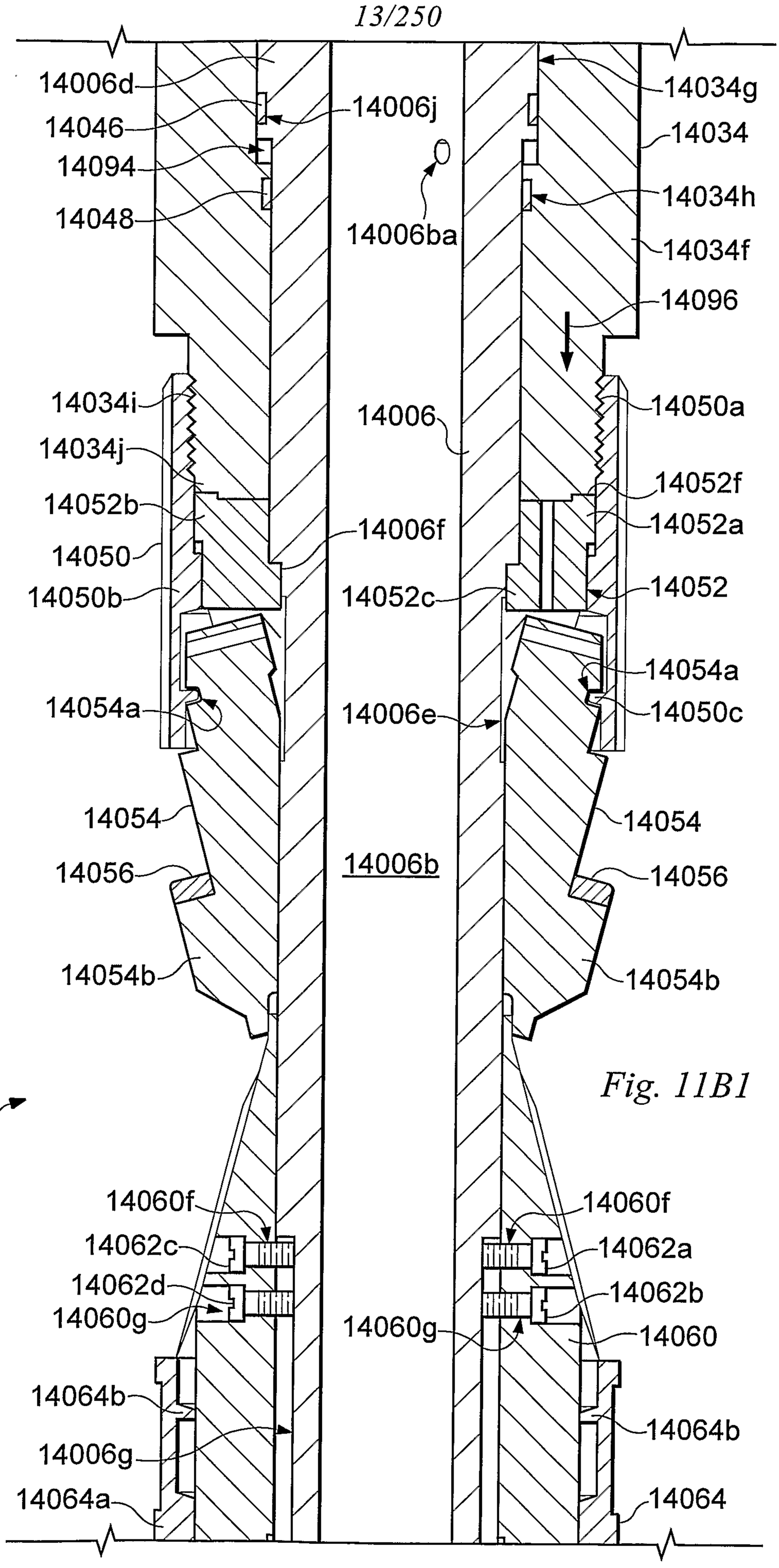

14006d
14046
14094
14048
14006j
14006ba
14034g
14034
14034h
14034f
14096
14034i
14034j
14052b
14050
14050b
14006f
14006
14050a
14052f
14052a
14052
14052c
14054a
14054a
14006e
14050c
14054
14056
14006b
14056
14054b
14054b
14
14060f
14062c
14062d
14060g
14064b
14006g
14064a
14060f
14062a
14062b
14060g
14060
14064b
14064

Fig. 11B1

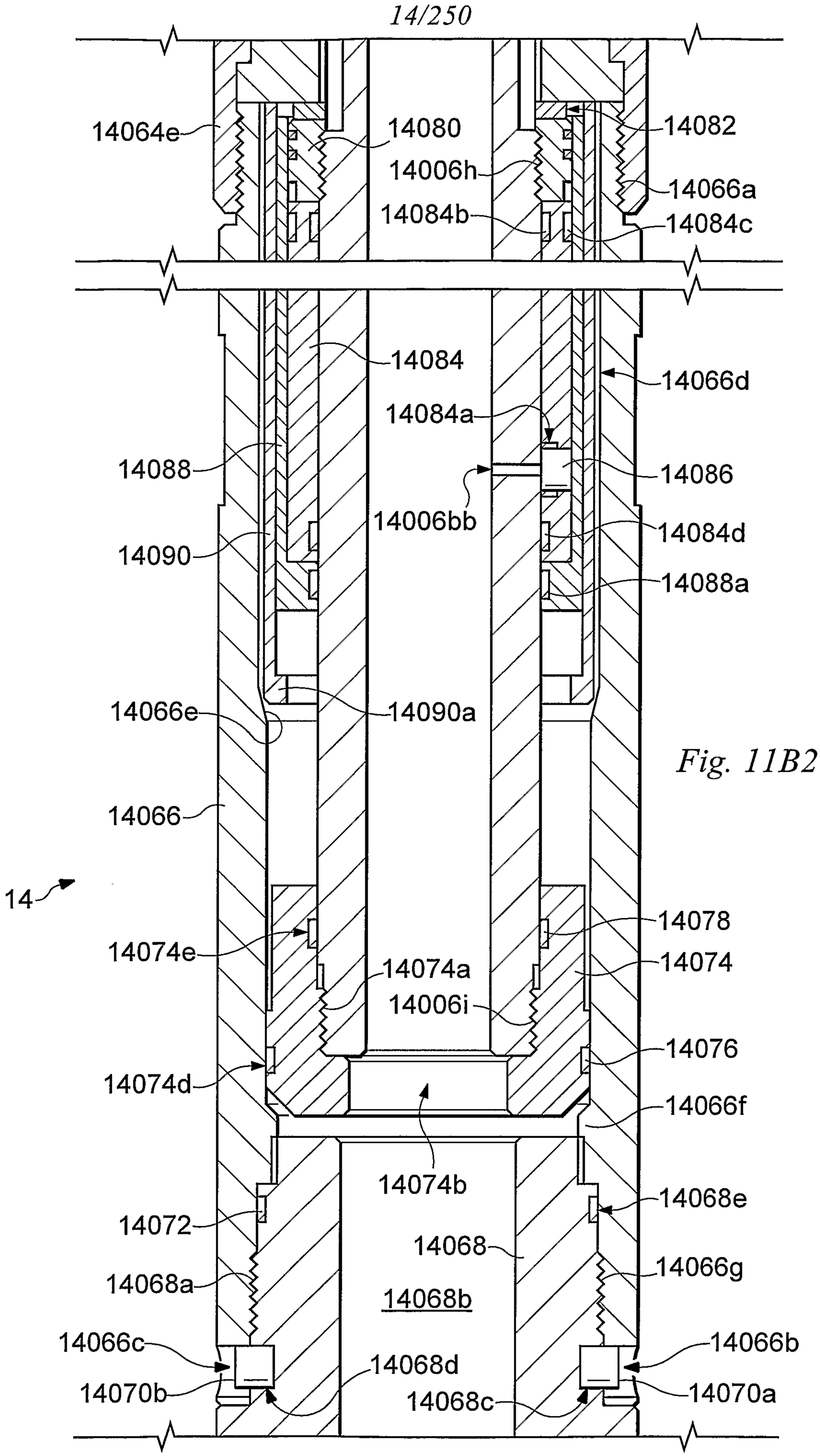

14064e
14080
14006h
14084b
14082
14066a
14084c
14084
14066d
14084a
14088
14086
14006bb
14084d
14090
14088a
14066e
14090a
14066
14
14078
14074e
14074a
14074
14006i
14076
14074d
14066f
14074b
14068e
14072
14068
14066g
14068a
14068b
14066c
14068d
14066b
14070b
14068c
14070a

Fig. 11B2

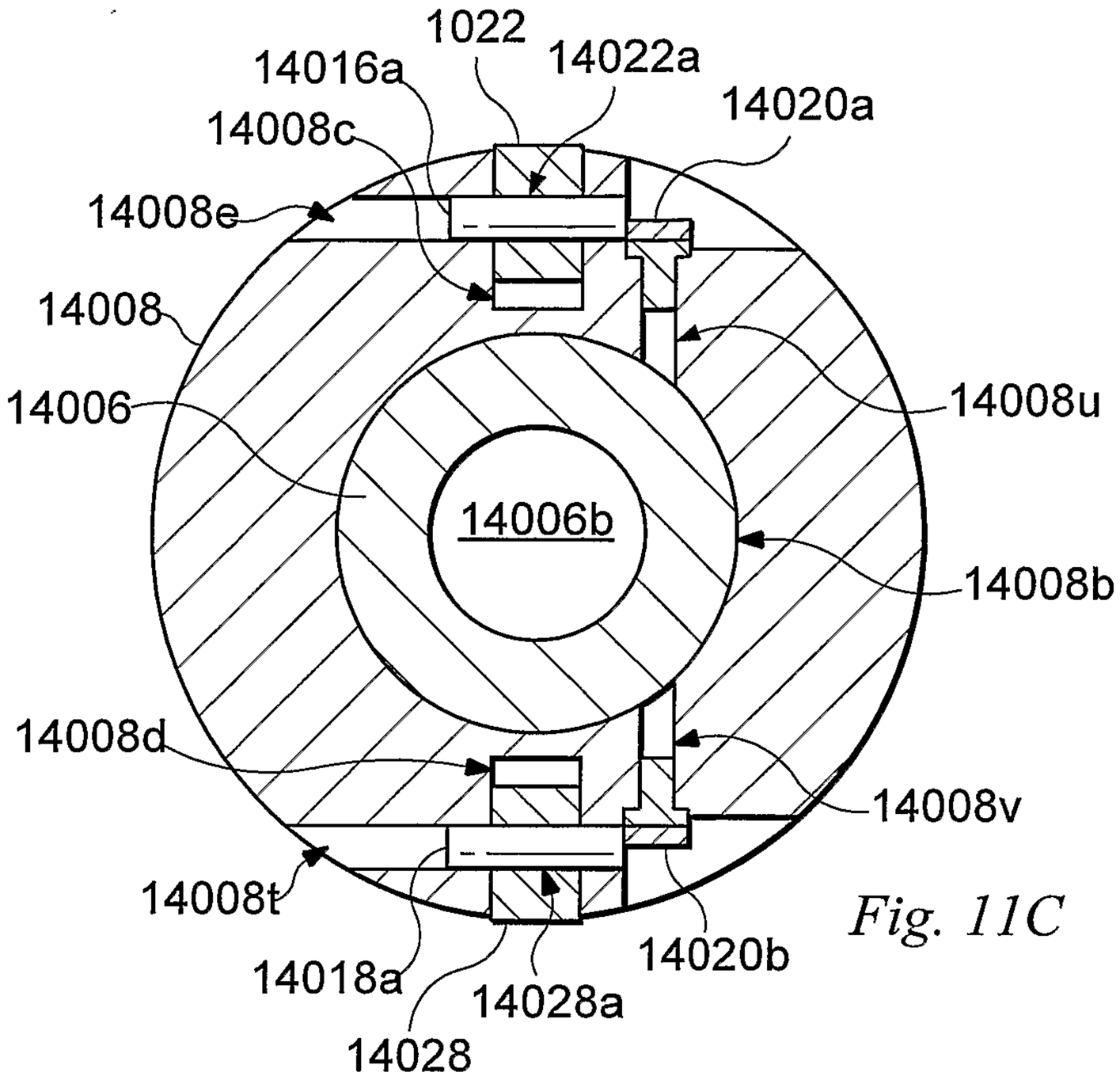


Fig. 11C

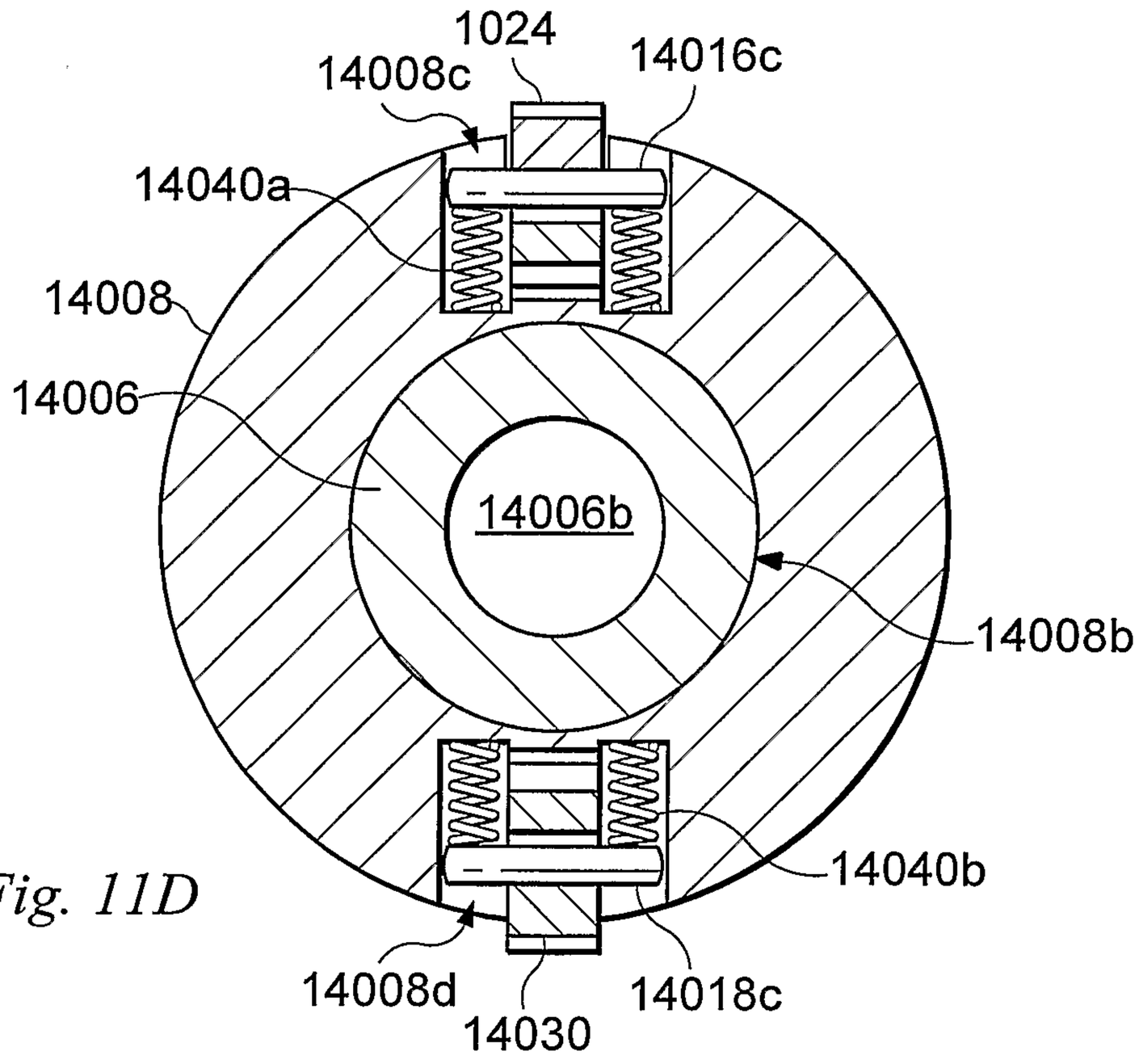


Fig. 11D

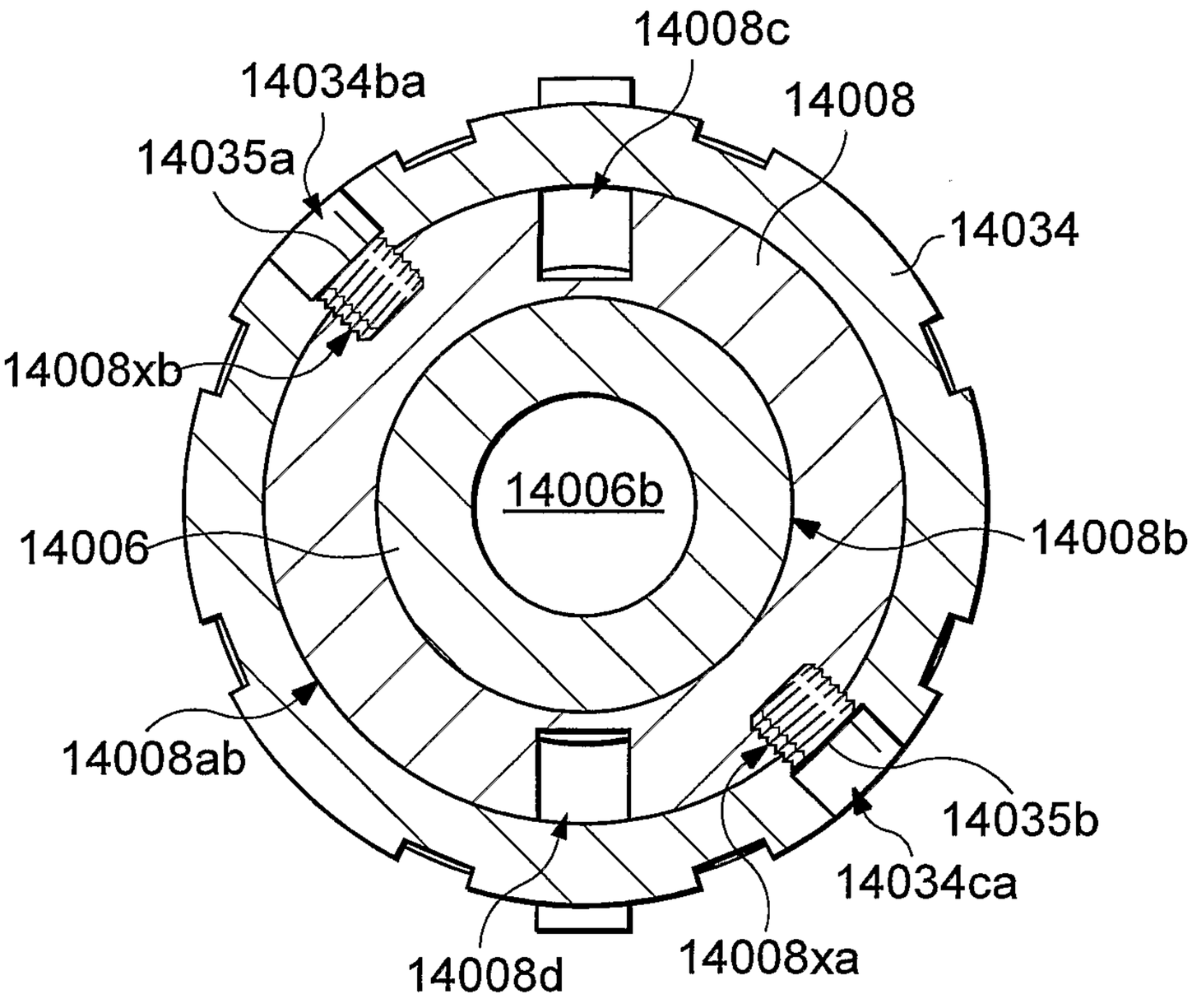


Fig. 11E

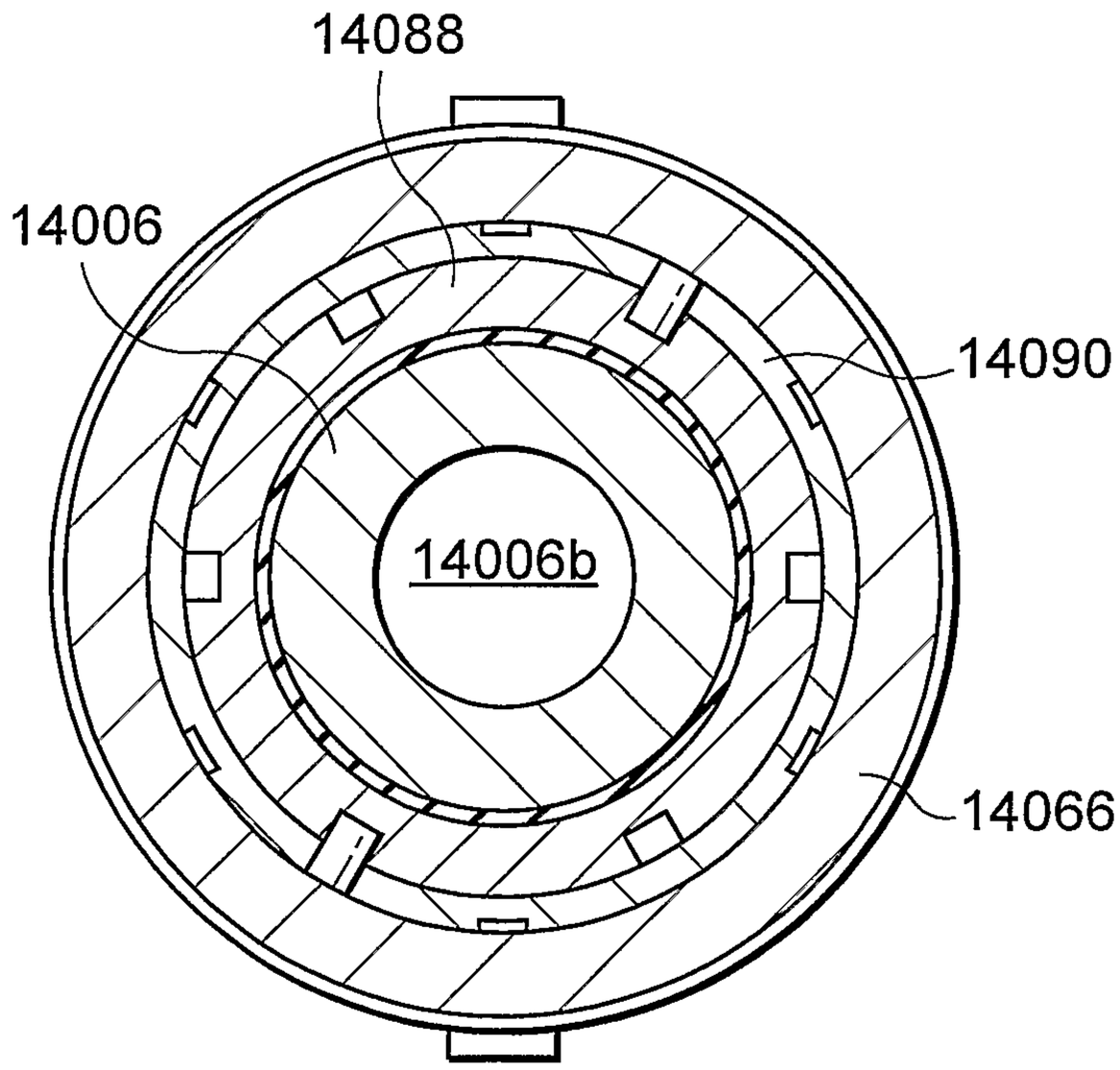


Fig. 11F

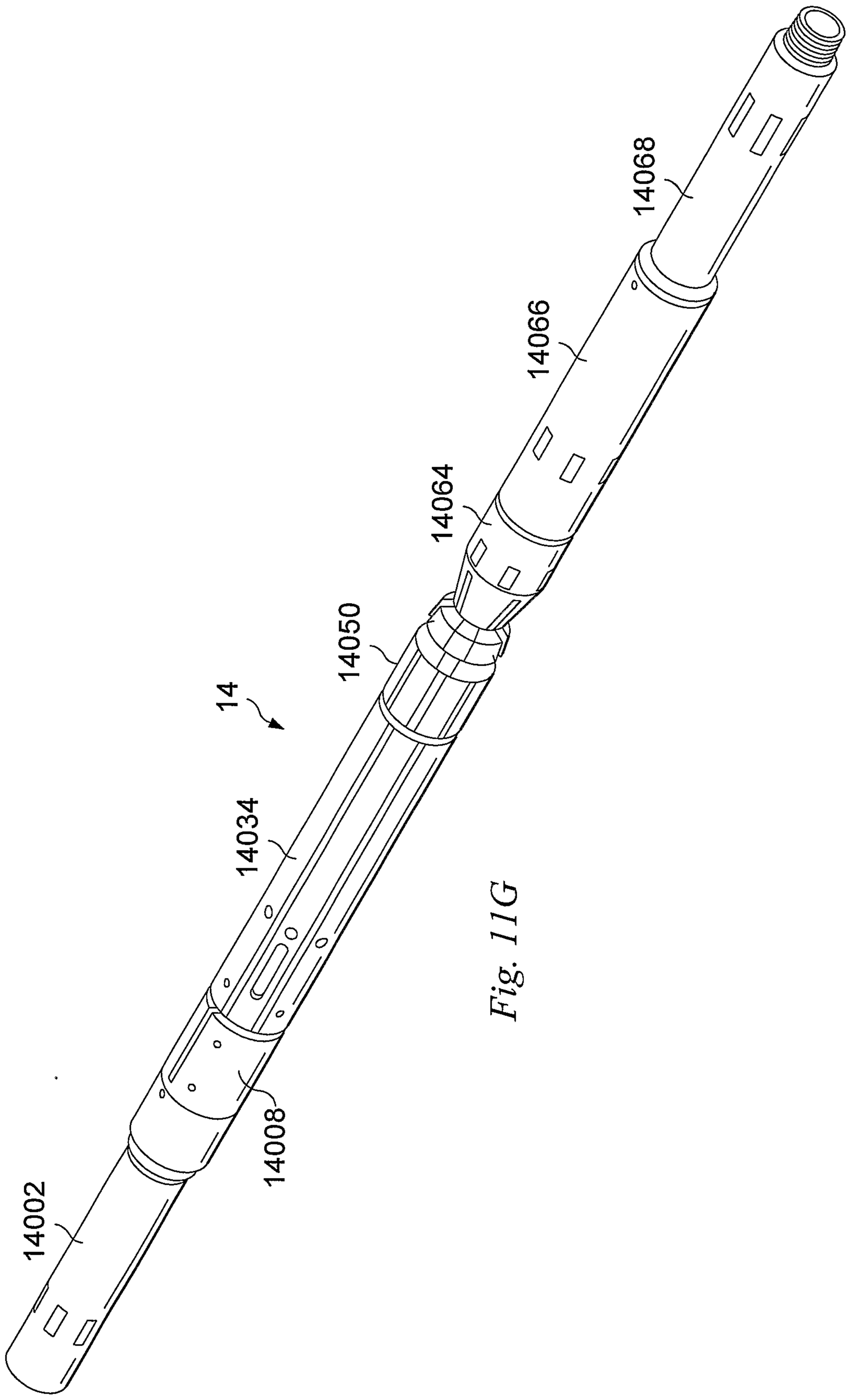


Fig. 11G

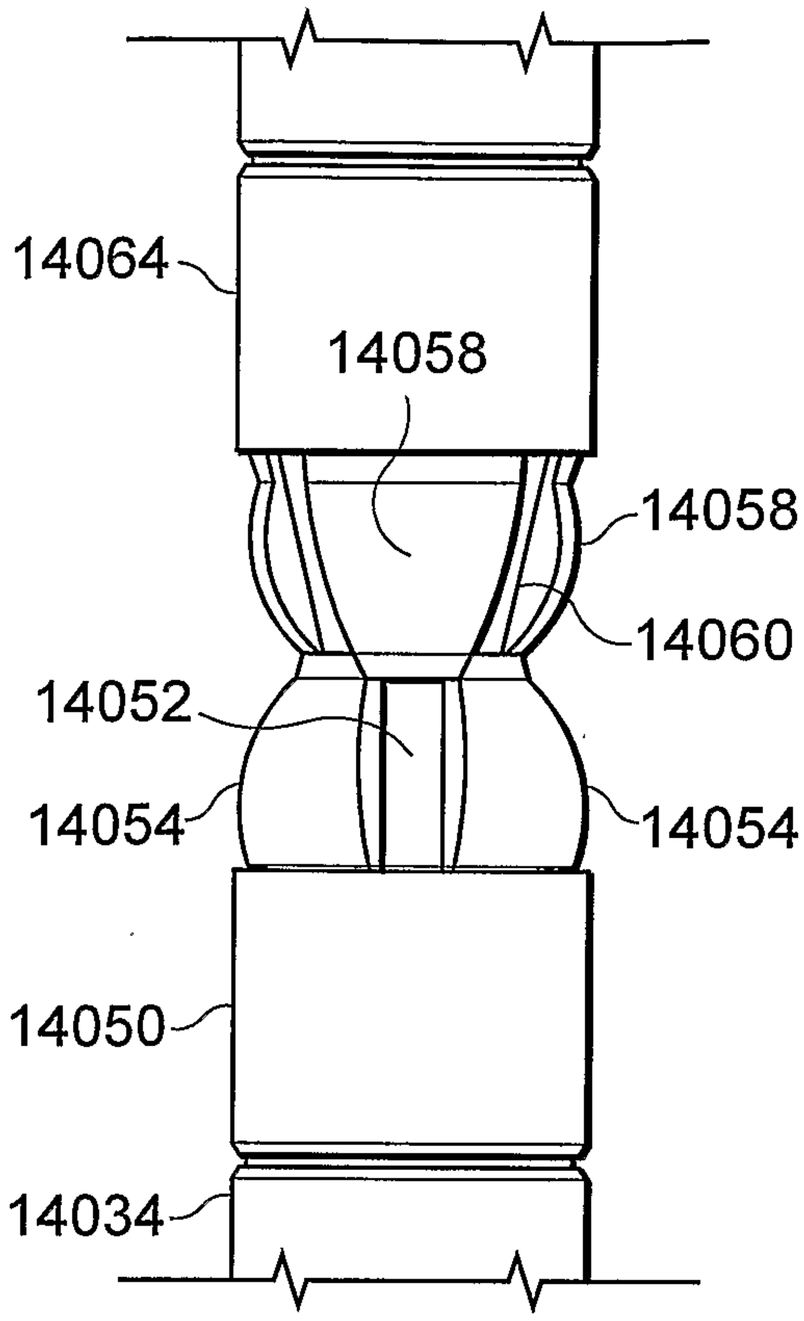


Fig. 11H

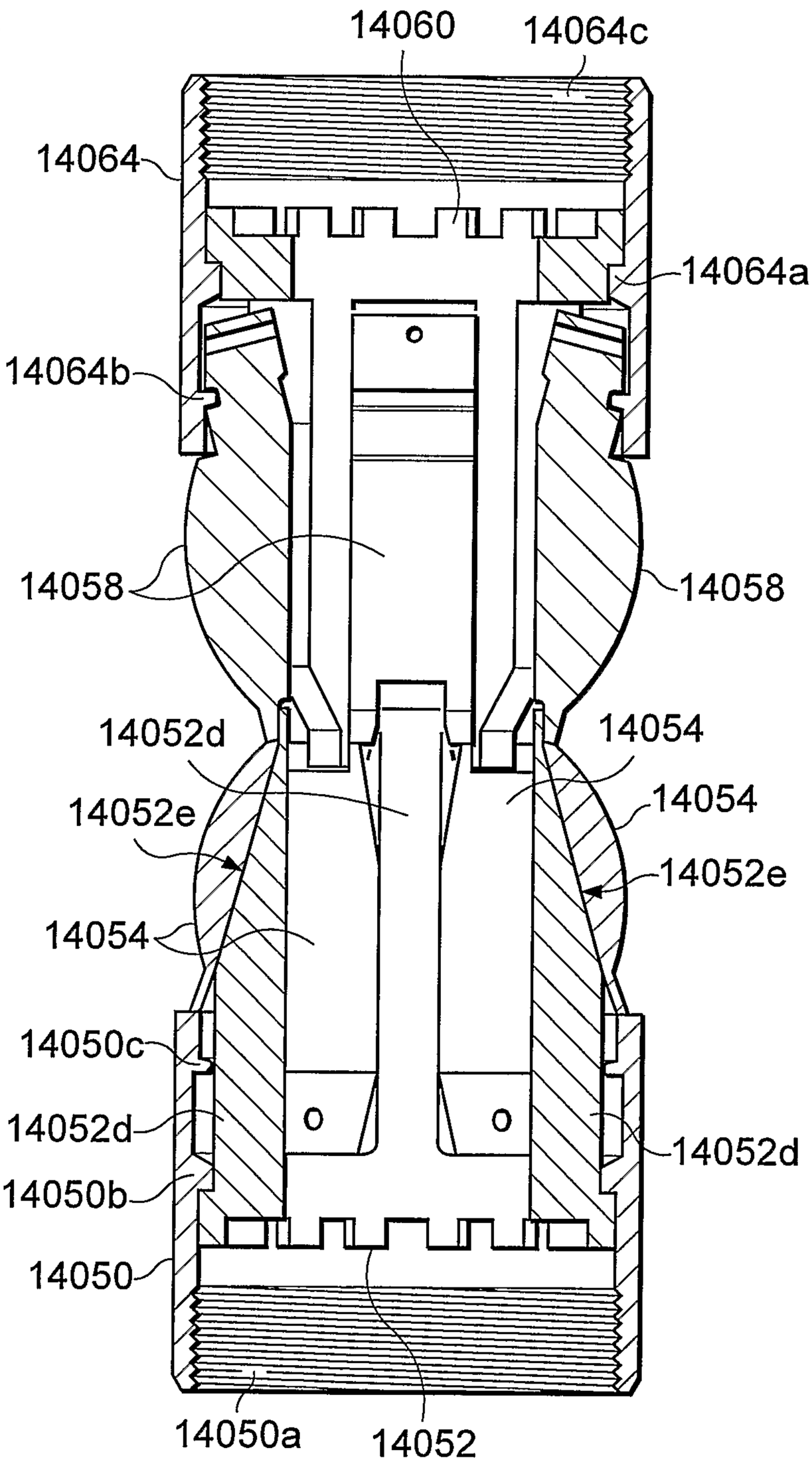


FIG. 11I

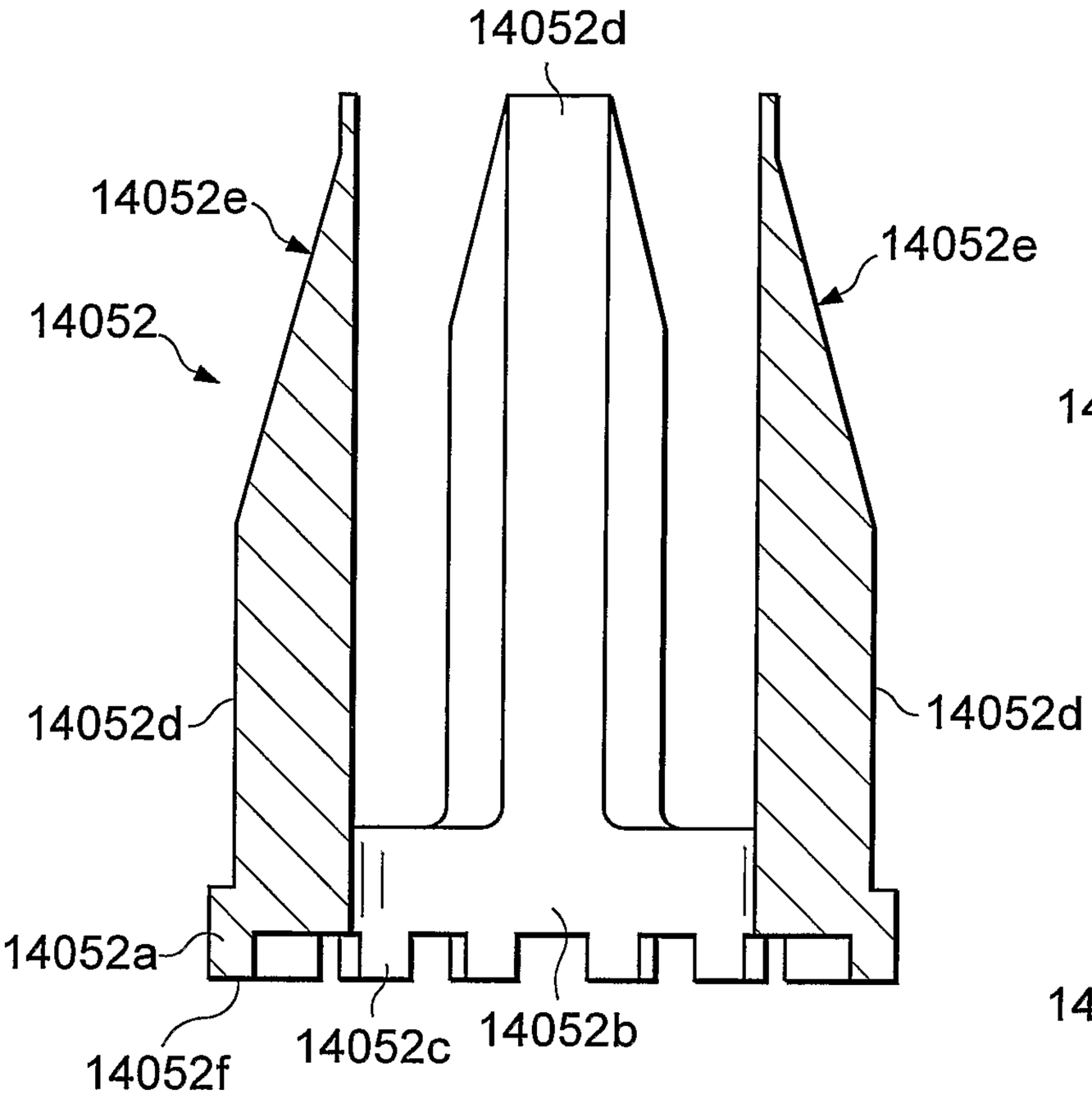


Fig. 11J

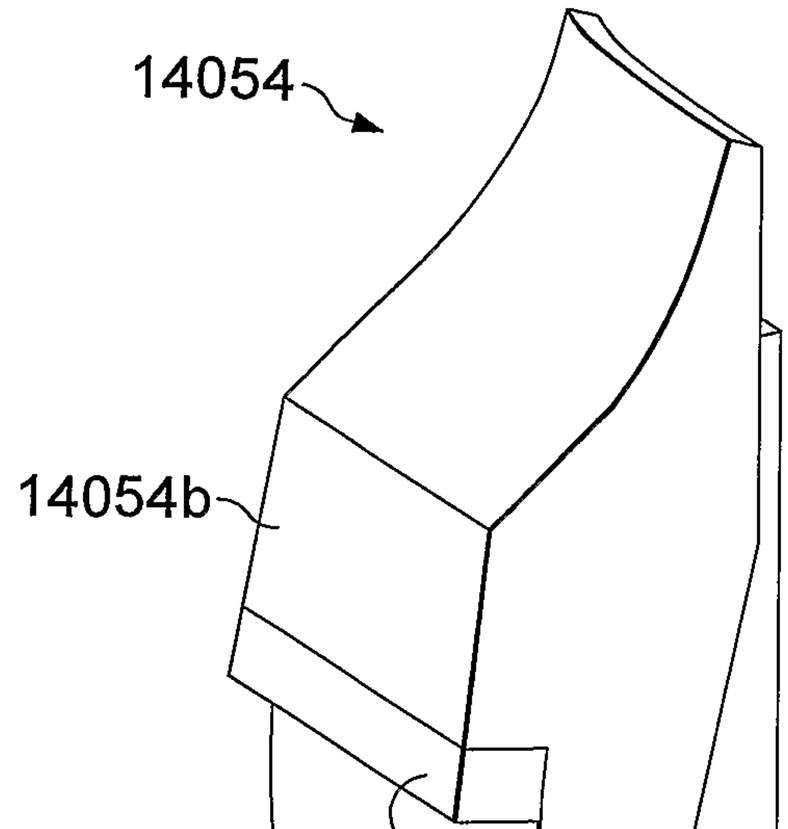


Fig. 11K

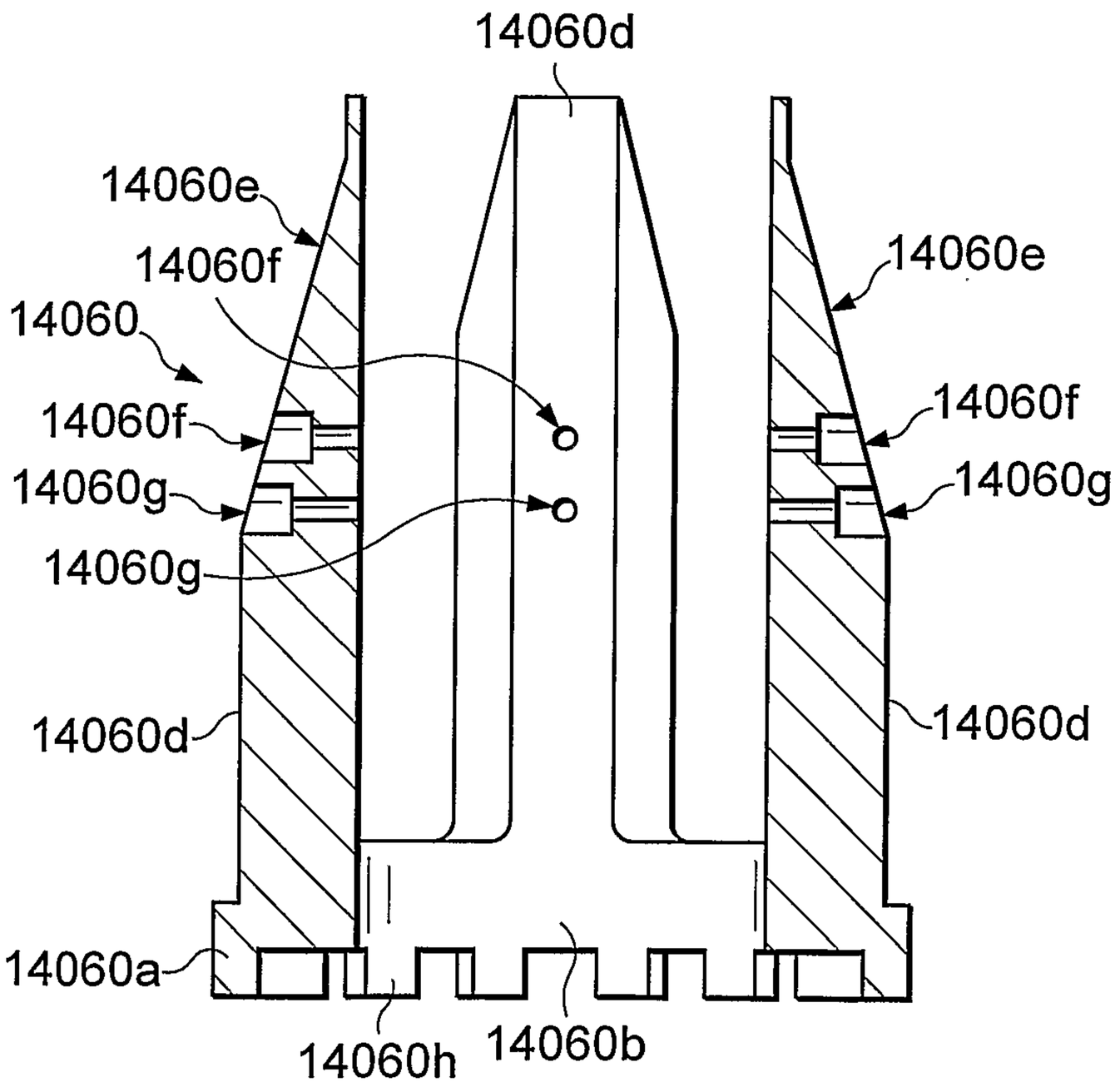


Fig. 11M

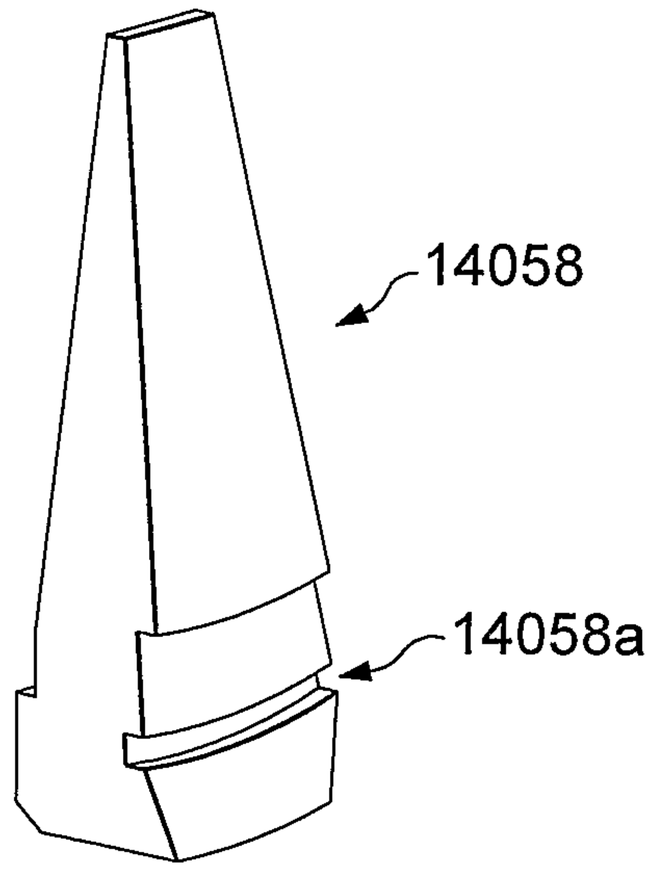


Fig. 11L

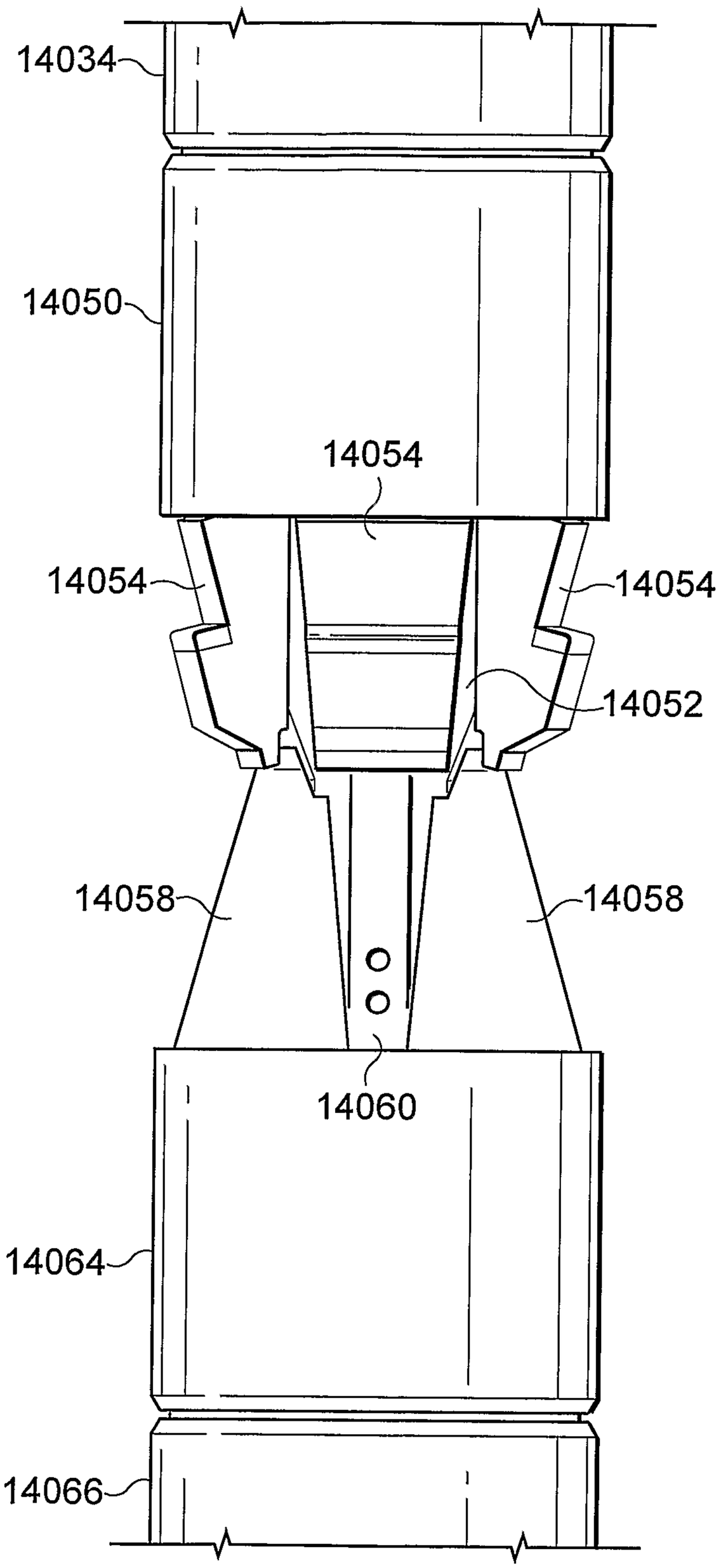

14034
14050
14054
14054
14054
14052
14058
14058
14060
14064
14066

Fig. 11N

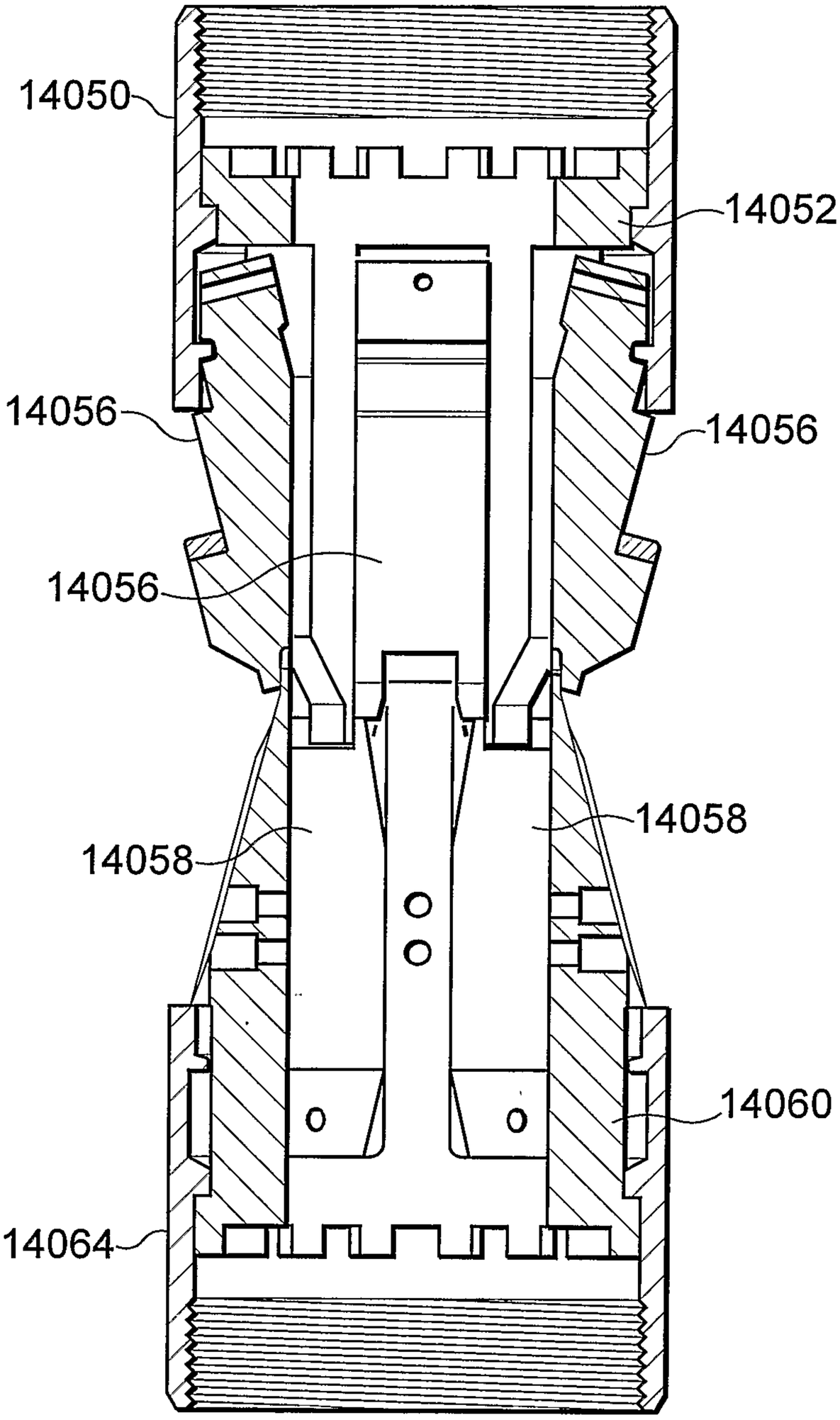


Fig. 11O

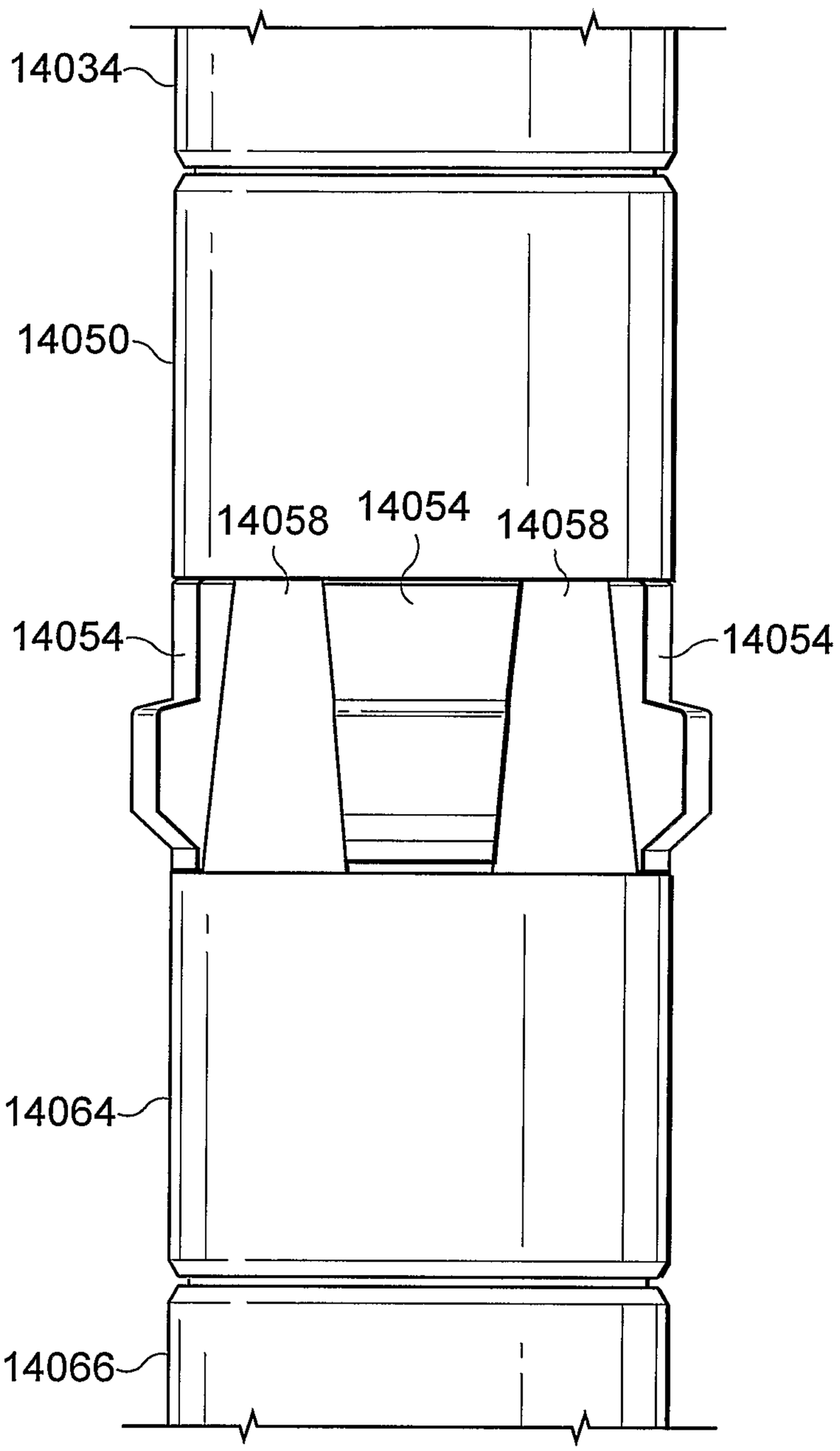


Fig. 11P

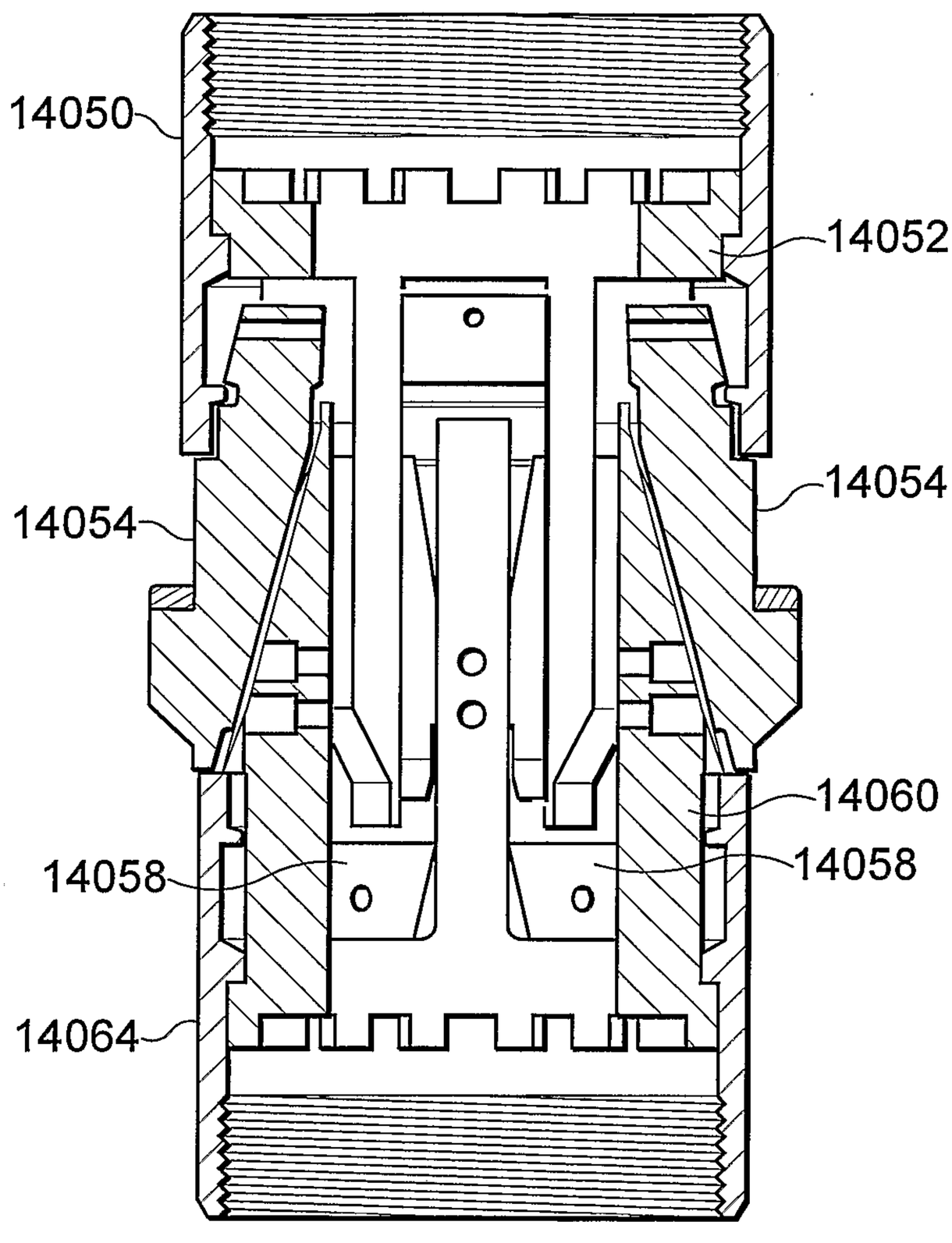


Fig. 11Q

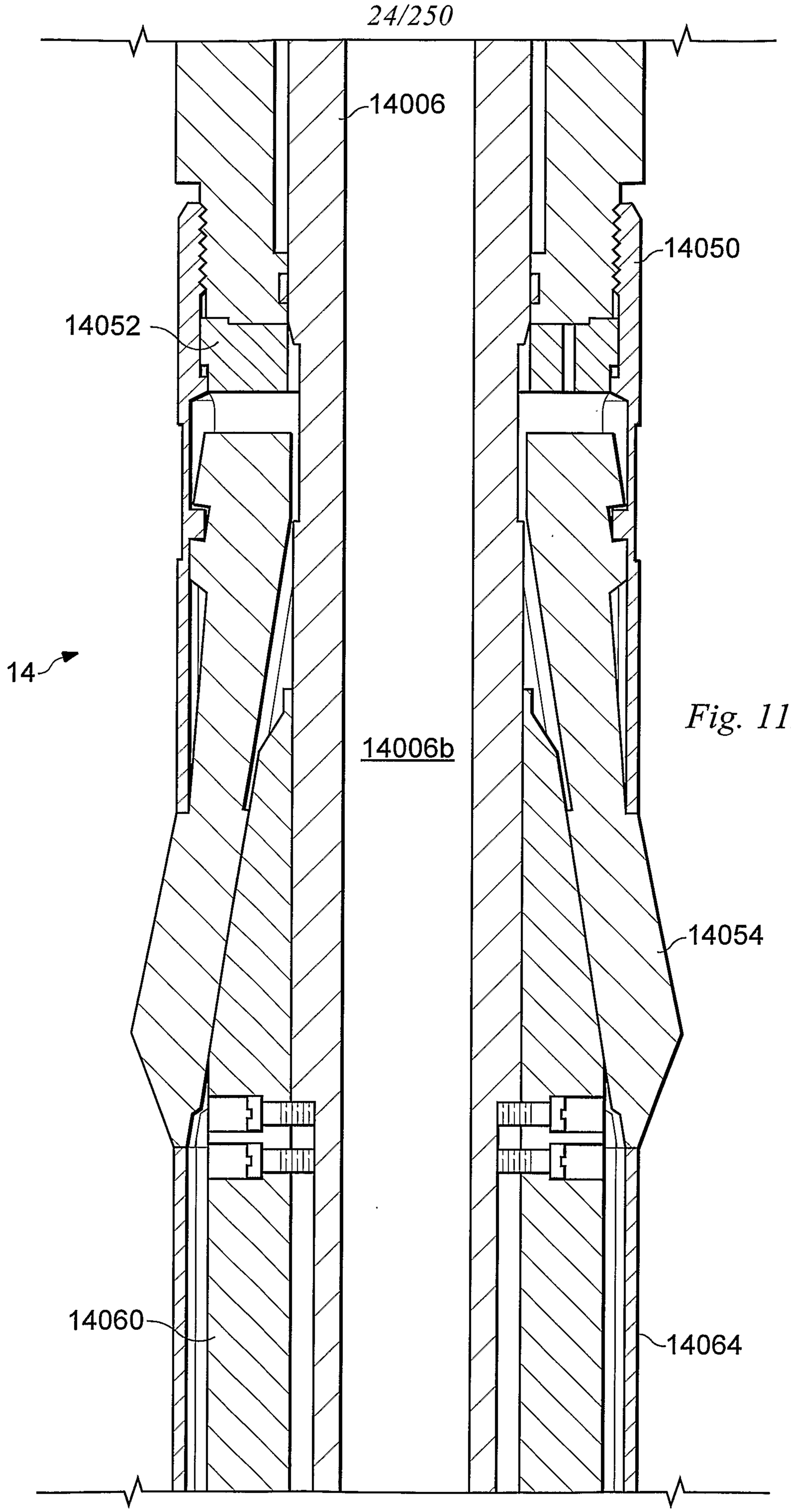


Fig. 11R

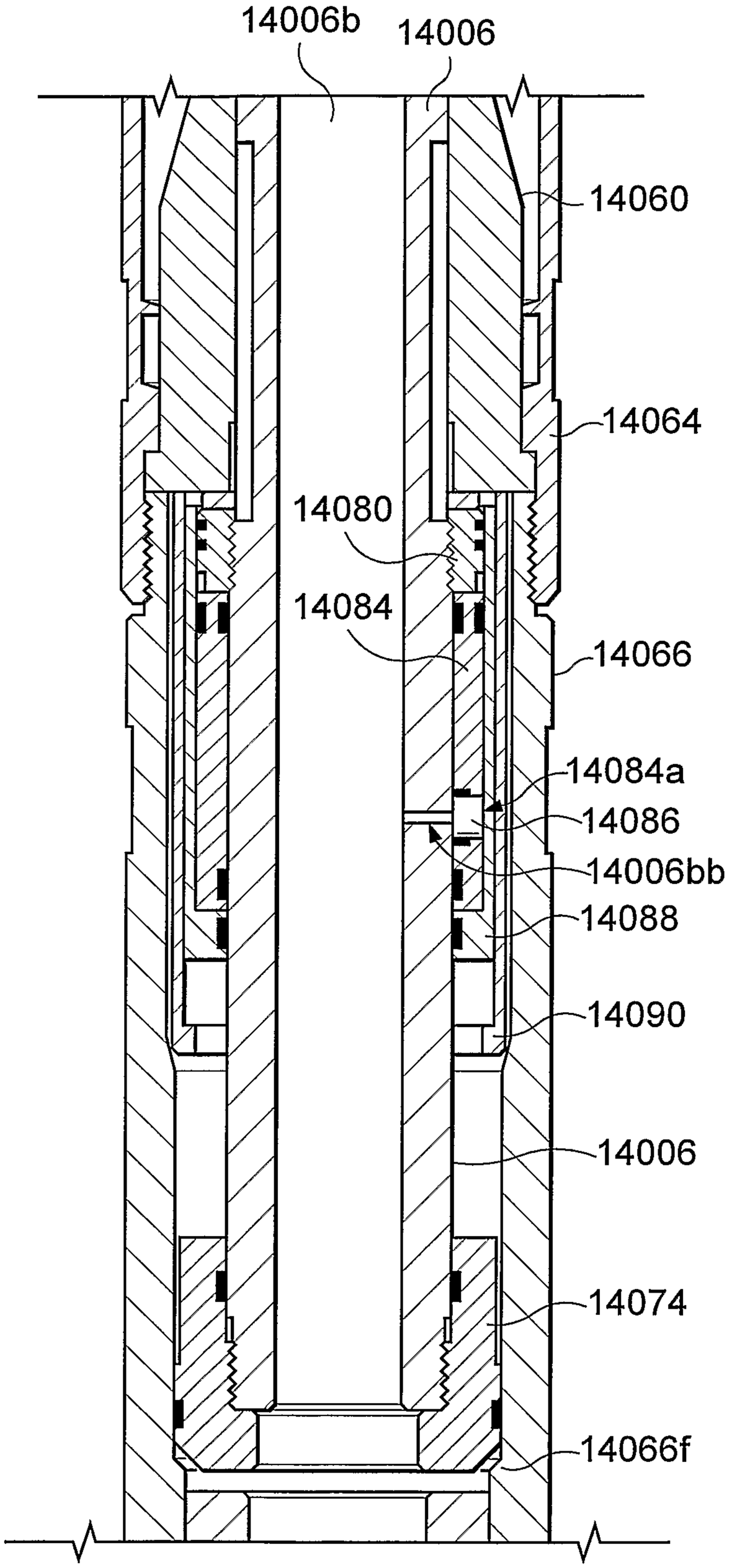

14006b
14006
14060
14064
14080
14084
14066
14084a
14086
14006bb
14088
14090
14006
14074
14066f

Fig. 11S

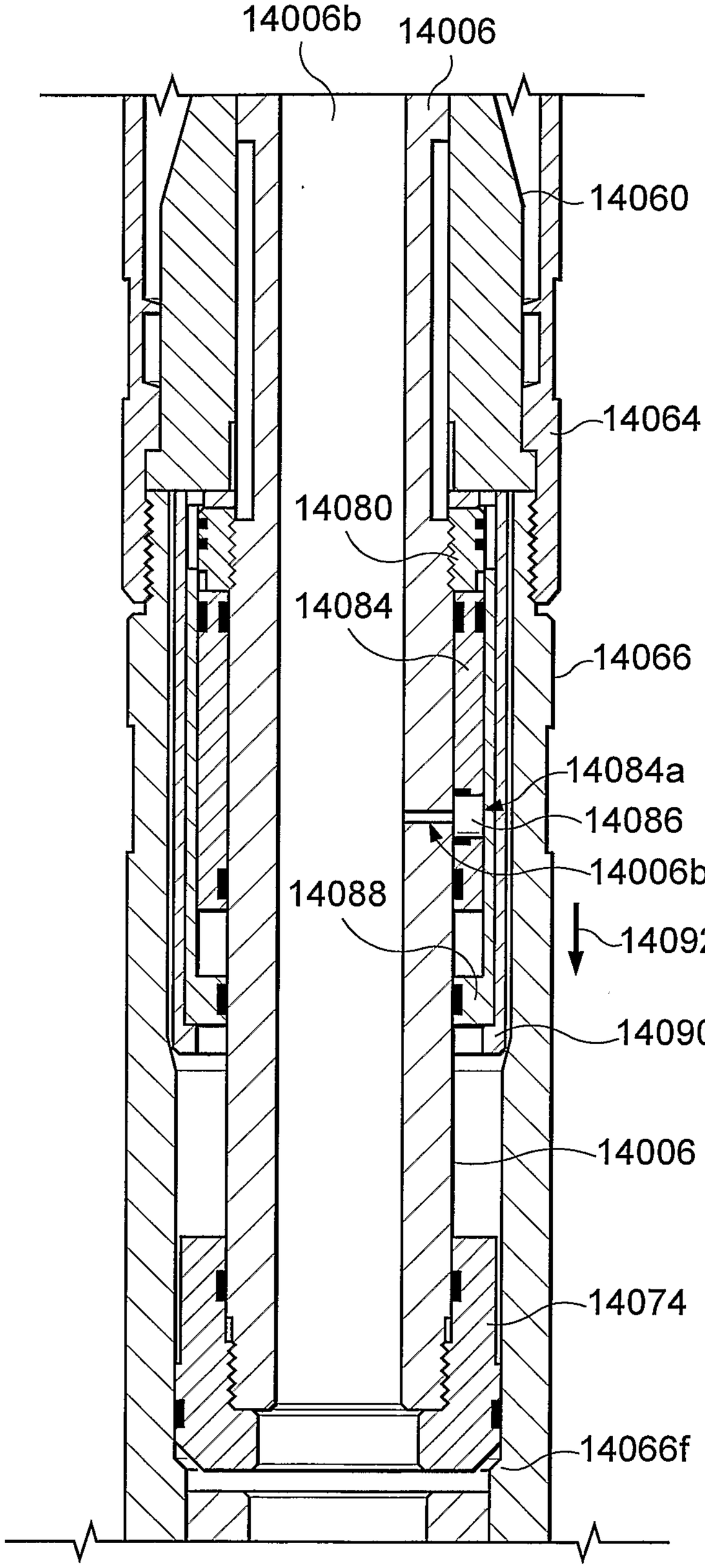

14006b
14006
14060
14064
14080
14084
14066
14084a
14086
14006bb
14088
14092
14090
14006
14074
14066f

Fig. 11T

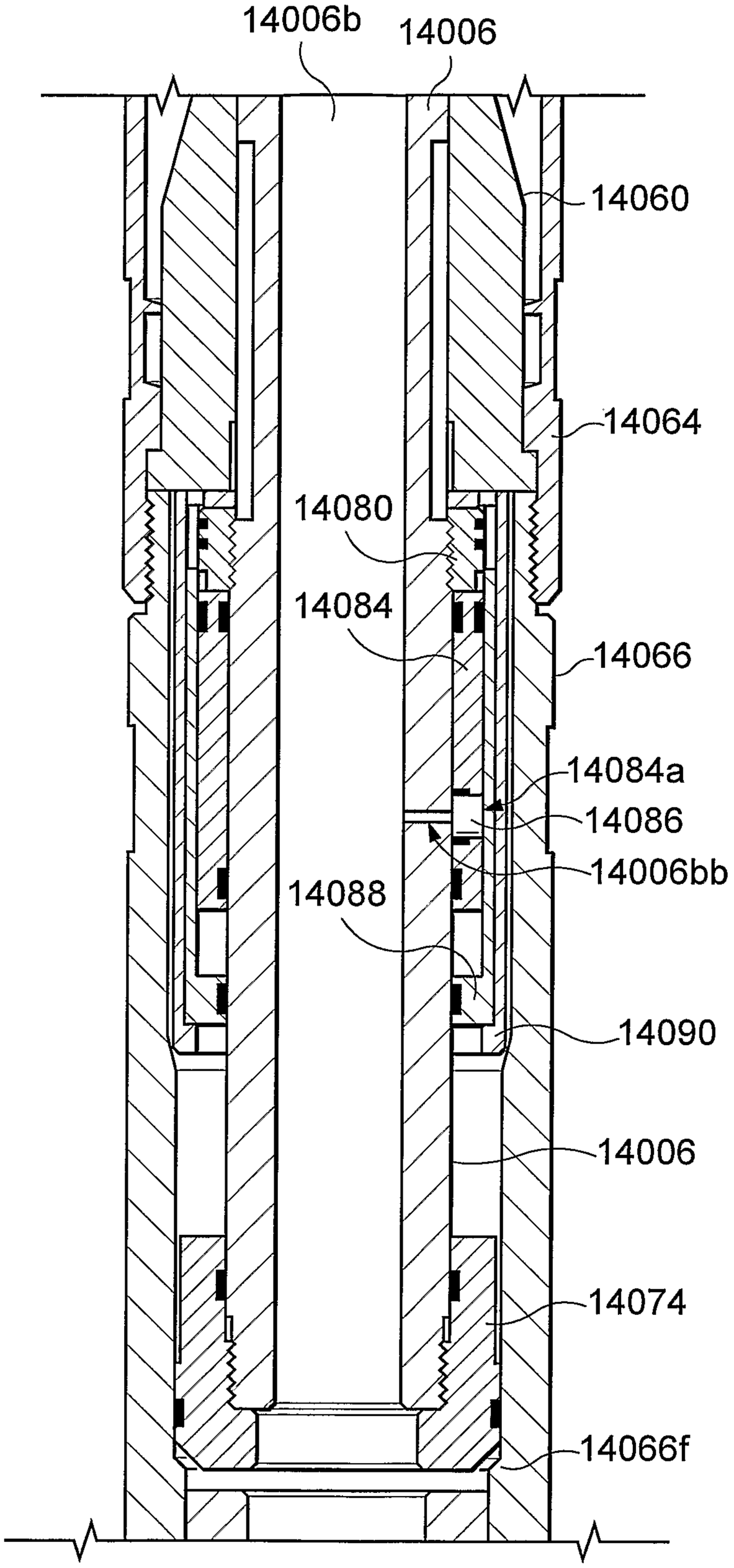

14006b
14006
14060
14064
14080
14084
14066
14084a
14086
14006bb
14088
14090
14006
14074
14066f

Fig. 11U

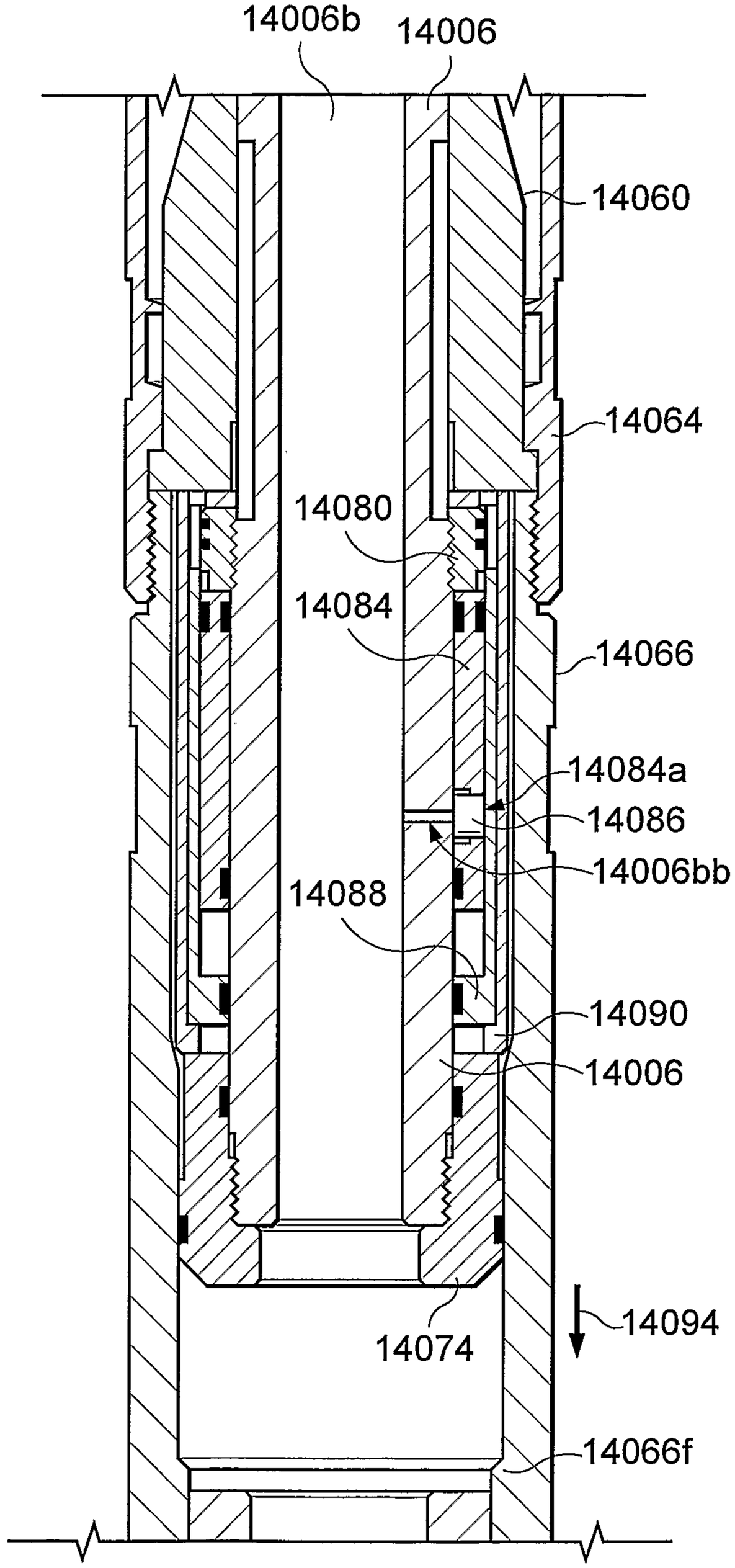

14006b
14006
14060
14064
14080
14084
14066
14084a
14086
14006bb
14088
14090
14006
14094
14074
14066f

Fig. 11V

Fig. 11W

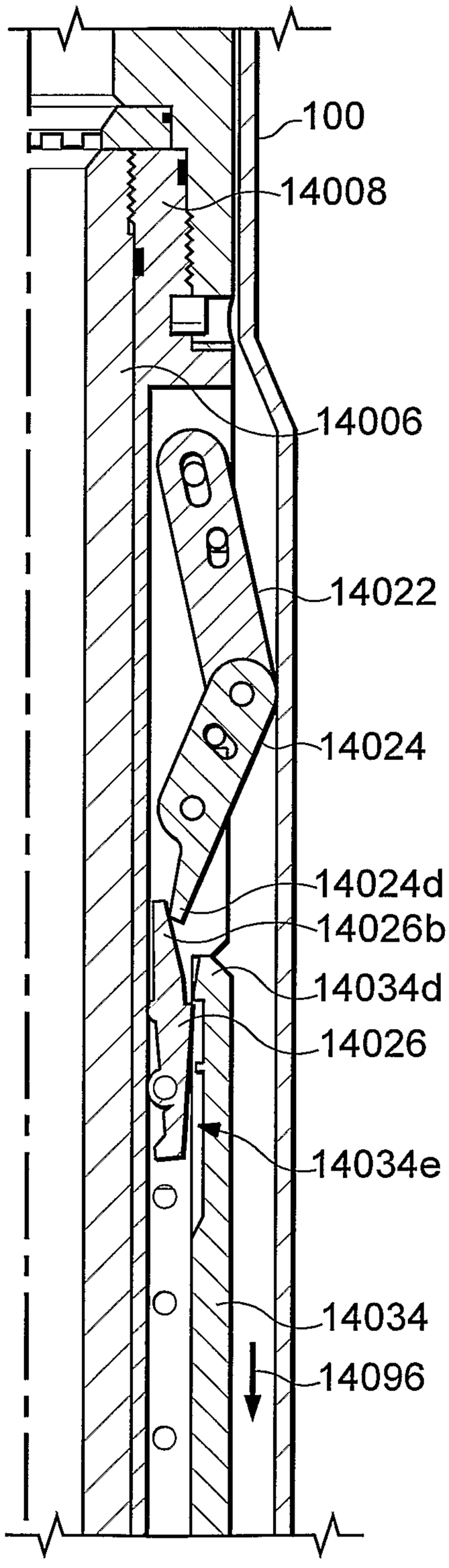


Fig. 11X

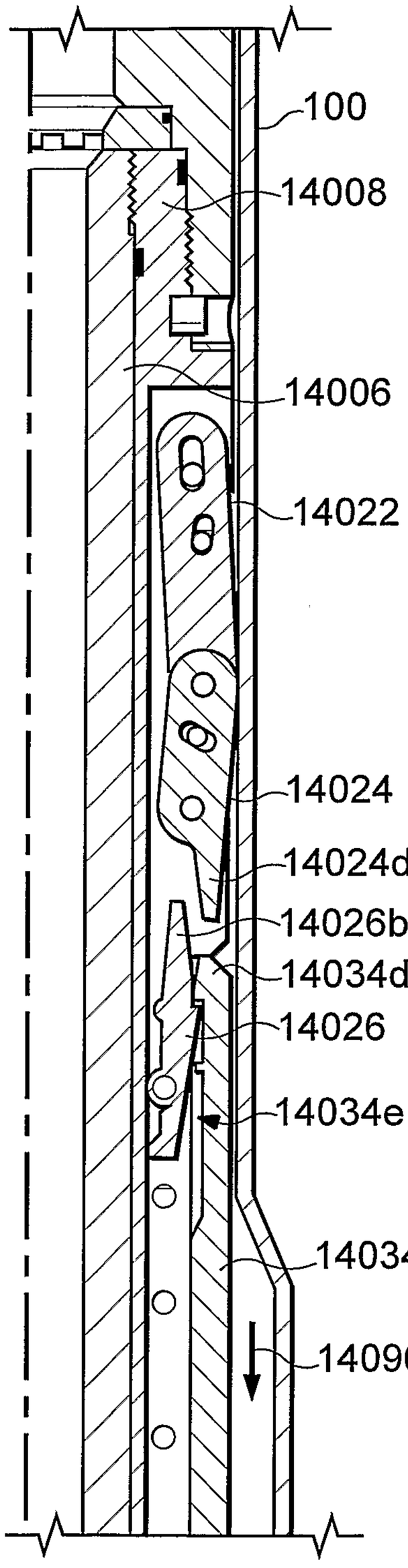
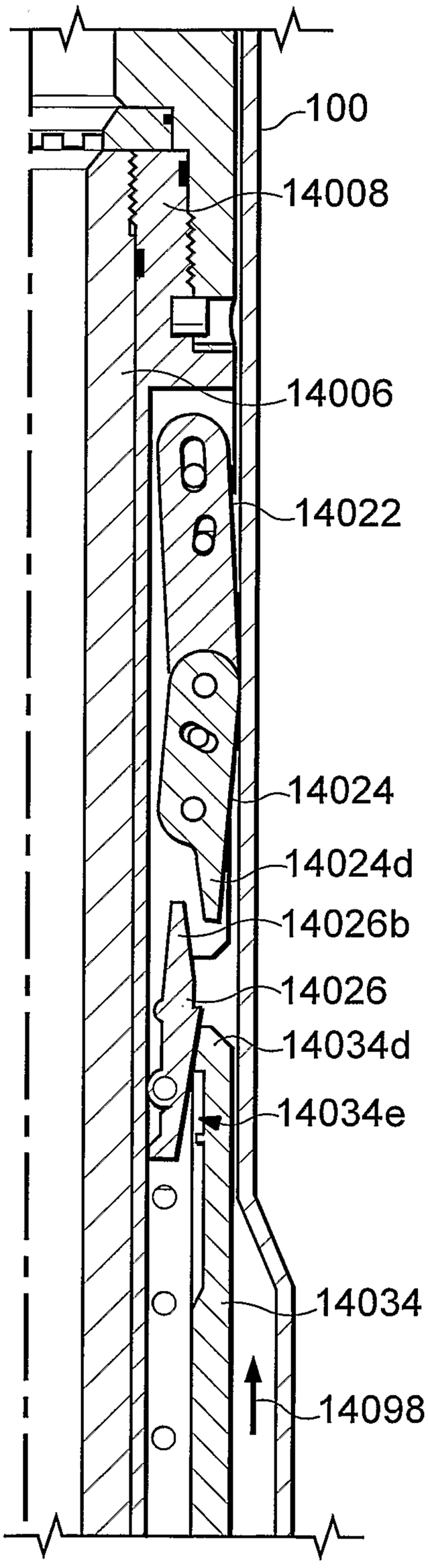


Fig. 11Y



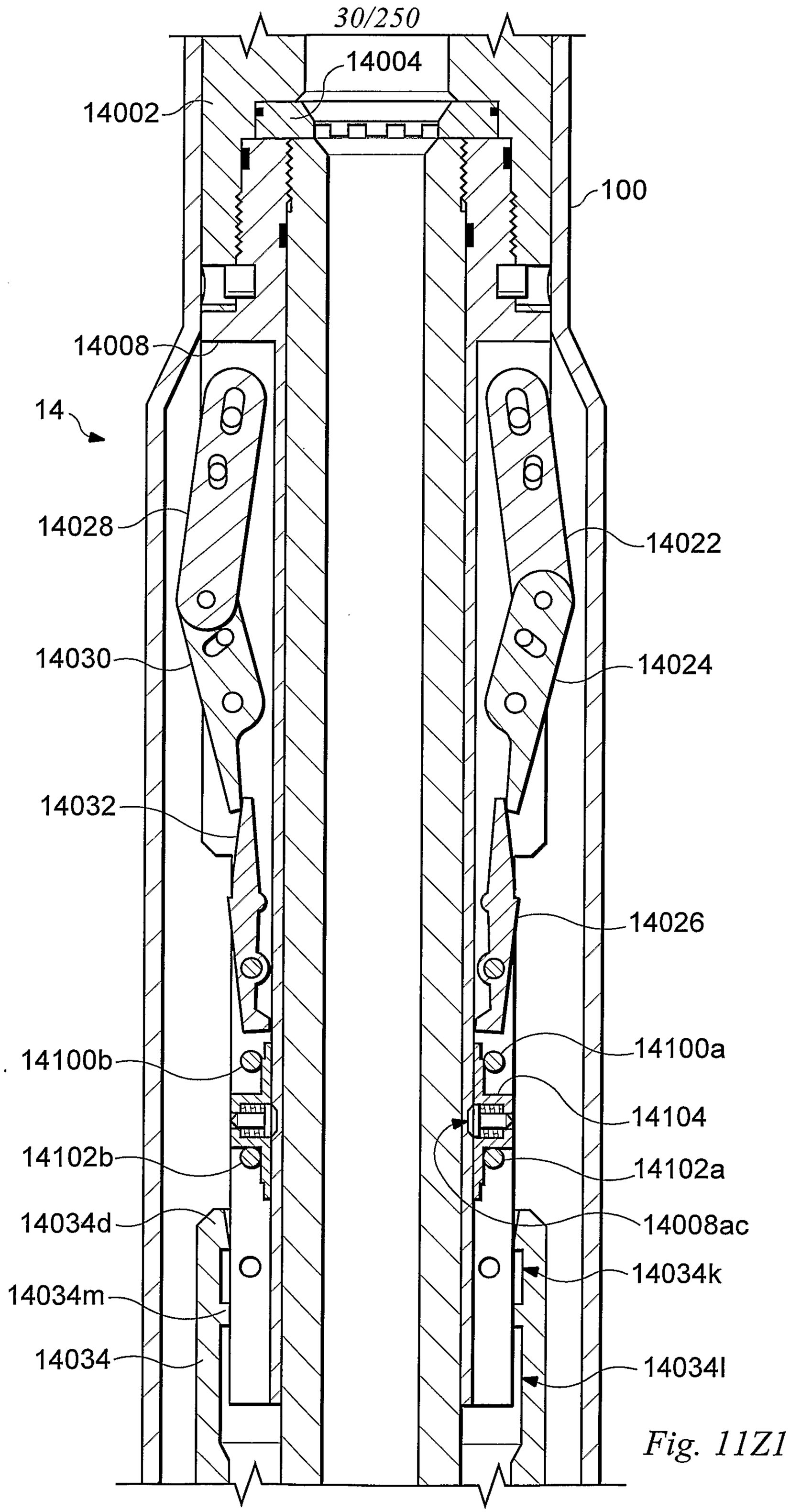

30/250
14004
14002
100
14008
14
14028
14030
14032
14022
14024
14026
14100b
14102b
14034d
14034m
14034
14100a
14104
14102a
14008ac
14034k
14034l

Fig. 11Z1

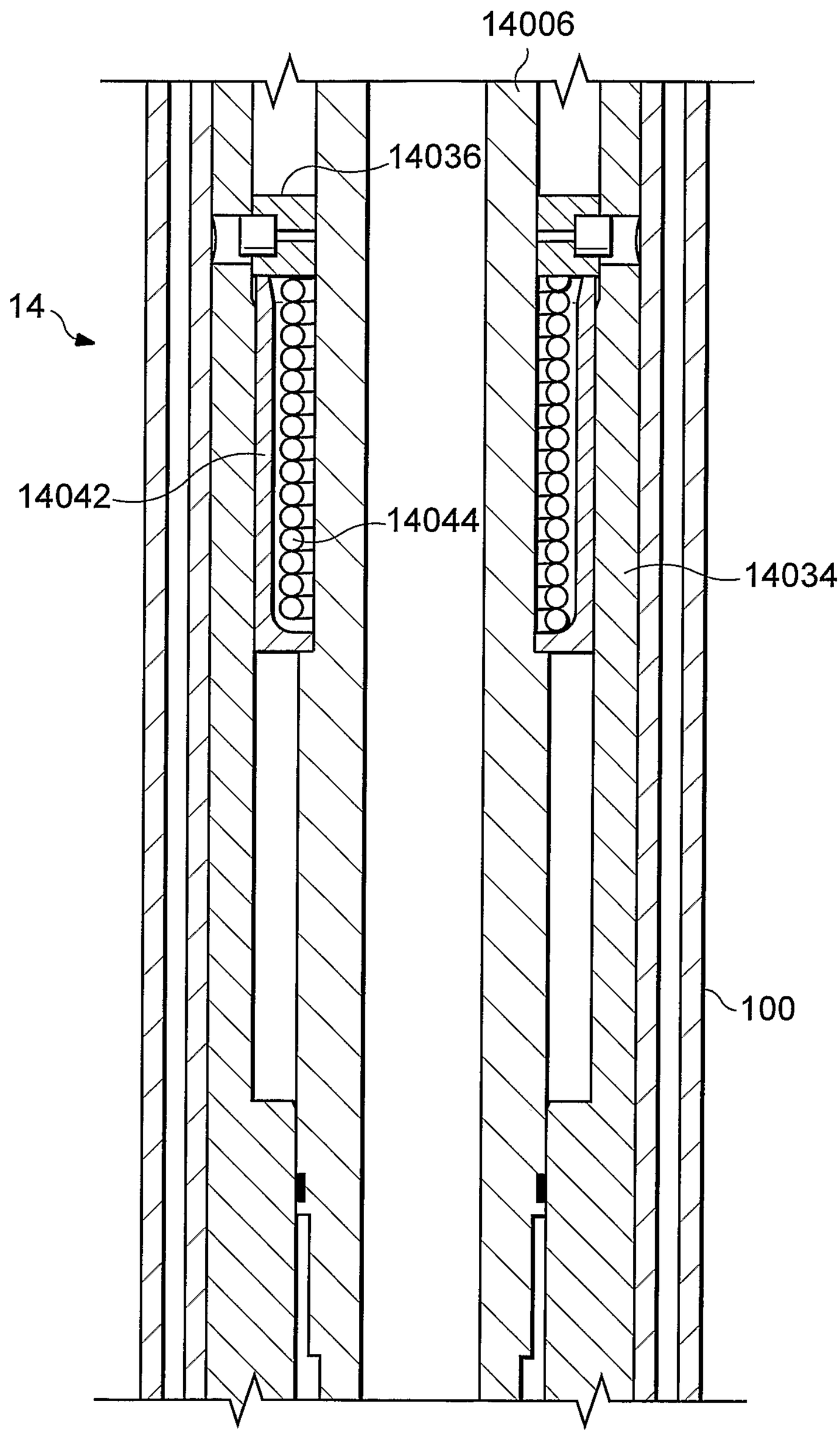


Fig. 11Z2

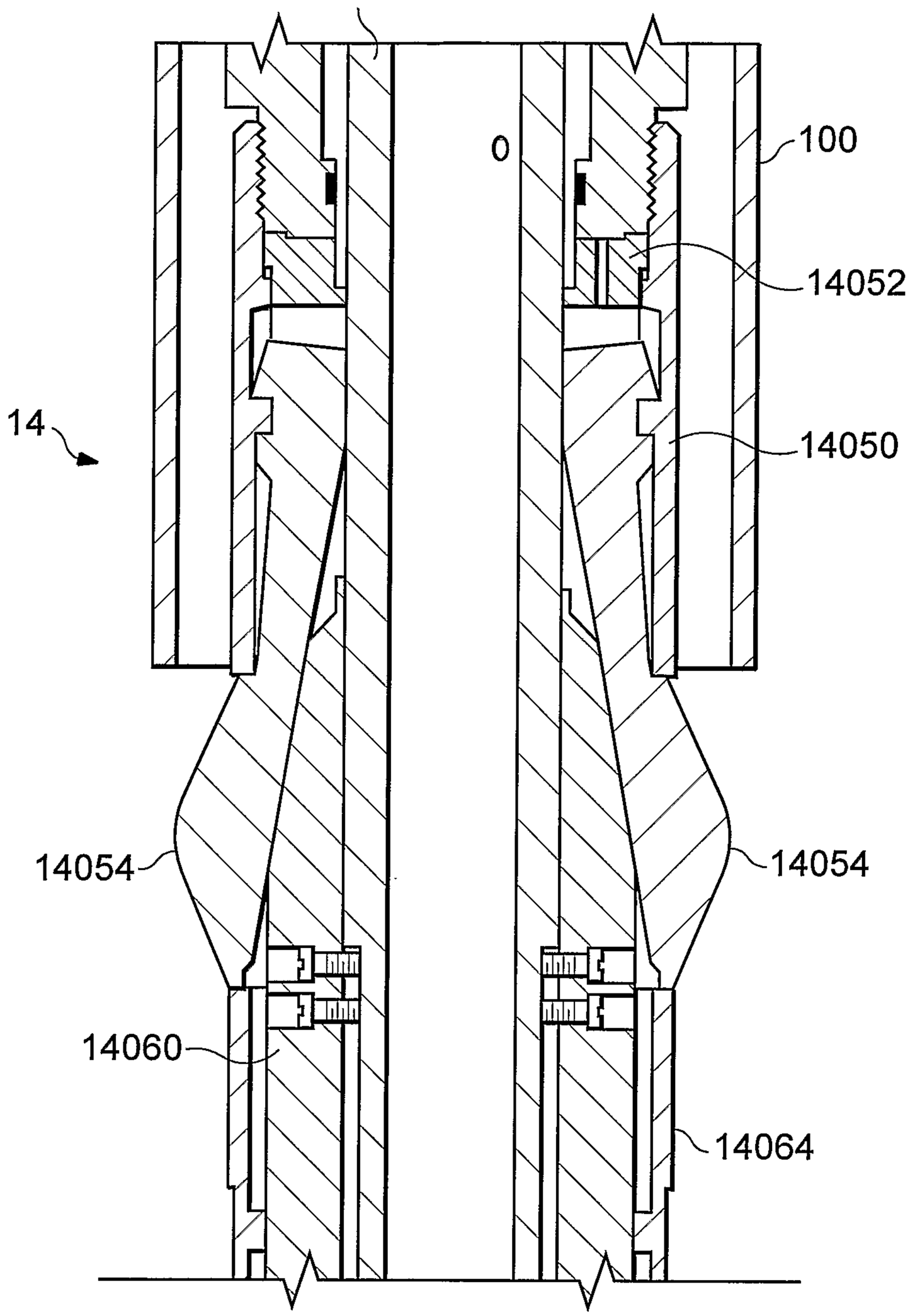


Fig. 11Z3

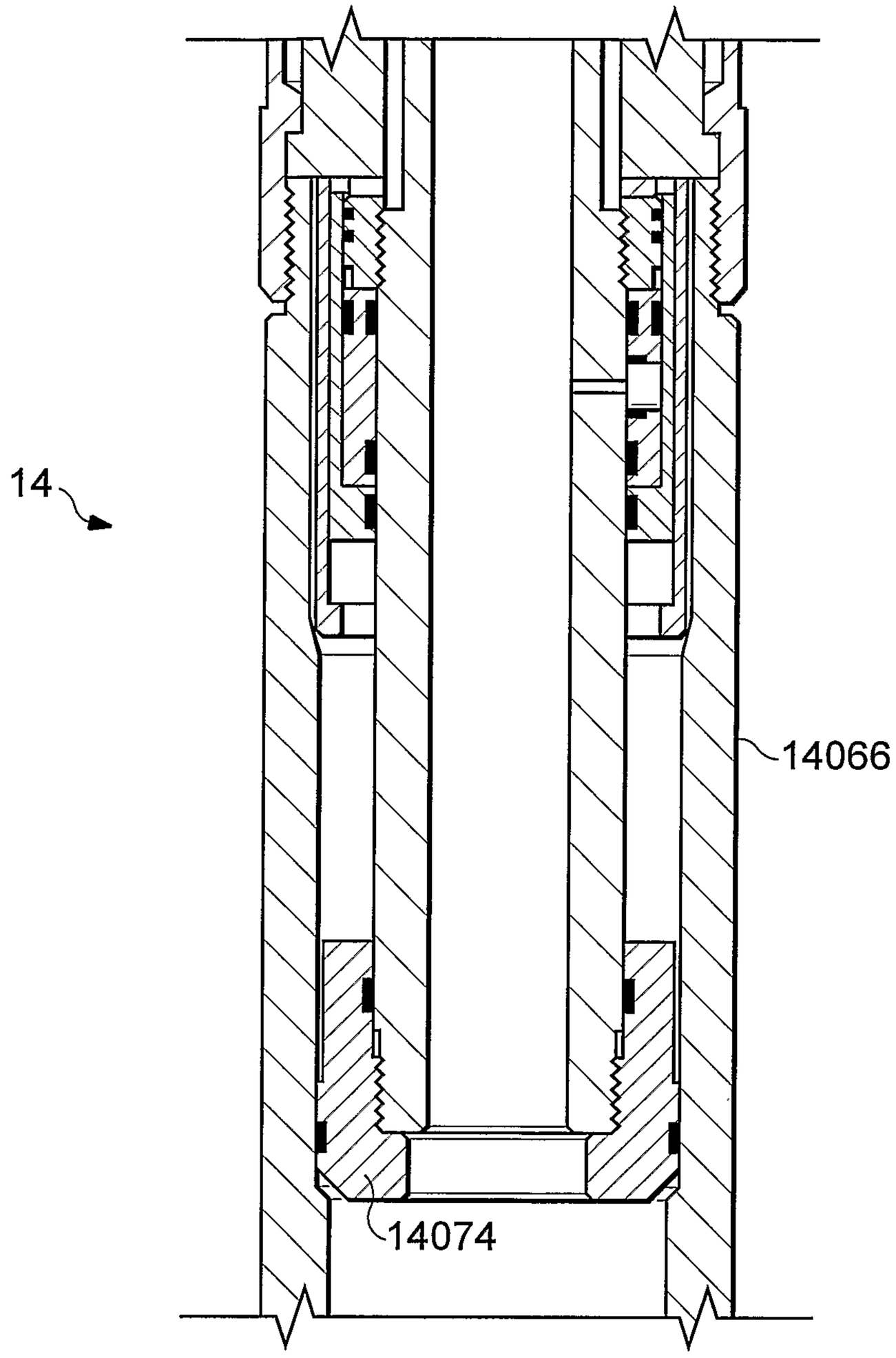


Fig. 11Z4

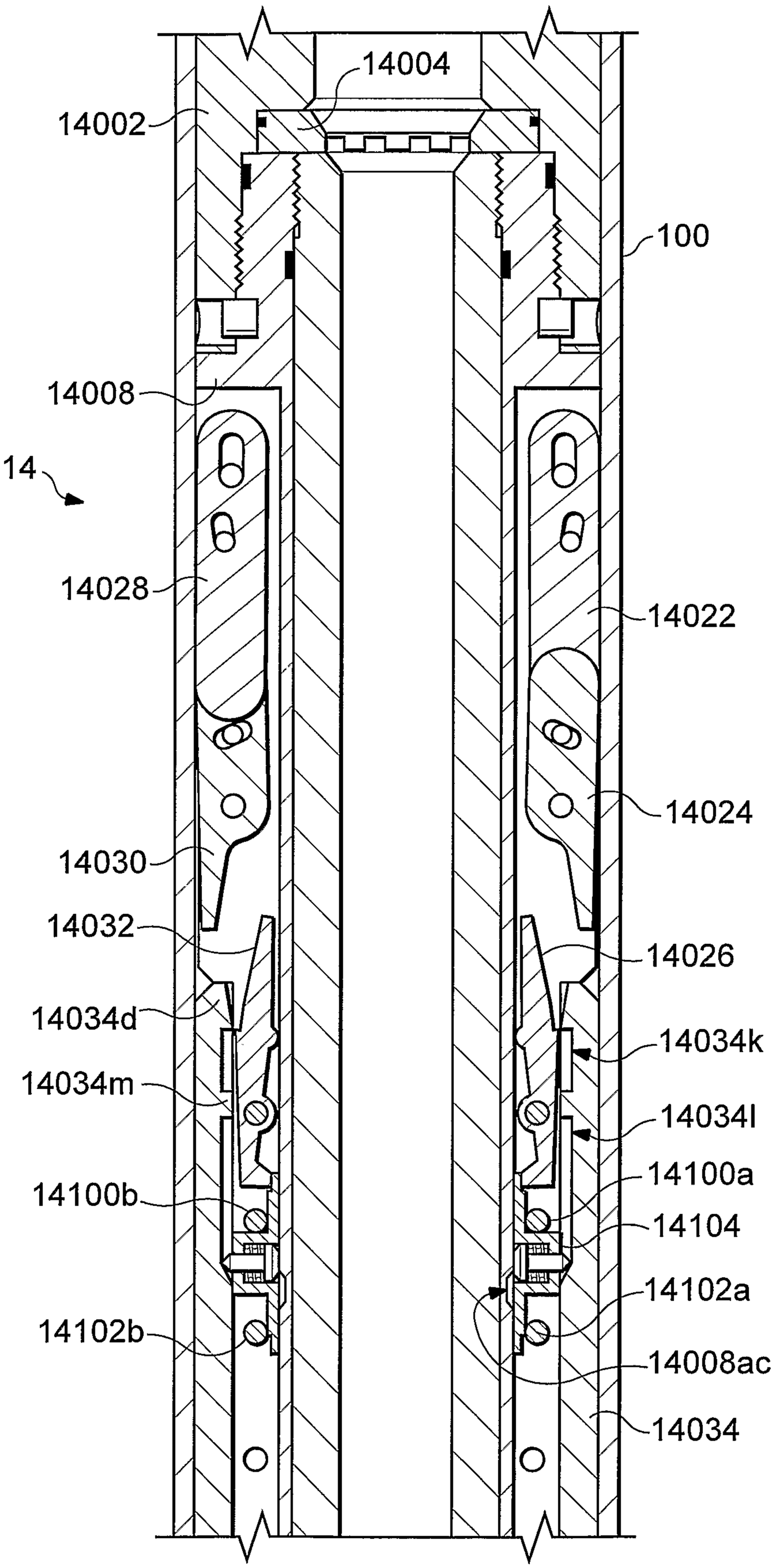

14004
14002
100
14008
14
14028
14022
14024
14030
14032
14026
14034d
14034k
14034m
14034l
14100a
14100b
14104
14102a
14102b
14008ac
14034

Fig. 11AA1

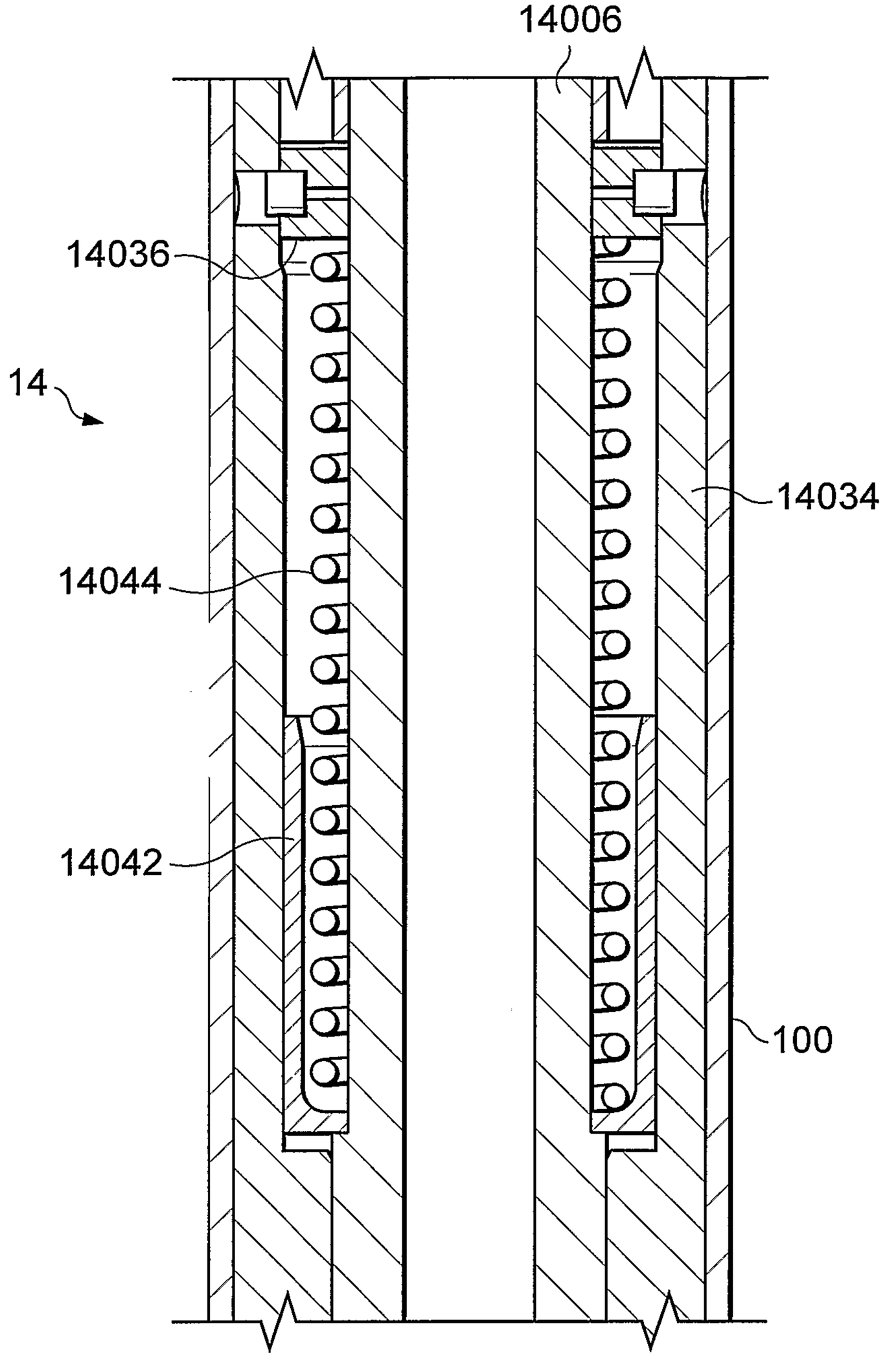


Fig. 11AA2

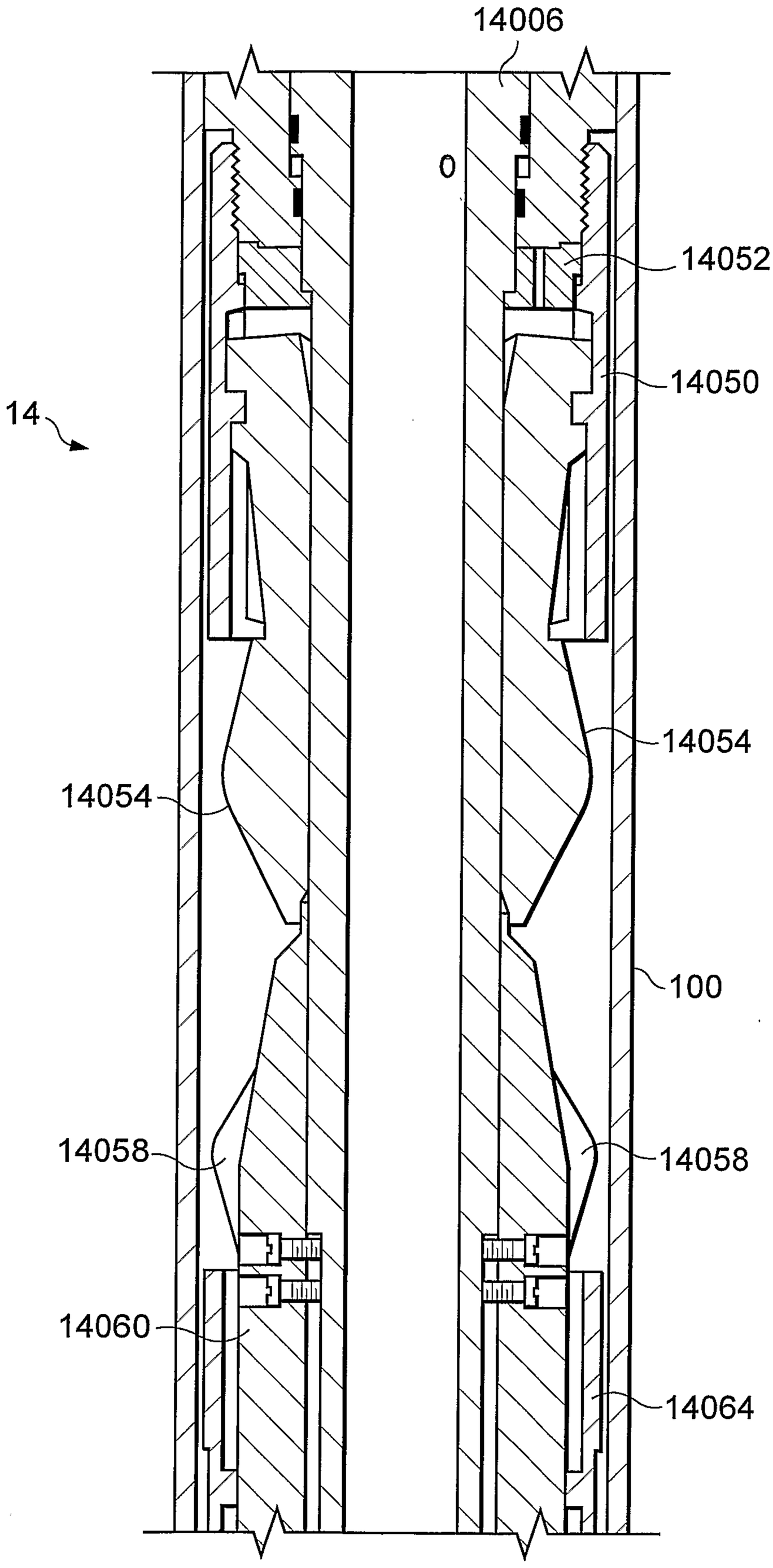

14006
0
14052
14050
14
14054
14054
14058
100
14058
14060
14064

Fig. 11AA3

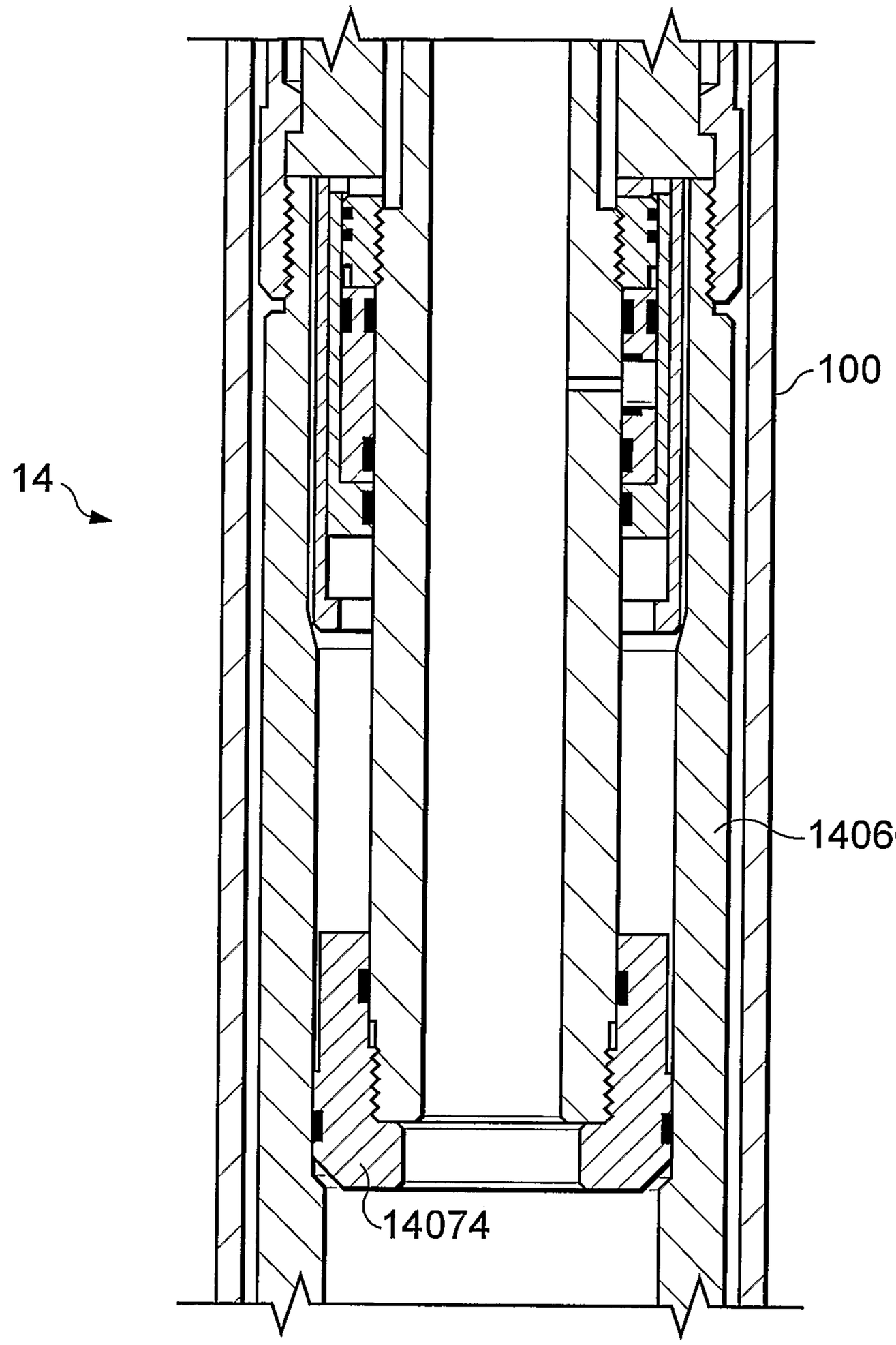


Fig. 11AA4

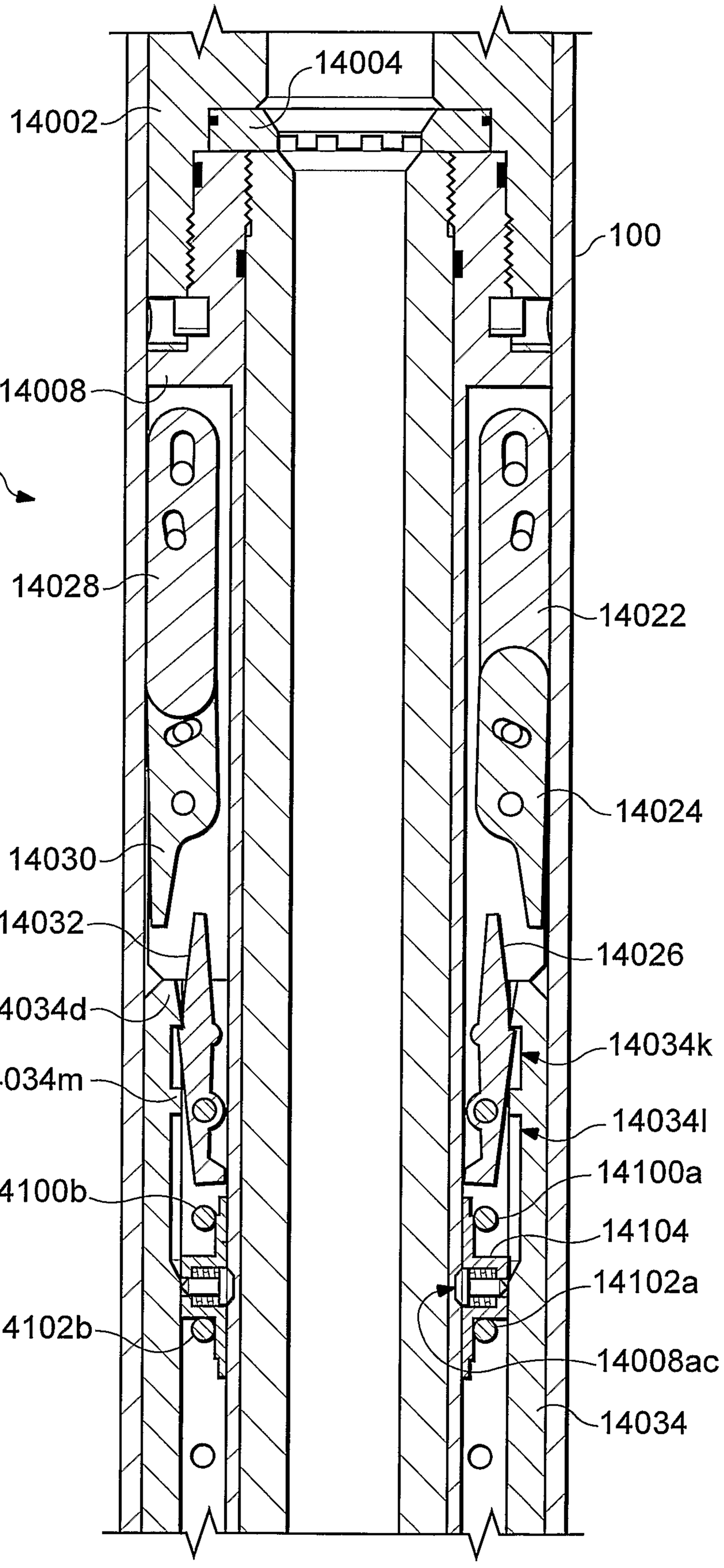

14004
14002
100
14008
14
14028
14022
14024
14030
14032
14026
14034d
14034k
14034m
14034l
14100a
14100b
14104
14102a
14102b
14008ac
14034

Fig. 11AB1

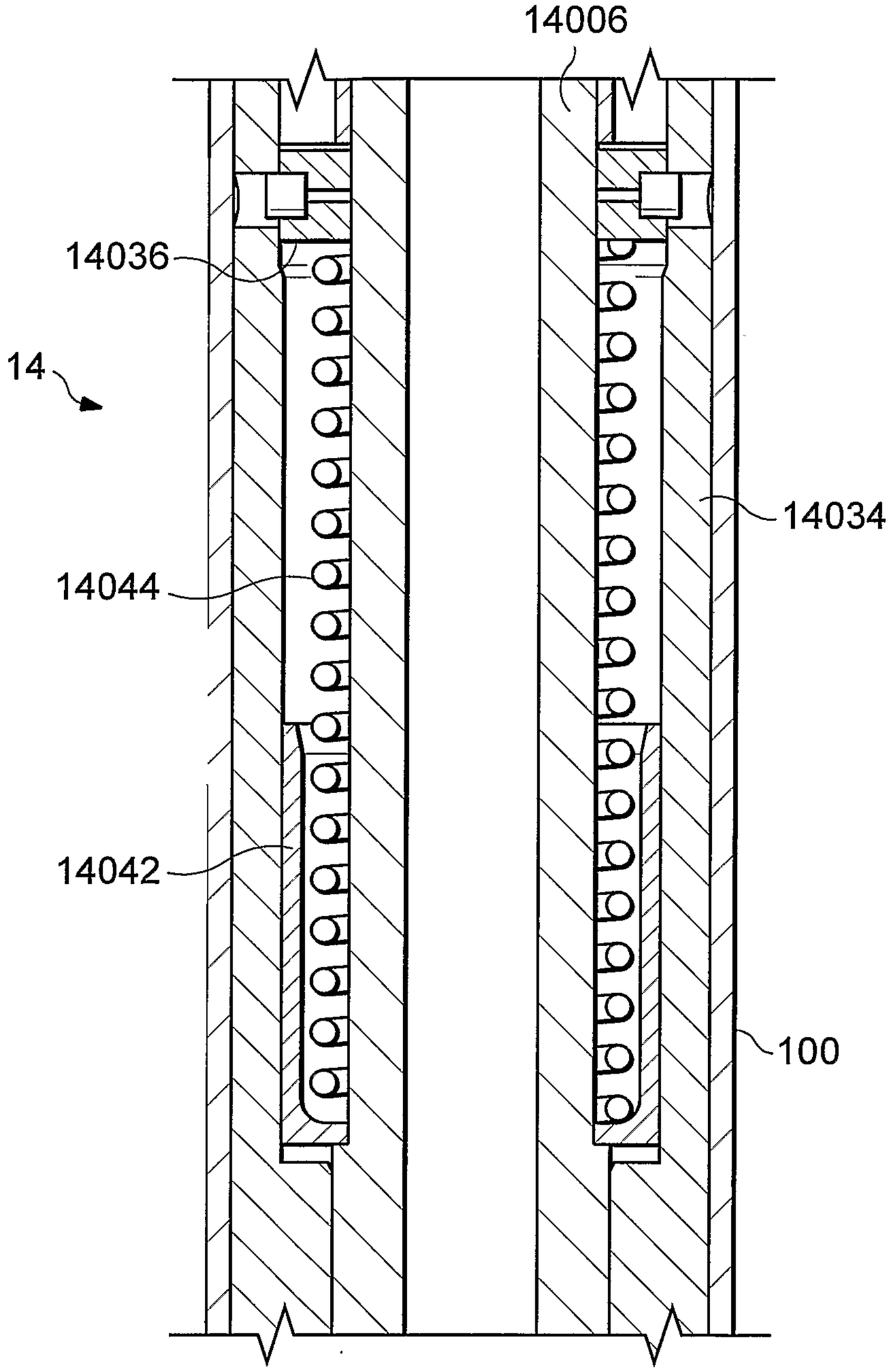


Fig. 11AB2

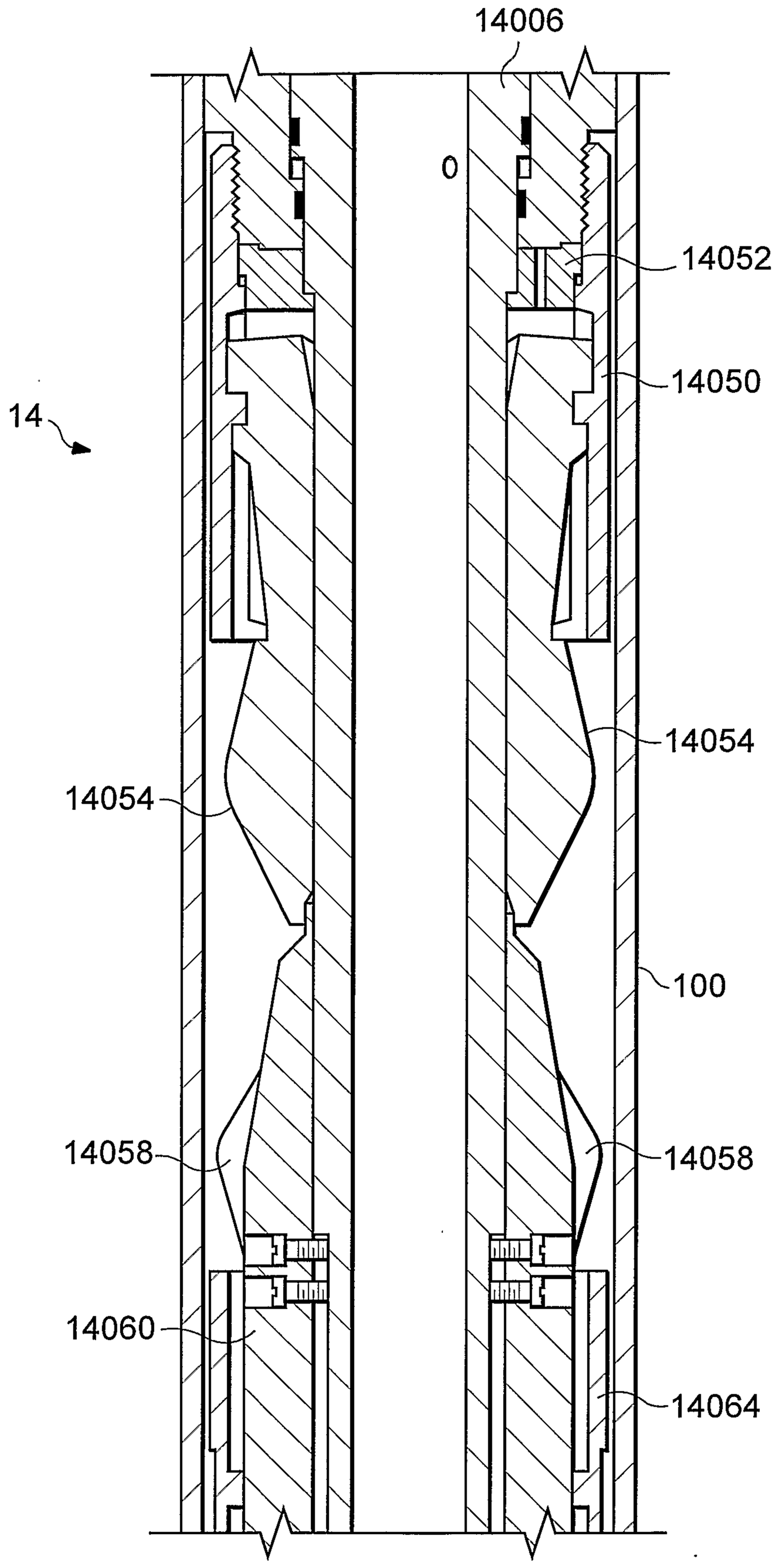

14006
0
14052
14050
14
14054
14054
14058
14058
100
14060
14064

Fig. 11AB3

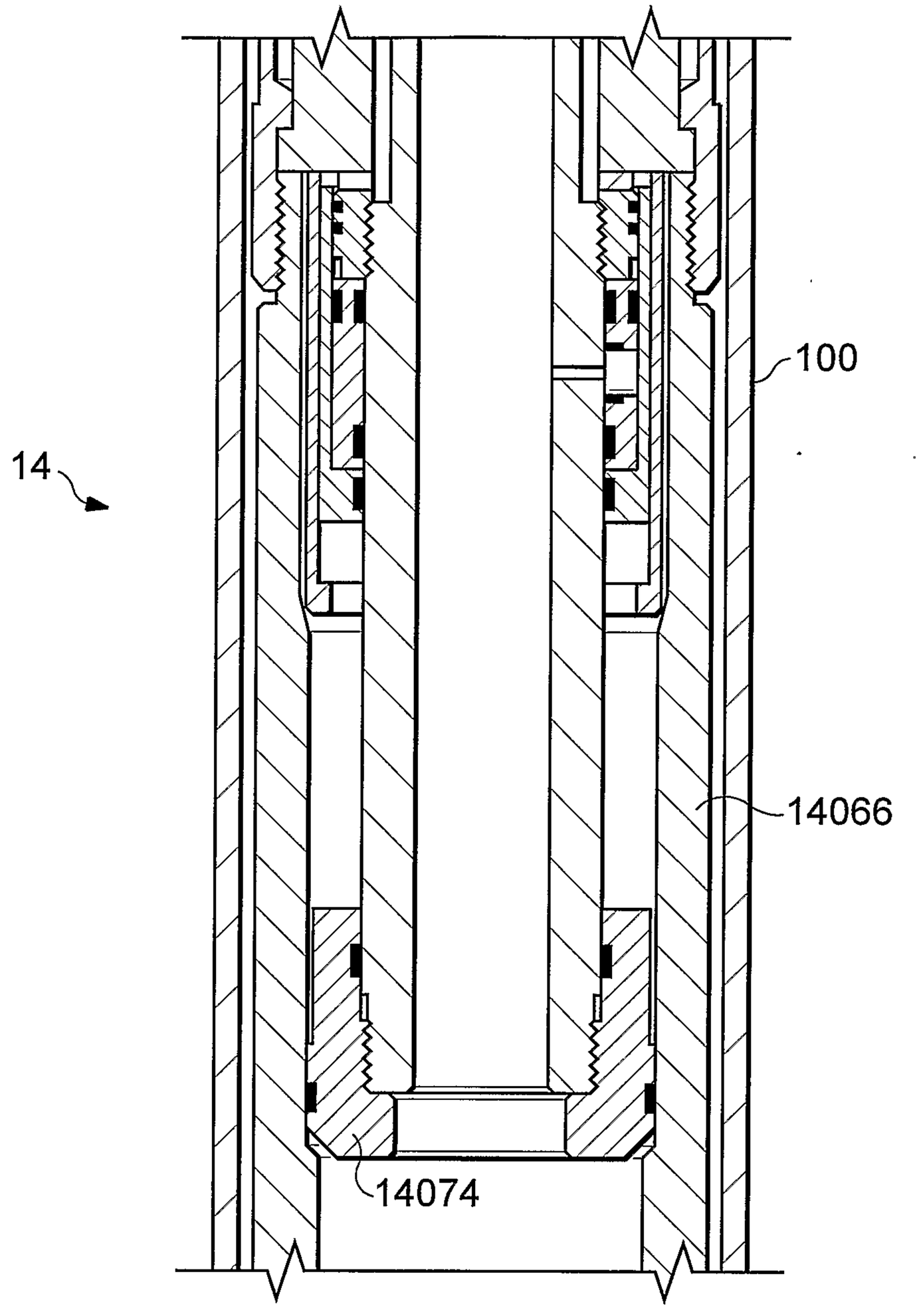


Fig. 11AB4

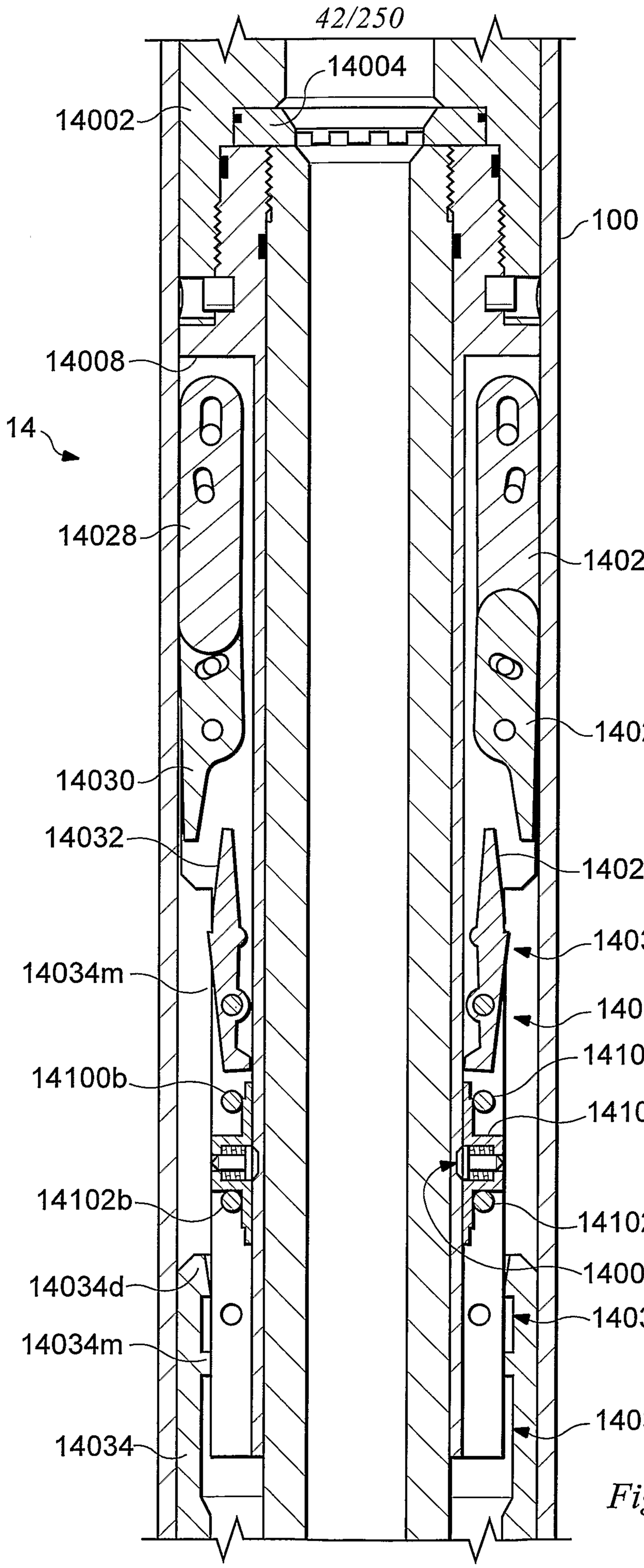

42/250
14004
14002
100
14008
14
14028
14022
14024
14030
14032
14026
14034k
14034m
14034l
14100a
14100b
14104
14102b
14102a
14008ac
14034d
14034k
14034m
14034l
14034

Fig. 11AC1

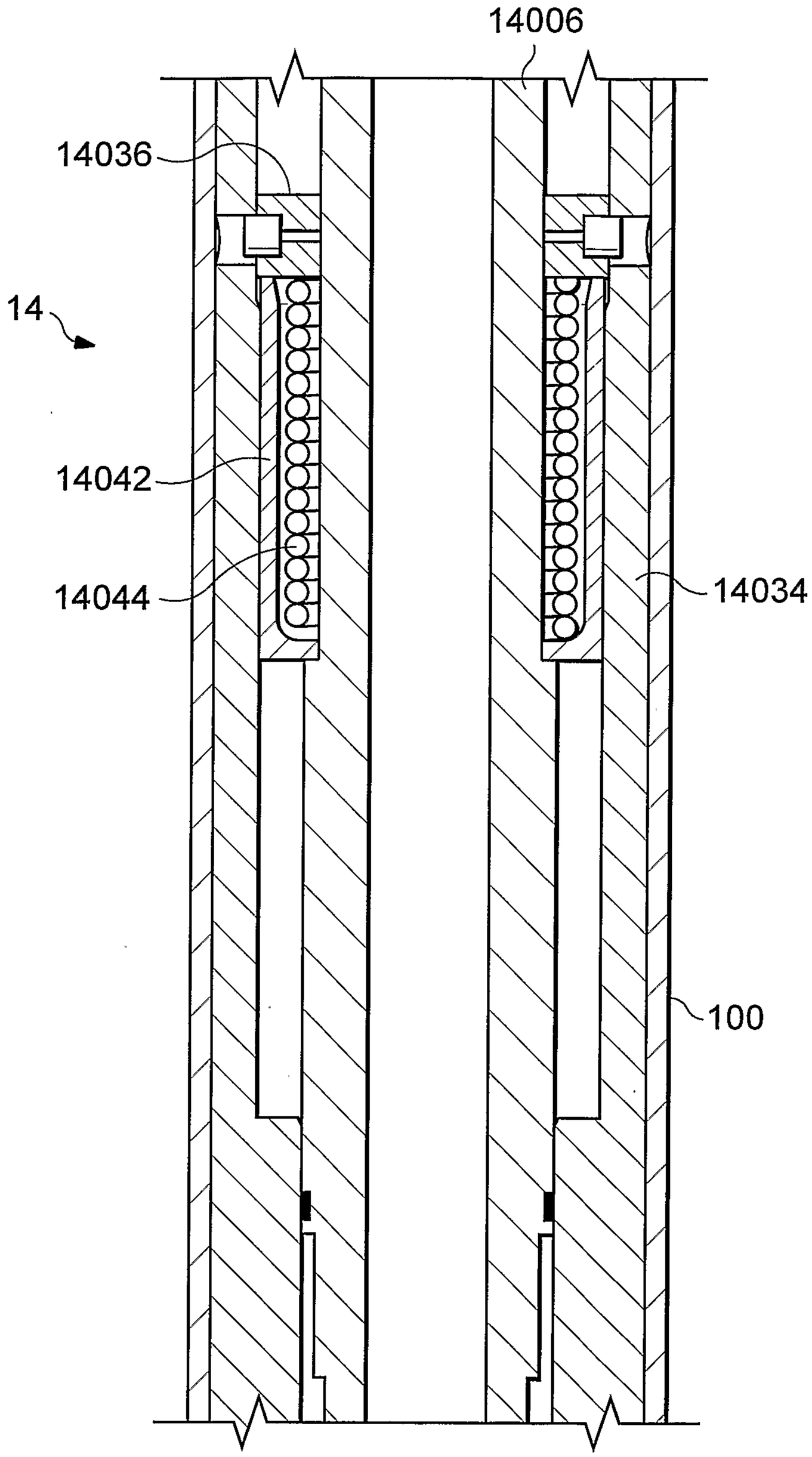


Fig. 11AC2

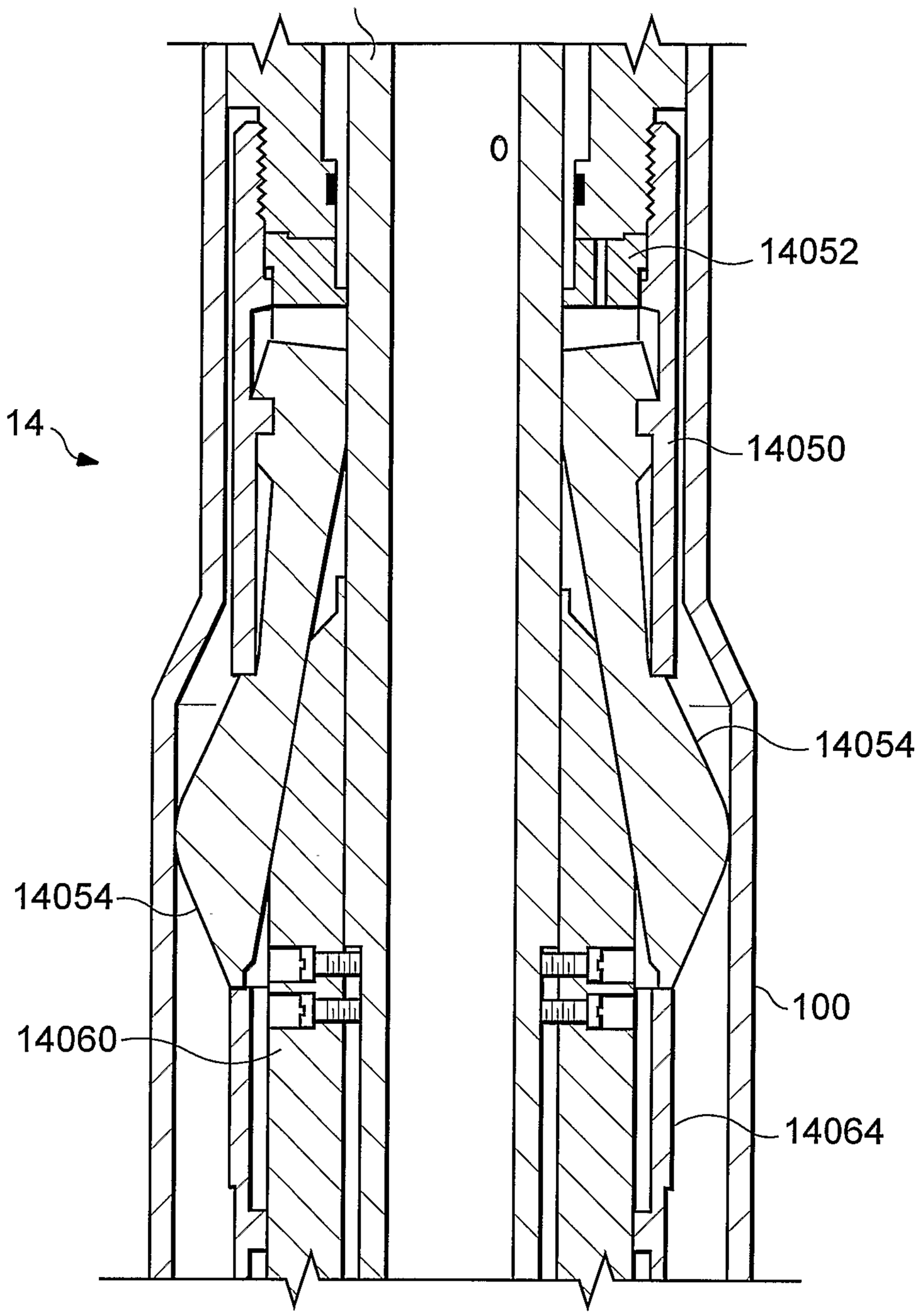


Fig. 11AC3

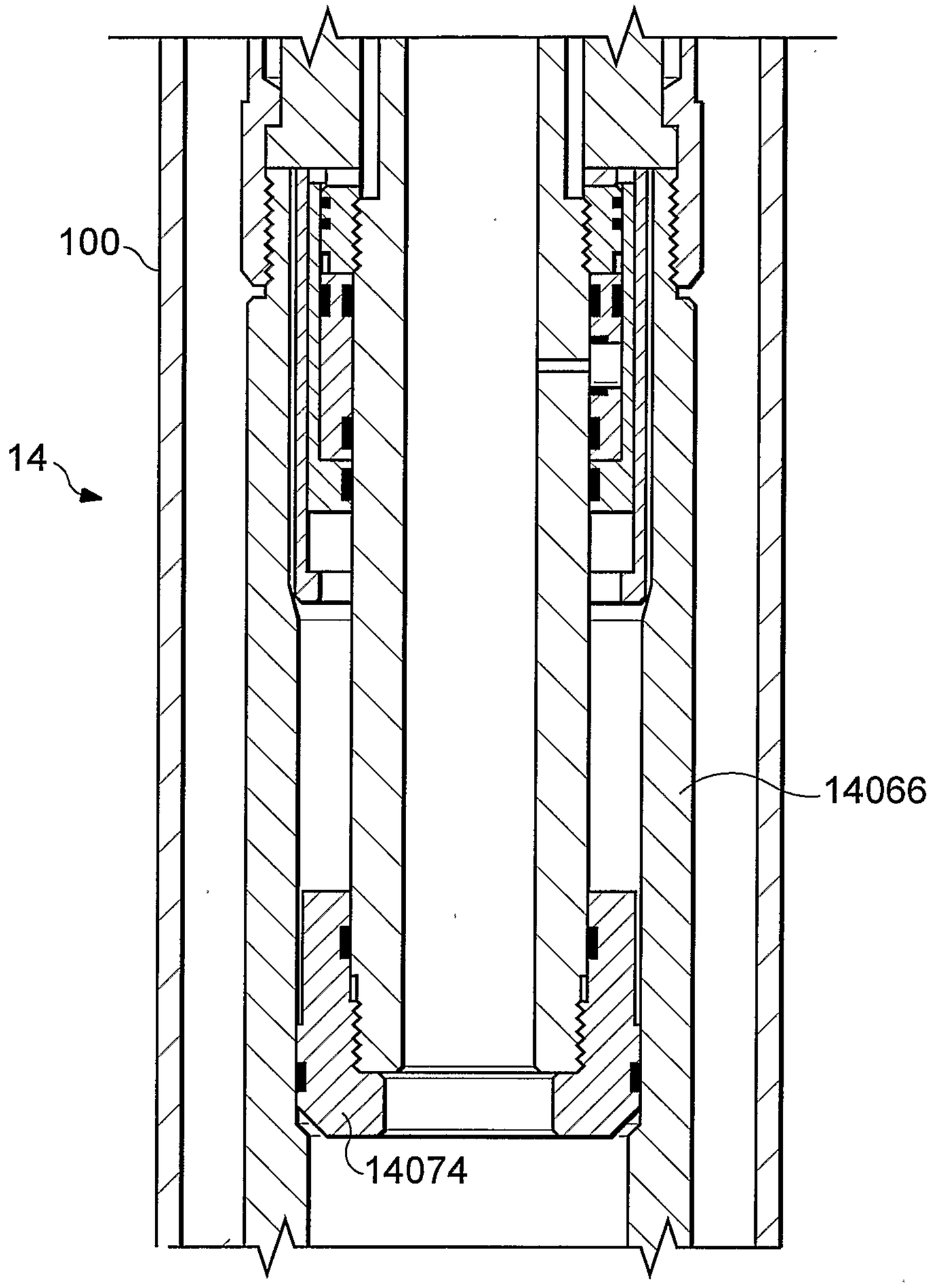


Fig. 11AC4

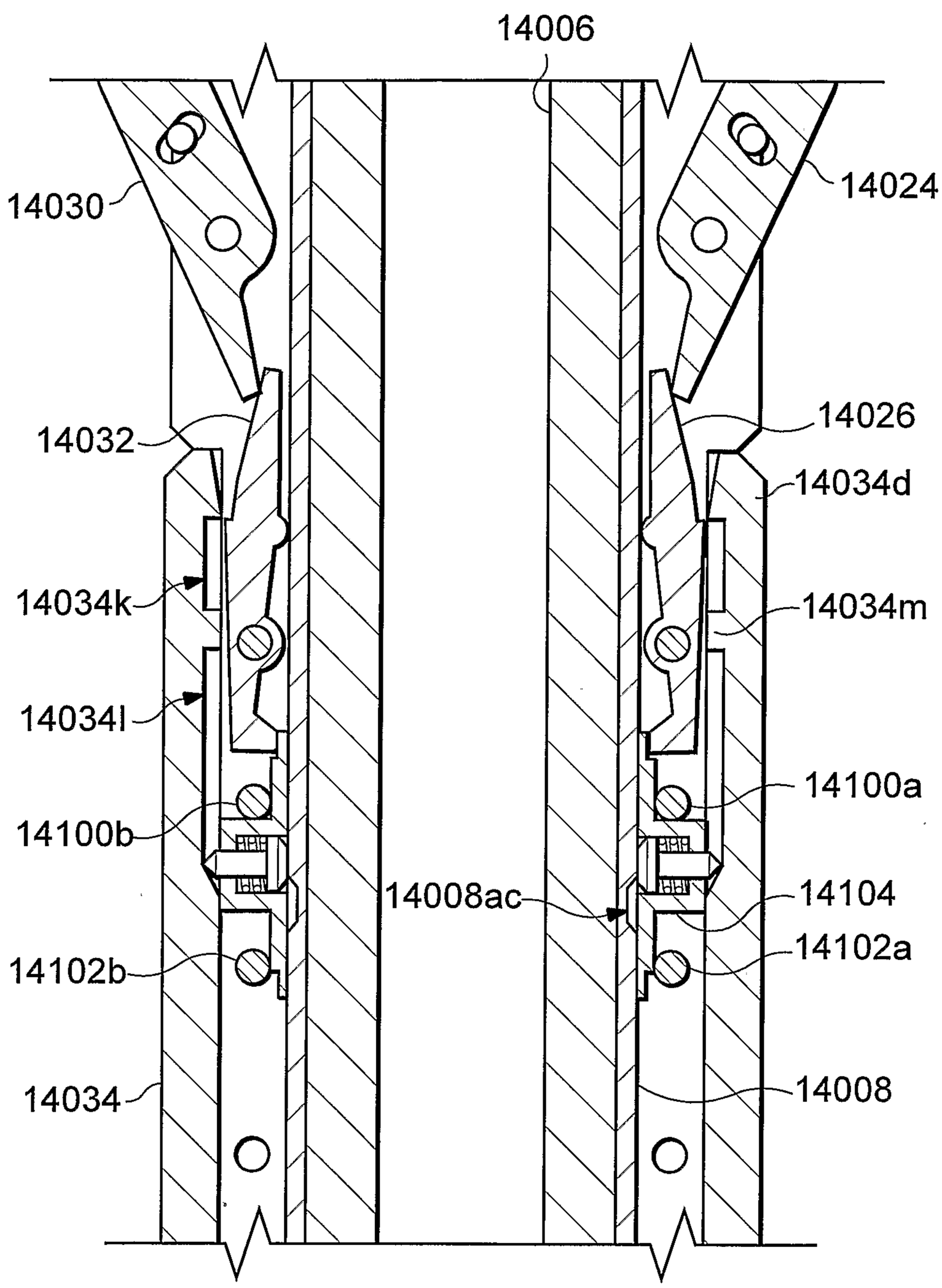

14006
14030
14024
14032
14026
14034d
14034k
14034m
14034l
14100a
14100b
14008ac
14104
14102b
14102a
14034
14008

Fig. 11AD

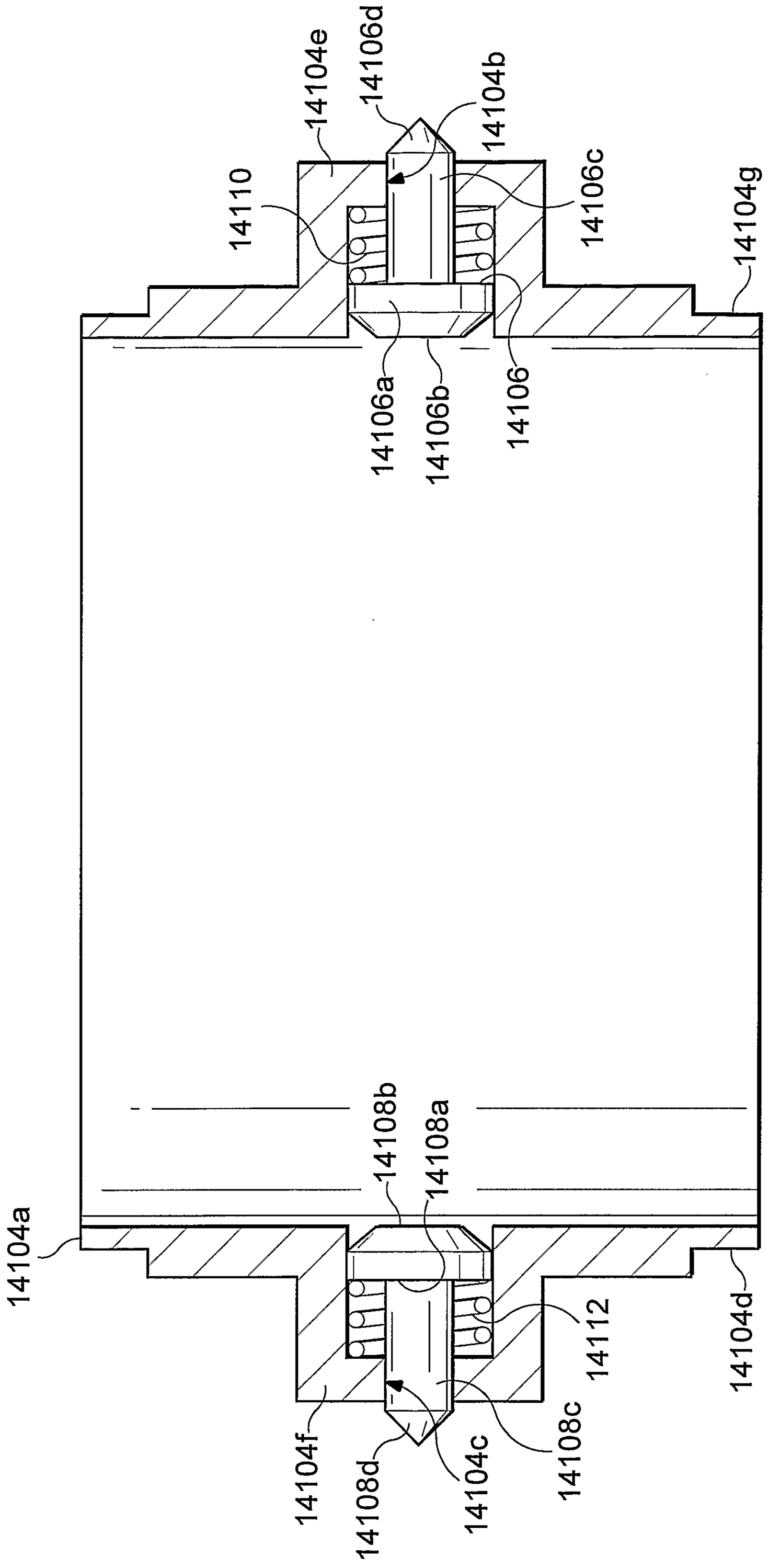

14104e
14106d
14104b
14110
14106c
14104g
14106a
14106b
14106
14104
14108b
14108a
14104a
14104f
14108d
14104c
14108c
14112
14104d

Fig. 11AE

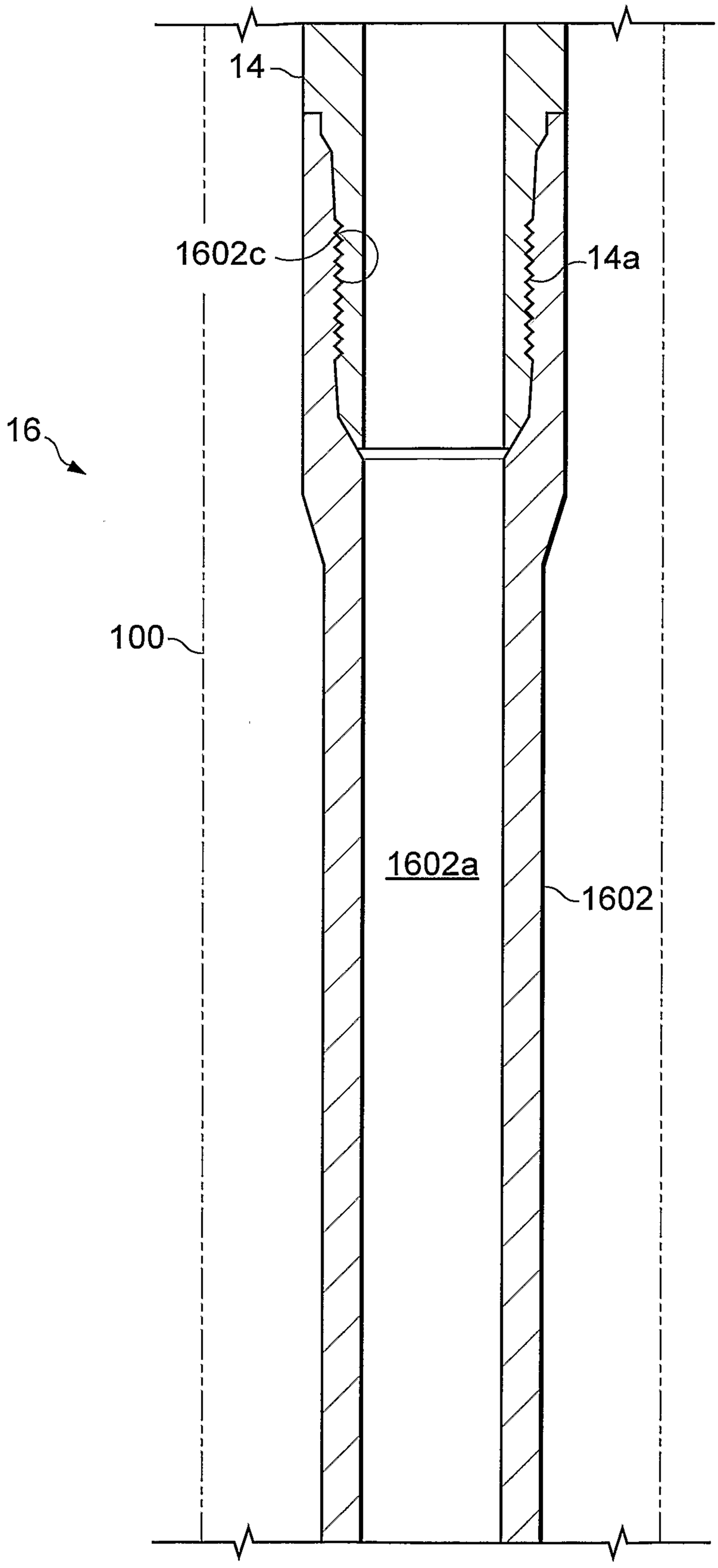


Fig. 12A1

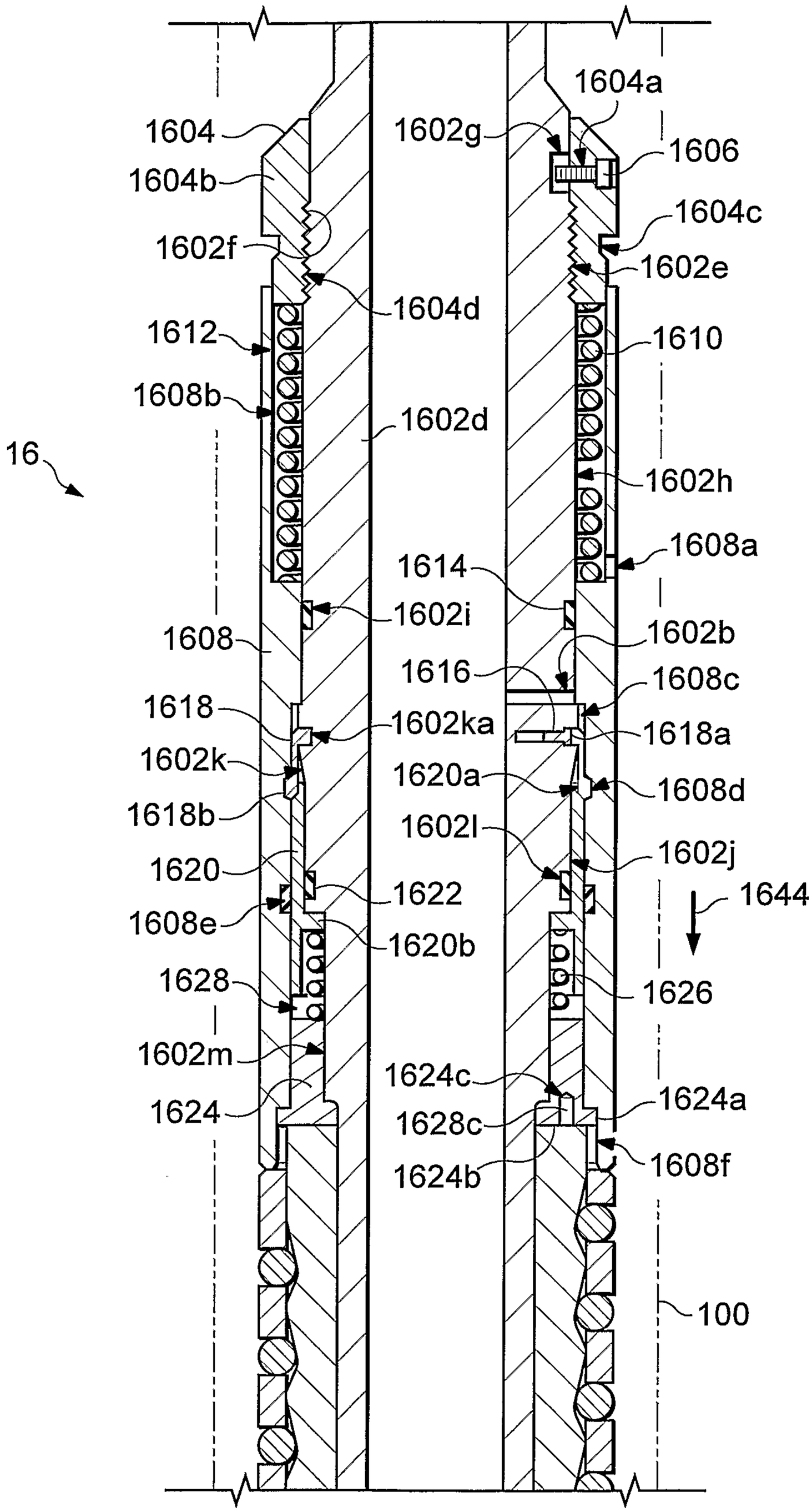

16
1604
1604b
1602f
1612
1608b
1608
1618
1602k
1618b
1620
1608e
1628
1602m
1624
1604a
1602g
1606
1604c
1602e
1604d
1610
1602d
1602h
1608a
1614
1602i
1602b
1616
1608c
1602ka
1618a
1620a
1608d
1602l
1602j
1644
1622
1620b
1626
1624c
1624a
1628c
1608f
1624b
100

Fig. 12A2

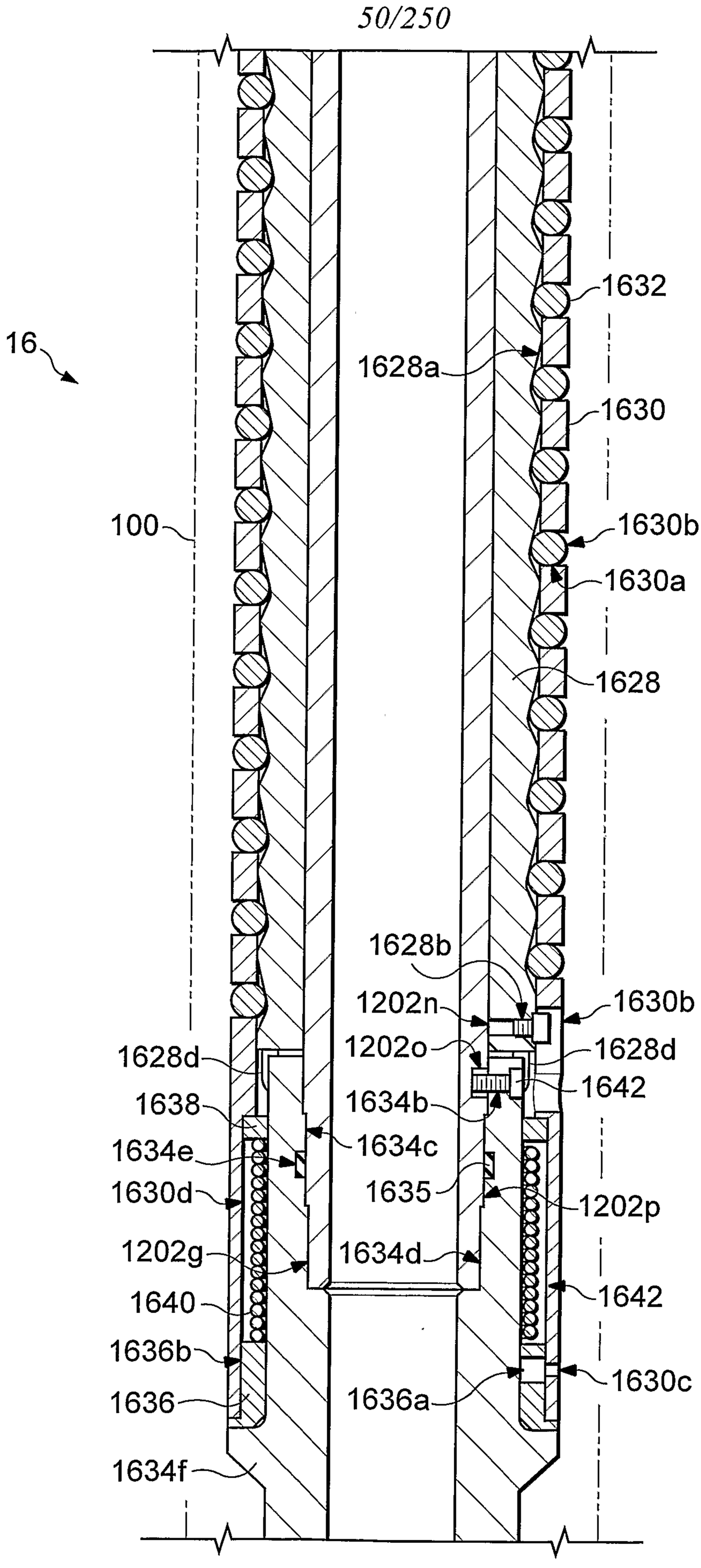

50/250
16
100
1632
1628a
1630
1630b
1630a
1628
1628b
1202n
1202o
1628d
1642
1634b
1638
1634c
1634e
1635
1630d
1202p
1202g
1634d
1640
1642
1636b
1630c
1636
1636a
1634f

Fig. 12A3

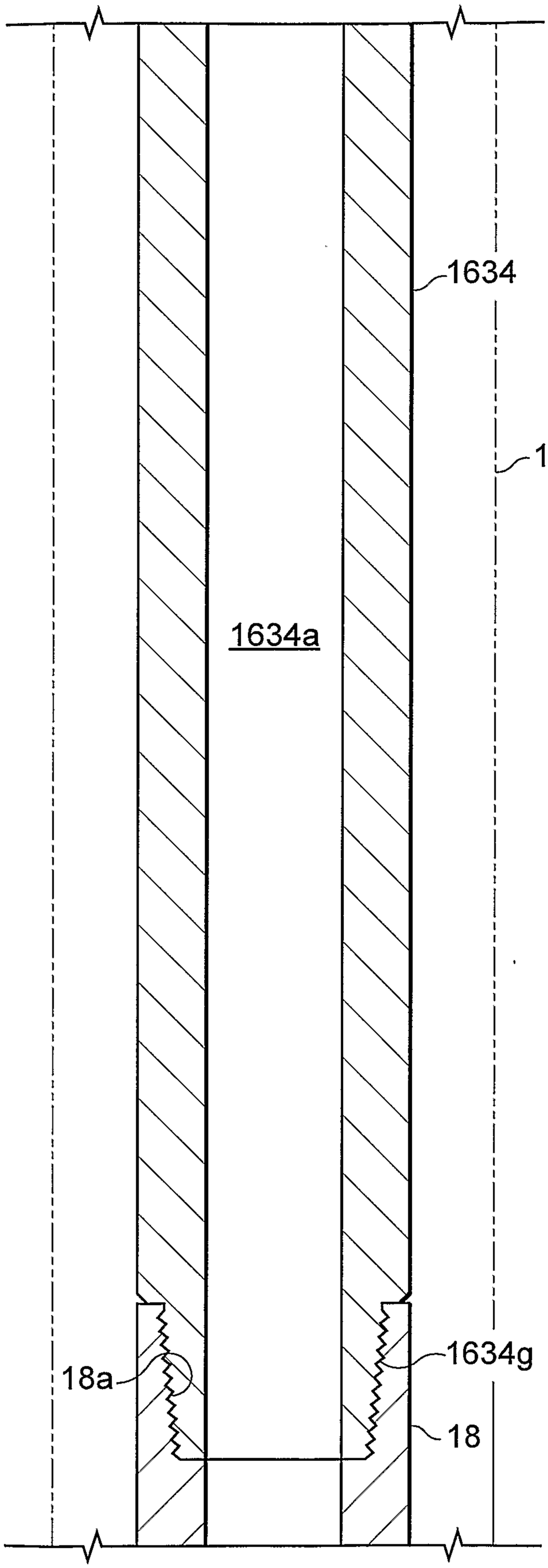


Fig. 12A4

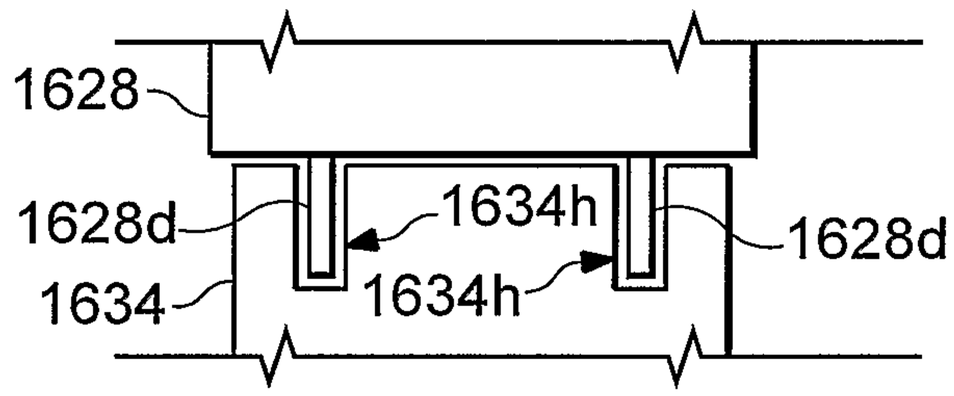


Fig. 12B

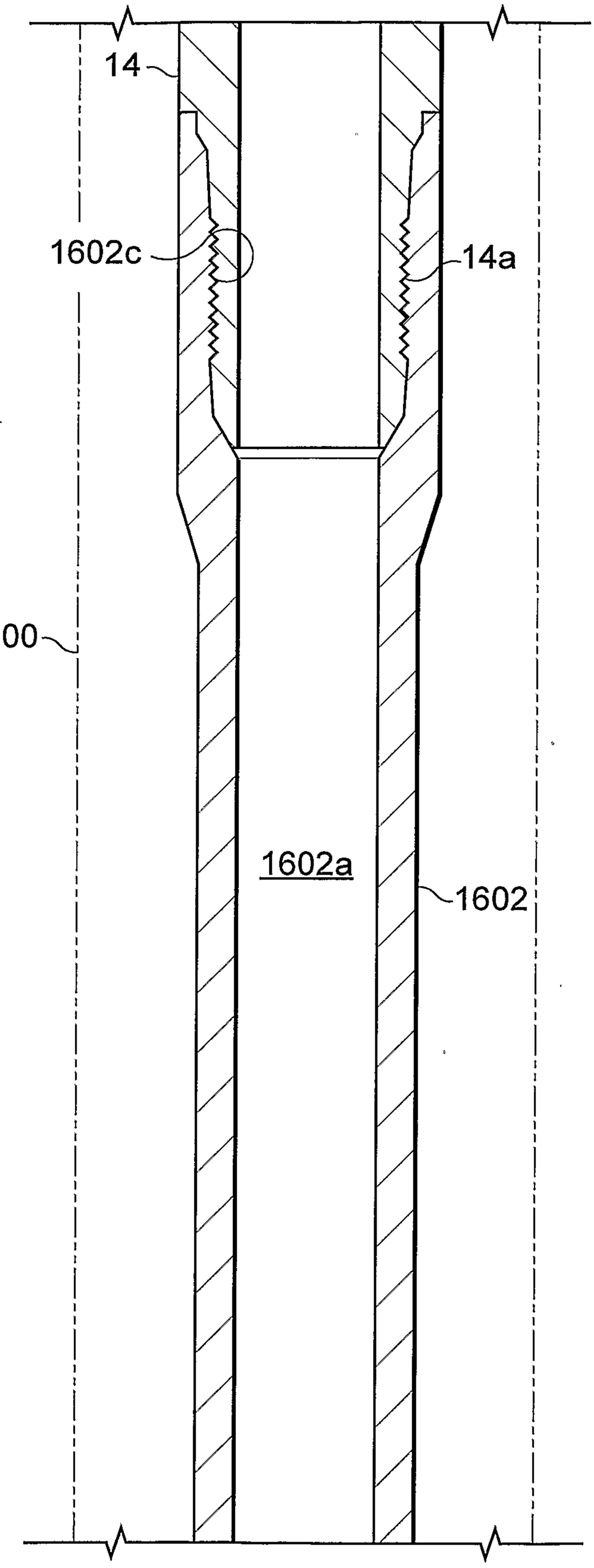


Fig. 12C1

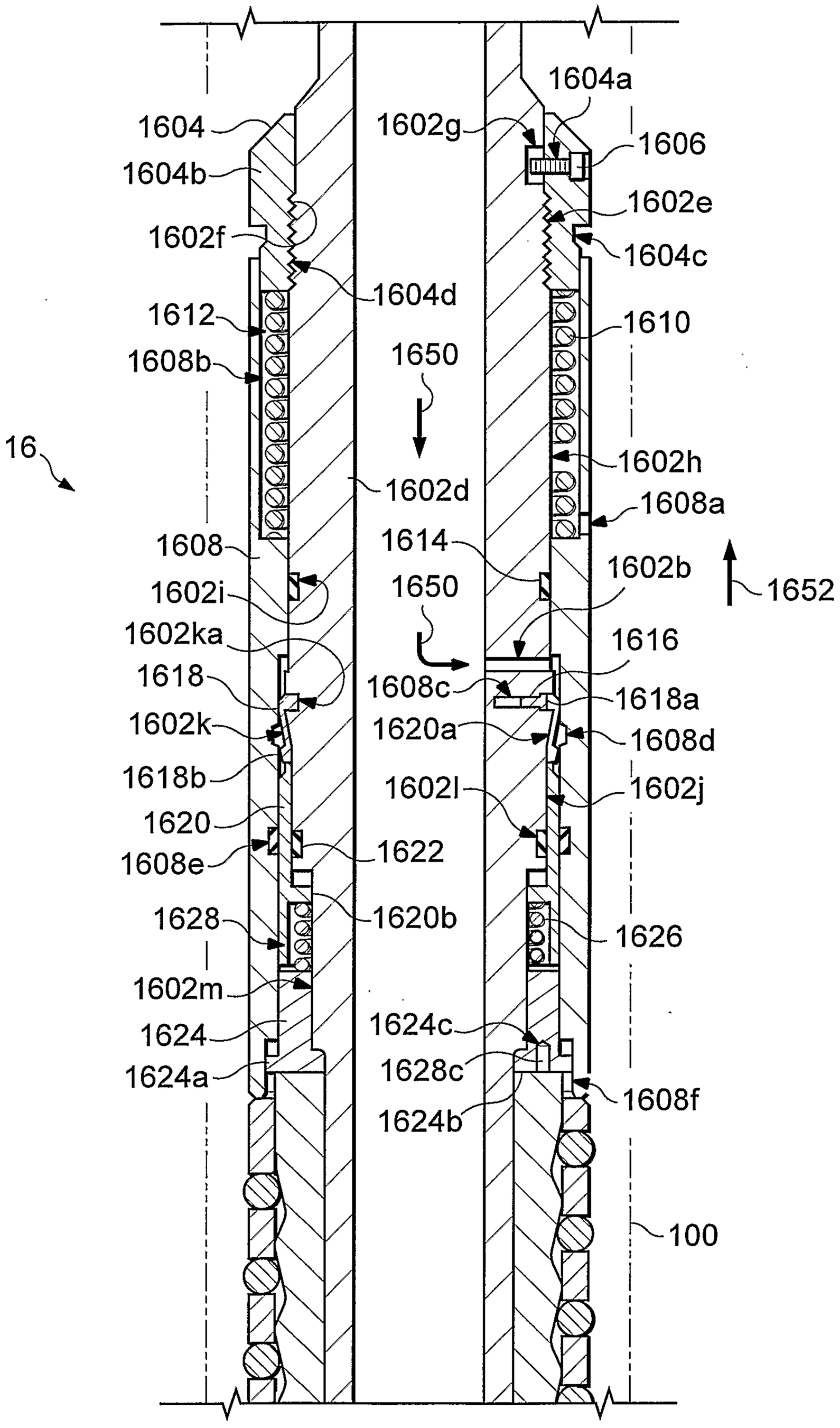

16
1604
1604b
1602f
1612
1608b
1608
1602i
1602ka
1618
1602k
1618b
1620
1608e
1628
1602m
1624
1624a
1602g
1604d
1650
1602d
1614
1650
1608c
1620a
1602l
1622
1620b
1604a
1606
1602e
1604c
1610
1602h
1608a
1602b
1652
1616
1618a
1608d
1602j
1626
1624c
1628c
1624b
1608f
100

Fig. 12C2

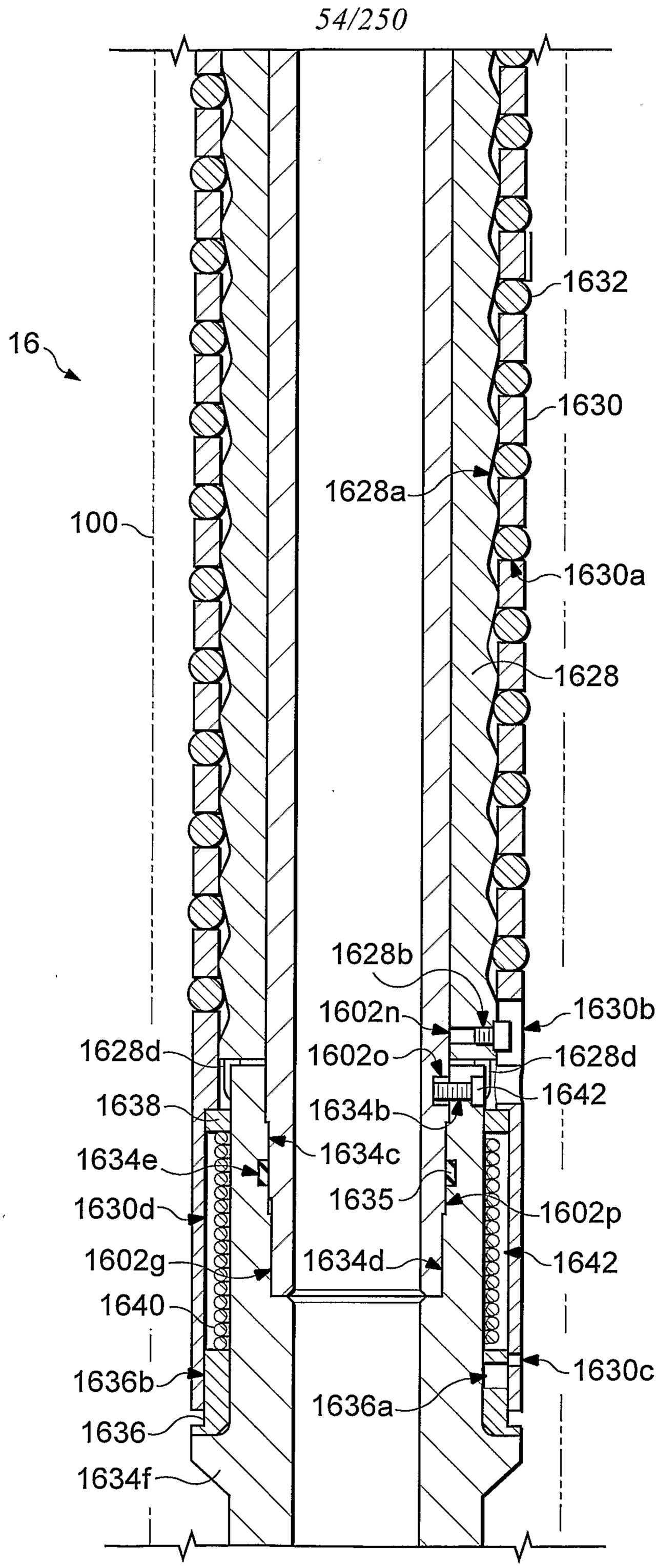

16
100
1632
1630
1628a
1630a
1628
1628b
1602n
1630b
1628d
1602o
1628d
1642
1638
1634b
1634e
1634c
1635
1630d
1602p
1602g
1634d
1642
1640
1630c
1636b
1636a
1636
1634f

Fig. 12C3

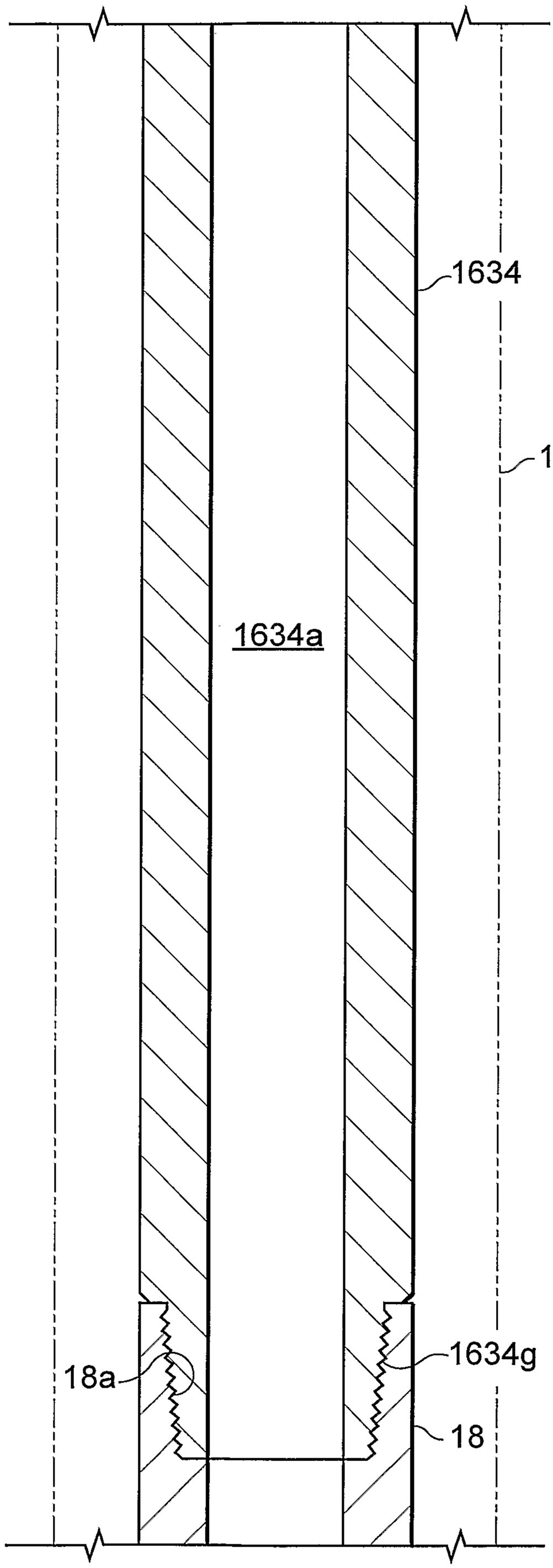


Fig. 12C4

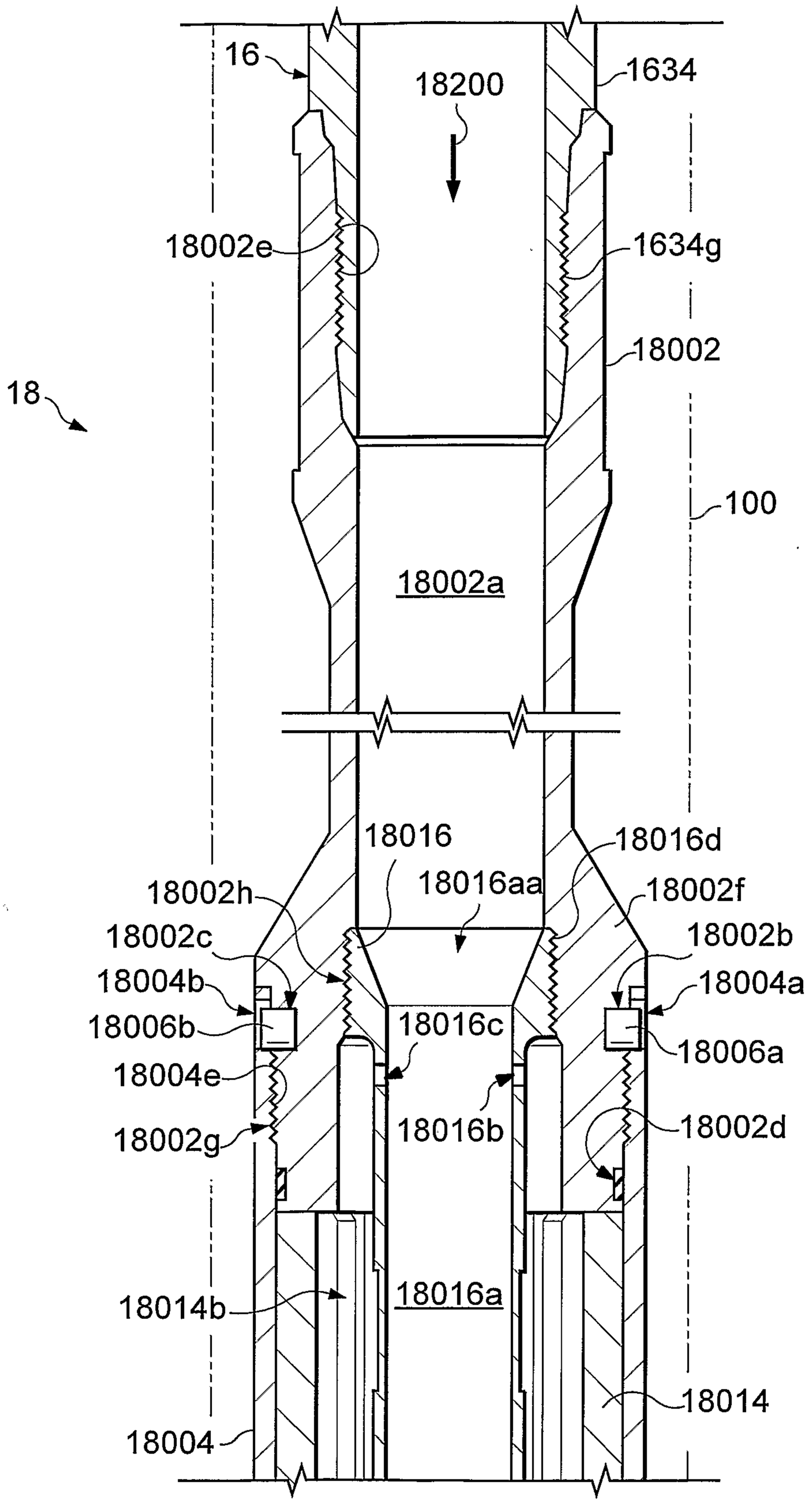

16
18200
1634
18002e
1634g
18
18002
100
18002a
18016
18016d
18016aa
18002h
18002f
18002c
18002b
18004b
18004a
18006b
18016c
18006a
18004e
18016b
18002g
18002d
18014b
18016a
18014
18004

Fig. 13A1

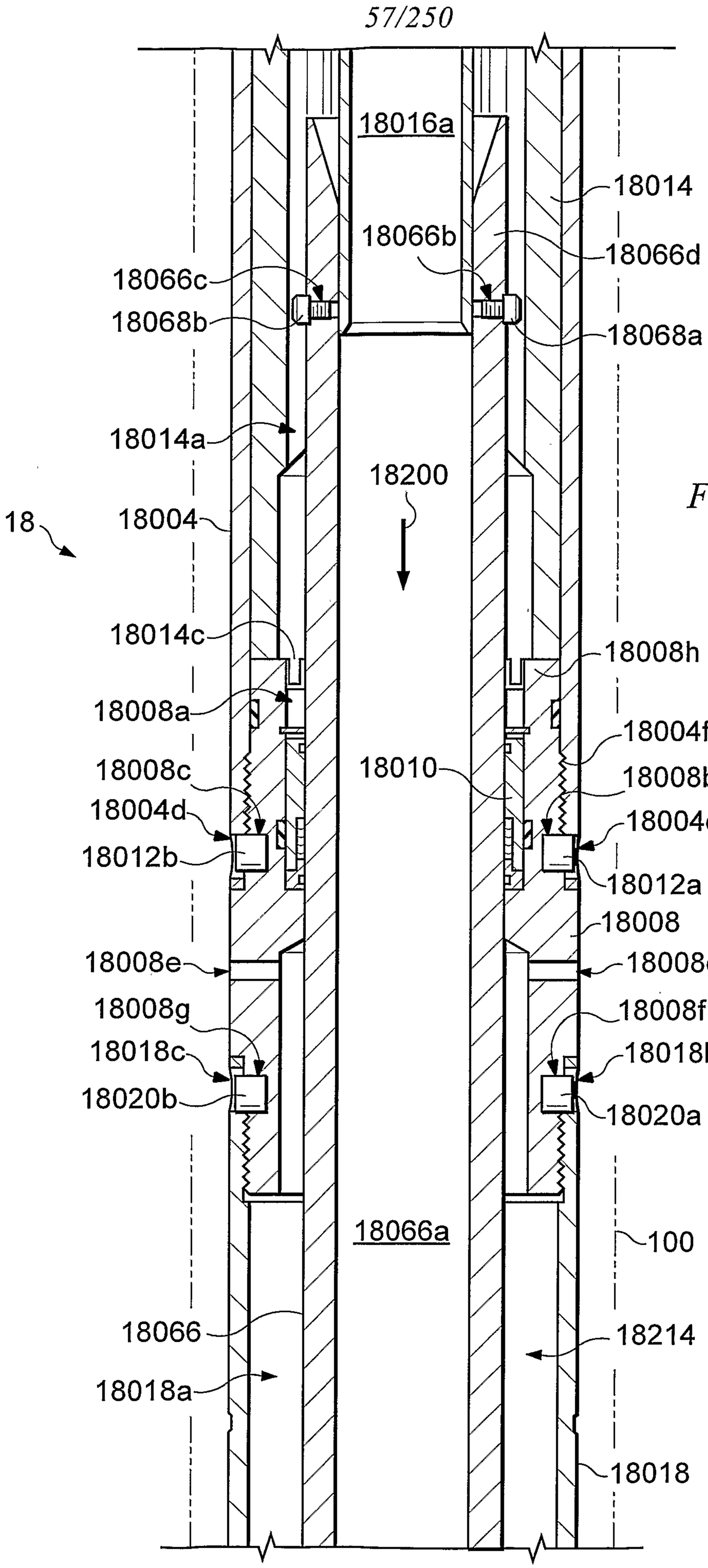

18016a
18014
18066b
18066d
18066c
18068b
18068a
18014a
18200
18
18004
18014c
18008h
18008a
18004f
18008c
18010
18008b
18004d
18004c
18012b
18012a
18008
18008e
18008d
18008g
18008f
18018c
18018b
18020b
18020a
18066a
100
18066
18214
18018a
18018

Fig. 13A2

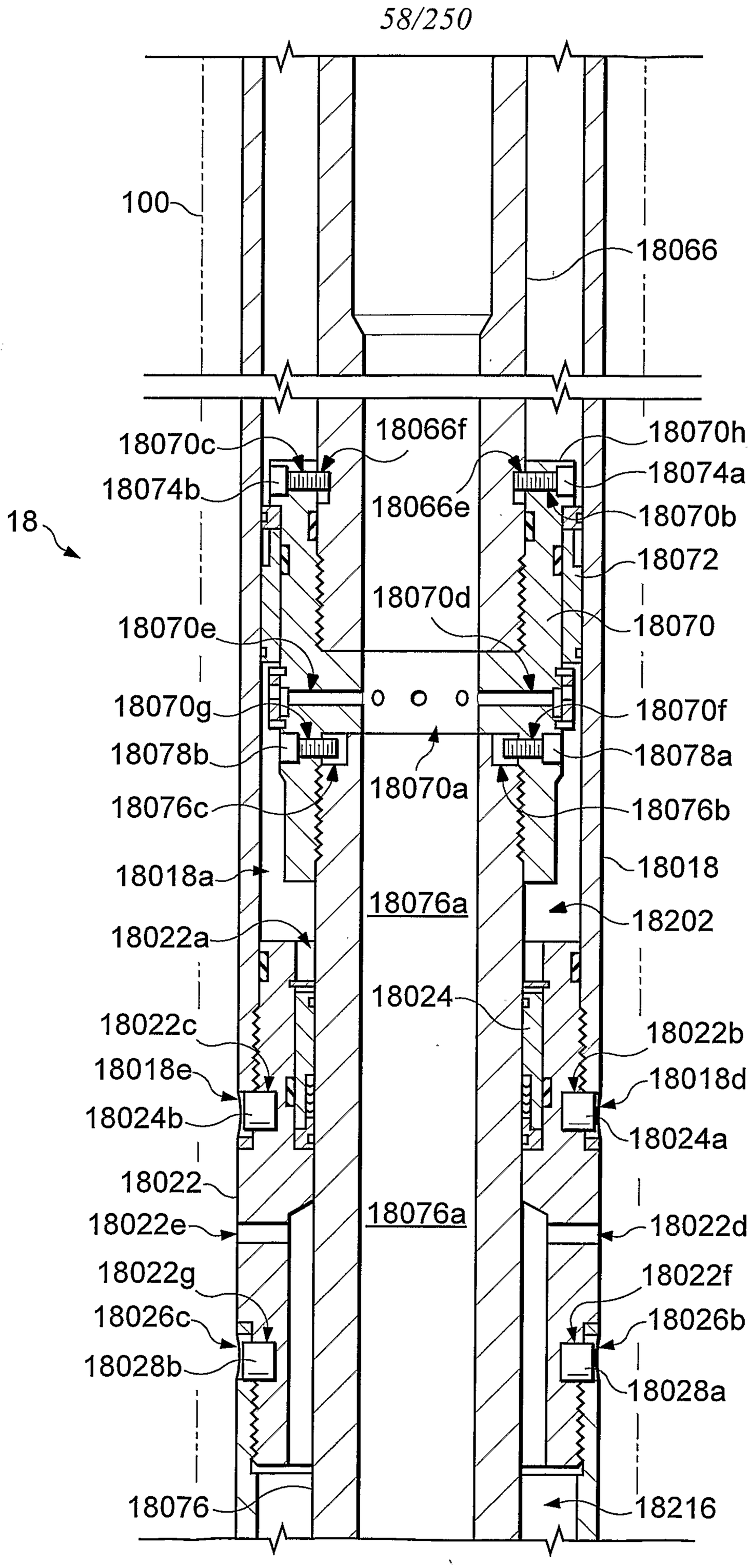

100
18066
18066f
18070c
18070h
18074b
18074a
18066e
18
18070b
18072
18070d
18070e
18070
18070g
18070f
18078b
18078a
18070a
18076c
18076b
18018a
18018
18076a
18022a
18202
18024
18022c
18022b
18018e
18018d
18024b
18024a
18022
18022e
18022d
18022g
18022f
18026c
18026b
18028b
18028a
18076
18216

Fig. 13A3

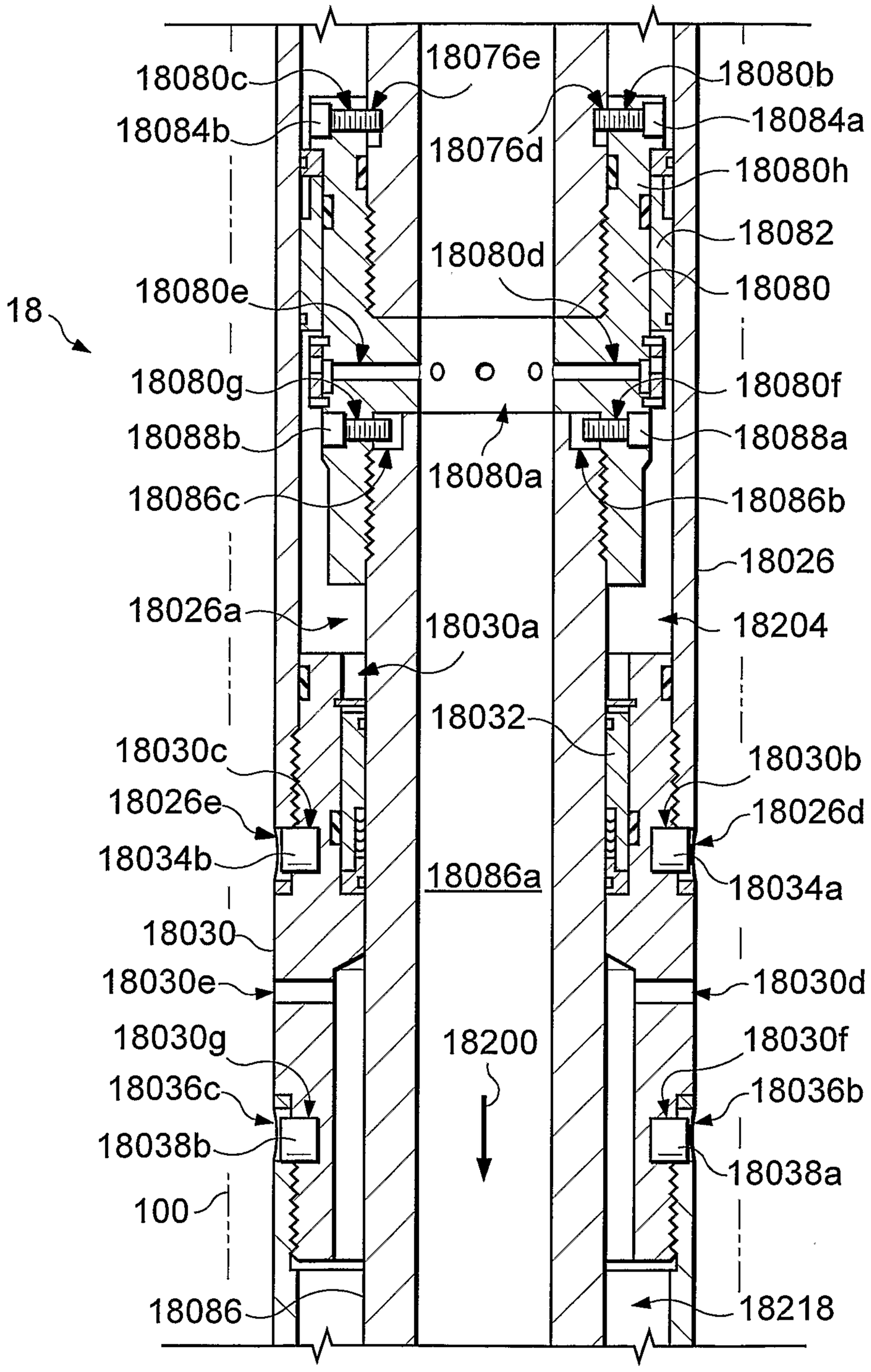

18
18080c
18084b
18080e
18080g
18088b
18086c
18026a
100
18030c
18026e
18034b
18030
18030e
18030g
18036c
18038b
18086
18076e
18076d
18080d
18080a
18086a
18030a
18032
18200
18080b
18084a
18080h
18082
18080
18080f
18088a
18086b
18026
18204
18030b
18026d
18034a
18030d
18030f
18036b
18038a
18218

Fig. 13A4

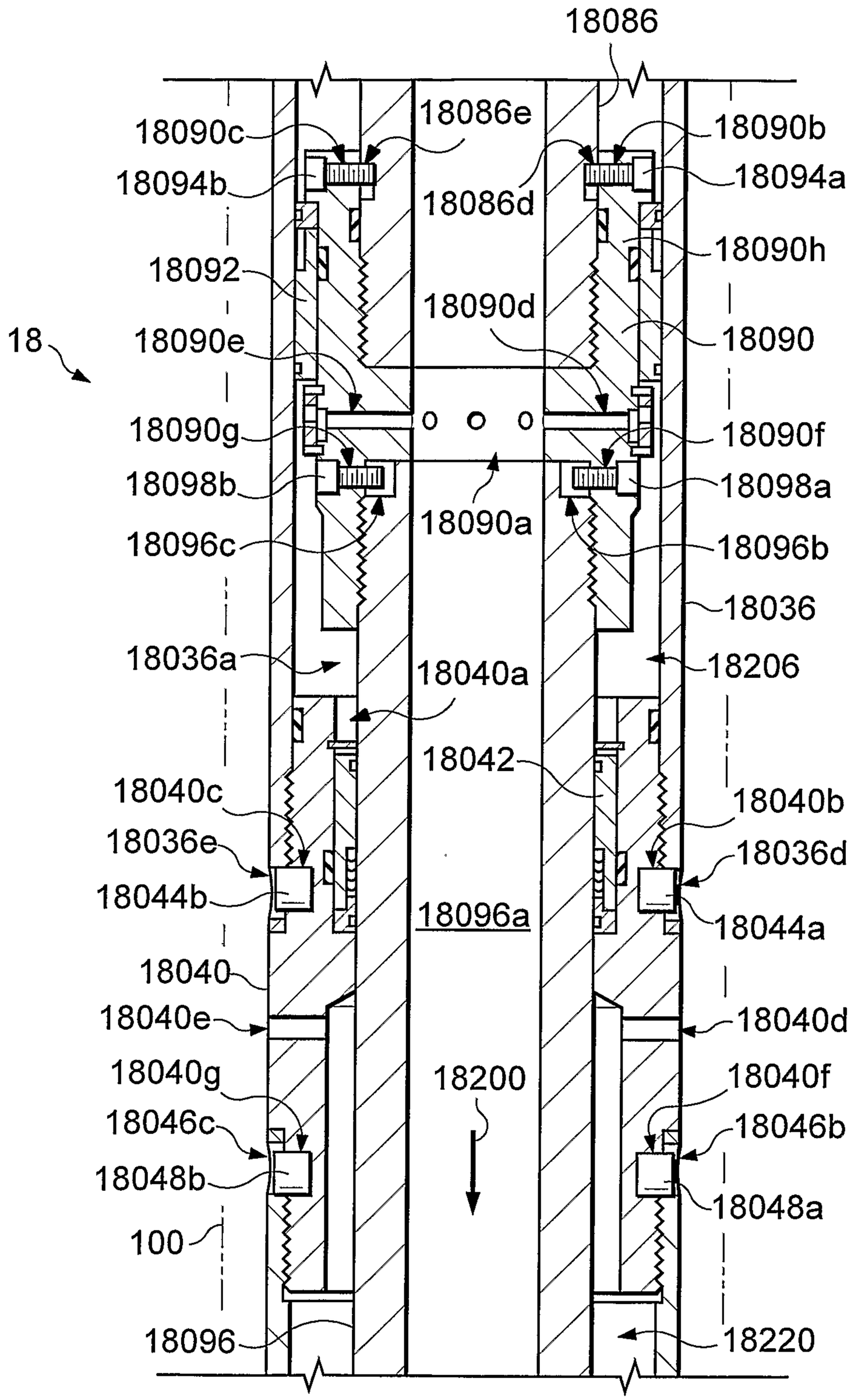

18086
18086e
18090c
18090b
18094b
18094a
18086d
18092
18090h
18090d
18090e
18090
18
18090g
18090f
18098b
18098a
18090a
18096c
18096b
18036
18036a
18040a
18206
18042
18040c
18040b
18036e
18036d
18044b
18096a
18044a
18040
18040e
18040d
18040g
18200
18040f
18046c
18046b
18048b
18048a
100
18096
18220

Fig. 13A5

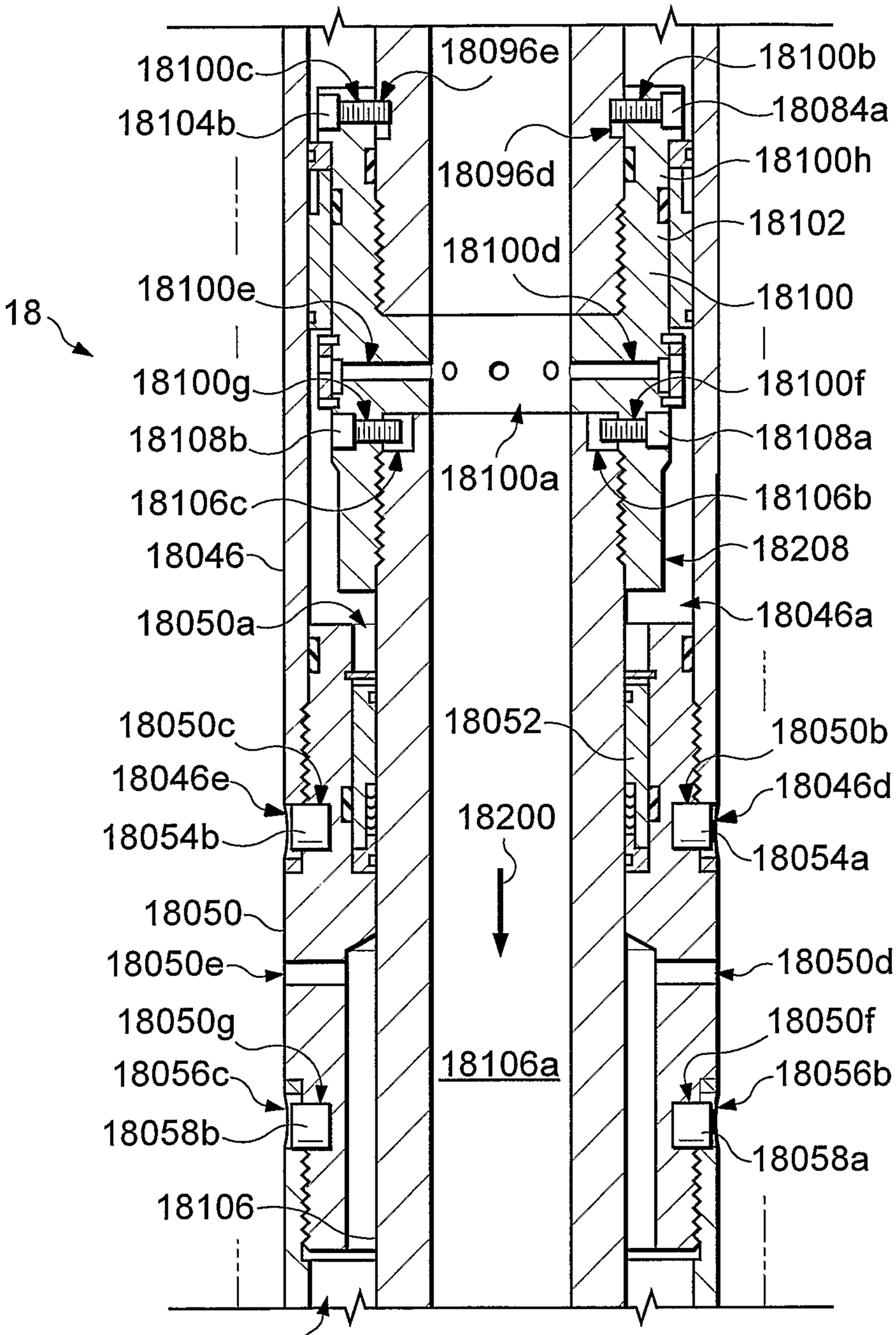

18
18100c
18104b
18100e
18100g
18108b
18106c
18046
18050a
18050c
18046e
18054b
18050
18050e
18050g
18056c
18058b
18106
18222
18096e
18096d
18100d
18100a
18052
18200
18106a
18100b
18084a
18100h
18102
18100
18100f
18108a
18106b
18208
18046a
18050b
18046d
18054a
18050d
18050f
18056b
18058a

Fig. 13A6

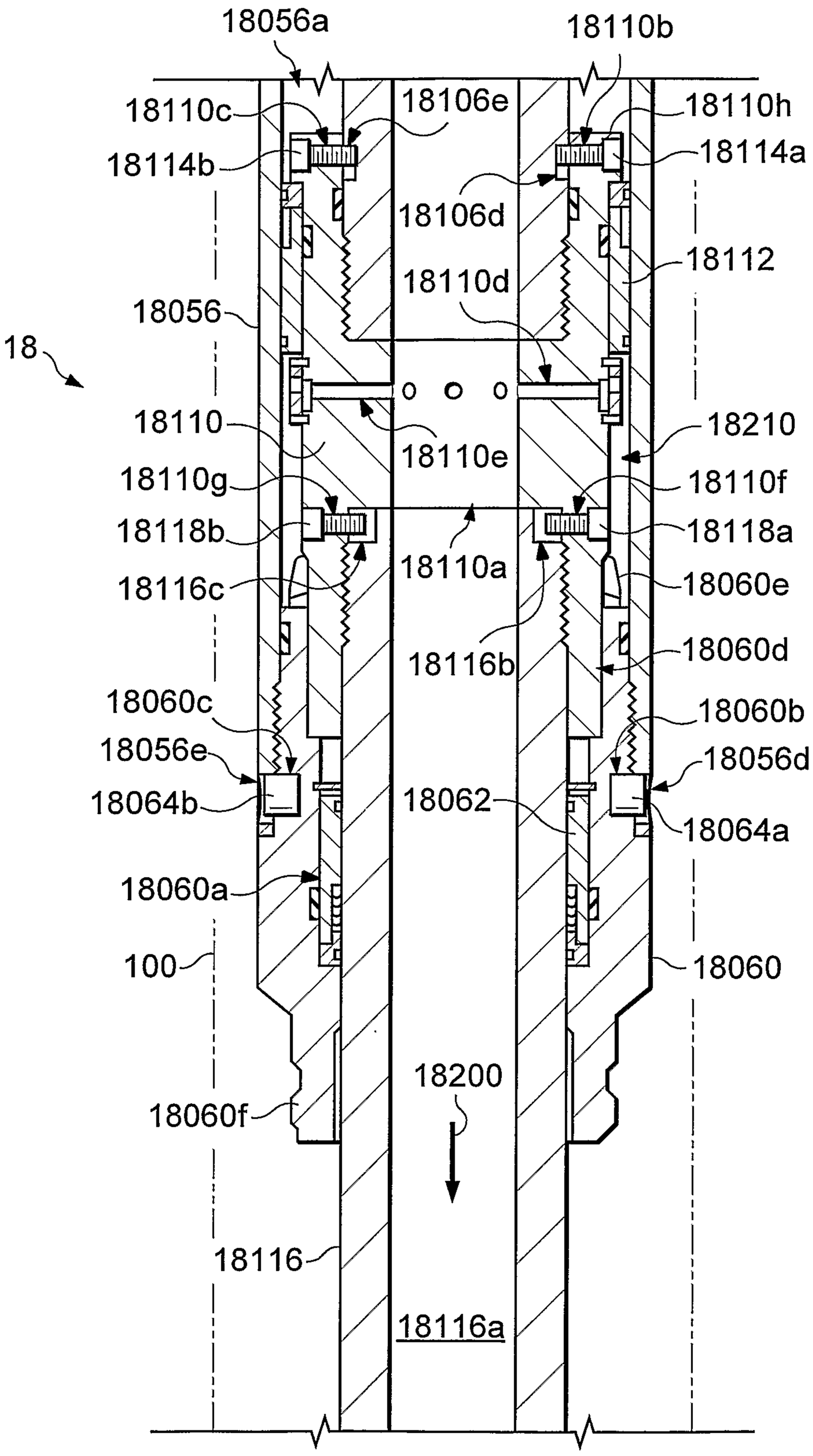

18056a
18110b
18110c
18106e
18110h
18114b
18114a
18106d
18112
18110d
18056
18
18110
18210
18110e
18110g
18110f
18118b
18118a
18110a
18116c
18060e
18116b
18060d
18060c
18060b
18056e
18056d
18064b
18062
18064a
18060a
100
18060
18200
18060f
18116
18116a

Fig. 13A7

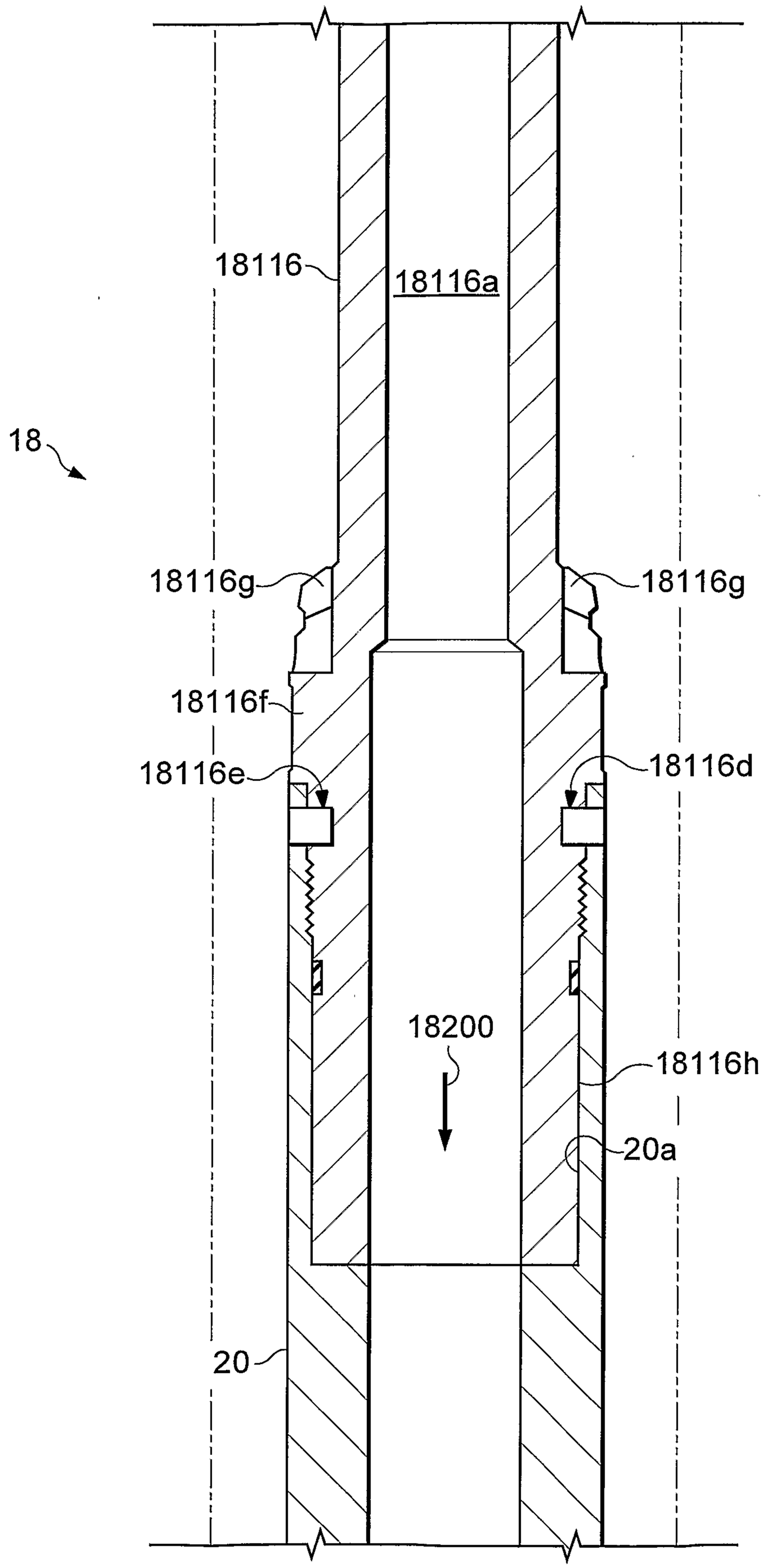

18
18116
18116a
18116g
18116g
18116f
18116e
18116d
18200
18116h
20a
20

Fig. 13A8

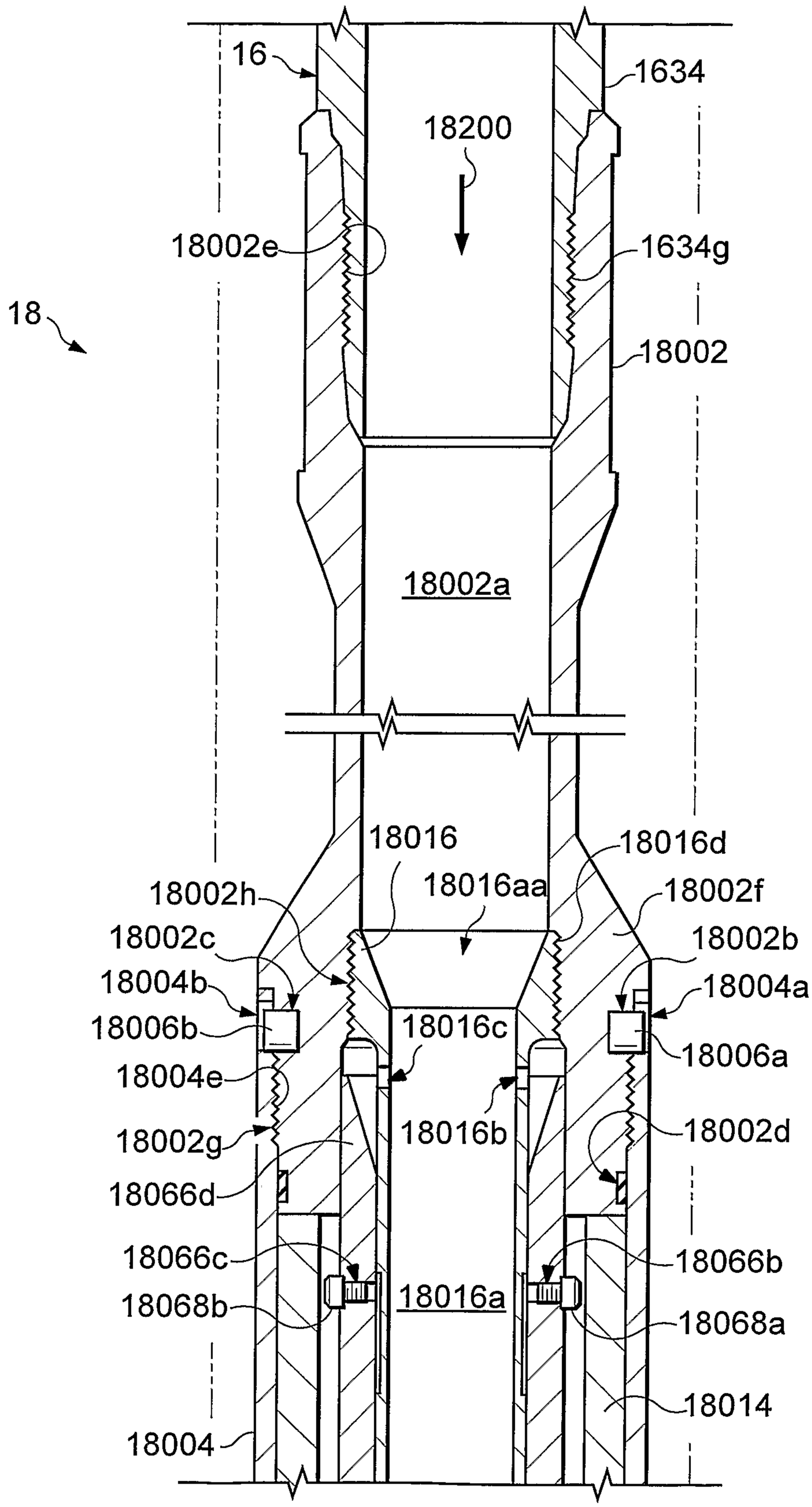

16
1634
18200
18002e
1634g
18
18002
18002a
18016
18016d
18016aa
18002h
18002f
18002c
18002b
18004b
18004a
18006b
18016c
18006a
18004e
18016b
18002d
18002g
18066d
18066c
18066b
18016a
18068b
18068a
18014
18004

Fig. 13B1

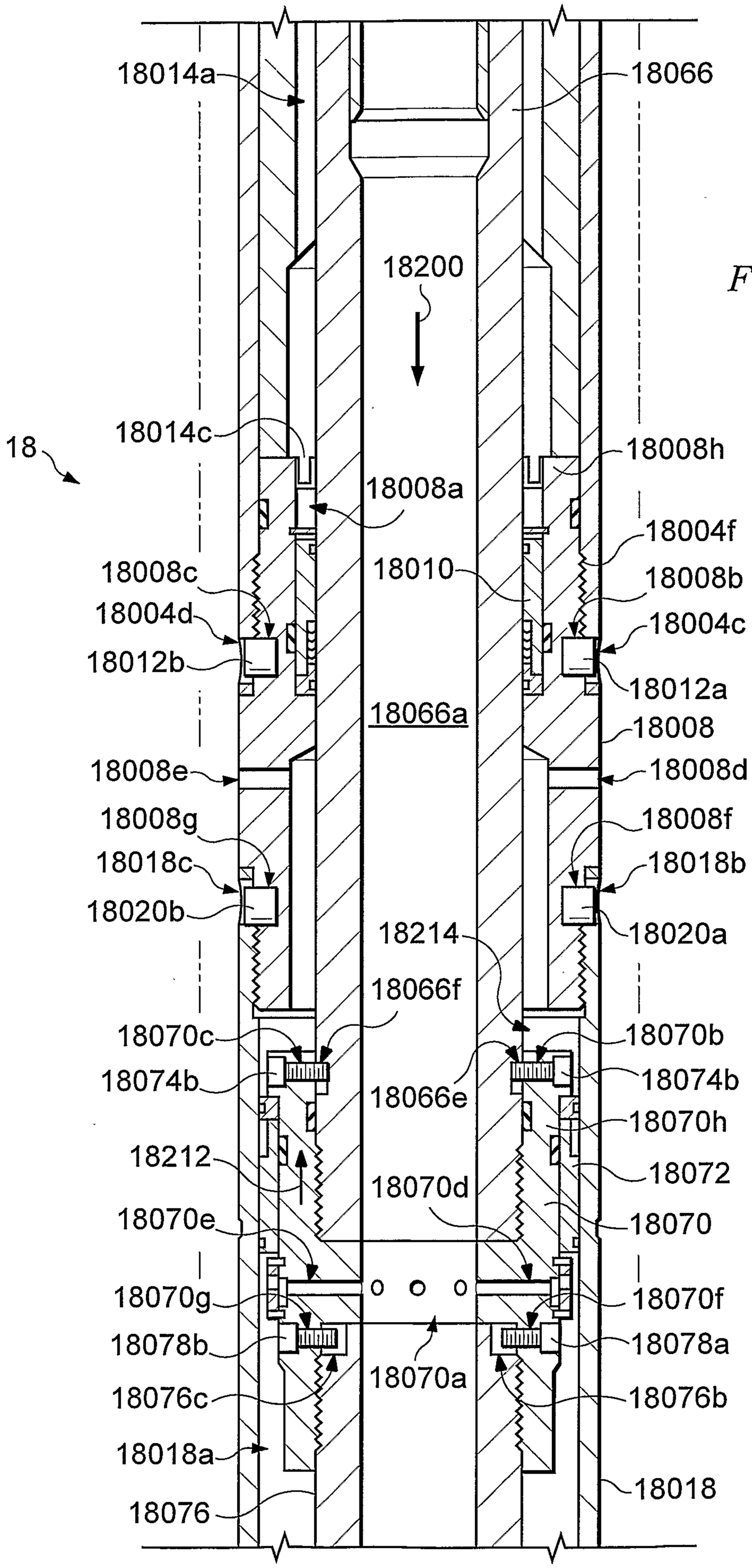

18014a
18066
18200
18014c
18
18008h
18008a
18004f
18008c
18010
18008b
18004d
18004c
18012b
18012a
18066a
18008
18008e
18008d
18008g
18008f
18018c
18018b
18020b
18020a
18214
18066f
18070b
18070c
18074b
18066e
18074b
18070h
18212
18072
18070d
18070e
18070
18070g
18070f
18078b
18078a
18070a
18076c
18076b
18018a
18018
18076

Fig. 13B2

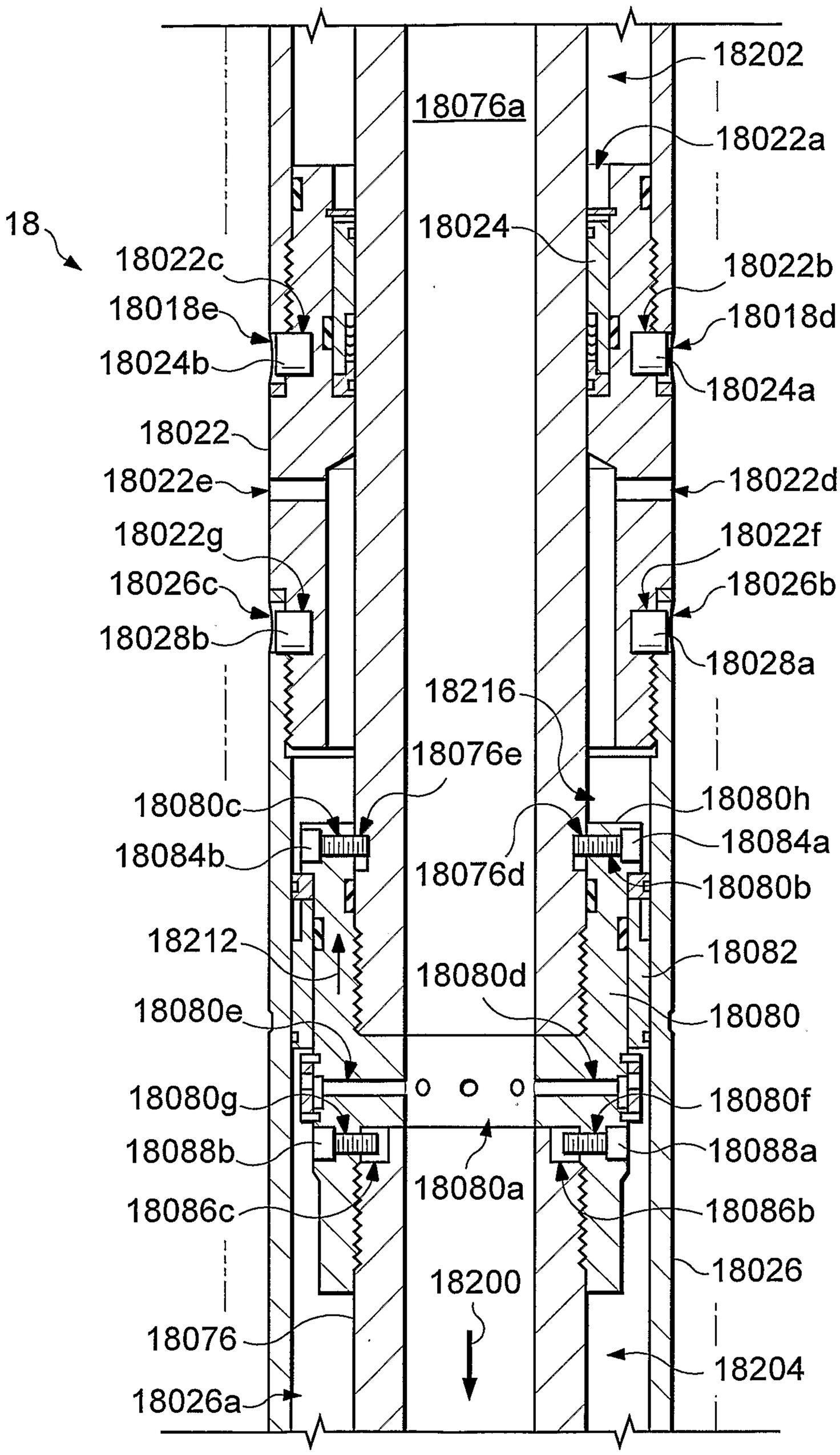

18
18202
18076a
18022a
18024
18022c
18022b
18018e
18018d
18024b
18024a
18022
18022e
18022d
18022g
18022f
18026c
18026b
18028b
18028a
18216
18076e
18080c
18080h
18084b
18084a
18076d
18080b
18212
18082
18080d
18080e
18080
18080g
18080f
18088b
18088a
18080a
18086c
18086b
18200
18026
18076
18204
18026a

Fig. 13B3

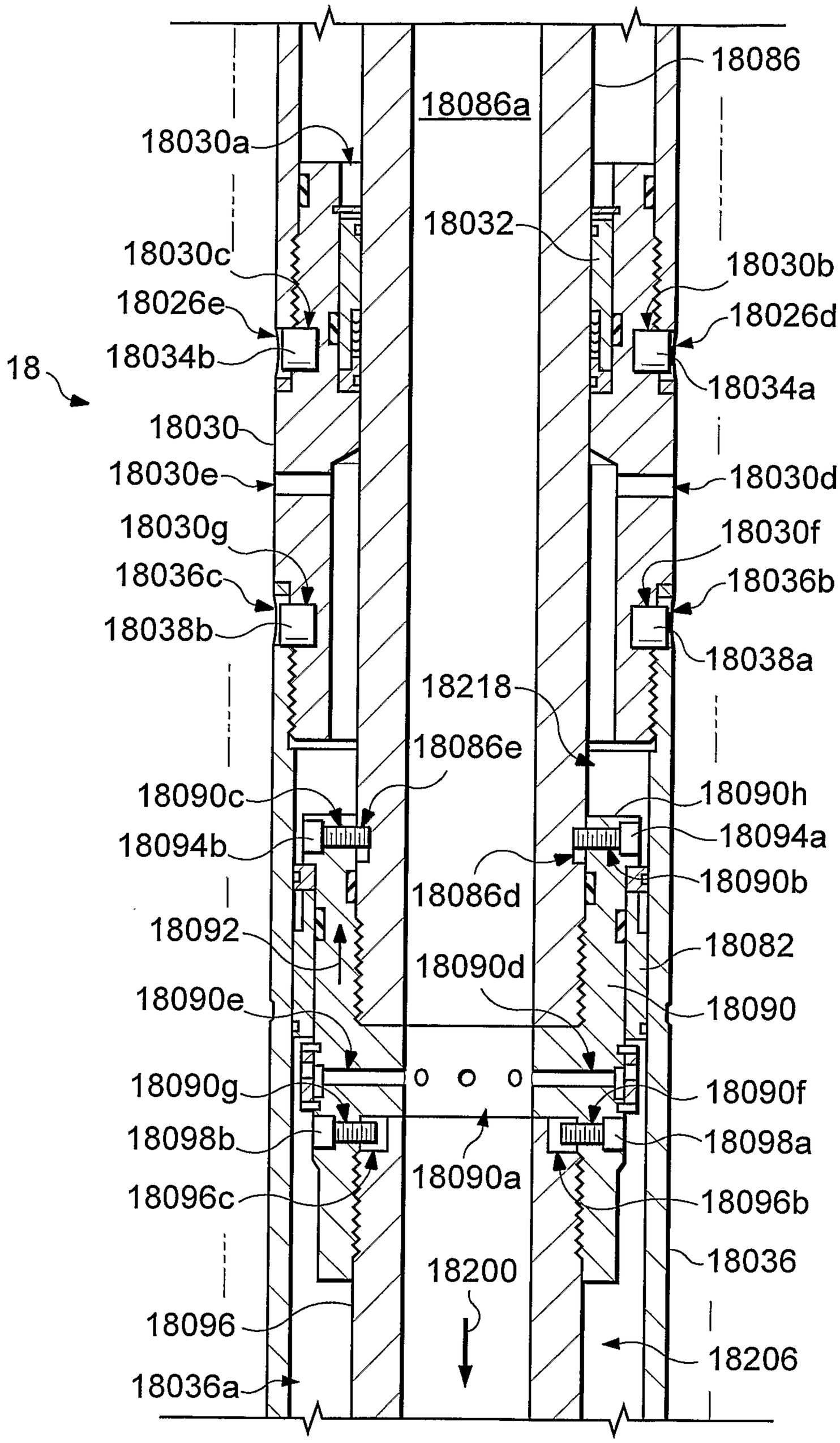

18086
18086a
18030a
18032
18030c
18030b
18026e
18026d
18034b
18
18034a
18030
18030e
18030d
18030g
18030f
18036c
18036b
18038b
18038a
18218
18086e
18090c
18090h
18094b
18094a
18086d
18090b
18092
18082
18090d
18090e
18090
18090g
18090f
18098b
18098a
18090a
18096c
18096b
18200
18036
18096
18206
18036a

Fig. 13B4

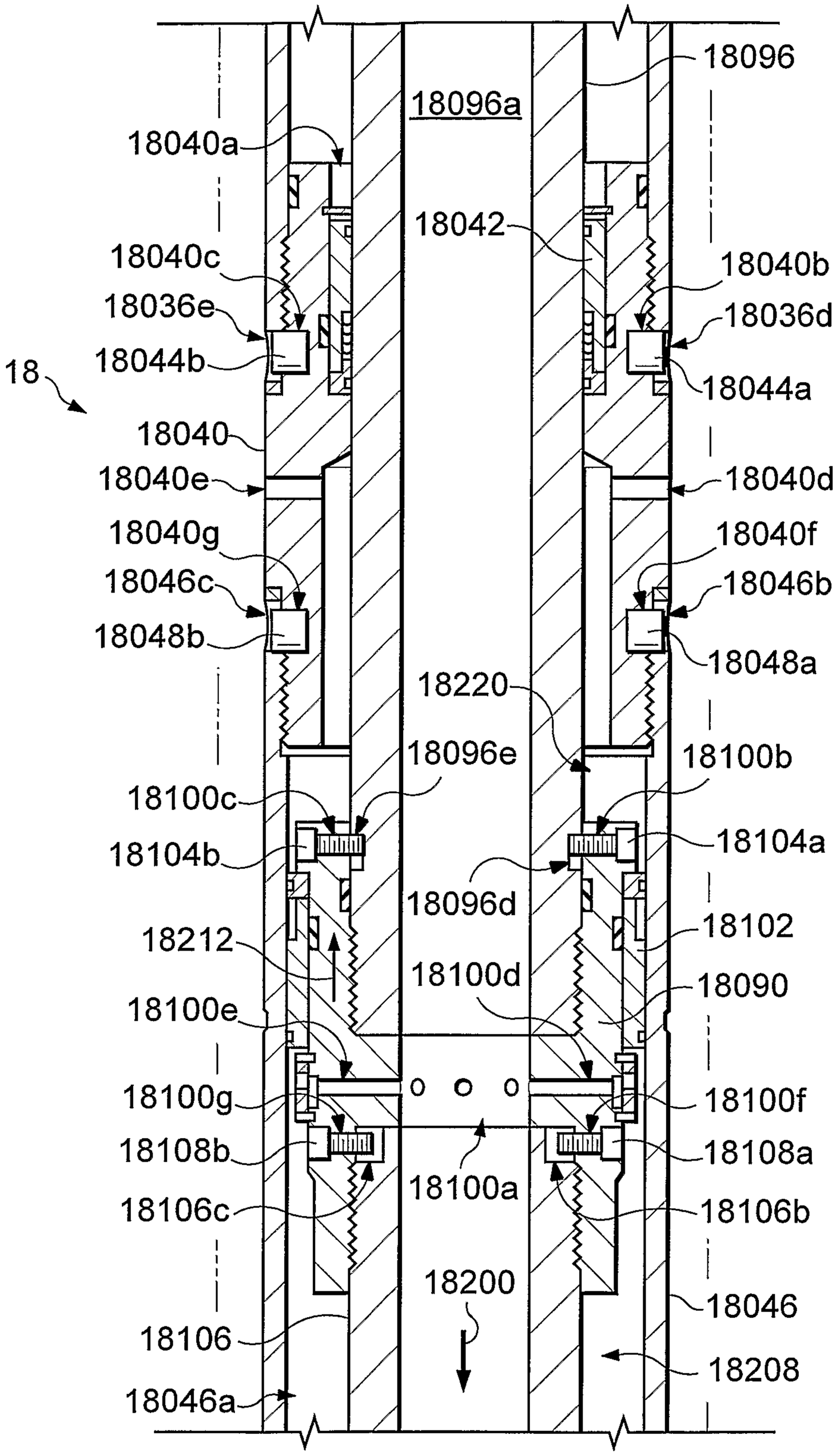

18096
18096a
18040a
18042
18040c
18040b
18036e
18036d
18044b
18044a
18
18040
18040d
18040e
18040f
18040g
18046b
18046c
18048a
18048b
18220
18096e
18100b
18100c
18104a
18104b
18096d
18102
18212
18100d
18090
18100e
18100f
18100g
18108a
18108b
18100a
18106b
18106c
18200
18046
18106
18208
18046a

Fig. 13B5

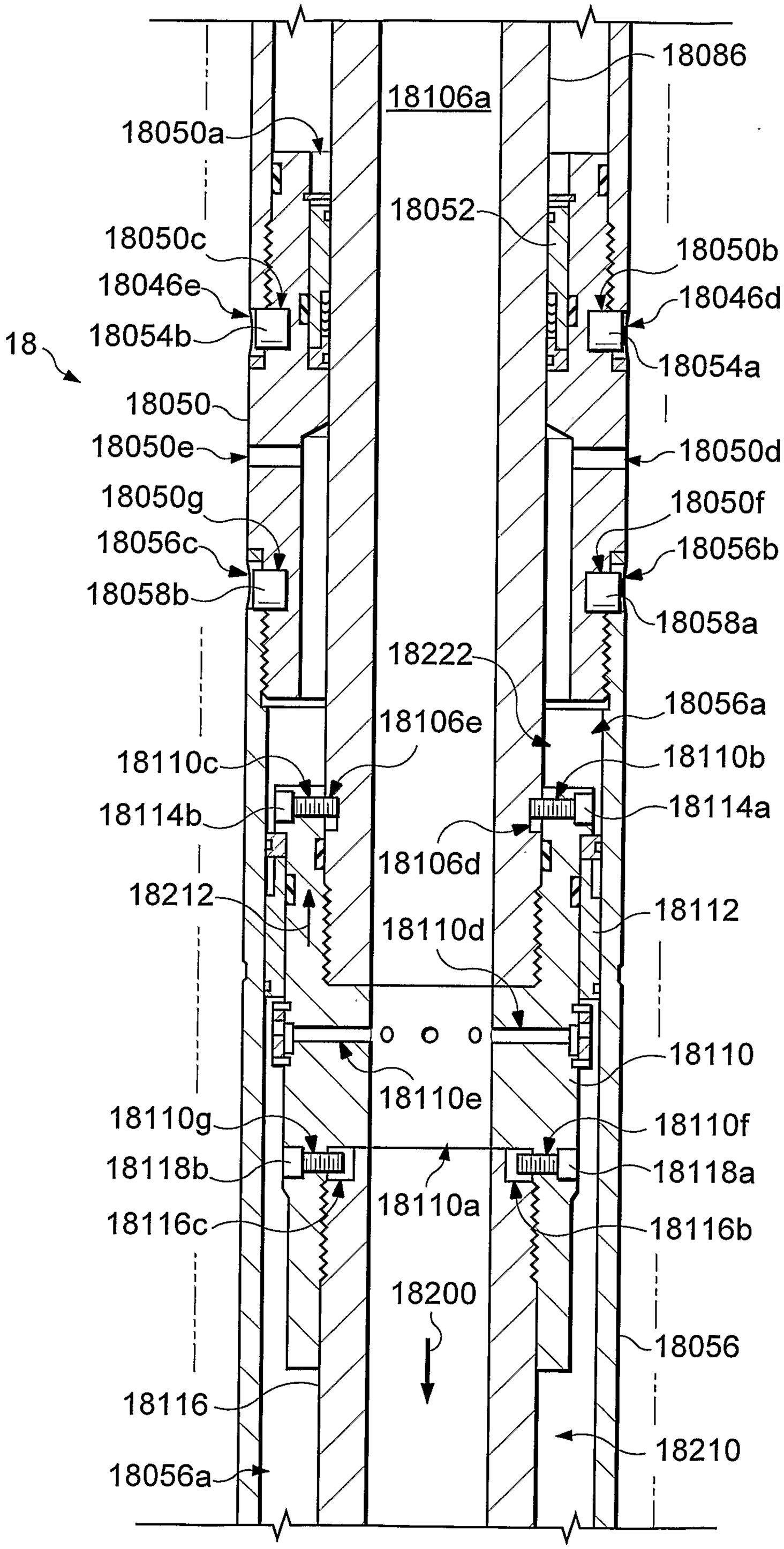

18086
18106a
18050a
18052
18050c
18050b
18046e
18046d
18054b
18054a
18
18050
18050e
18050d
18050g
18050f
18056c
18056b
18058b
18058a
18222
18106e
18056a
18110c
18110b
18114b
18114a
18106d
18212
18112
18110d
18110
18110e
18110g
18110f
18118b
18118a
18110a
18116c
18116b
18200
18056
18116
18210
18056a

Fig. 13B6

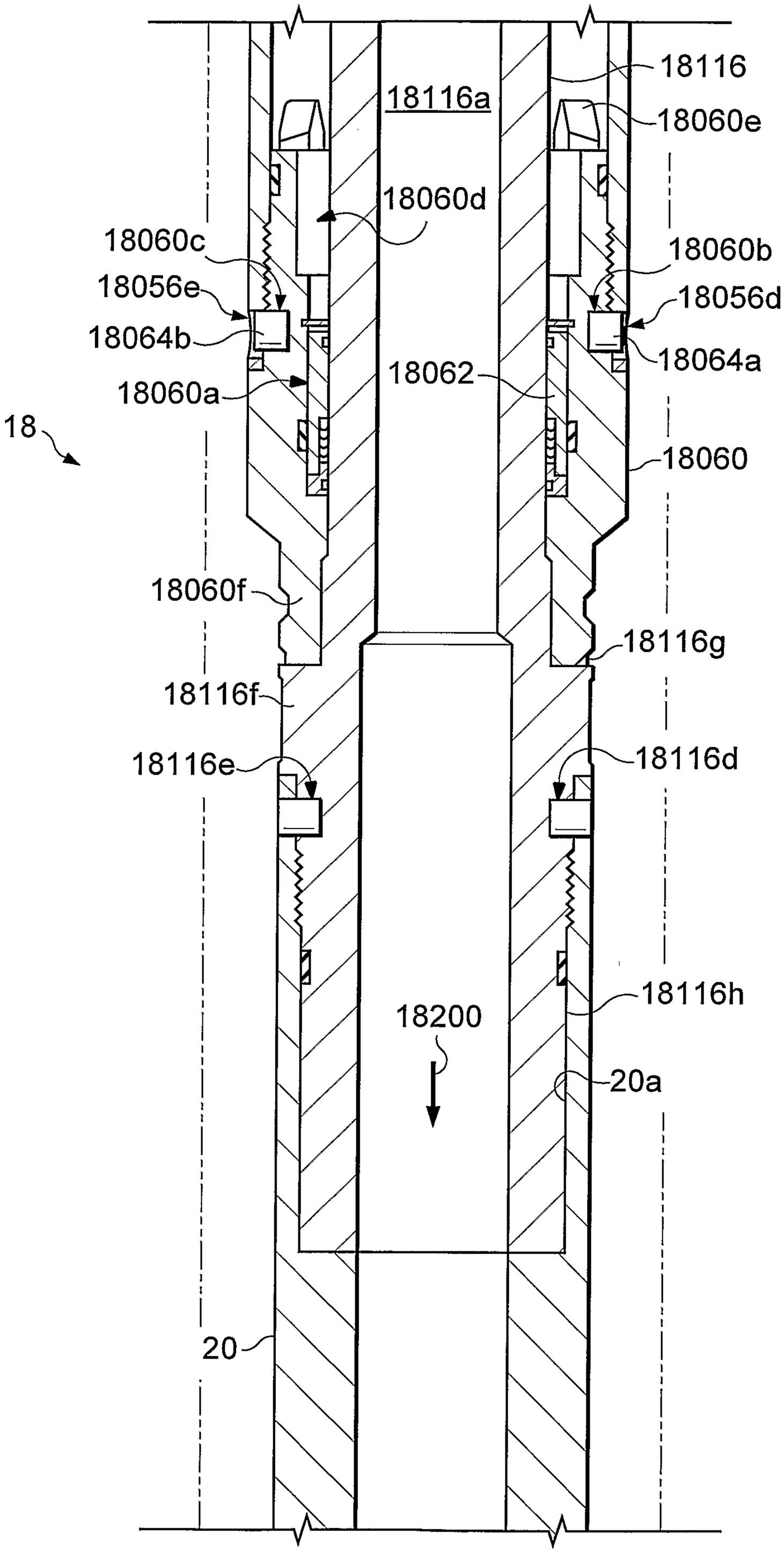

18116
18116a
18060e
18060d
18060c
18060b
18056e
18056d
18064b
18064a
18062
18060a
18
18060
18060f
18116g
18116f
18116e
18116d
18116h
18200
20a
20

Fig. 13B7

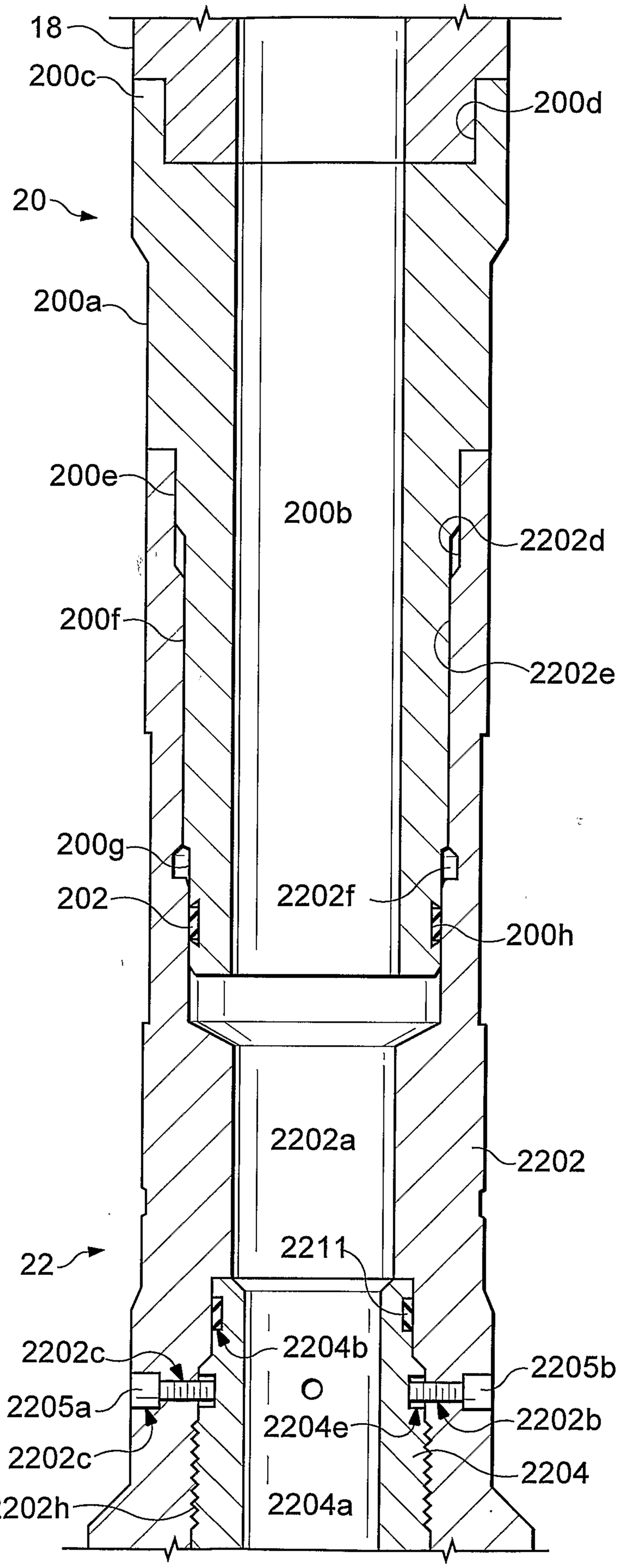

18
200c
200d
20
200a
200e
200b
2202d
200f
2202e
200g
202
2202f
200h
2202a
2202
22
2211
2202c
2204b
2205b
2205a
2204e
2202b
2202c
2204
2202h
2204a

Fig. 14A

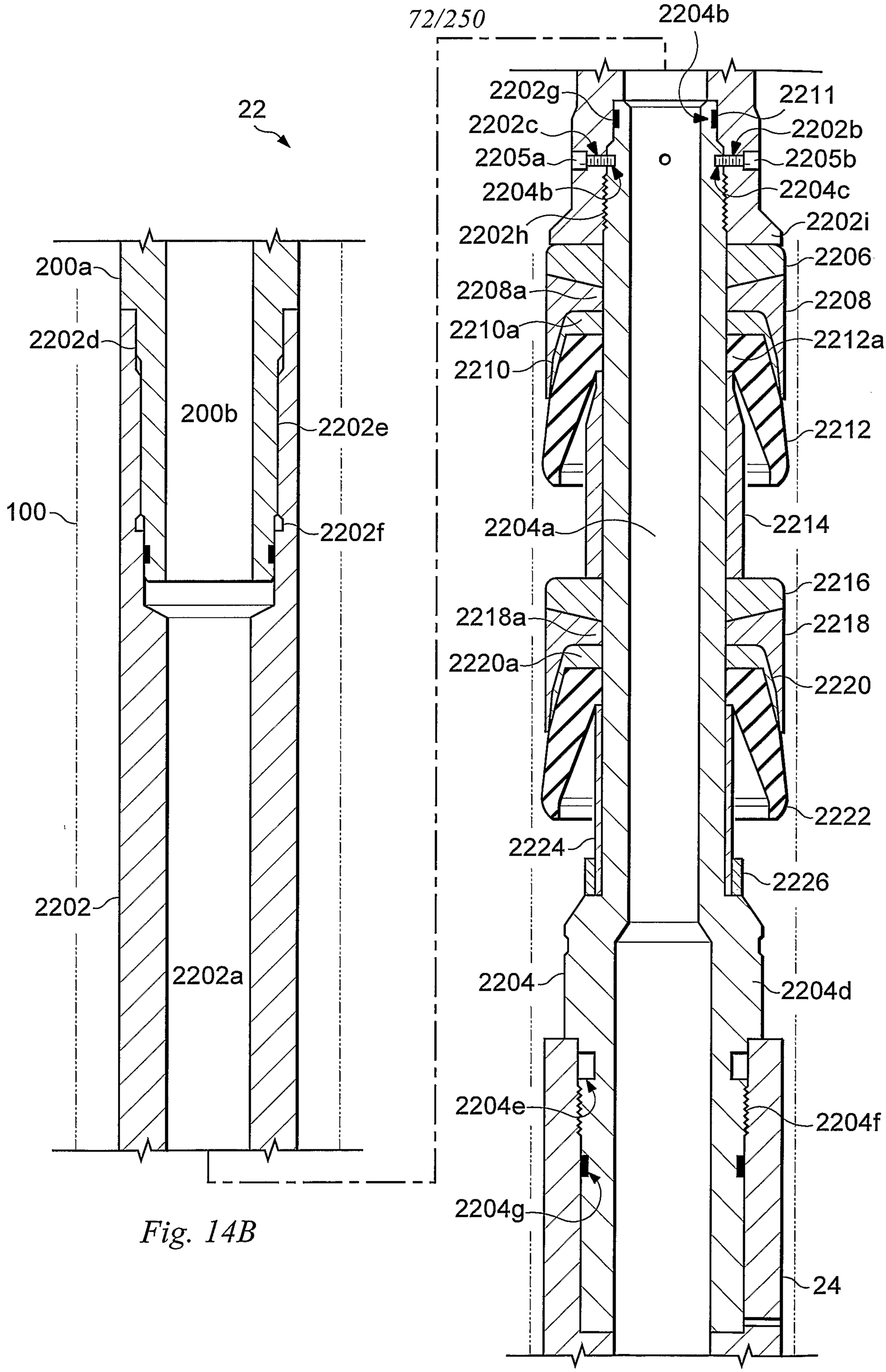

72/250
22
200a
2202d
200b
2202e
100
2202f
2202
2202a
2204b
2202g
2202c
2205a
2202h
2208a
2210a
2210
2204a
2218a
2220a
2224
2204
2204e
2204g
2211
2202b
2205b
2204c
2202i
2206
2208
2212a
2212
2214
2216
2218
2220
2222
2226
2204d
2204f
24

Fig. 14B

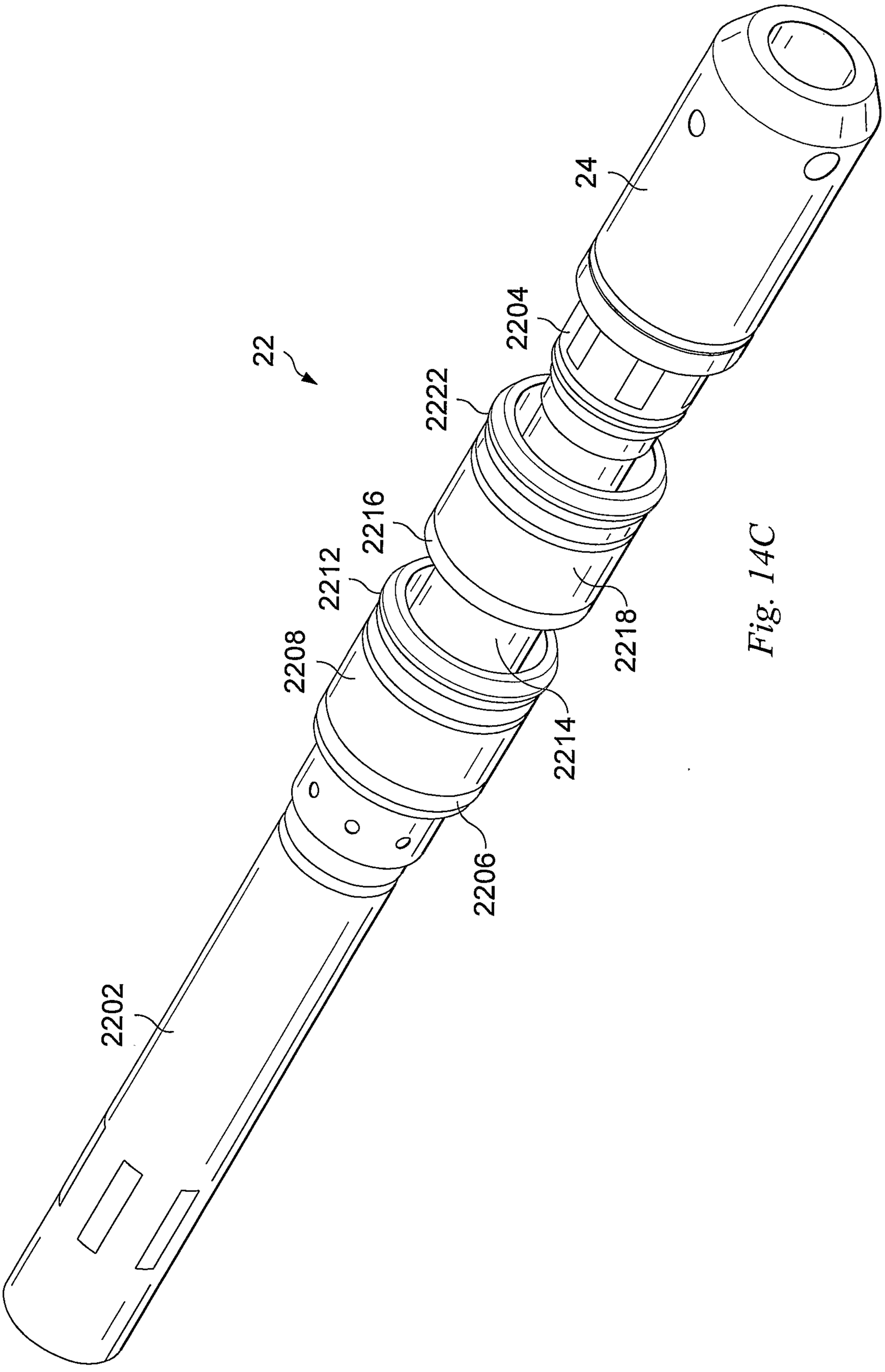


Fig. 14C

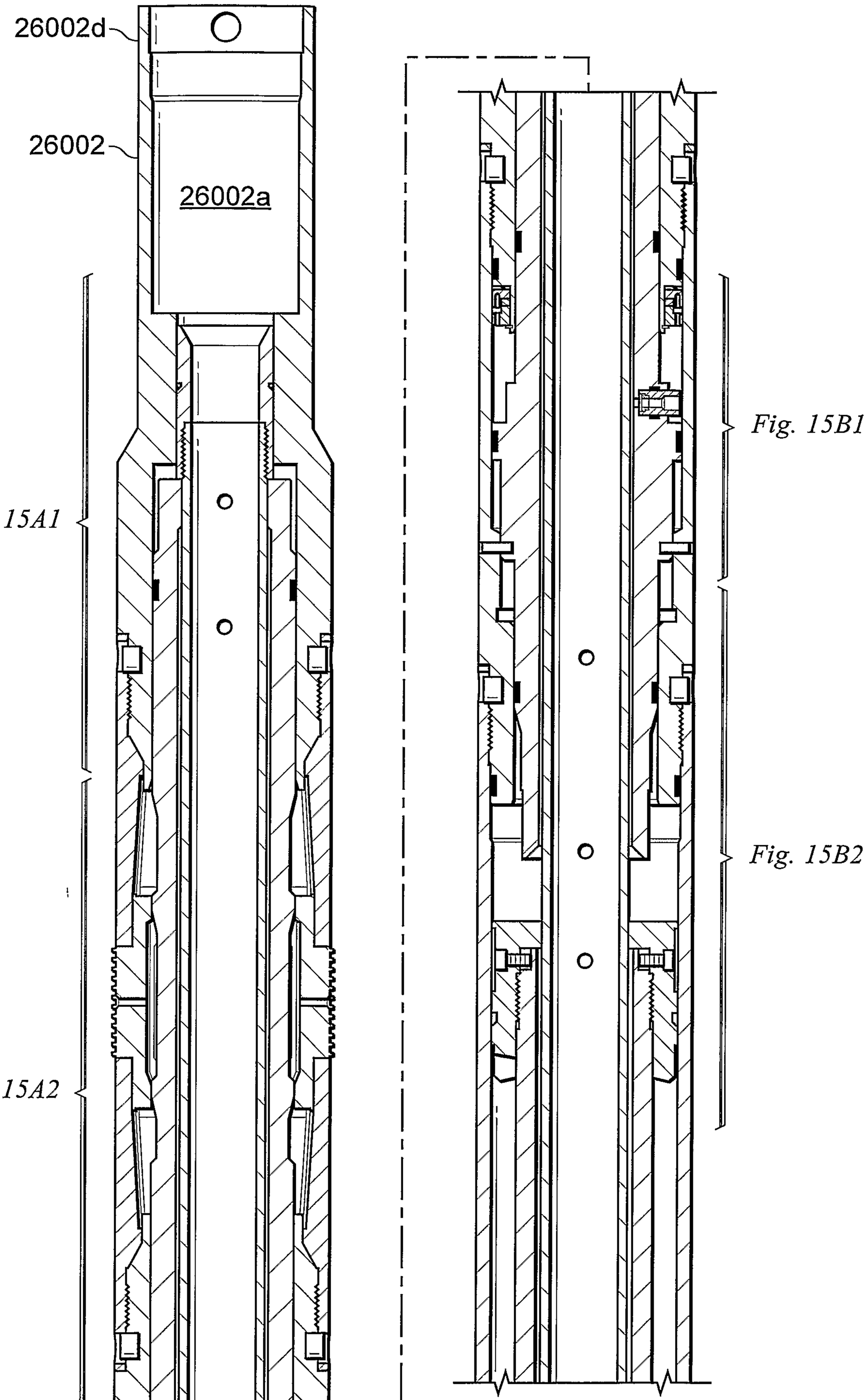


Fig. 15A1

Fig. 15A2

Fig. 15B1

Fig. 15B2

Fig. 15-1

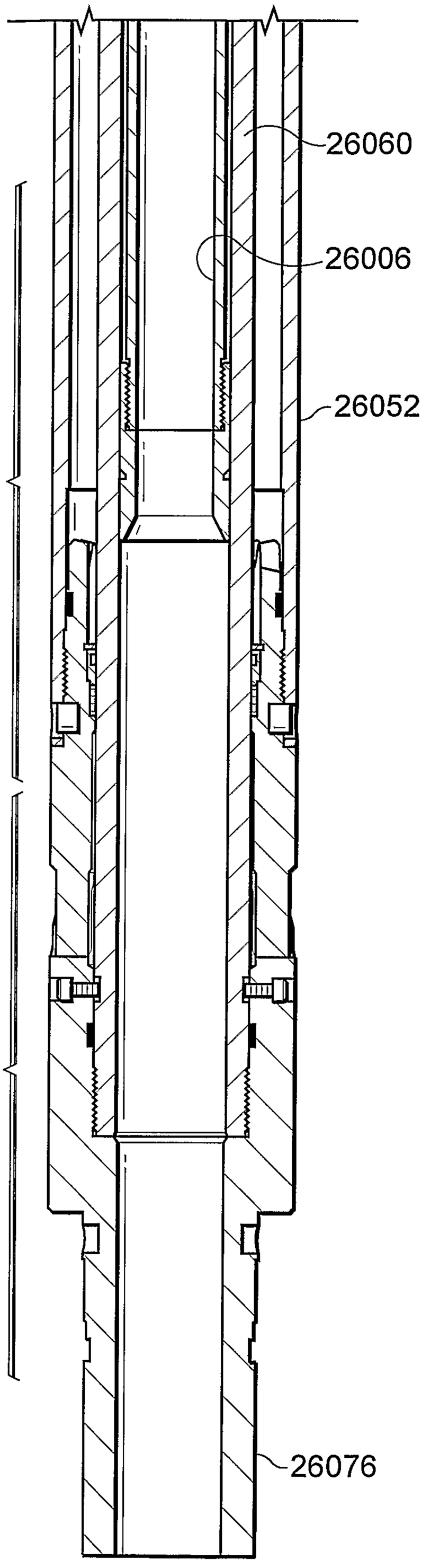


Fig. 15C1

Fig. 15C2

Fig. 15-2

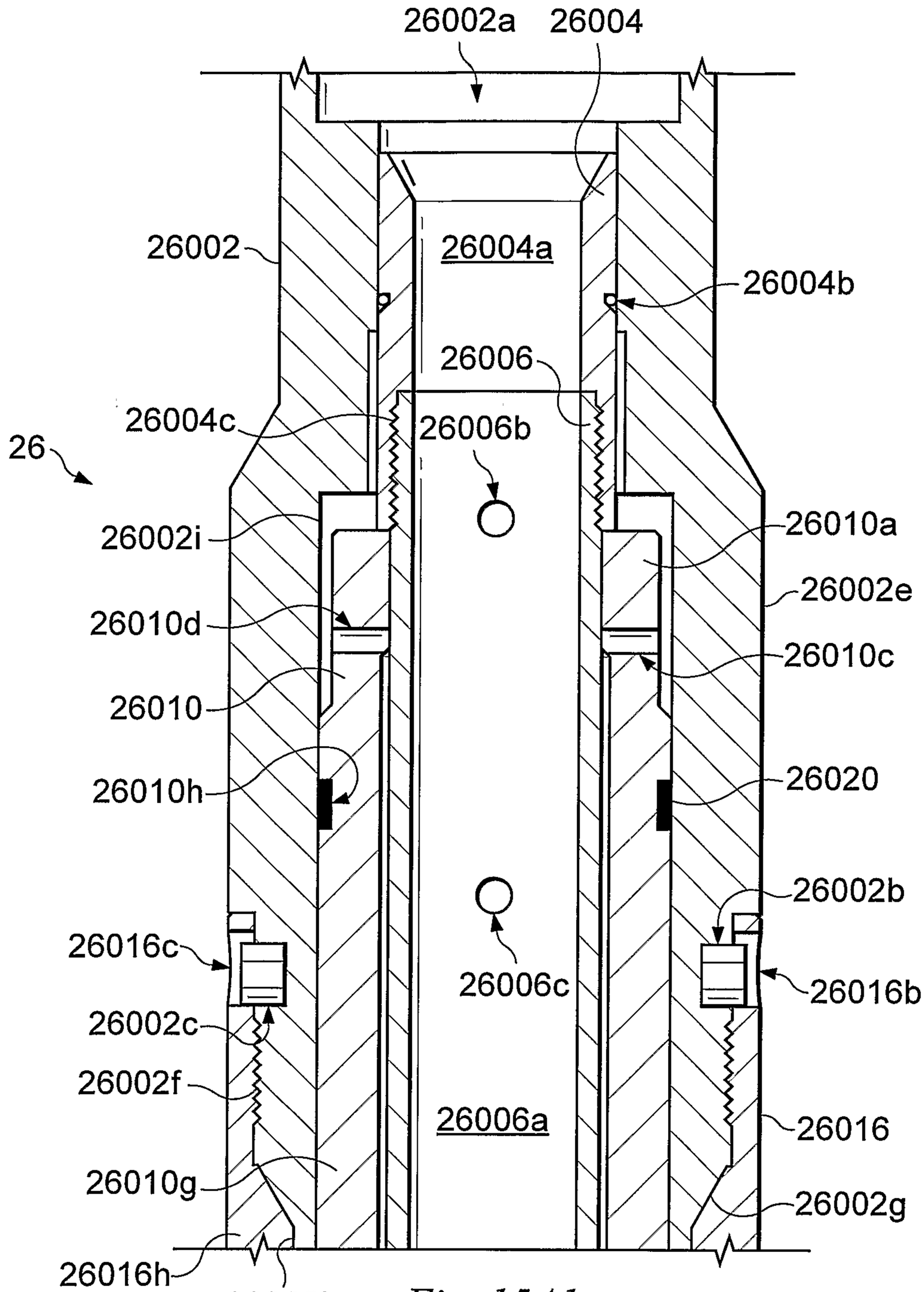

26002a
26004
26002
26004a
26004b
26006
26004c
26006b
26
26002i
26010a
26010d
26002e
26010c
26010
26010h
26020
26002b
26016c
26006c
26016b
26002c
26002f
26006a
26016
26010g
26002g
26016h
26002h

Fig. 15A1

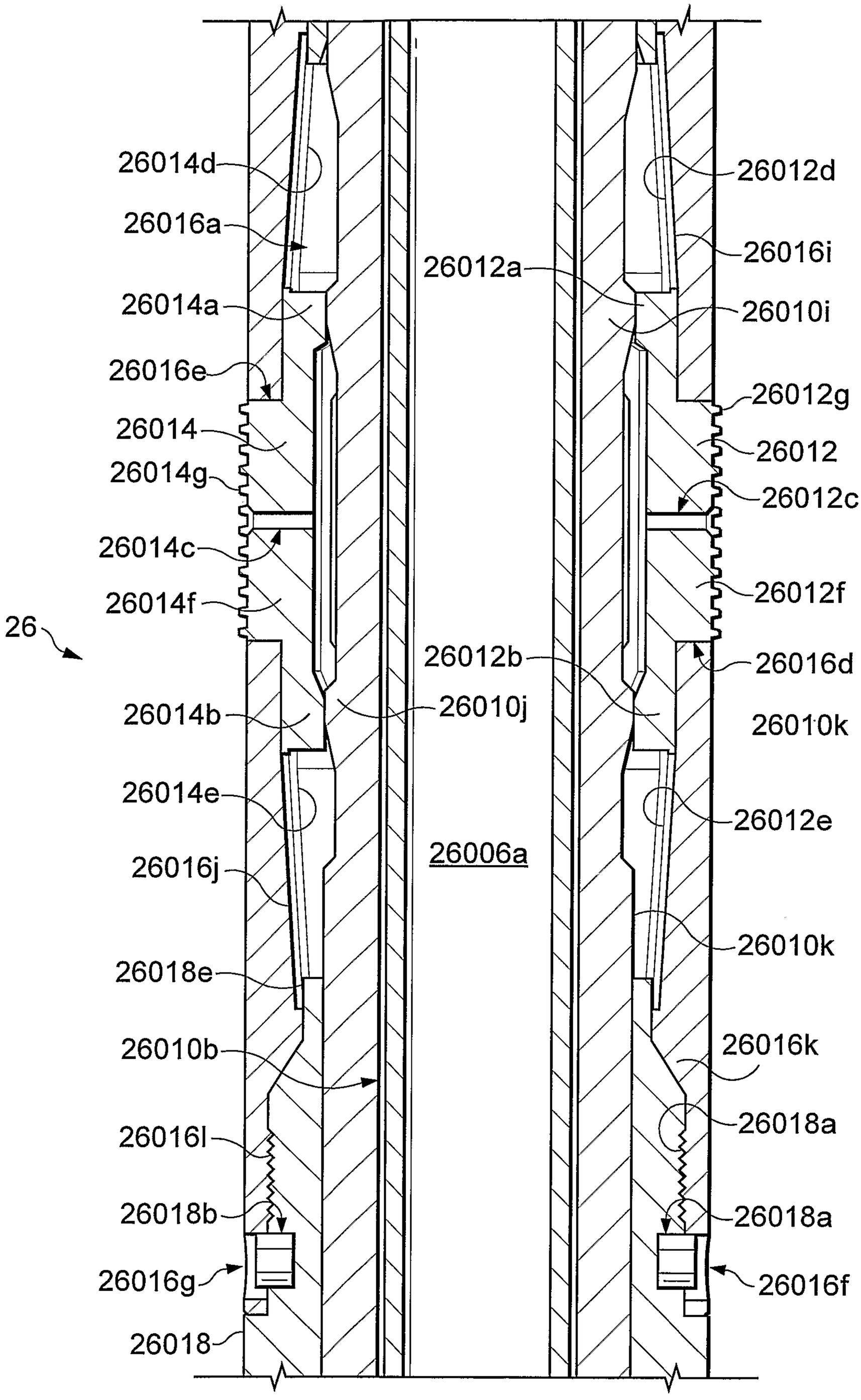

26014d
26016a
26014a
26016e
26014
26014g
26014c
26014f
26
26014b
26014e
26016j
26018e
26010b
26016l
26018b
26016g
26018
26012d
26012a
26016i
26010i
26012g
26012
26012c
26012f
26012b
26010j
26016d
26010k
26006a
26012e
26010k
26016k
26018a
26018a
26016f

Fig. 15A2

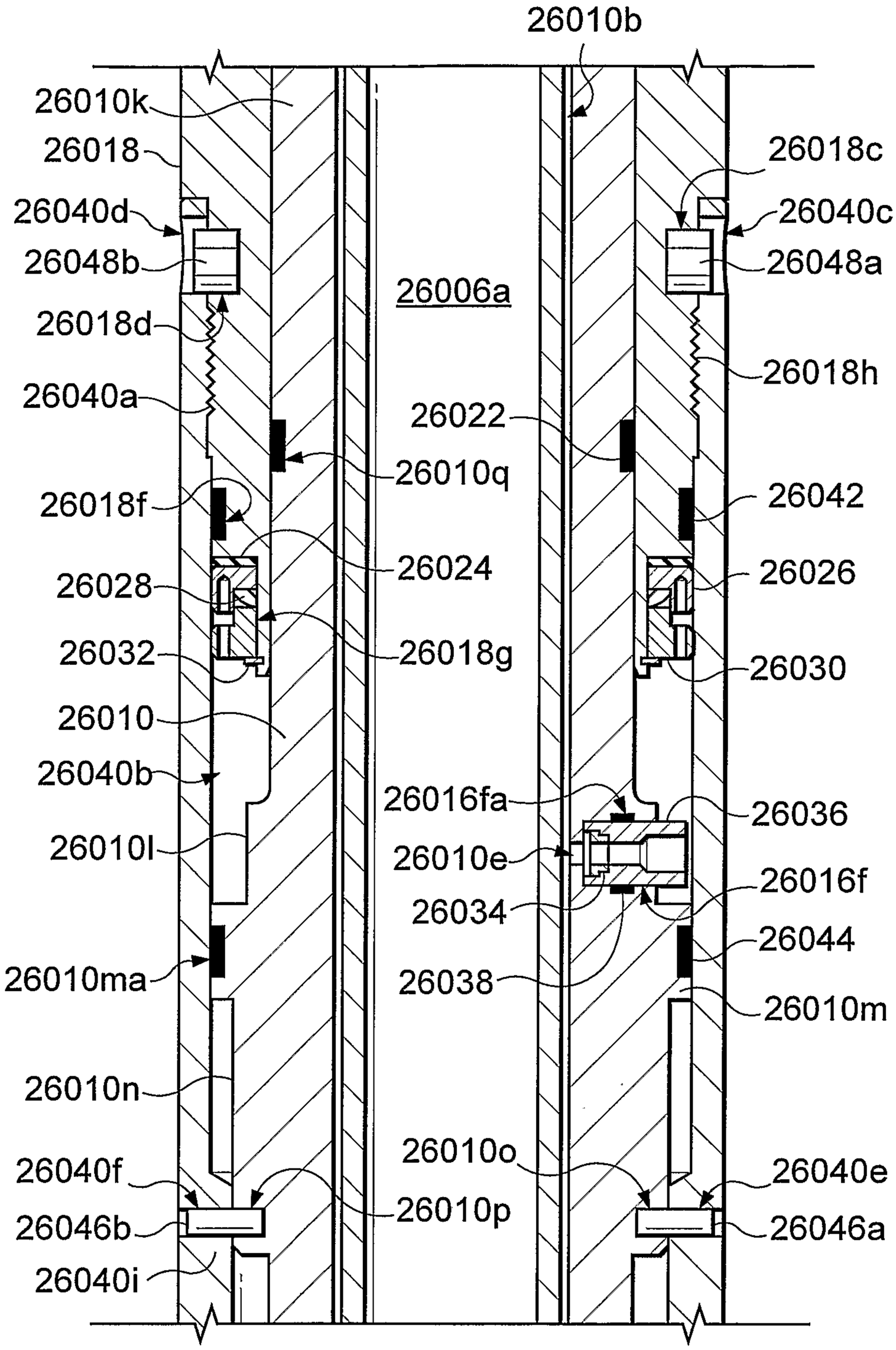

26010b
26010k
26018
26040d
26048b
26018d
26040a
26018f
26028
26032
26010
26040b
26010l
26010ma
26010n
26040f
26046b
26040i
26006a
26010q
26024
26018g
26010p
26016fa
26010e
26034
26038
26010o
26018c
26040c
26048a
26018h
26022
26042
26026
26030
26036
26016f
26044
26010m
26040e
26046a

Fig. 15B1

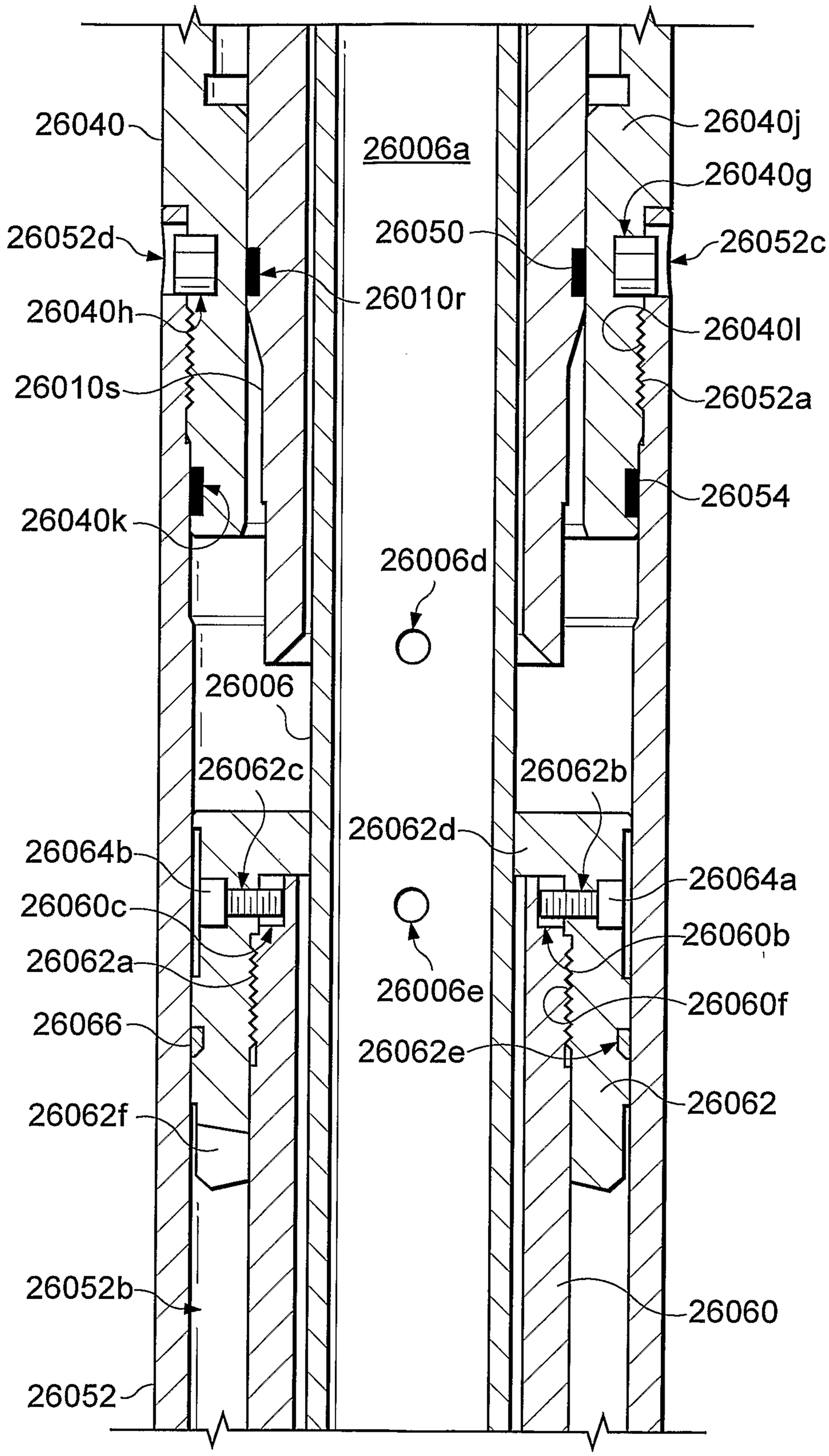

26040
26006a
26040j
26040g
26052d
26050
26052c
26010r
26040h
26040l
26010s
26052a
26040k
26054
26006d
26006
26062c
26062b
26064b
26062d
26064a
26060c
26062a
26006e
26060b
26066
26060f
26062e
26062f
26062
26052b
26060
26052

Fig. 15B2

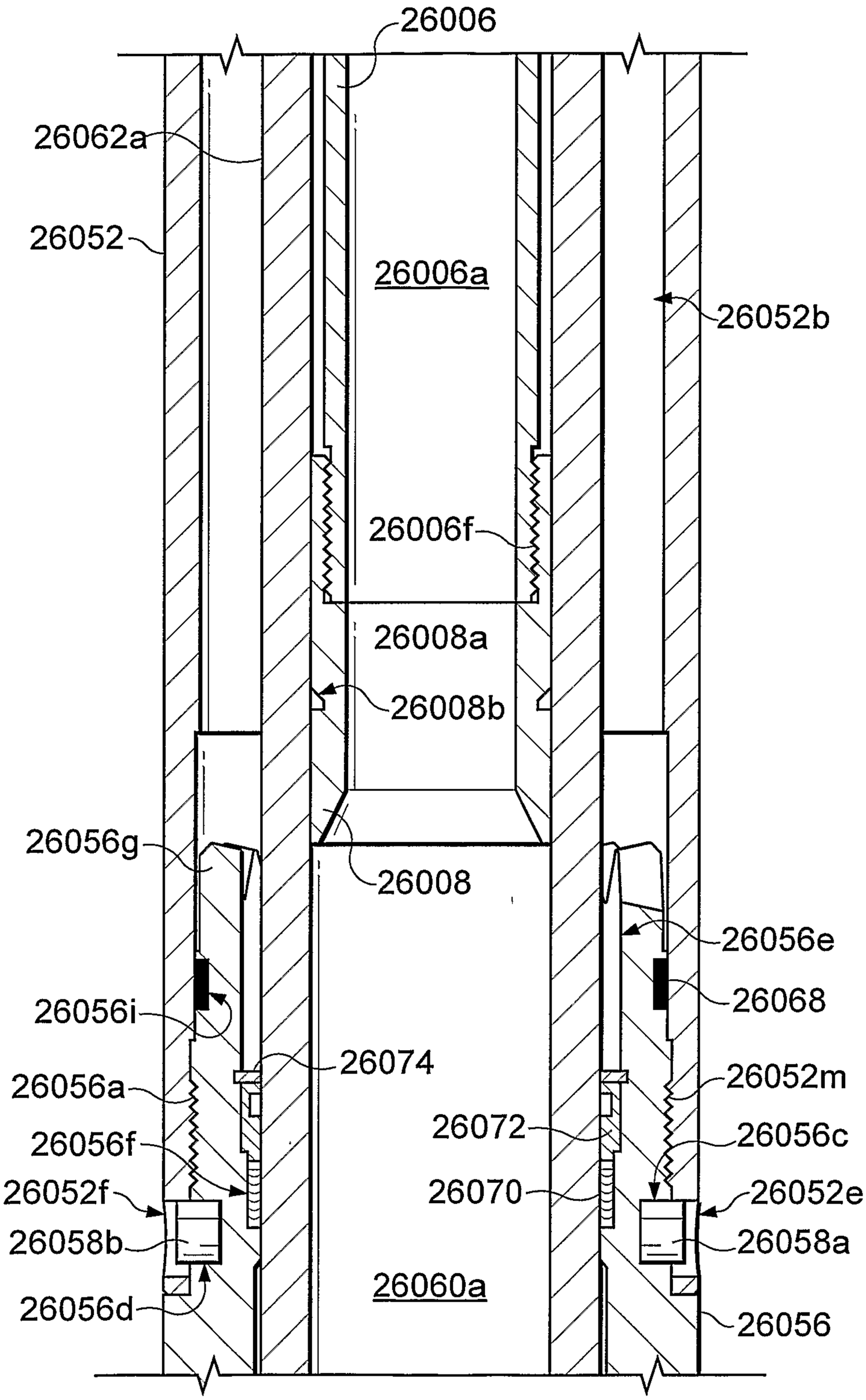

26006
26062a
26052
26006a
26052b
26006f
26008a
26008b
26008
26056g
26056e
26068
26056i
26074
26052m
26056a
26072
26056c
26056f
26070
26052e
26052f
26058a
26058b
26060a
26056d
26056

Fig. 15C1

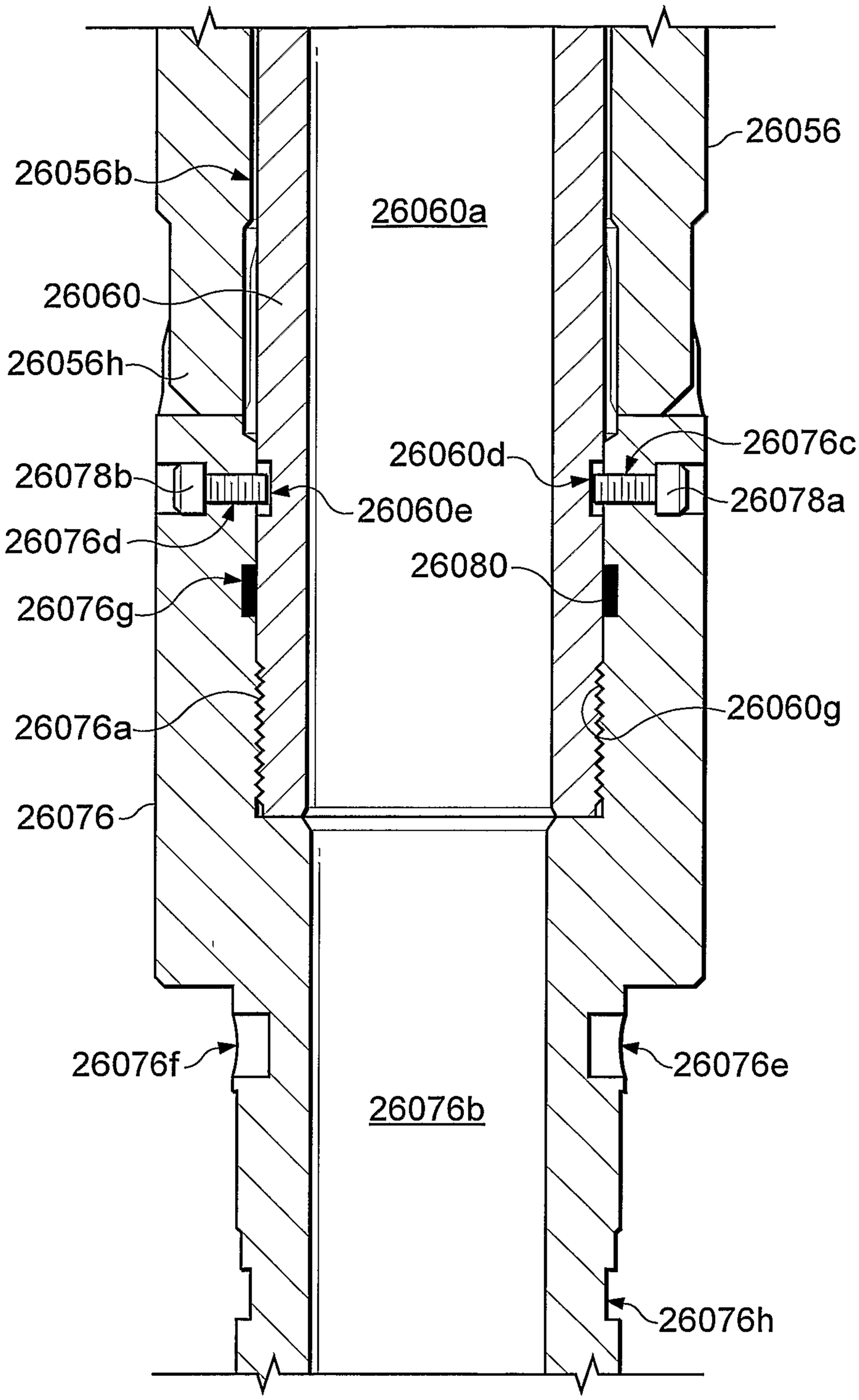

26056
26056b
26060a
26060
26056h
26060d
26076c
26078b
26060e
26078a
26076d
26080
26076g
26060g
26076a
26076
26076f
26076e
26076b
26076h

Fig. 15C2

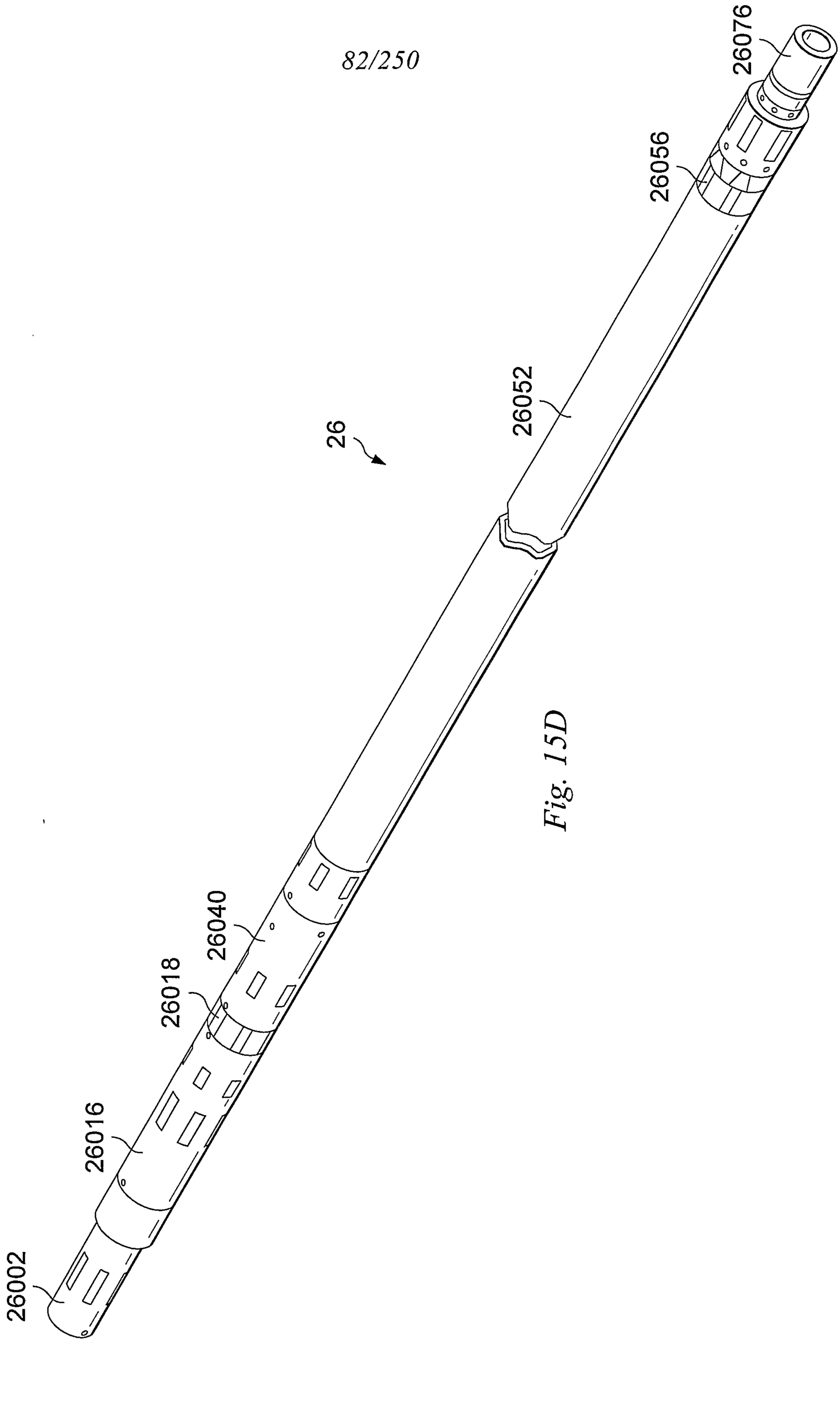


Fig. 15D

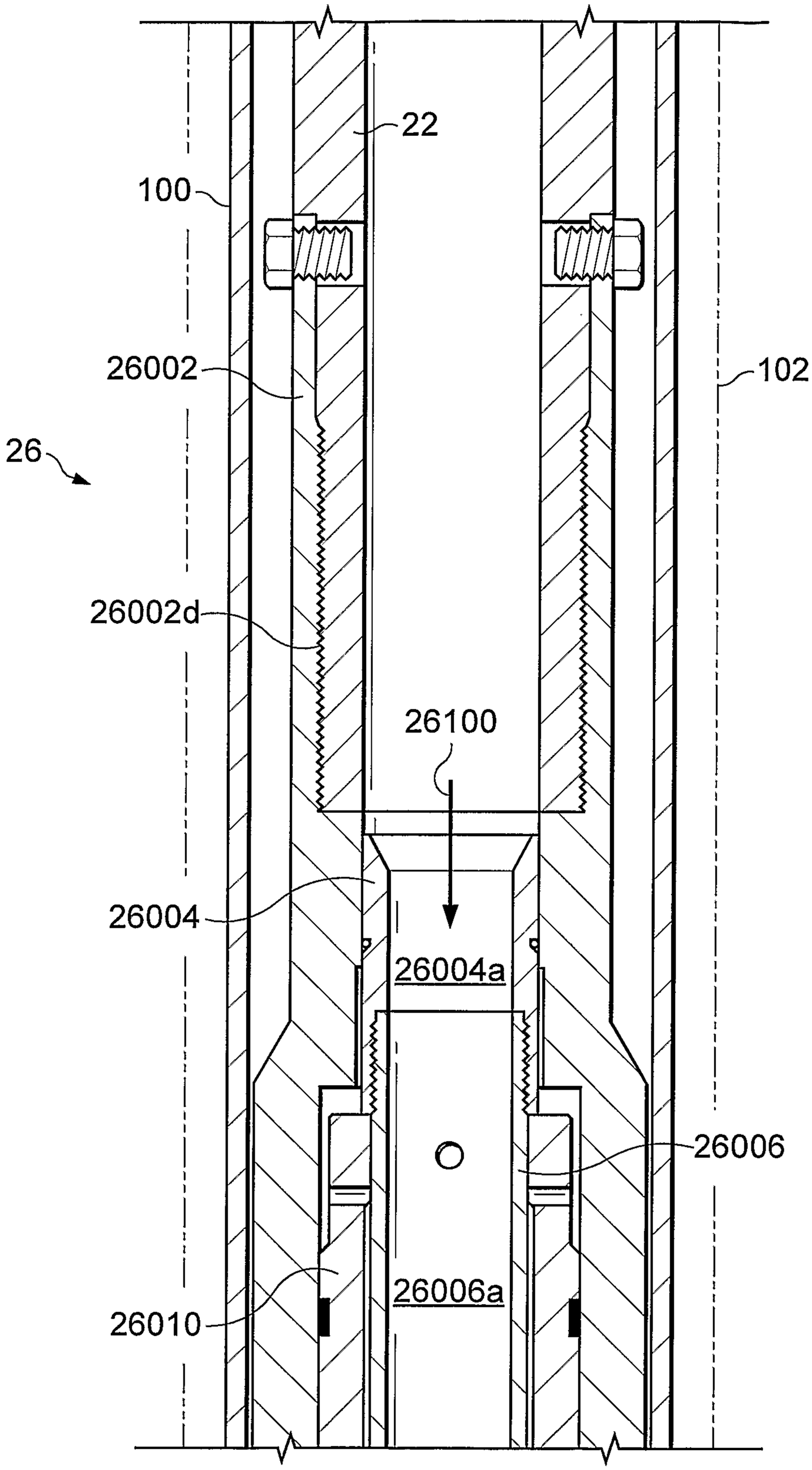

22
100
26002
102
26
26002d
26100
26004
26004a
26006
26006a
26010

Fig. 15E1

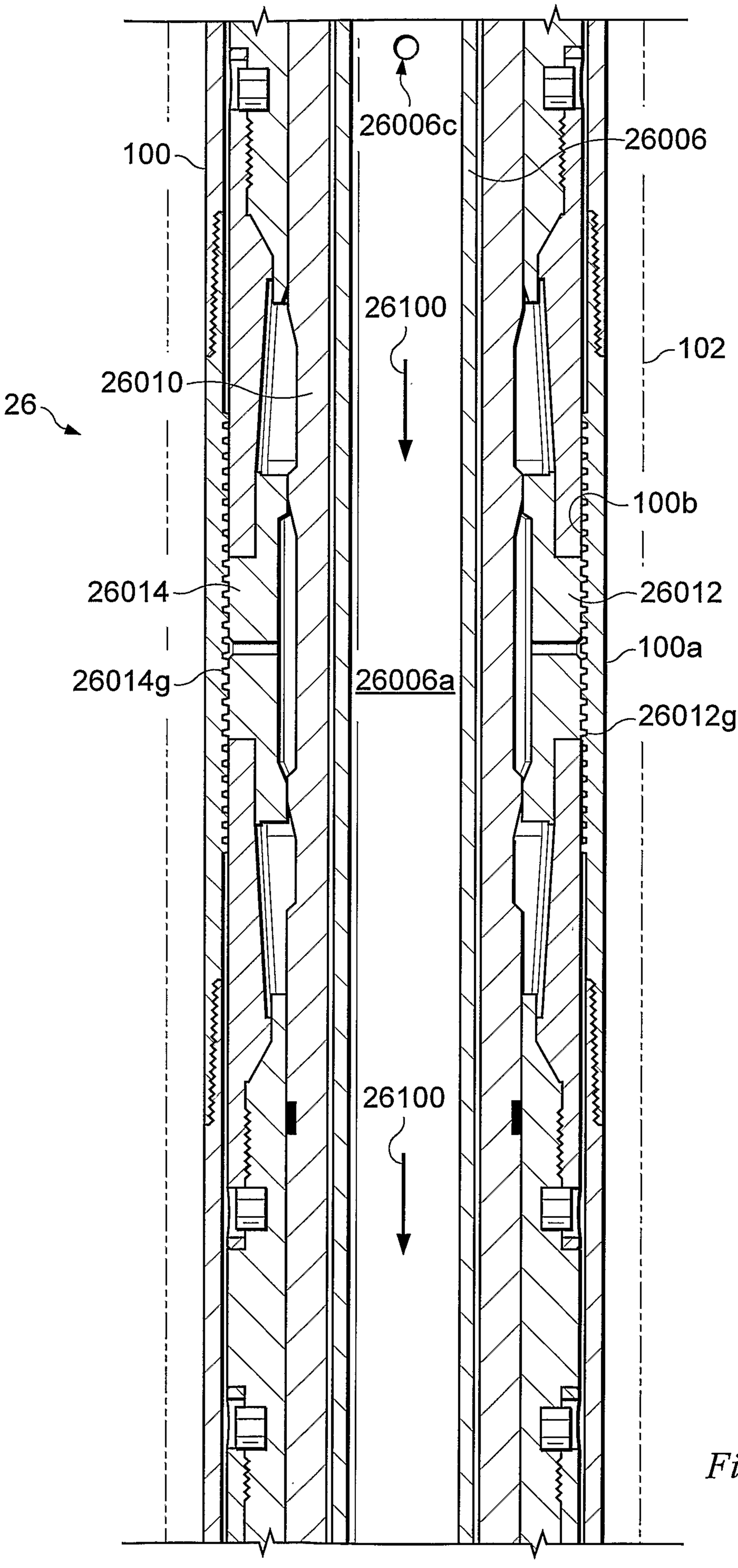

26006c
100
26006
26100
102
26010
26
100b
26014
26012
100a
26014g
26006a
26012g
26100

Fig. 15E2

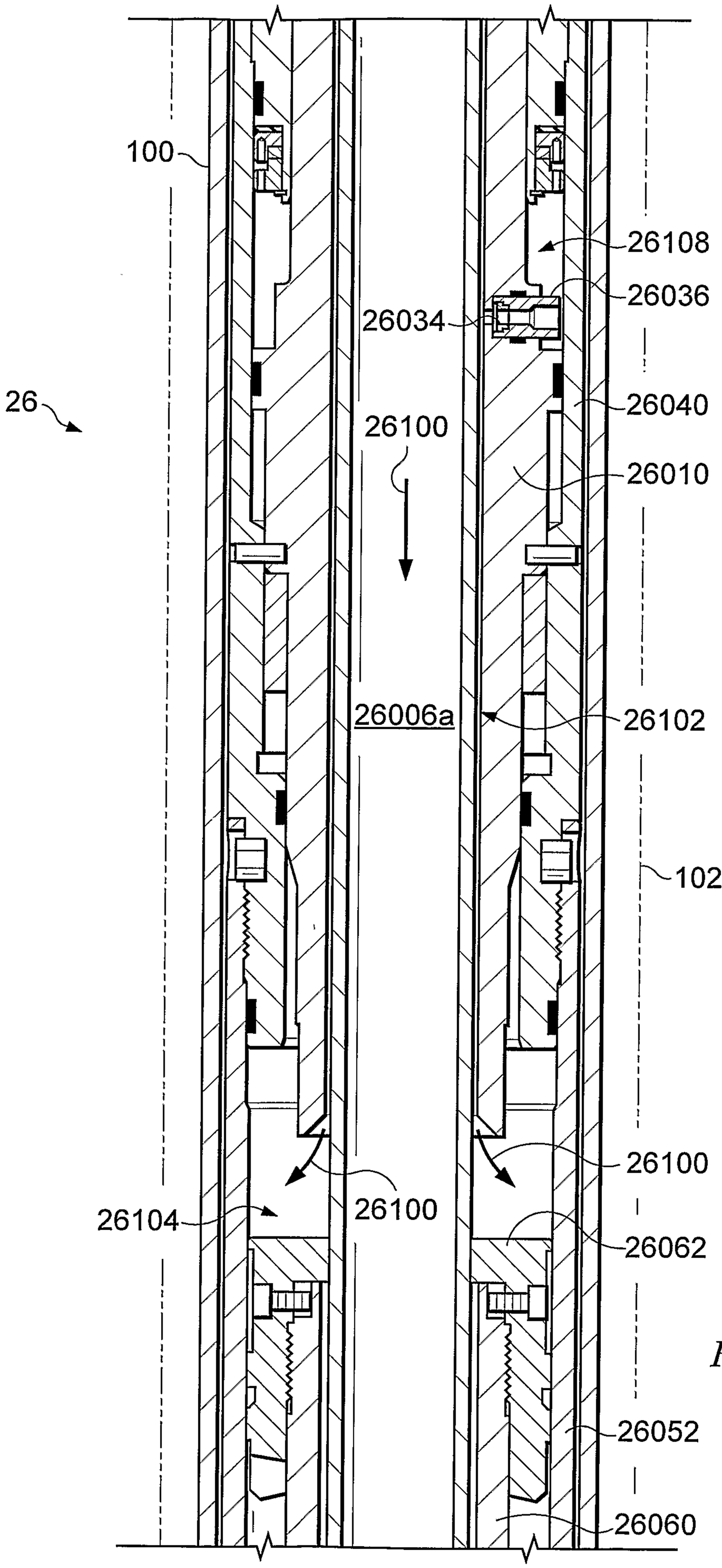

100
26
26108
26036
26034
26040
26100
26010
26006a
26102
102
26100
26104
26100
26062
26052
26060

Fig. 15E3

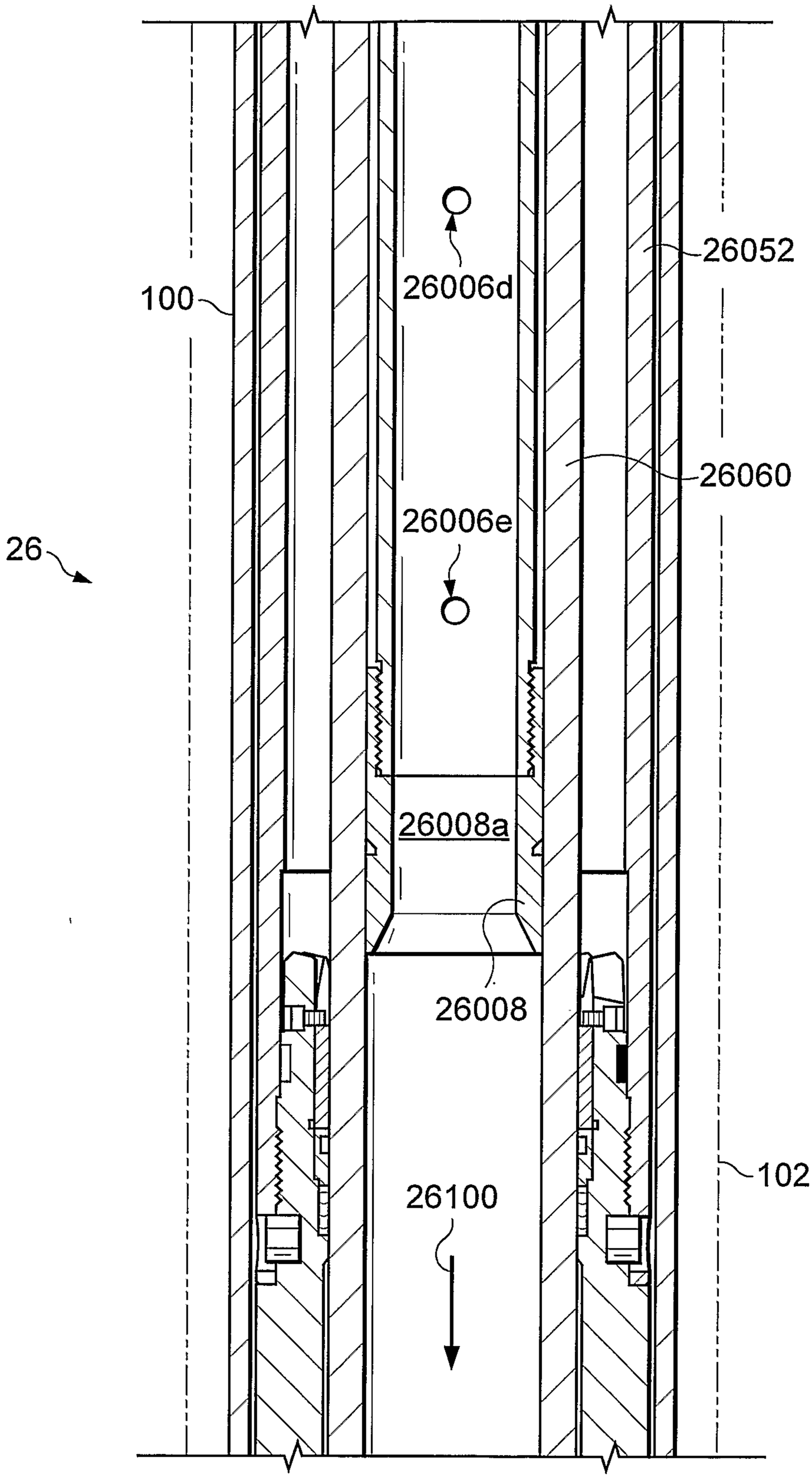


Fig. 15E4

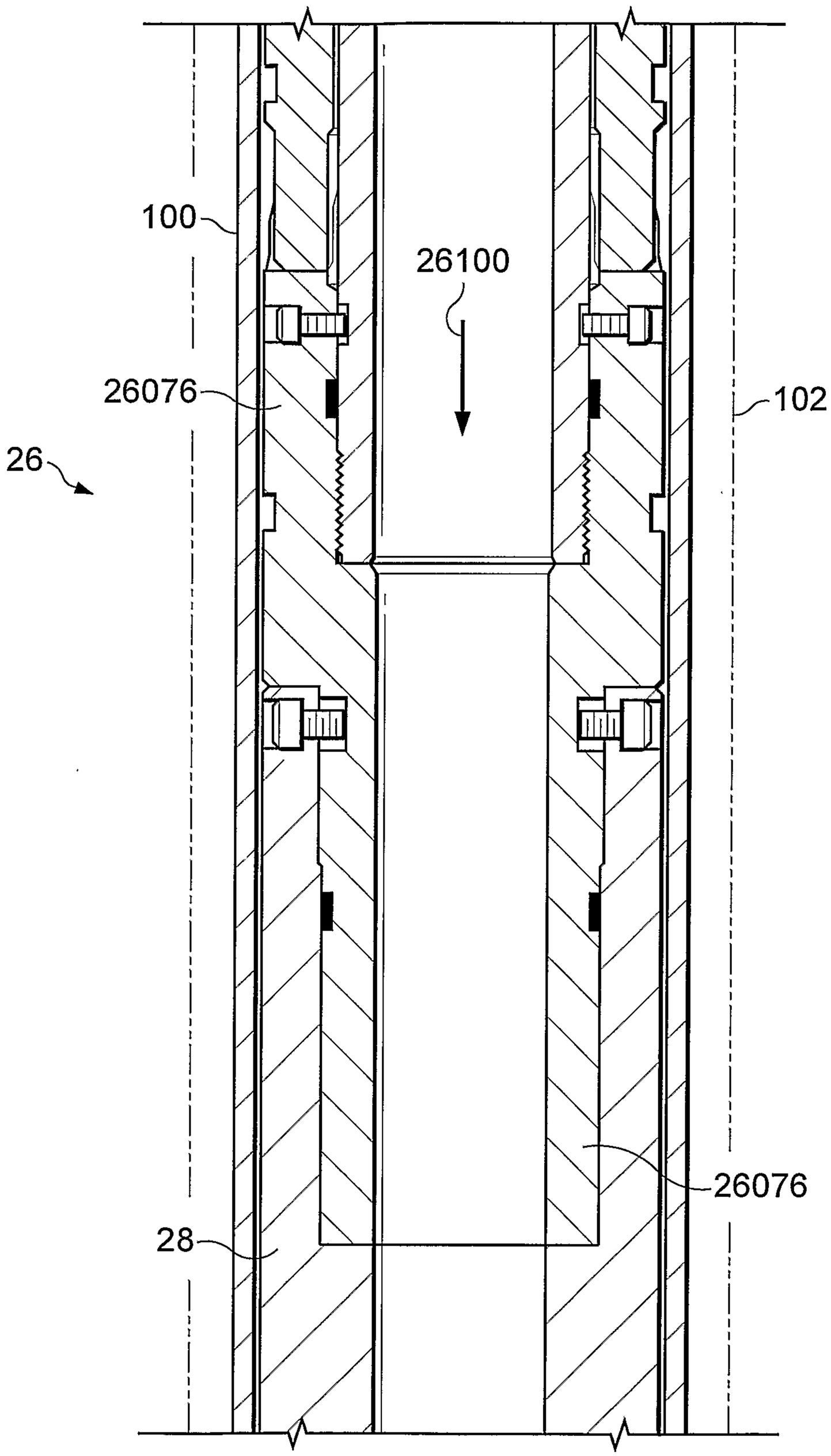


Fig. 15E5

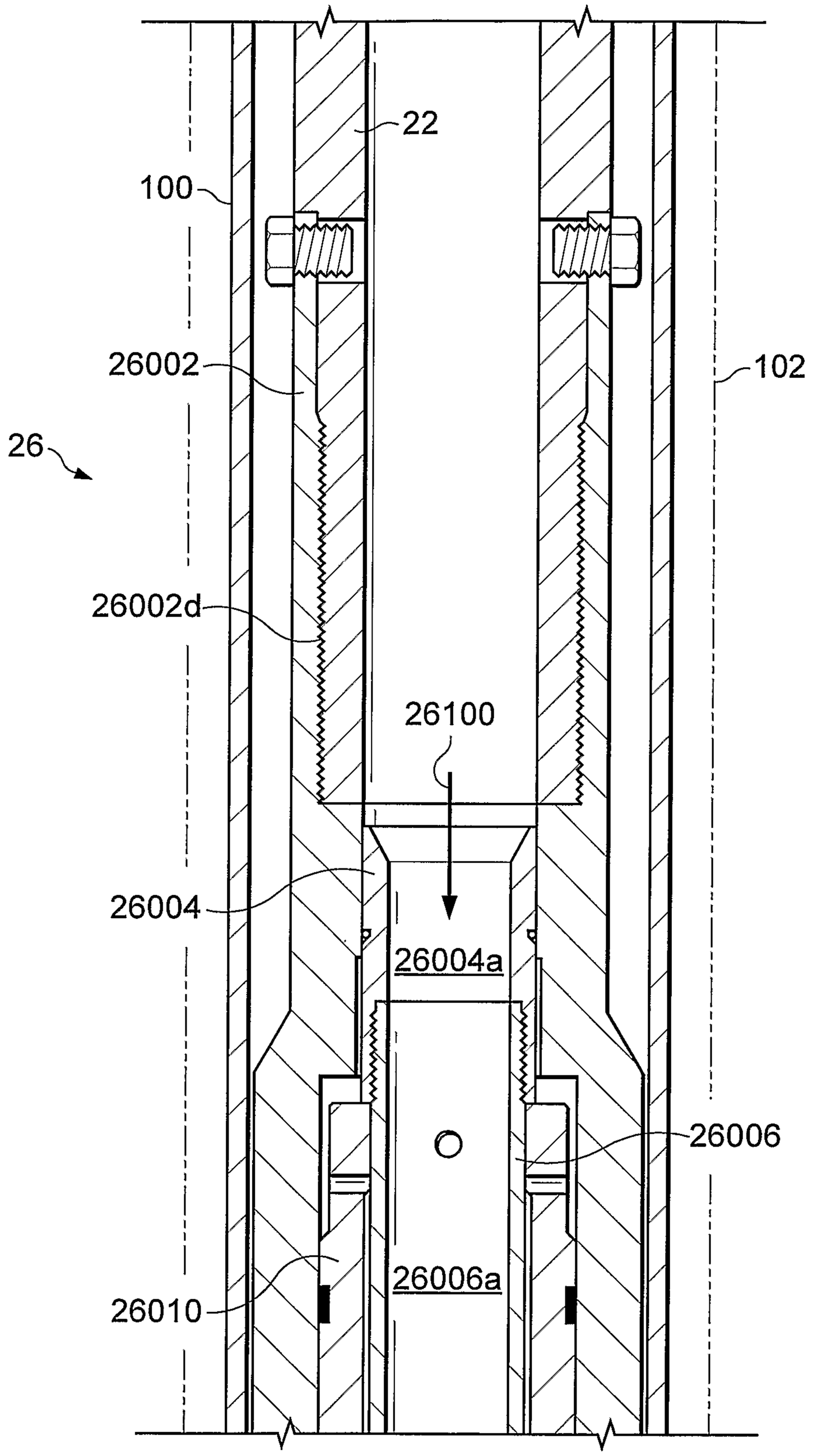

22
100
26002
102
26
26002d
26100
26004
26004a
26006
26006a
26010

Fig. 15F1

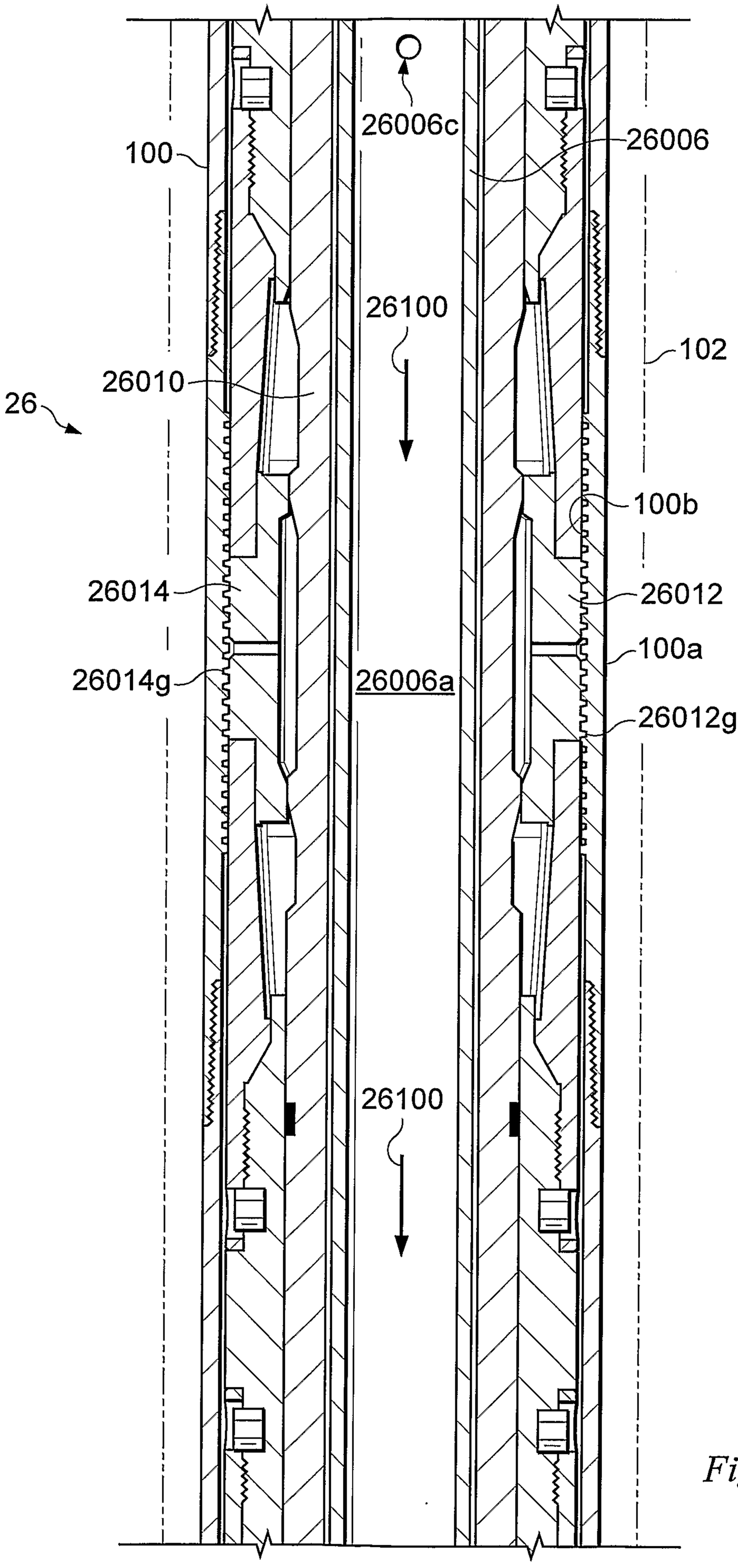

26006c
100
26006
26100
102
26010
26
100b
26014
26012
100a
26014g
26006a
26012g
26100

Fig. 15F2

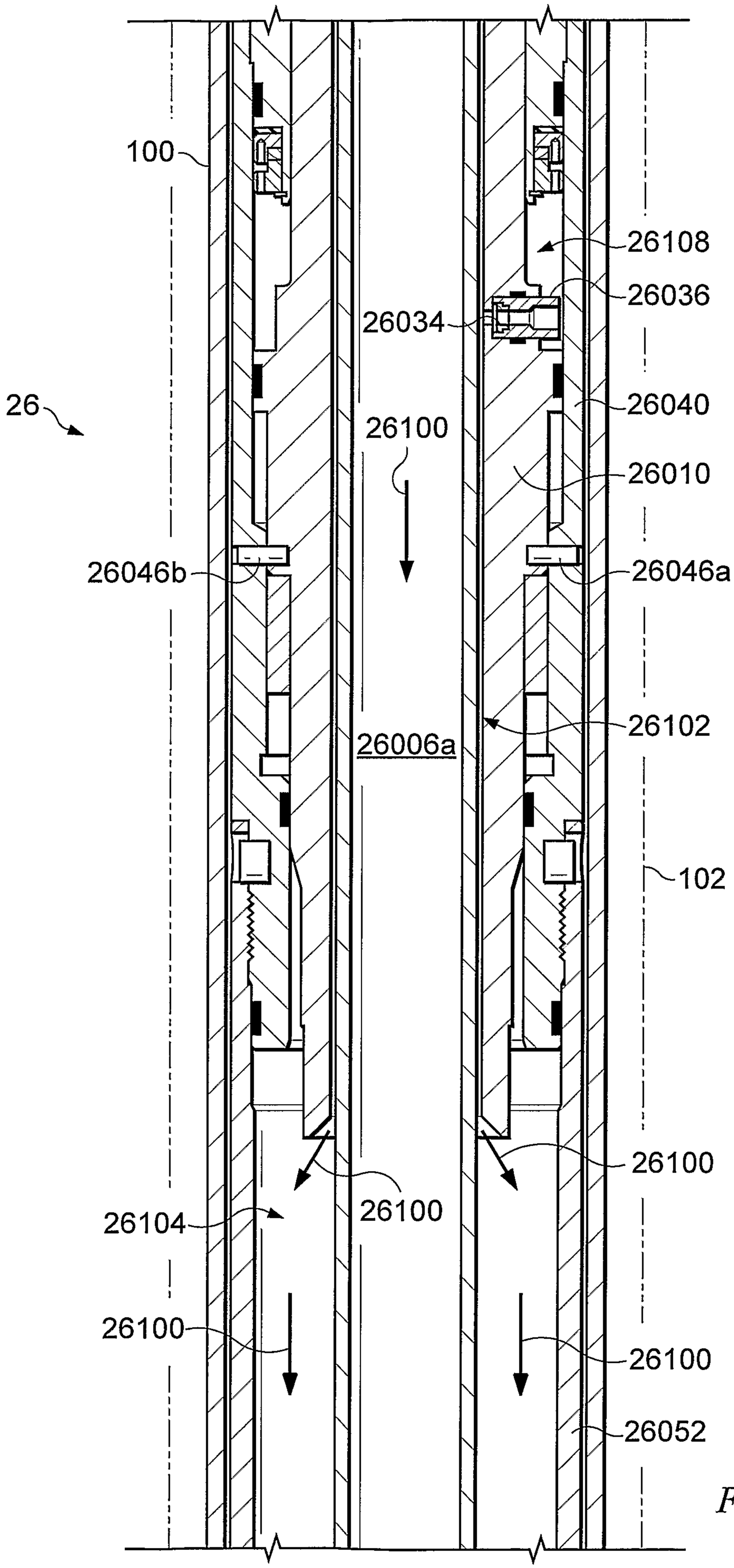

100
26108
26036
26034
26040
26
26100
26010
26046b
26046a
26006a
26102
102
26100
26104
26100
26100
26052

Fig. 15F3

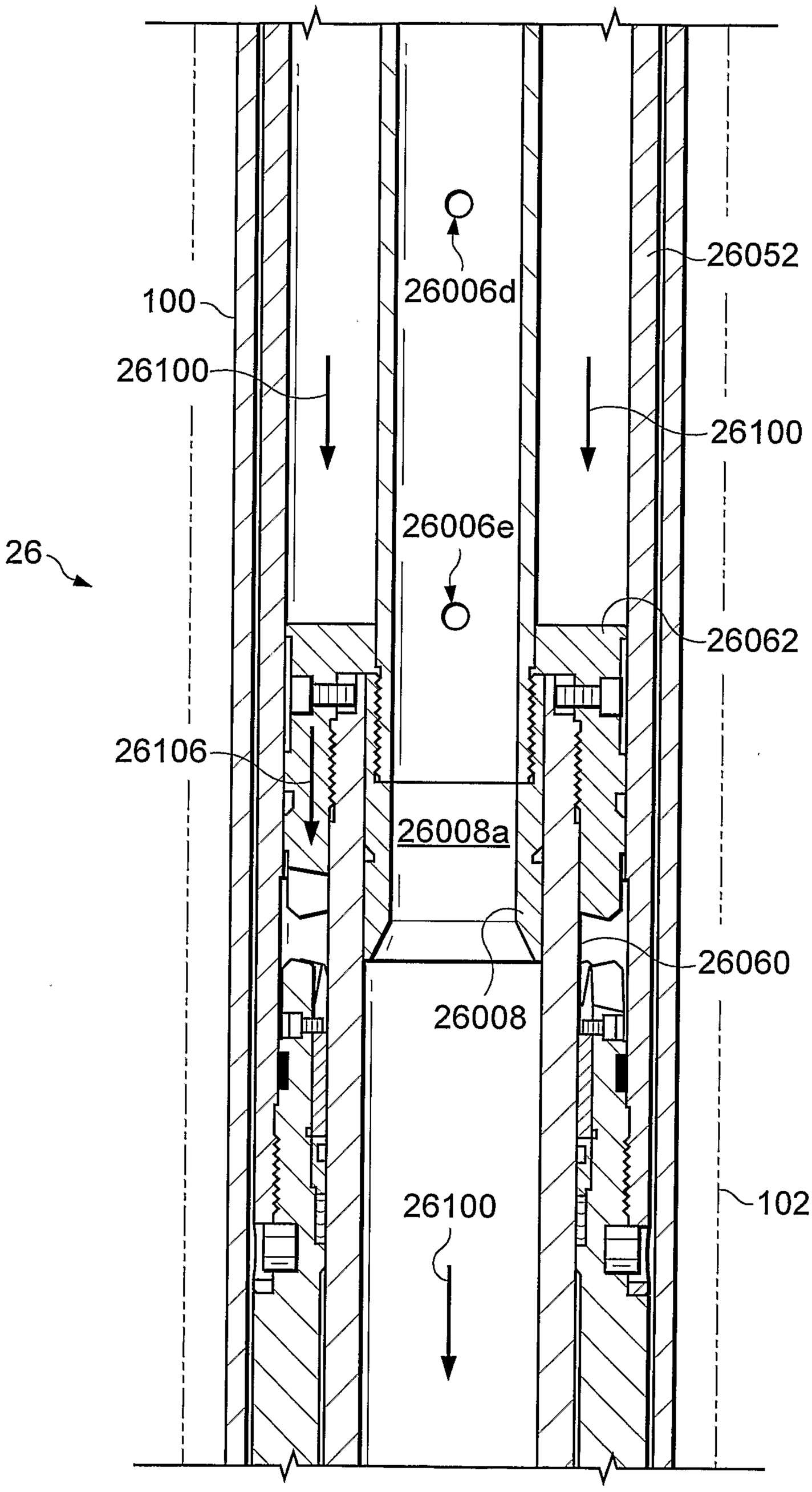

26
100
26100
26106
26006d
26006e
26008a
26008
26100
26052
26100
26062
26060
102

Fig. 15F4

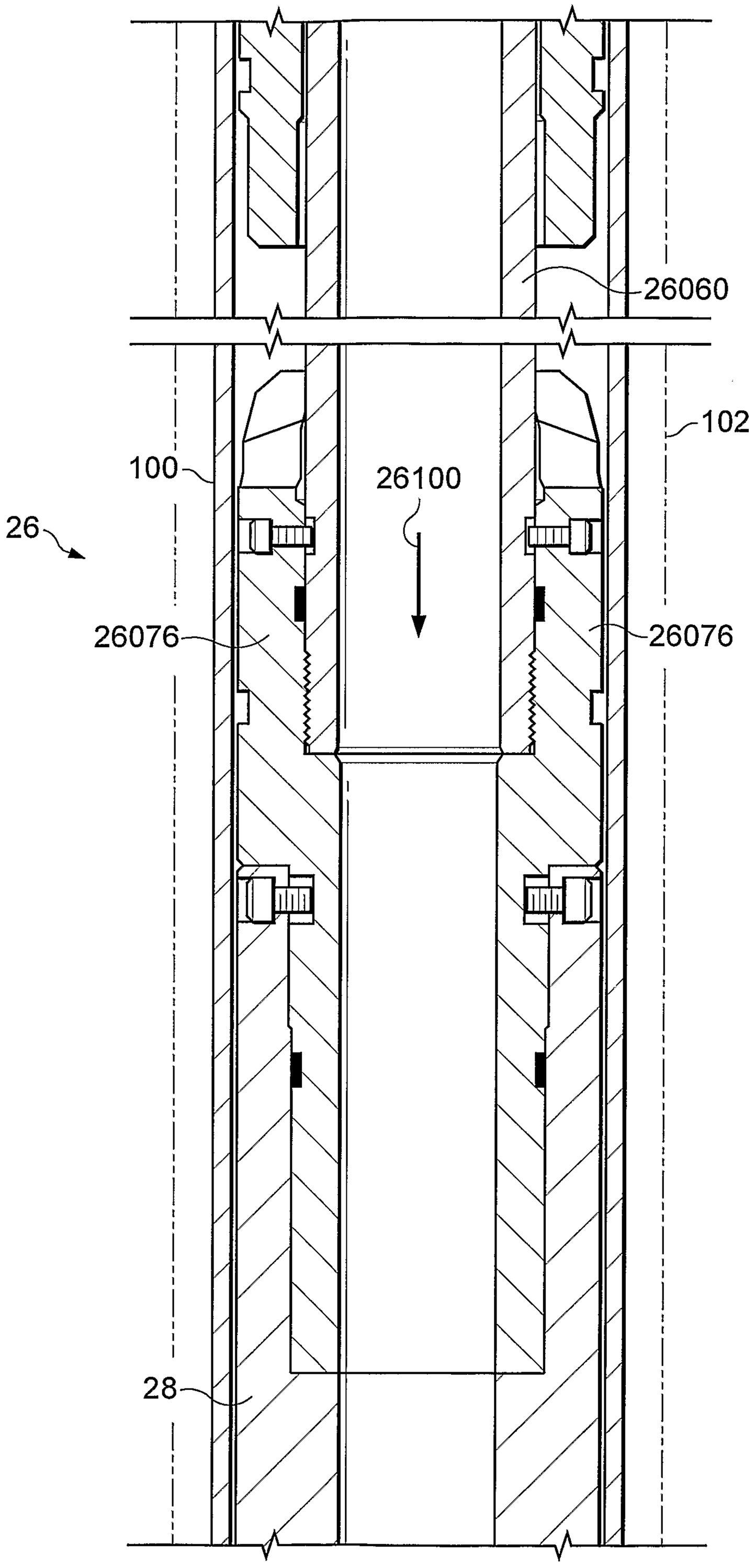


Fig. 15F5

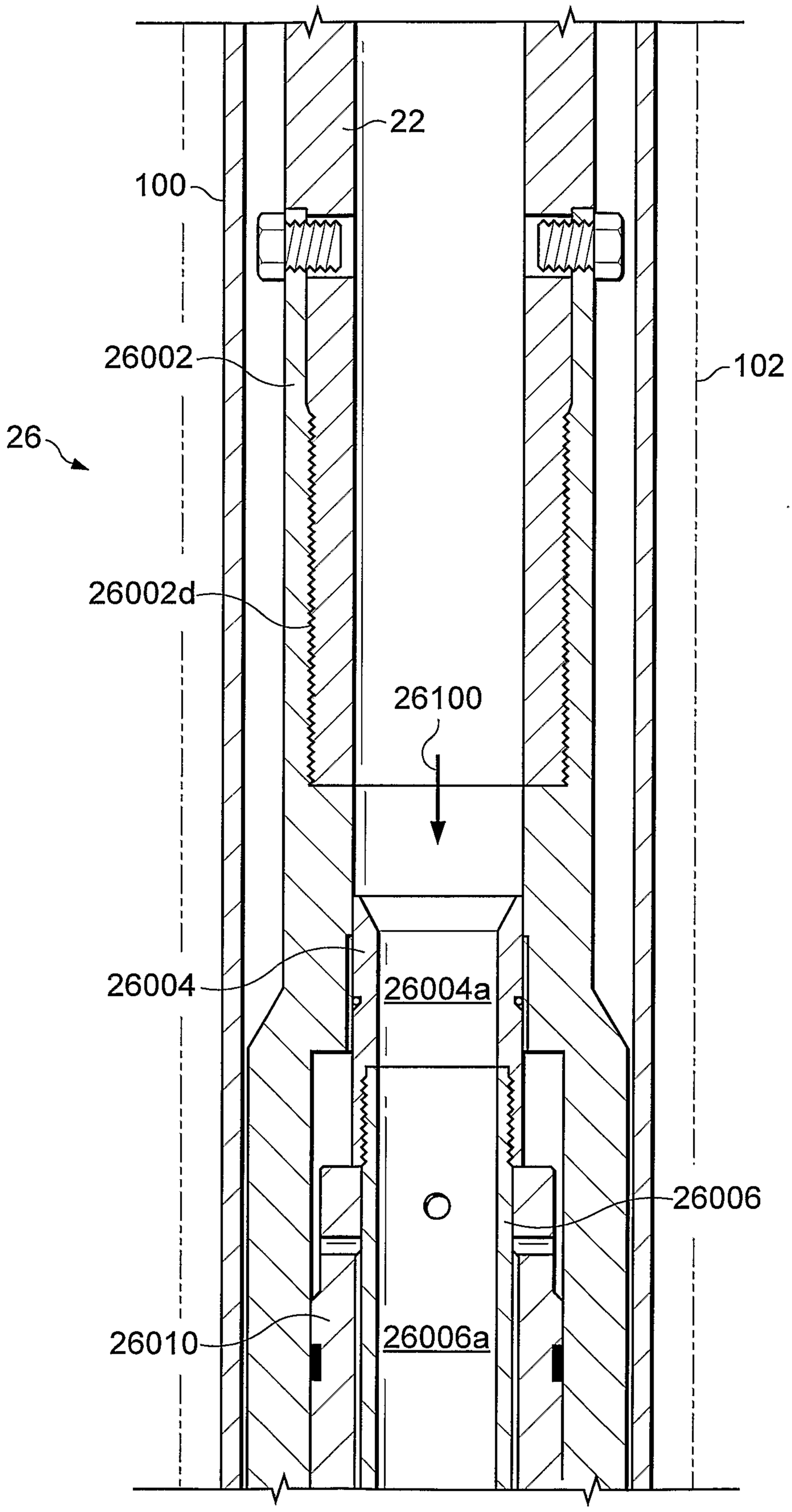

22
100
26002
102
26
26002d
26100
26004
26004a
26006
26010
26006a

Fig. 15G1

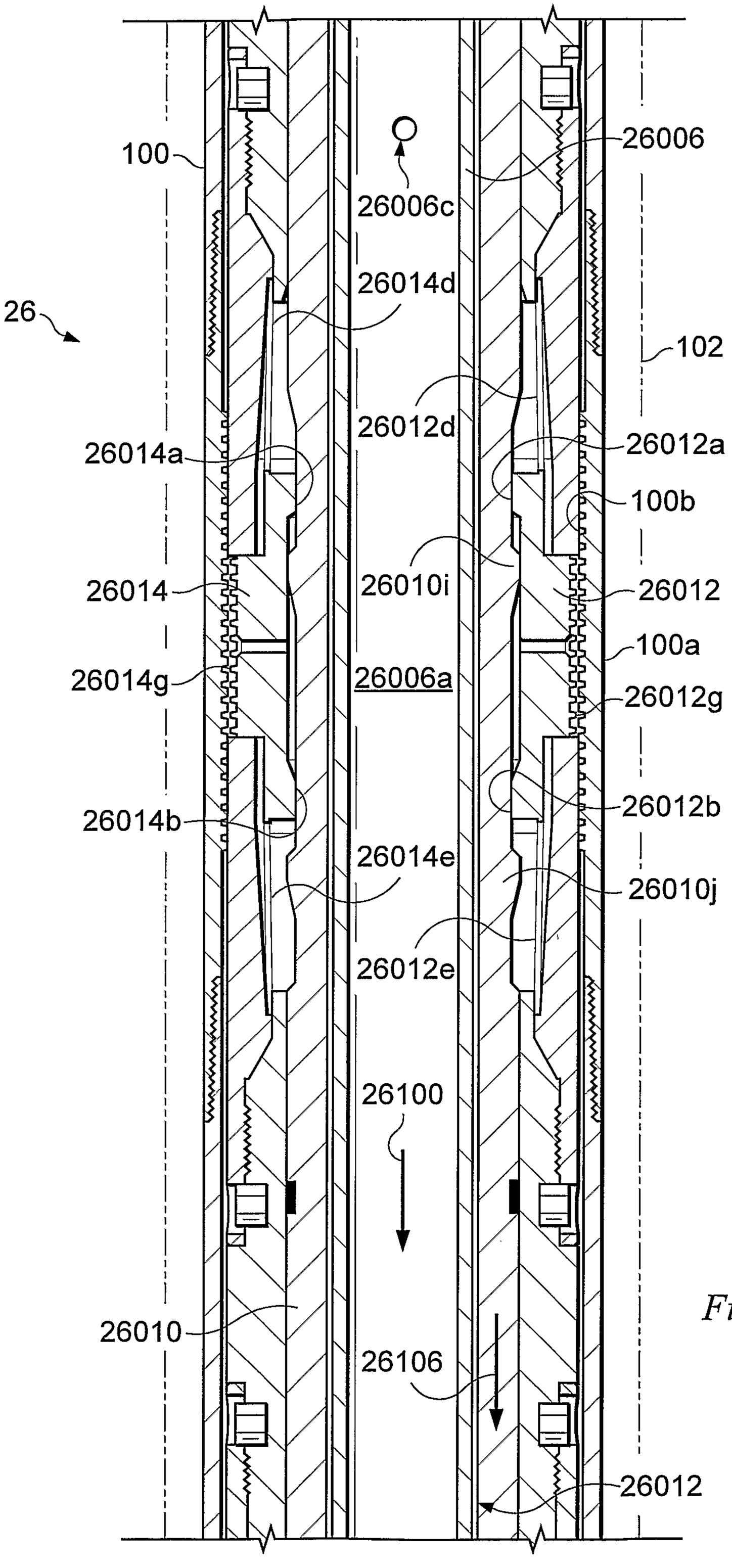

100
26006
26006c
26014d
26
102
26012d
26014a
26012a
100b
26014
26010i
26012
100a
26014g
26006a
26012g
26012b
26014b
26014e
26010j
26012e
26100
26010
26106
26012

Fig. 15G2

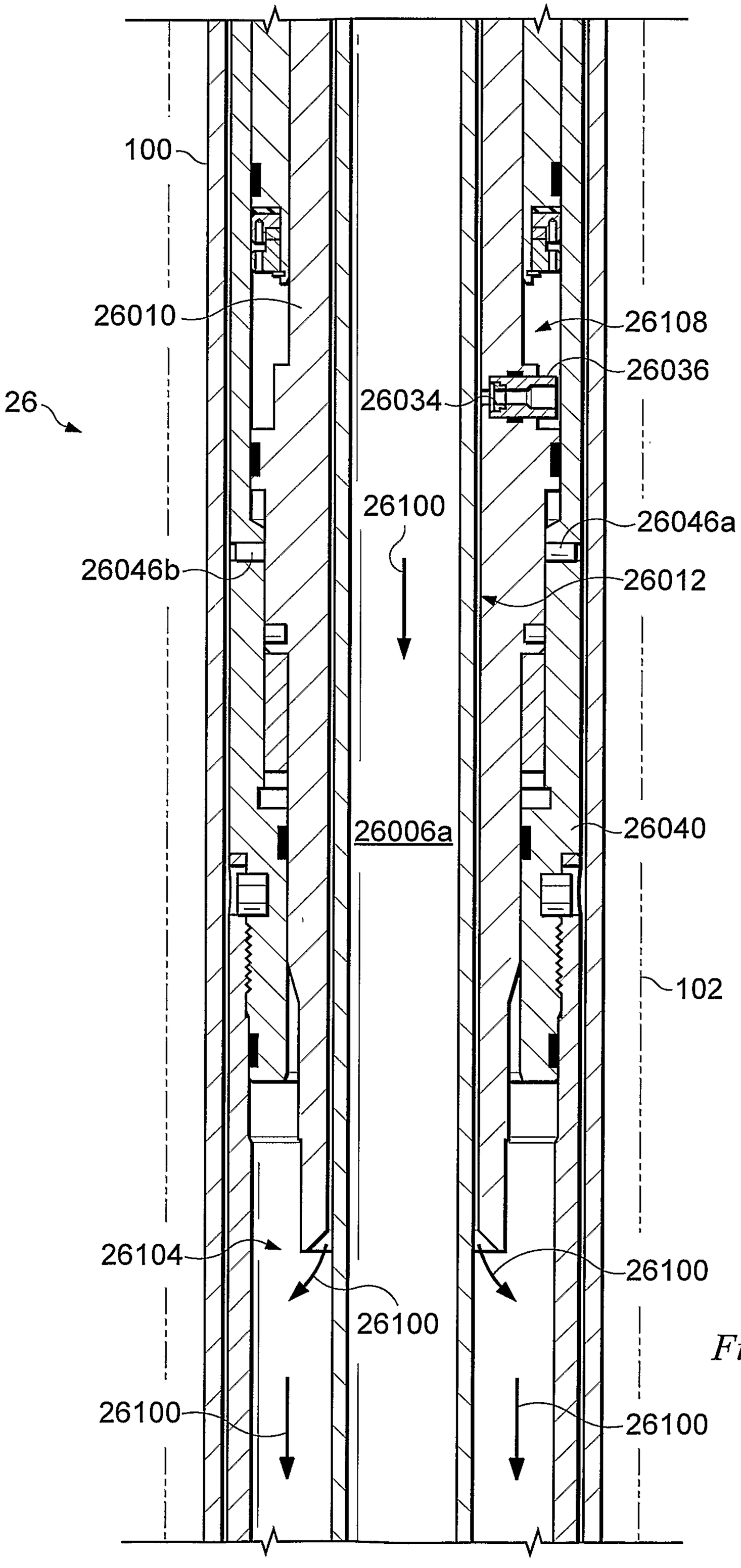

100
26010
26
26108
26036
26034
26100
26046a
26046b
26012
26006a
26040
102
26104
26100
26100
26100
26100

Fig. 15G3

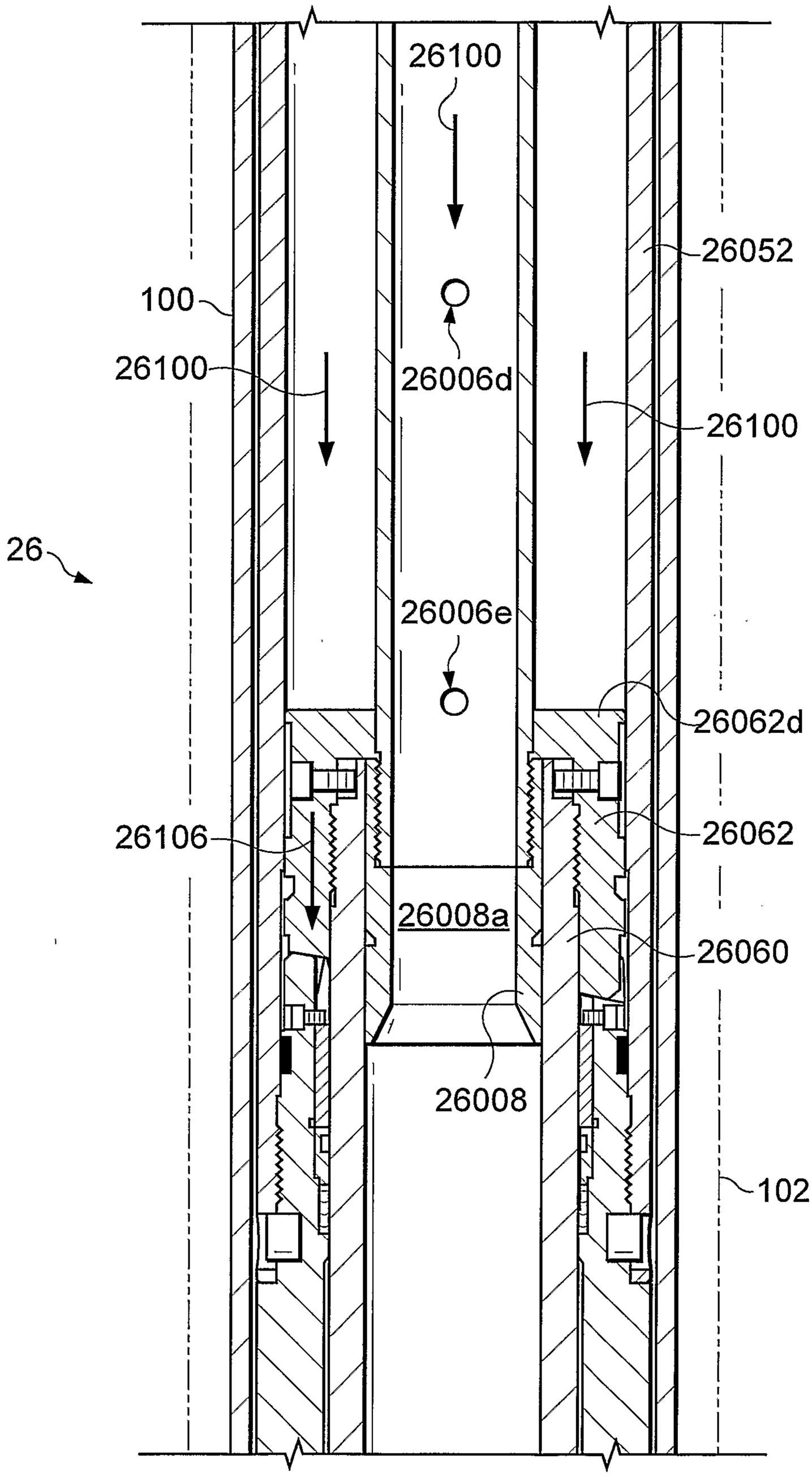

26100
26052
100
26100
26006d
26100
26
26006e
26062d
26106
26062
26008a
26060
26008
102

Fig. 15G4

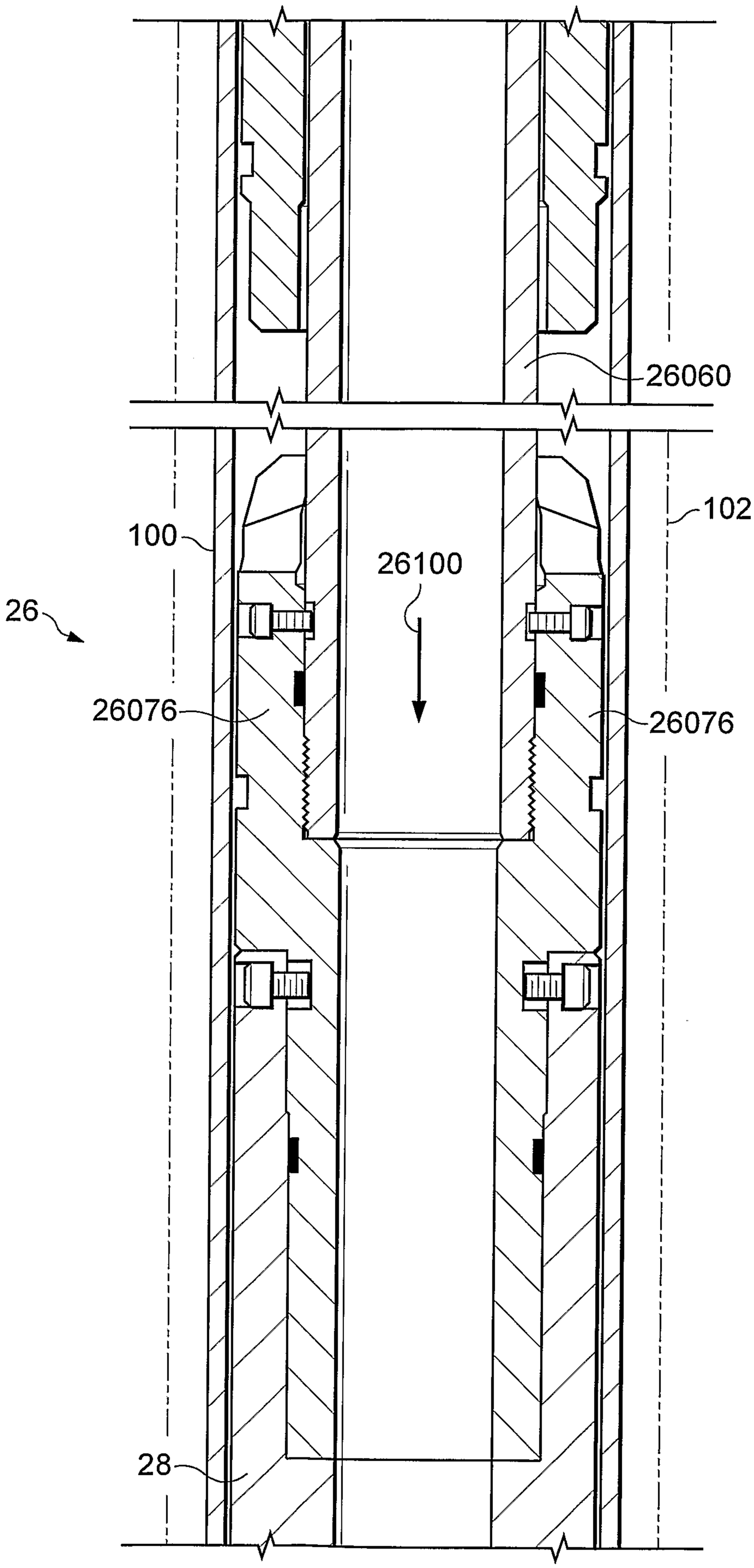


Fig. 15G5

Fig. 16-1

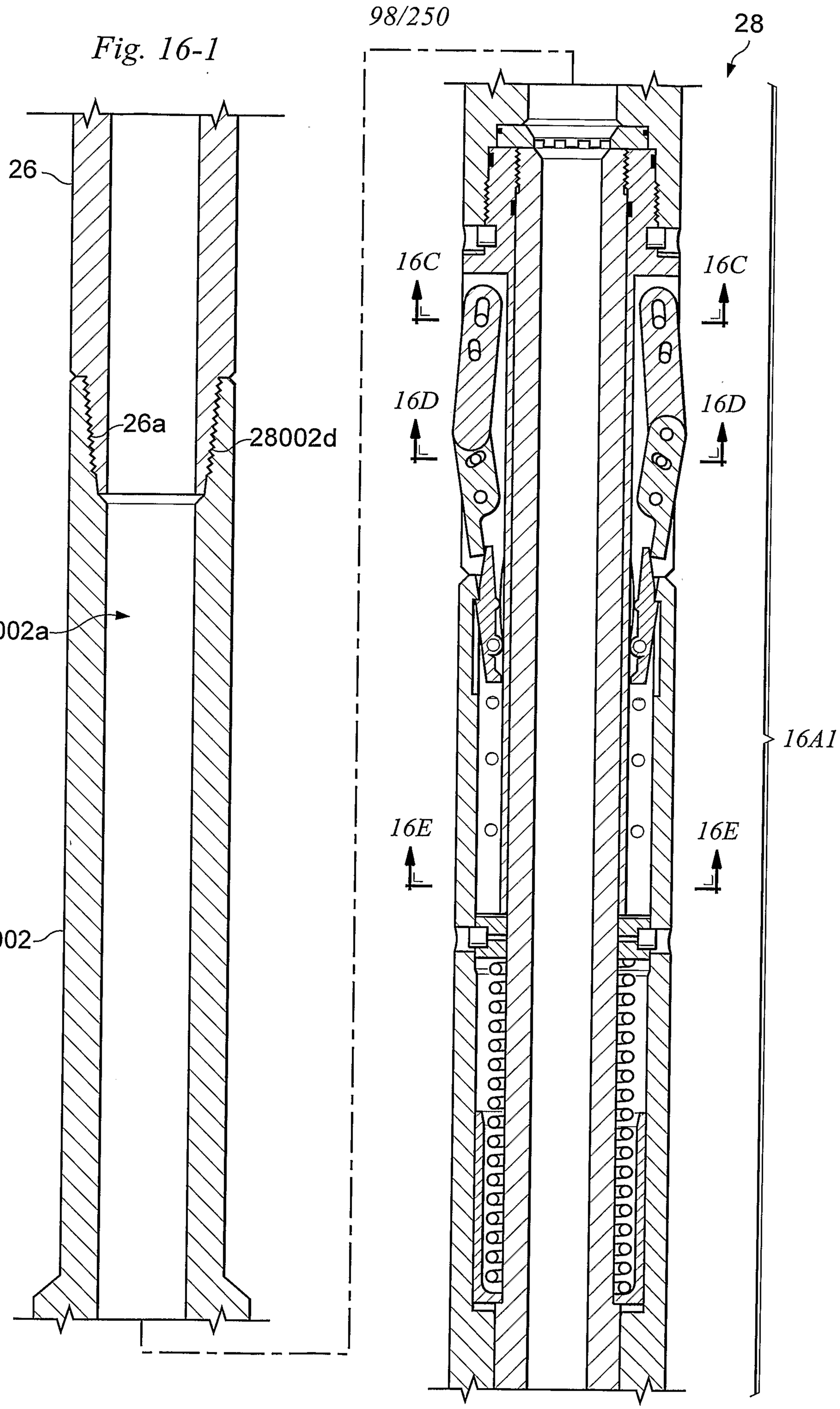
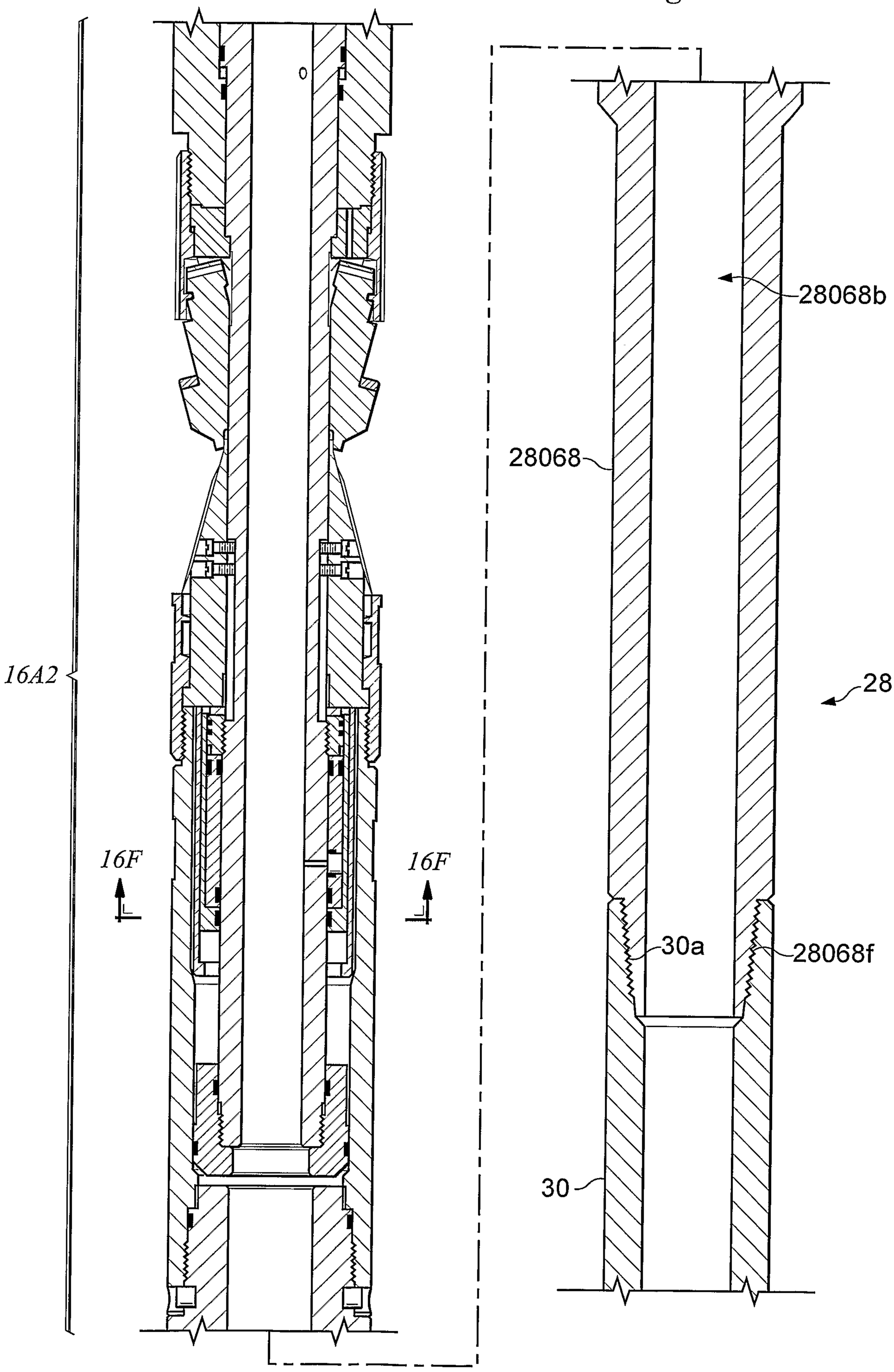
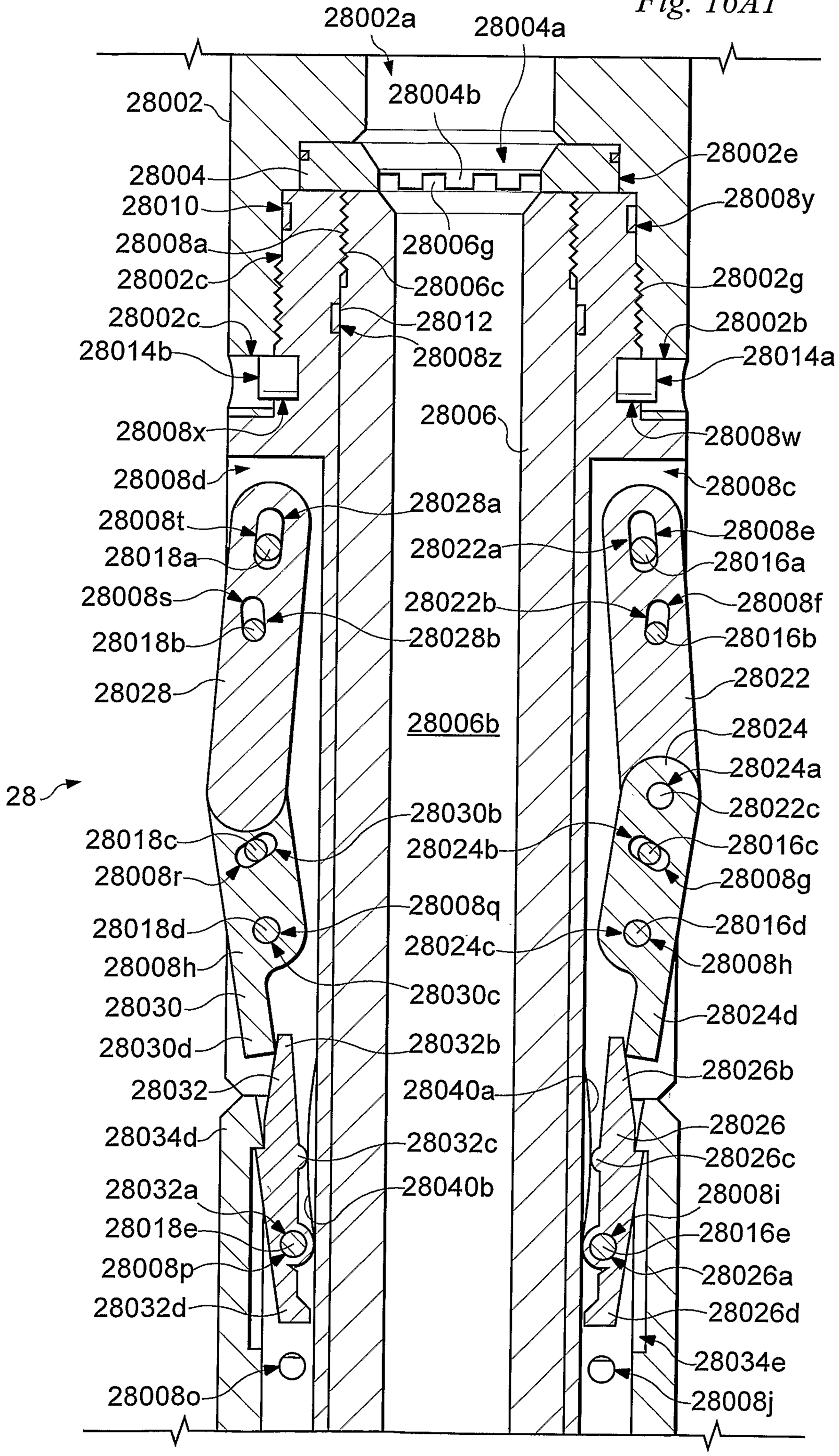

98/250
28
26
16C
16C
16D
16D
26a
28002d
28002a
16E
16E
16A1
28002

Fig. 16-2



100/250

Fig. 16A1



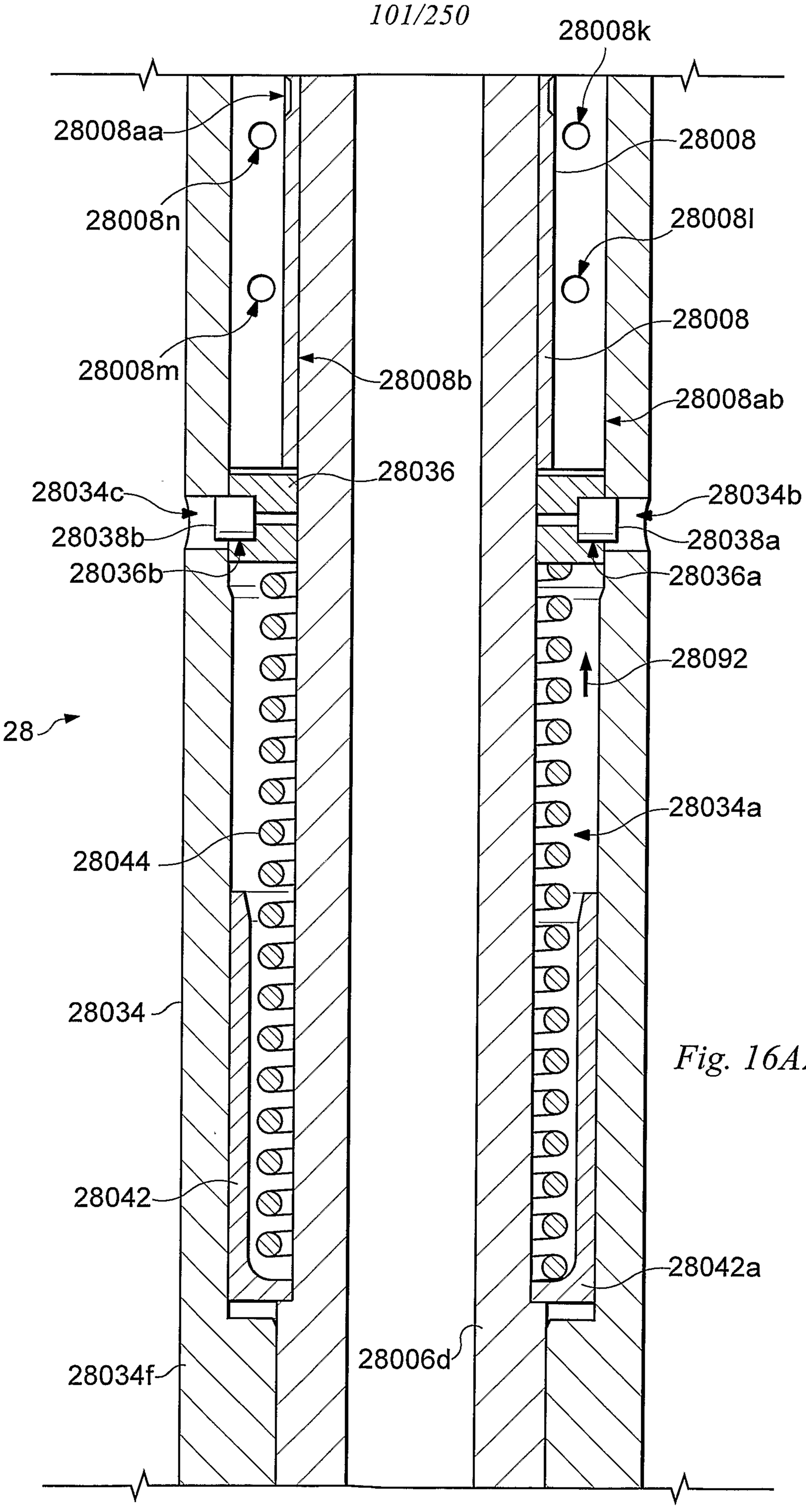

28008k
28008aa
28008
28008n
28008l
28008m
28008
28008b
28008ab
28036
28034c
28034b
28038b
28038a
28036b
28036a
28092
28
28034a
28044
28034
28042
28042a
28034f
28006d

Fig. 16A2

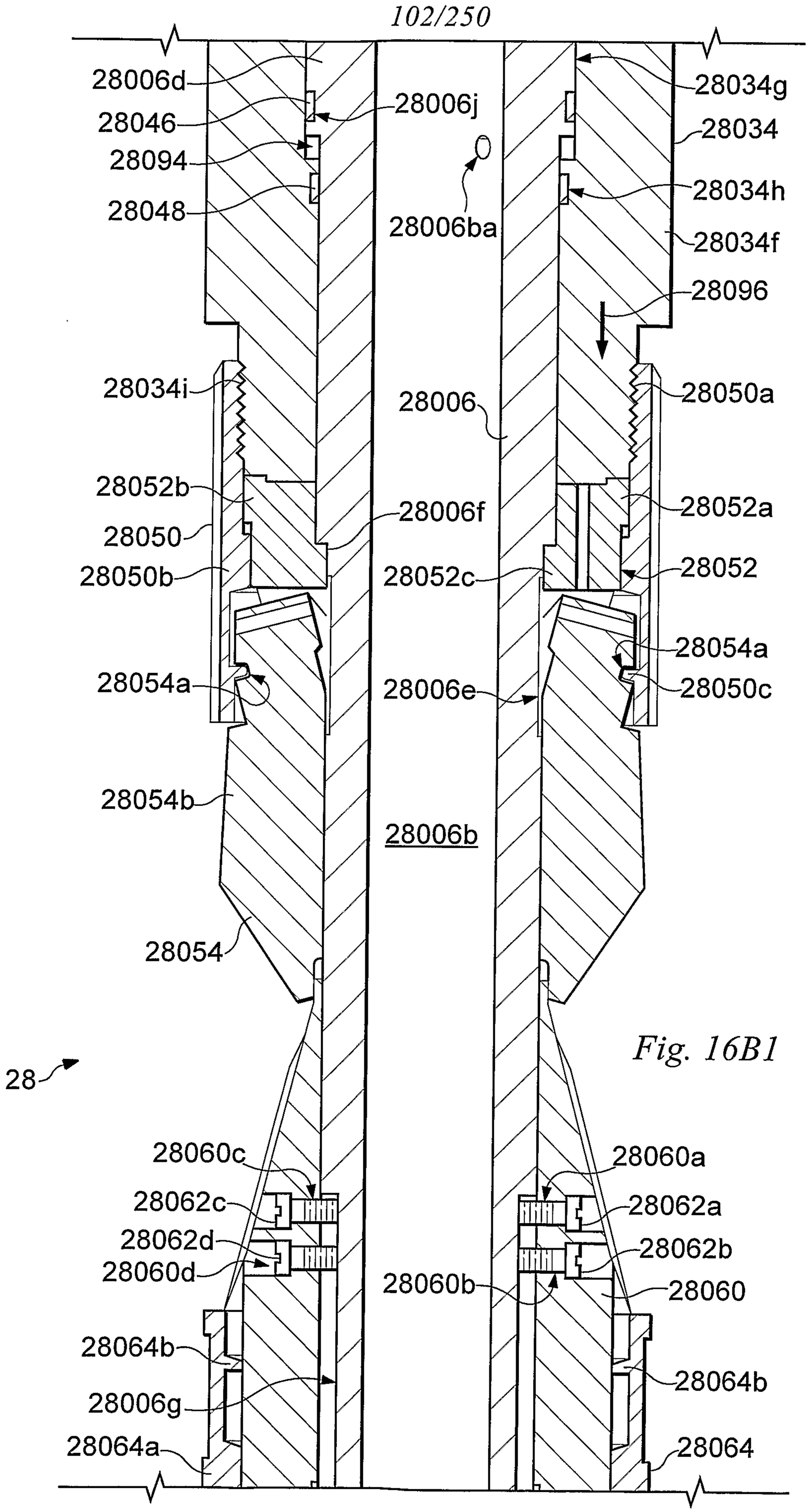

28006d
28046
28094
28048
28034i
28052b
28050
28050b
28054a
28054b
28054
28
28006j
28006ba
28006
28006f
28052c
28006e
28006b
28060c
28062c
28062d
28060d
28064b
28006g
28064a
28034g
28034
28034h
28034f
28096
28050a
28052a
28052
28054a
28050c
28060a
28062a
28062b
28060b
28060
28064b
28064

Fig. 16B1

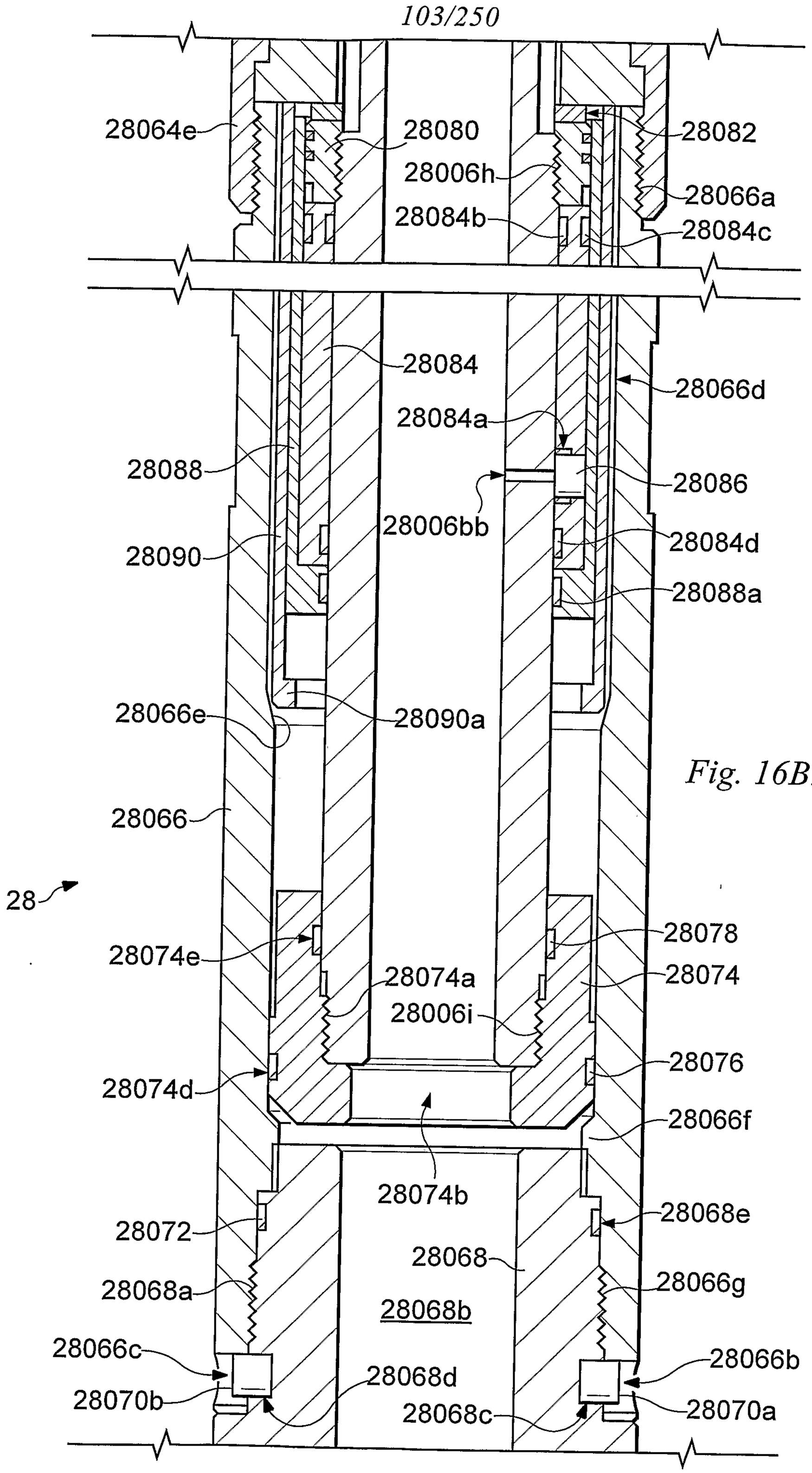

28064e
28080
28082
28006h
28066a
28084b
28084c
28084
28066d
28084a
28088
28086
28006bb
28084d
28090
28088a
28066e
28090a
28066
28
28078
28074e
28074a
28074
28006i
28074d
28076
28066f
28074b
28072
28068e
28068
28068a
28066g
28068b
28066c
28068d
28066b
28070b
28068c
28070a

Fig. 16B2

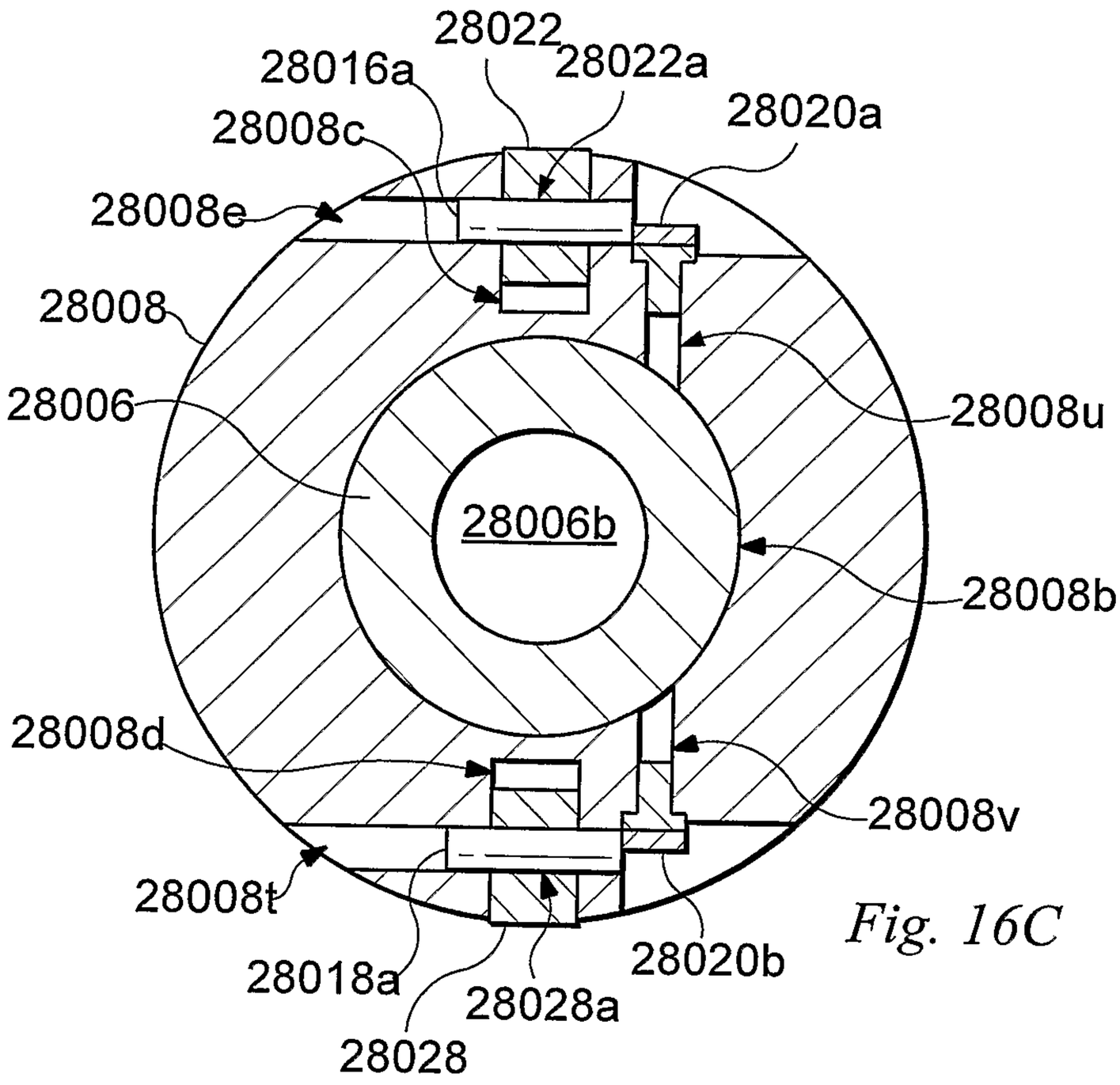


Fig. 16C

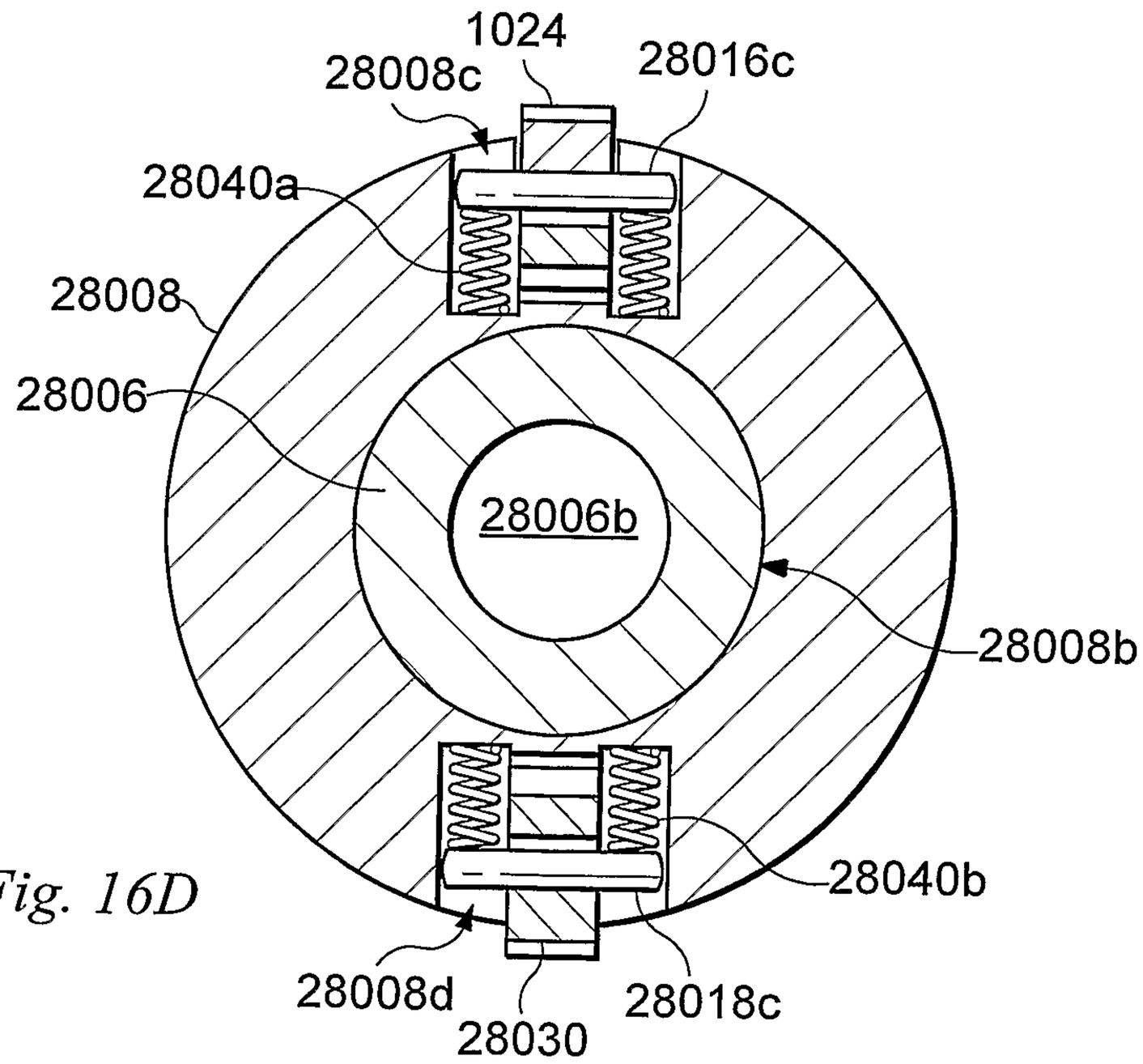


Fig. 16D

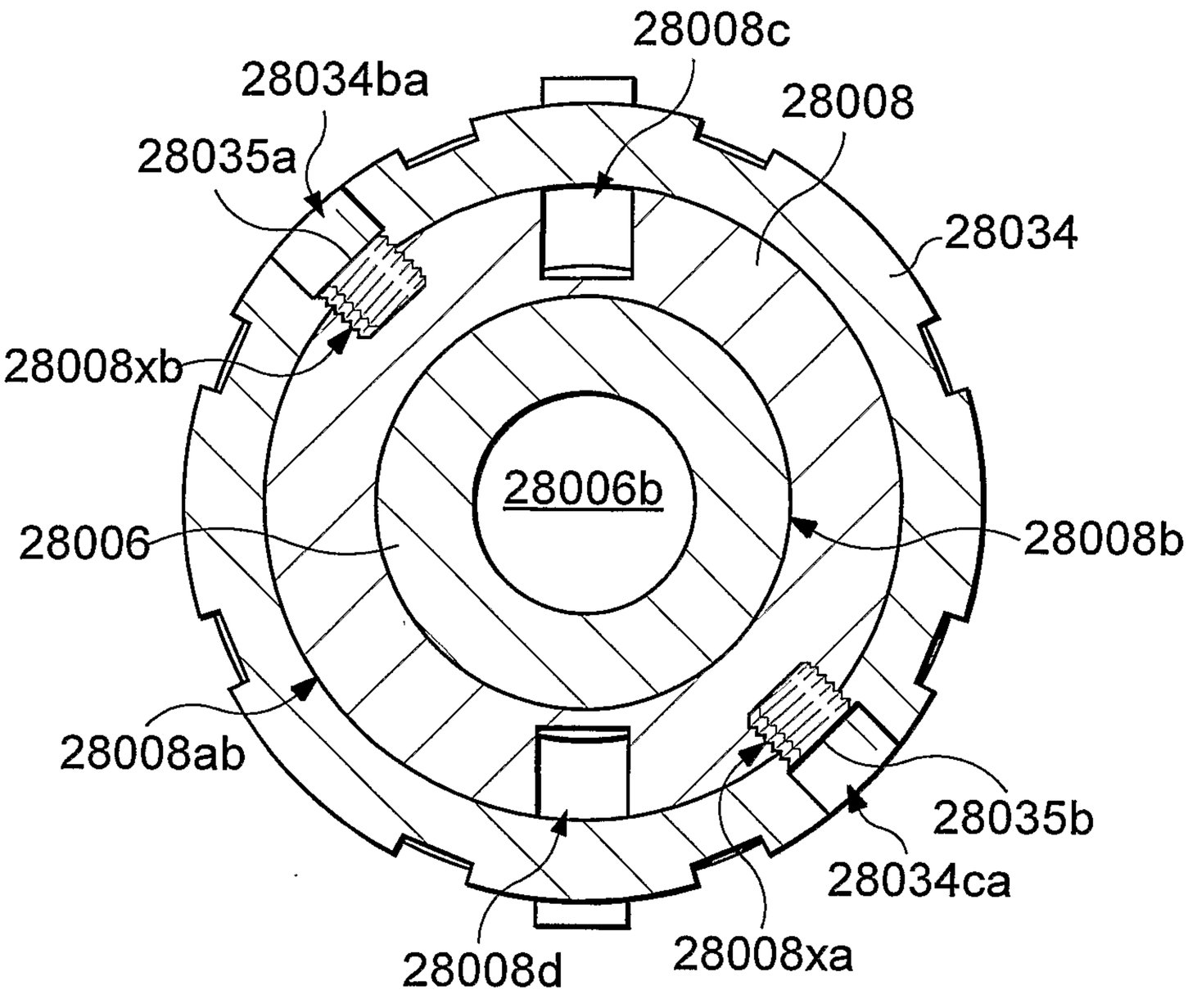


Fig. 16E

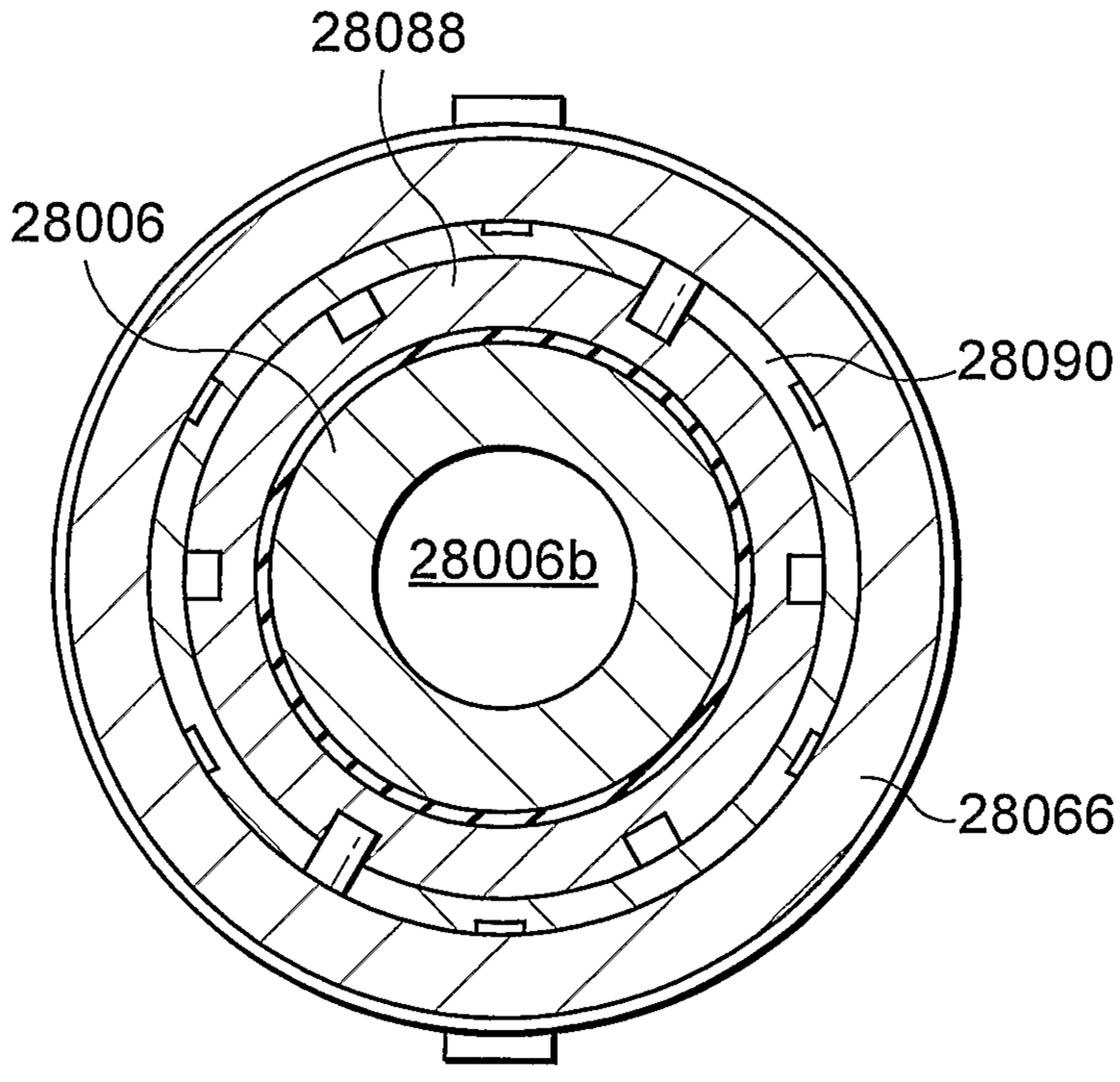


Fig. 16F

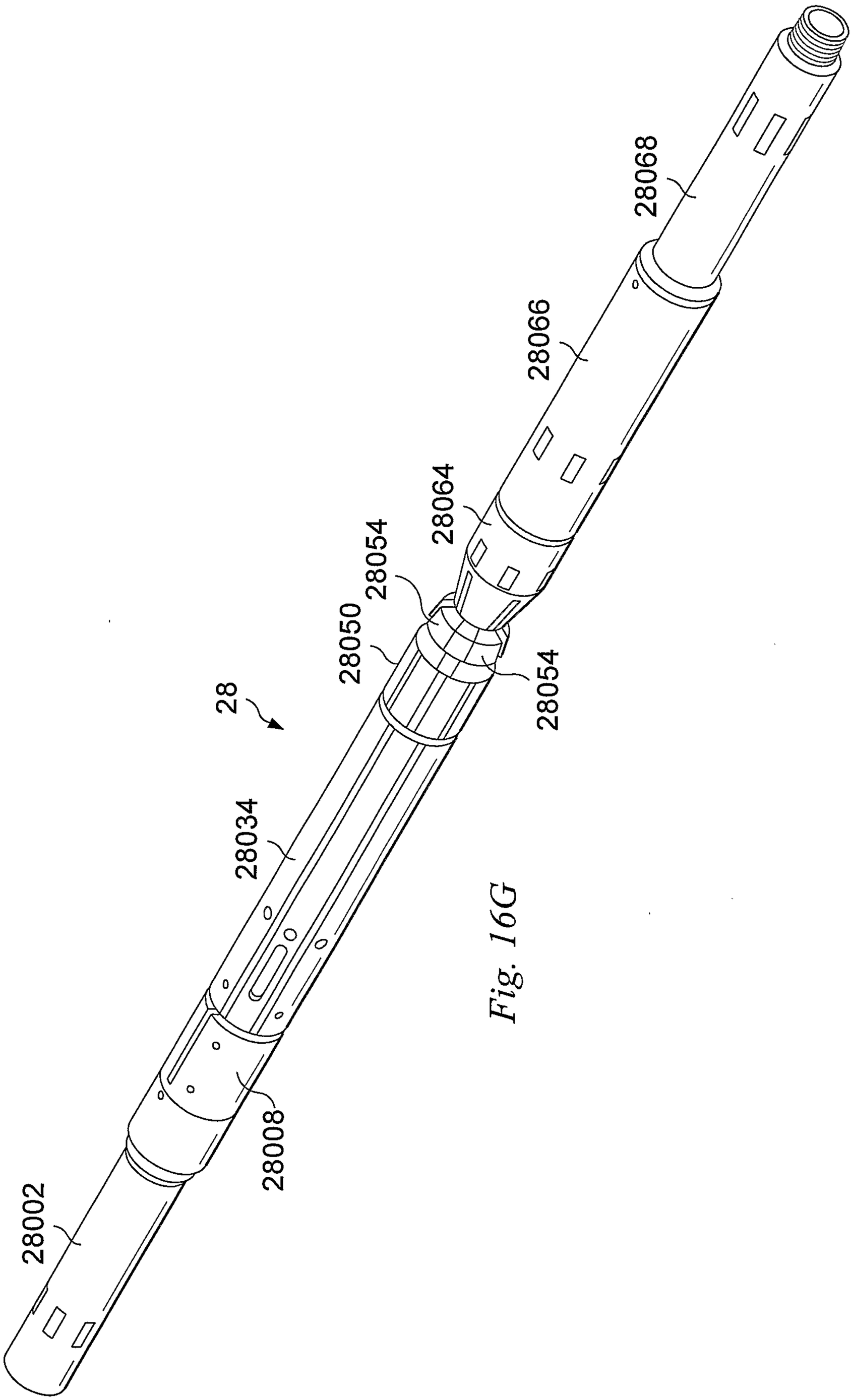


Fig. 16G

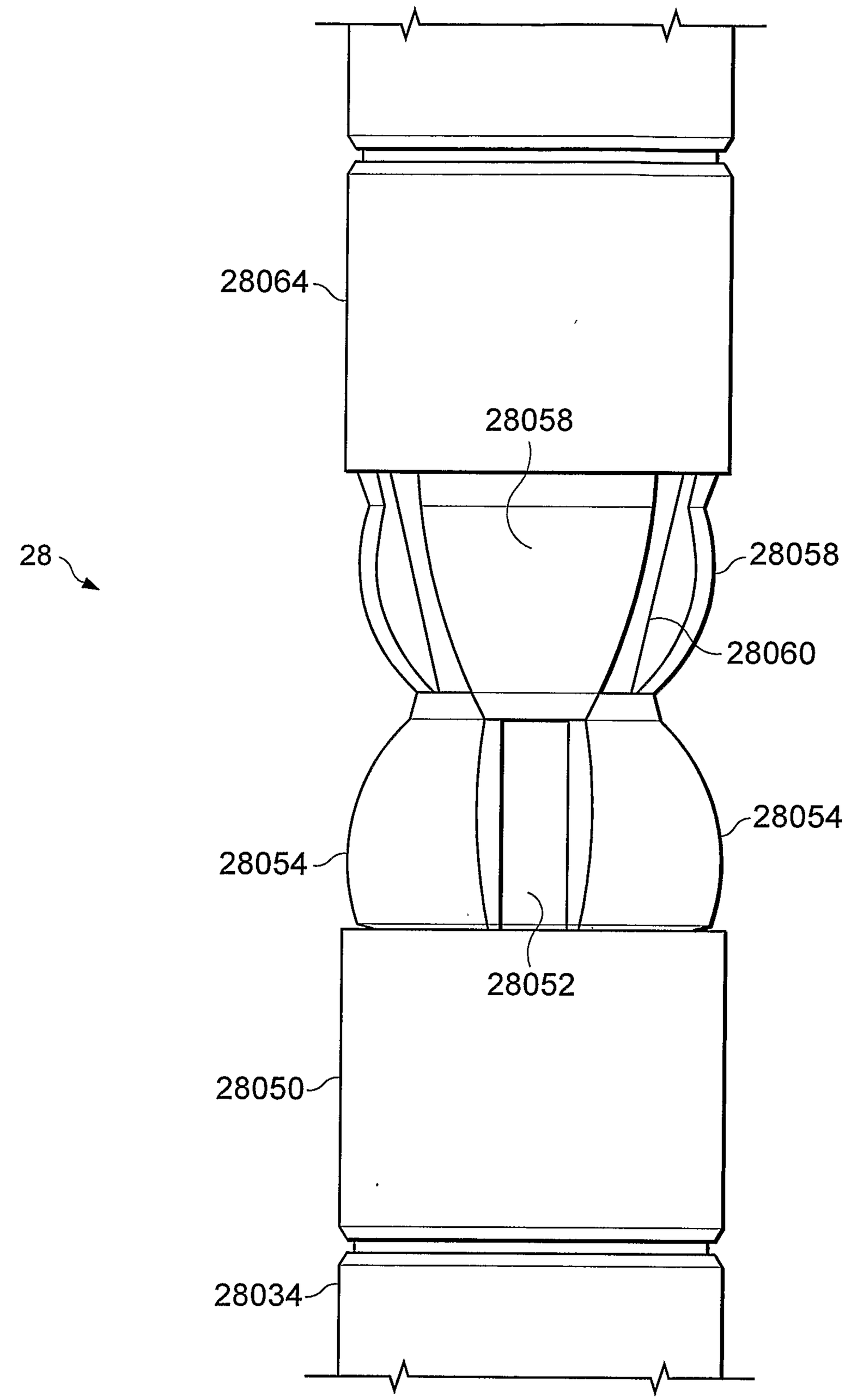


Fig. 16H

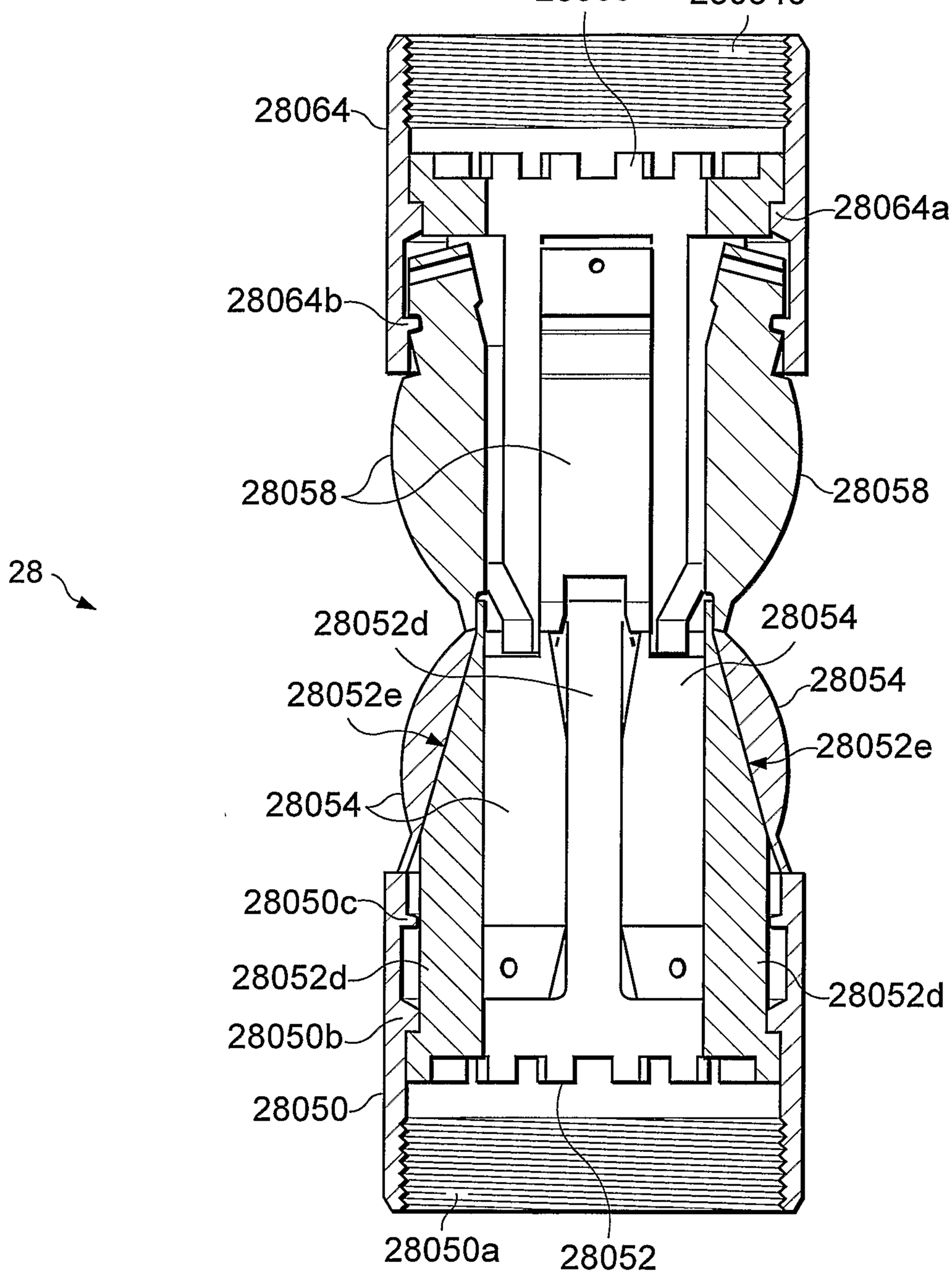

28060
28064c
28064
28064a
28064b
28058
28058
28
28052d
28054
28052e
28054
28052e
28054
28050c
28052d
28052d
28050b
28050
28050a
28052

FIG. 16I

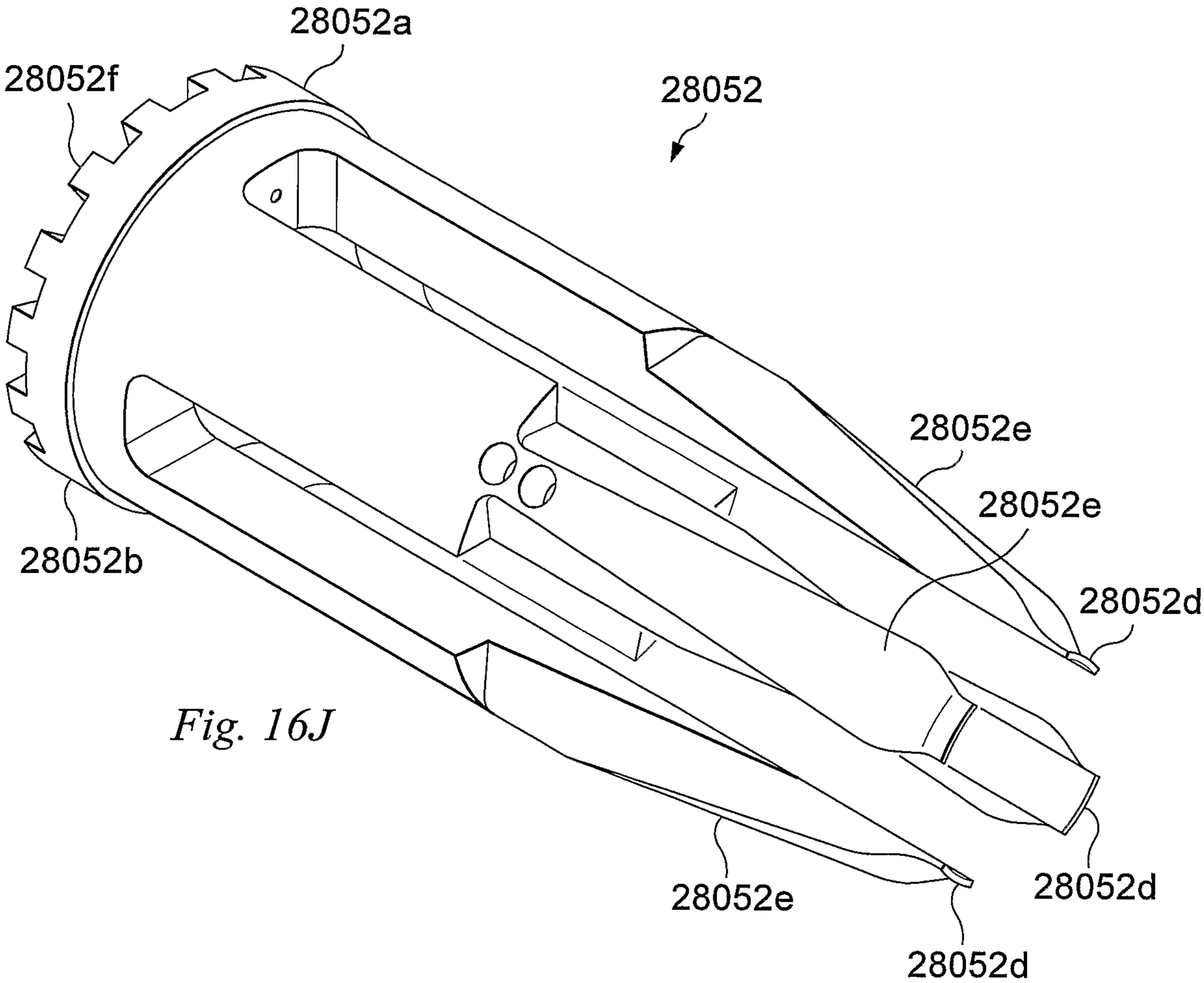


Fig. 16J

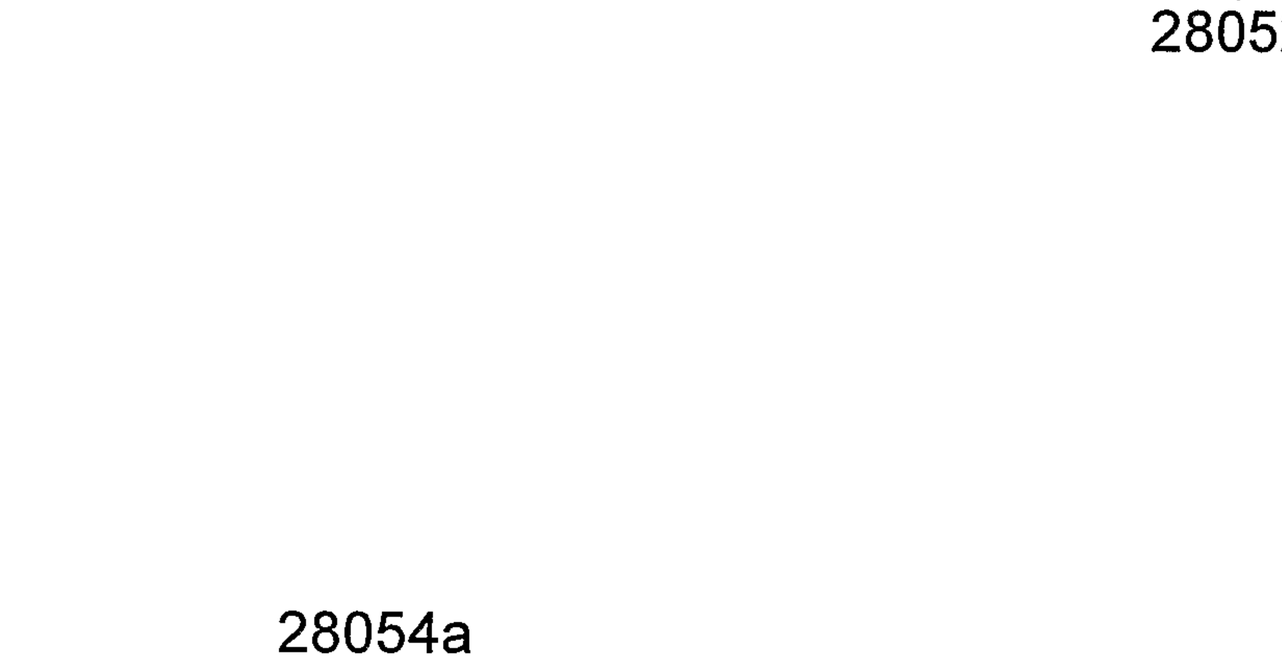


Fig. 16K

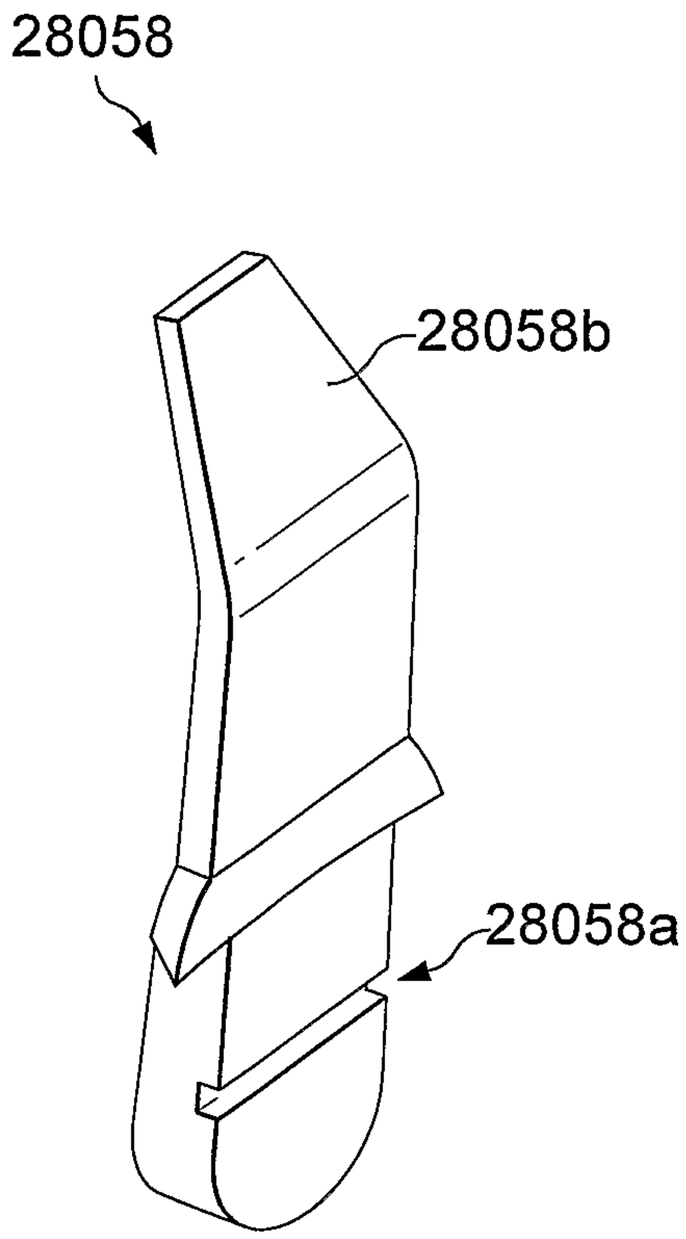


Fig. 16L

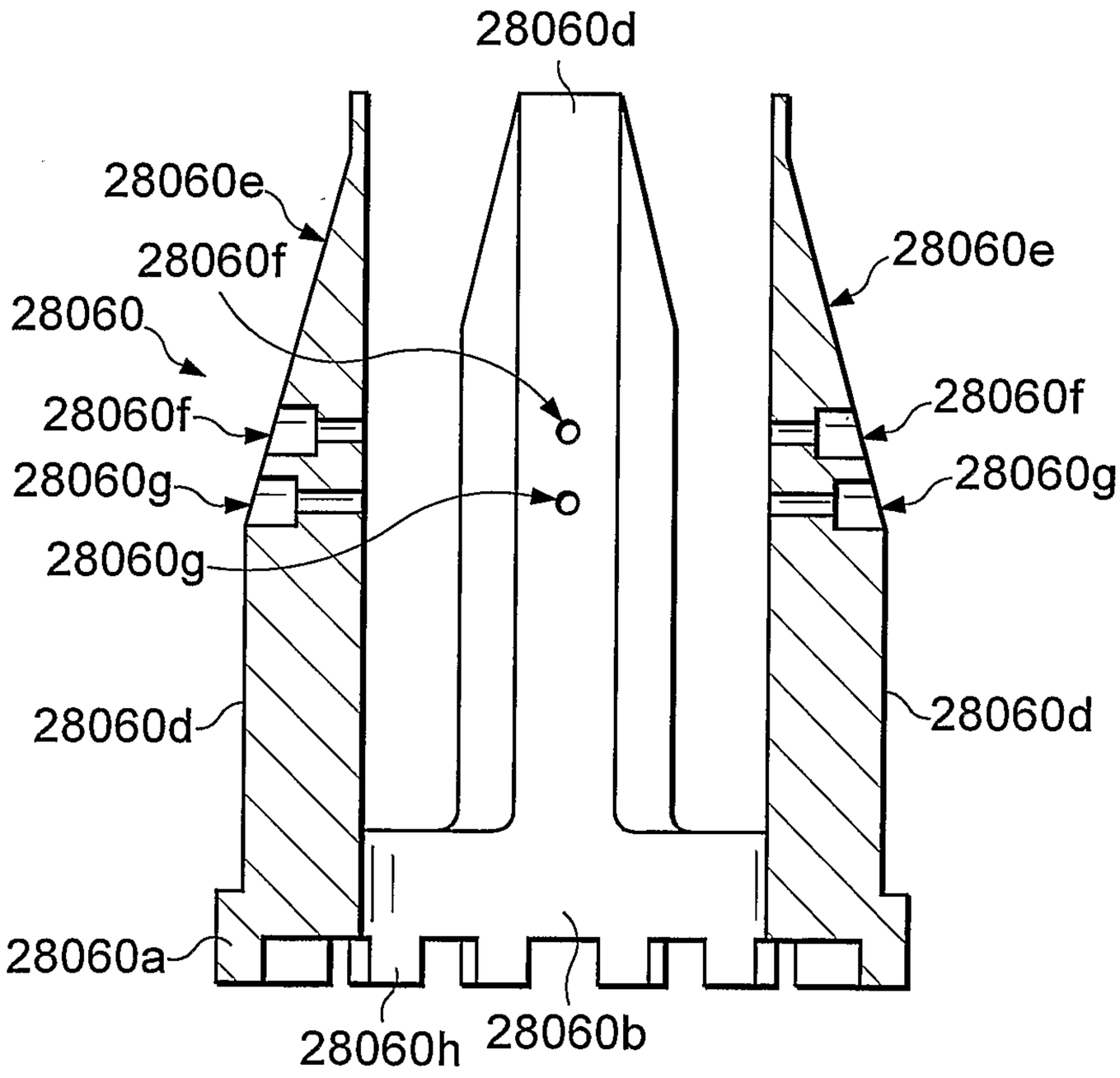


Fig. 16M

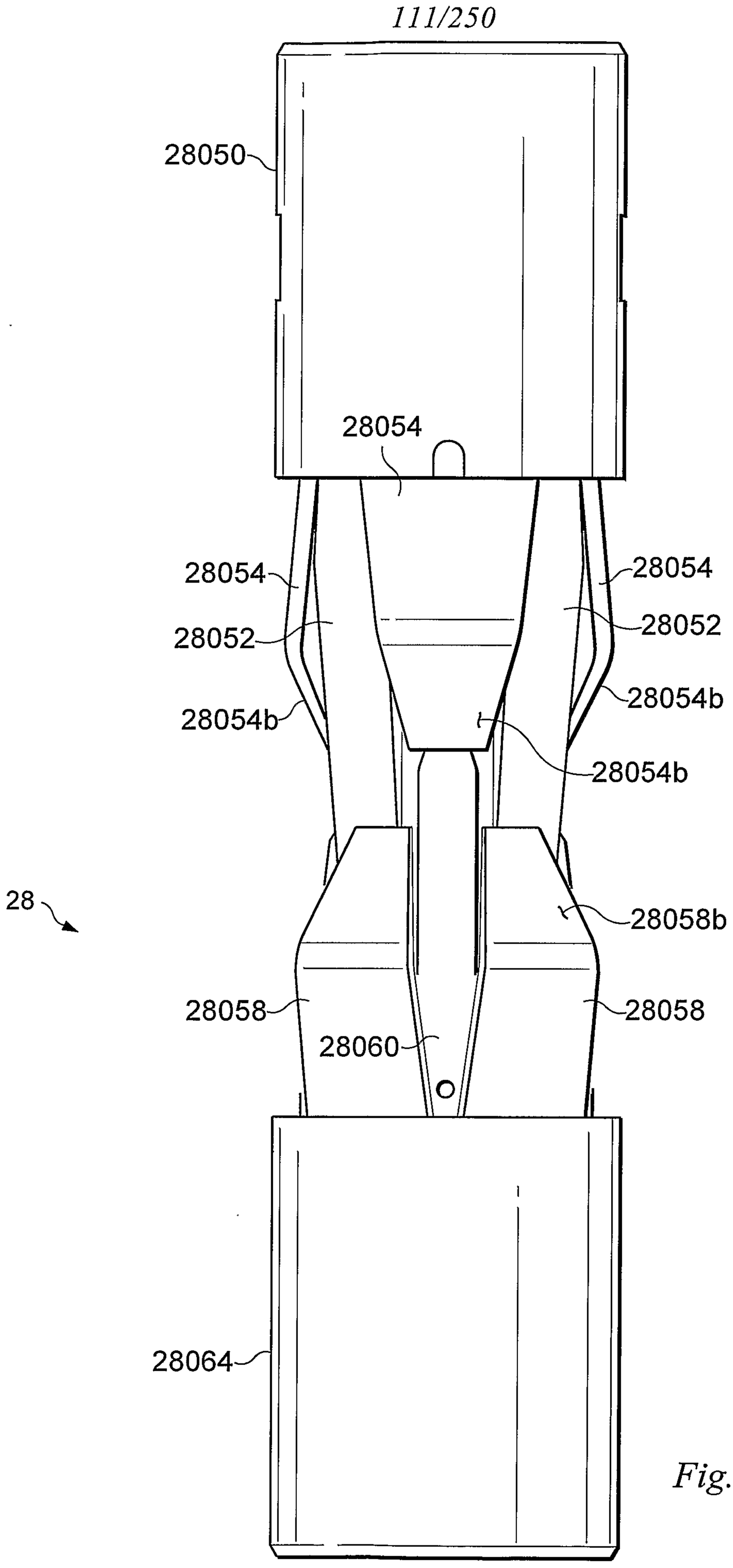

28050
28054
28054
28054
28052
28052
28054b
28054b
28054b
28
28058b
28058
28058
28060
28064

Fig. 16N

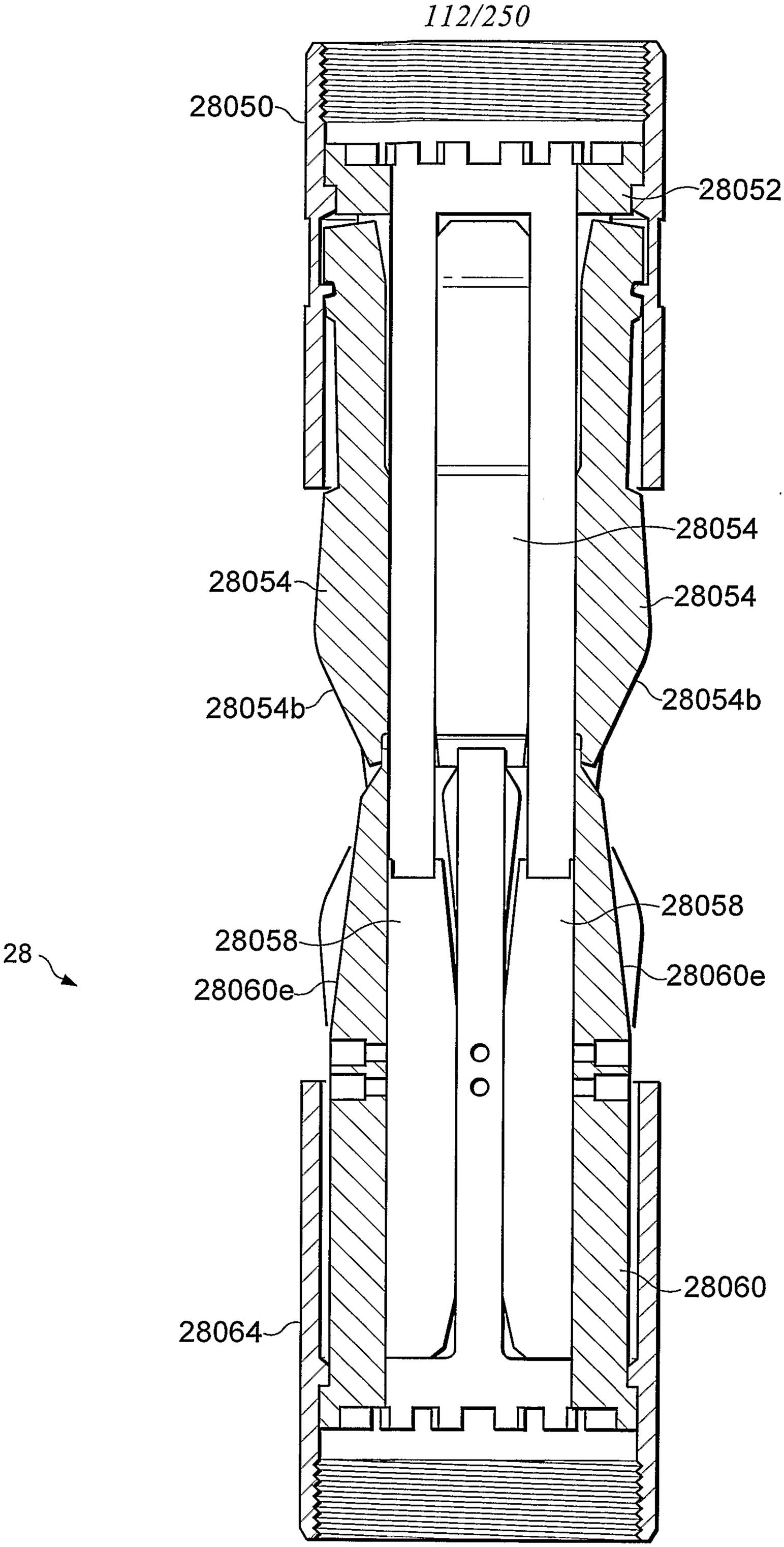

28050
28052
28054
28054
28054
28054b
28054b
28058
28058
28060e
28060e
28
28060
28064

Fig. 16O

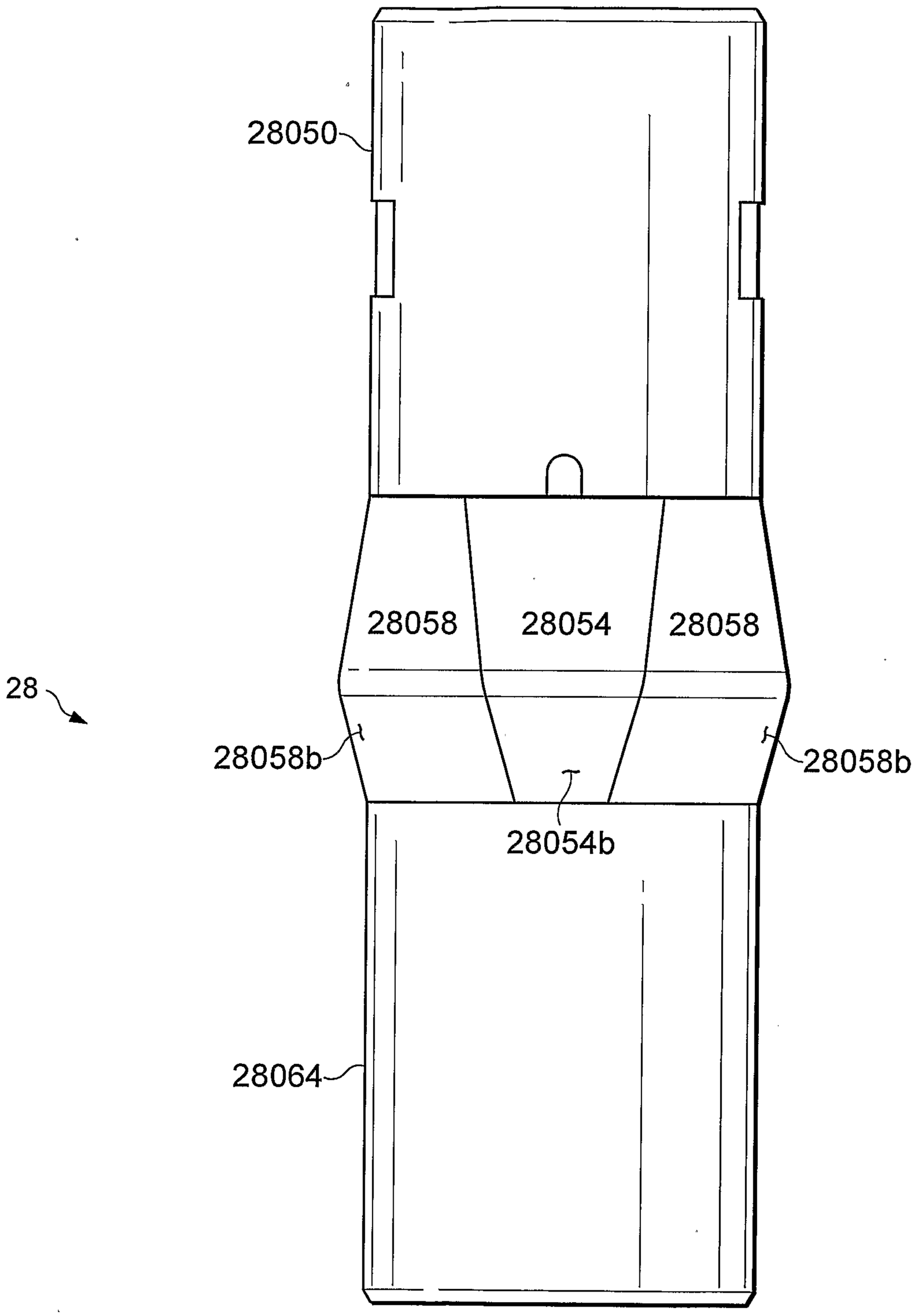


Fig. 16P

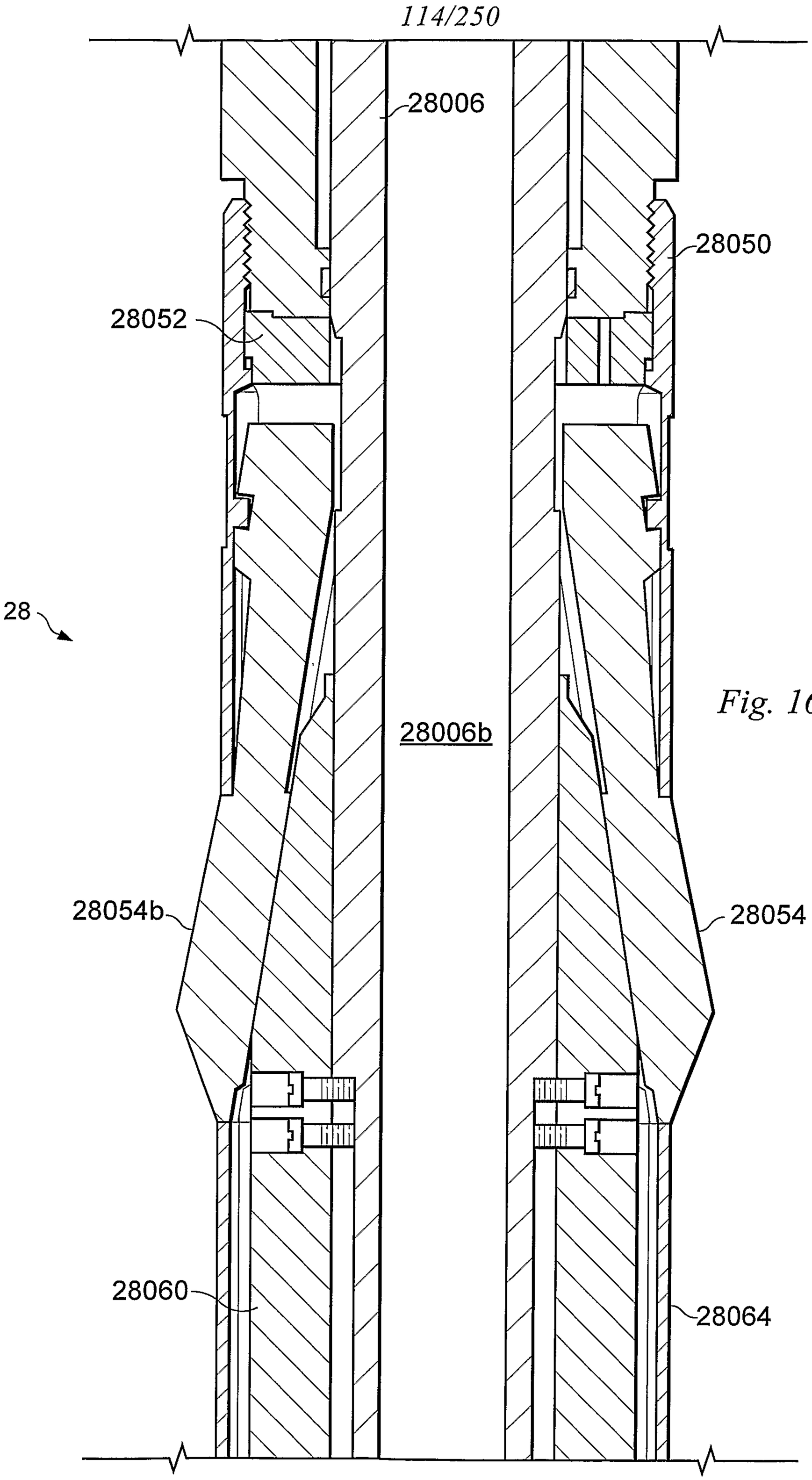

114/250
28006
28050
28052
28
28006b
28054b
28054
28060
28064

Fig. 16R

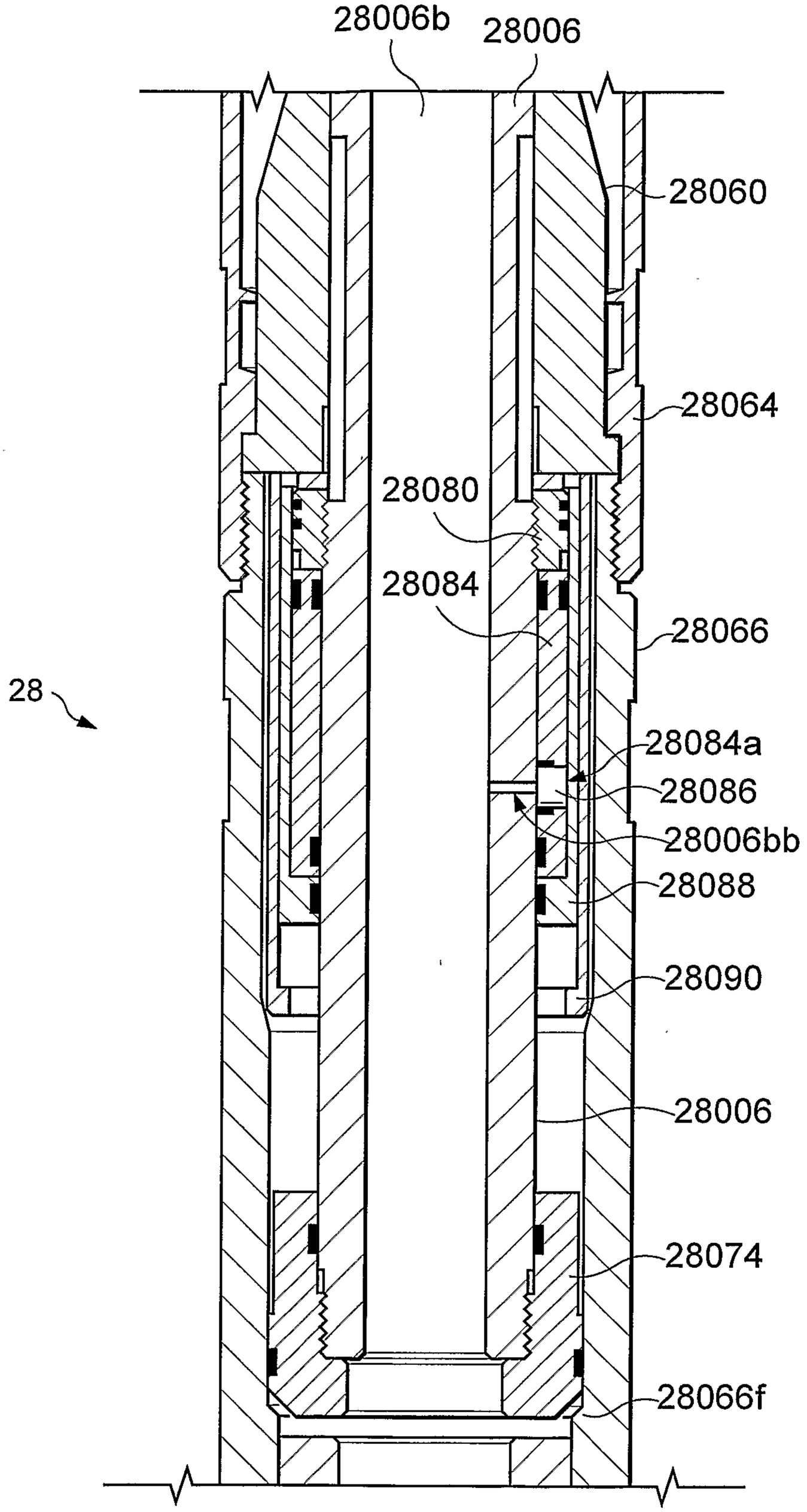

28006b
28006
28060
28064
28080
28084
28066
28
28084a
28086
28006bb
28088
28090
28006
28074
28066f

Fig. 16S

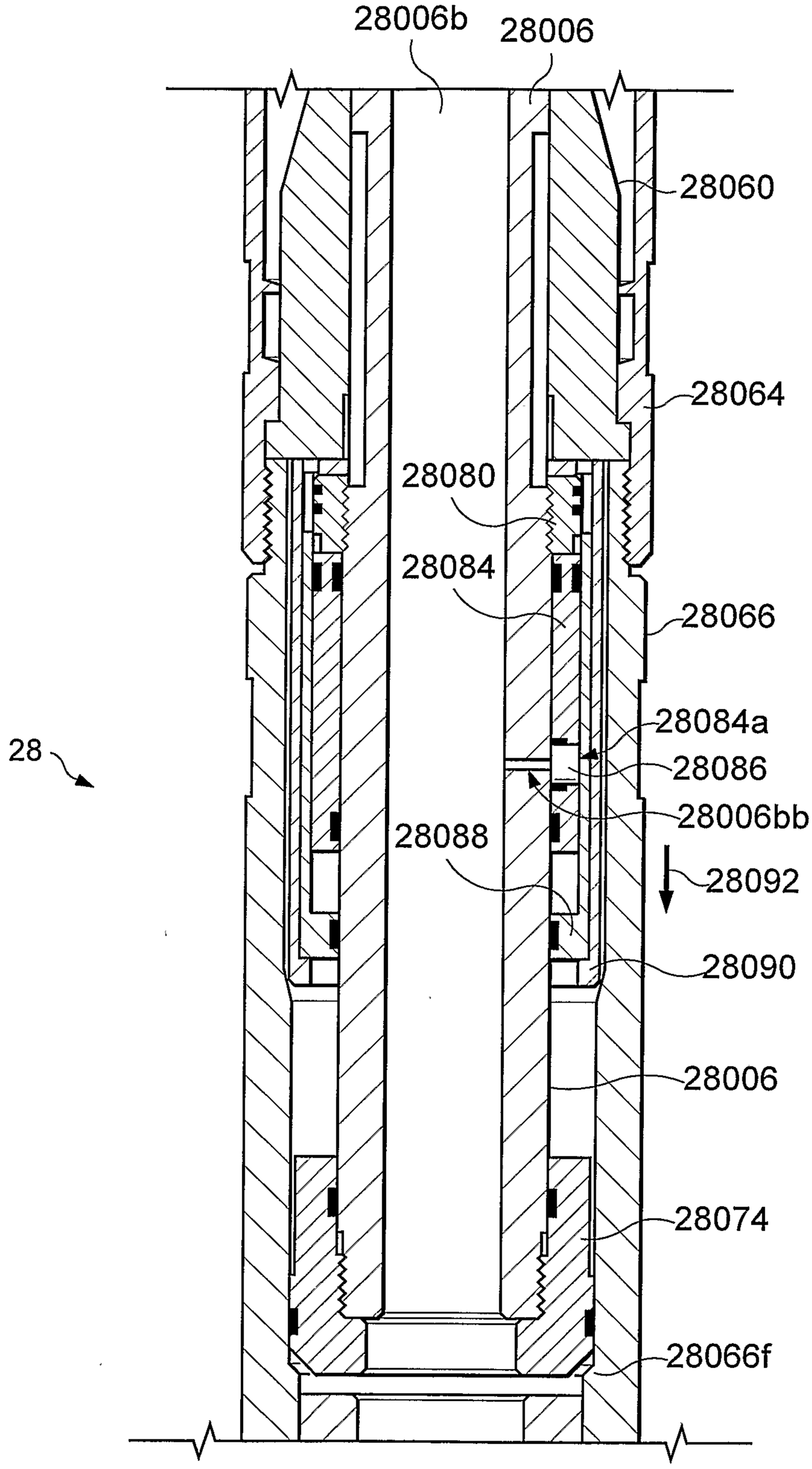

28006b
28006
28060
28064
28080
28084
28066
28
28084a
28086
28088
28006bb
28092
28090
28006
28074
28066f

Fig. 16T

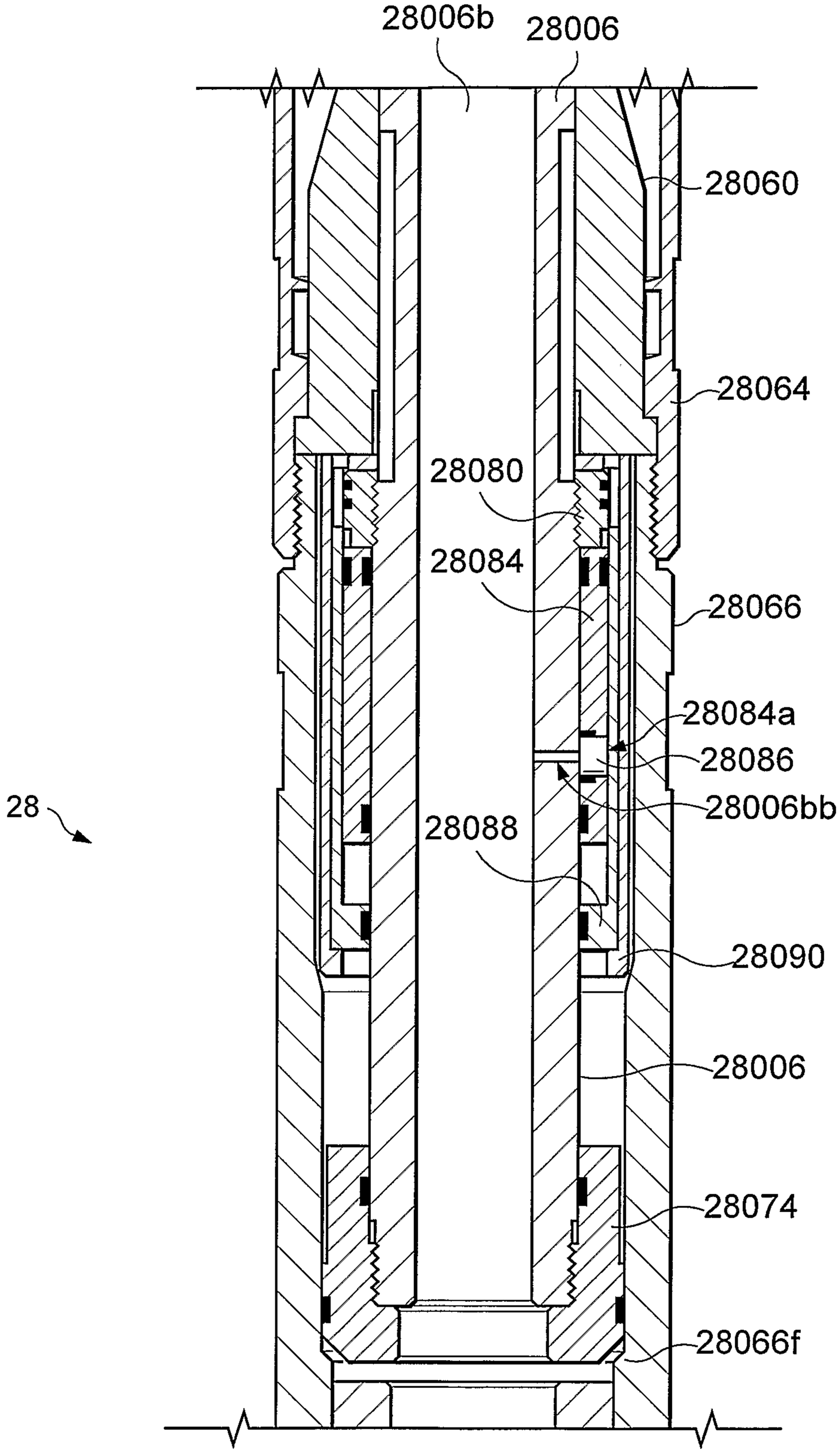

28006b
28006
28060
28064
28080
28084
28066
28084a
28086
28006bb
28088
28090
28006
28074
28066f
28
28

Fig. 16U

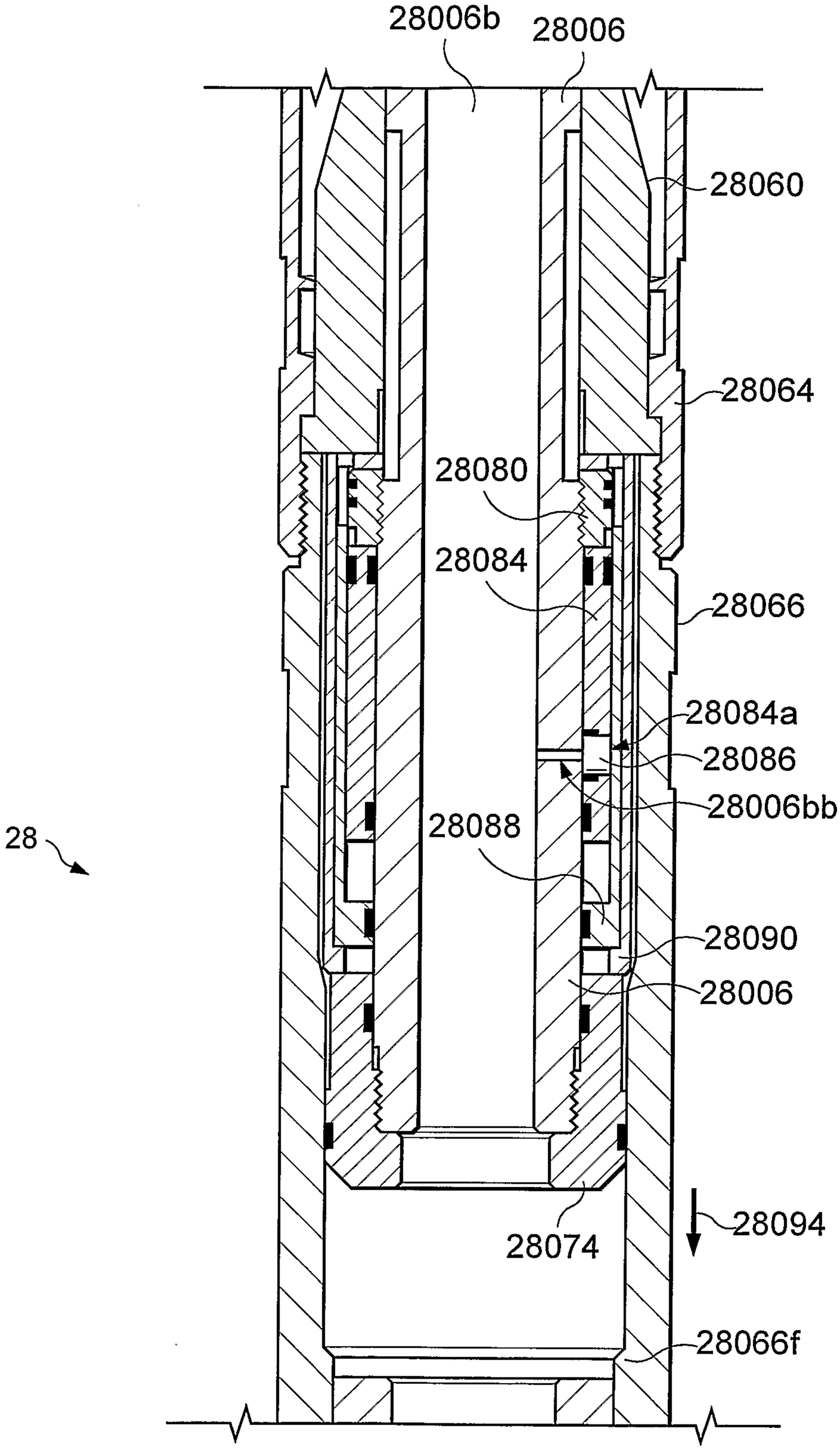

28006b
28006
28060
28064
28080
28084
28066
28084a
28086
28006bb
28088
28090
28006
28
28074
28094
28066f

Fig. 16V

Fig. 16W

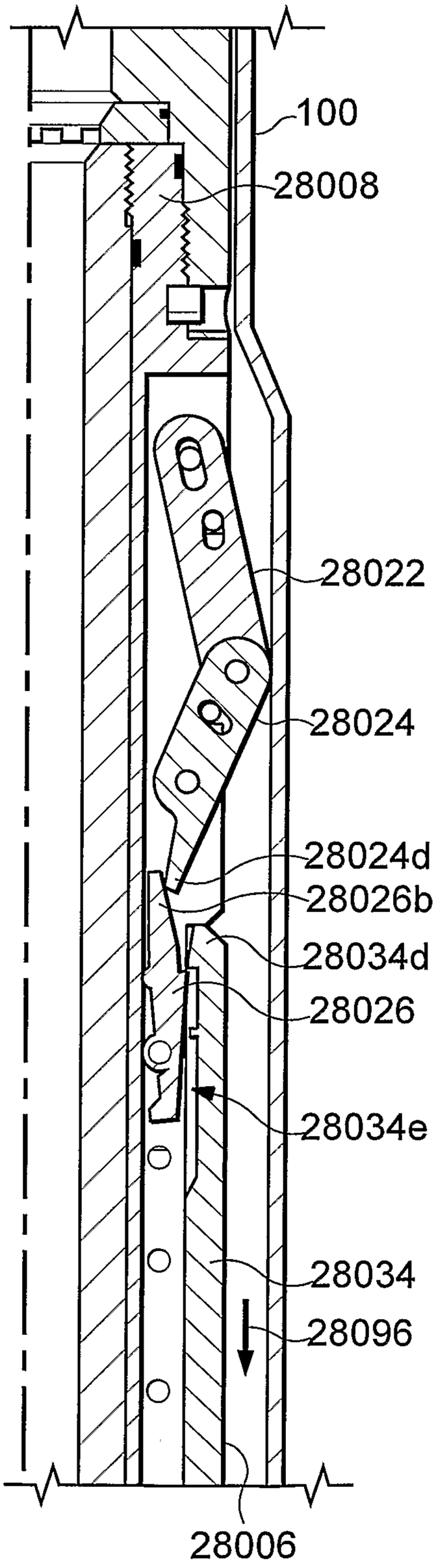


Fig. 16X

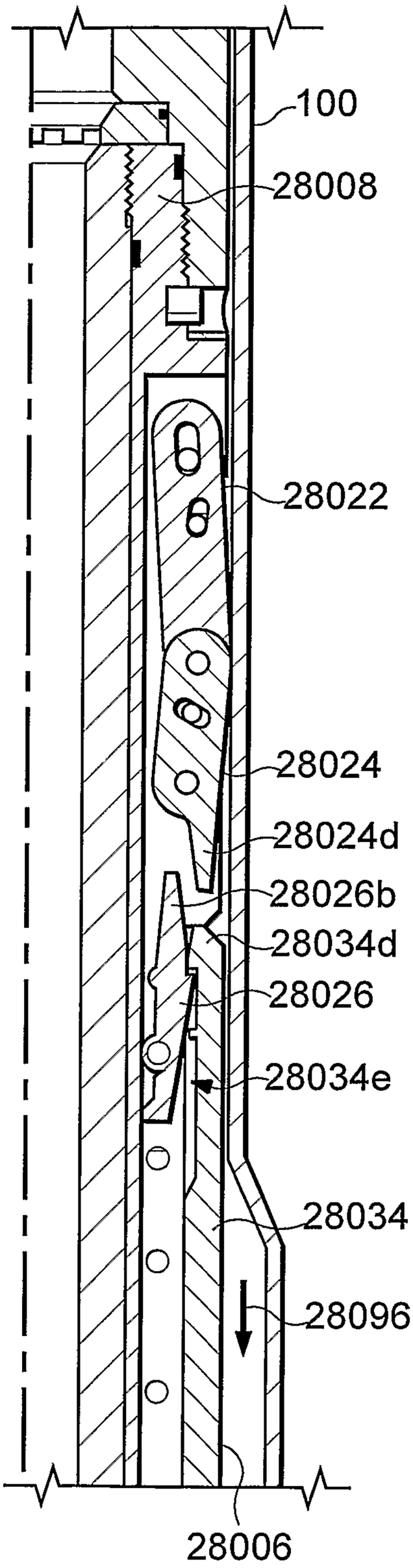
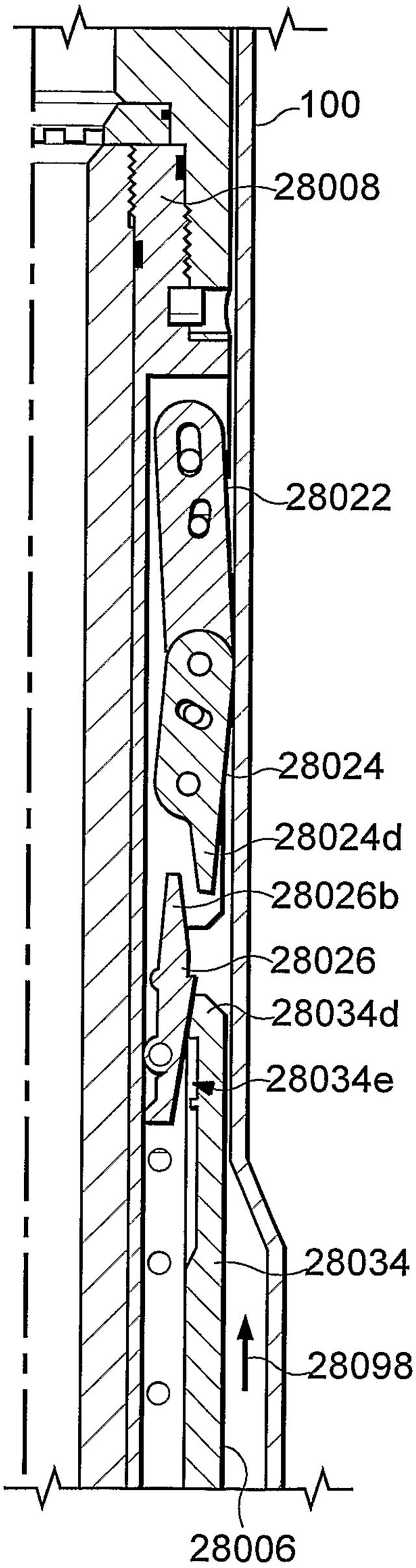


Fig. 16Y



120/250

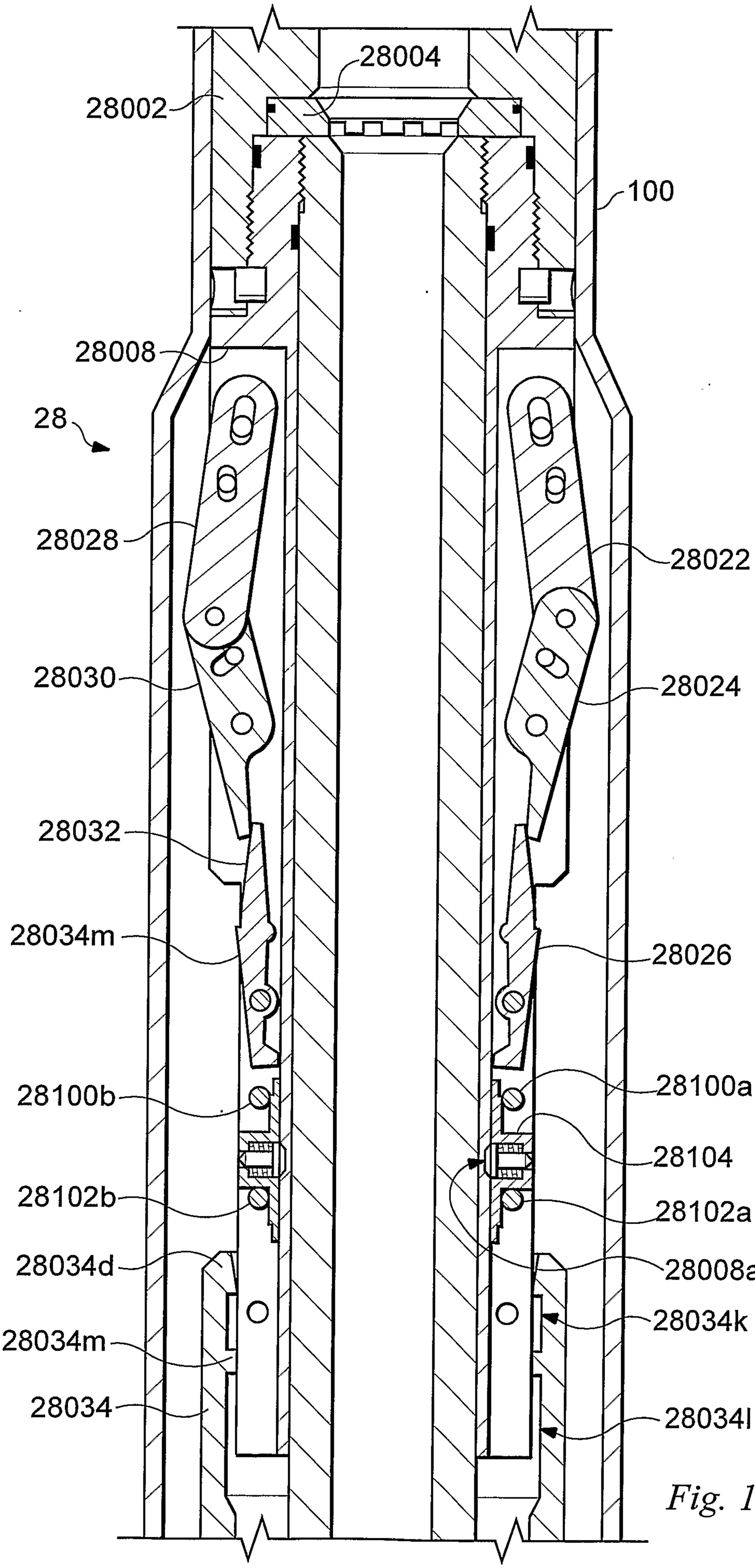


Fig. 16Z1

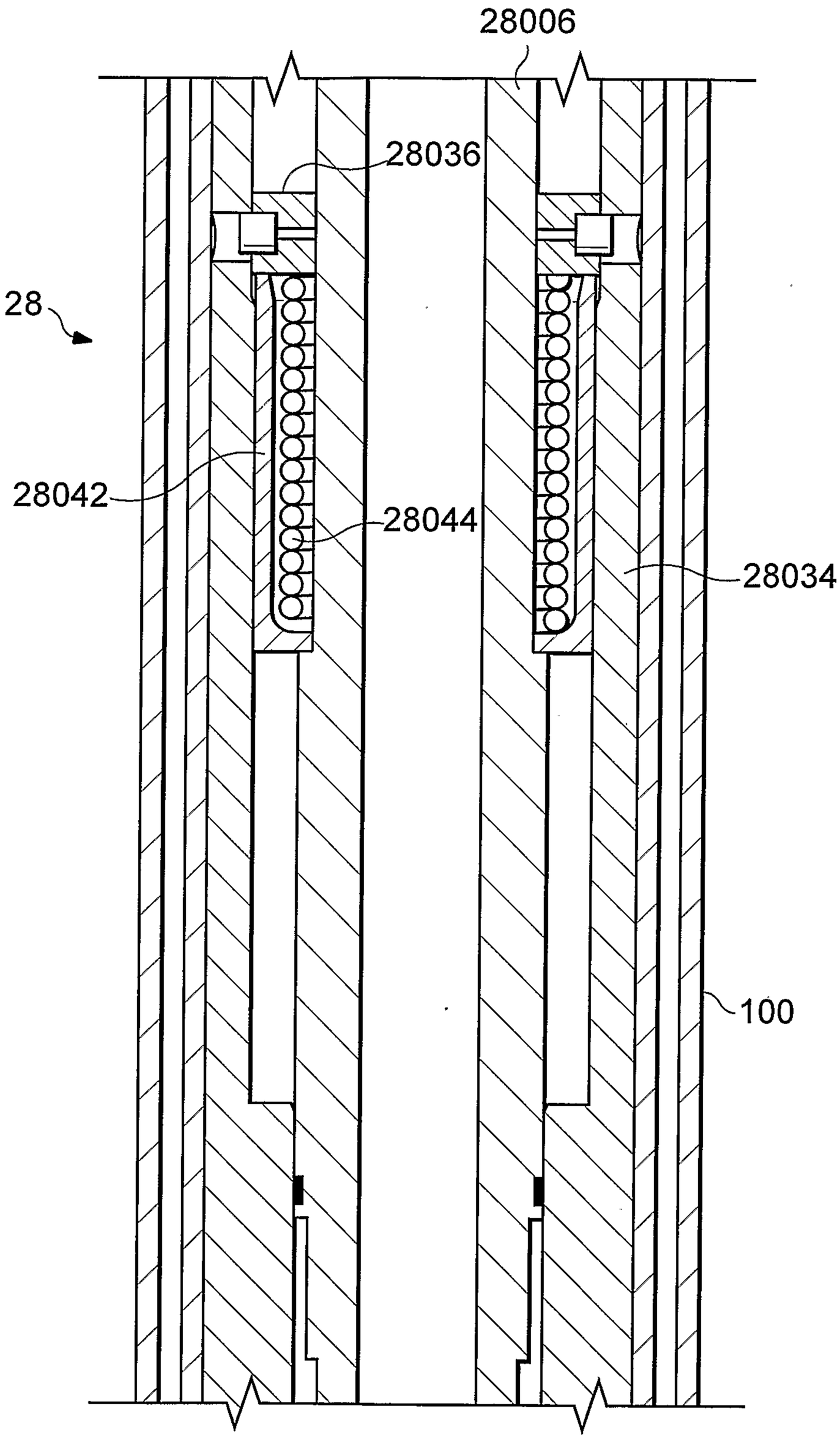


Fig. 16Z2

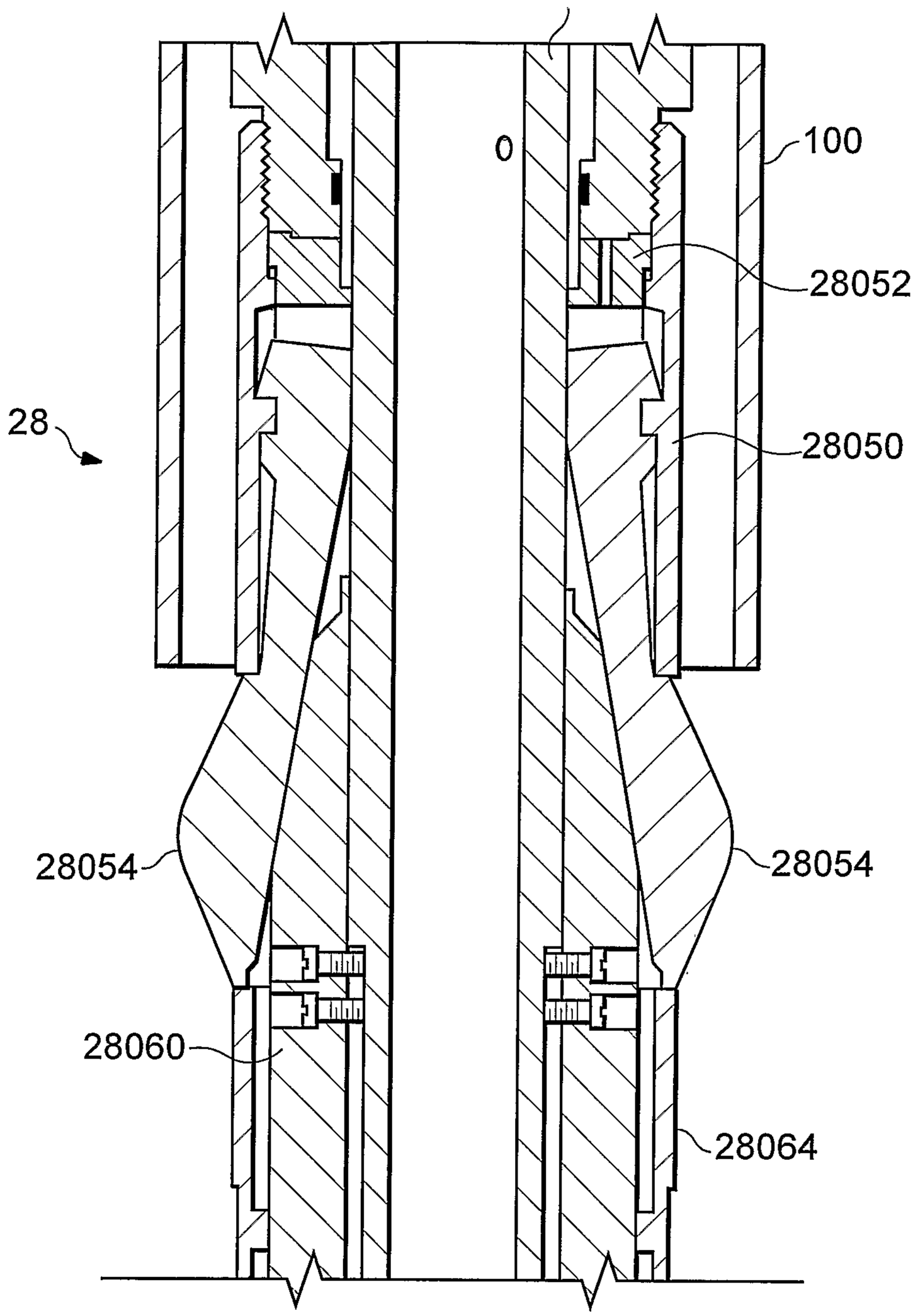


Fig. 16Z3

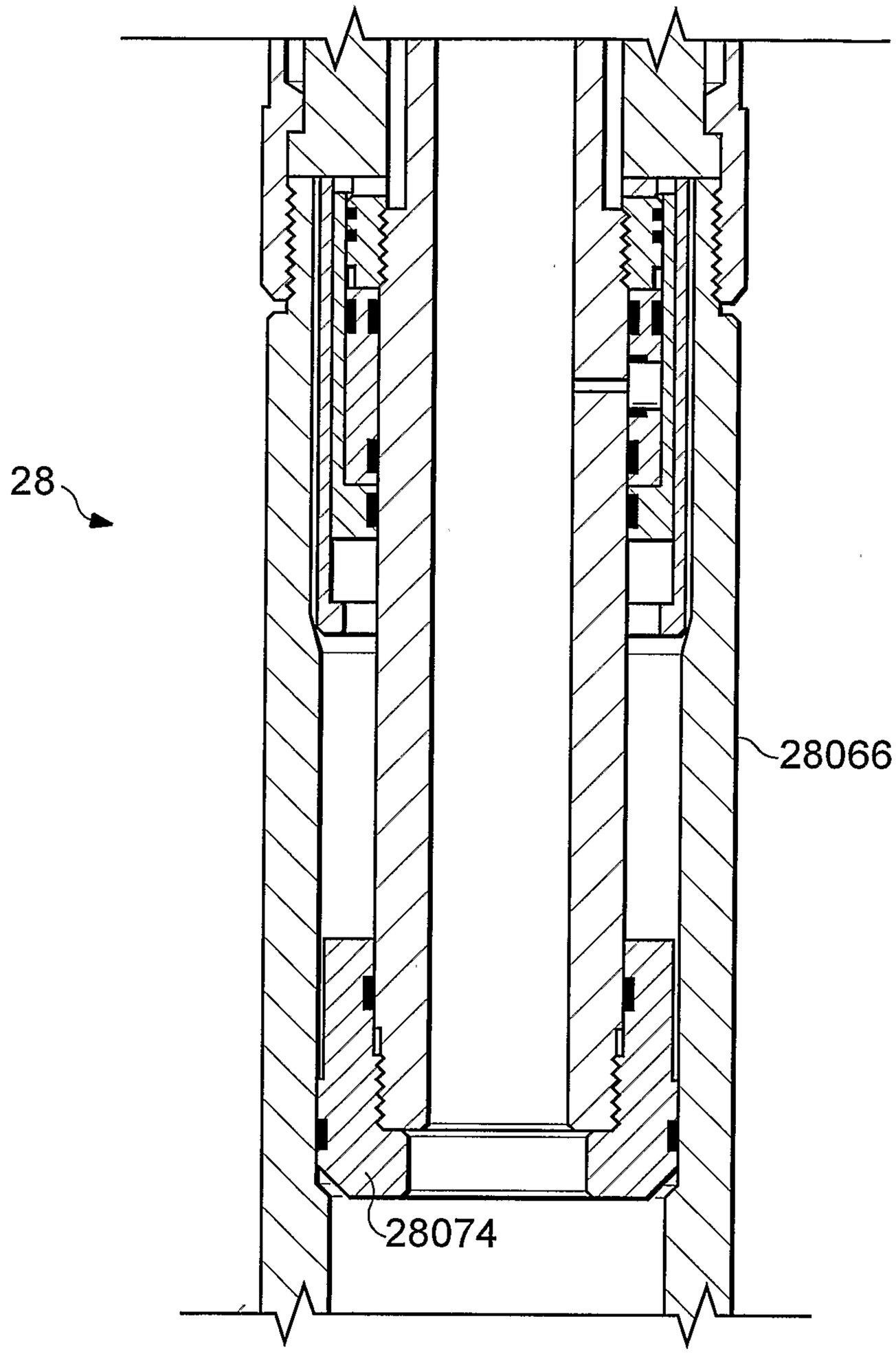


Fig. 16Z4

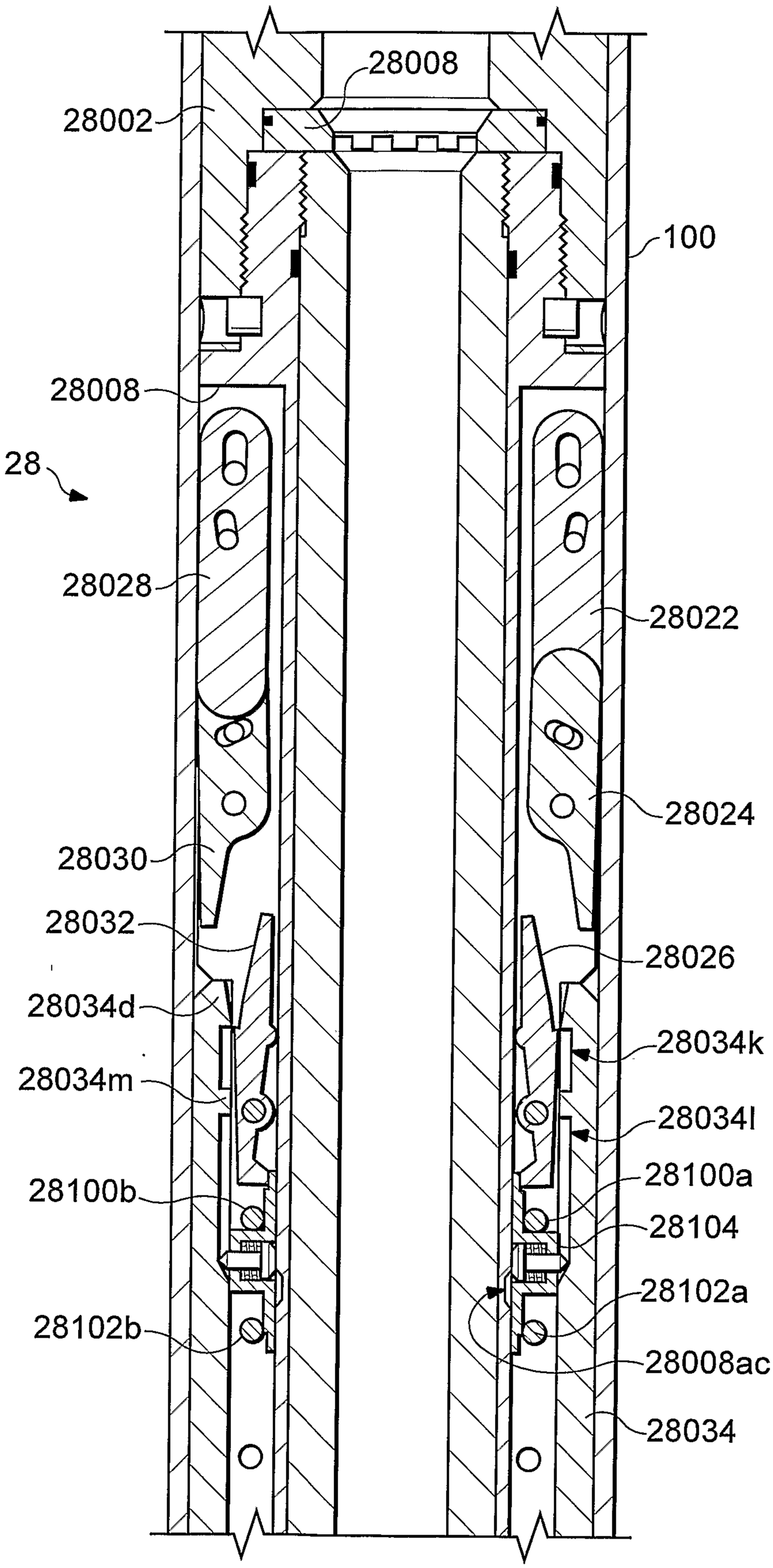

28008
28002
100
28008
28
28028
28022
28024
28030
28032
28026
28034d
28034k
28034m
28034l
28100b
28100a
28104
28102a
28102b
28008ac
28034

Fig. 16AA1

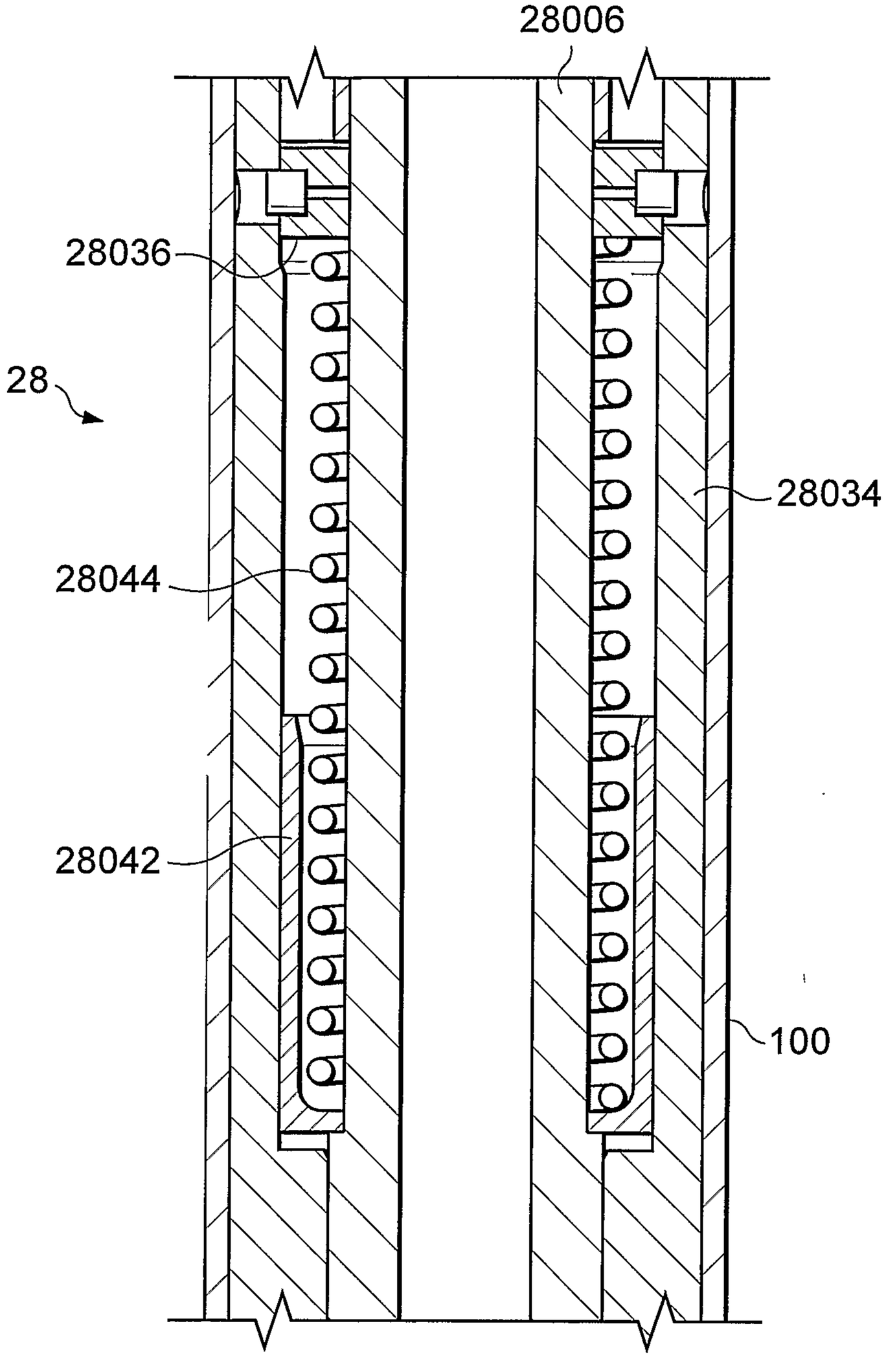


Fig. 16AA2

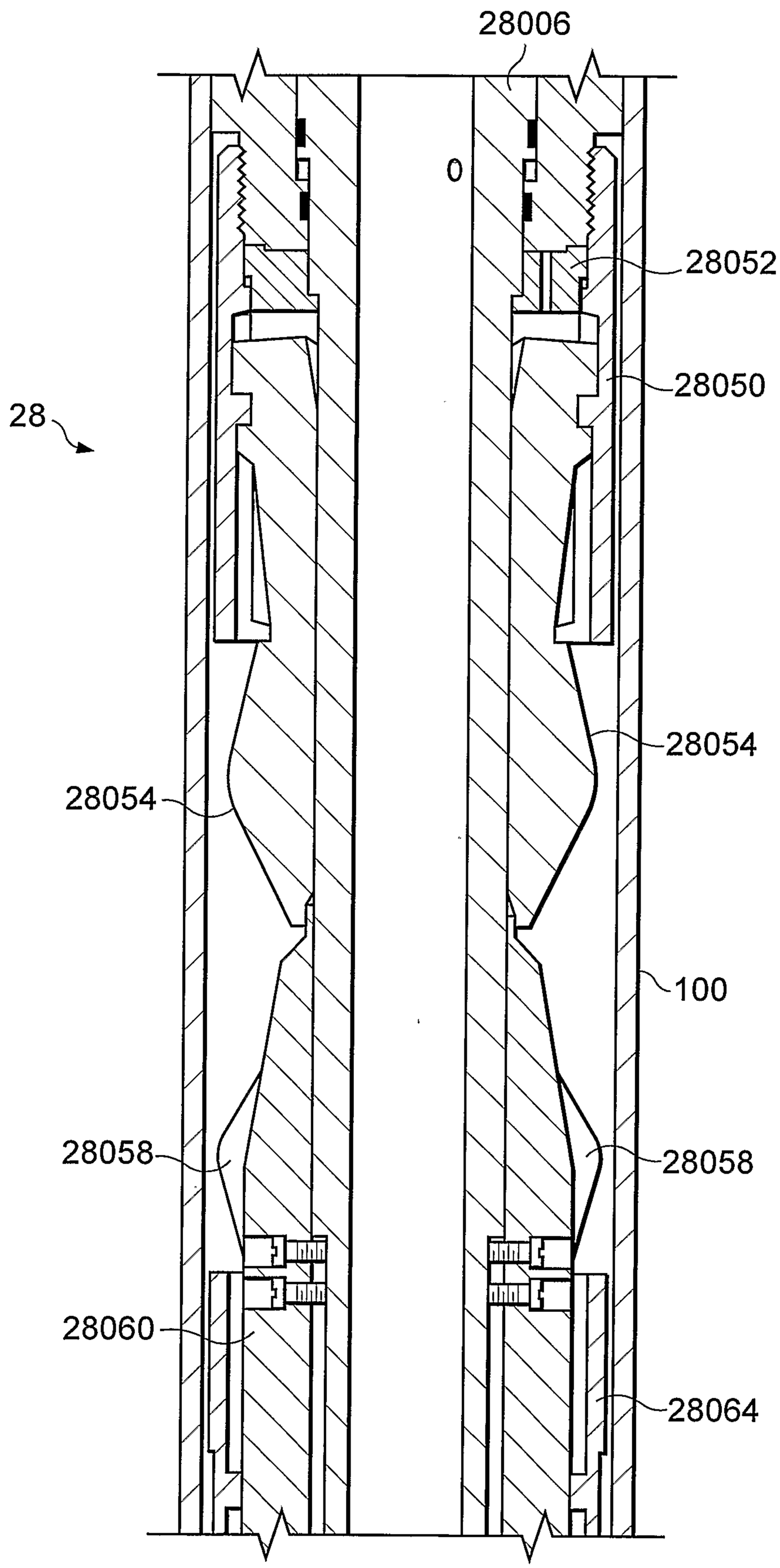

28006
0
28052
28
28050
28054
28054
100
28058
28058
28060
28064

Fig. 16AA3

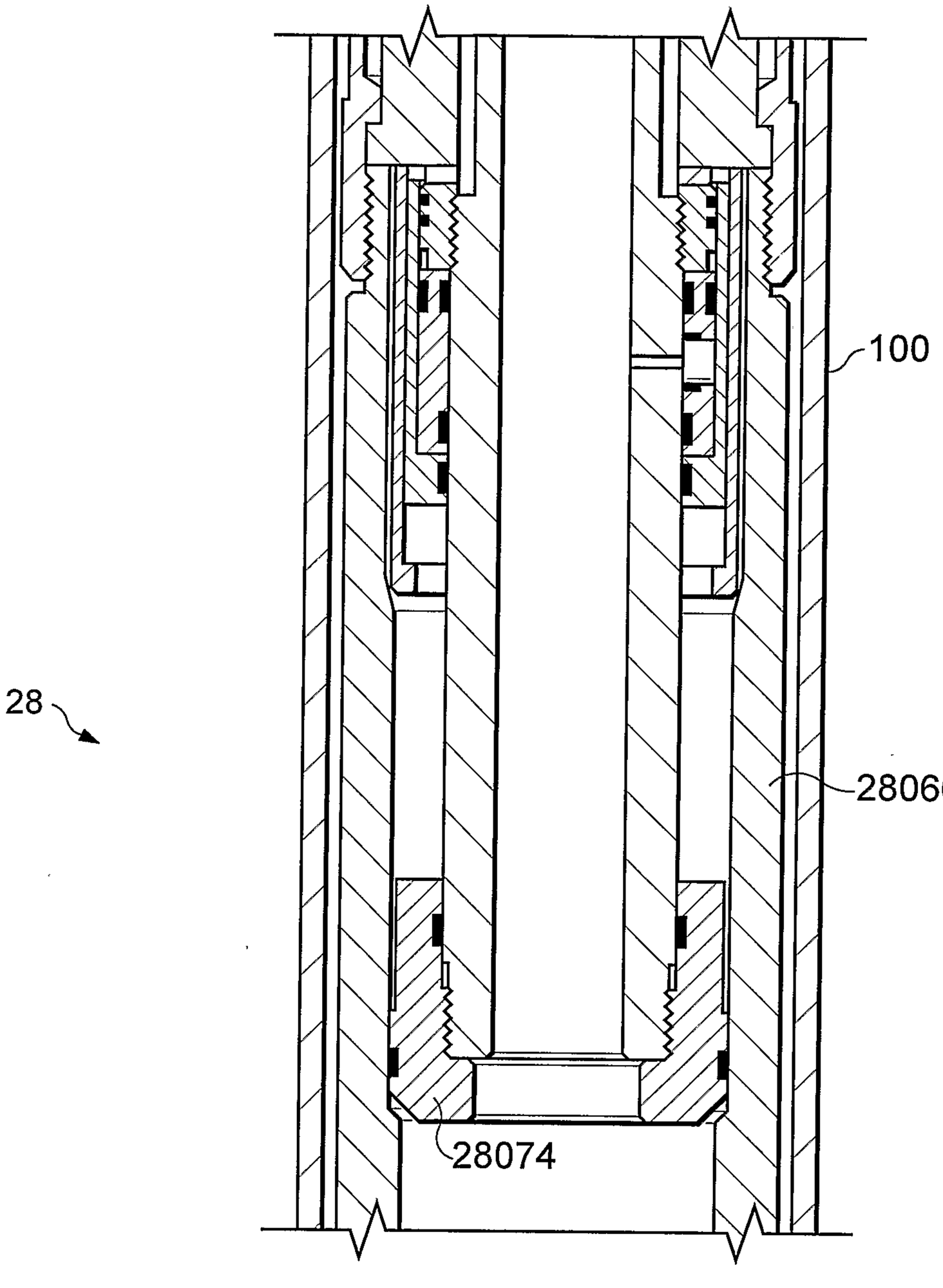


Fig. 16AA4

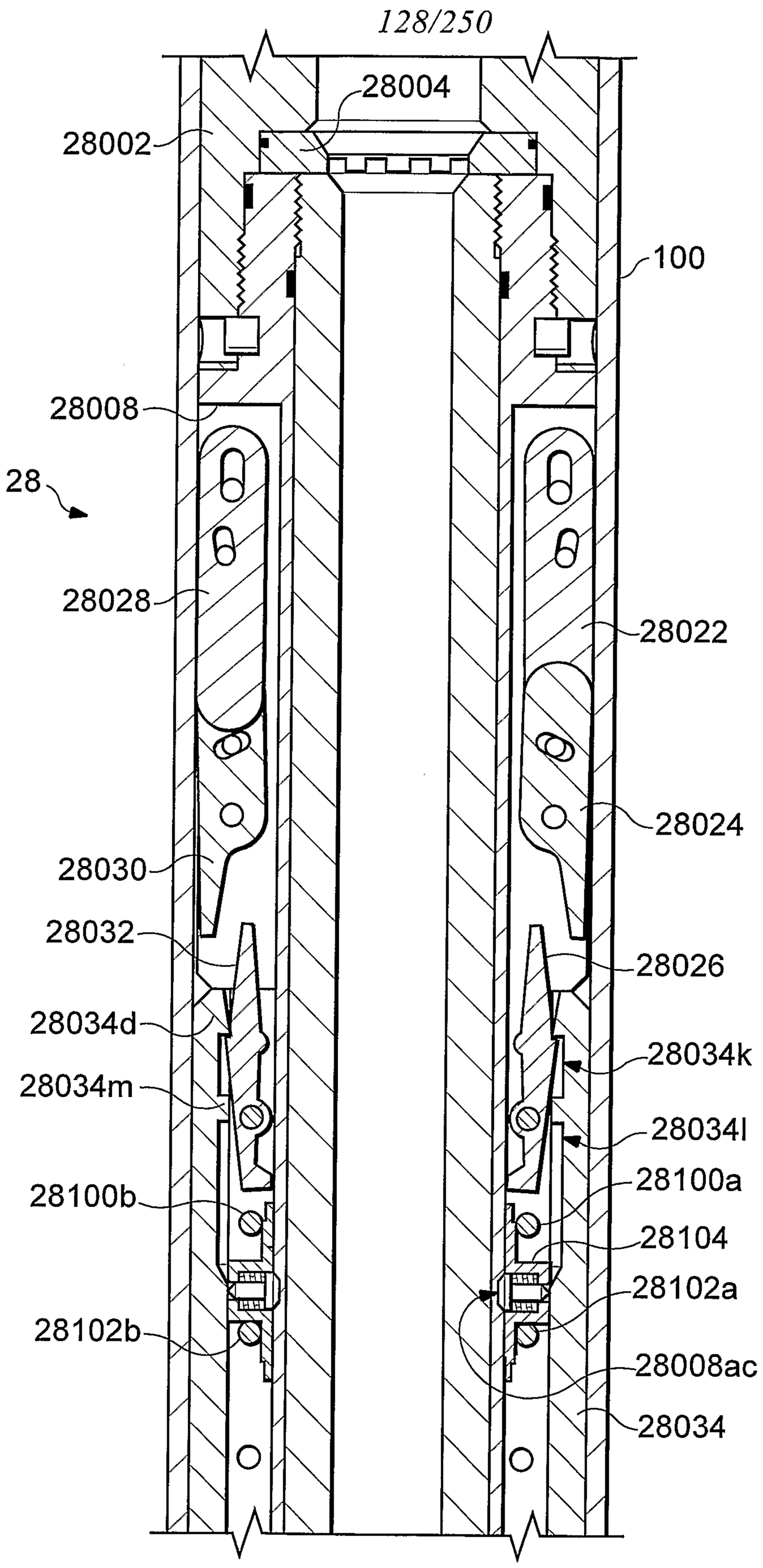

128/250
28004
28002
100
28008
28
28028
28022
28030
28024
28032
28026
28034d
28034k
28034m
28034l
28100b
28100a
28104
28102a
28102b
28008ac
28034

Fig. 16AB1

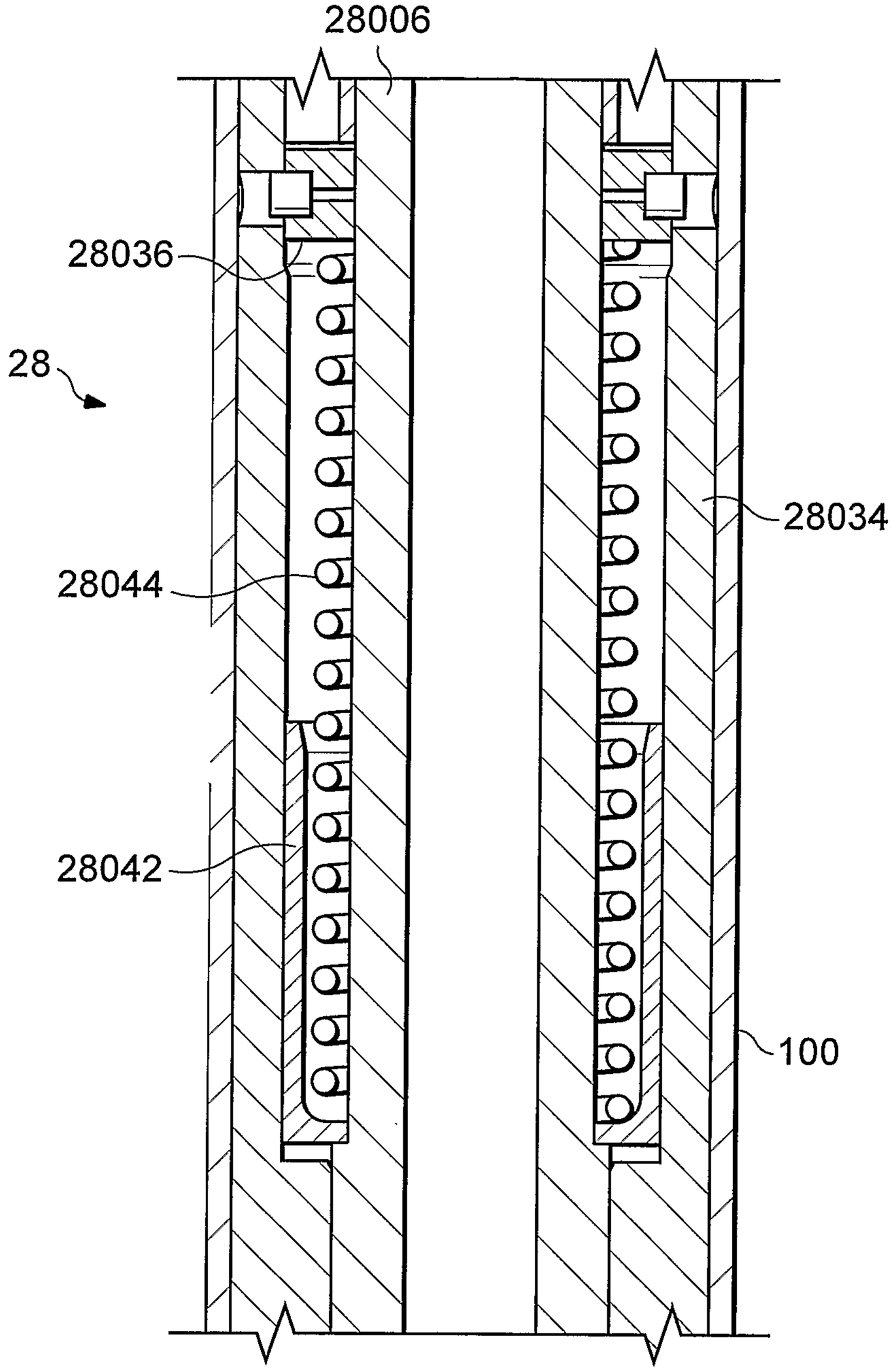


Fig. 16AB2

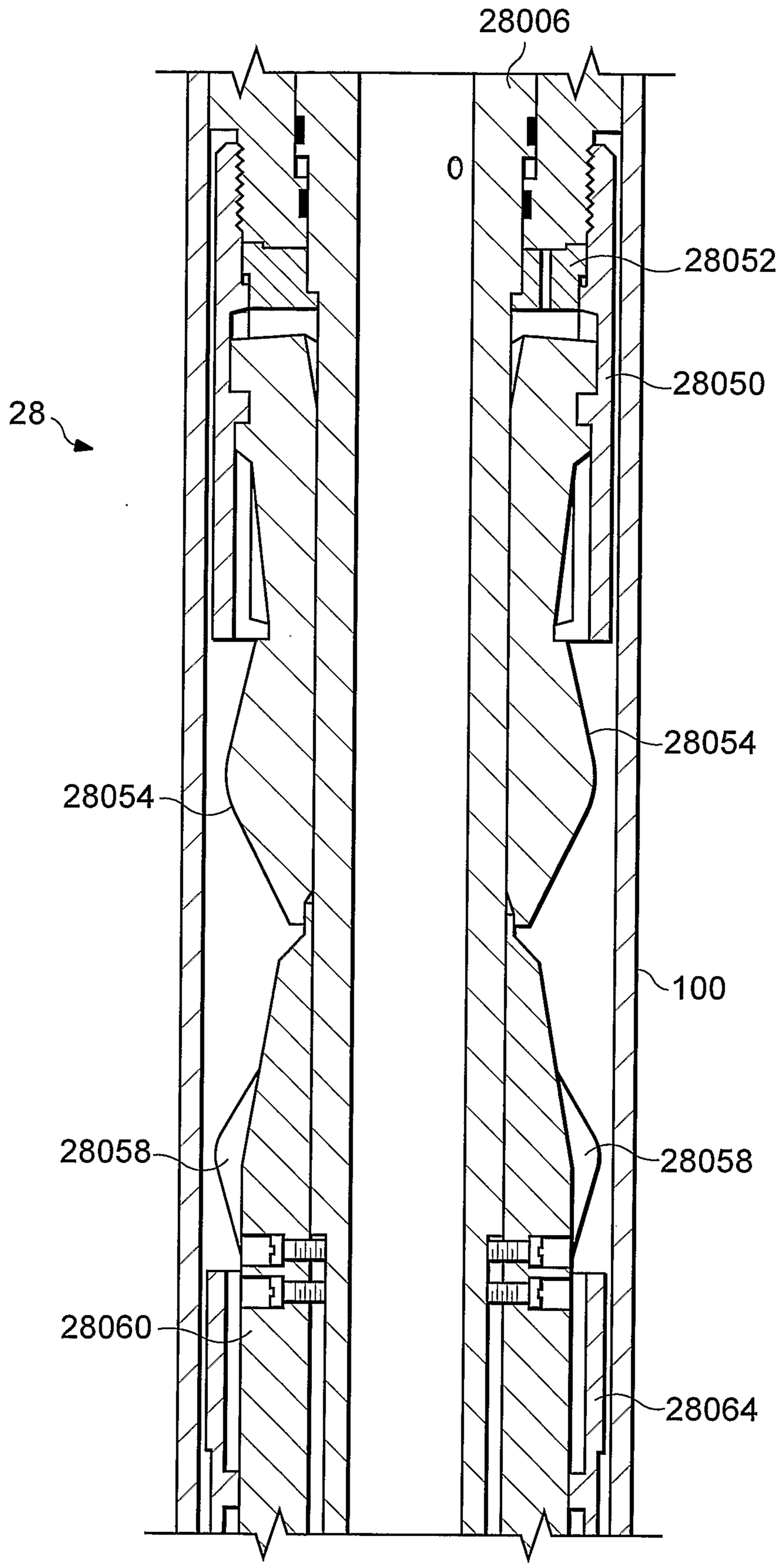

28006
0
28052
28050
28
28054
28054
100
28058
28058
28060
28064

Fig. 16AB3

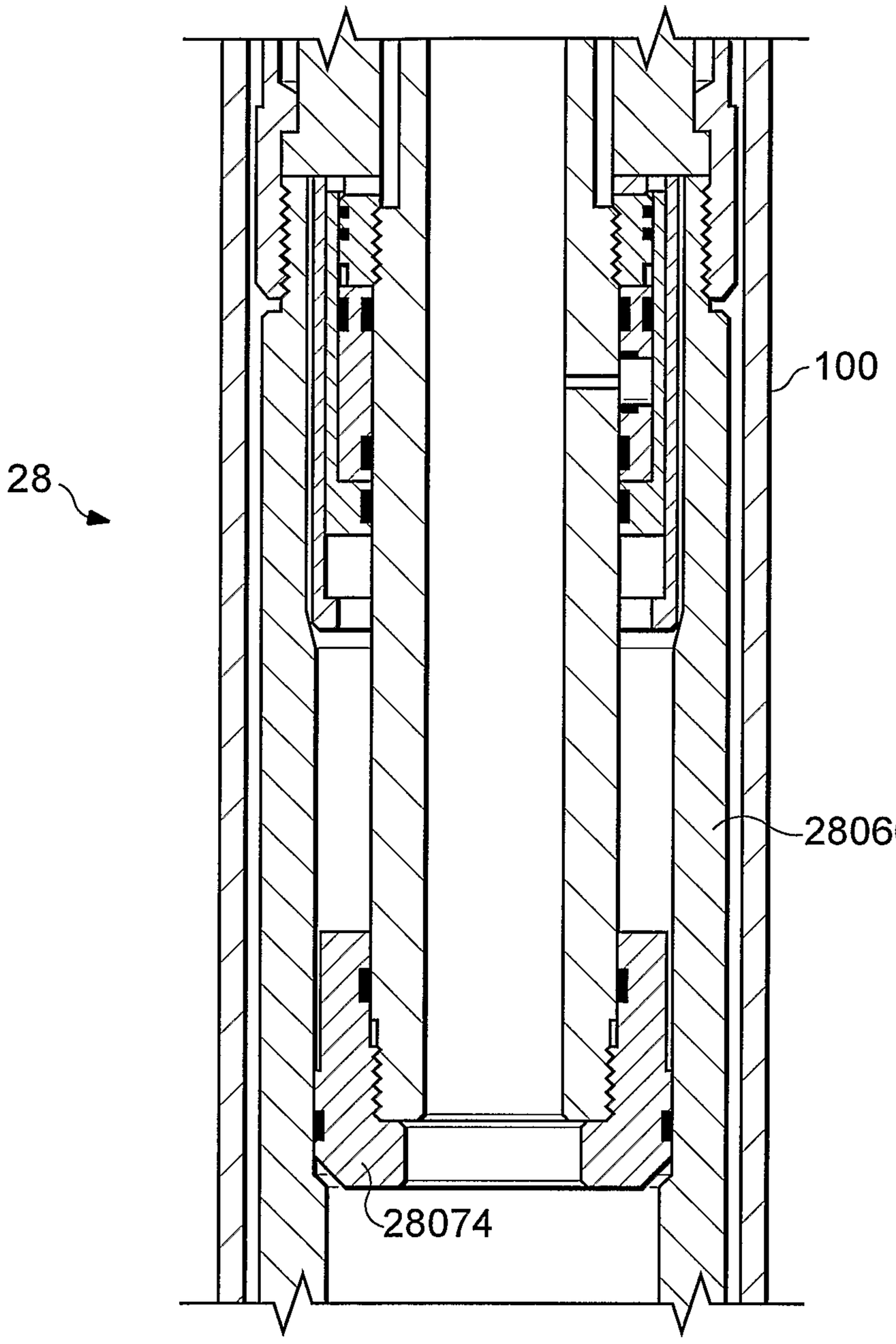


Fig. 16AB4

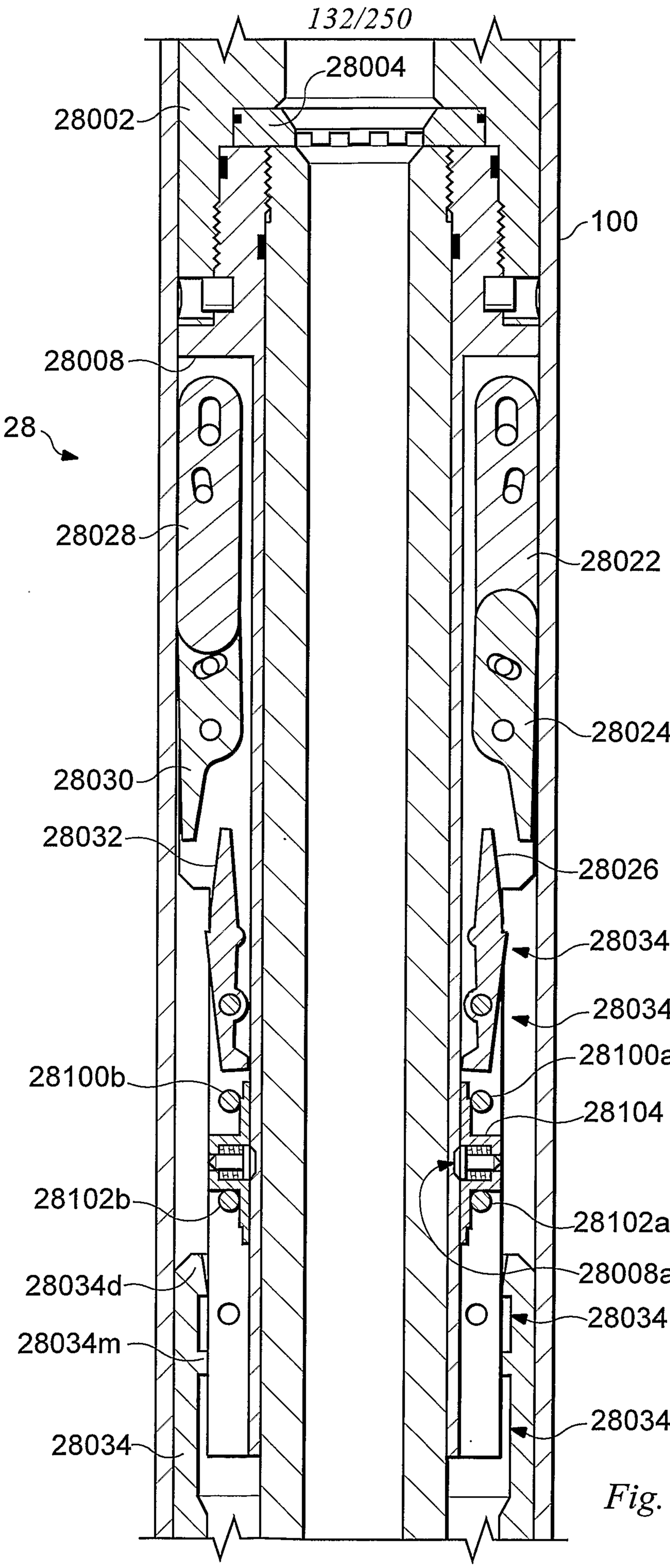

132/250
28004
28002
100
28008
28
28028
28022
28024
28030
28032
28026
28034k
28034l
28100b
28100a
28104
28102b
28102a
28008ac
28034d
28034m
28034k
28034
28034l

Fig. 16AC1

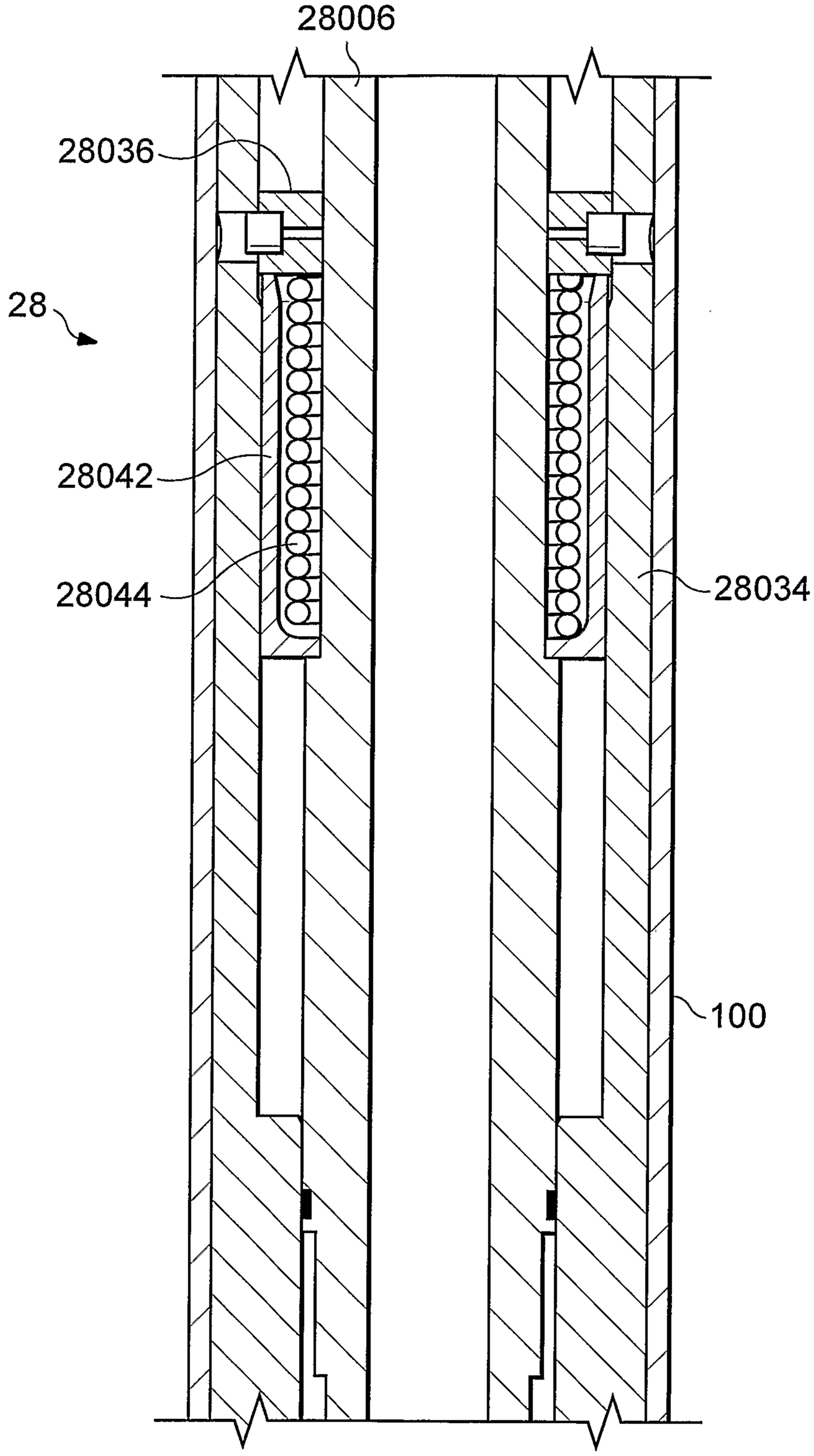


Fig. 16AC2

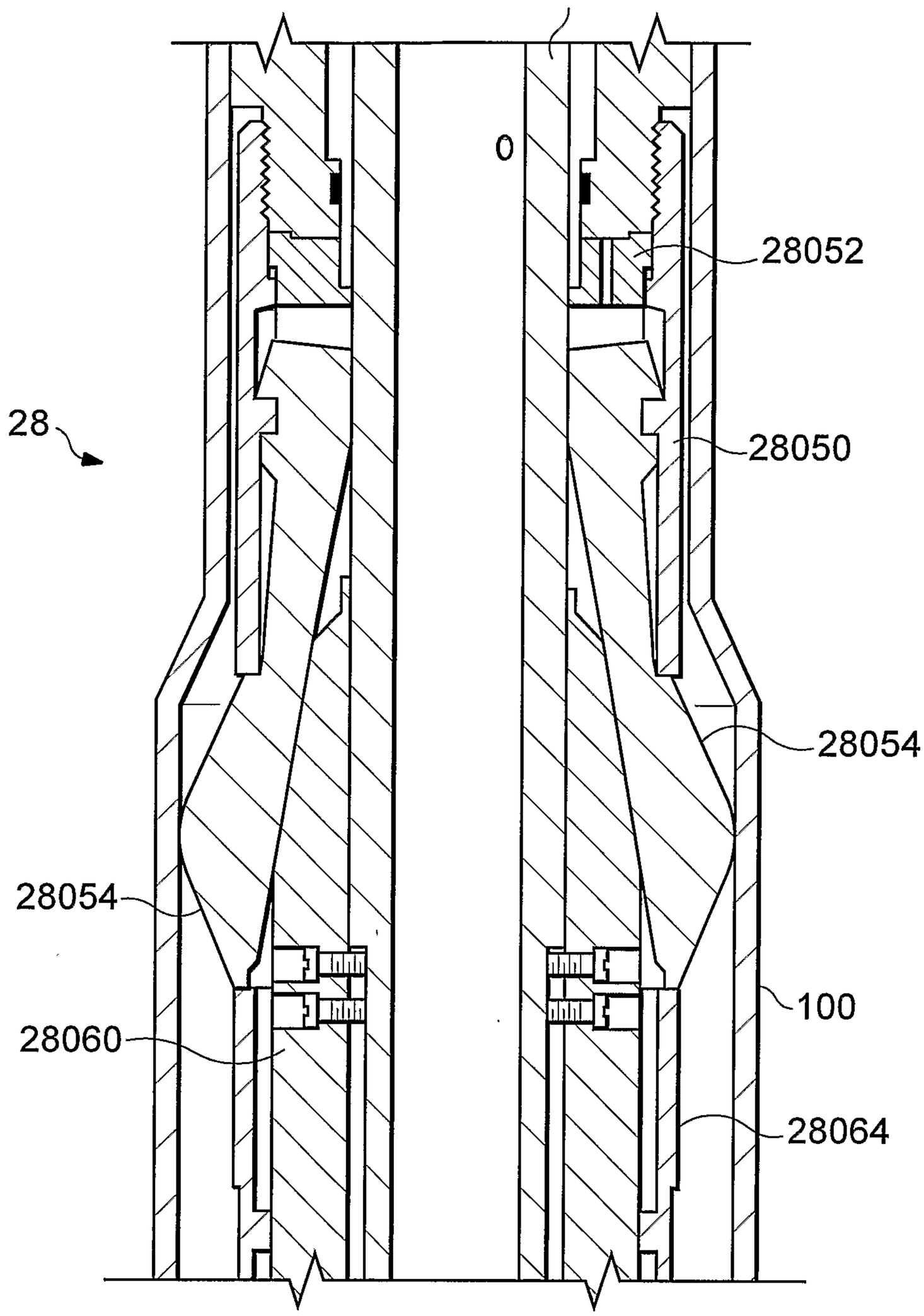


Fig. 16AC3

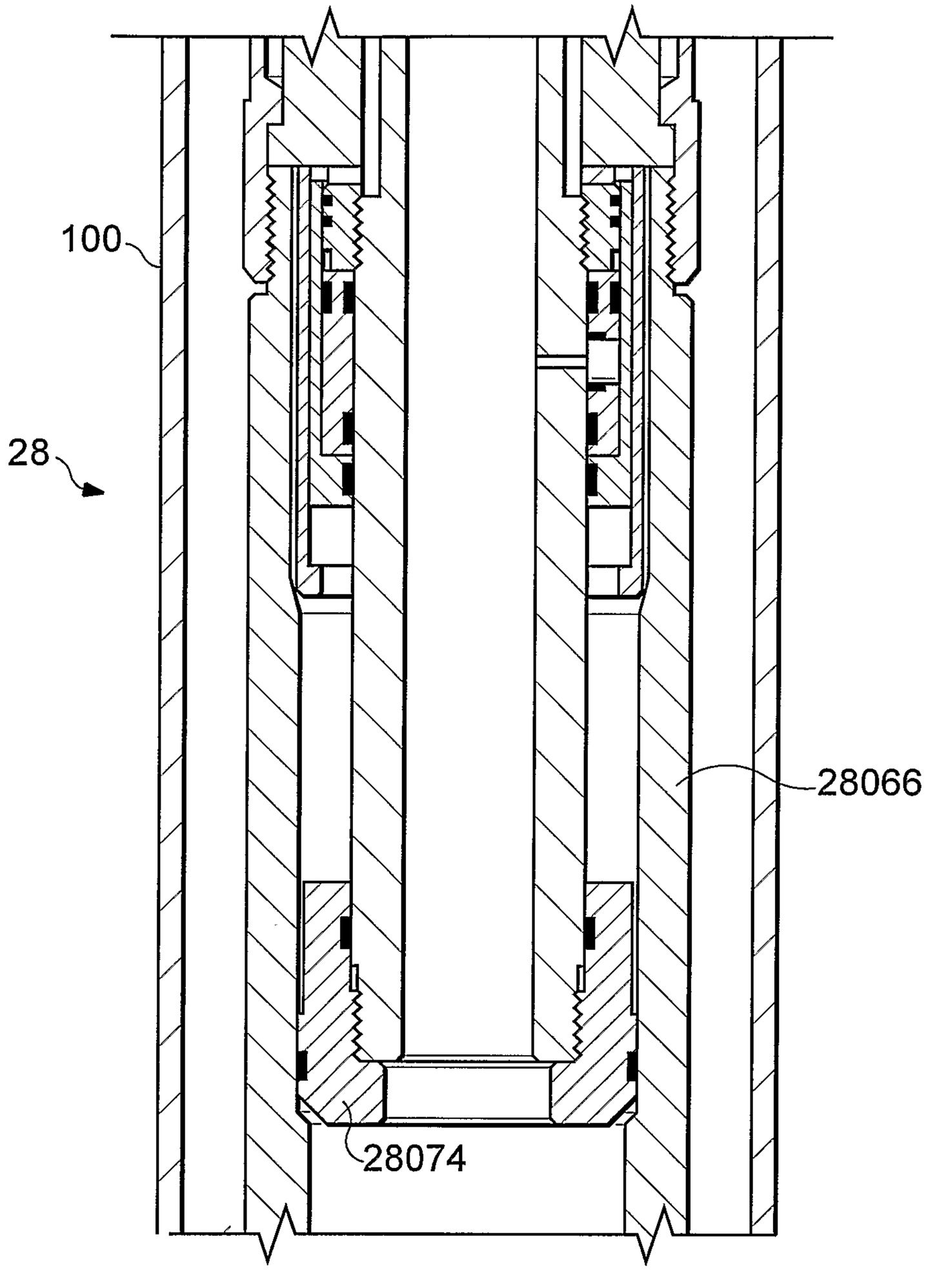


Fig. 16AC4

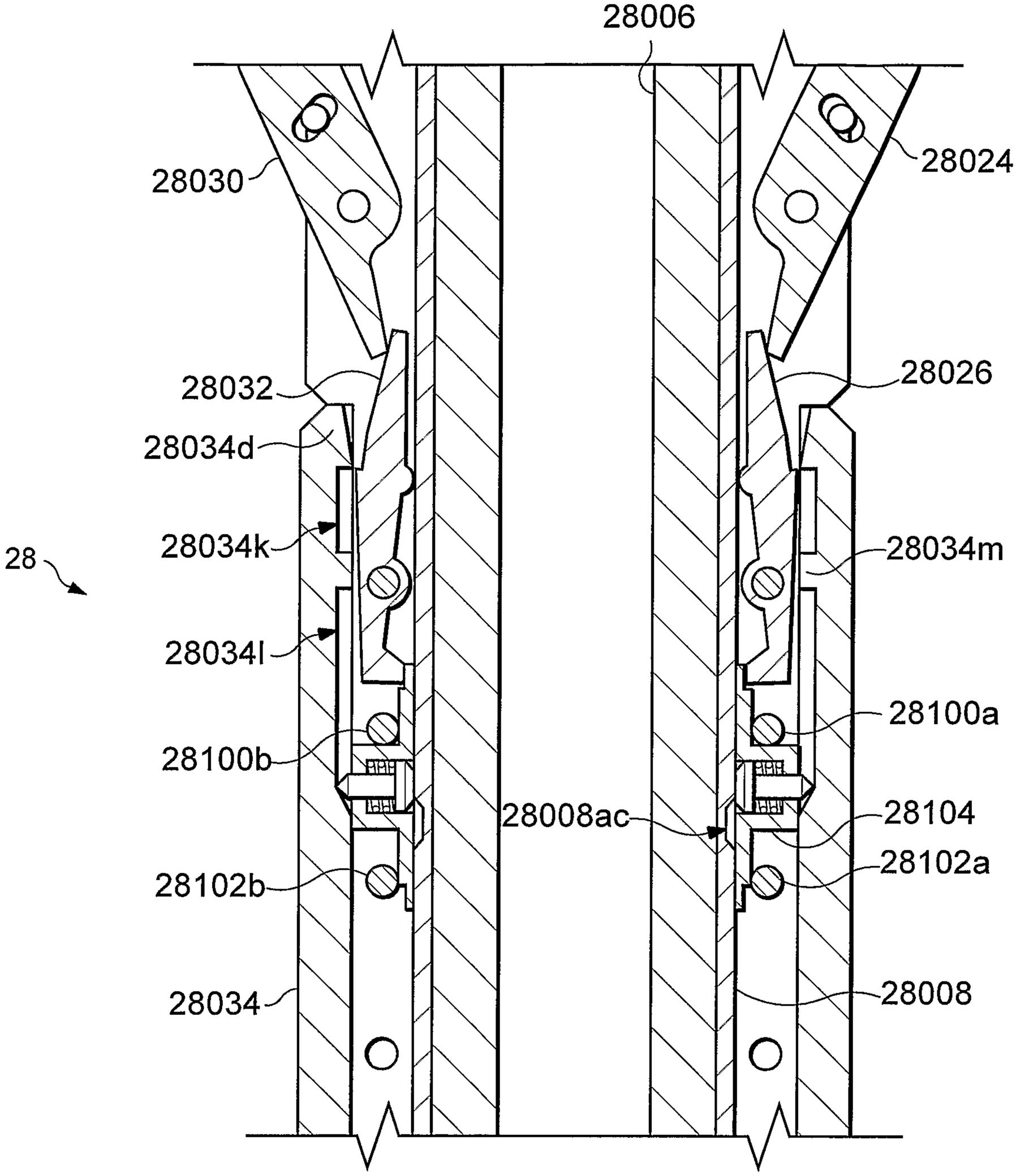

28006
28030
28024
28032
28026
28034d
28034k
28034m
28
28034l
28100a
28100b
28008ac
28104
28102a
28102b
28034
28008

Fig. 16AD

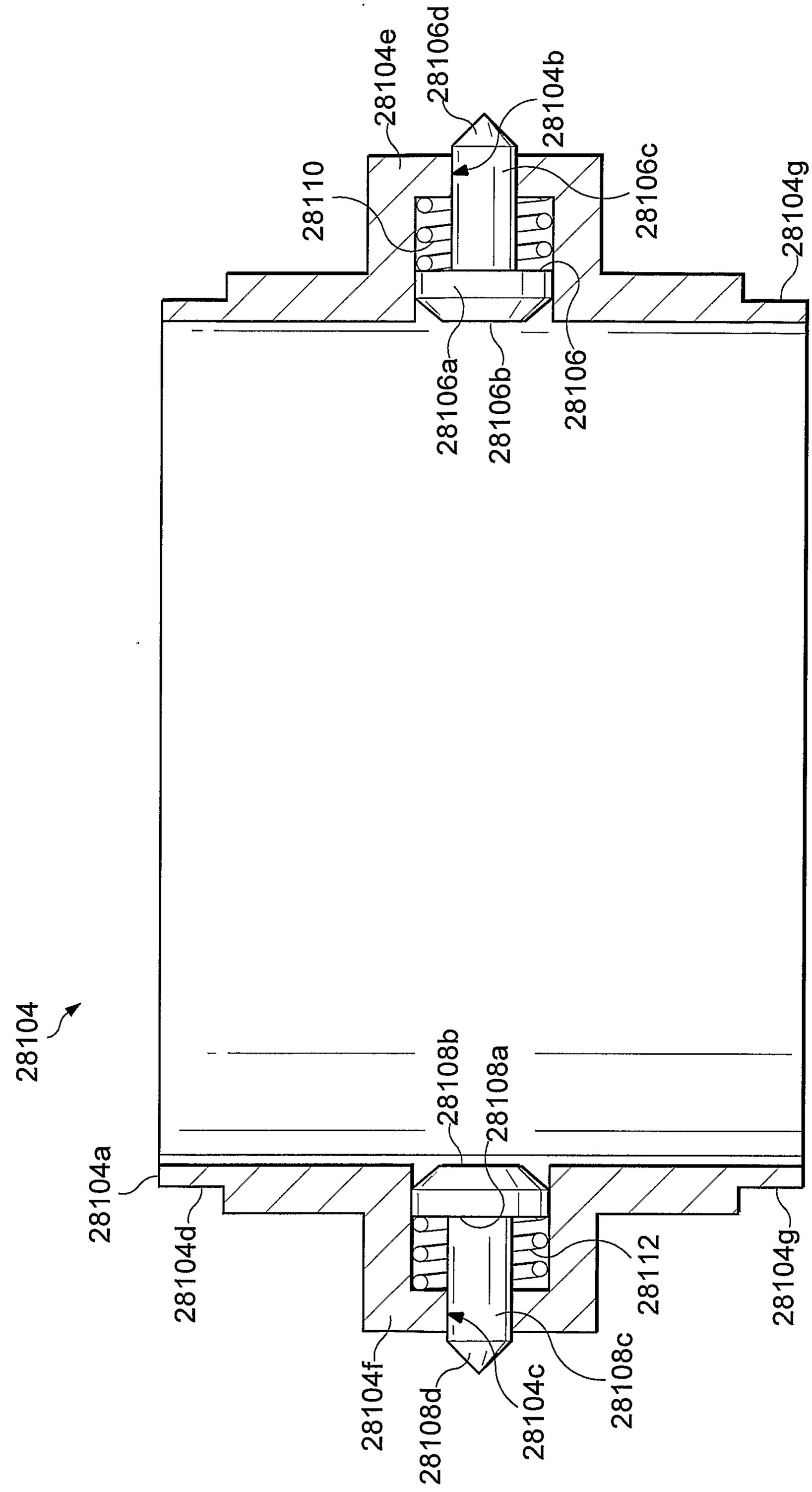

28104e
28106d
28104b
28110
28106c
28104g
28106a
28106b
28106
28104
28108b
28108a
28104a
28104d
28104f
28108d
28104c
28108c
28112
28104g

Fig. 16AE

Fig. 17-1

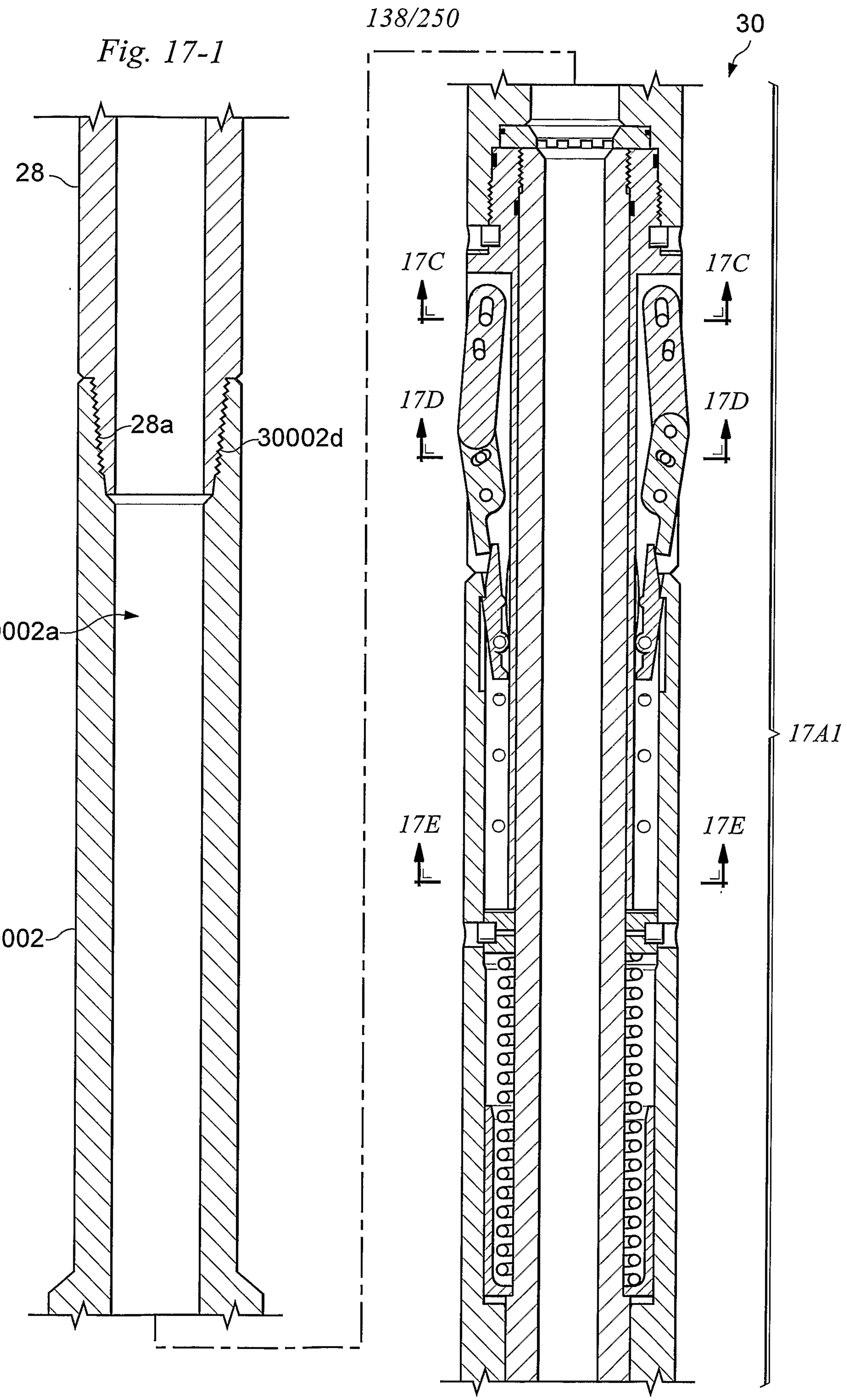

138/250
30
28
28a
30002d
30002a
30002
17C
17C
17D
17D
17E
17E
17A1

Fig. 17-2

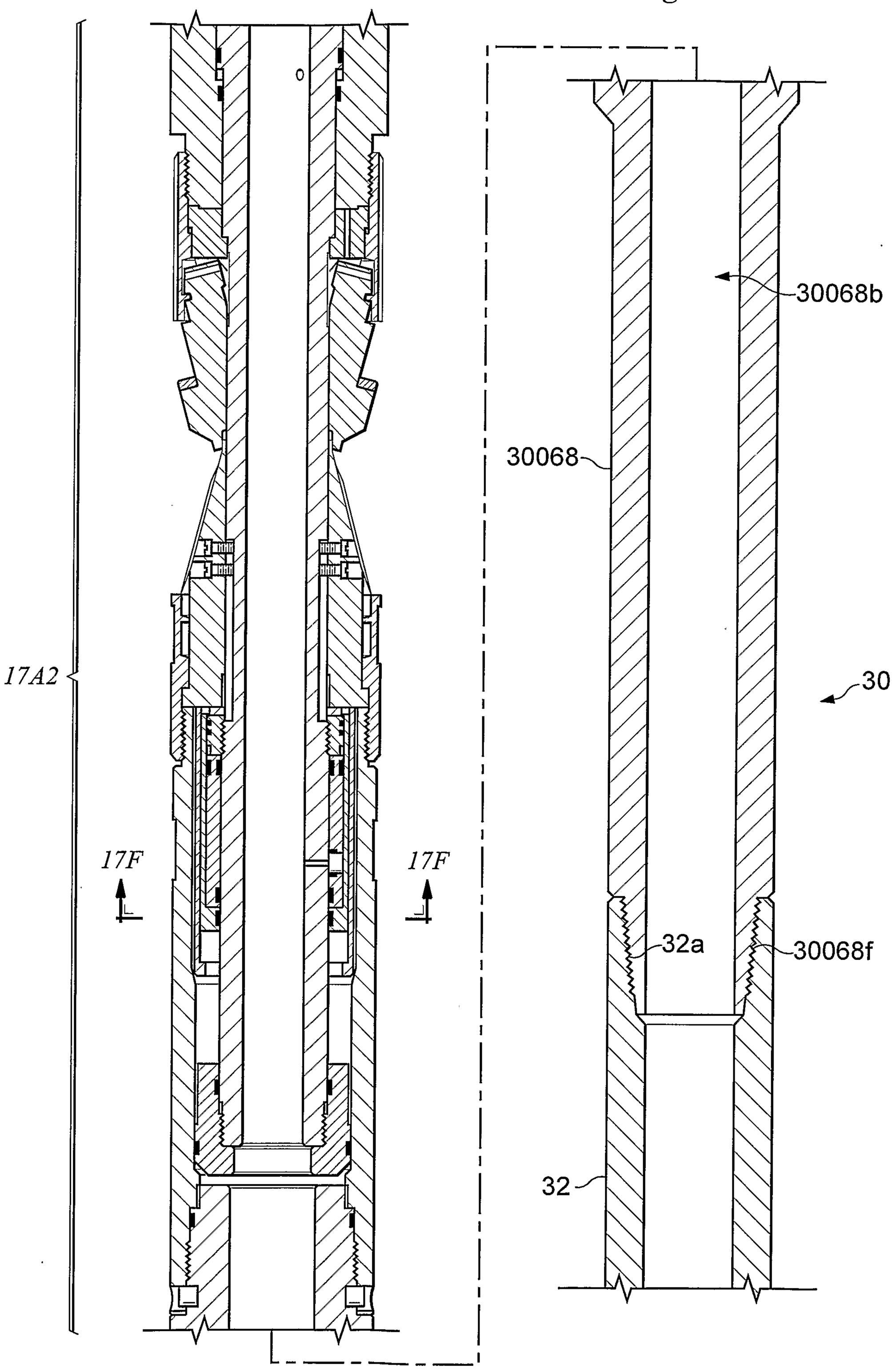
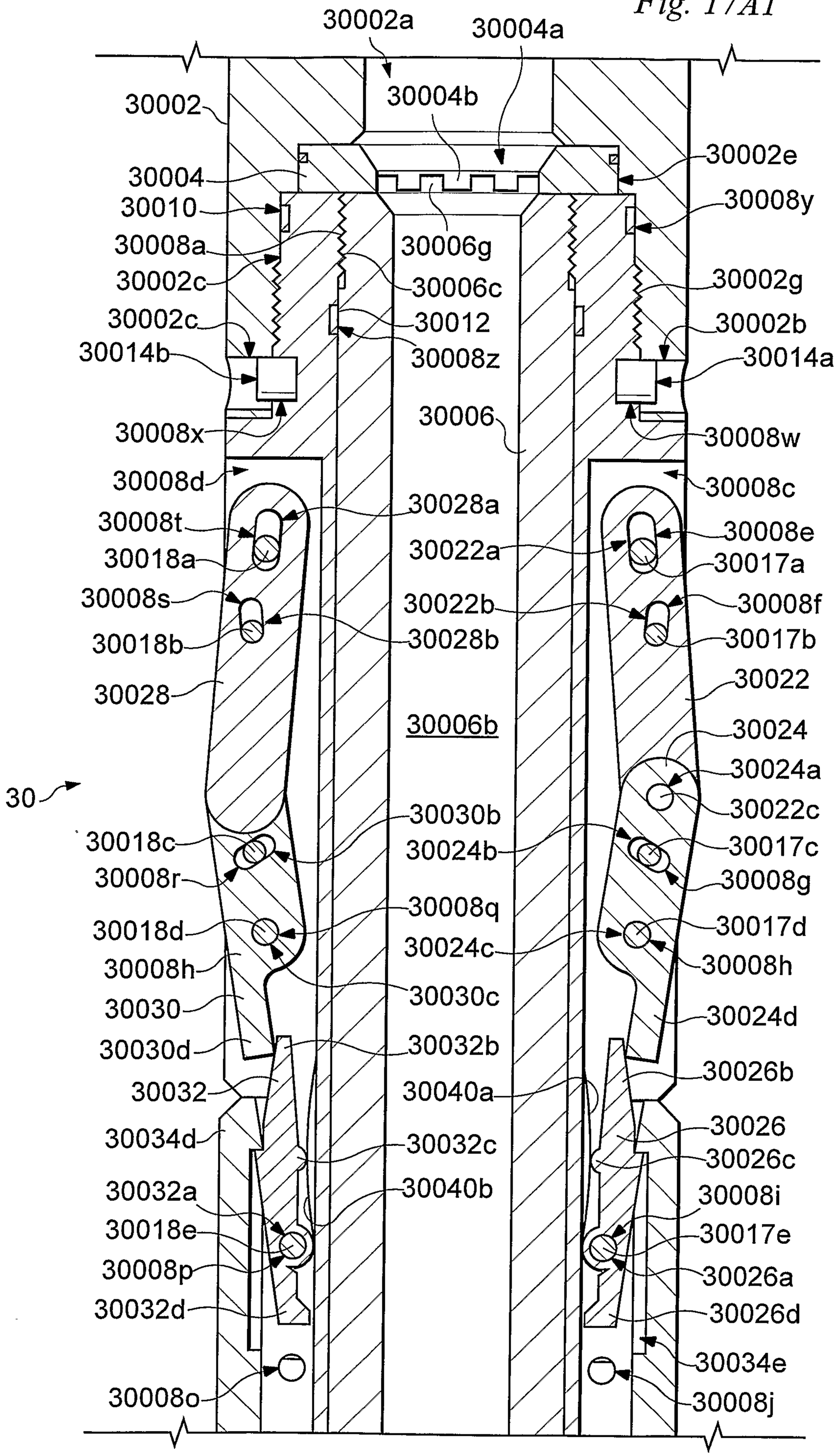


Fig. 17A1


30002a
30004a
30002
30004b
30004
30002e
30010
30008y
30008a
30006g
30002c
30006c
30002g
30002c
30012
30002b
30014b
30008z
30014a
30006
30008x
30008w
30008d
30008c
30028a
30008t
30008e
30022a
30018a
30017a
30008s
30022b
30008f
30018b
30028b
30017b
30028
30022
30006b
30024
30024a
30030b
30022c
30018c
30024b
30017c
30008r
30008g
30008q
30018d
30017d
30024c
30008h
30008h
30030c
30030
30024d
30030d
30032b
30026b
30040a
30032
30026
30034d
30032c
30026c
30040b
30008i
30032a
30017e
30018e
30026a
30008p
30026d
30032d
30034e
30008o
30008j
30

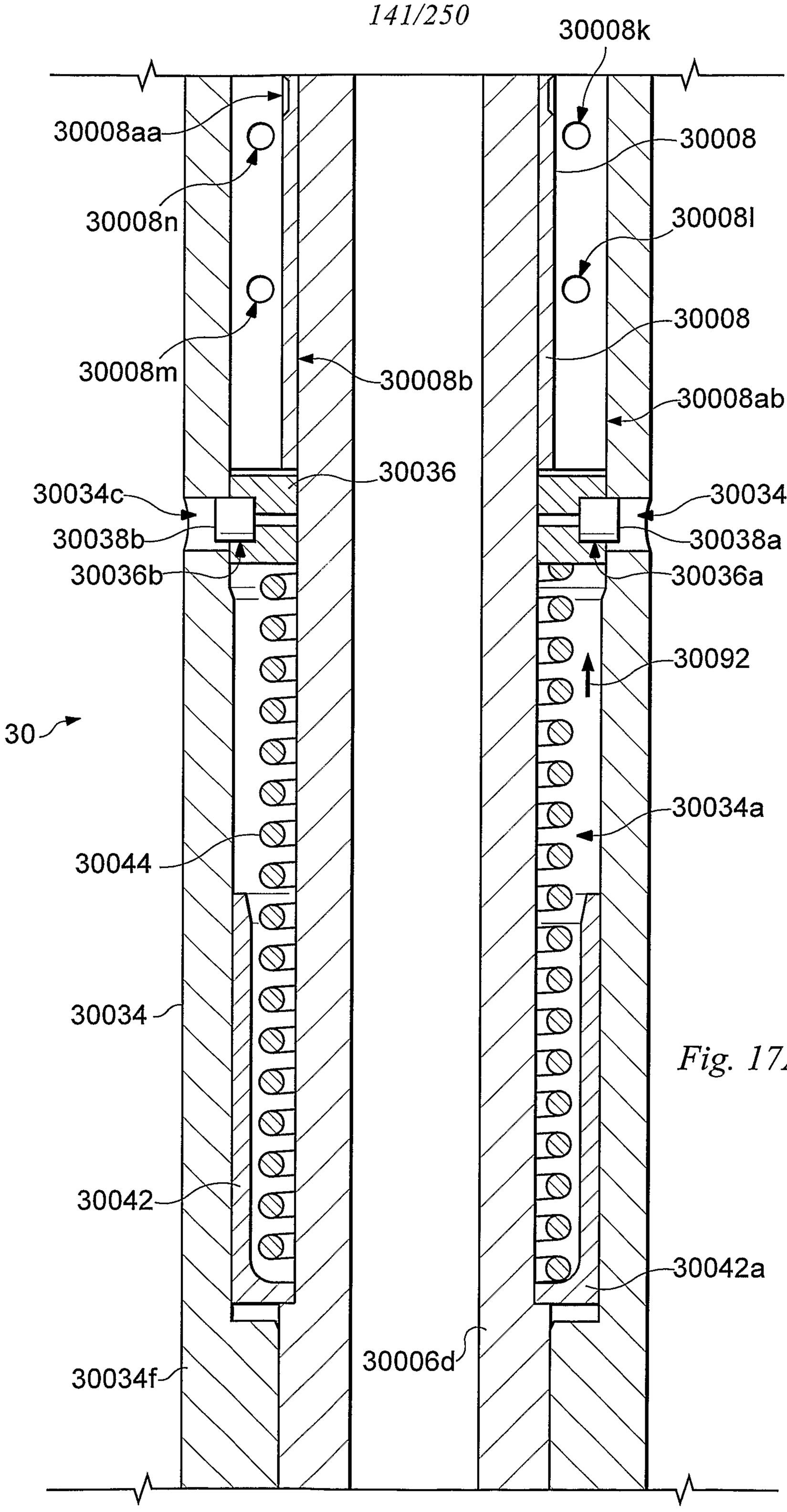

30008k
30008aa
30008
30008n
30008l
30008m
30008b
30008
30008ab
30036
30034c
30034b
30038b
30038a
30036b
30036a
30092
30
30034a
30044
30034
30042
30042a
30034f
30006d

Fig. 17A2

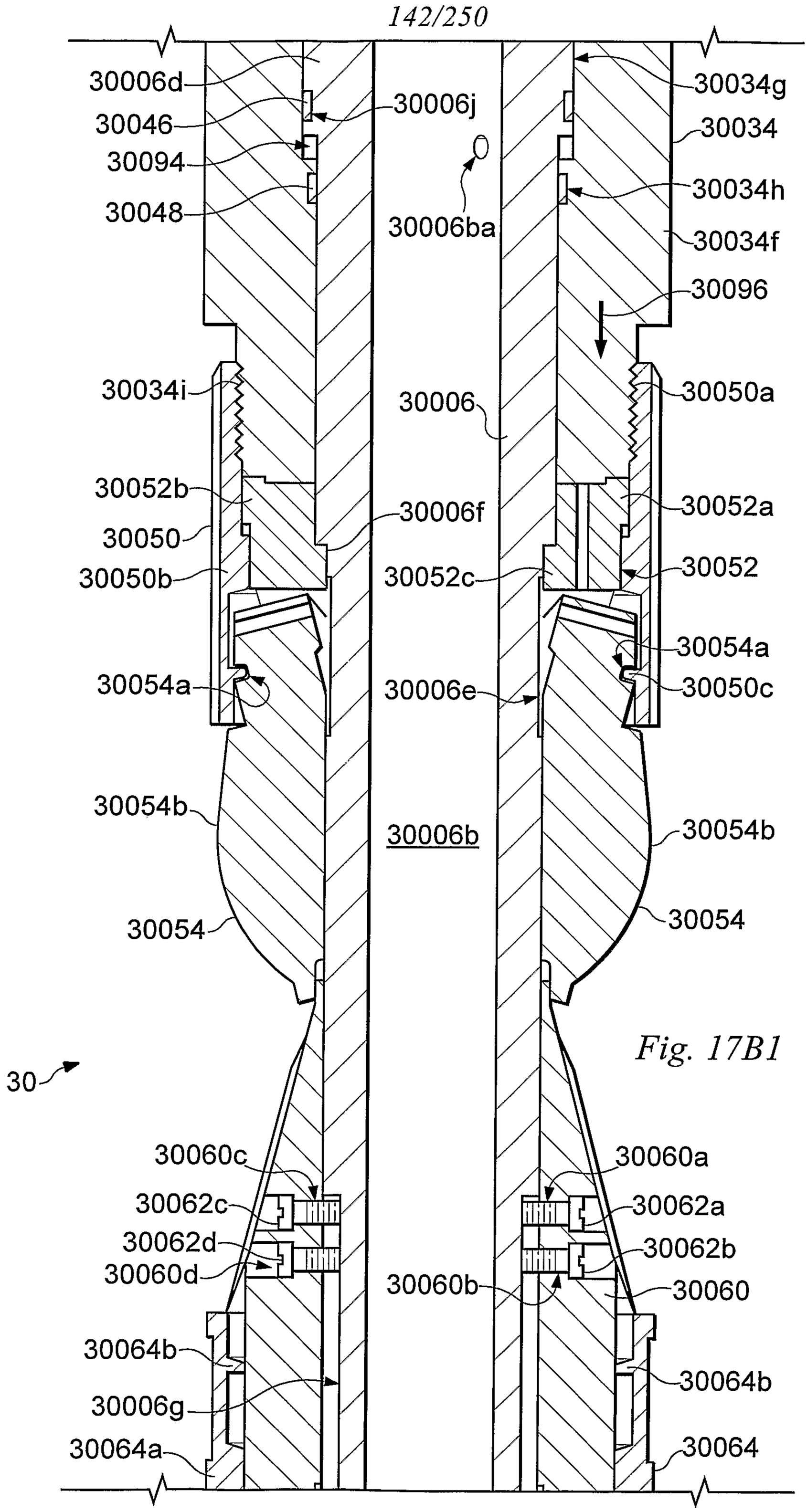

30006d
30046
30094
30048
30006j
30006ba
30034g
30034
30034h
30034f
30096
30034i
30006
30050a
30052b
30006f
30050
30052a
30050b
30052c
30052
30054a
30006e
30054a
30050c
30054b
30006b
30054b
30054
30054
30060c
30060a
30062c
30062a
30062d
30062b
30060d
30060b
30060
30064b
30064b
30006g
30064a
30064
30

Fig. 17B1

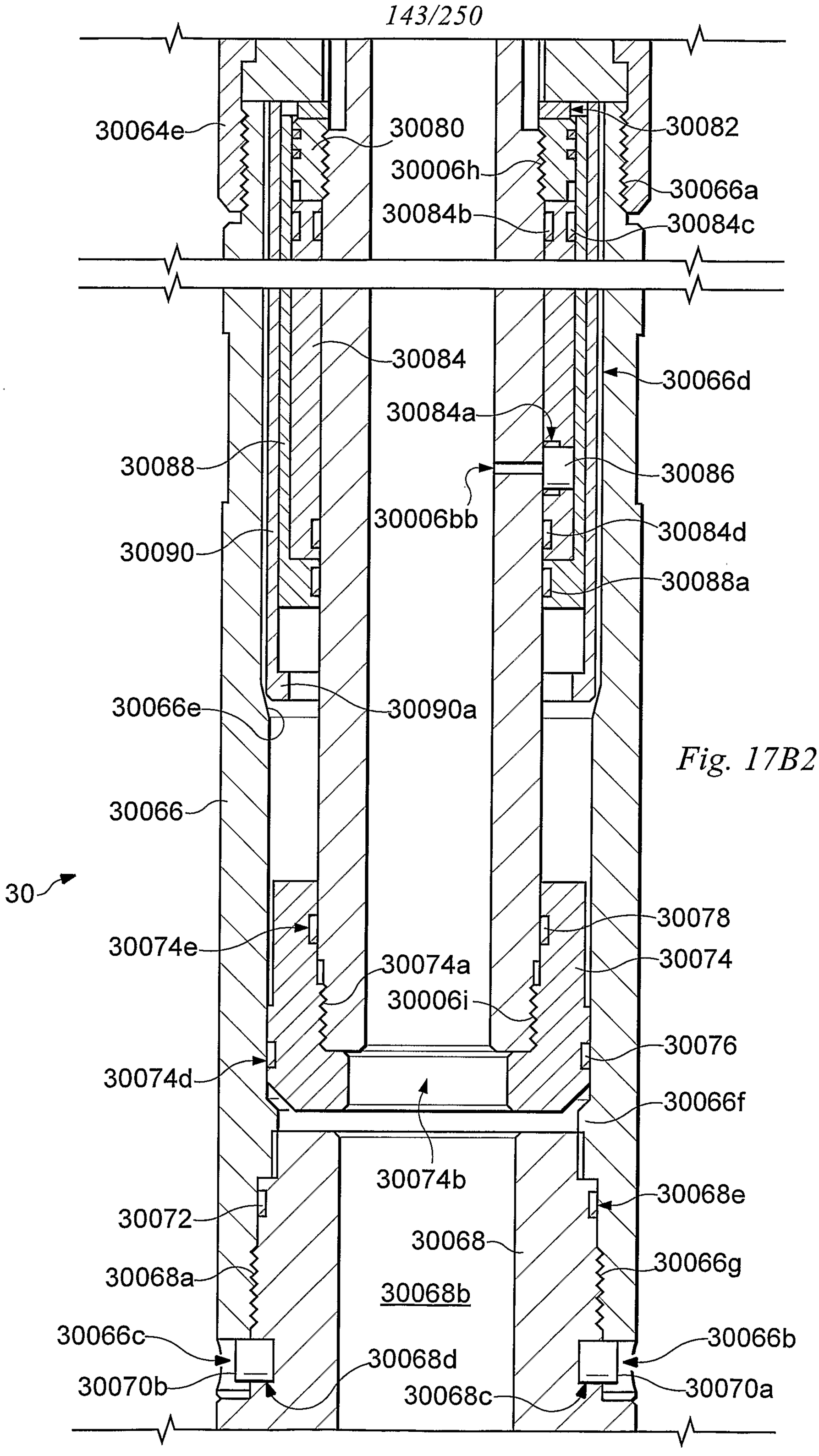

30064e
30080
30006h
30084b
30082
30066a
30084c
30084
30066d
30084a
30088
30086
30006bb
30090
30084d
30088a
30066e
30090a
30066
30
30078
30074e
30074a
30074
30006i
30076
30074d
30066f
30074b
30072
30068e
30068
30068a
30066g
30068b
30066c
30066b
30068d
30070b
30068c
30070a

Fig. 17B2

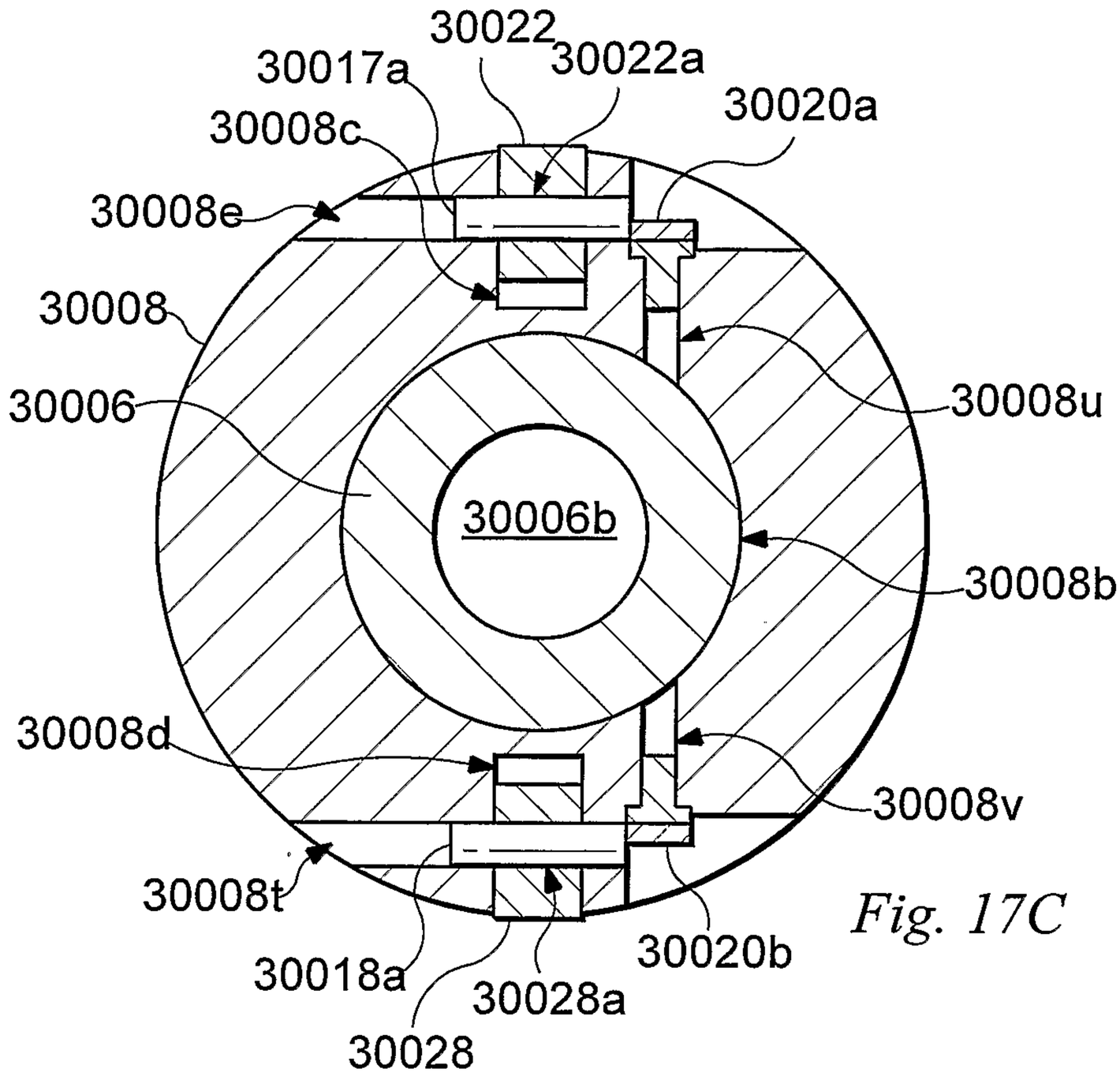


Fig. 17C

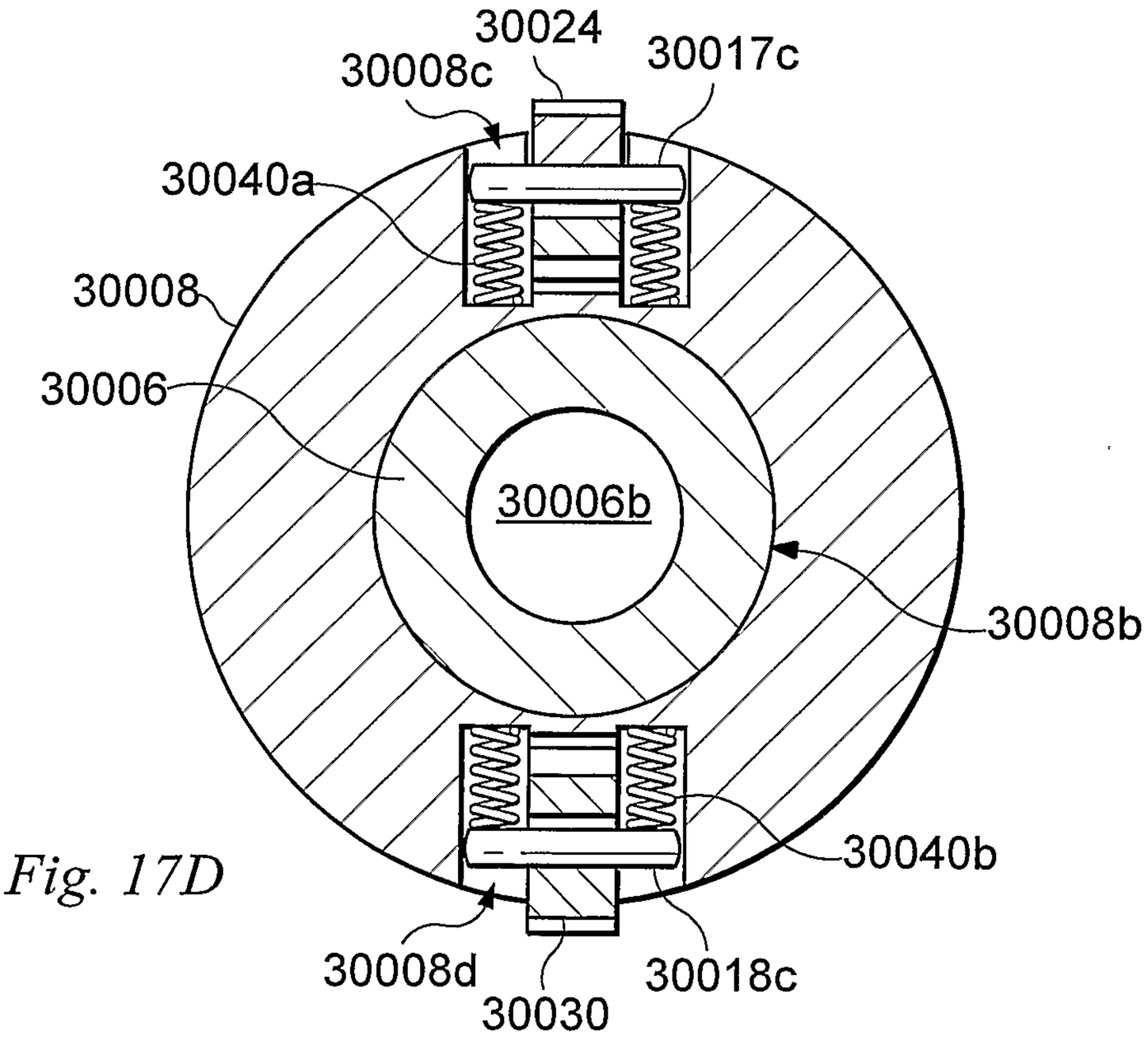


Fig. 17D

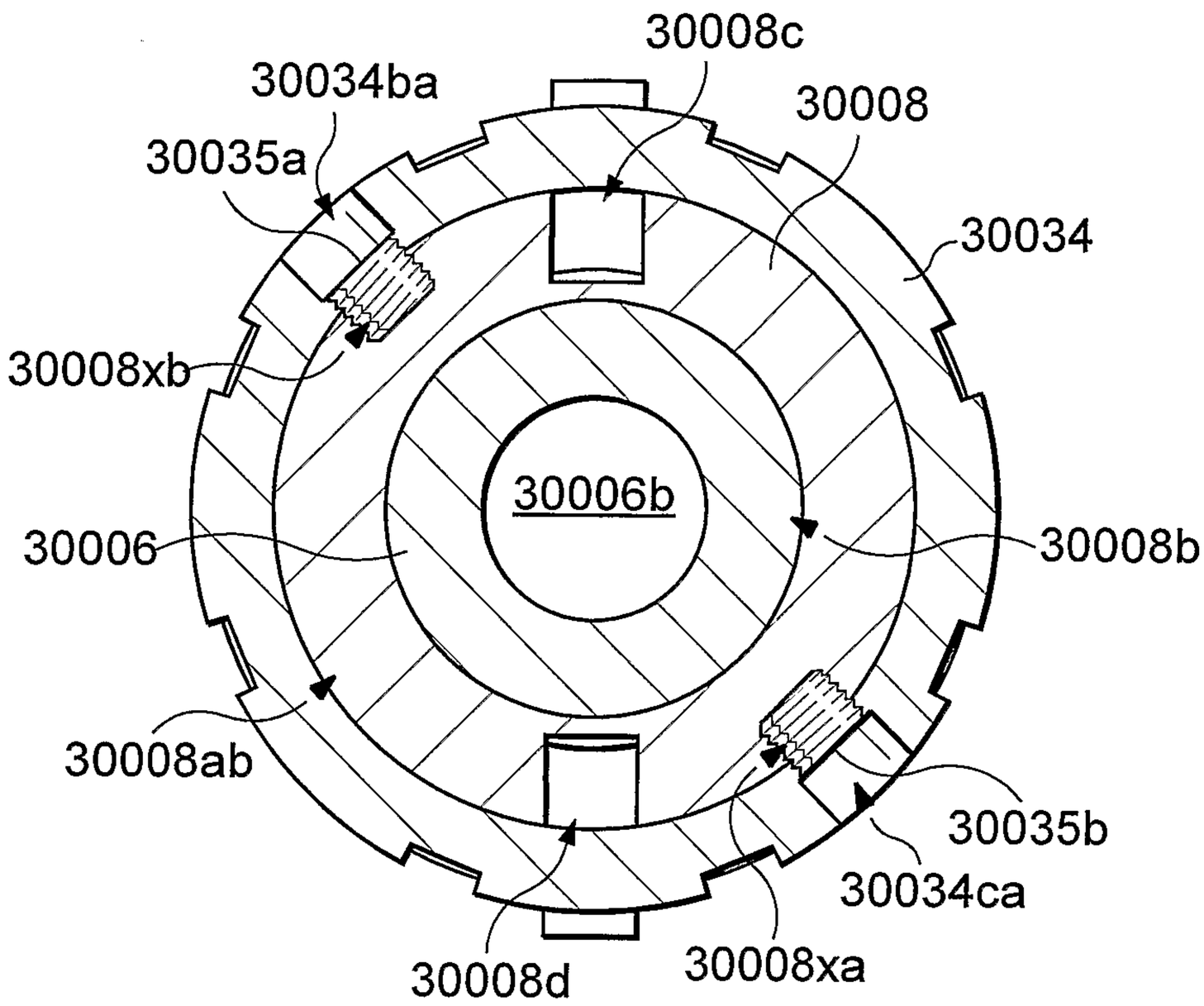


Fig. 17E

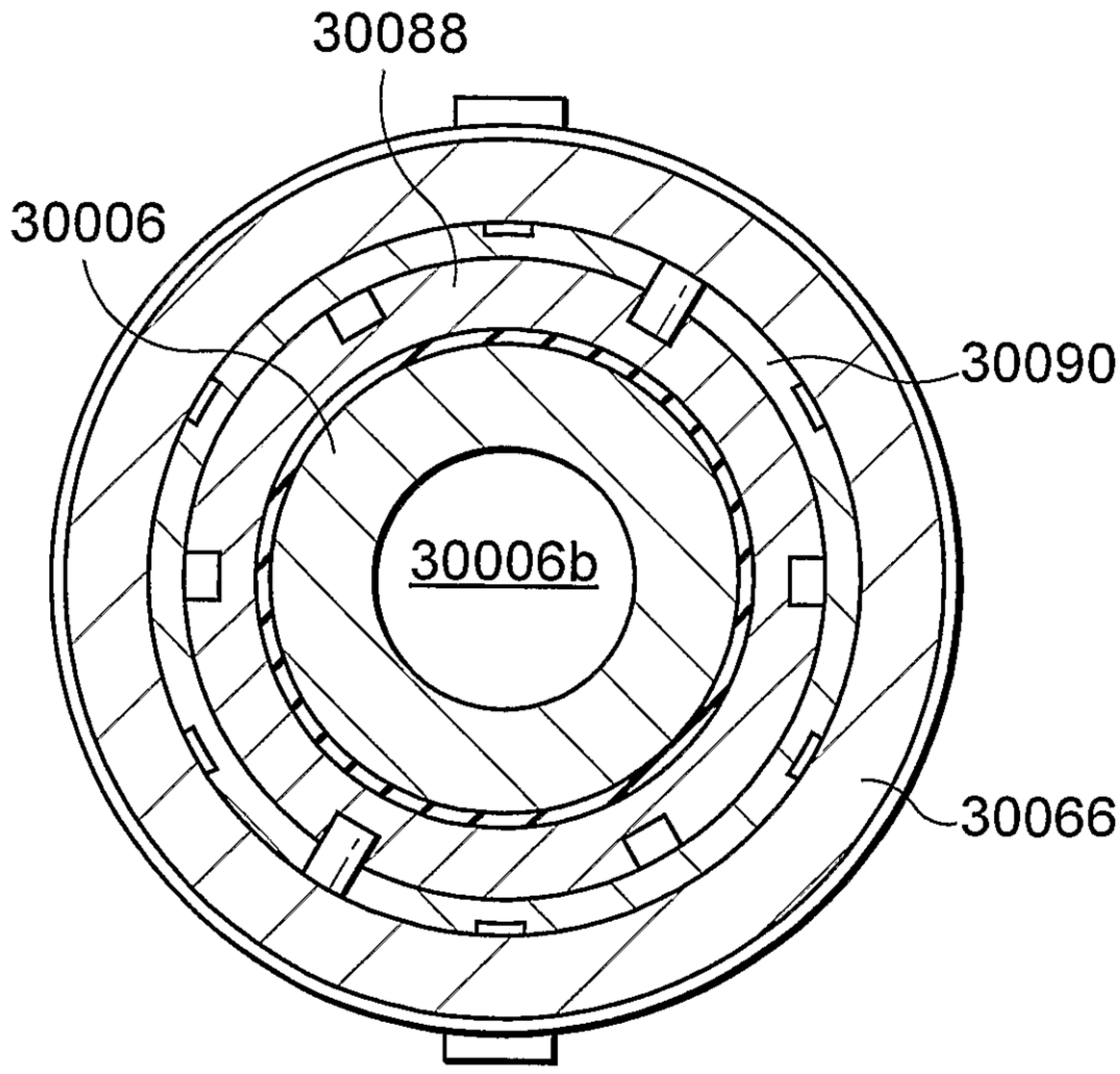


Fig. 17F

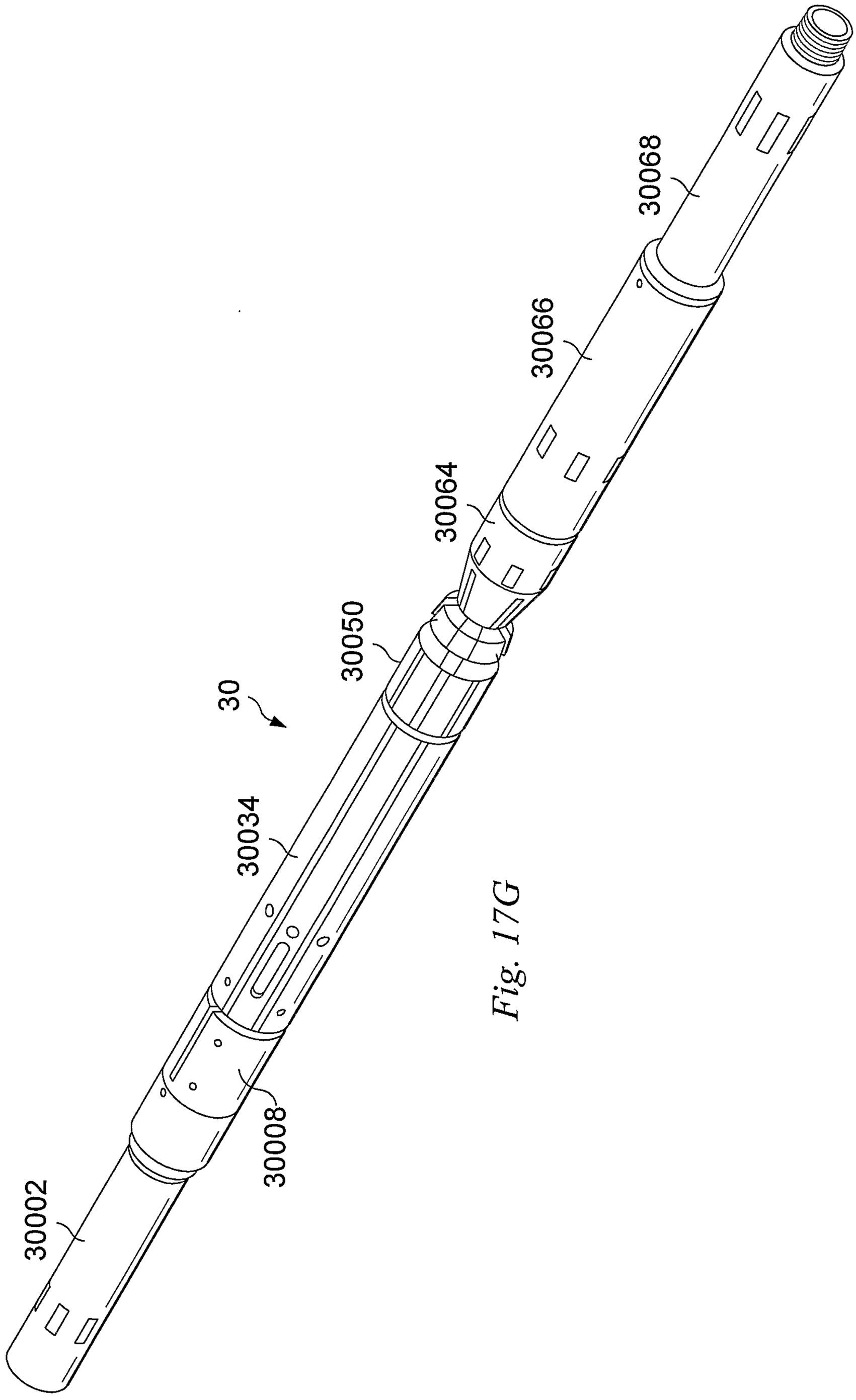


Fig. 17G

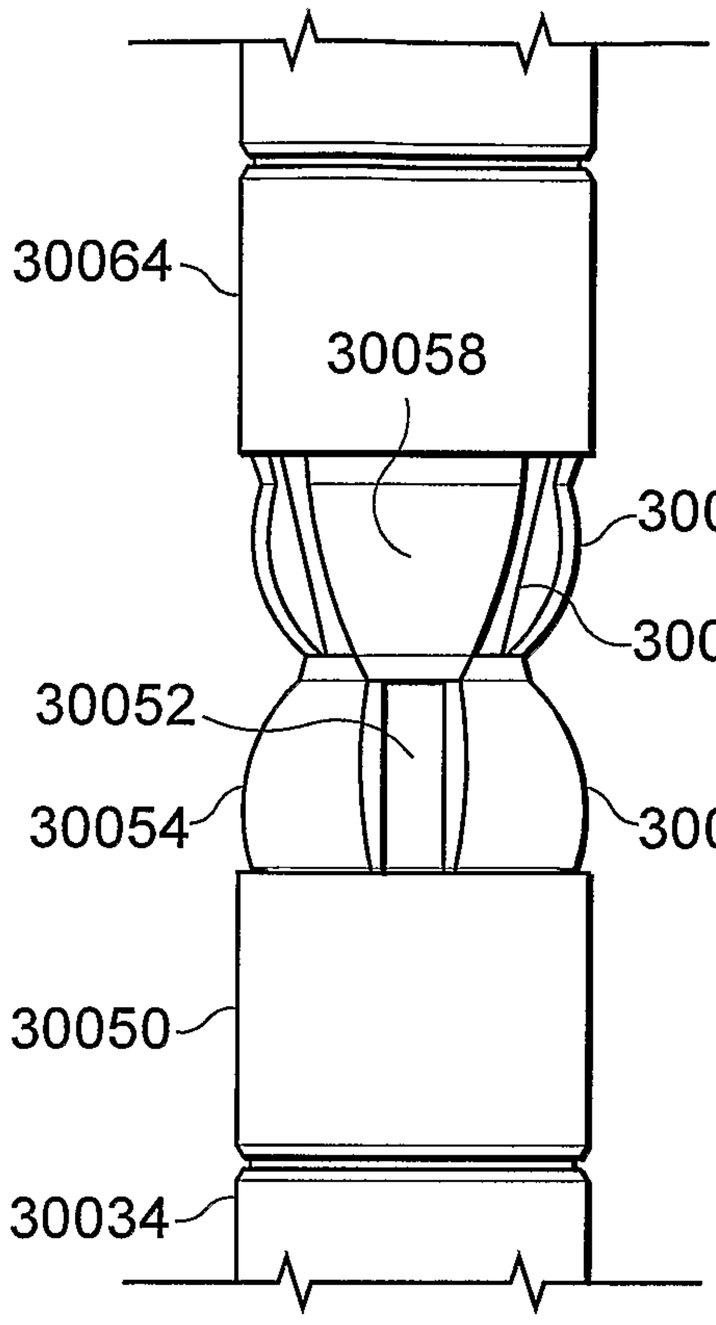


Fig. 17H

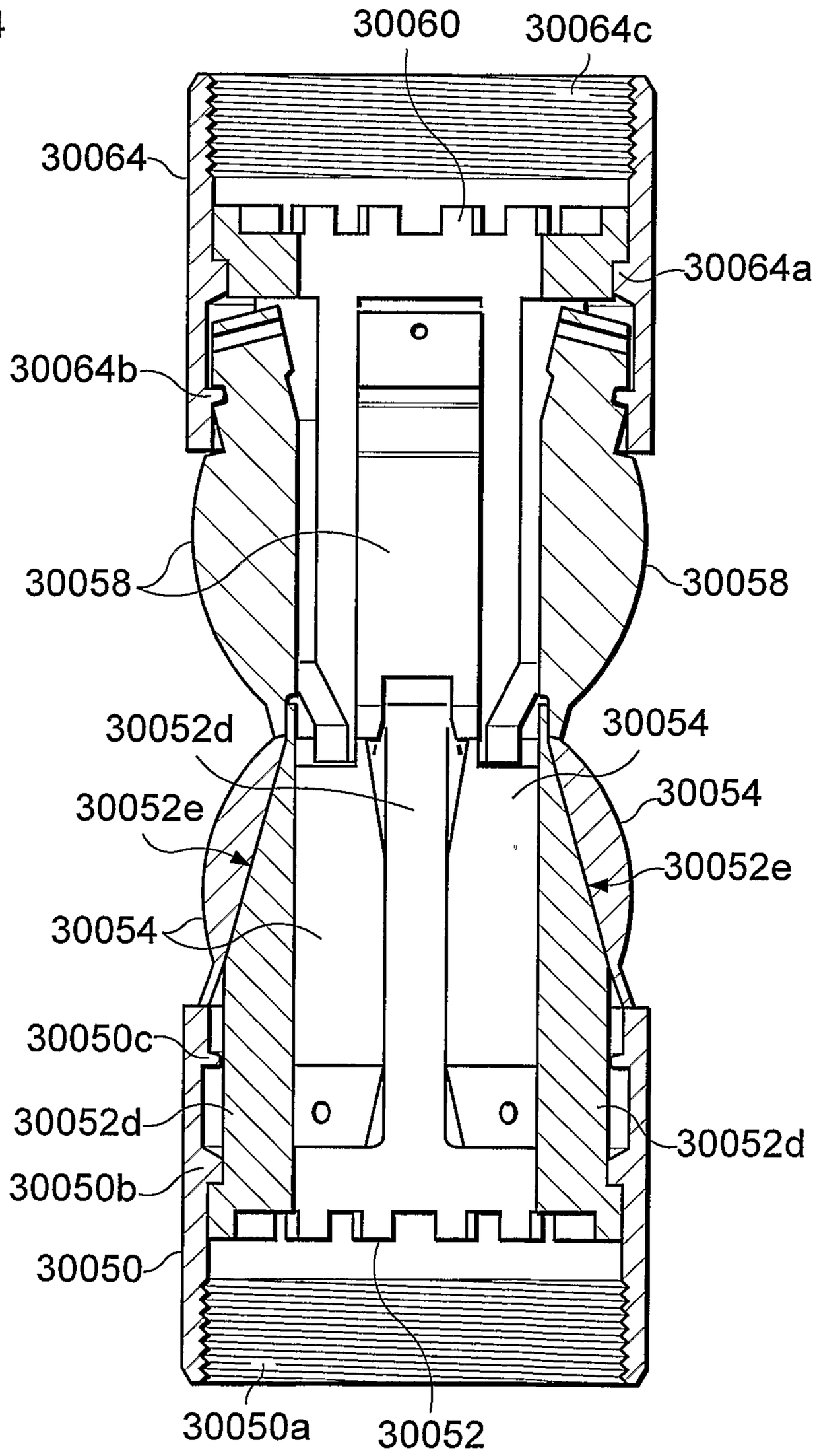


FIG. 17I

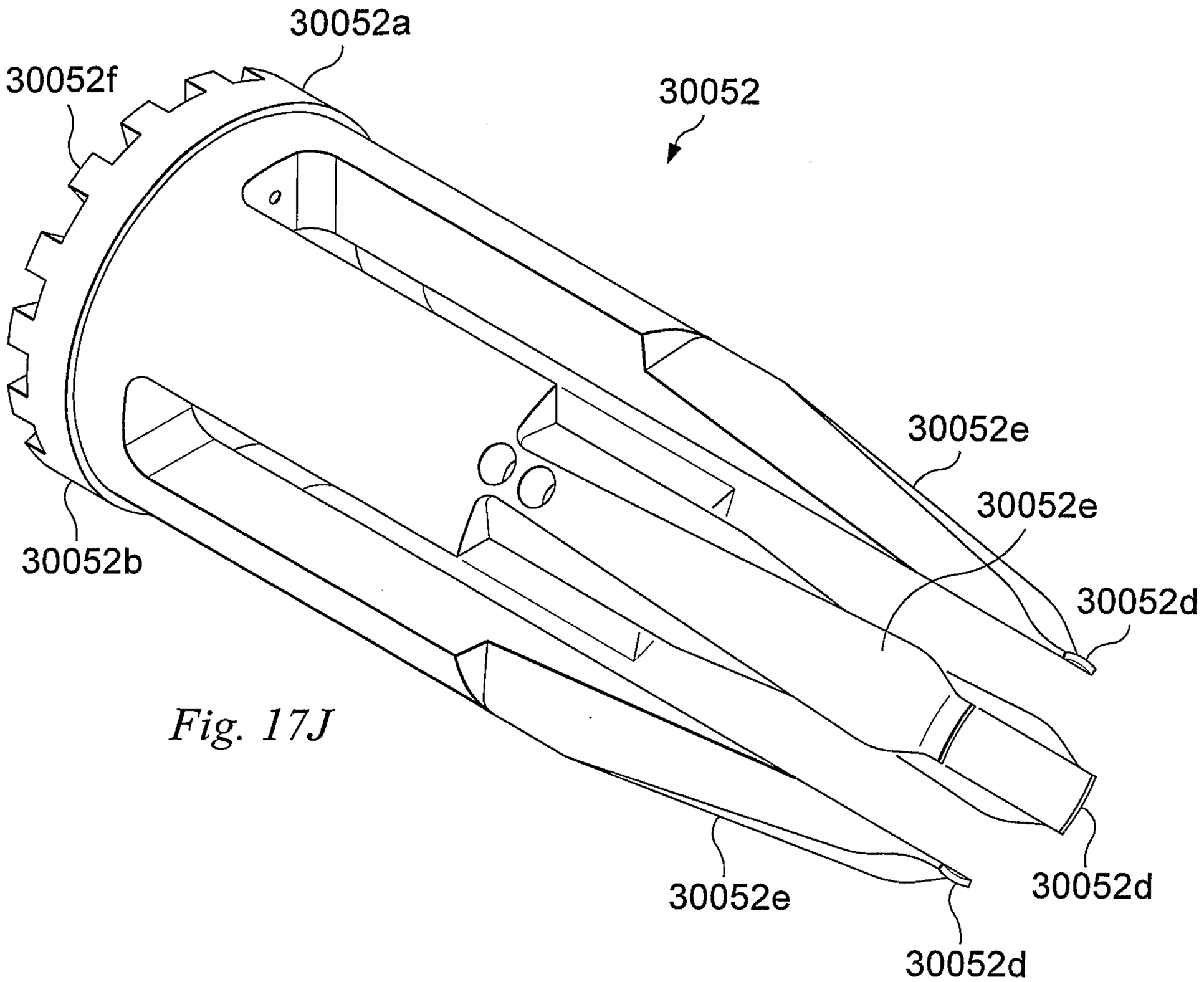


Fig. 17J

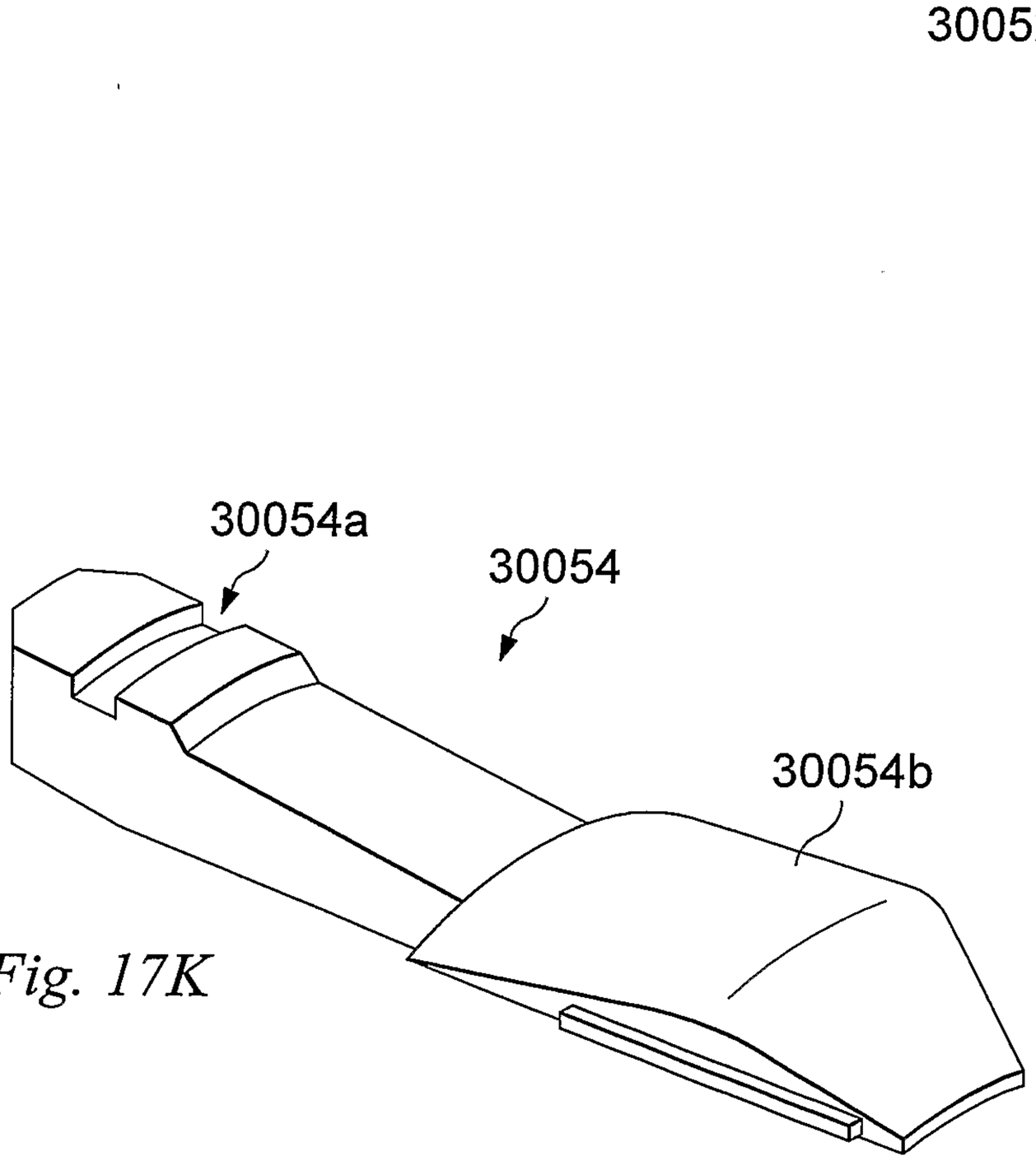


Fig. 17K

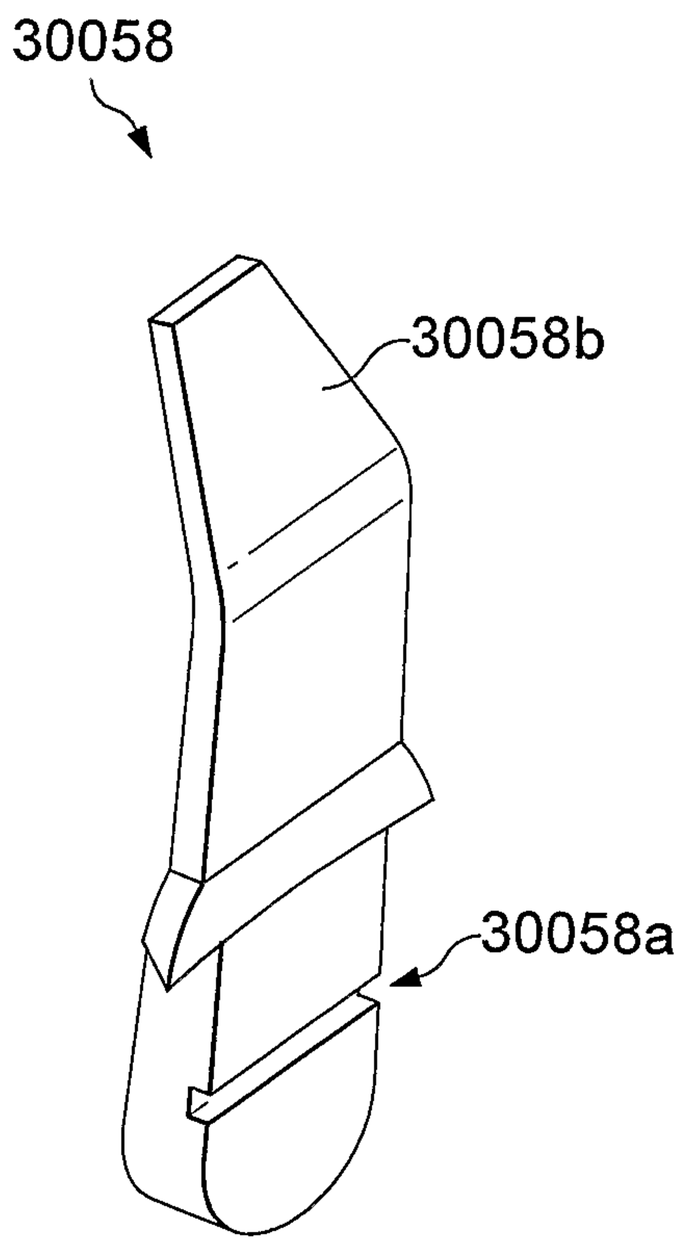


Fig. 17L

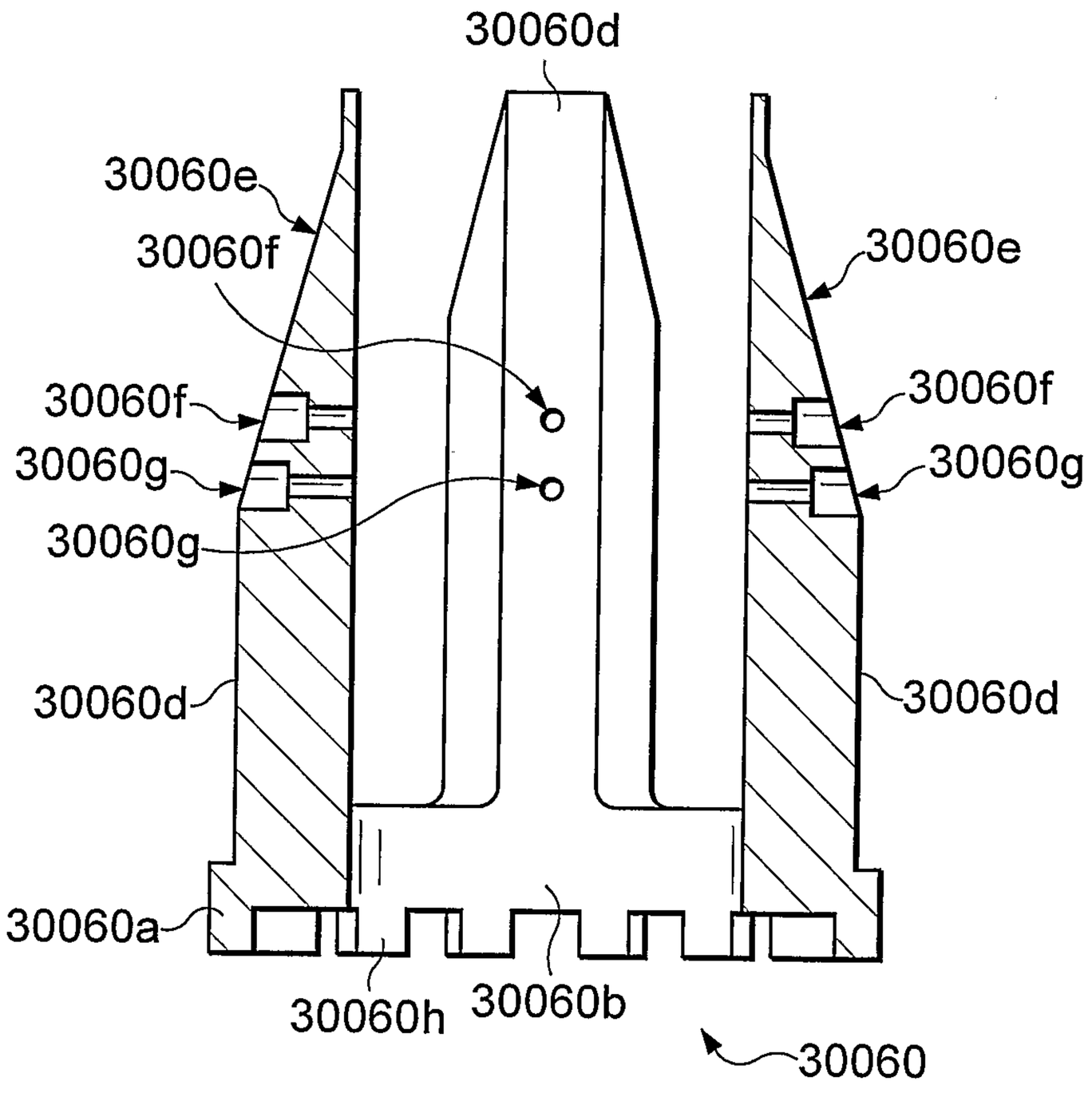


Fig. 17M

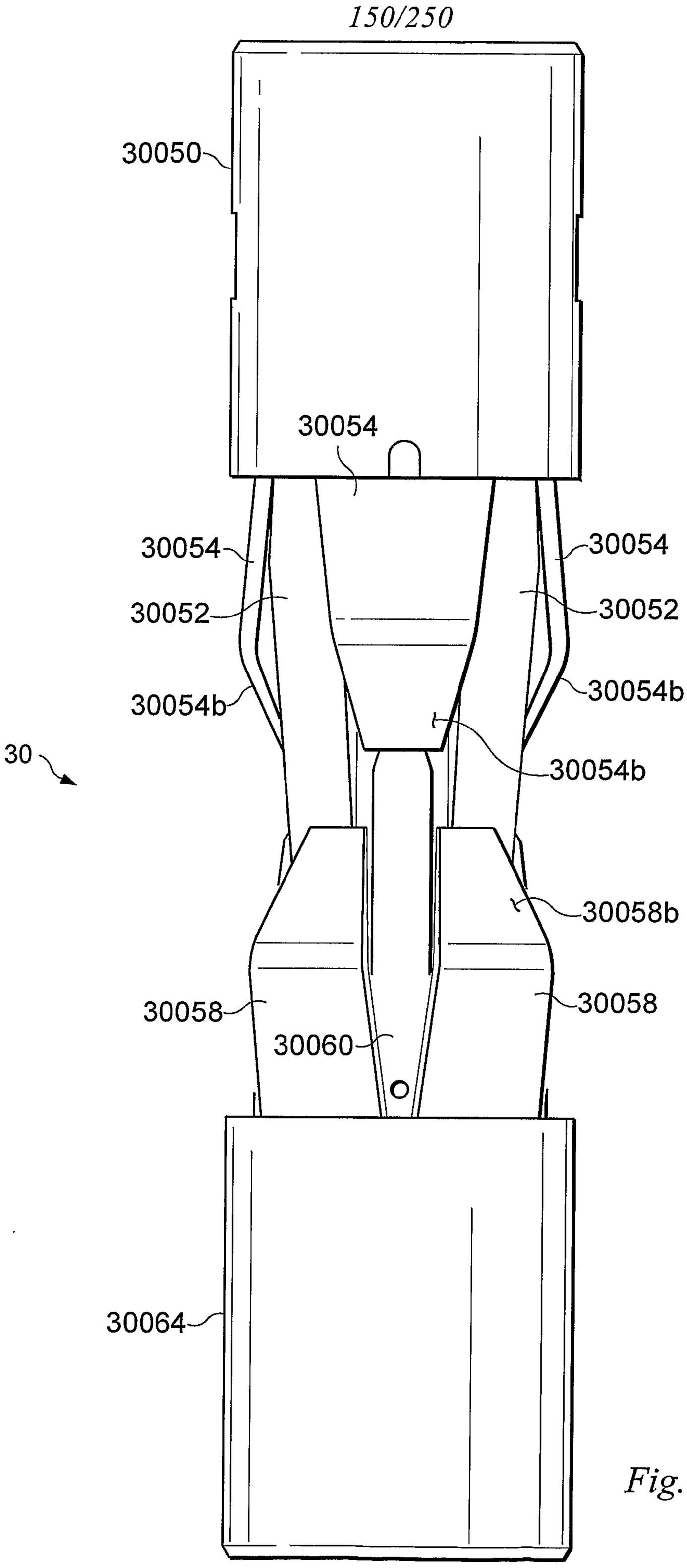

150/250
30050
30054
30054
30054
30052
30052
30054b
30054b
30054b
30
30058b
30058
30058
30060
30064

Fig. 17N

151/250

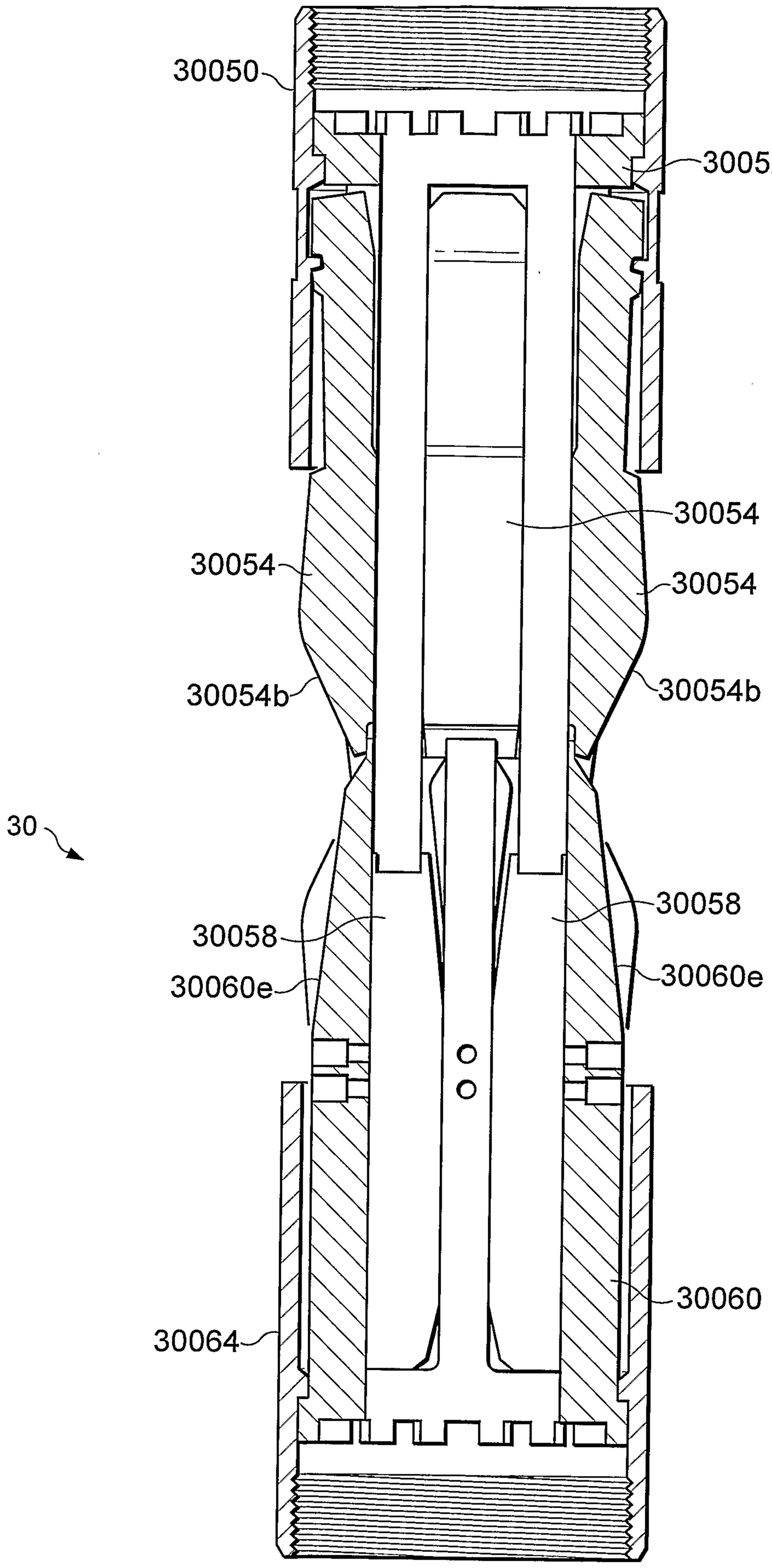


Fig. 17O

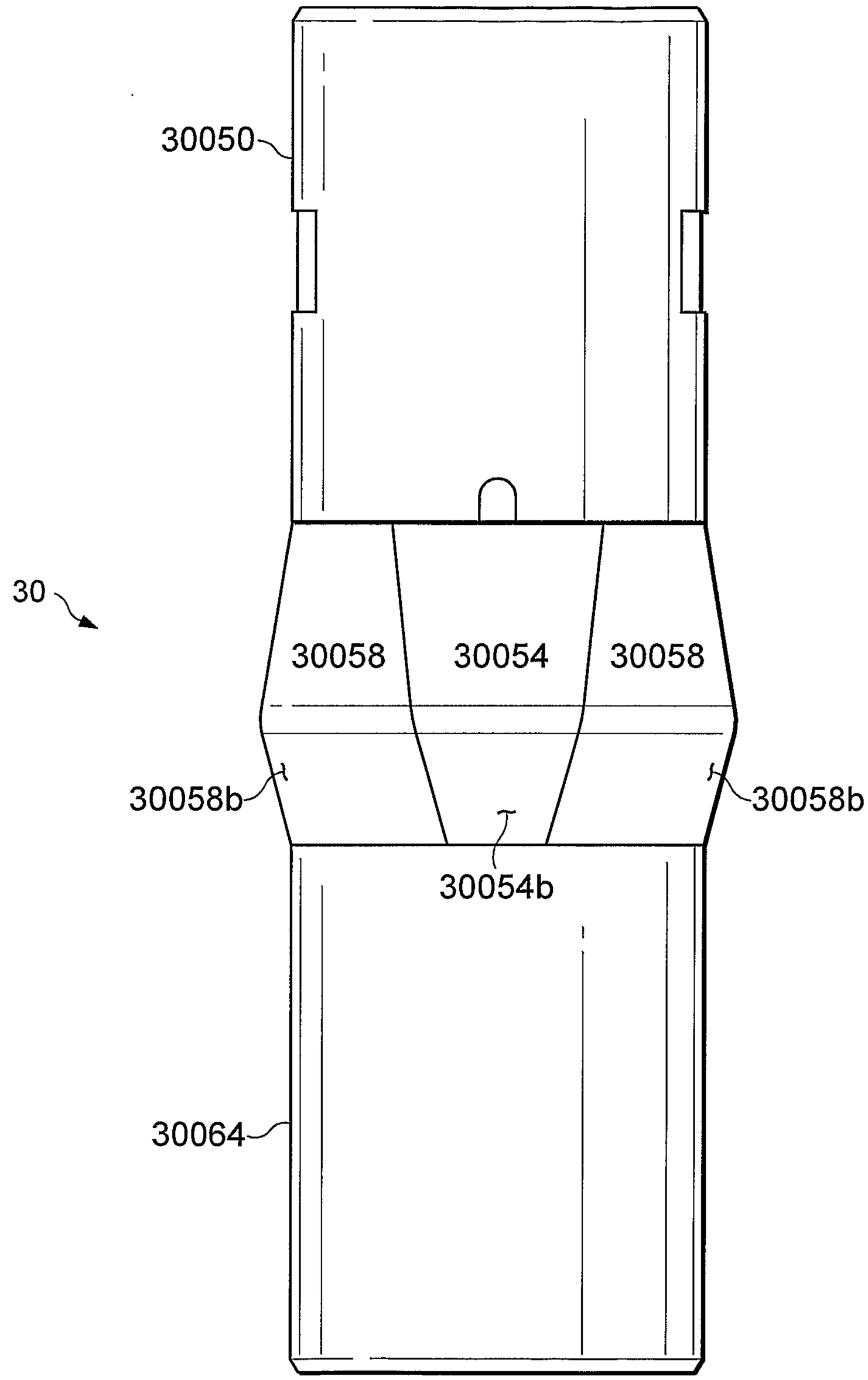


Fig. 17P

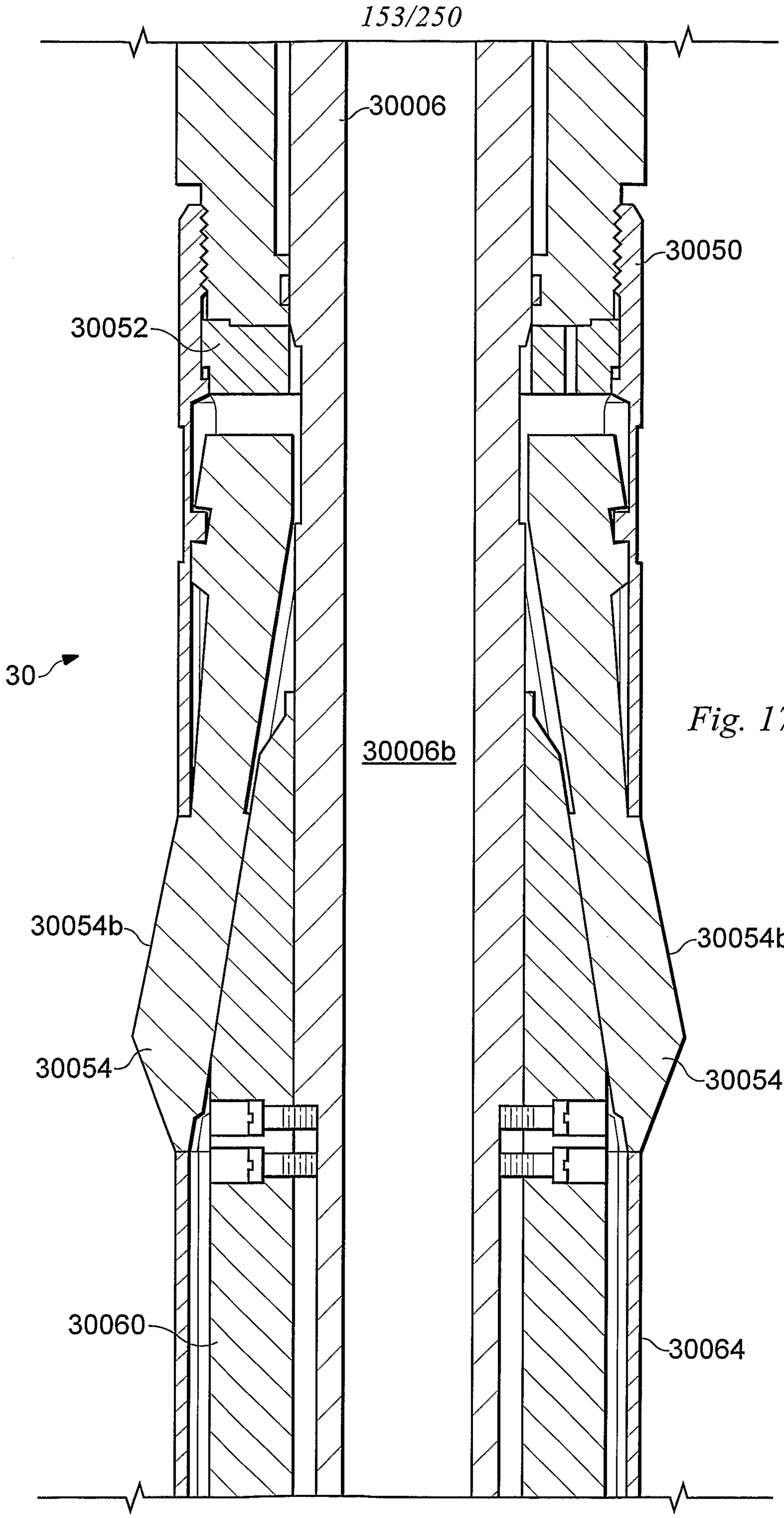

153/250
30006
30050
30052
30
30006b
30054b
30054
30060
30064

Fig. 17R

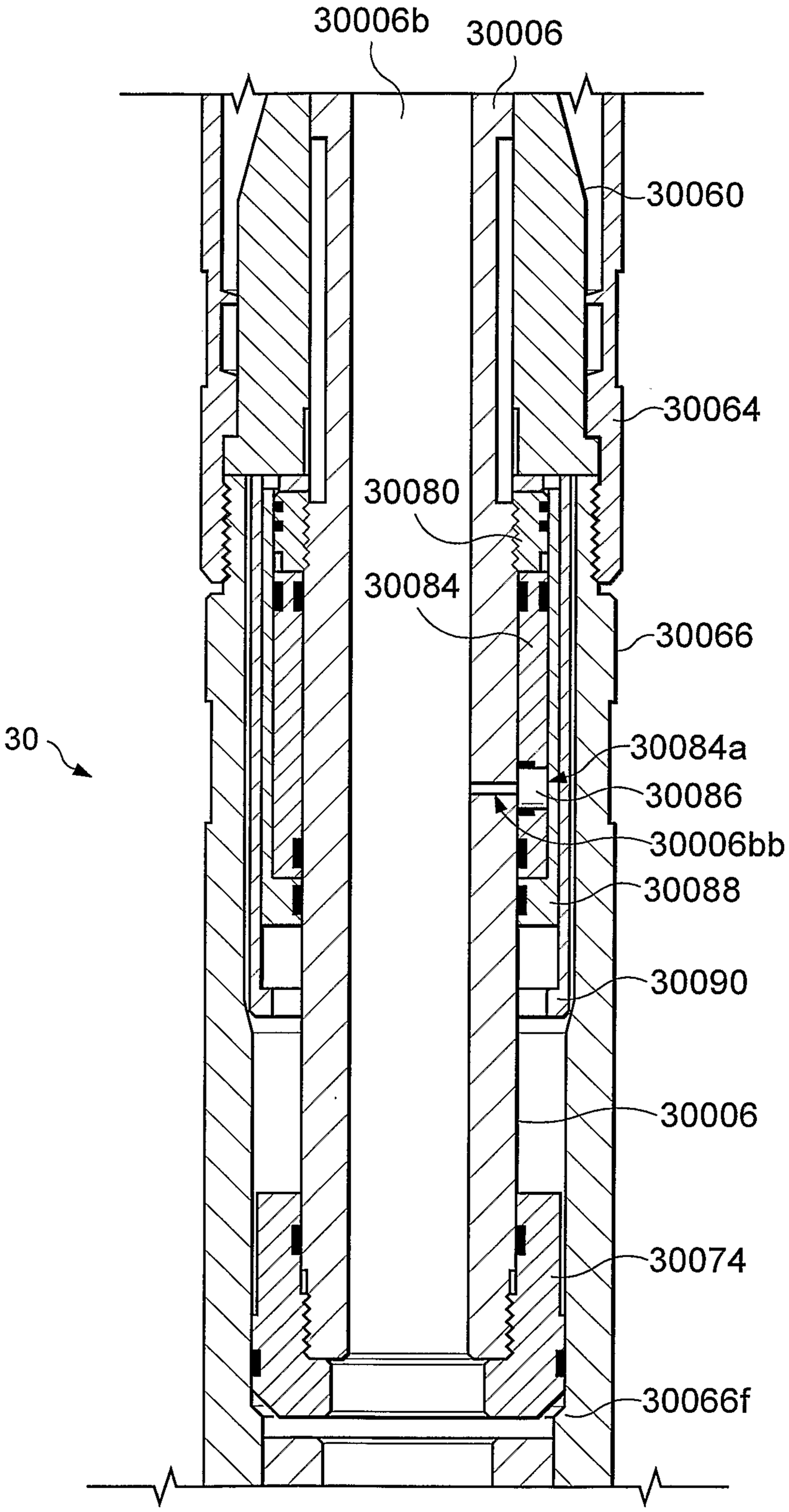

30006b
30006
30060
30064
30080
30084
30066
30
30084a
30086
30006bb
30088
30090
30006
30074
30066f

Fig. 17S

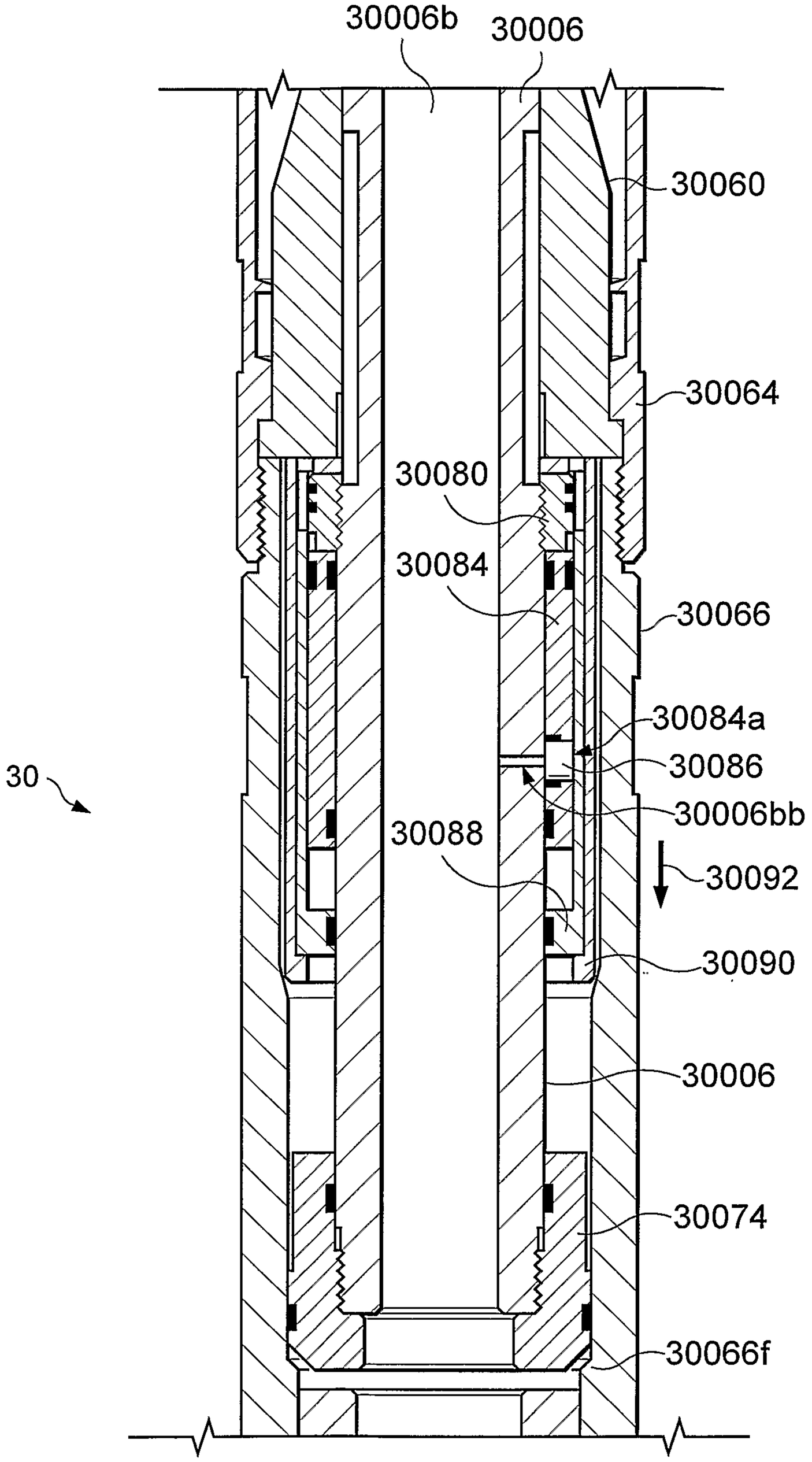

30006b
30006
30060
30064
30080
30084
30066
30084a
30086
30006bb
30092
30088
30090
30006
30074
30066f
30

Fig. 17T

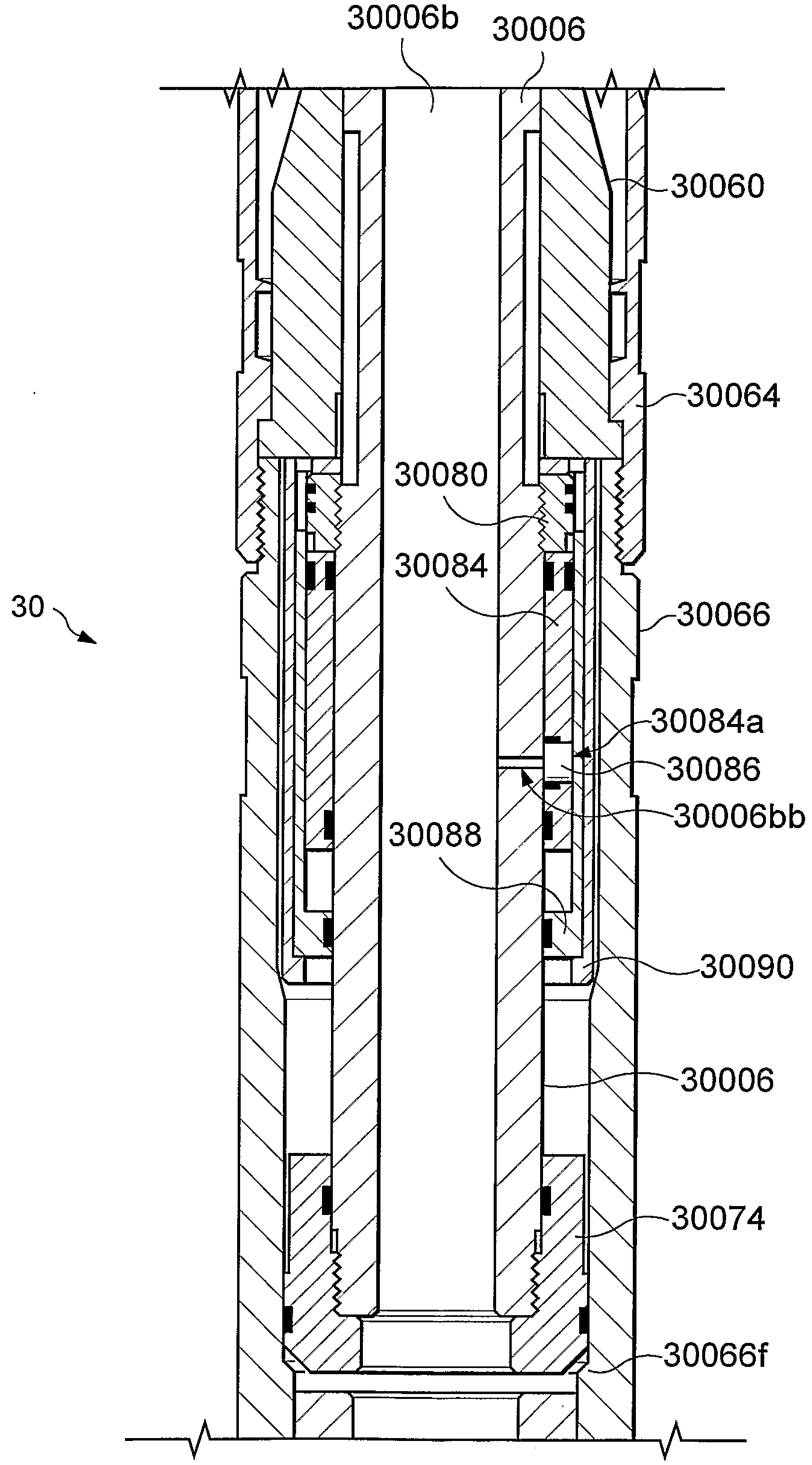

30006b
30006
30060
30064
30080
30084
30066
30
30084a
30086
30006bb
30088
30090
30006
30074
30066f

Fig. 17U

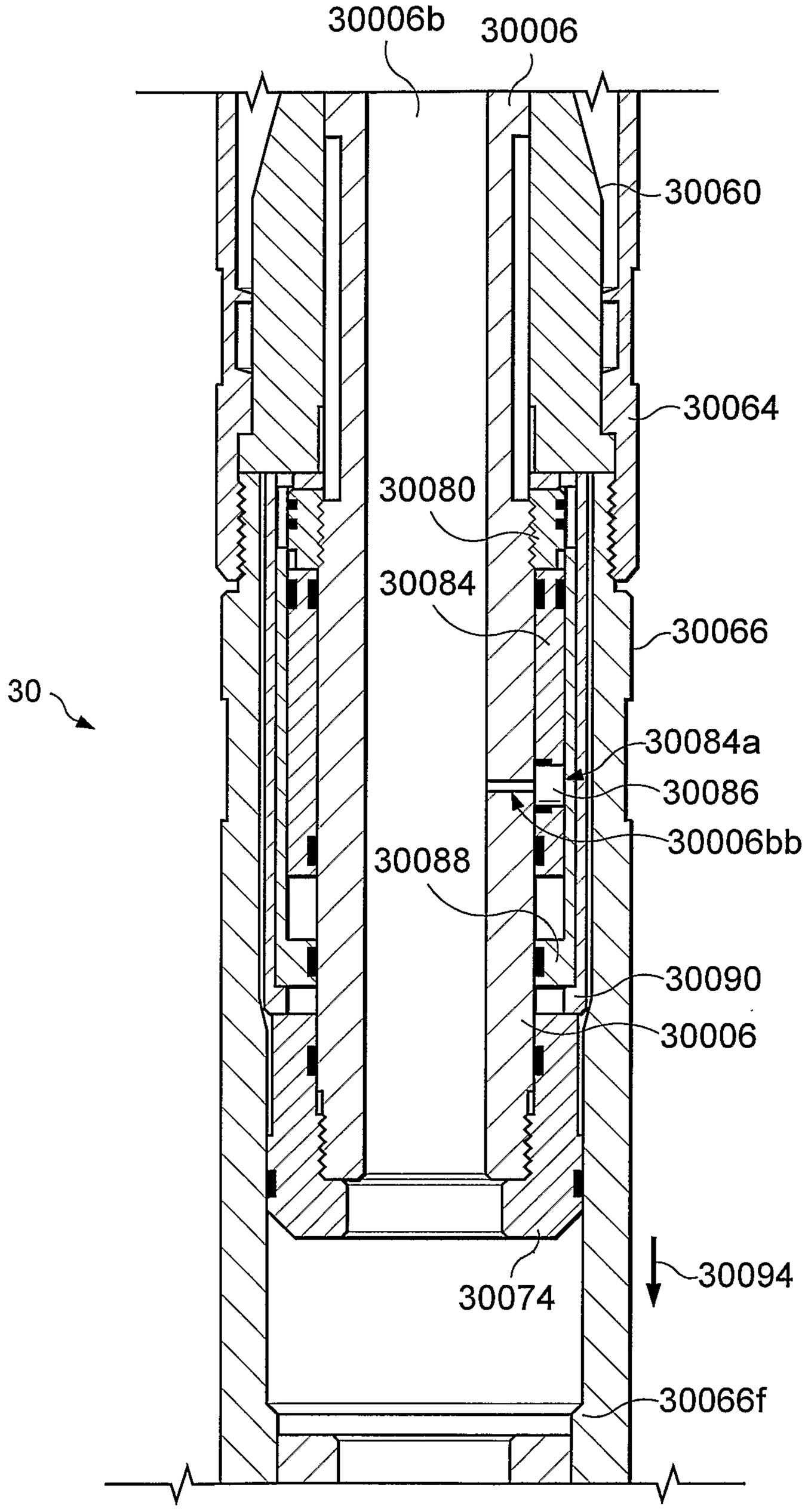

30006b
30006
30060
30064
30080
30084
30066
30
30084a
30086
30006bb
30088
30090
30006
30074
30094
30066f

Fig. 17V

Fig. 17W

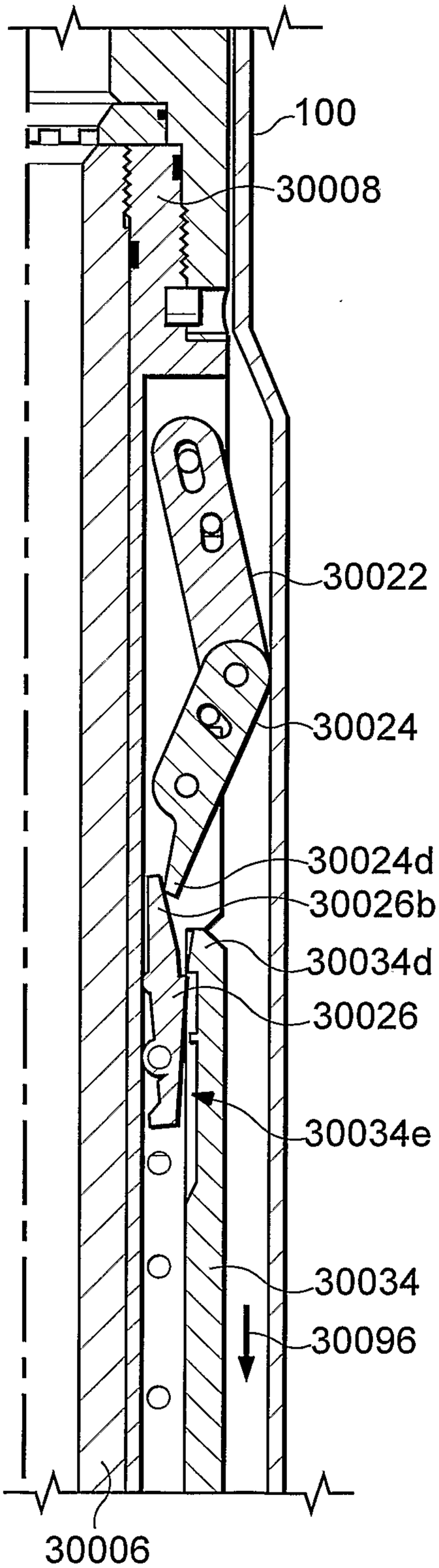


Fig. 17X

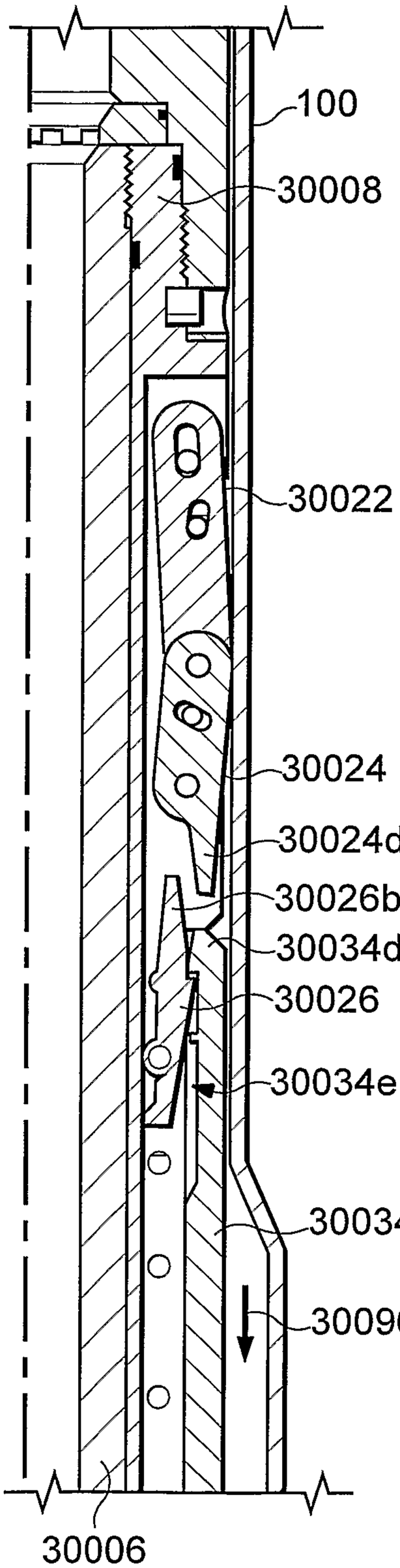
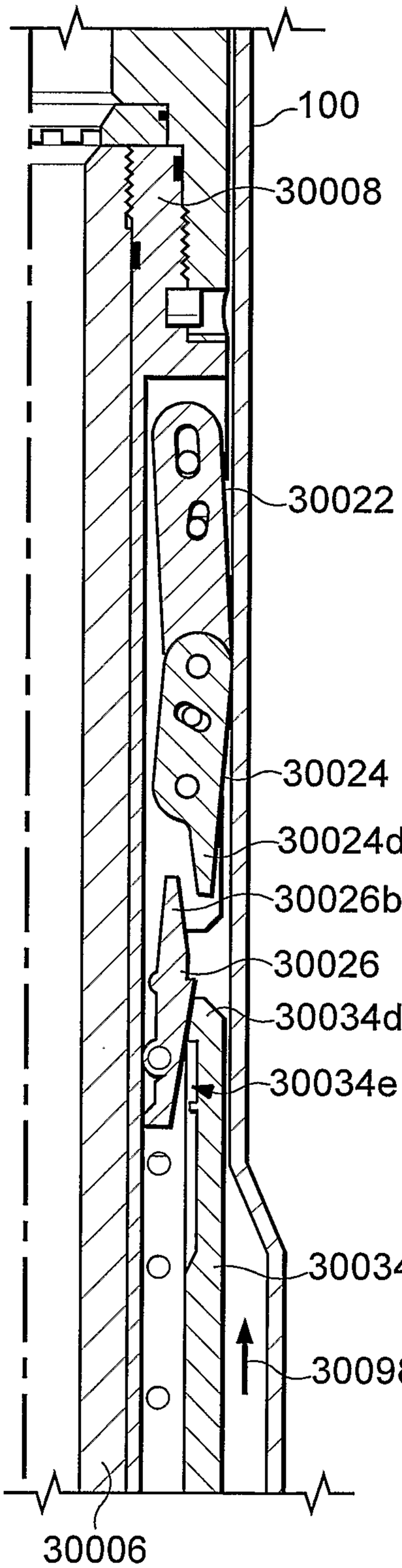


Fig. 17Y



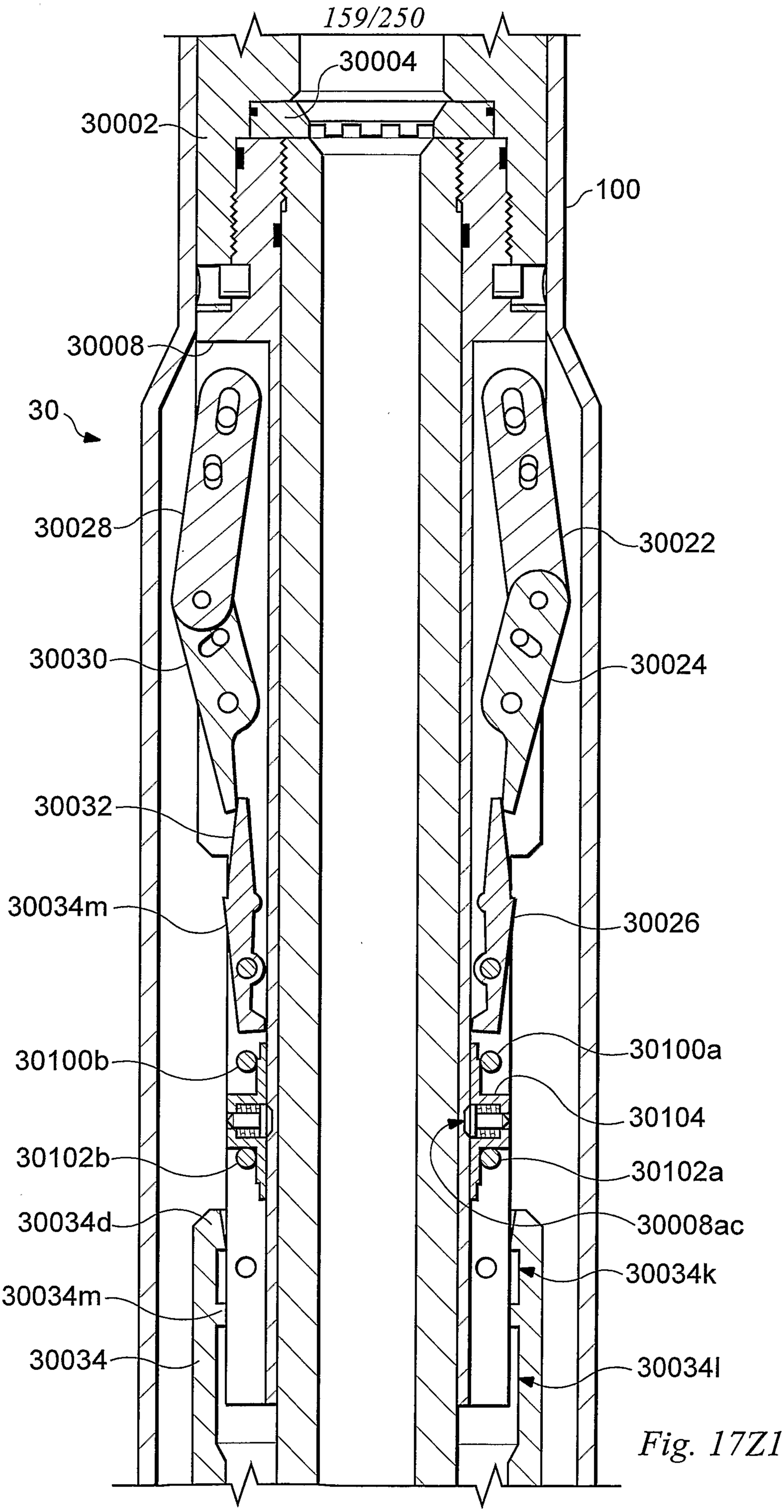

159/250
30004
30002
100
30008
30
30028
30022
30030
30024
30032
30026
30034m
30100a
30100b
30104
30102b
30102a
30034d
30008ac
30034m
30034k
30034
30034l

Fig. 17Z1

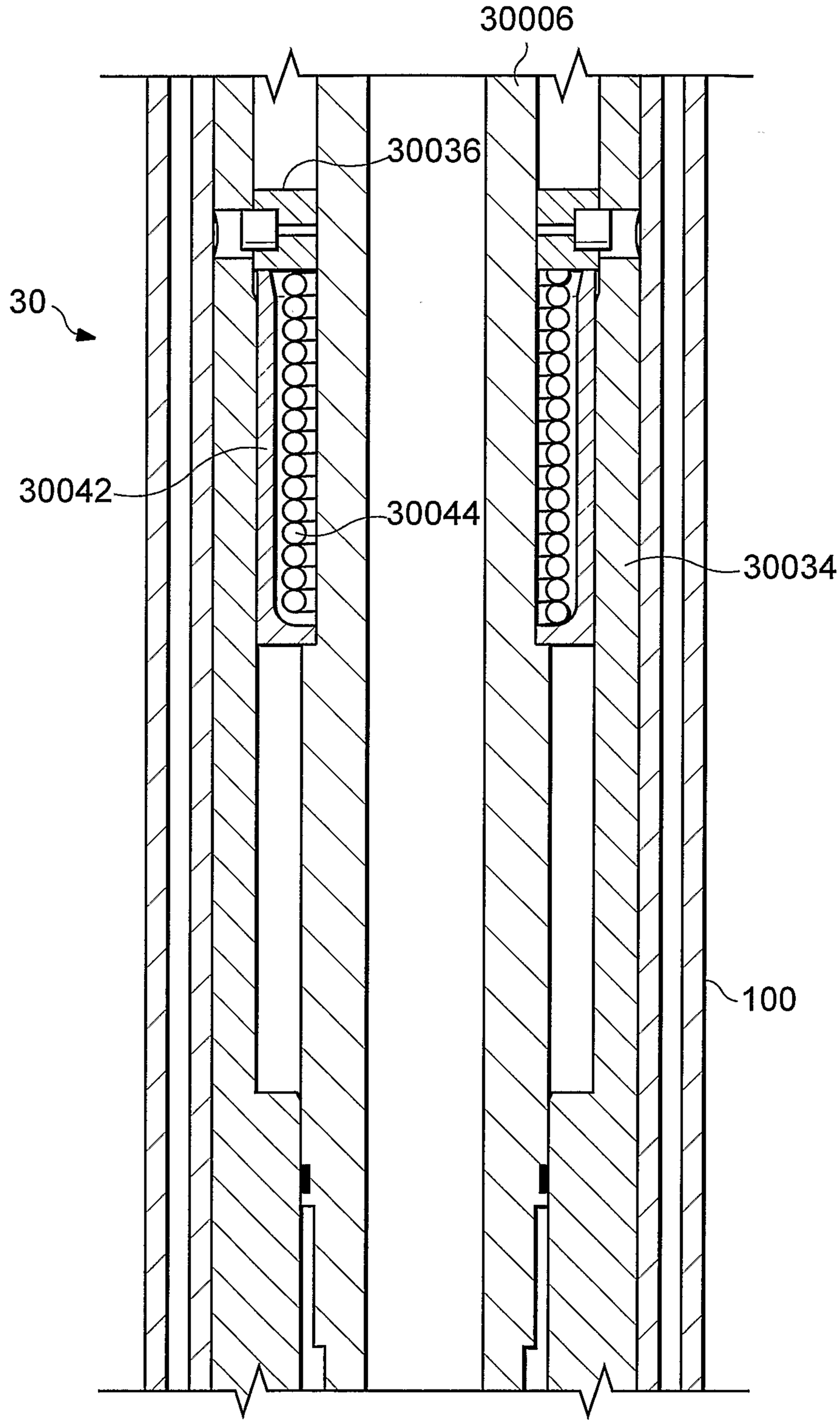


Fig. 17Z2

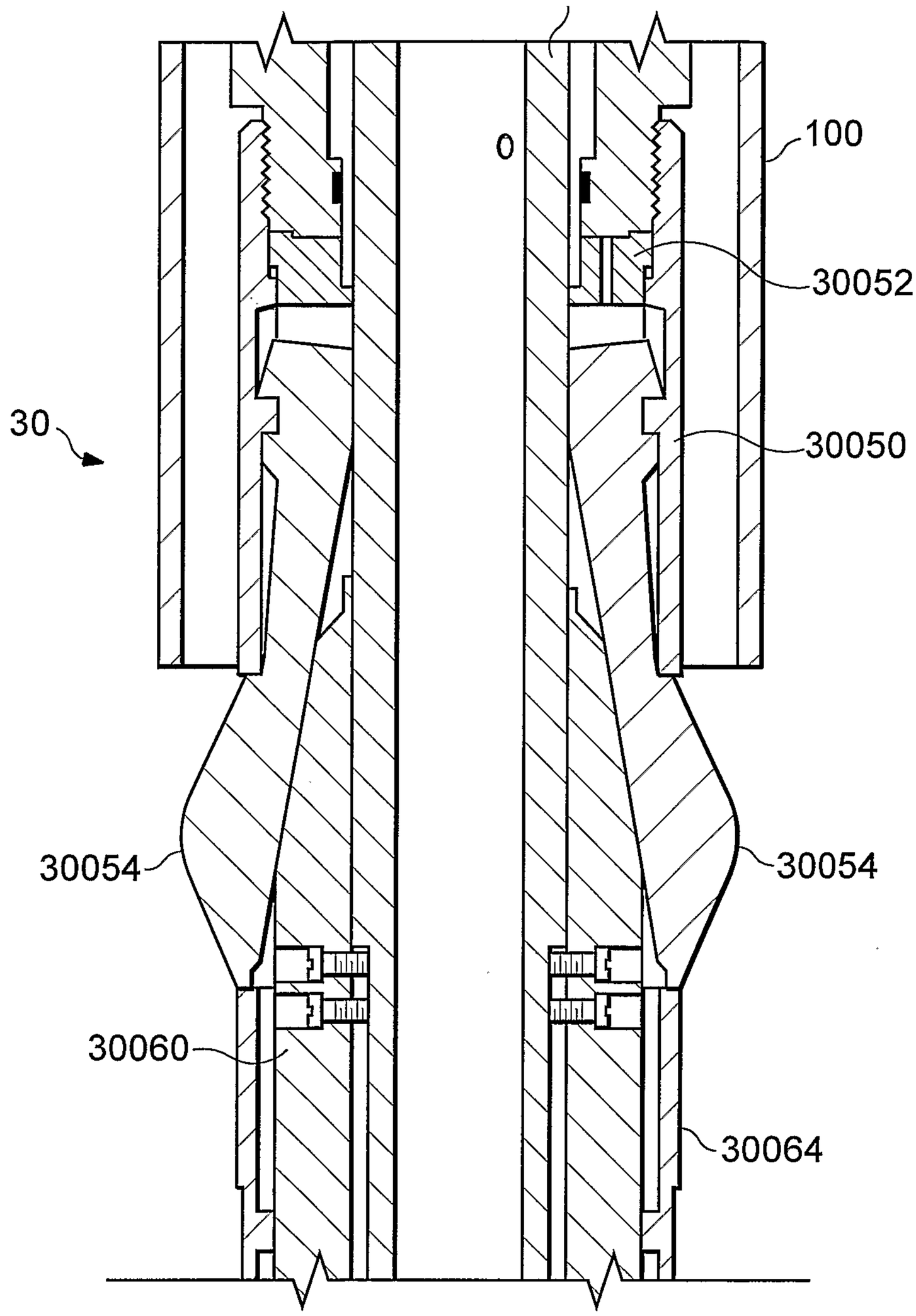


Fig. 17Z3

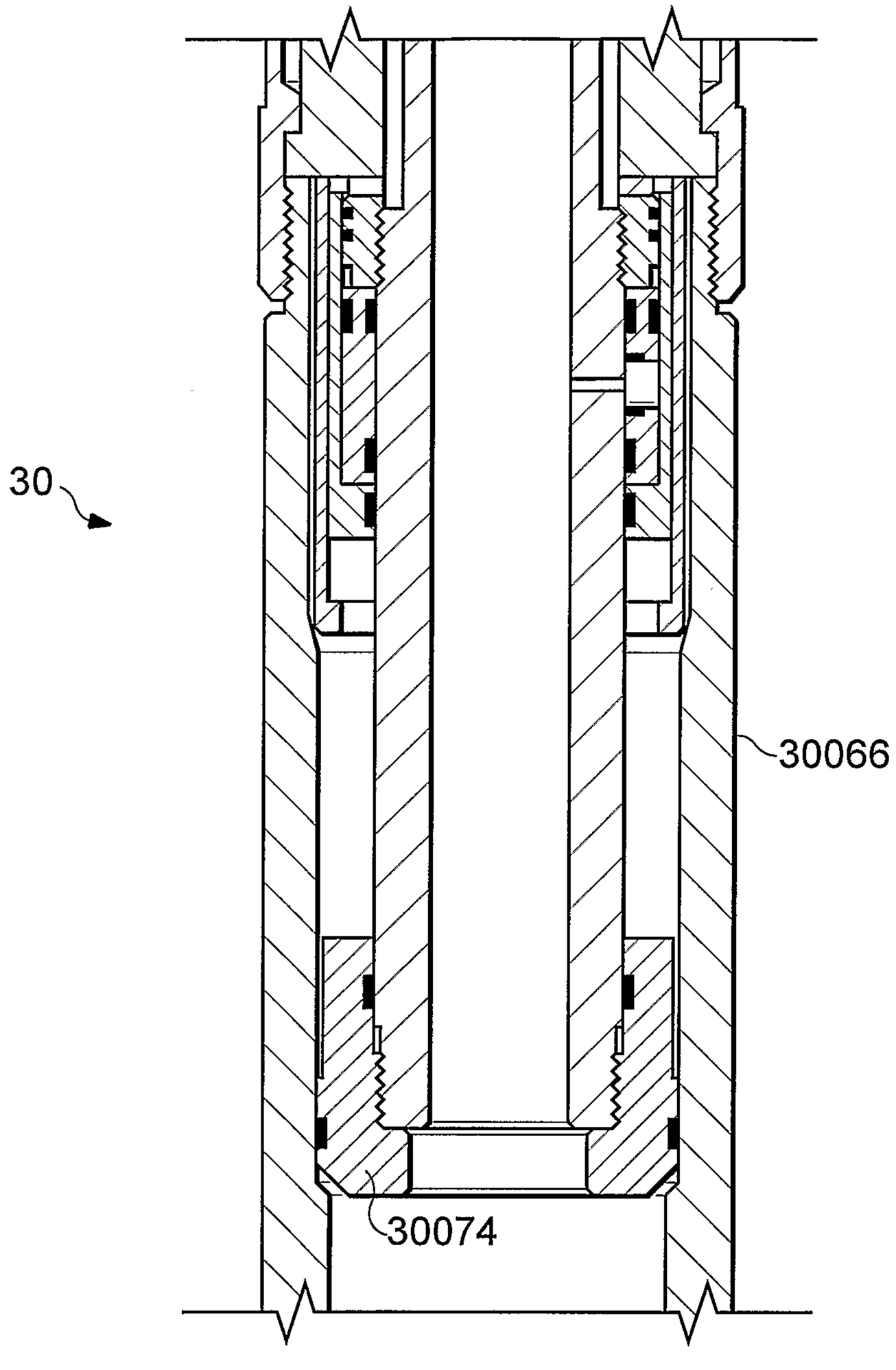


Fig. 17Z4

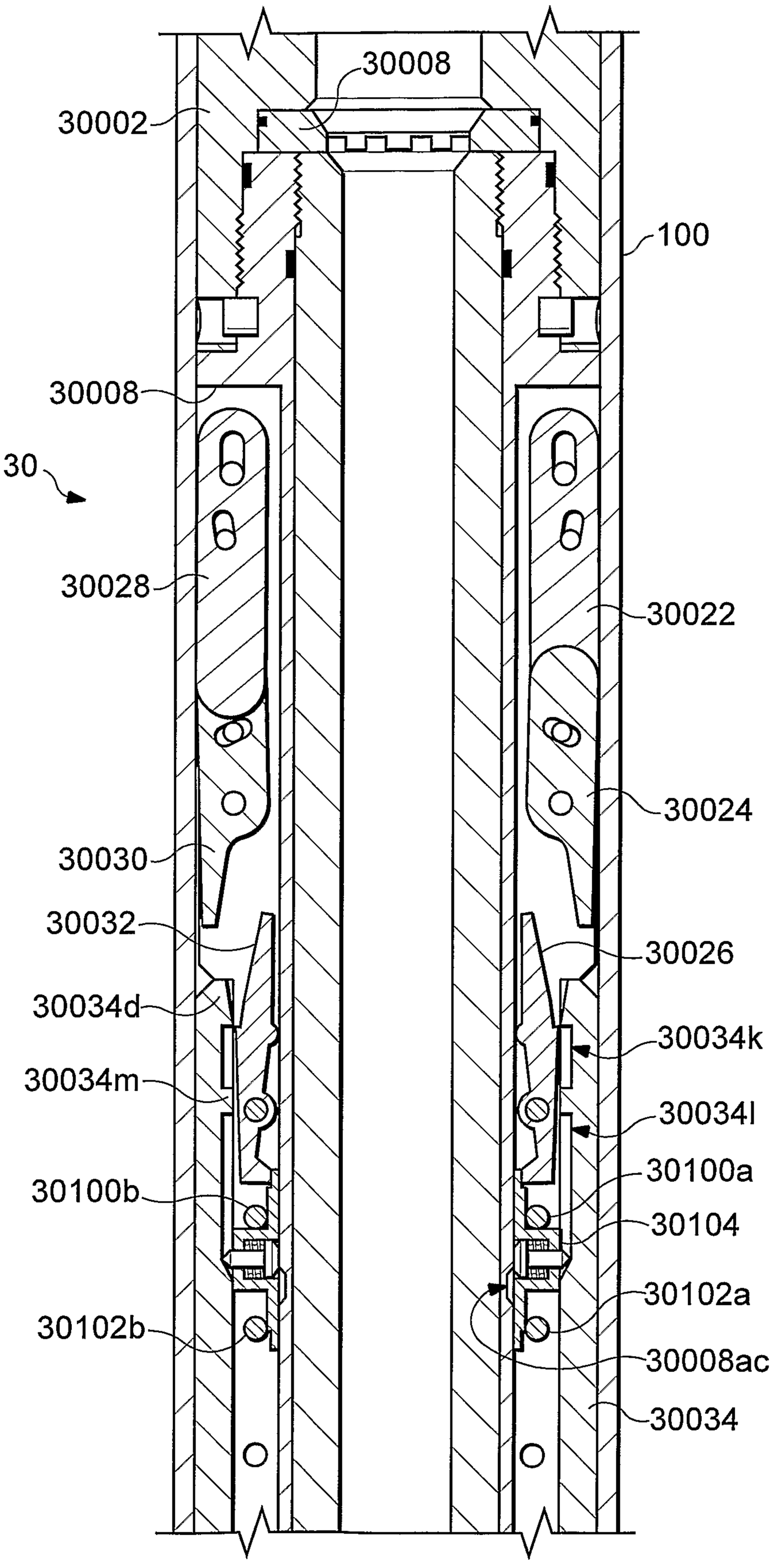

30008
30002
100
30008
30
30028
30022
30024
30030
30032
30026
30034d
30034k
30034m
30034l
30100a
30100b
30104
30102a
30102b
30008ac
30034

Fig. 17AA1

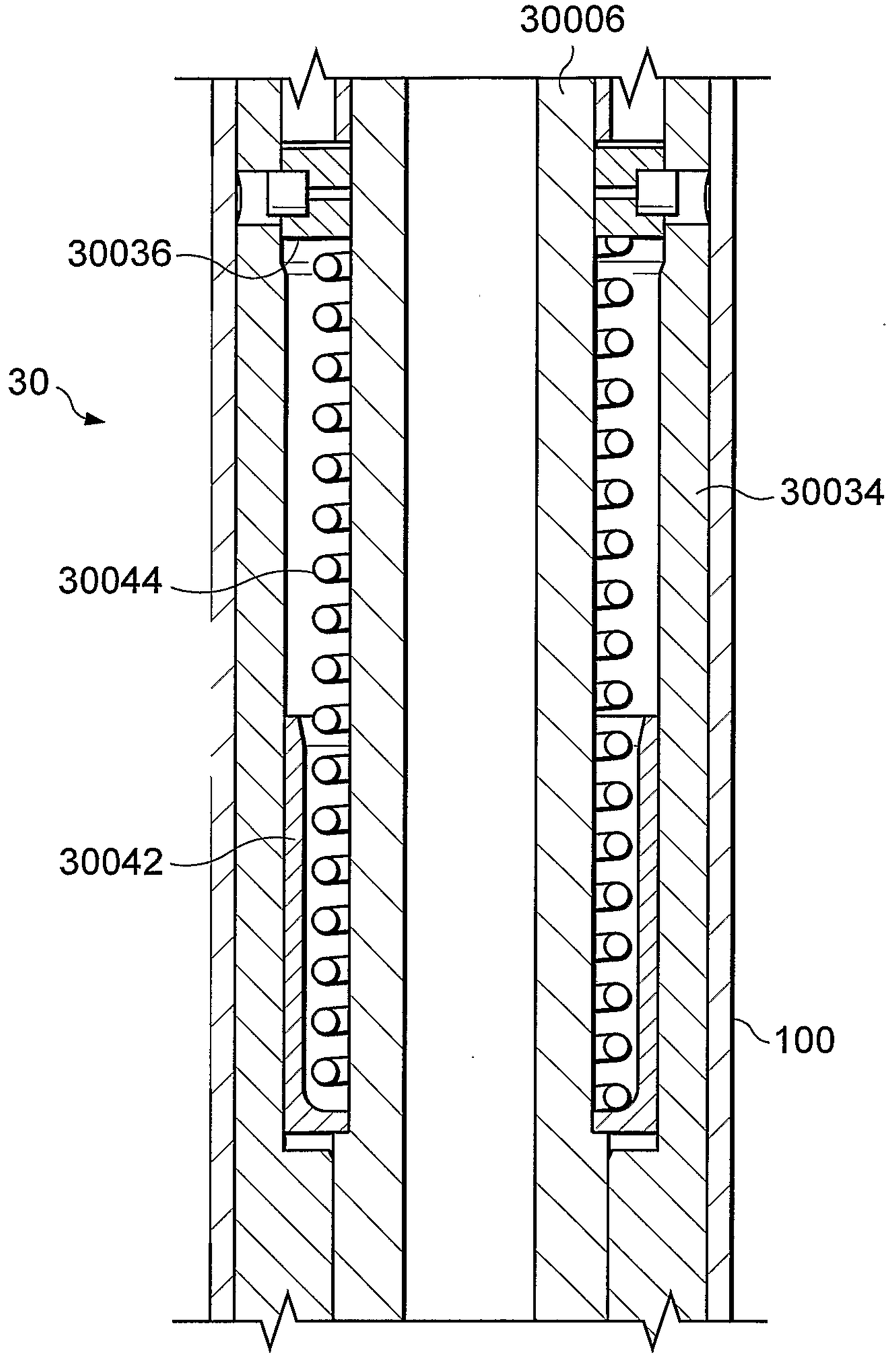


Fig. 17AA2

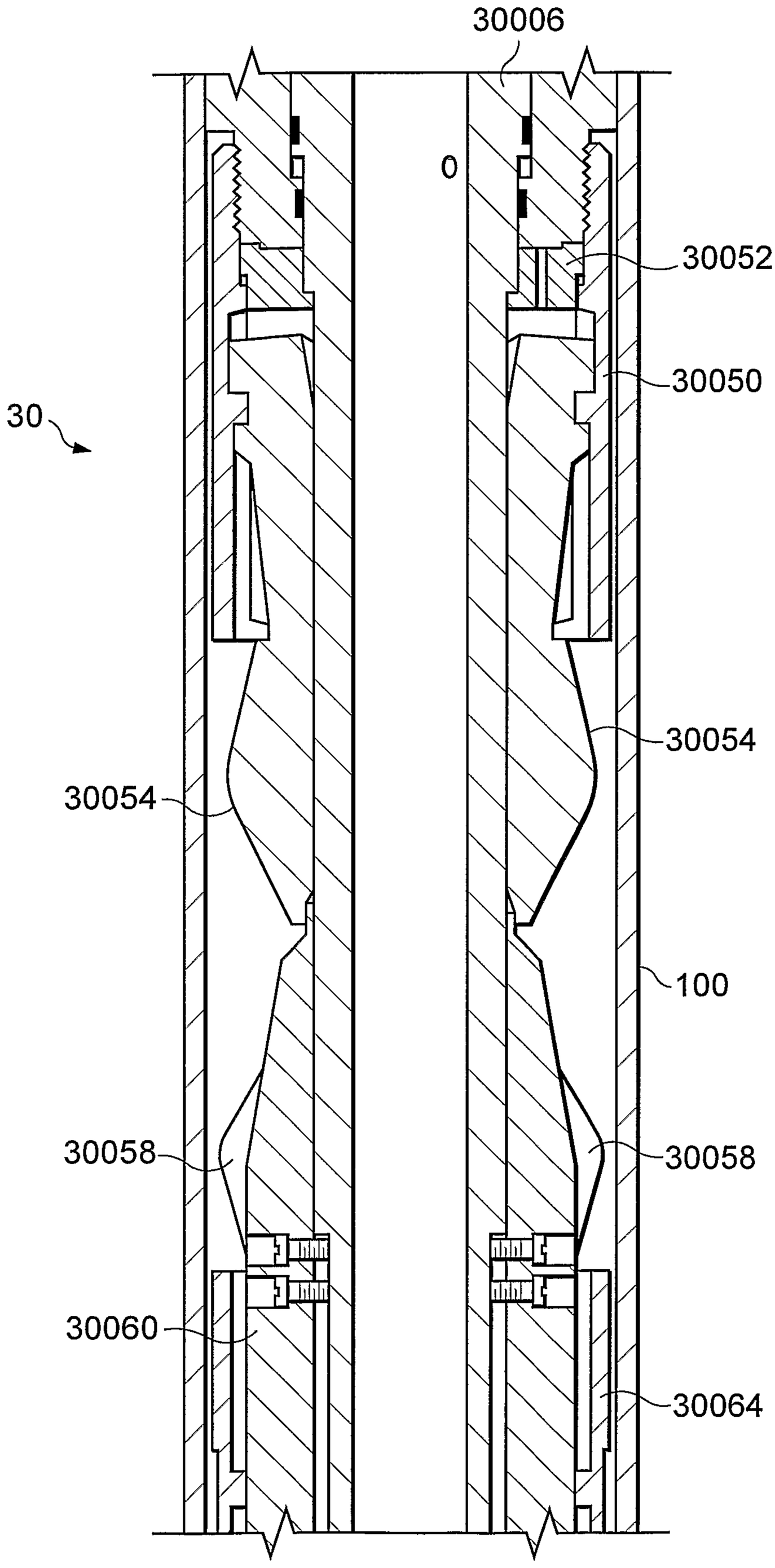

30006
0
30052
30050
30
30054
30054
100
30058
30058
30060
30064

Fig. 17AA3

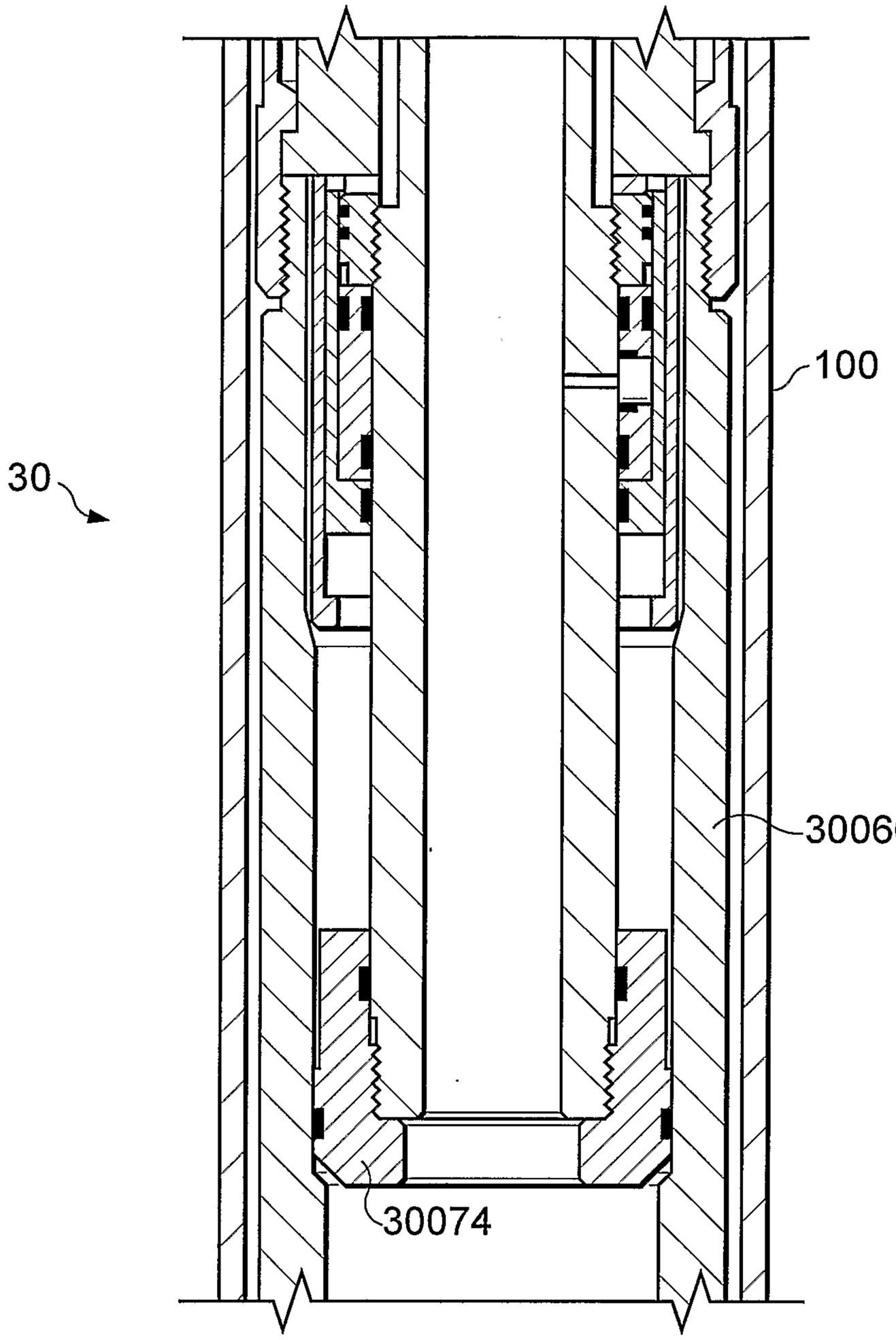


Fig. 17AA4

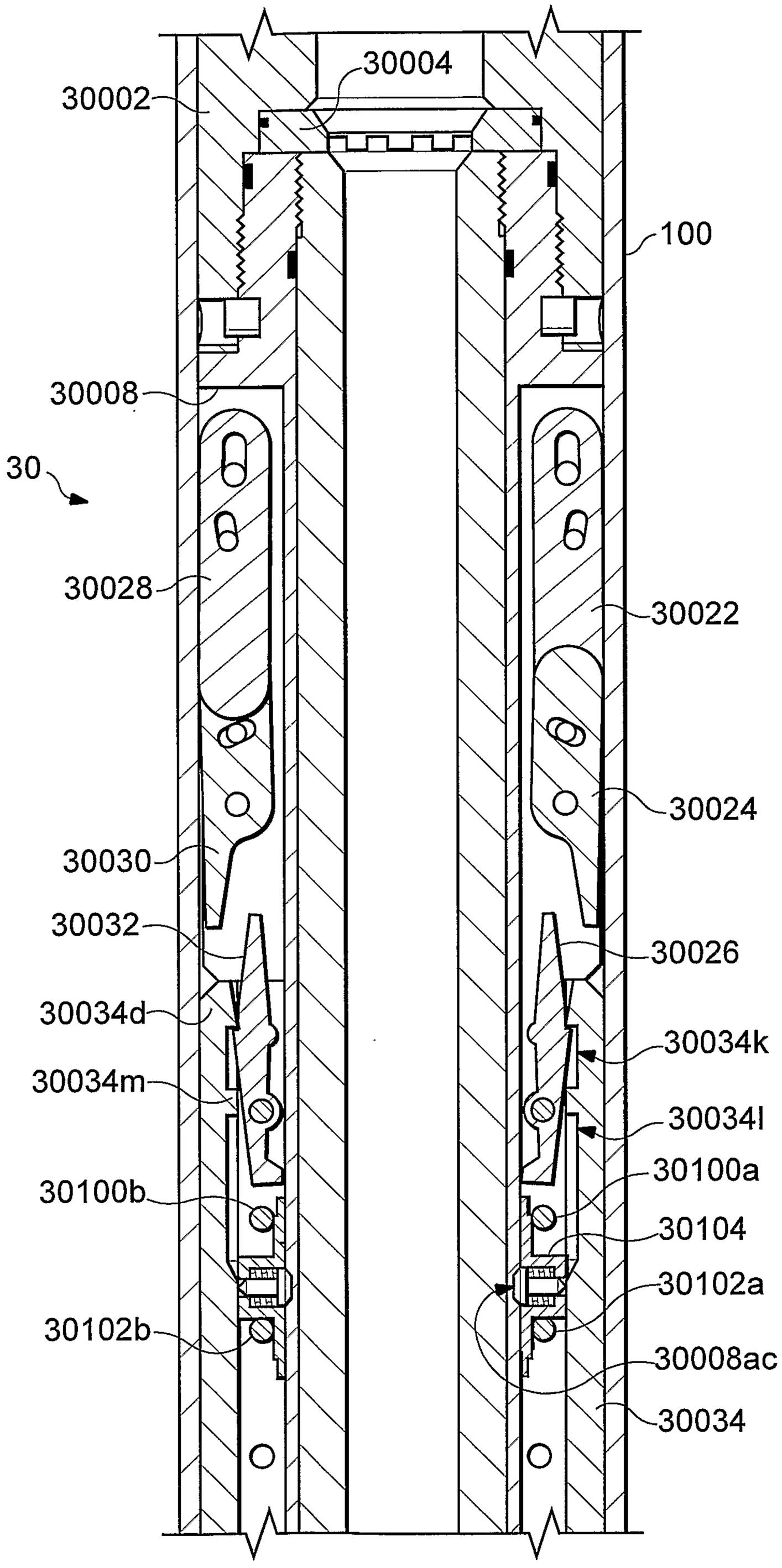

30004
30002
100
30008
30
30028
30022
30024
30030
30032
30026
30034d
30034k
30034m
30034l
30100a
30100b
30104
30102a
30102b
30008ac
30034

Fig. 17AB1

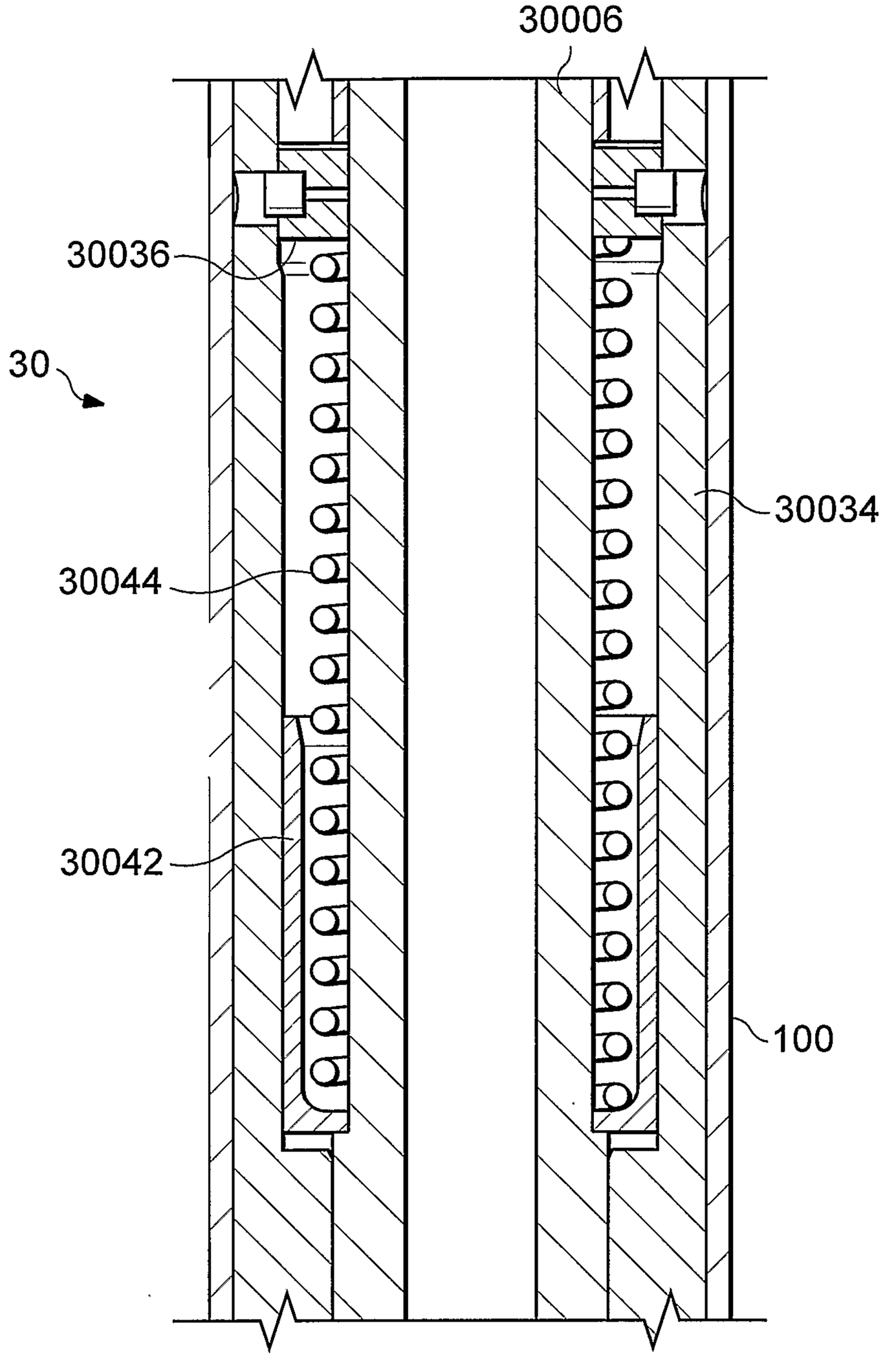


Fig. 17AB2

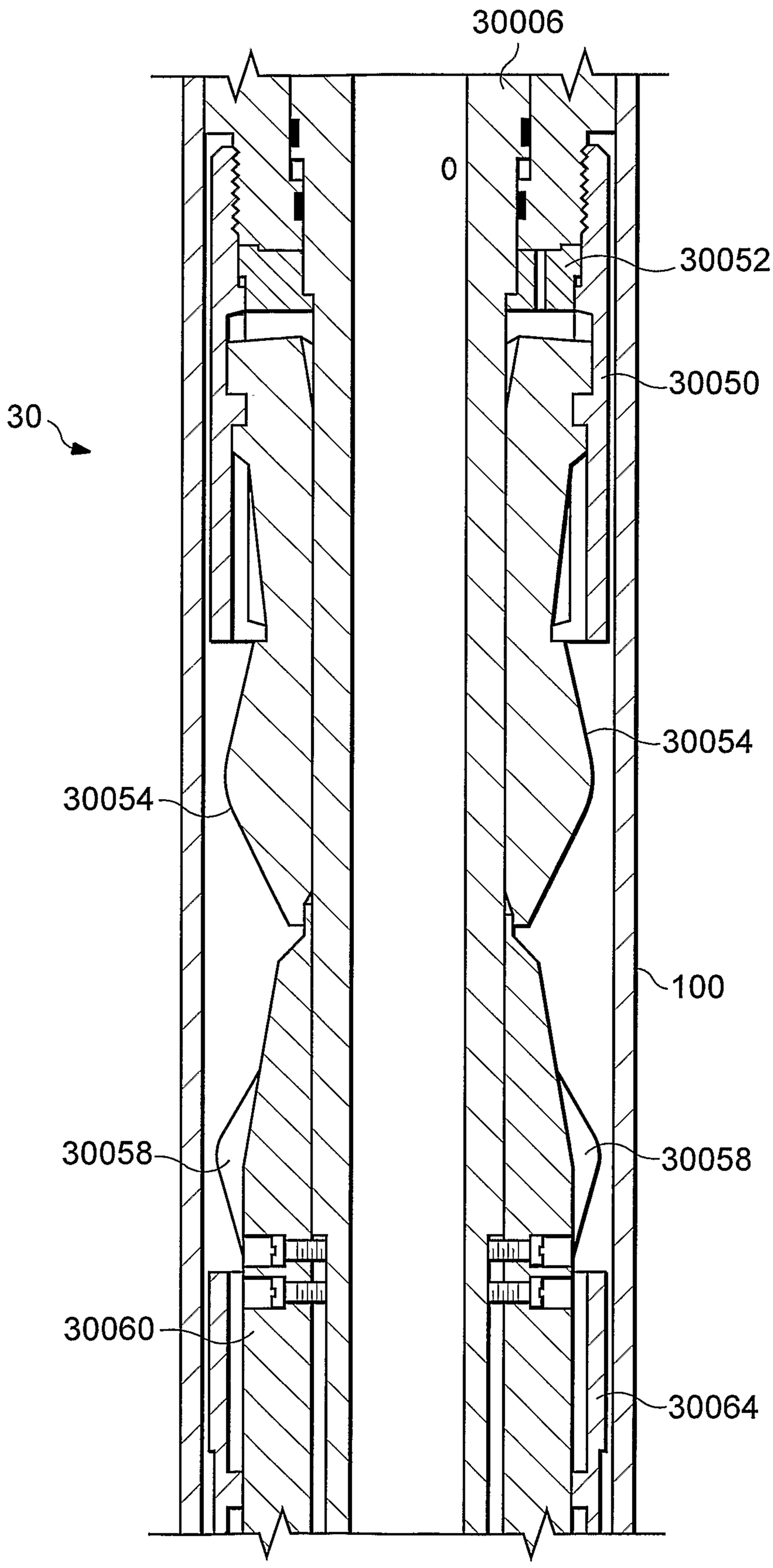

30006
0
30052
30050
30
30054
30054
100
30058
30058
30060
30064

Fig. 17AB3

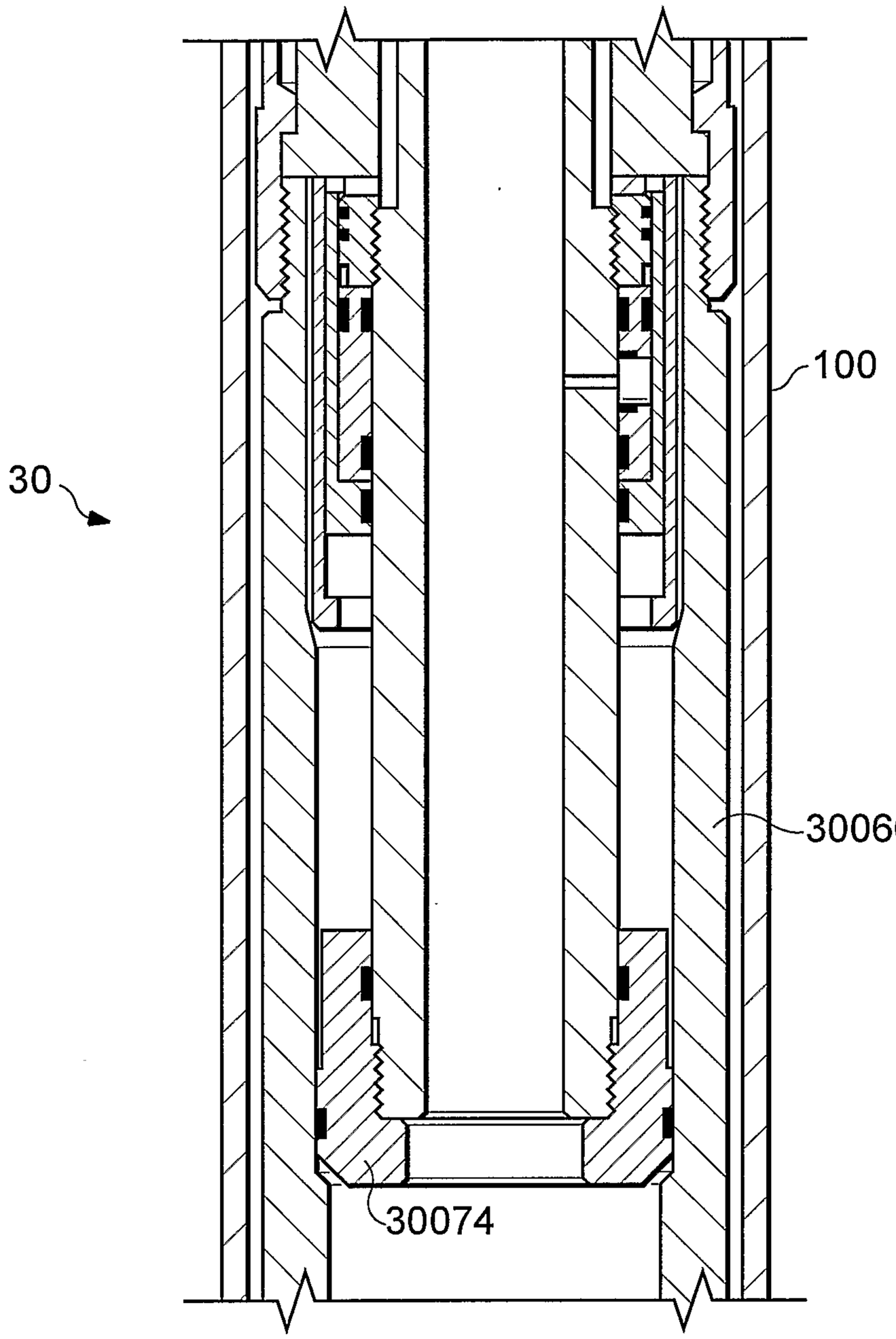


Fig. 17AB4

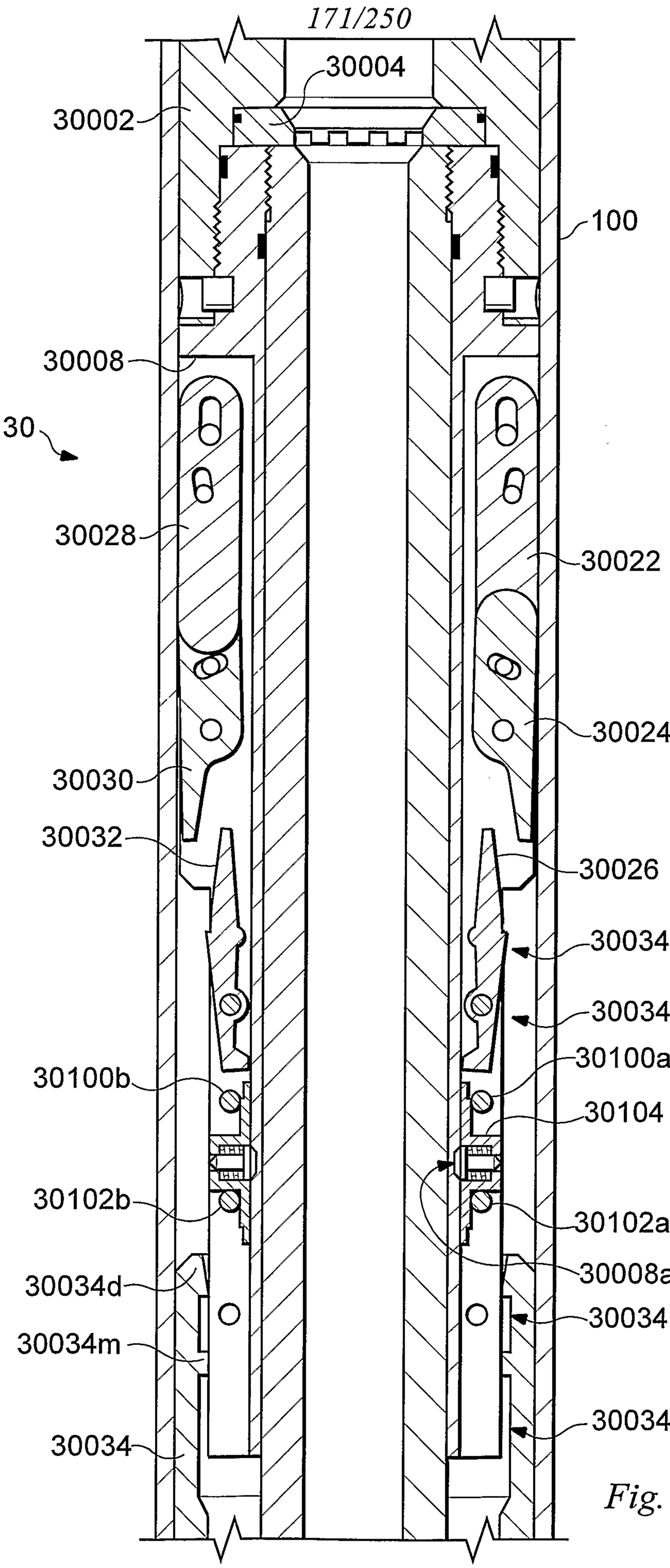

171/250
30004
30002
100
30008
30
30028
30022
30024
30030
30032
30026
30034k
30034l
30100b
30100a
30104
30102b
30102a
30008ac
30034d
30034m
30034k
30034
30034l

Fig. 17AC1

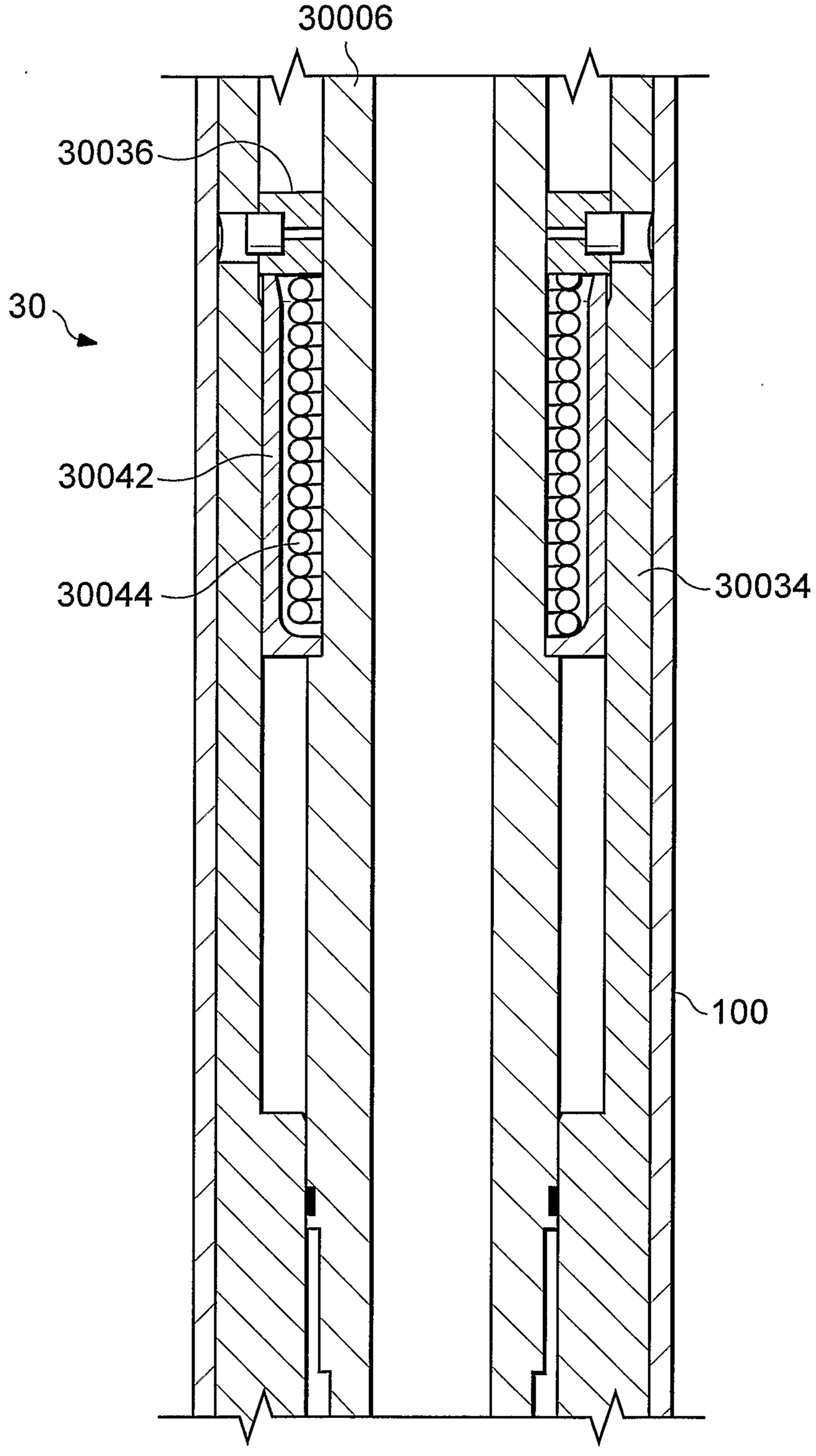


Fig. 17AC2

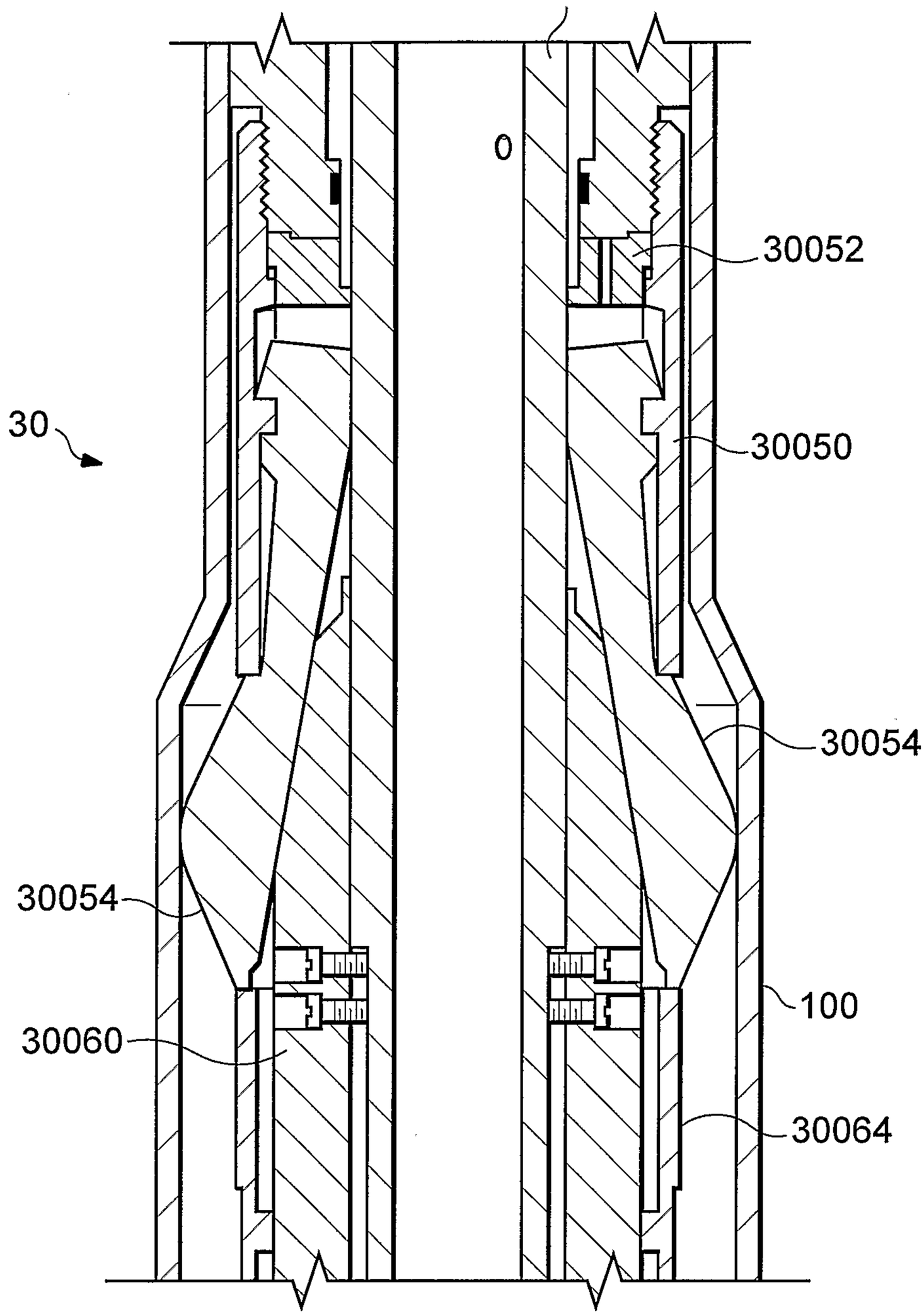


Fig. 17AC3

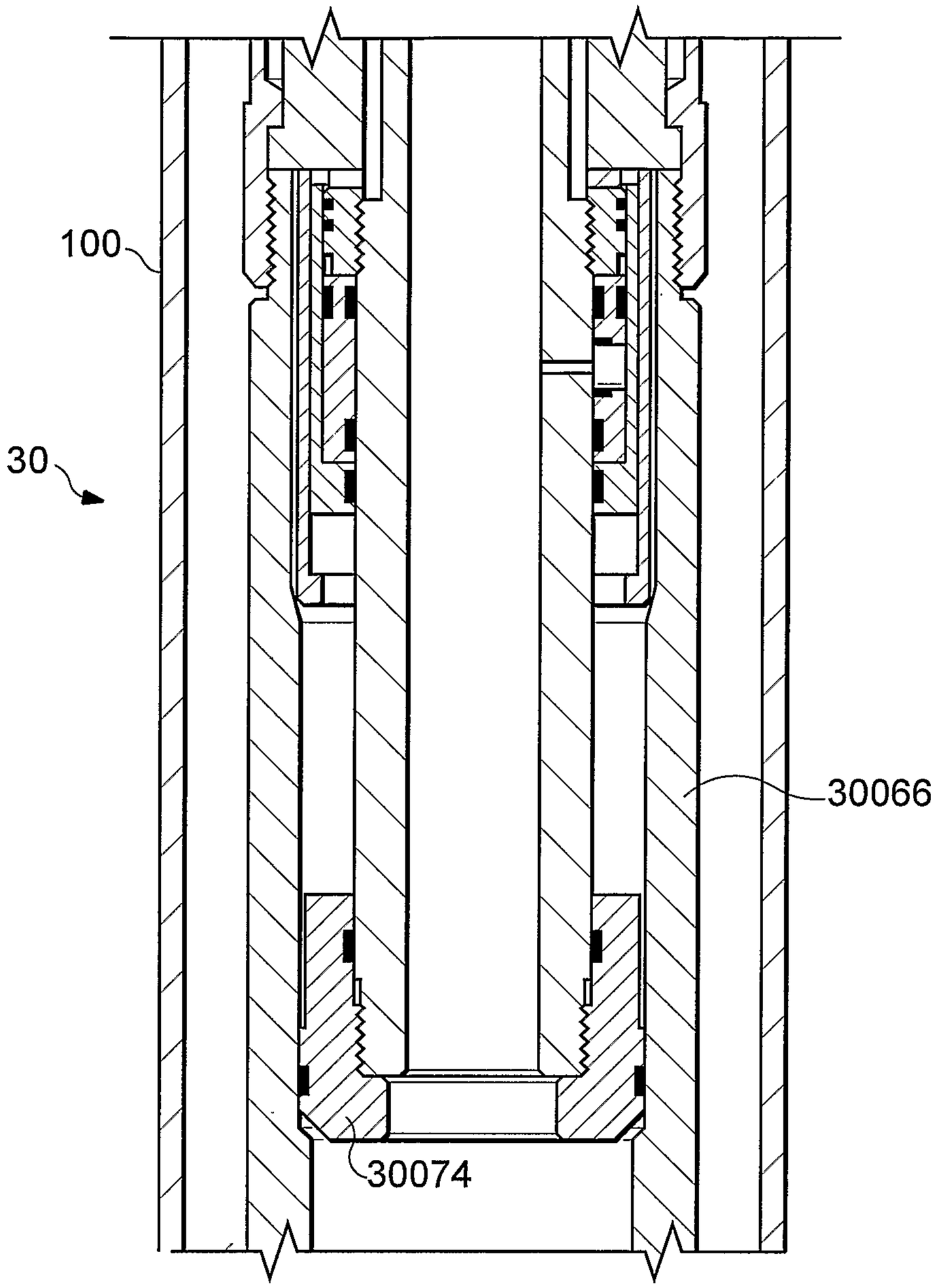


Fig. 17AC4

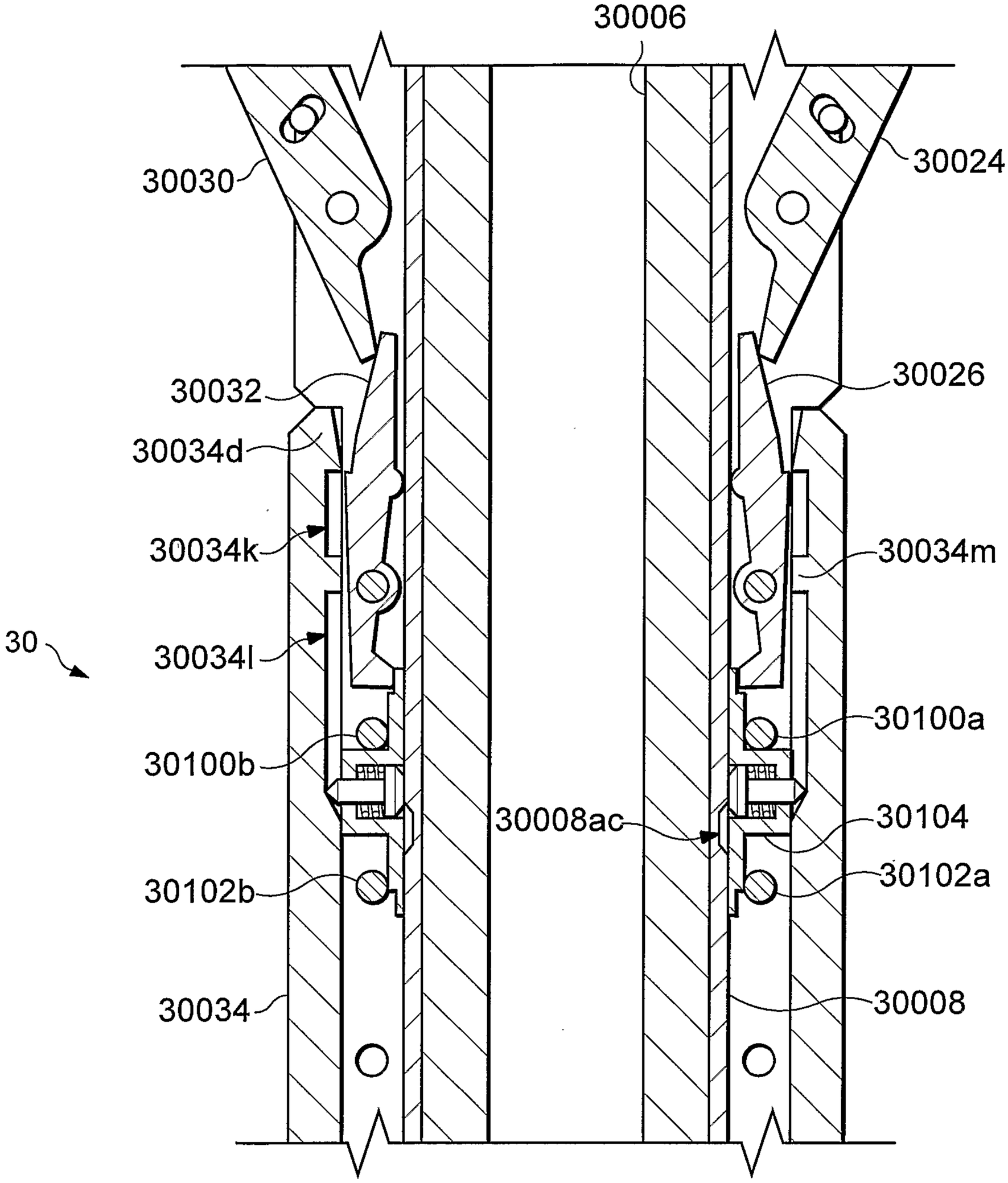

30006
30030
30024
30032
30026
30034d
30034k
30034m
30
30034l
30100a
30100b
30008ac
30104
30102b
30102a
30034
30008

Fig. 17AD

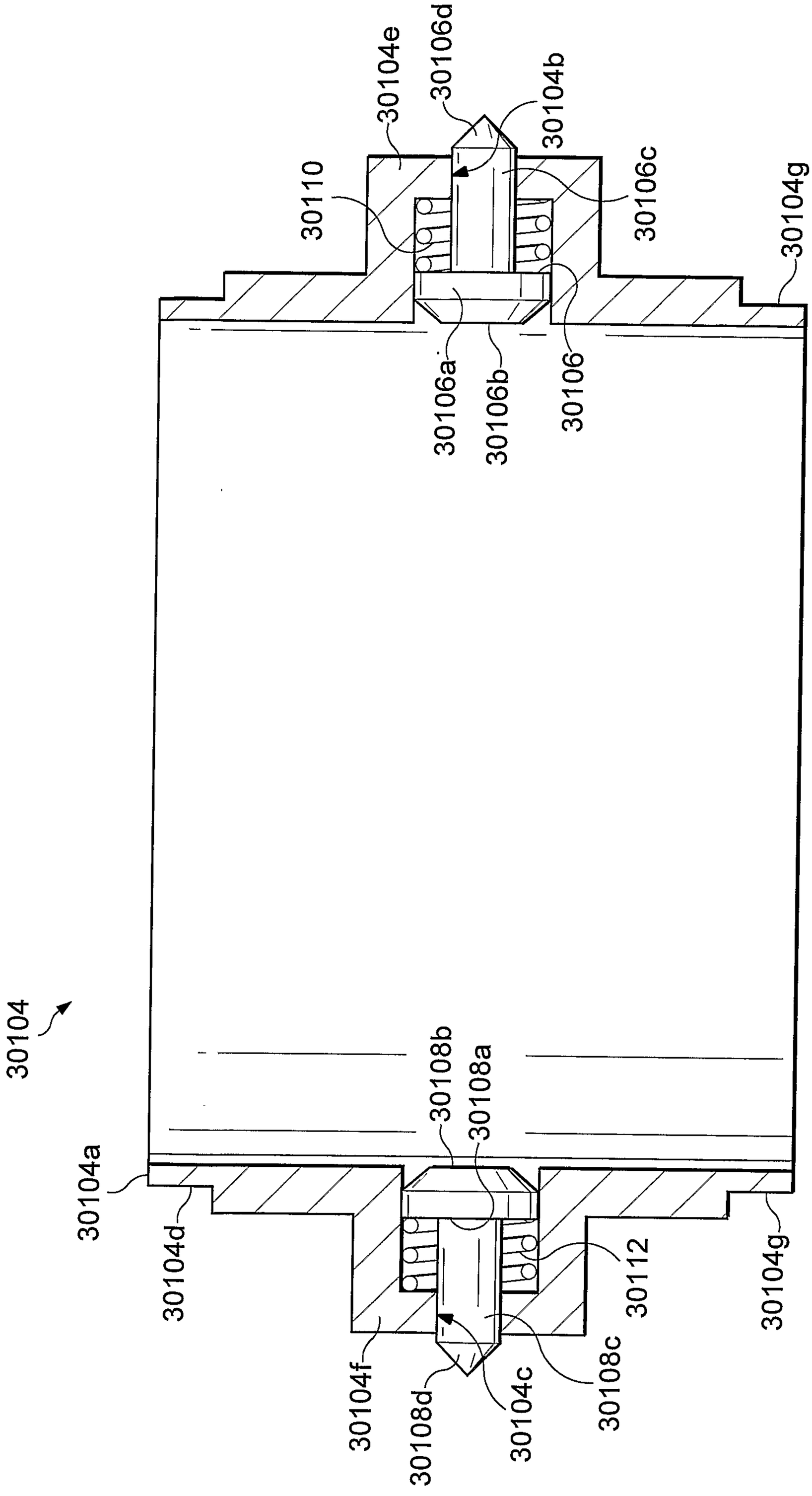

30104e
30106d
30104b
30110
30106c
30104g
30106a
30106b
30106
30104
30108b
30108a
30104a
30104d
30104f
30108d
30104c
30108c
30112
30104g

Fig. 17AE

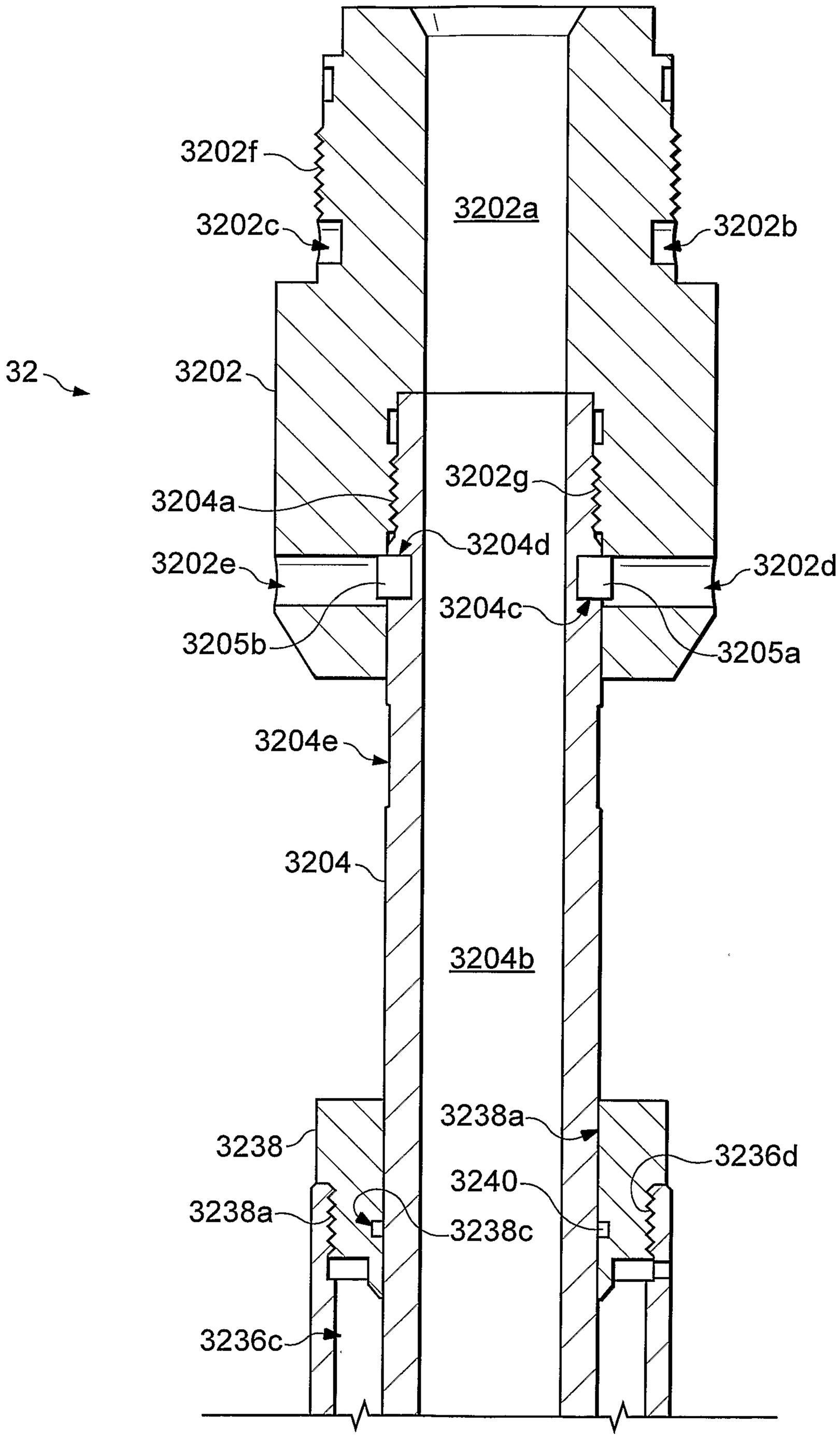

3202f
3202a
3202c
3202b
32
3202
3202g
3204a
3204d
3202e
3202d
3204c
3205b
3205a
3204e
3204
3204b
3238a
3238
3236d
3240
3238a
3238c
3236c

Fig. 18A

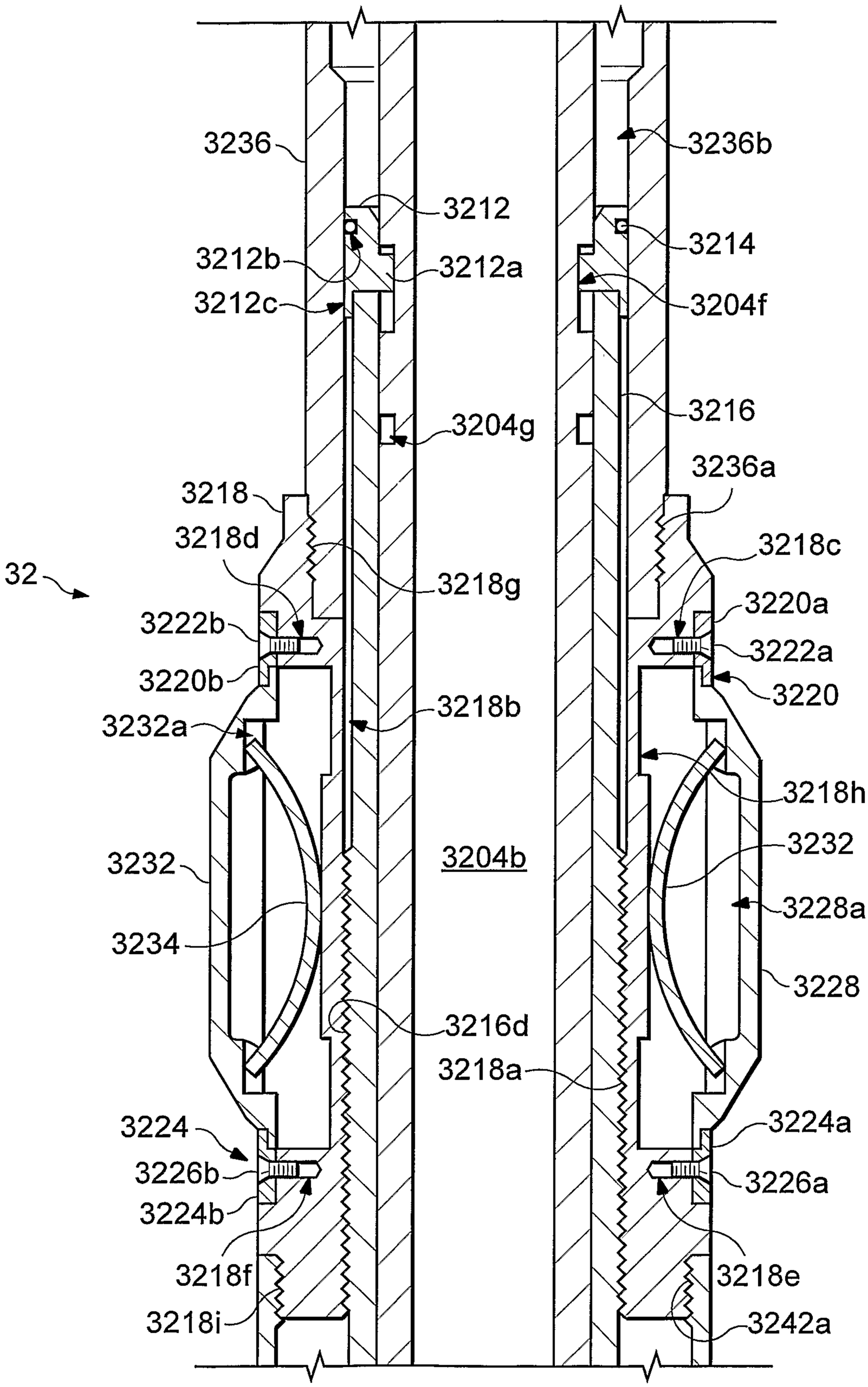

3236
3212
3212b
3212a
3212c
3204g
3218
3218d
32
3218g
3222b
3220b
3218b
3232a
3232
3204b
3234
3216d
3218a
3224
3226b
3224b
3218f
3218i
3236b
3214
3204f
3216
3236a
3218c
3220a
3222a
3220
3218h
3232
3228a
3228
3224a
3226a
3218e
3242a

Fig. 18B

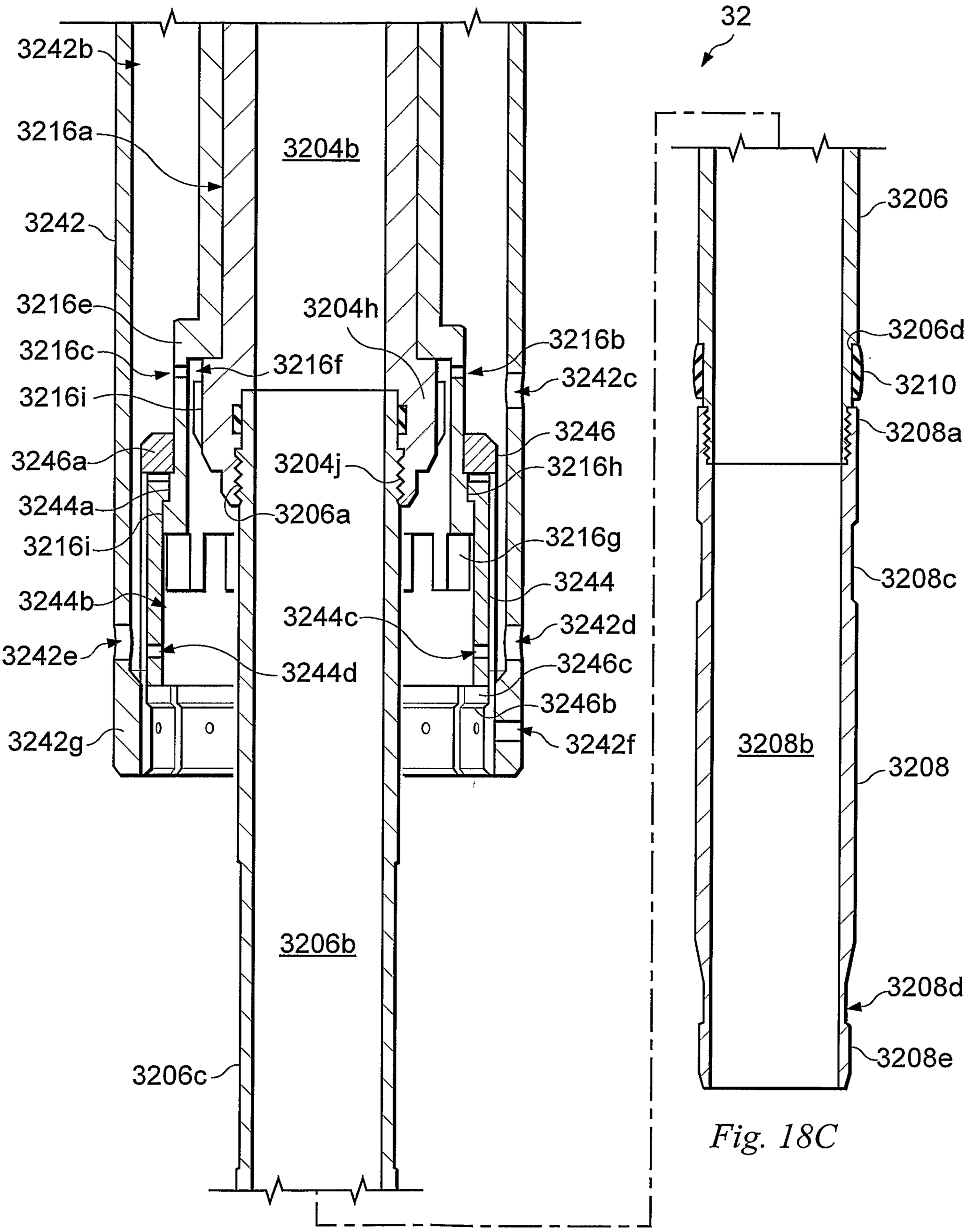

32
3242b
3216a
3204b
3242
3216e
3204h
3216b
3216c
3216f
3242c
3216i
3246
3246a
3204j
3216h
3244a
3206a
3216i
3216g
3244
3244b
3244c
3242d
3242e
3244d
3246c
3246b
3242g
3242f
3206b
3206c
3206
3206d
3210
3208a
3208c
3208b
3208
3208d
3208e

Fig. 18C

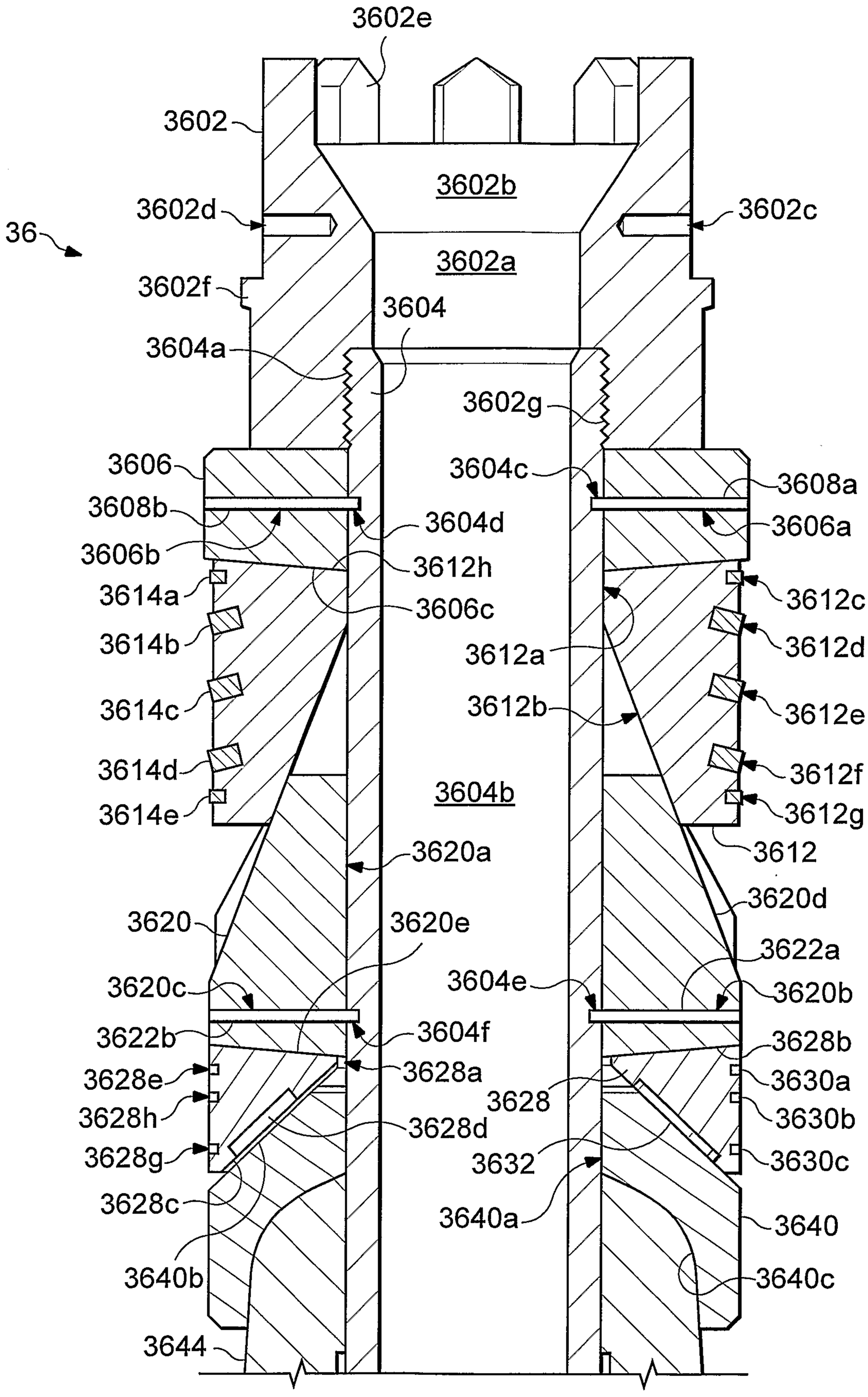

3602e
3602
3602b
3602d
3602c
36
3602a
3602f
3604
3604a
3602g
3606
3604c
3608a
3608b
3604d
3606a
3606b
3612h
3614a
3606c
3612c
3614b
3612a
3612d
3614c
3612b
3612e
3614d
3612f
3614e
3604b
3612g
3620a
3612
3620
3620e
3620d
3622a
3620c
3604e
3620b
3622b
3604f
3628b
3628a
3628e
3630a
3628
3628h
3628d
3630b
3628g
3632
3630c
3628c
3640a
3640
3640b
3640c
3644

Fig. 19-1

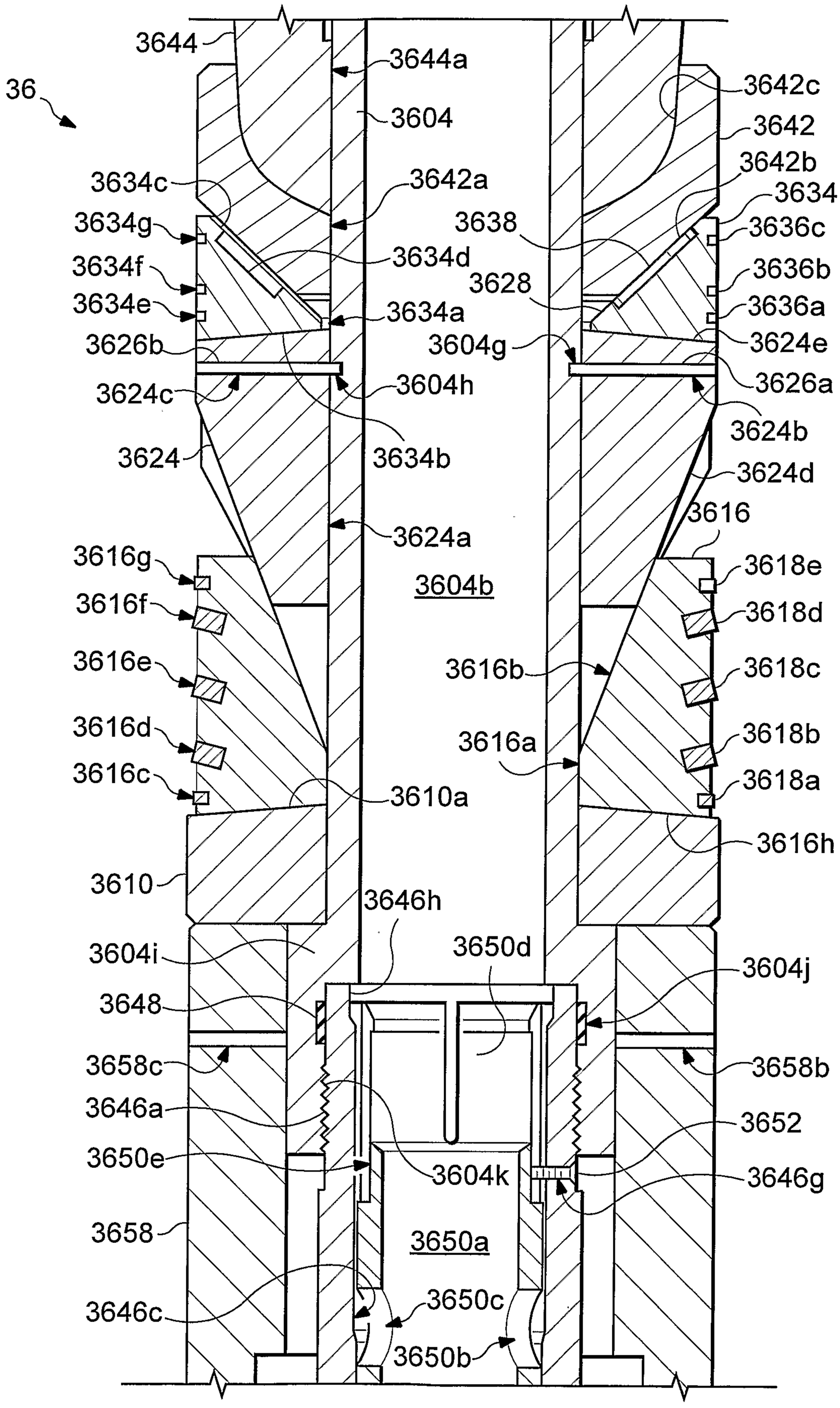

36
3644
3644a
3604
3642c
3642
3642b
3634
3636c
3636b
3636a
3624e
3626a
3624b
3624d
3616
3618e
3618d
3618c
3618b
3618a
3616h
3642a
3634c
3634g
3634f
3634e
3626b
3624c
3624
3634d
3634a
3634b
3624a
3616g
3616f
3616e
3616d
3616c
3610a
3610
3604i
3648
3658c
3646a
3650e
3658
3646c
3604b
3638
3628
3604g
3626a
3624b
3616b
3616a
3646h
3650d
3604j
3658b
3652
3646g
3604k
3650a
3650c
3650b

Fig. 19-2

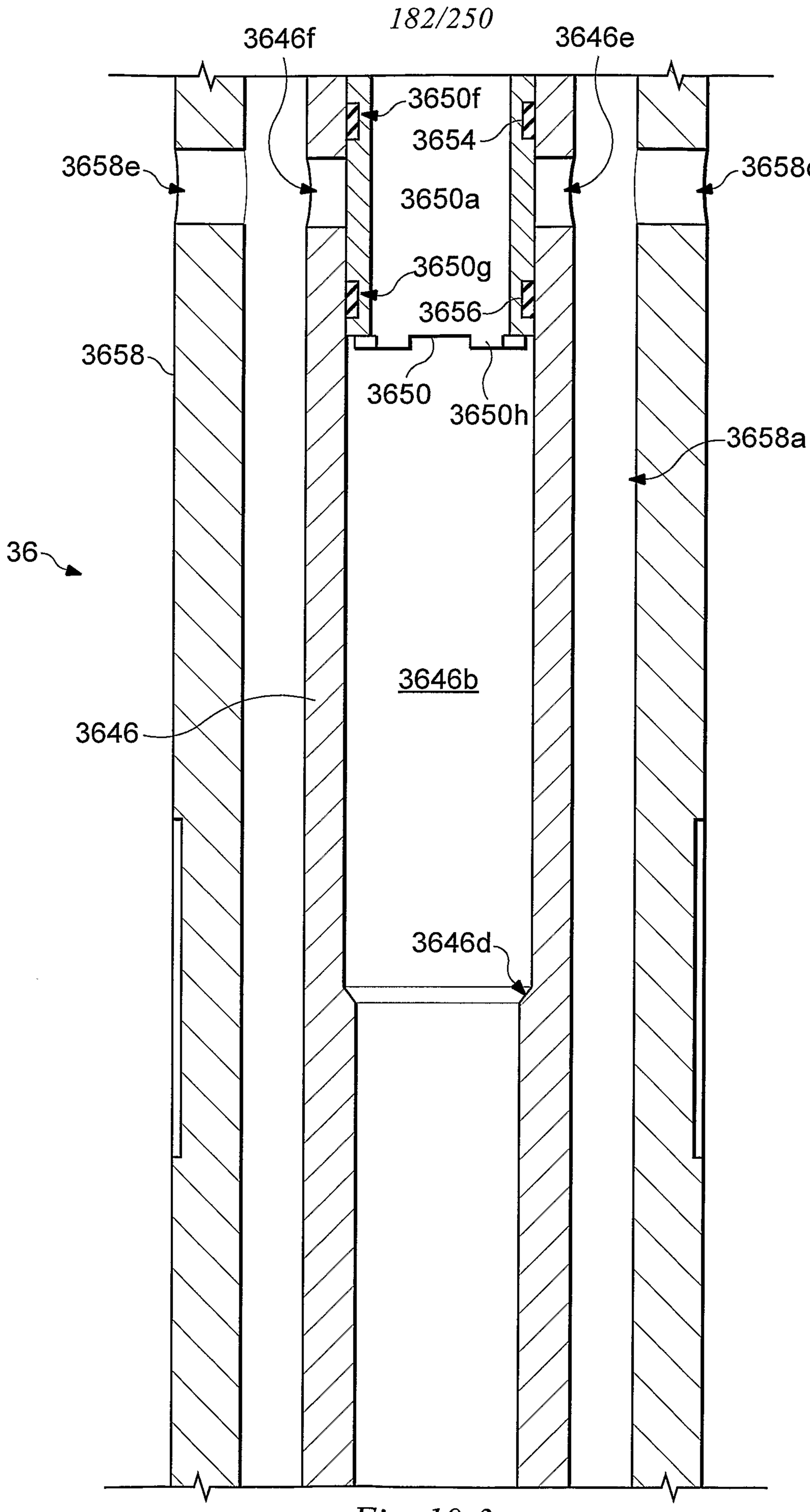

3646f
3646e
3650f
3654
3658e
3658d
3650a
3650g
3656
3658
3650
3650h
3658a
36
3646b
3646
3646d

Fig. 19-3

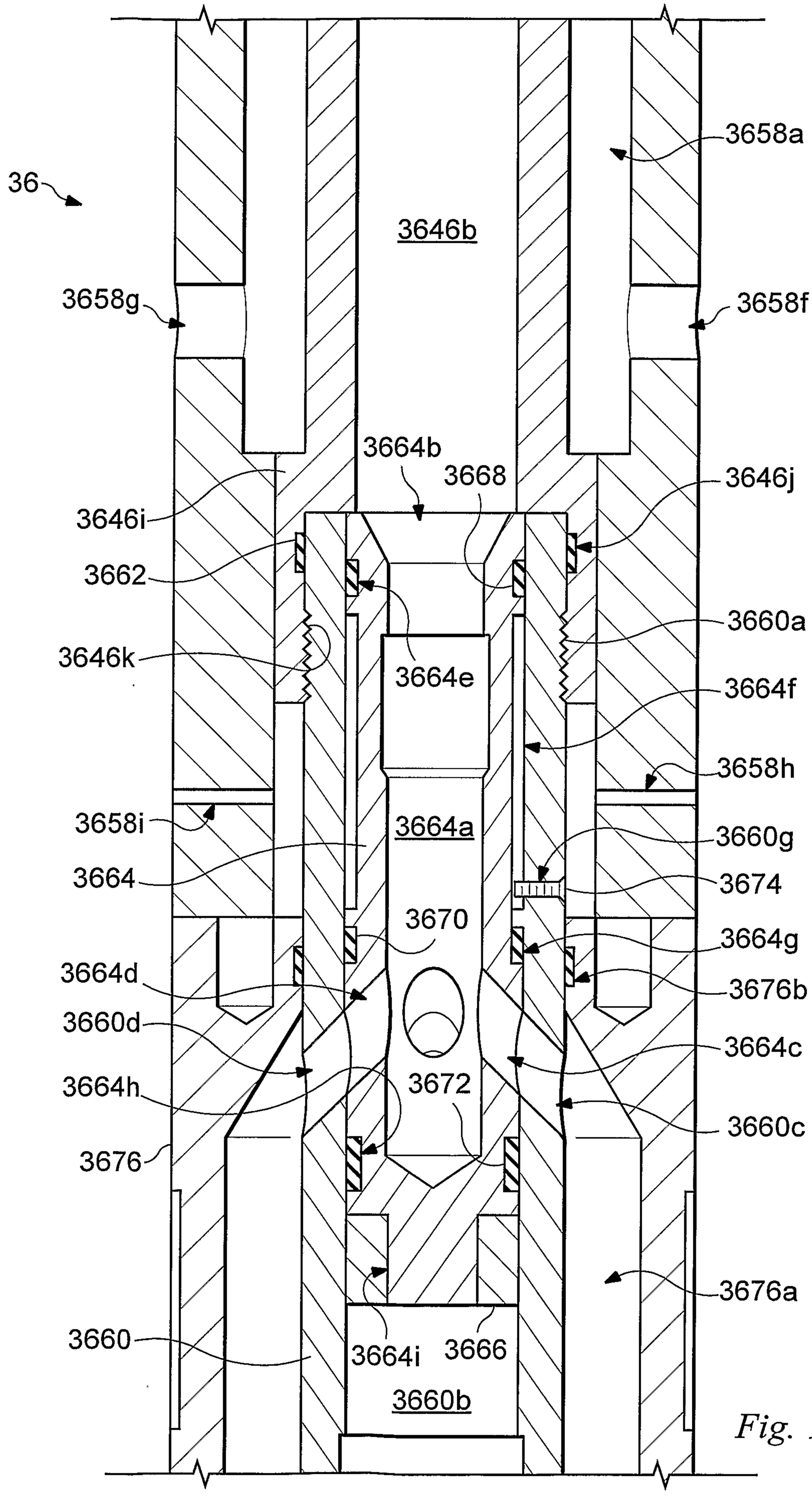

36
3658a
3646b
3658g
3658f
3664b
3668
3646j
3646i
3662
3660a
3646k
3664e
3664f
3658h
3658i
3664a
3660g
3664
3674
3670
3664g
3664d
3676b
3660d
3664c
3664h
3672
3660c
3676
3676a
3660
3664i
3666
3660b

Fig. 19-4

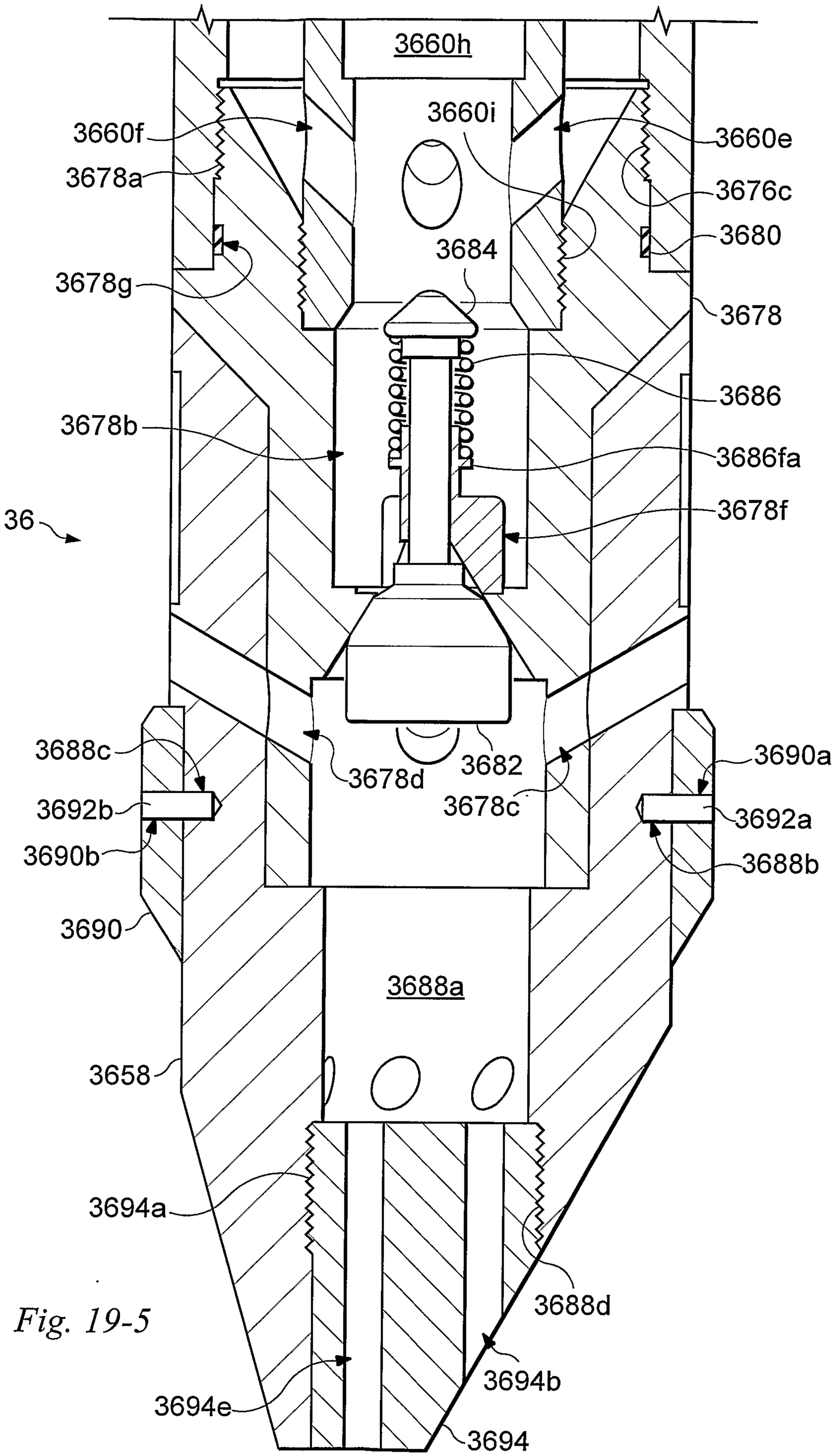

3660h
3660i
3660f
3660e
3678a
3676c
3680
3684
3678g
3678
3686
3678b
3686fa
36
3678f
3688c
3678d
3682
3678c
3690a
3692b
3692a
3690b
3688b
3690
3688a
3658
3694a
3688d
3694b
3694e
3694

Fig. 19-5

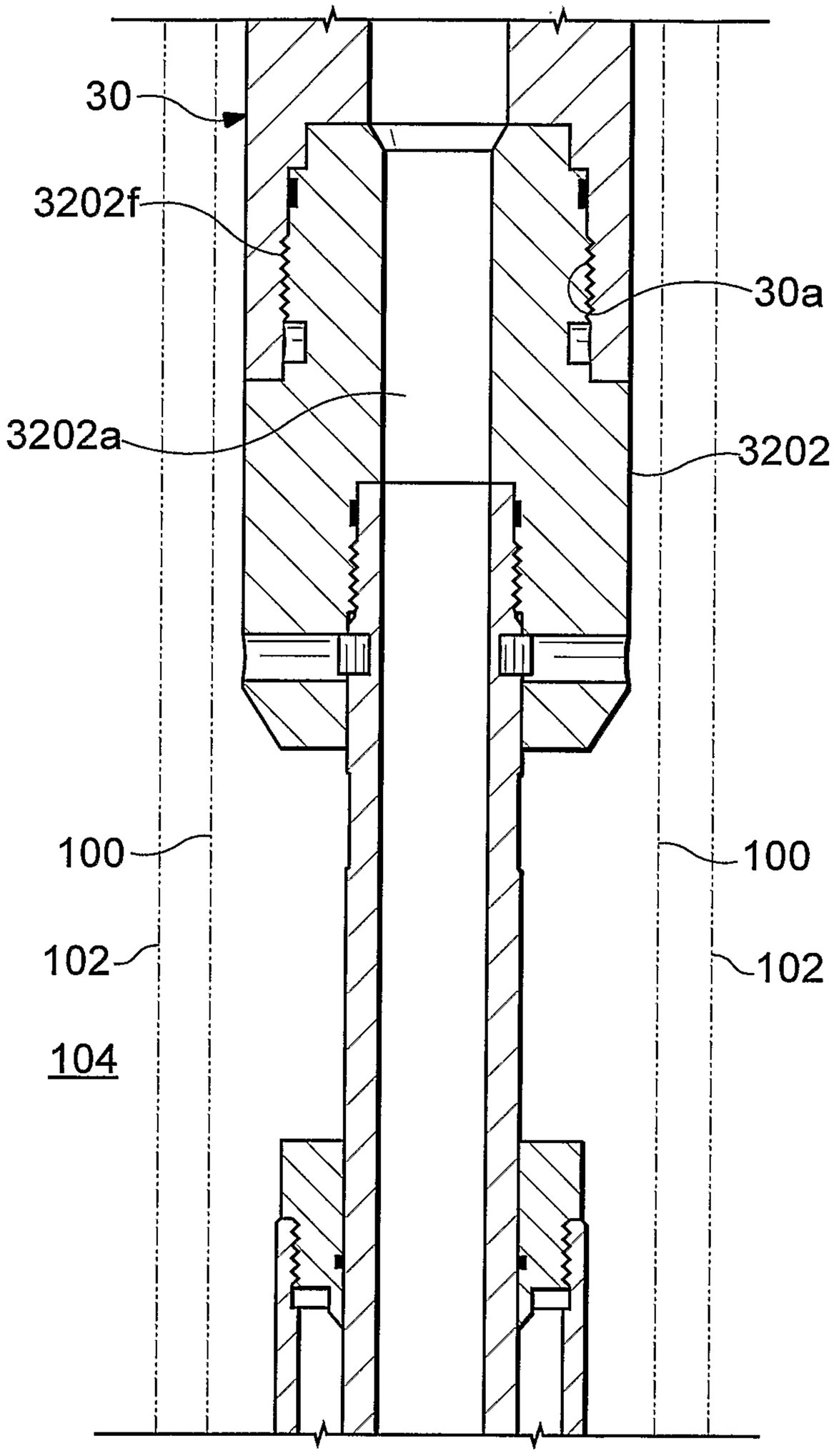


Fig. 20A1

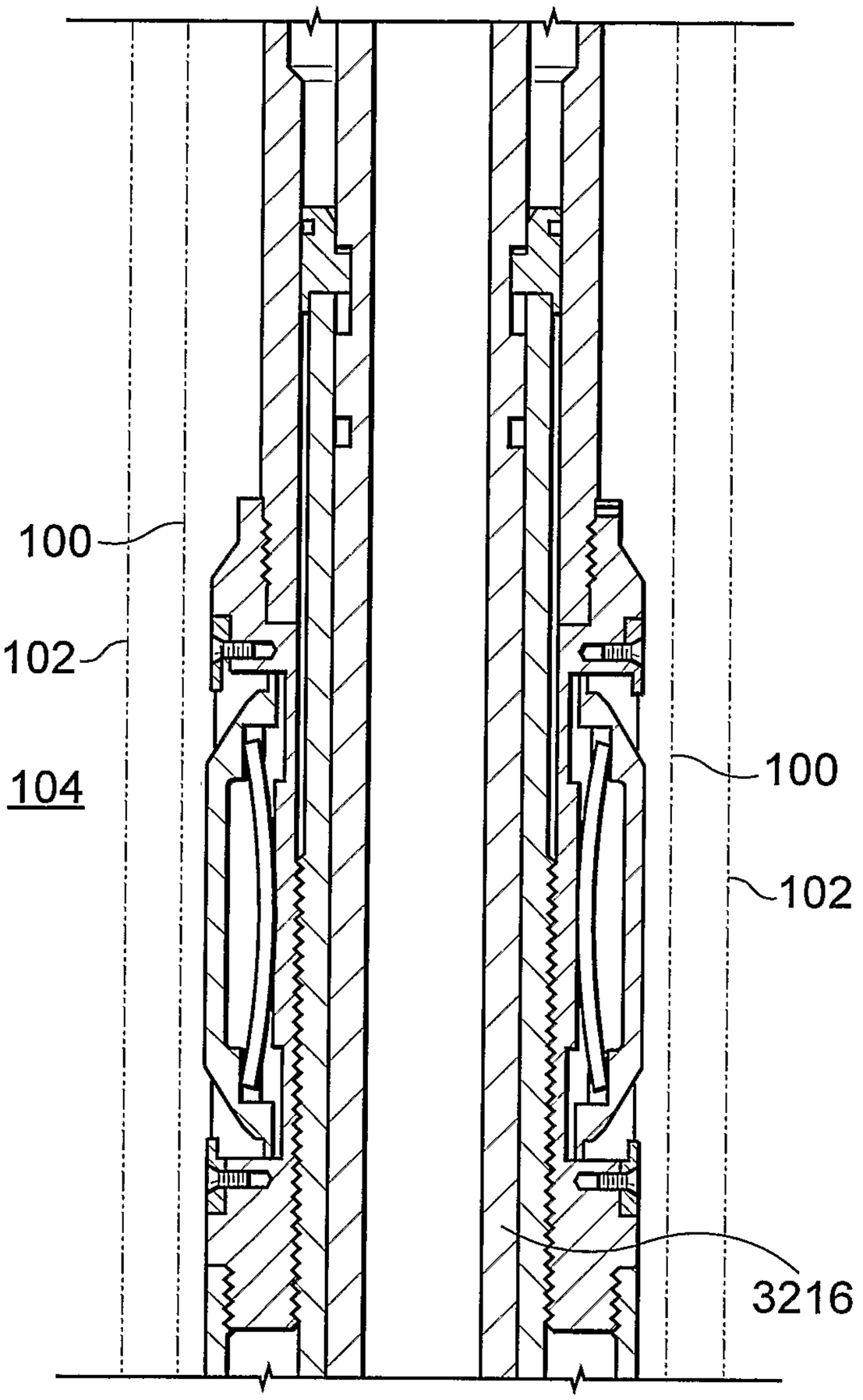


Fig. 20A2

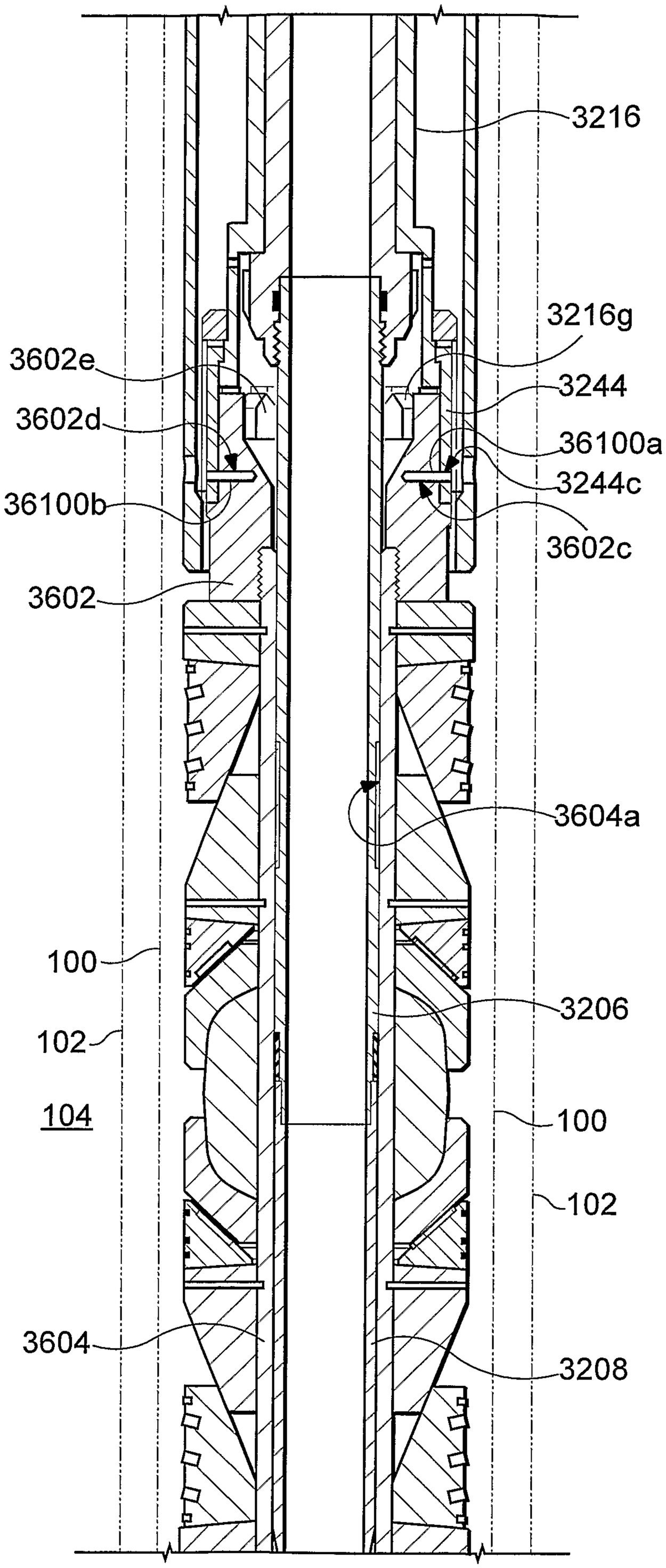

3216
3216g
3602e
3244
3602d
36100a
3244c
36100b
3602c
3602
3604a
100
3206
102
104
100
102
3604
3208

Fig. 20A3

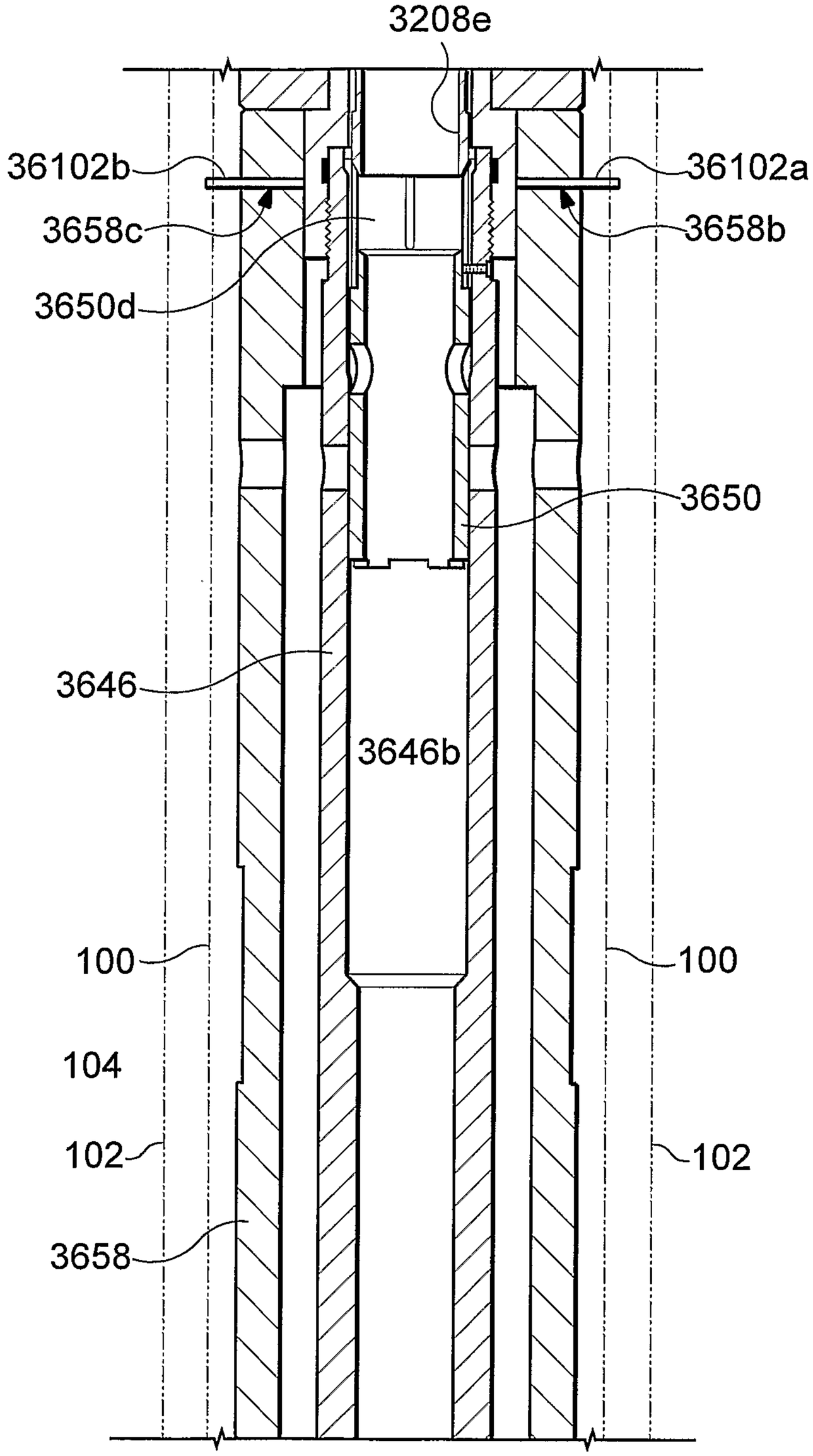

3208e
36102b
36102a
3658c
3658b
3650d
3650
3646
3646b
100
100
104
102
102
3658

Fig. 20A4

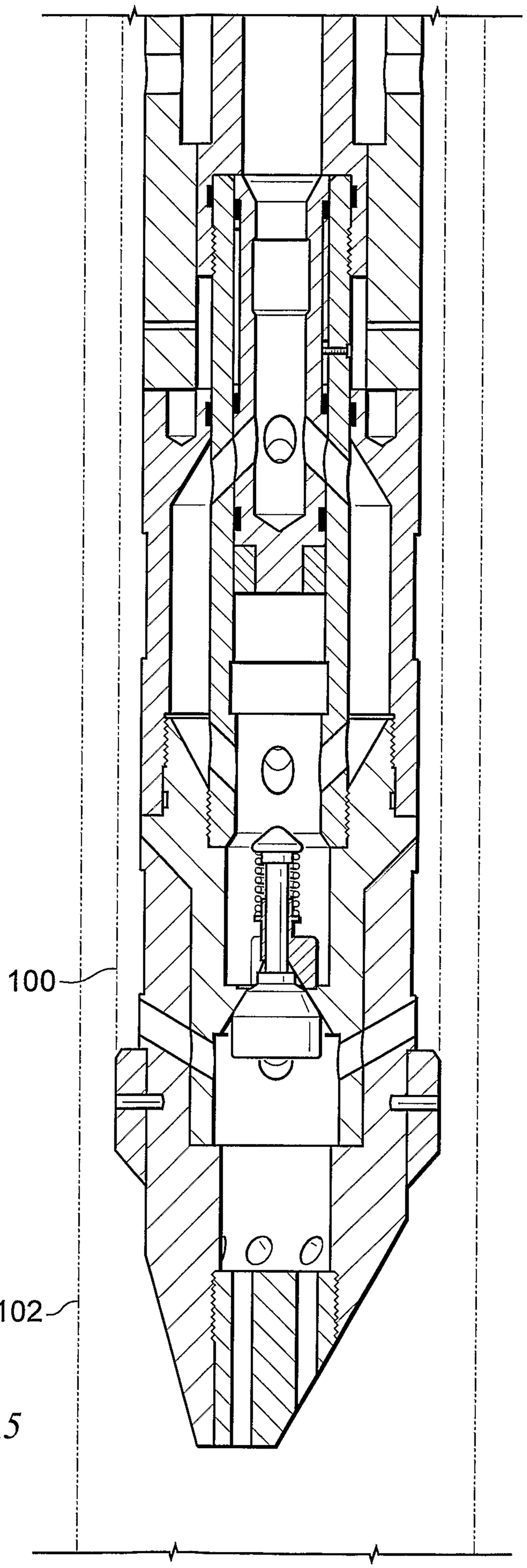


Fig. 20A5

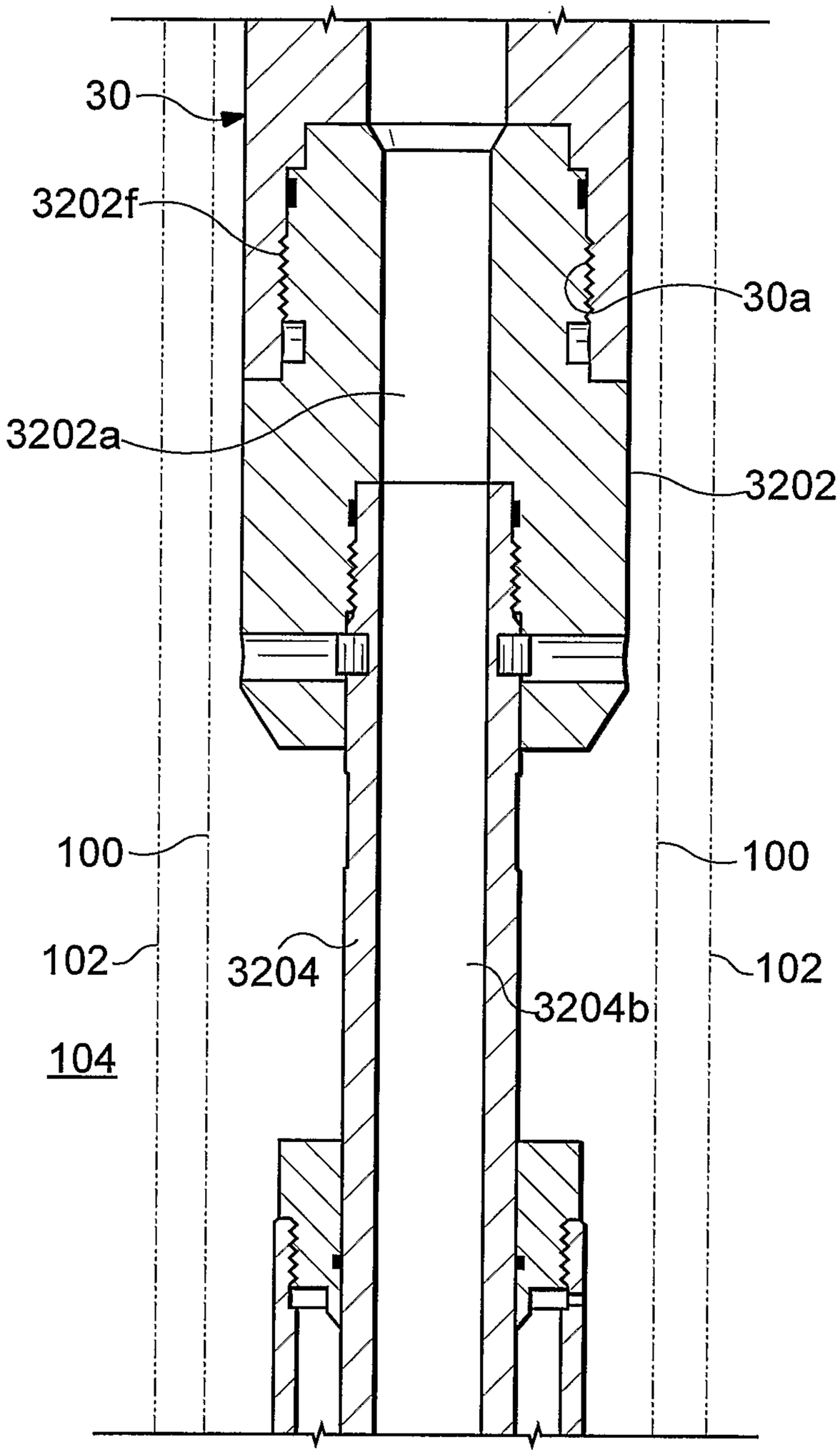


Fig. 20B1

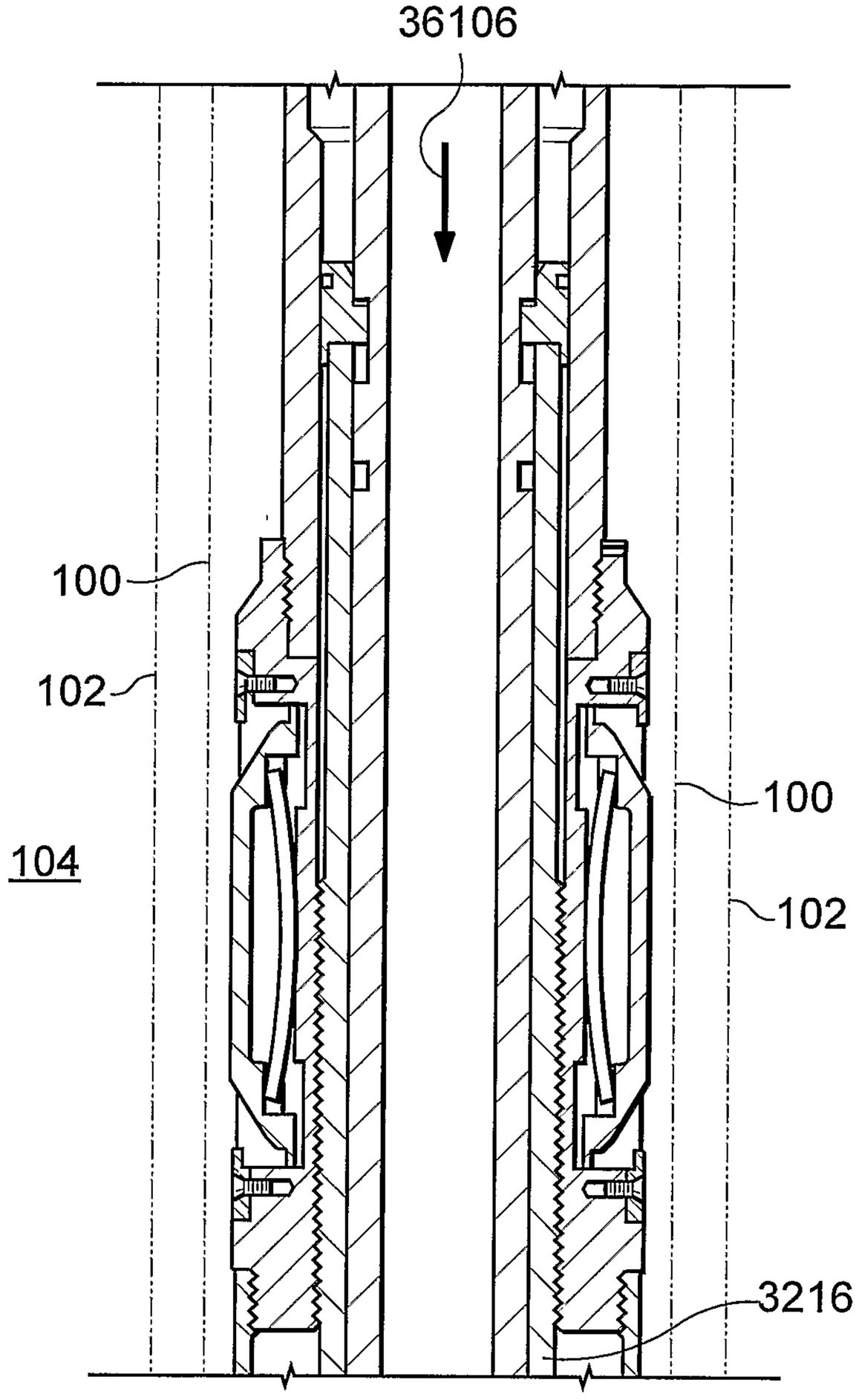


Fig. 20B2

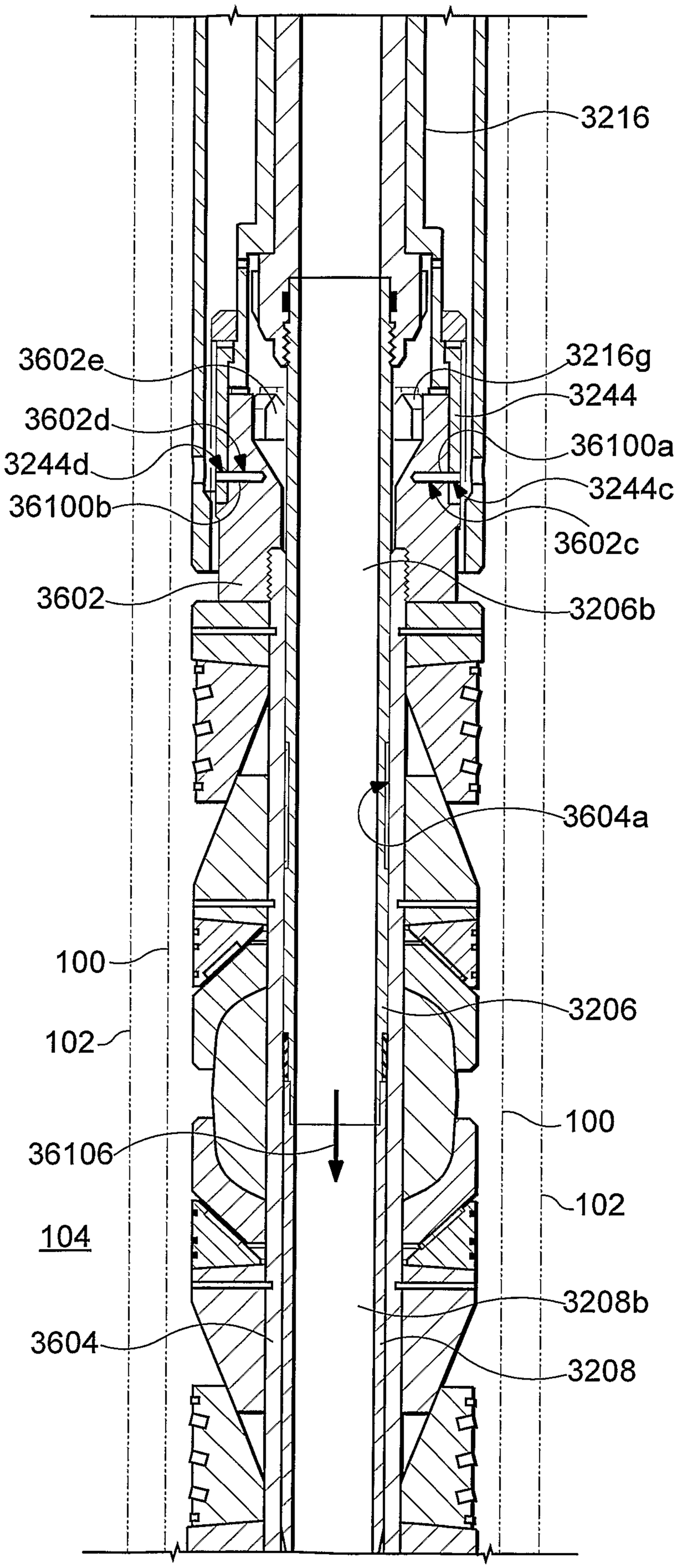

3216
3602e
3216g
3244
3602d
36100a
3244d
3244c
36100b
3602c
3602
3206b
3604a
100
3206
102
100
36106
102
104
3208b
3604
3208

Fig. 20B3

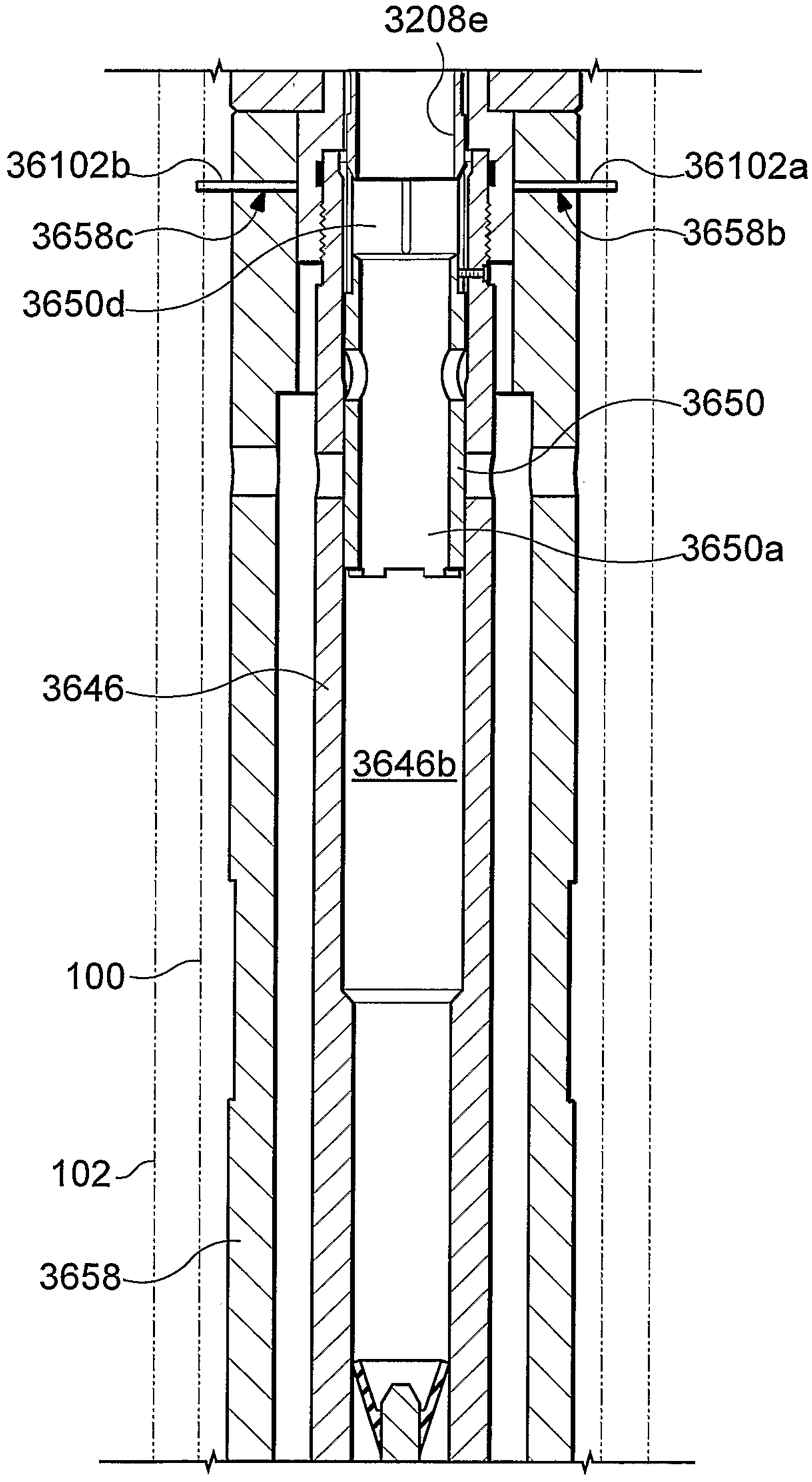

3208e
36102b
36102a
3658c
3658b
3650d
3650
3650a
3646
3646b
100
102
3658

Fig. 20B4

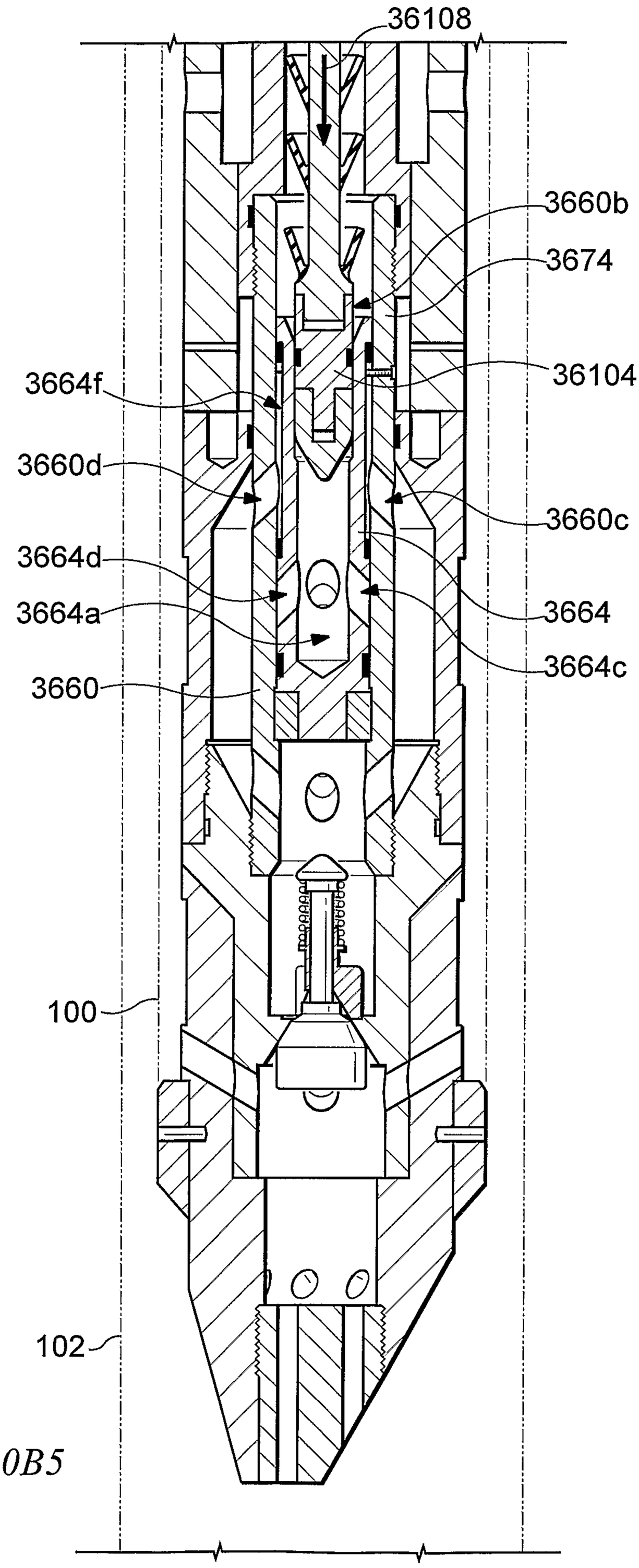

36108
3660b
3674
36104
3664f
3660d
3660c
3664d
3664
3664a
3664c
3660
100
102

Fig. 20B5

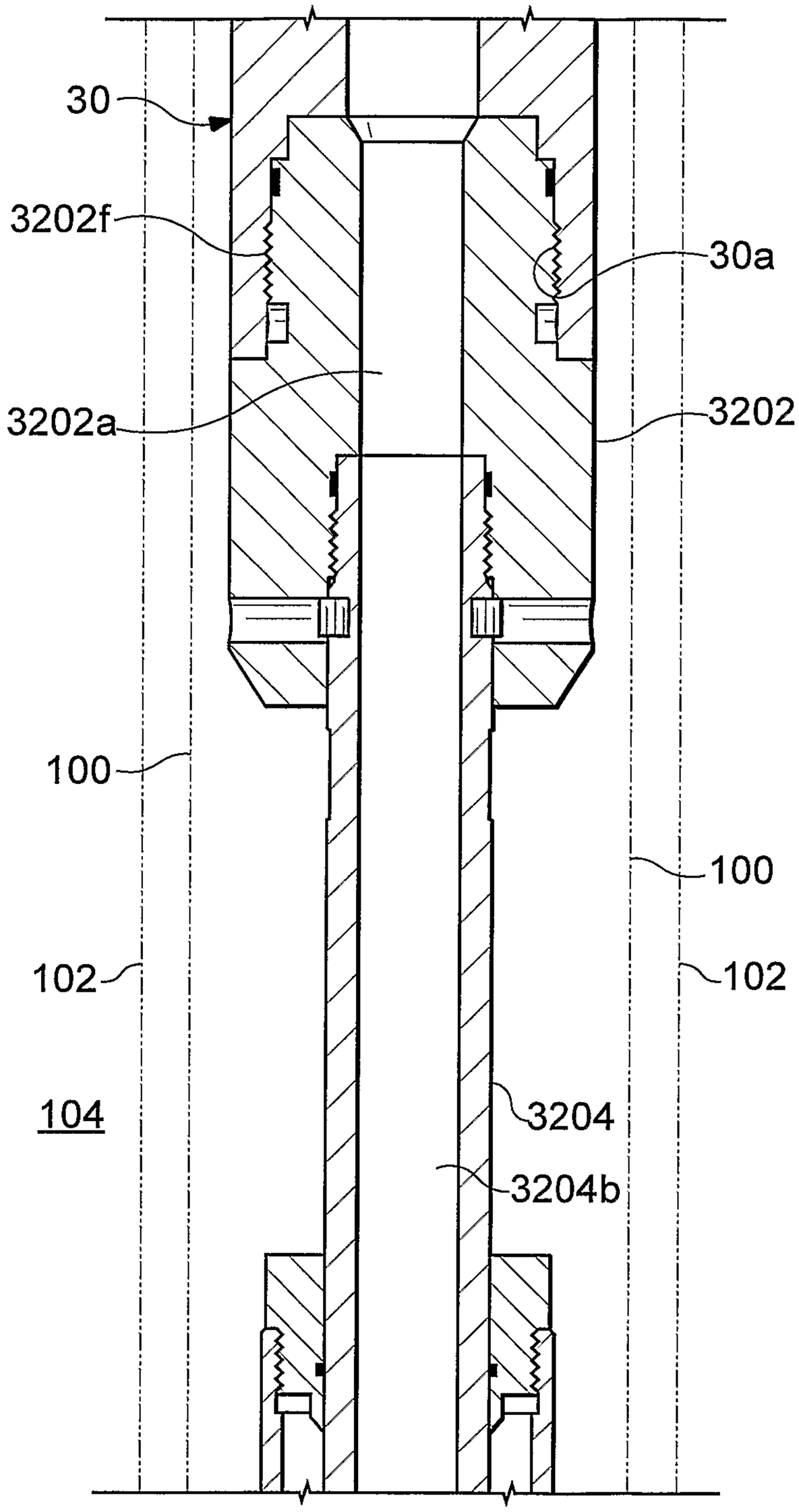


Fig. 20C1

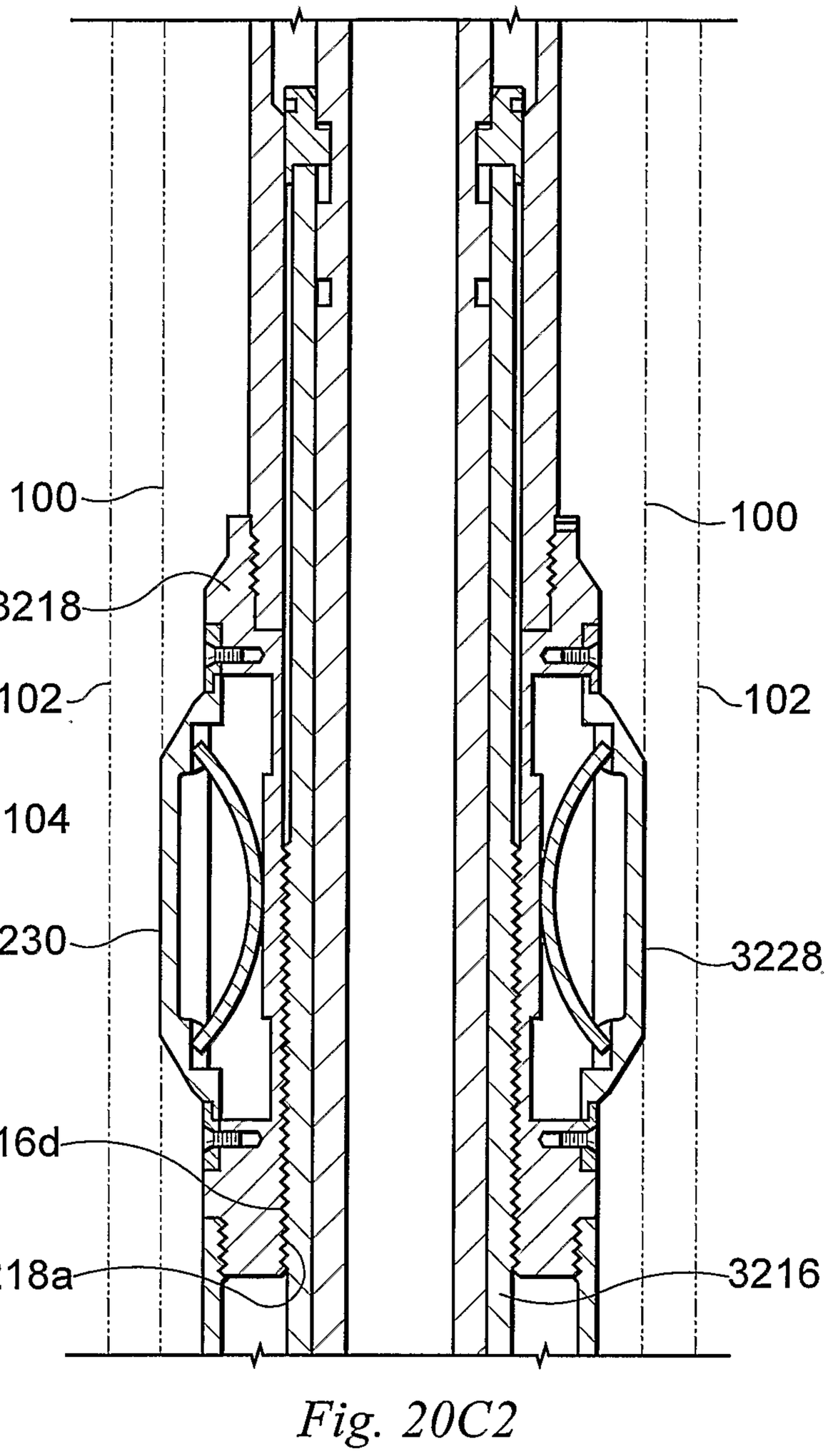


Fig. 20C2

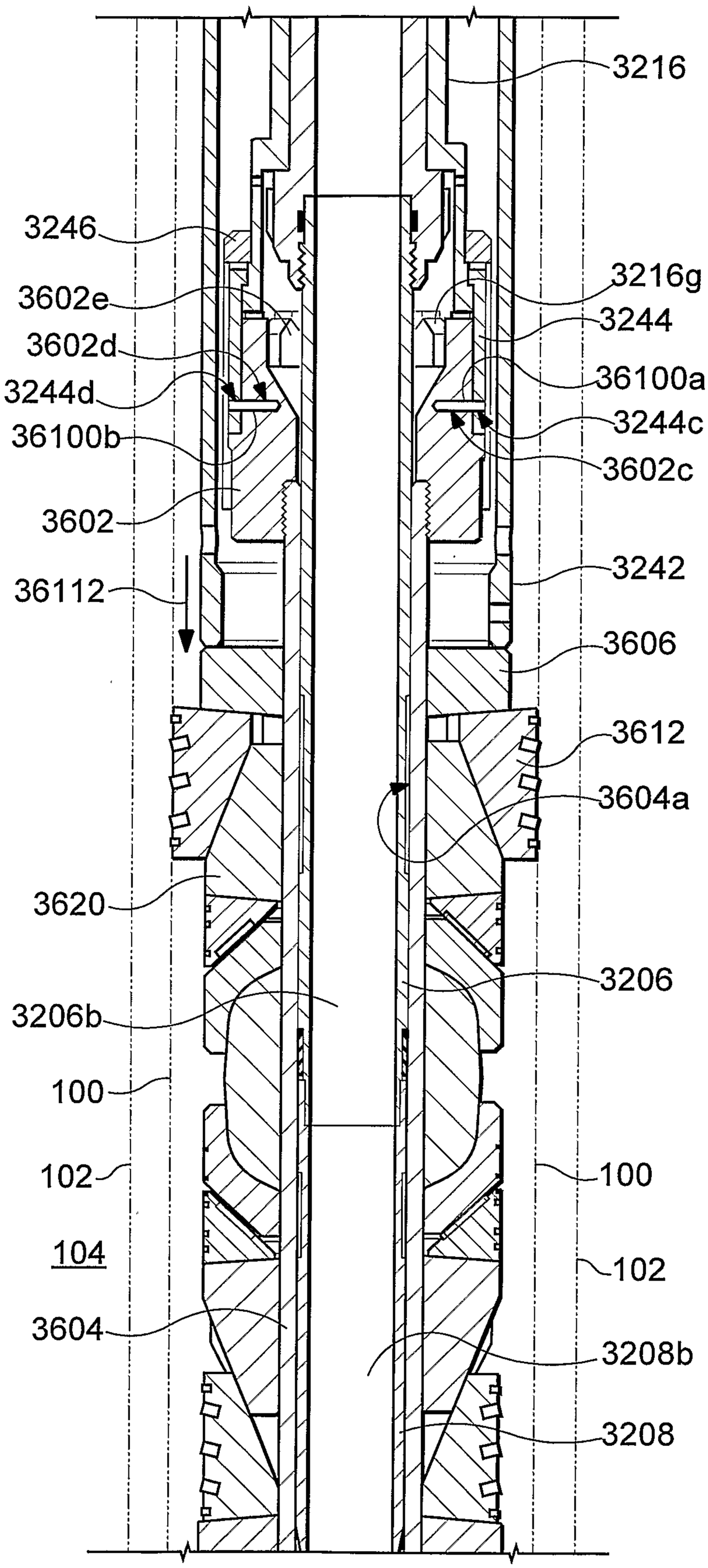

3216
3246
3602e
3602d
3244d
36100b
3602
36112
3620
3206b
100
102
104
3604
3216g
3244
36100a
3244c
3602c
3242
3606
3612
3604a
3206
100
102
3208b
3208

Fig. 20C3

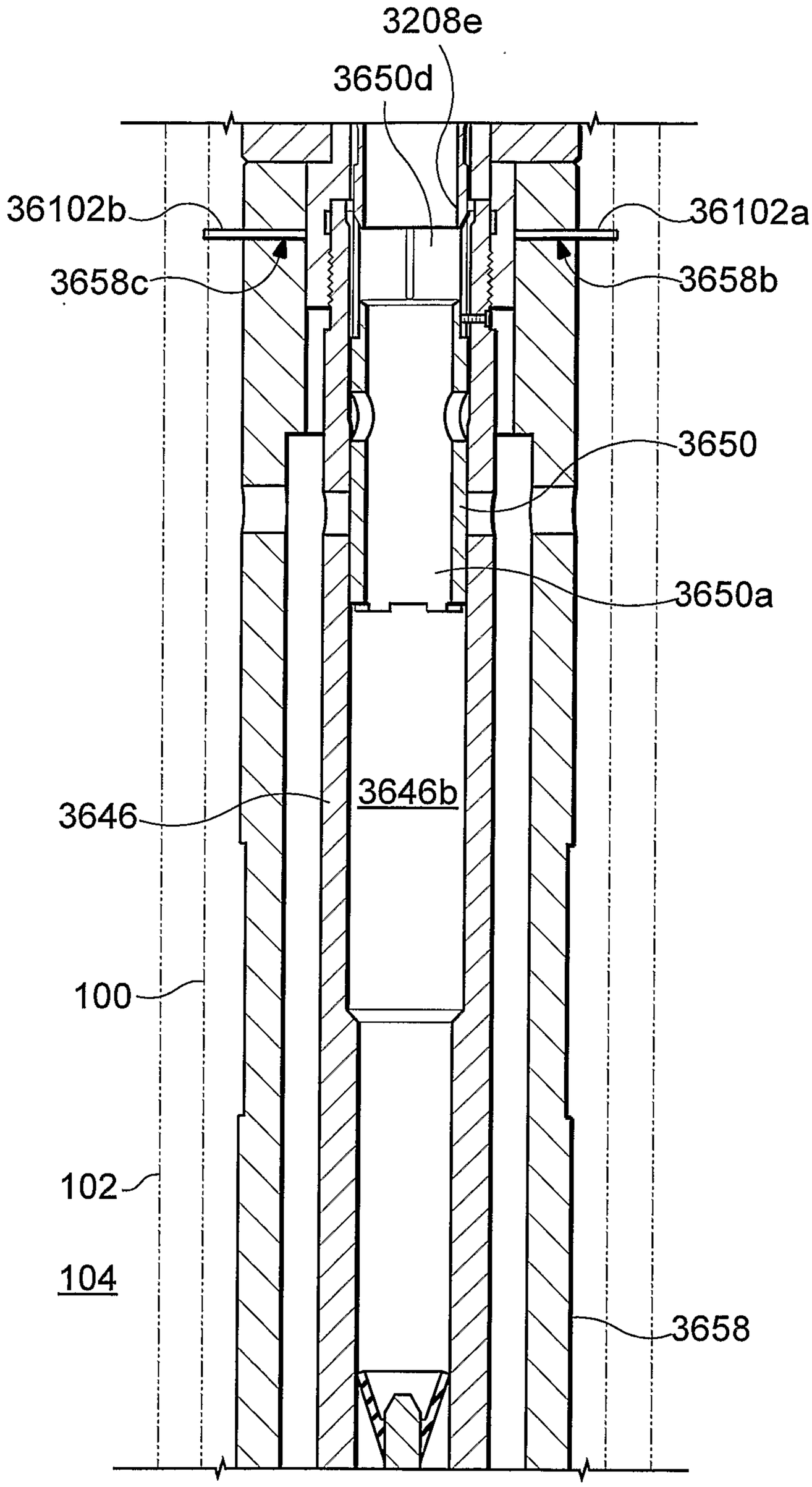

3208e
3650d
36102b
36102a
3658c
3658b
3650
3650a
3646b
3646
100
102
104
3658

Fig. 20C4

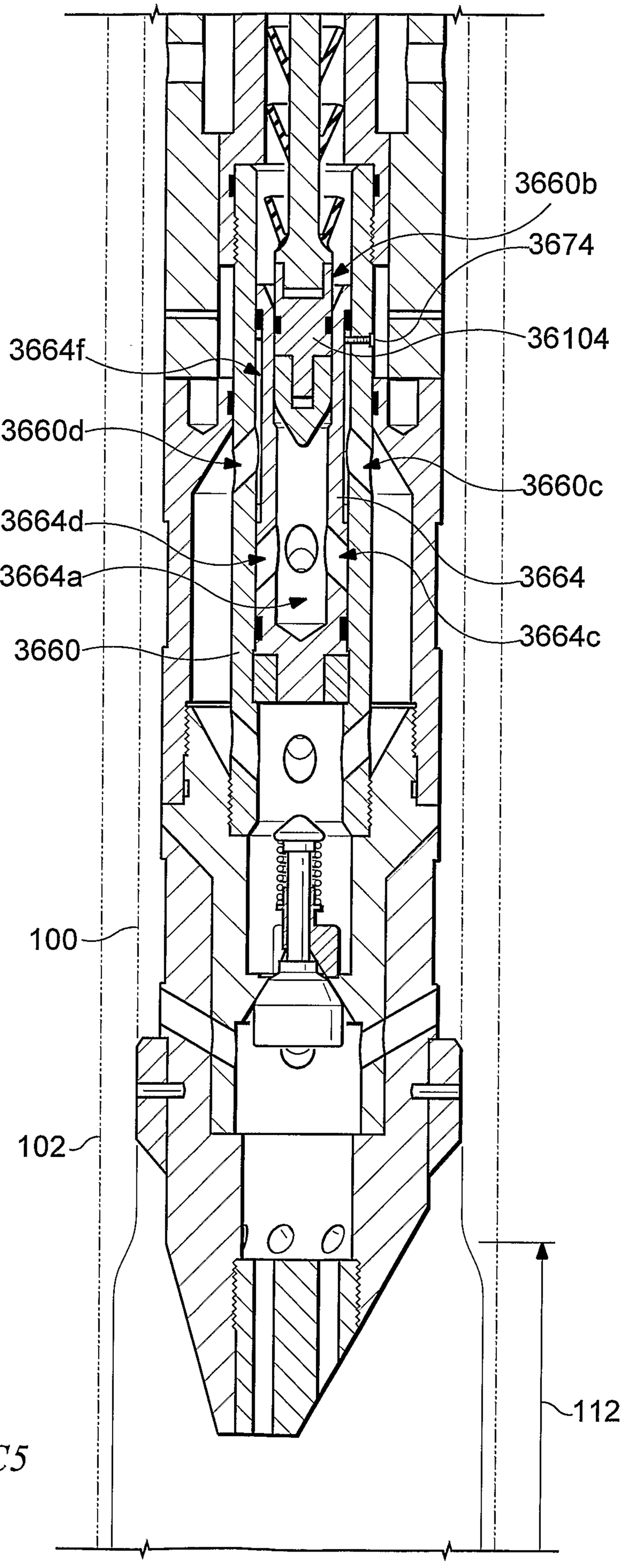

3660b
3674
36104
3664f
3660d
3660c
3664d
3664
3664a
3664c
3660
100
102
36
112

Fig. 20C5

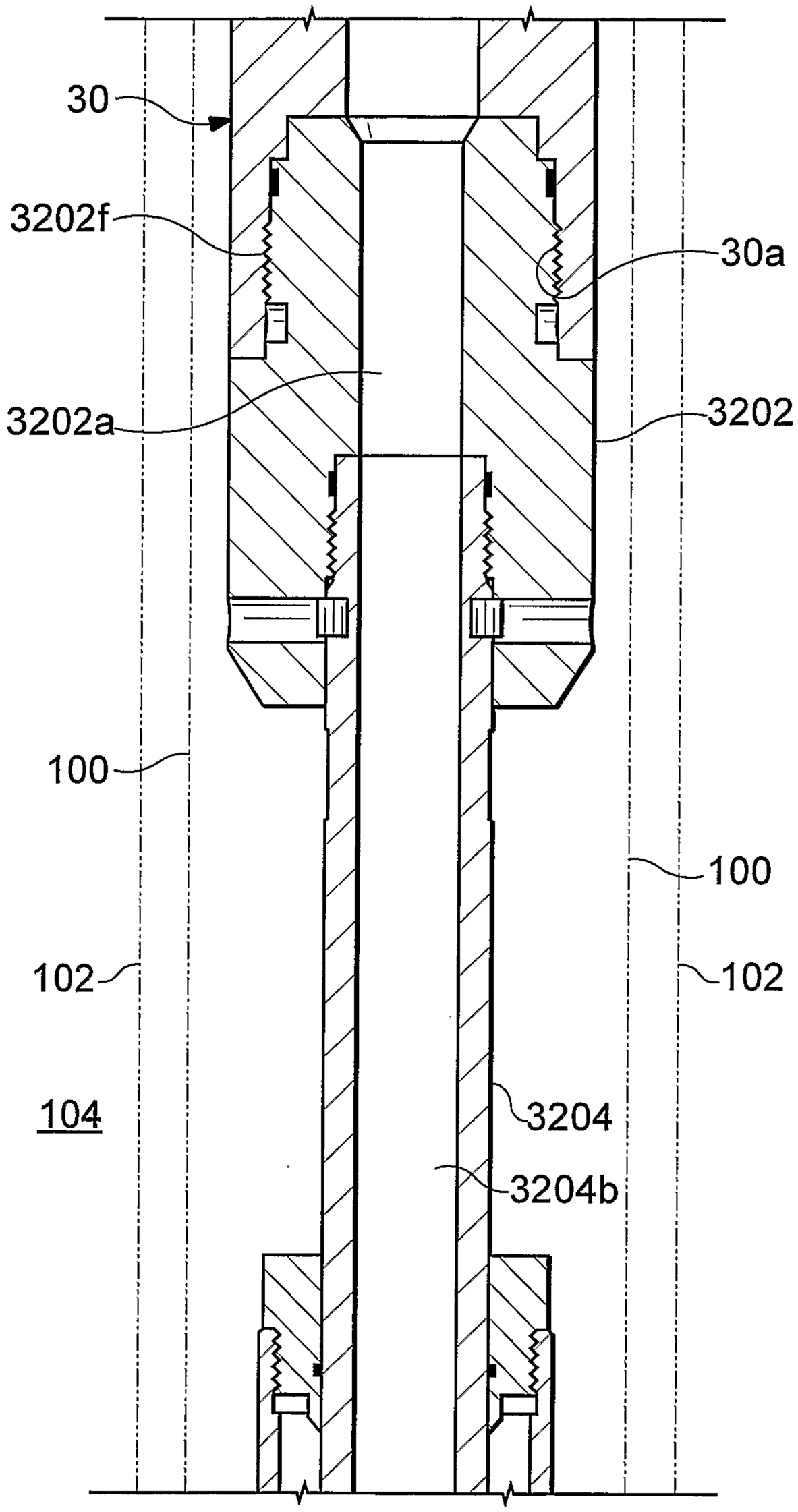


Fig. 20D1

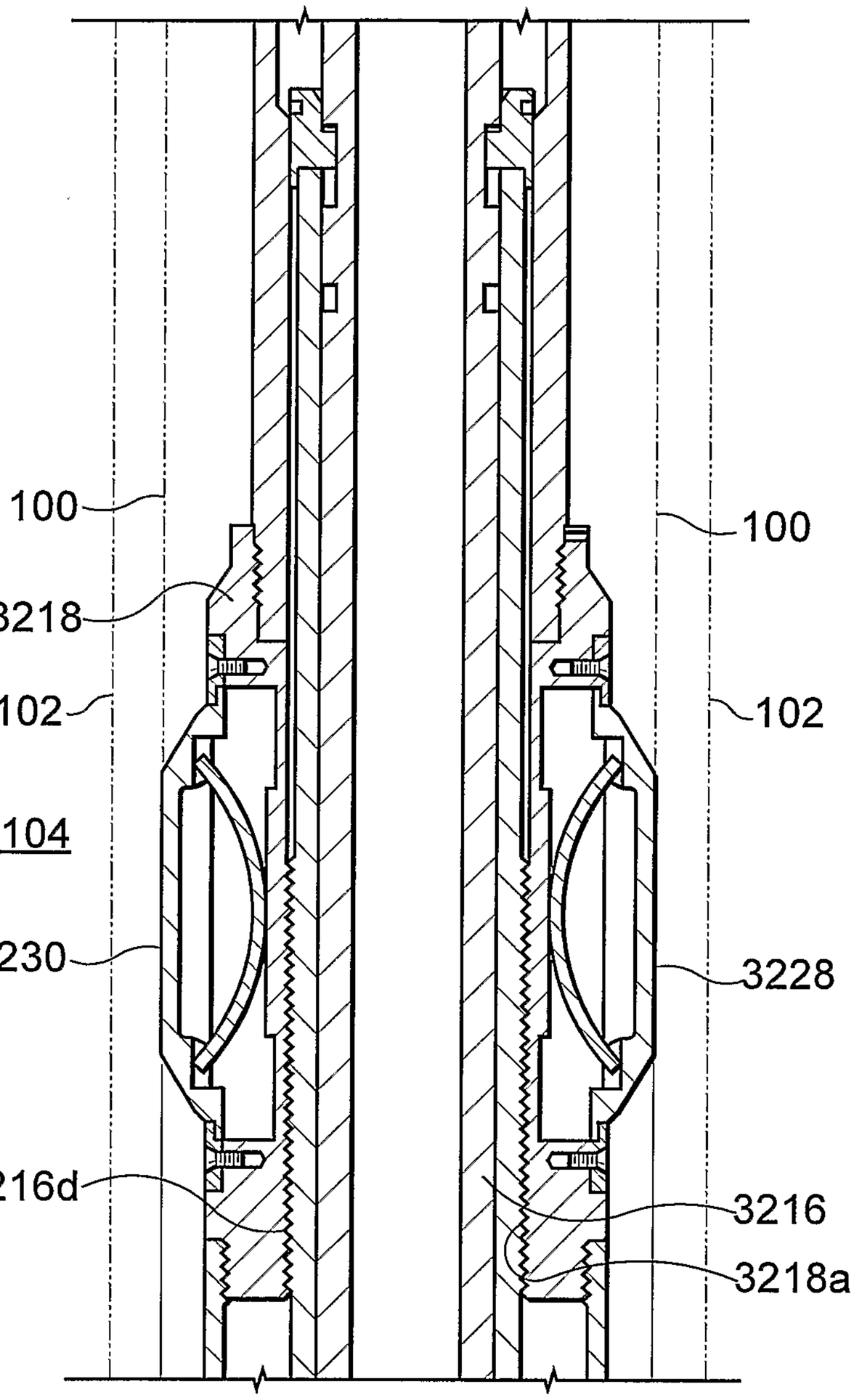


Fig. 20D2

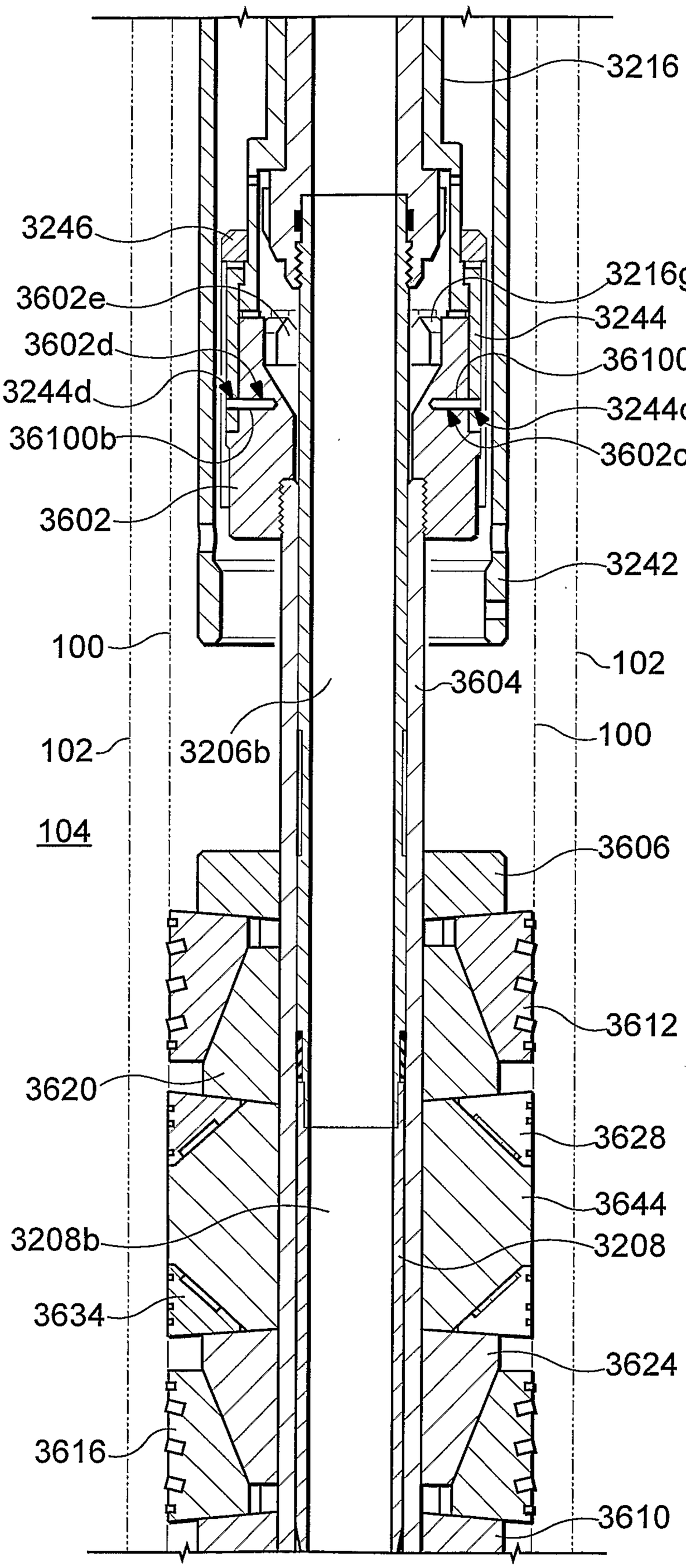

3216
3246
3602e
3602d
3244d
36100b
3602
100
102
104
3206b
3216g
3244
36100a
3244c
3602c
3242
3604
102
100
3606
3612
3620
3628
3644
3208b
3208
3634
3624
3616
3610

Fig. 20D3

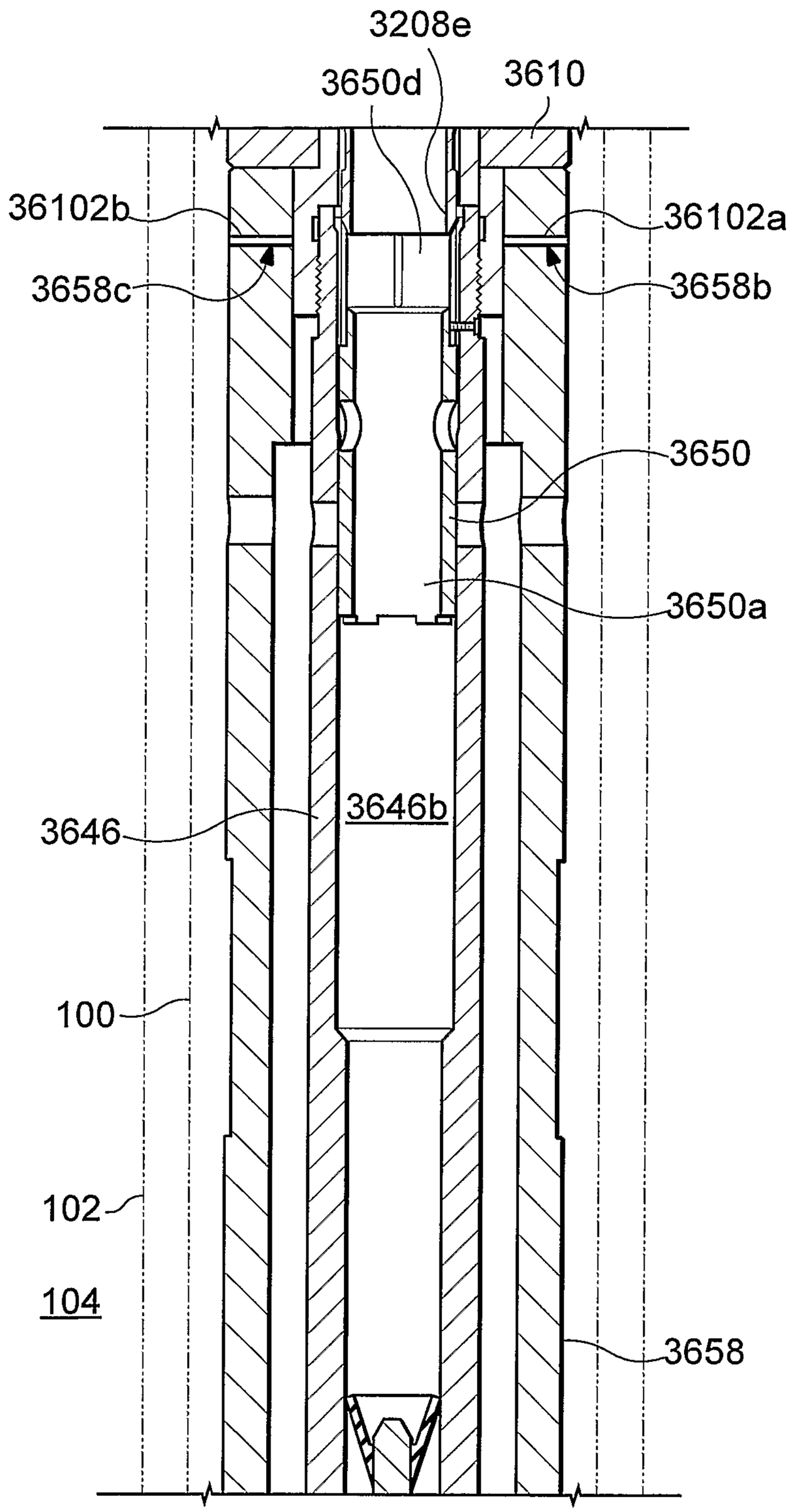

3208e
3650d
3610
36102b
36102a
3658c
3658b
3650
3650a
3646b
3646
100
102
104
3658

Fig. 20D4

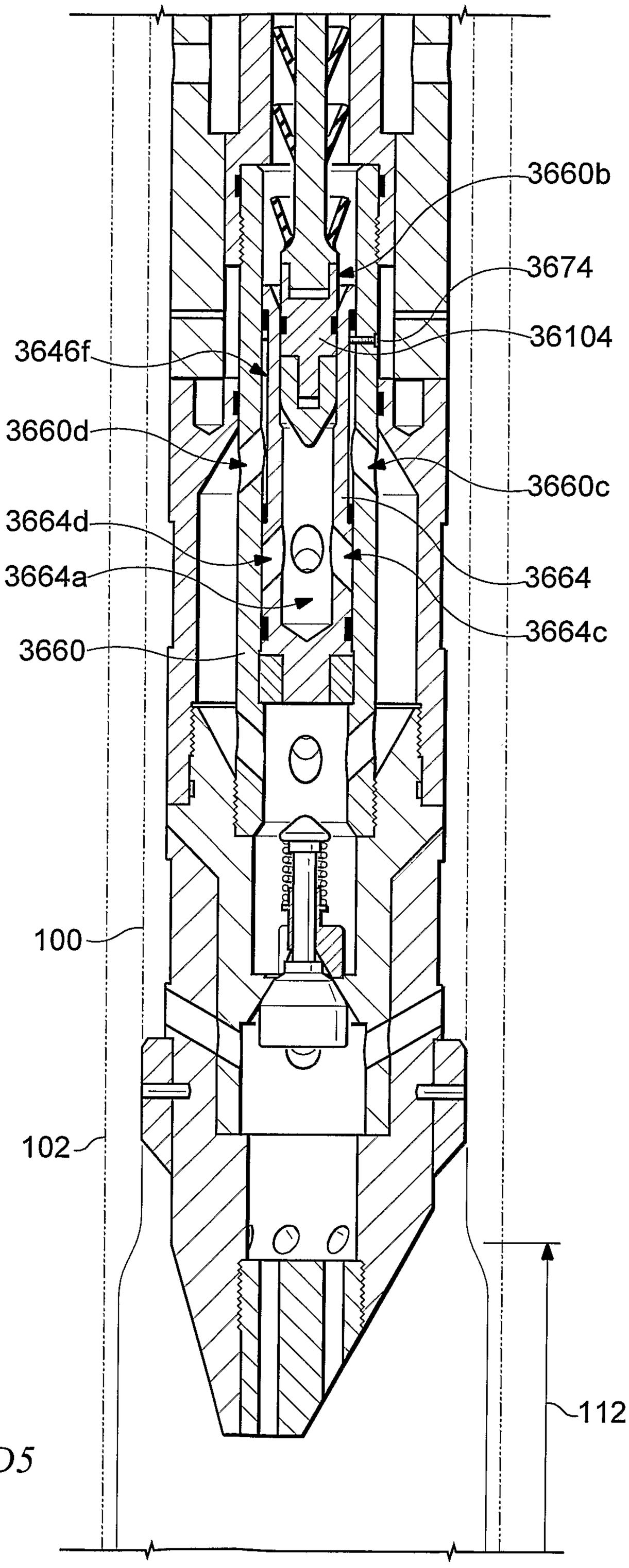

3660b
3674
36104
3646f
3660d
3660c
3664d
3664
3664a
3664c
3660
100
102
112

Fig. 20D5

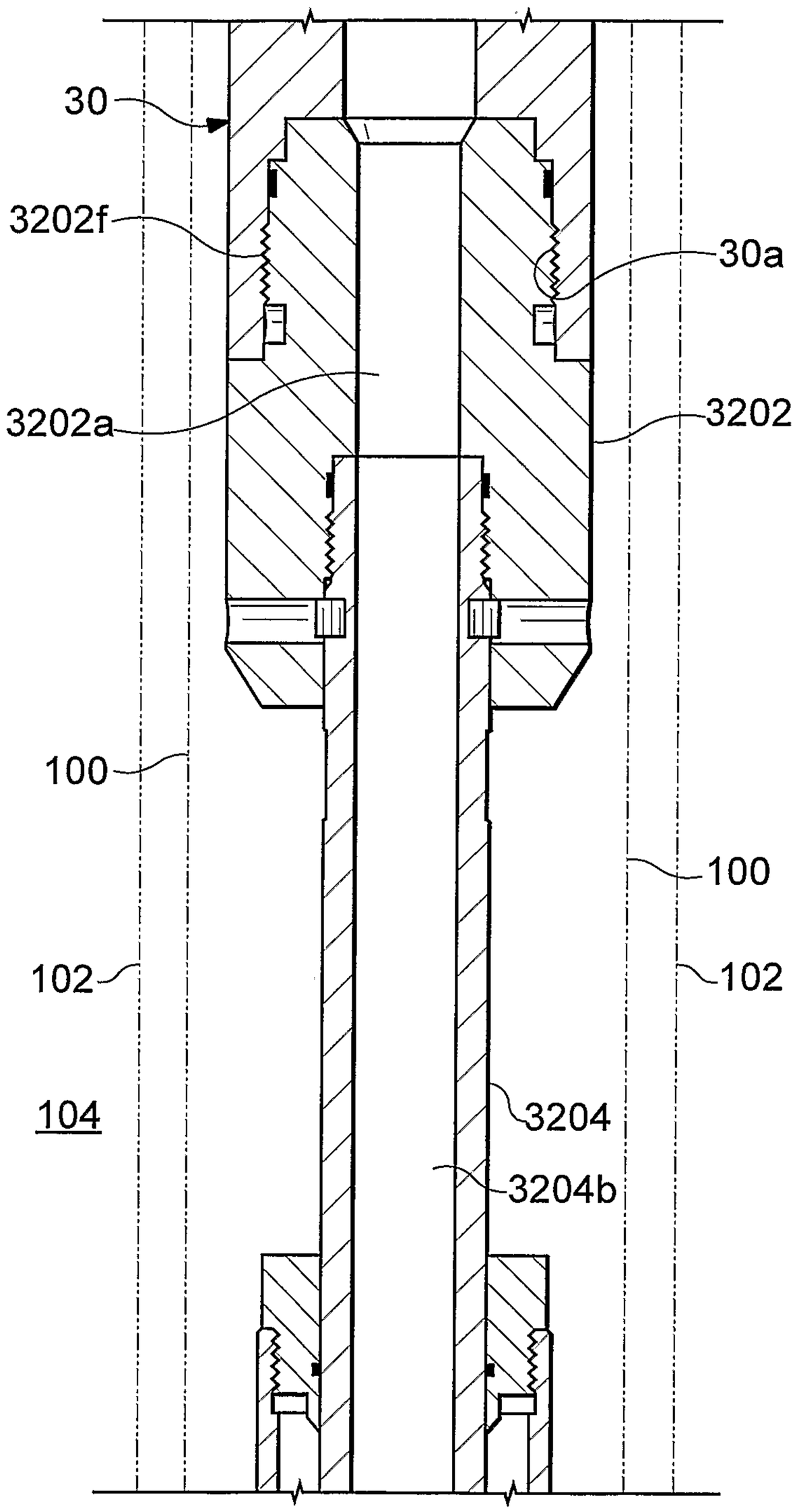


Fig. 20E1

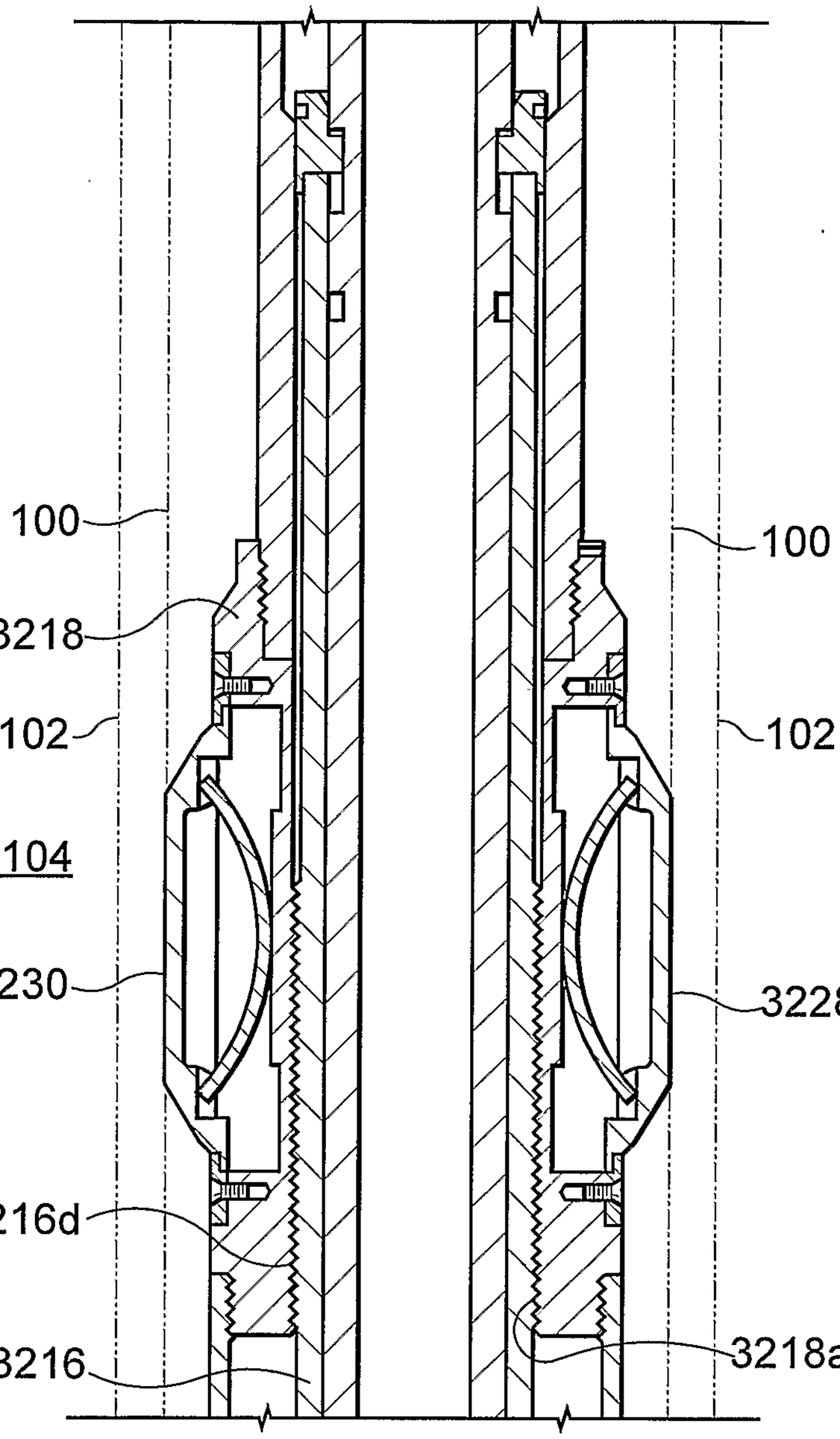


Fig. 20E2

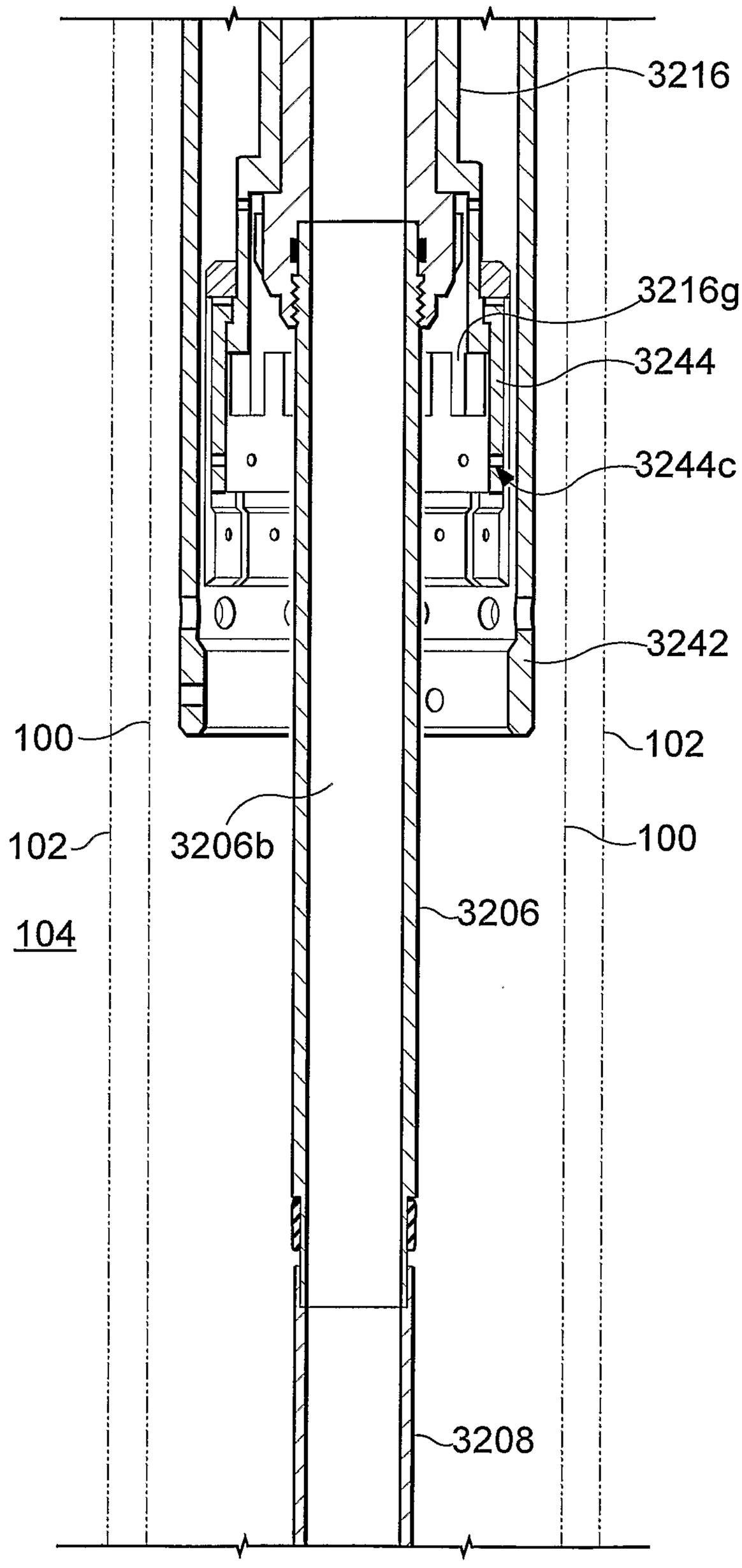

3216
3216g
3244
3244c
3242
100
102
3206b
102
100
104
3206
3208

Fig. 20E3

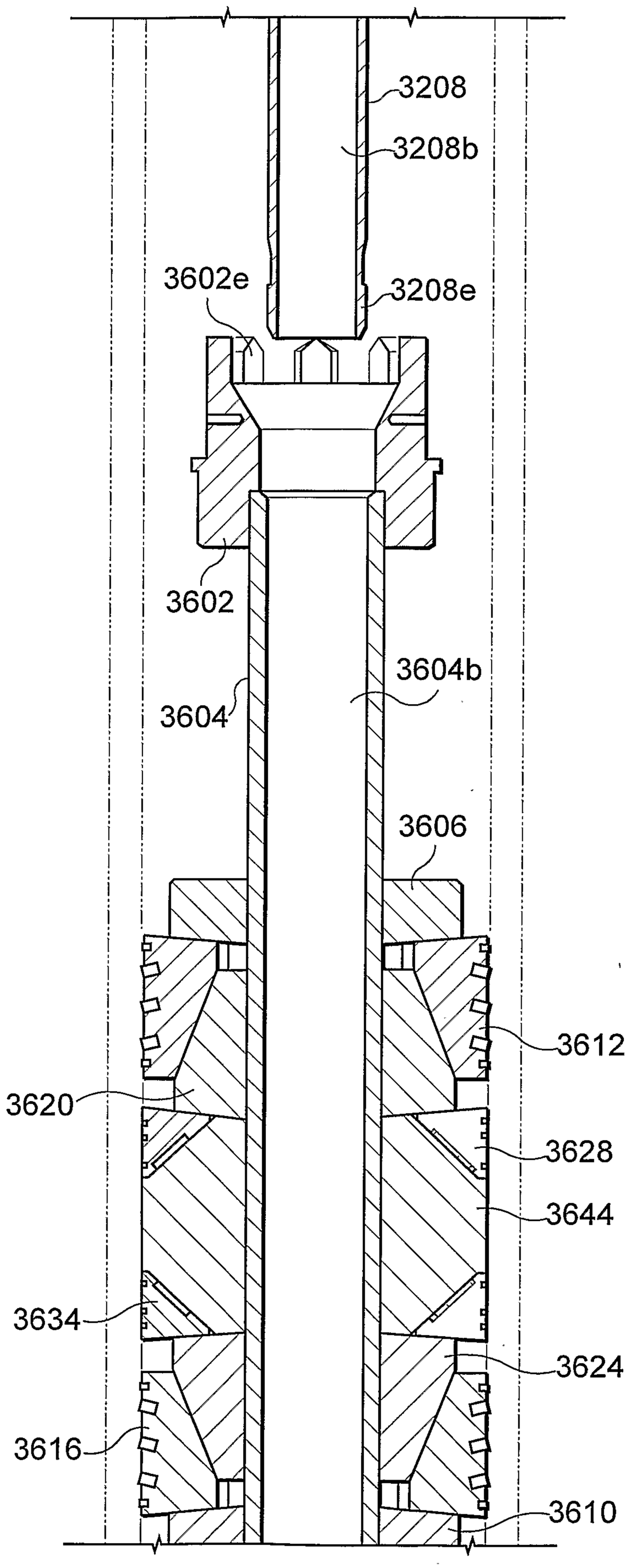

3208
3208b
3602e
3208e
3602
3604b
3604
3606
3612
3620
3628
3644
3634
3624
3616
3610

Fig. 20E4

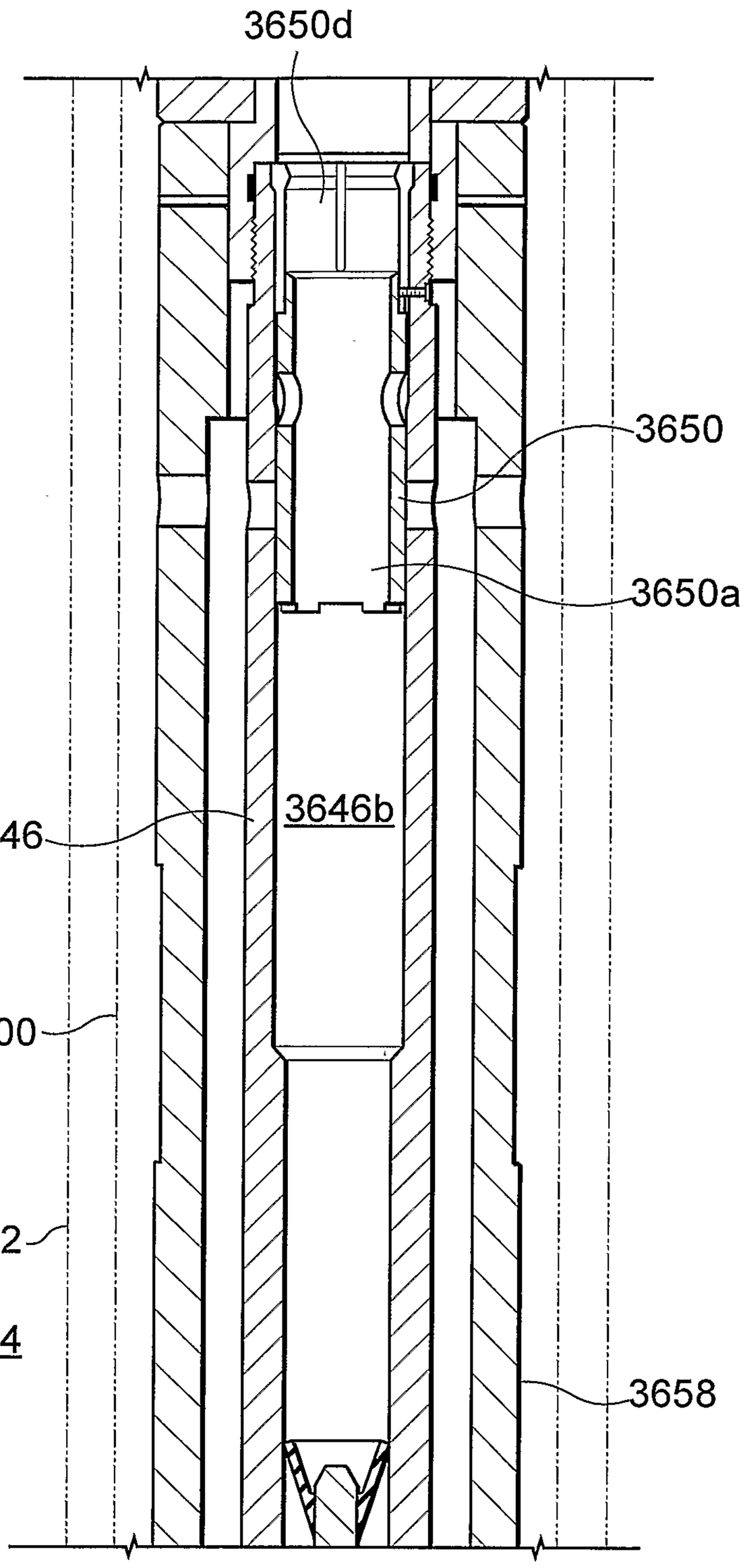


Fig. 20E5

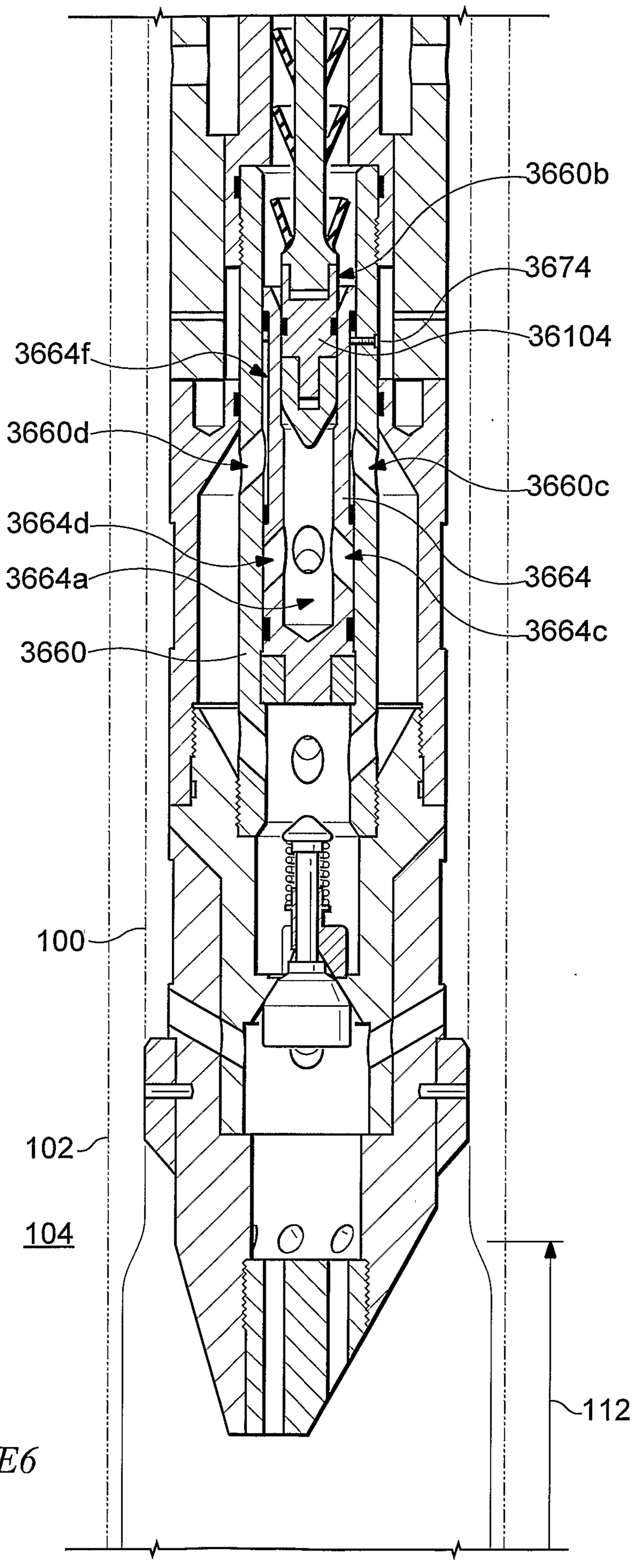

3660b
3674
36104
3664f
3660d
3660c
3664d
3664
3664a
3664c
3660
100
102
104
112

Fig. 20E6

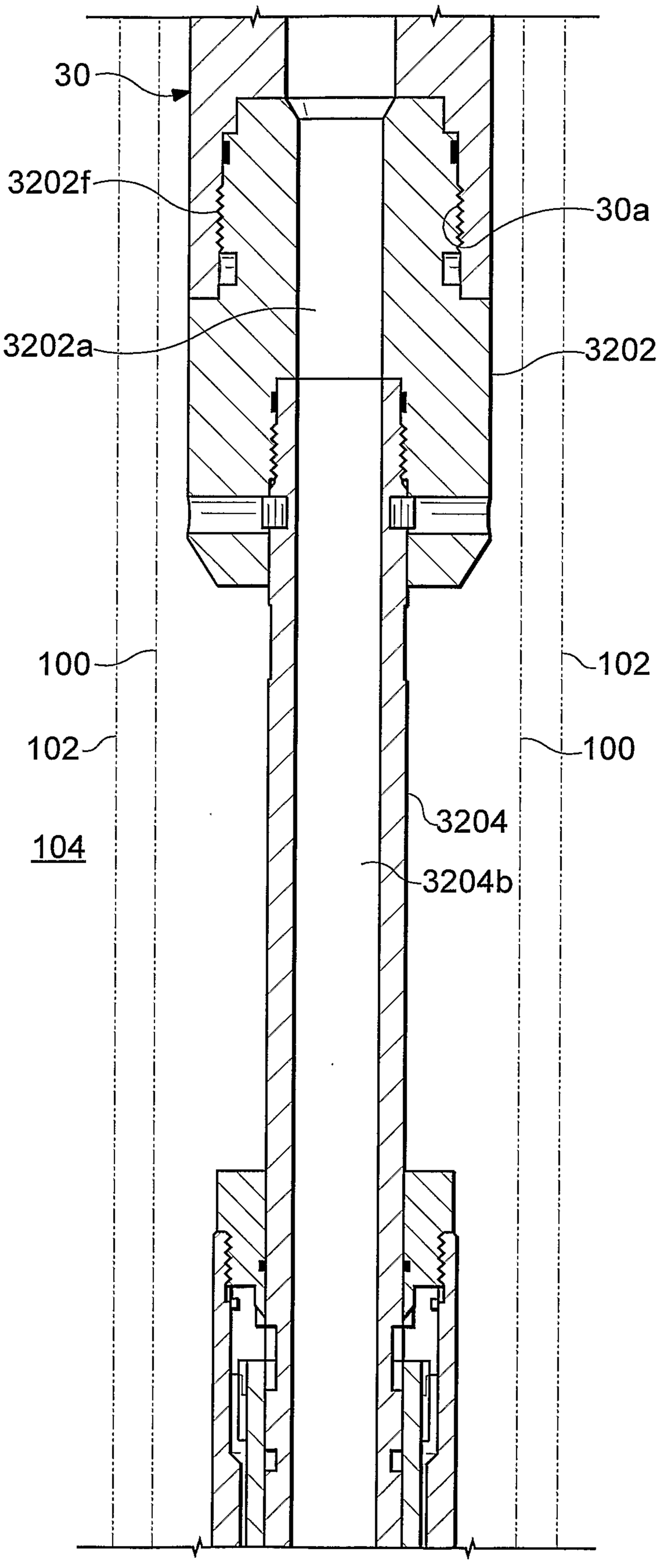


Fig. 20F1

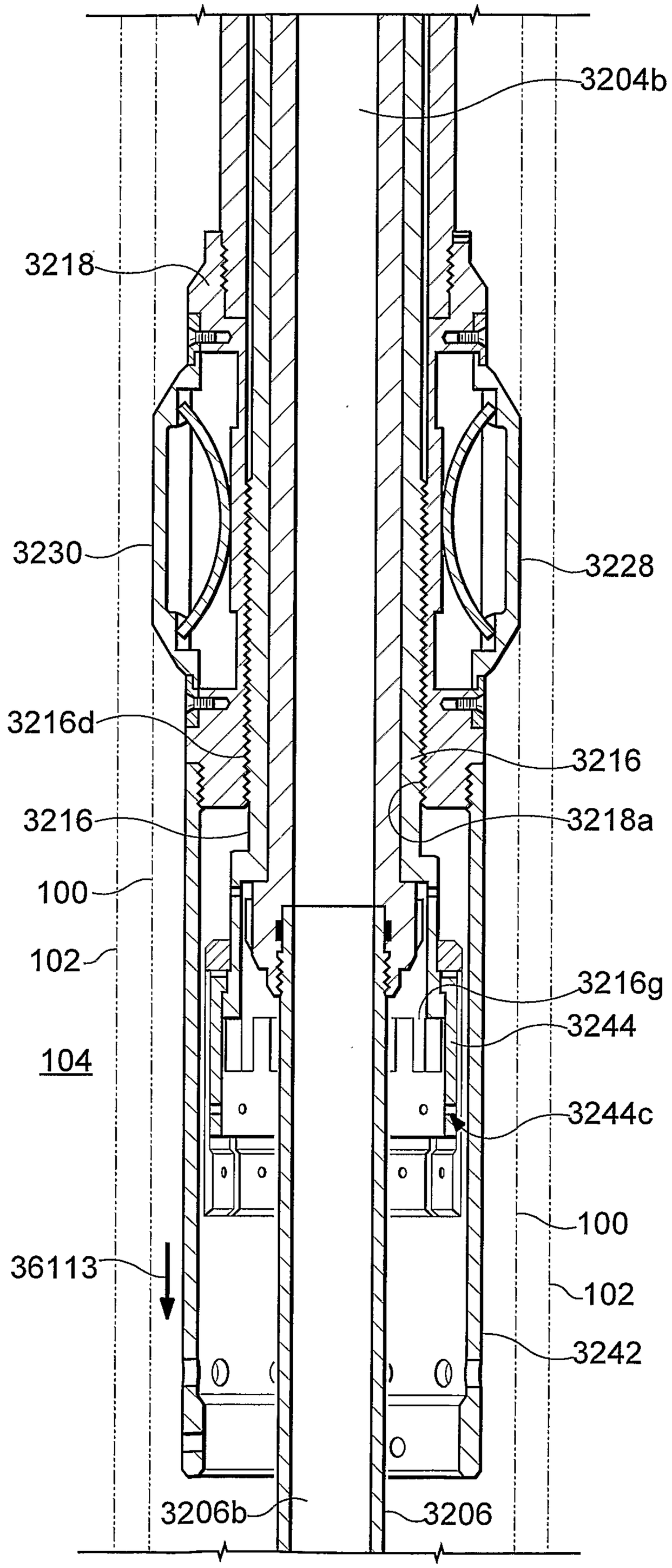

3204b
3218
3230
3216d
3216
100
102
104
36113
3206b
3228
3216
3218a
3216g
3244
3244c
100
102
3242
3206

Fig. 20F2

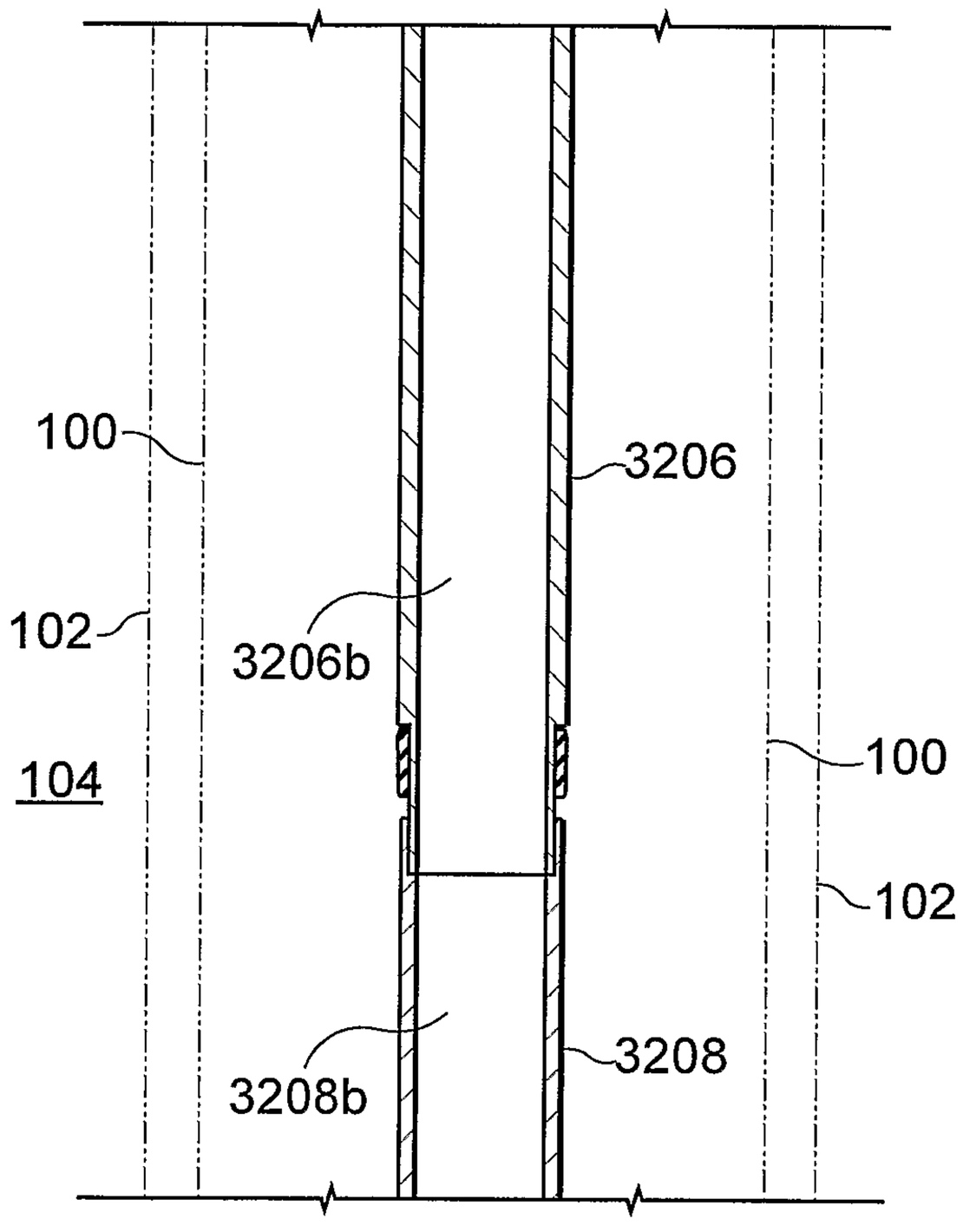


Fig. 20F3

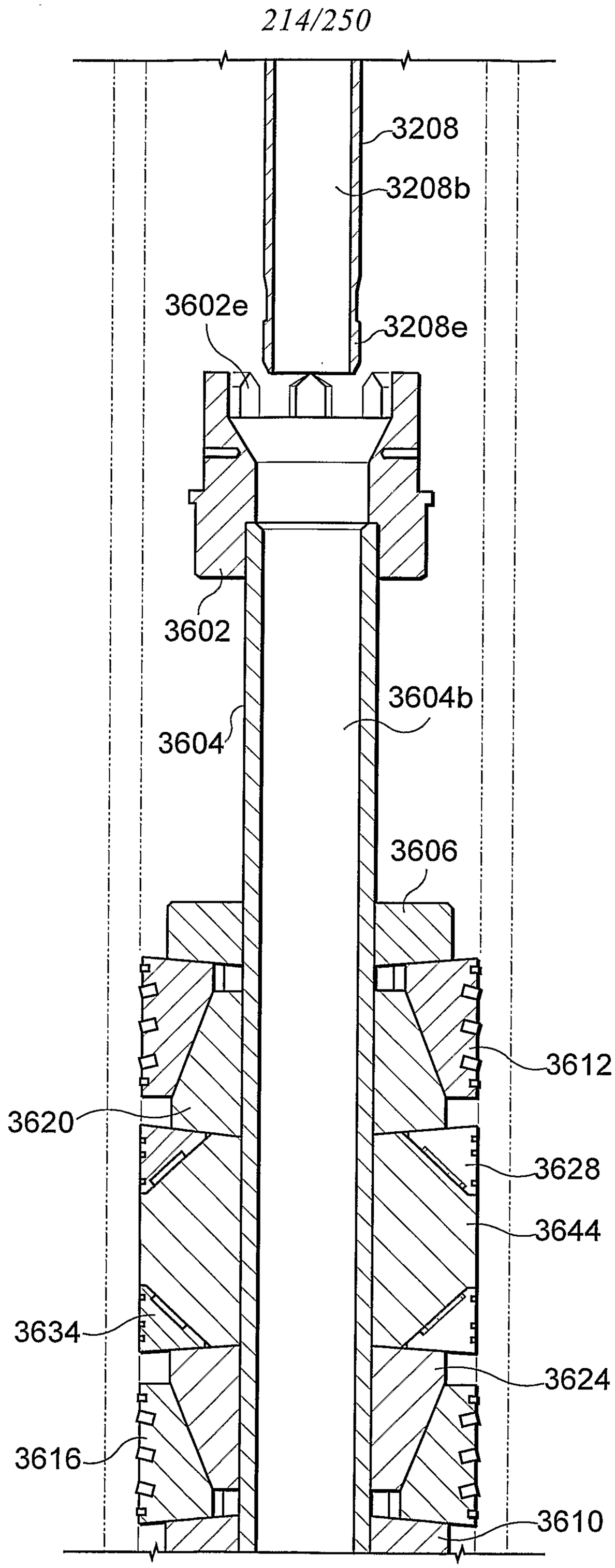

3208
3208b
3602e
3208e
3602
3604b
3604
3606
3612
3620
3628
3644
3634
3624
3616
3610

Fig. 20F4

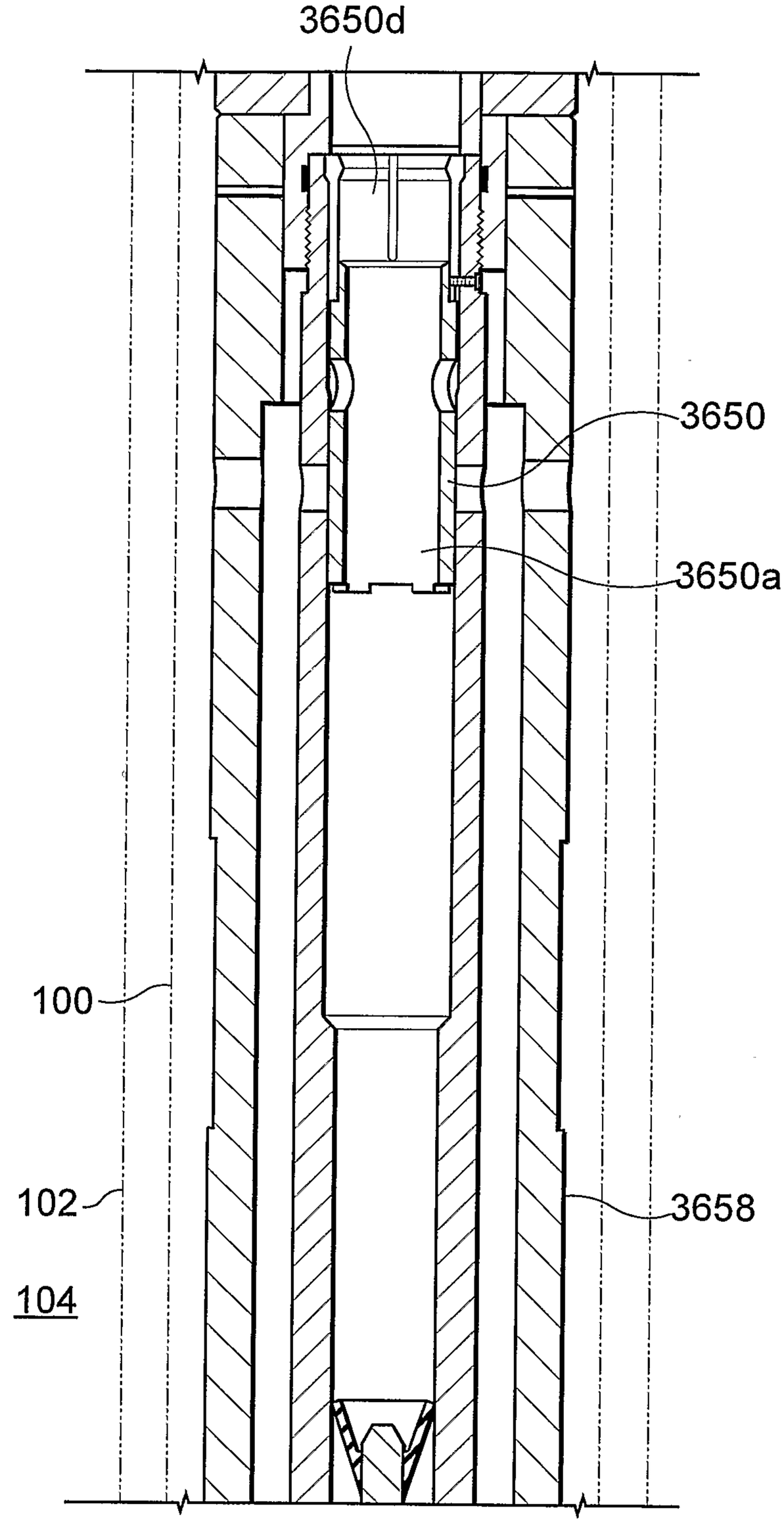


Fig. 20F5

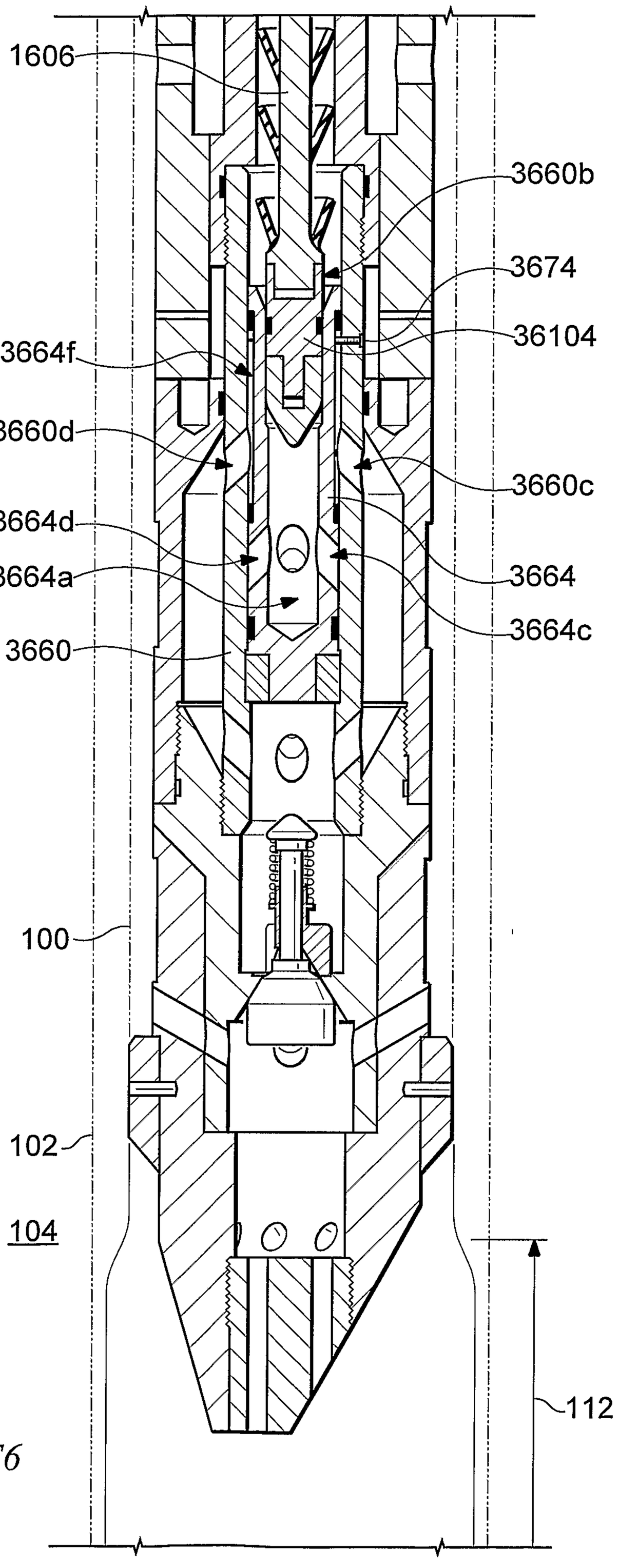

1606
3660b
3674
36104
3664f
3660d
3660c
3664d
3664
3664a
3664c
3660
100
102
104
112

Fig. 20F6

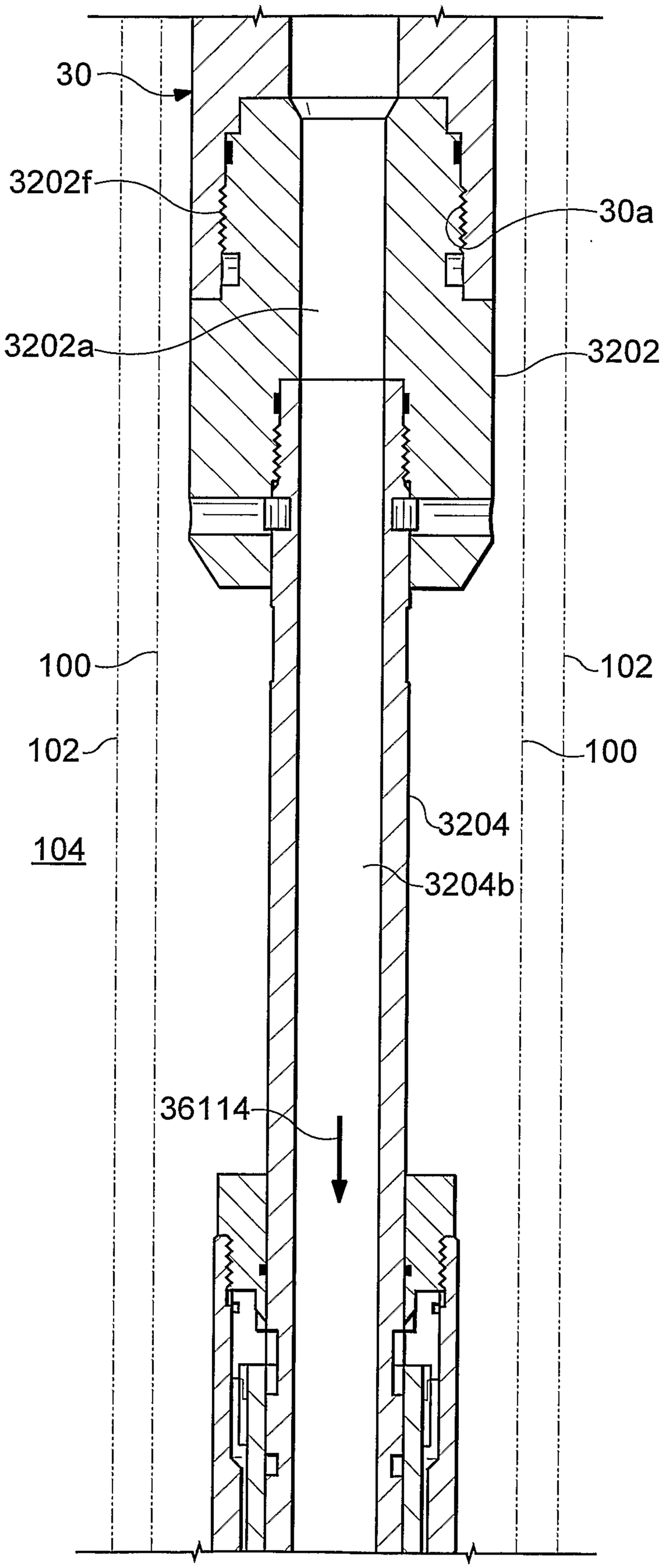


Fig. 20G1

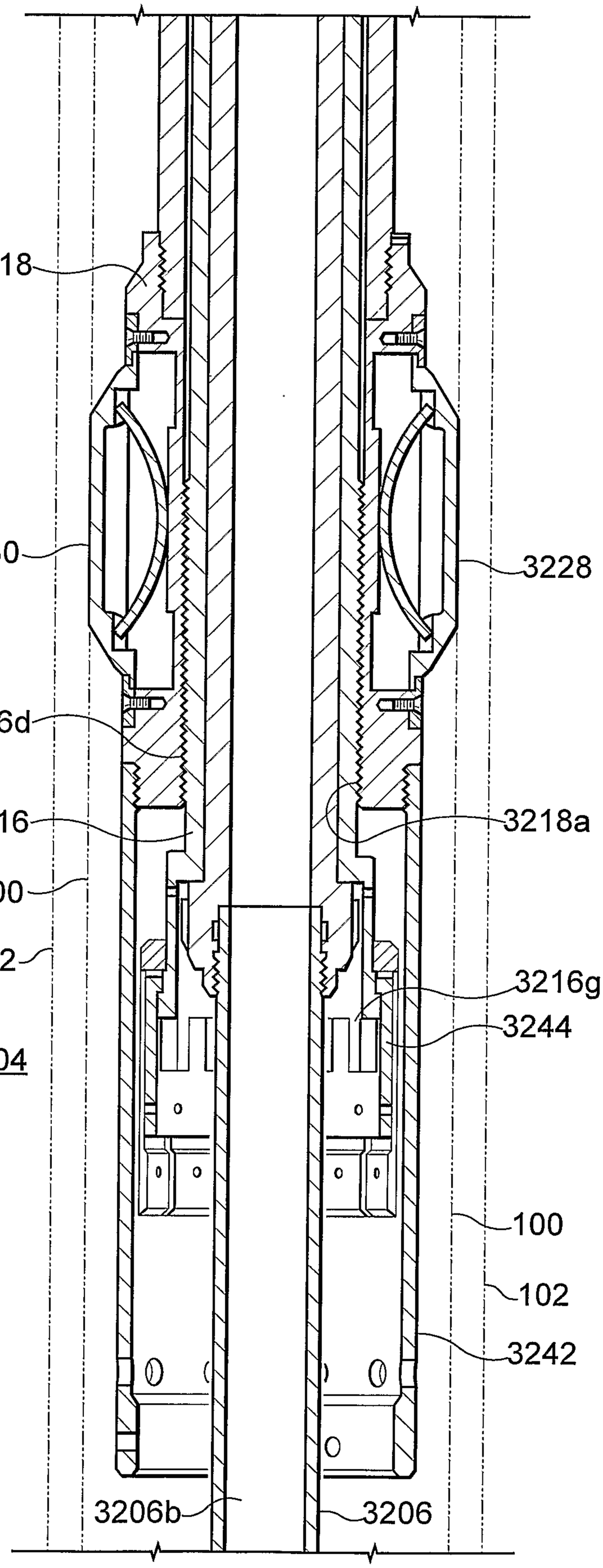

3218
3230
3216d
3216
100
102
104
3228
3218a
3216g
3244
100
102
3242
3206b
3206

Fig. 20G2

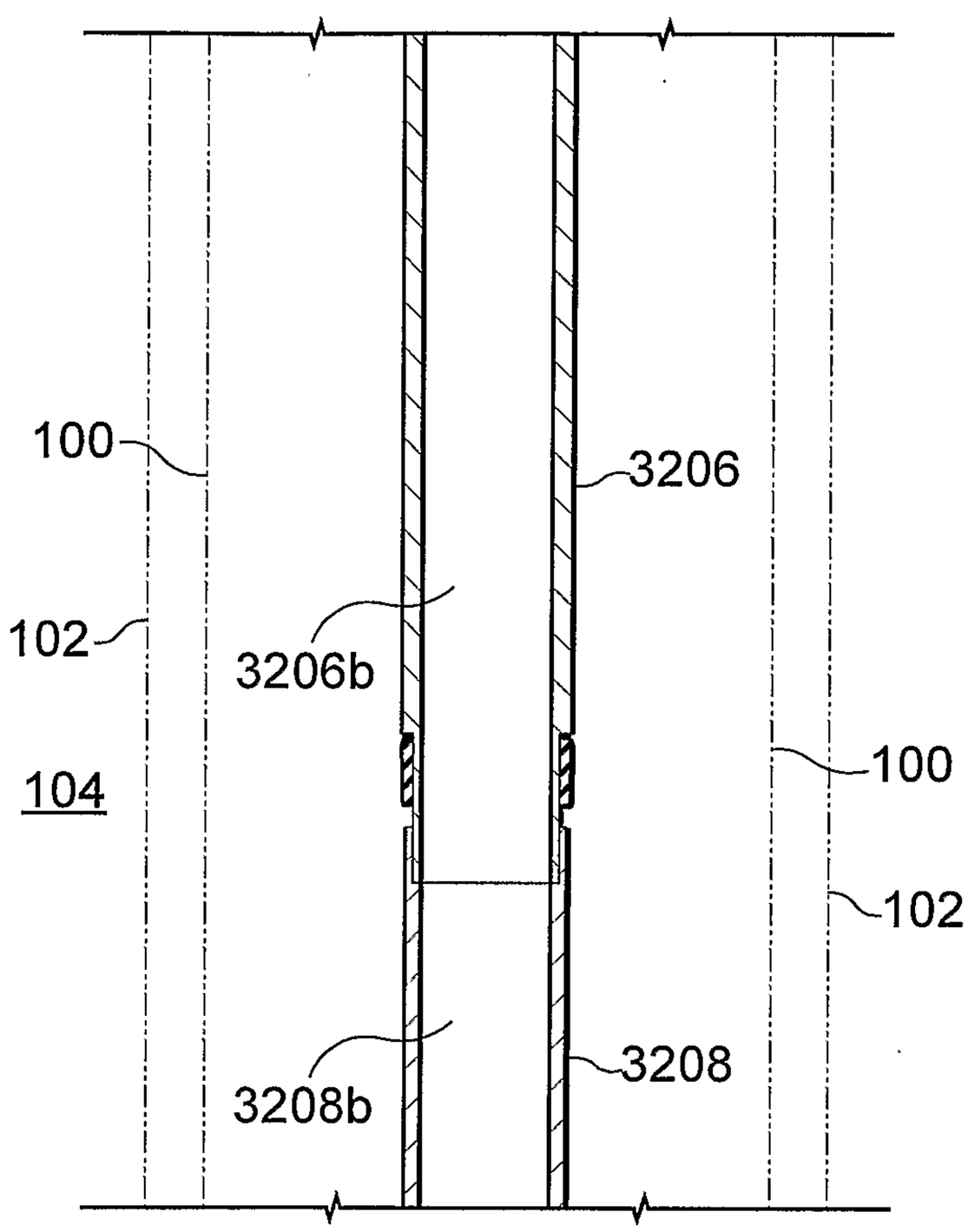


Fig. 20G3

220/250

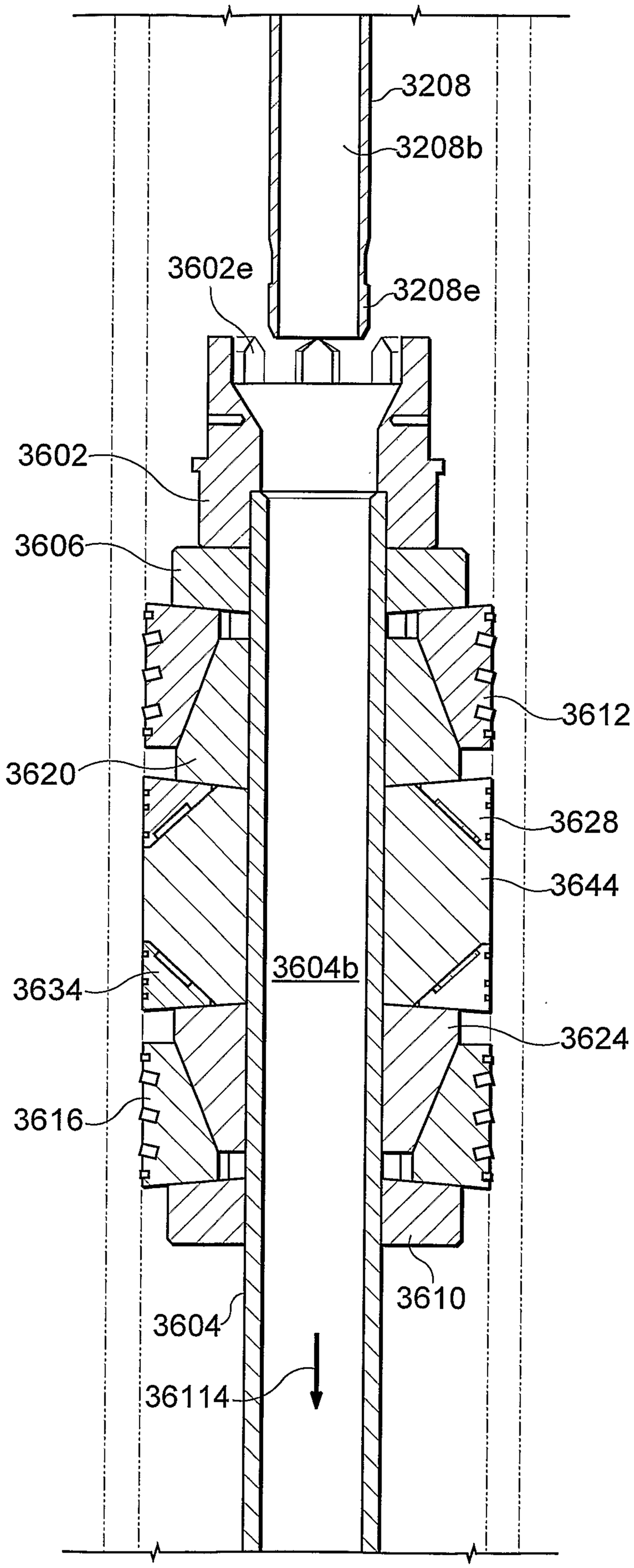


Fig. 20G4

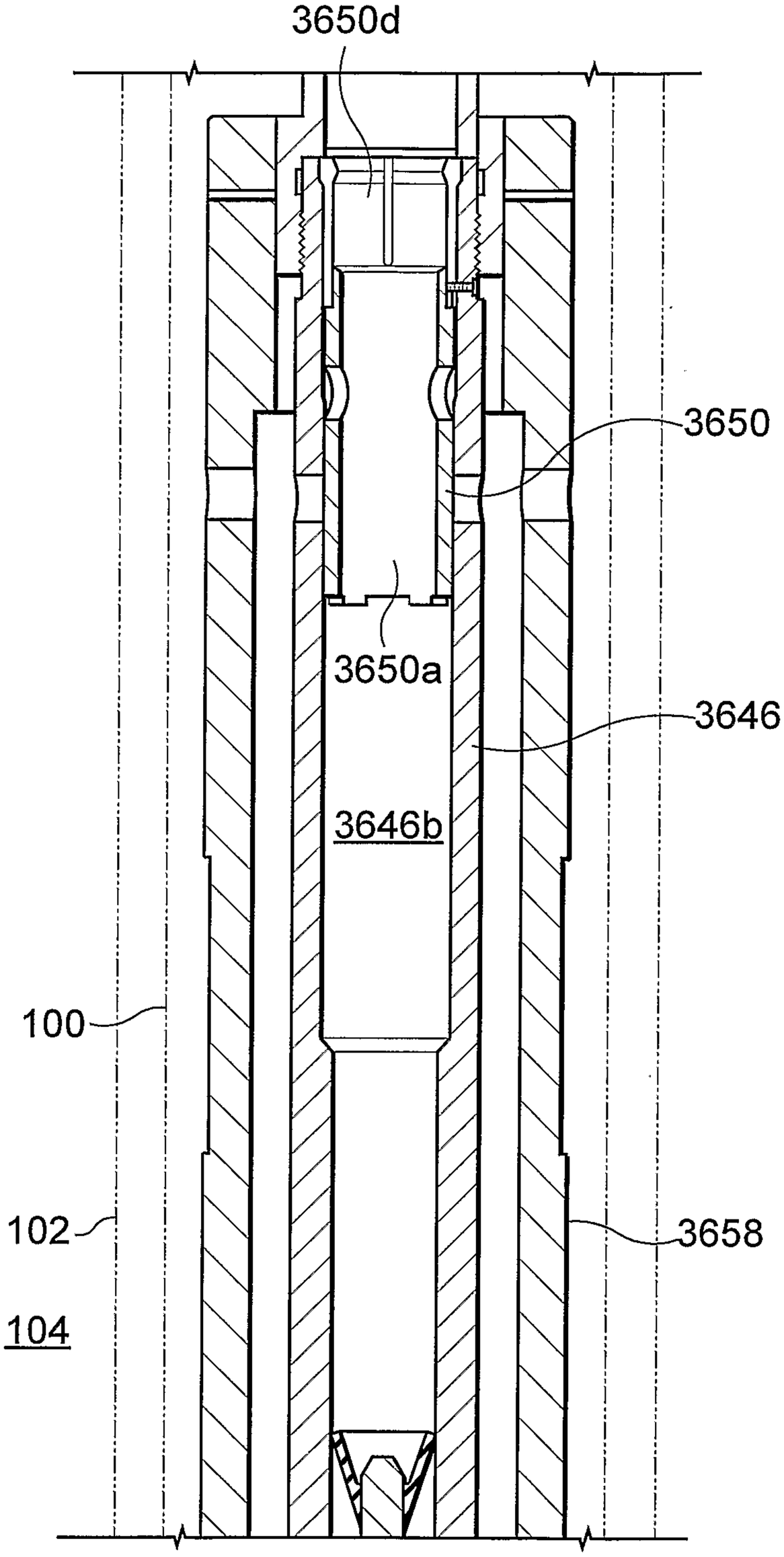


Fig. 20G5

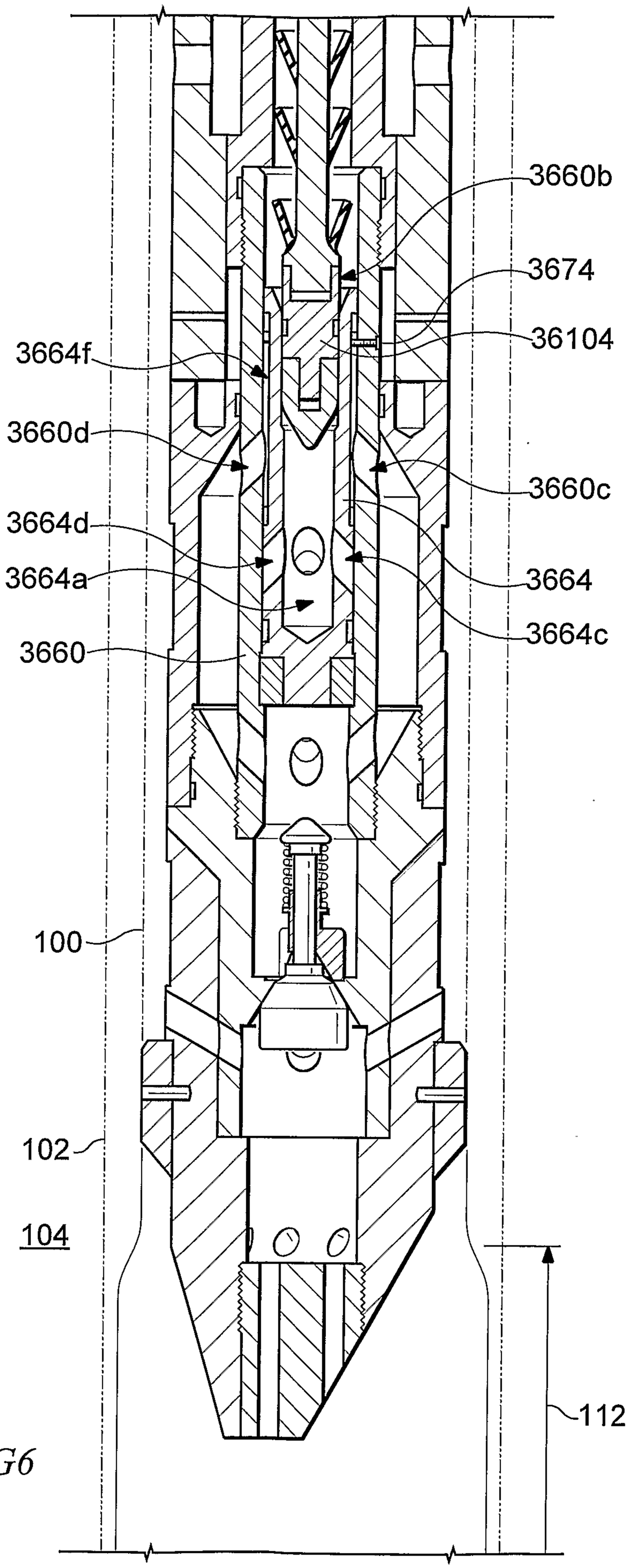

3660b
3674
36104
3664f
3660d
3660c
3664d
3664
3664a
3664c
3660
100
102
104
112

Fig. 20G6

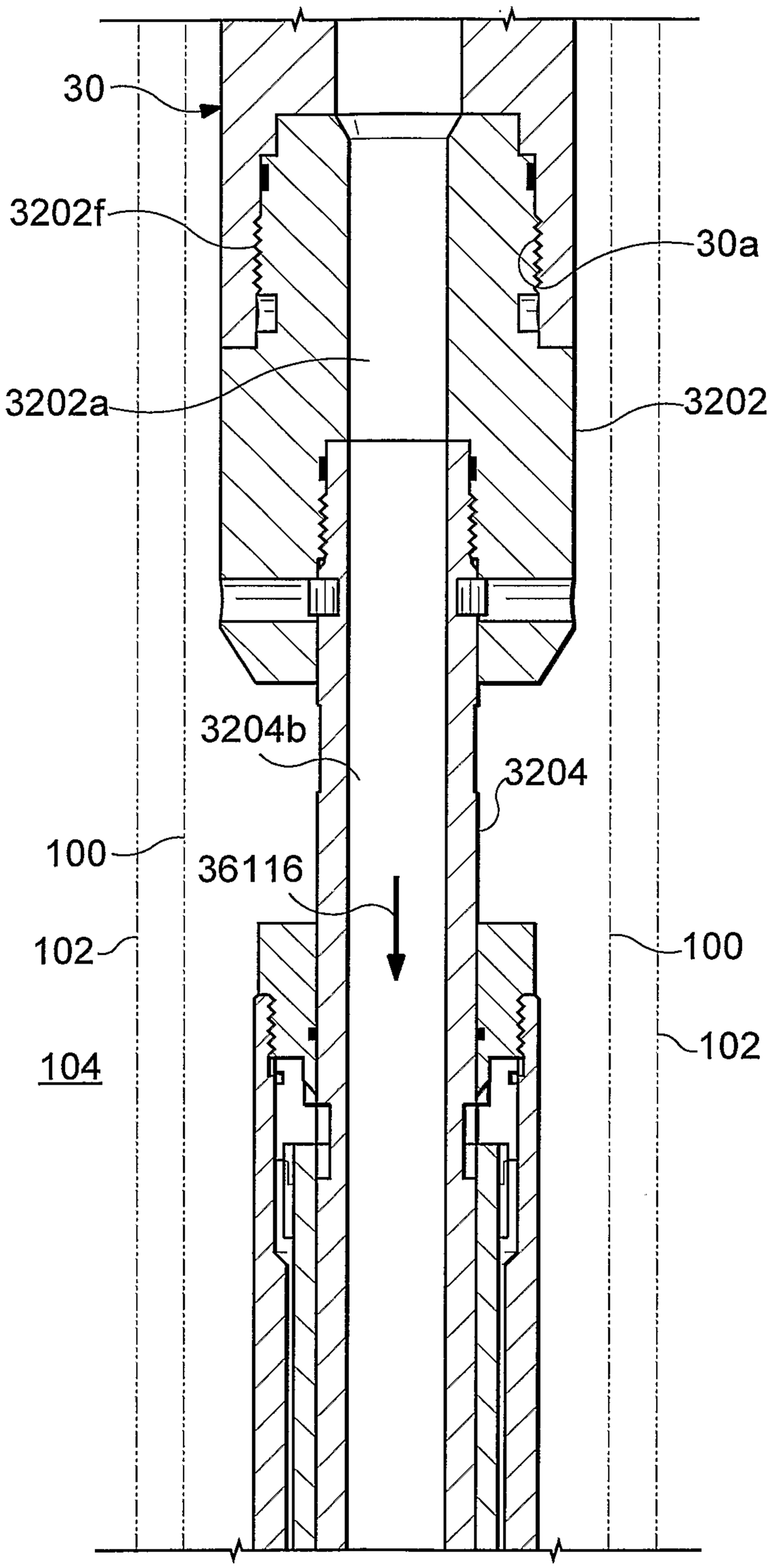


Fig. 20H1

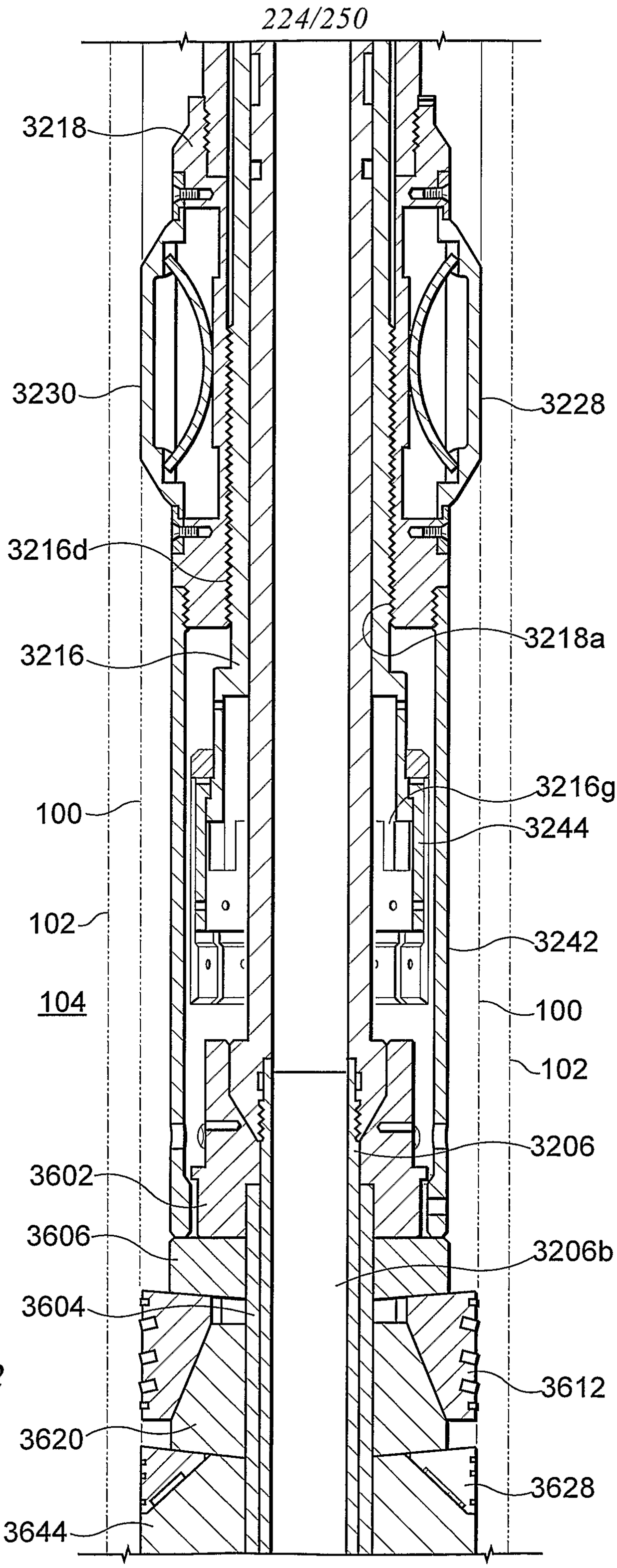

224/250
3218
3230
3228
3216d
3218a
3216
3216g
3244
100
102
3242
104
100
102
3206
3602
3606
3206b
3604
3612
3620
3628
3644

Fig. 20H2

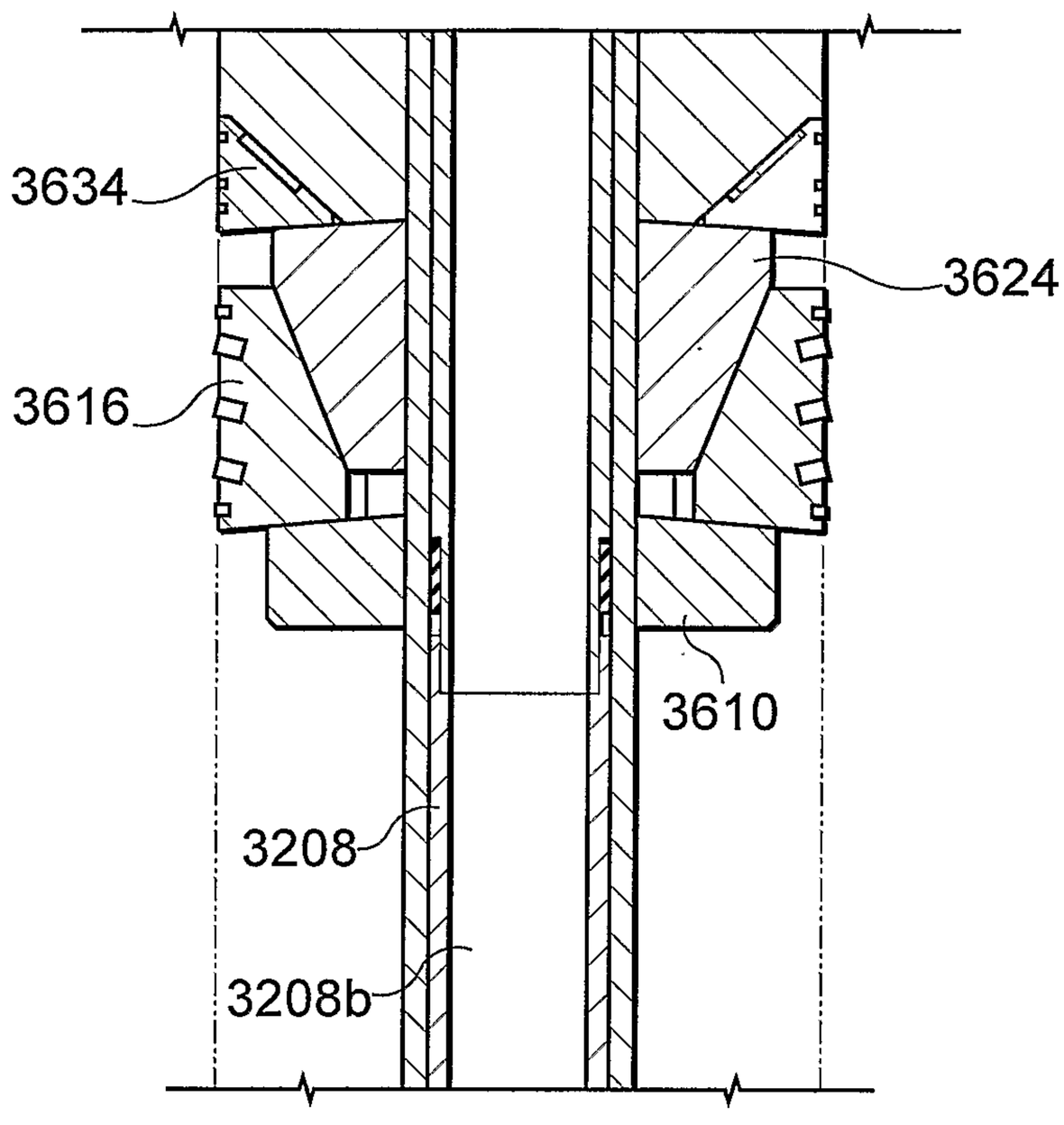


Fig. 20H3

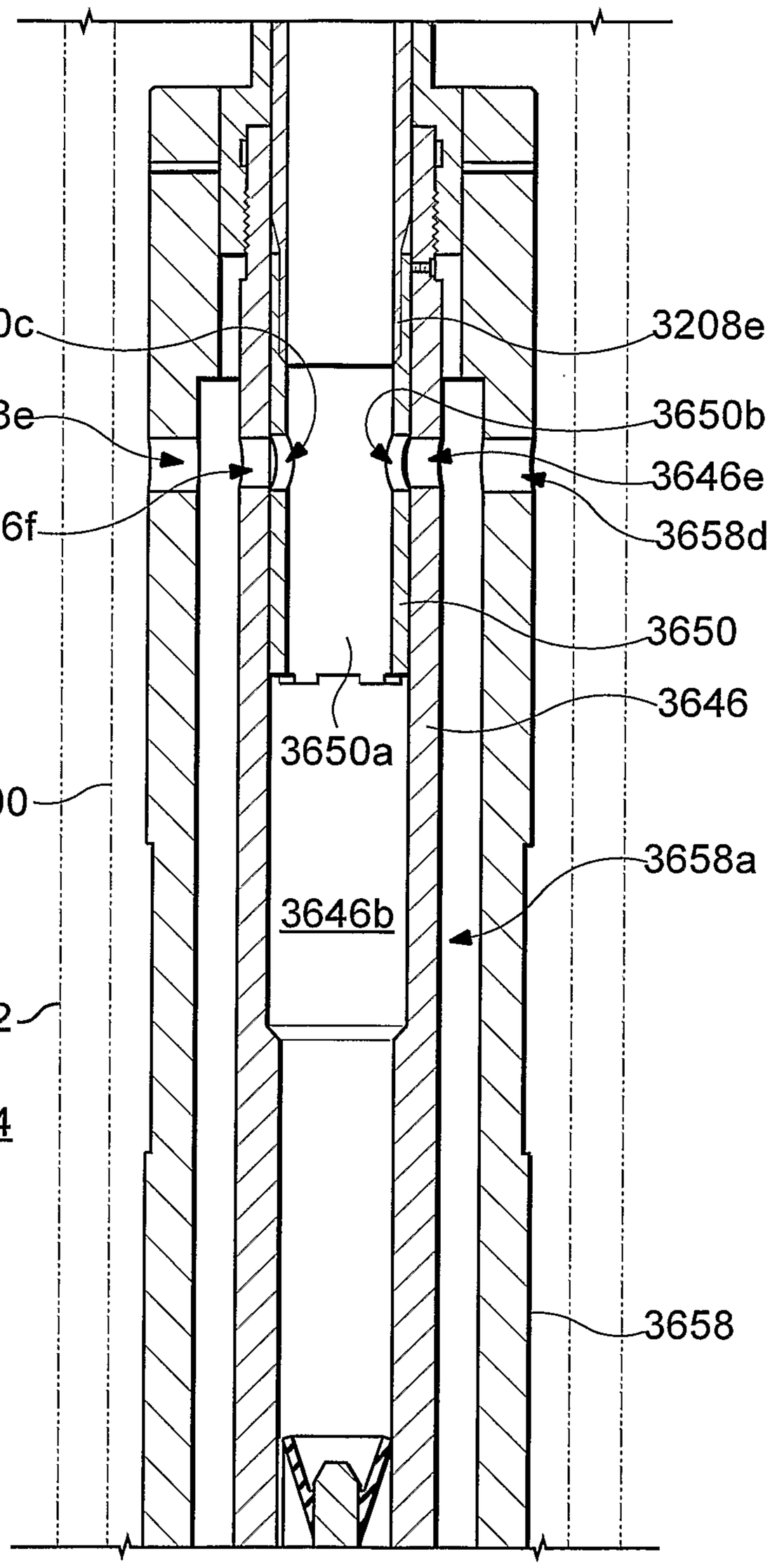

3650c
3208e
3658e
3650b
3646e
3646f
3658d
3650
3646
3650a
100
3658a
3646b
102
104
3658

Fig. 20H4

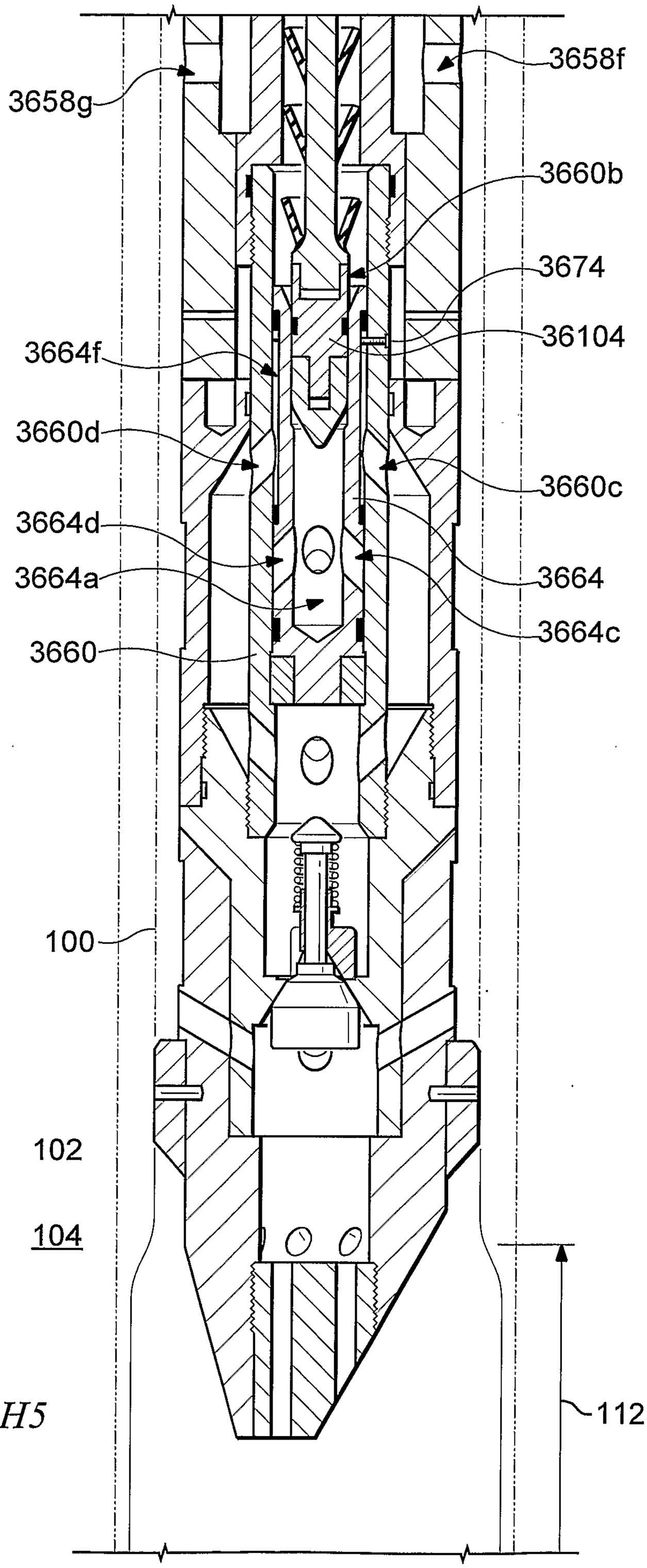

3658g
3658f
3660b
3674
36104
3664f
3660d
3660c
3664d
3664
3664a
3664c
3660
100
102
104
112

Fig. 20H5

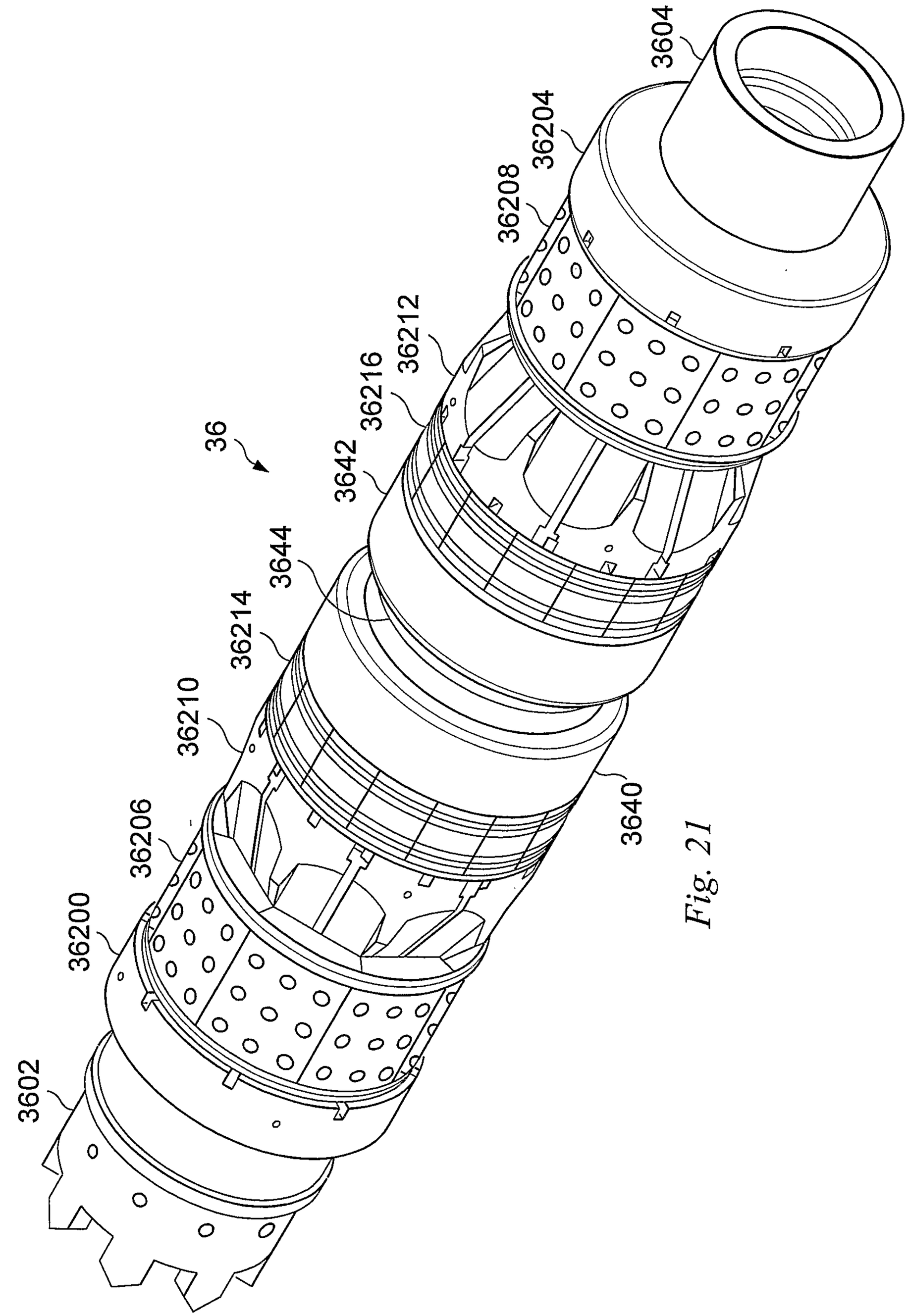

36
3604
36204
36208
36212
36216
3642
3644
36214
36210
36206
36200
3640
3602

Fig. 21

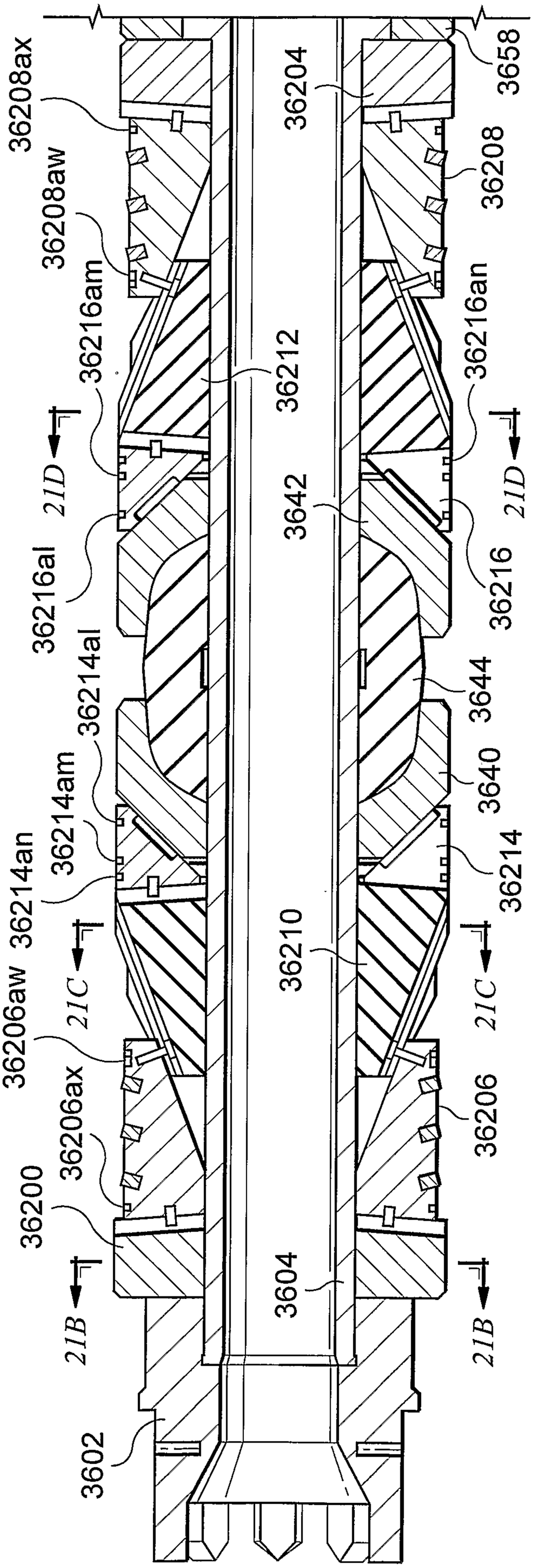

36208ax
36208aw
36216am
36216al
21D
36214al
36214am
36214an
36206aw
21C
36206ax
36200
36204
3658
36208
36212
3642
36216an
21D
36216
36214
3644
3640
36210
21C
36206
3604
21B
21B
3602

Fig. 21A

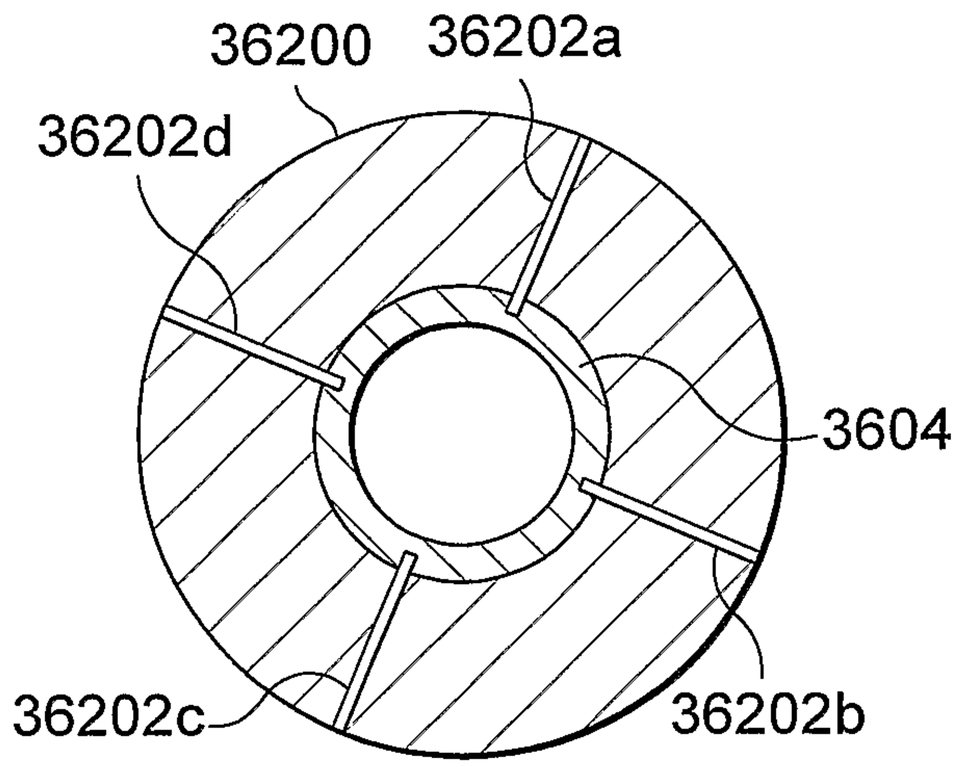


Fig. 21B

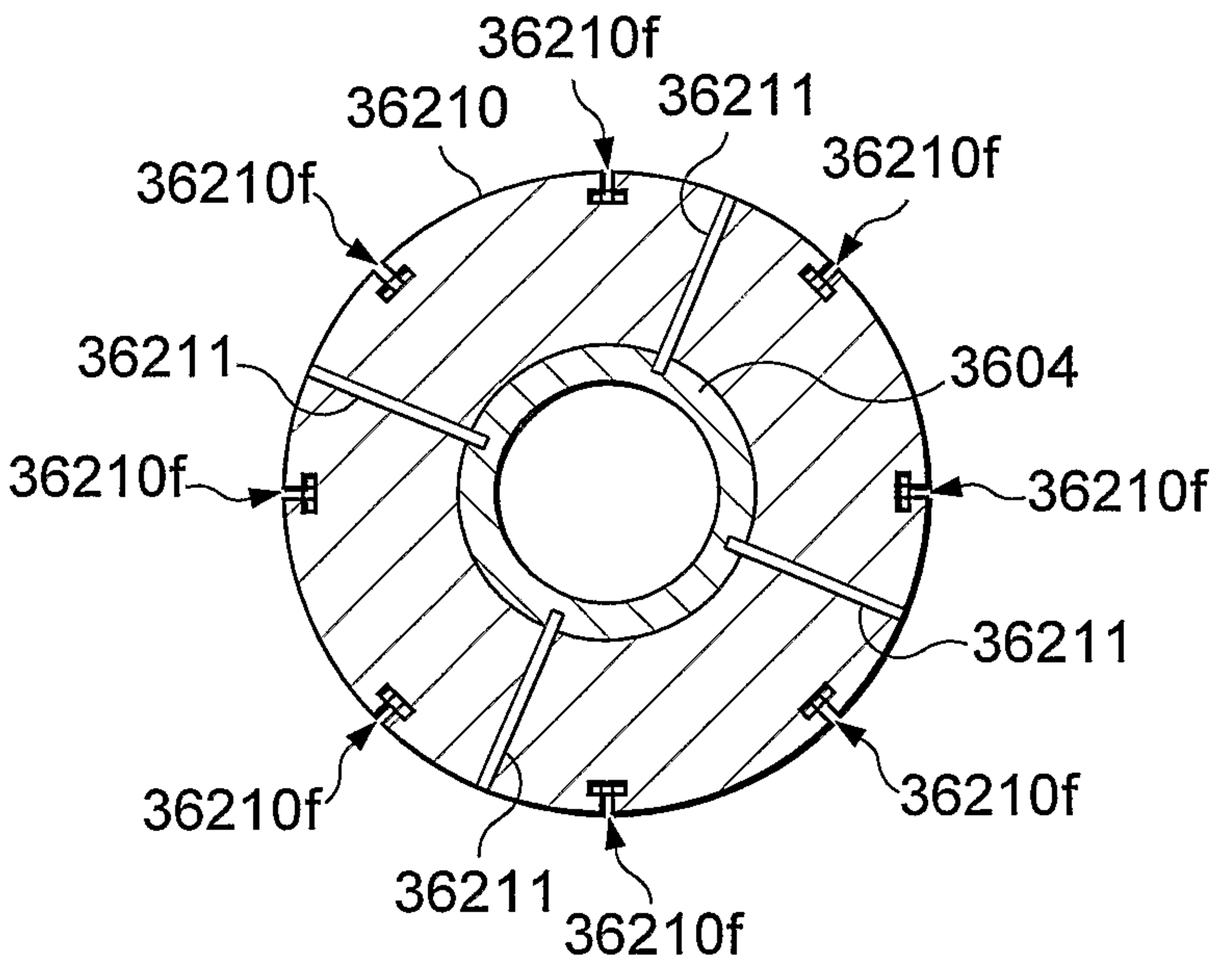


Fig. 21C

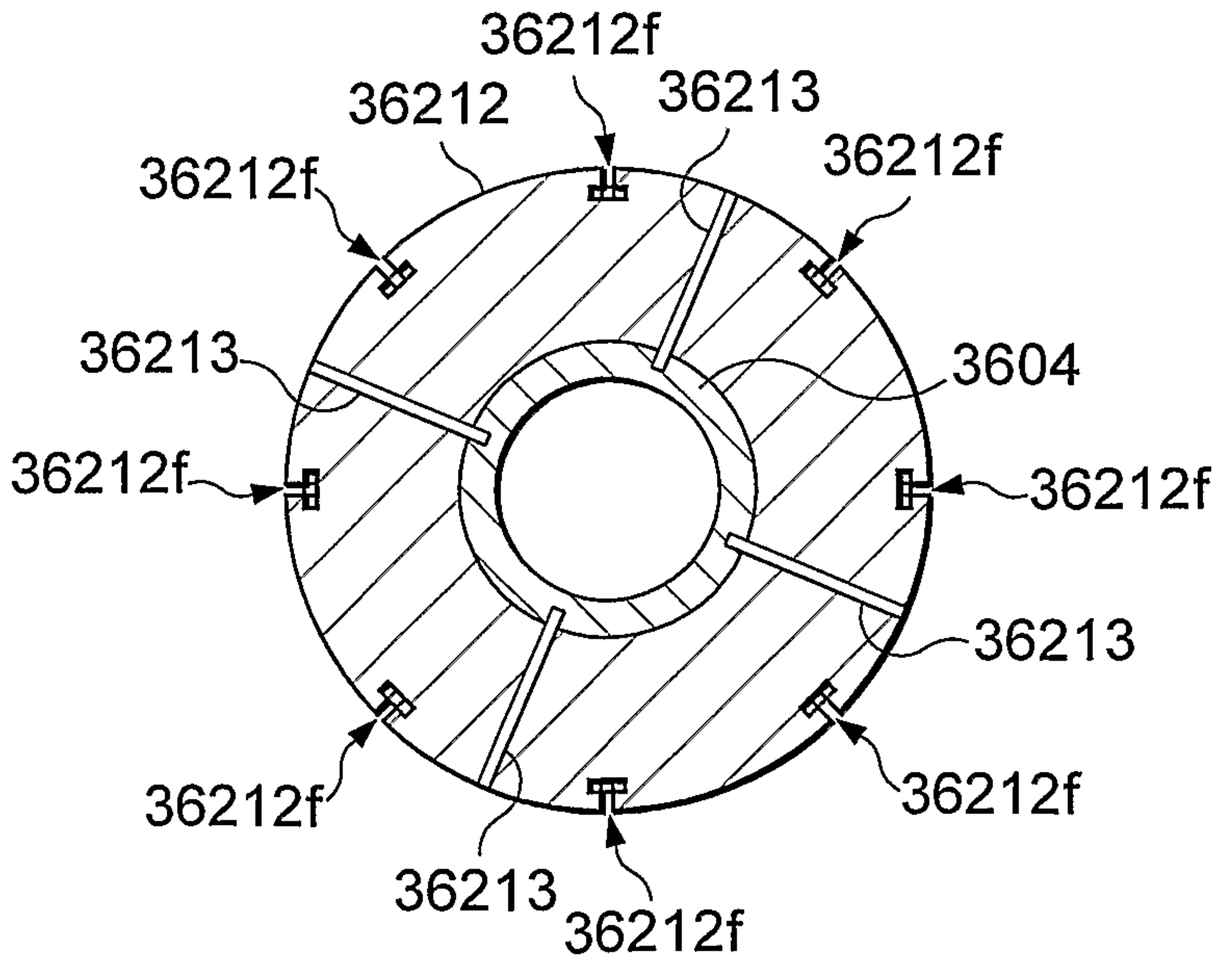


Fig. 21D

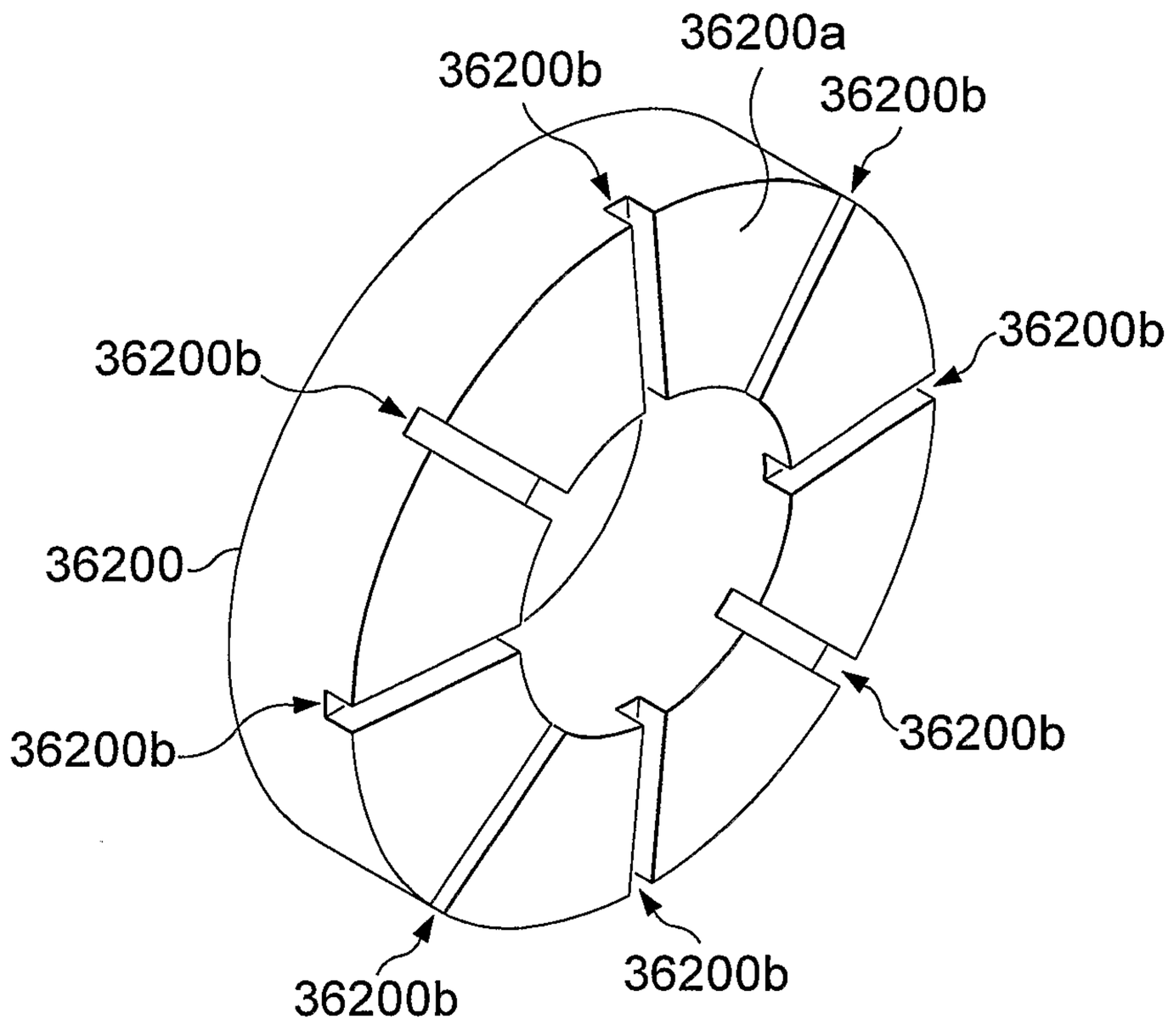


Fig. 21E

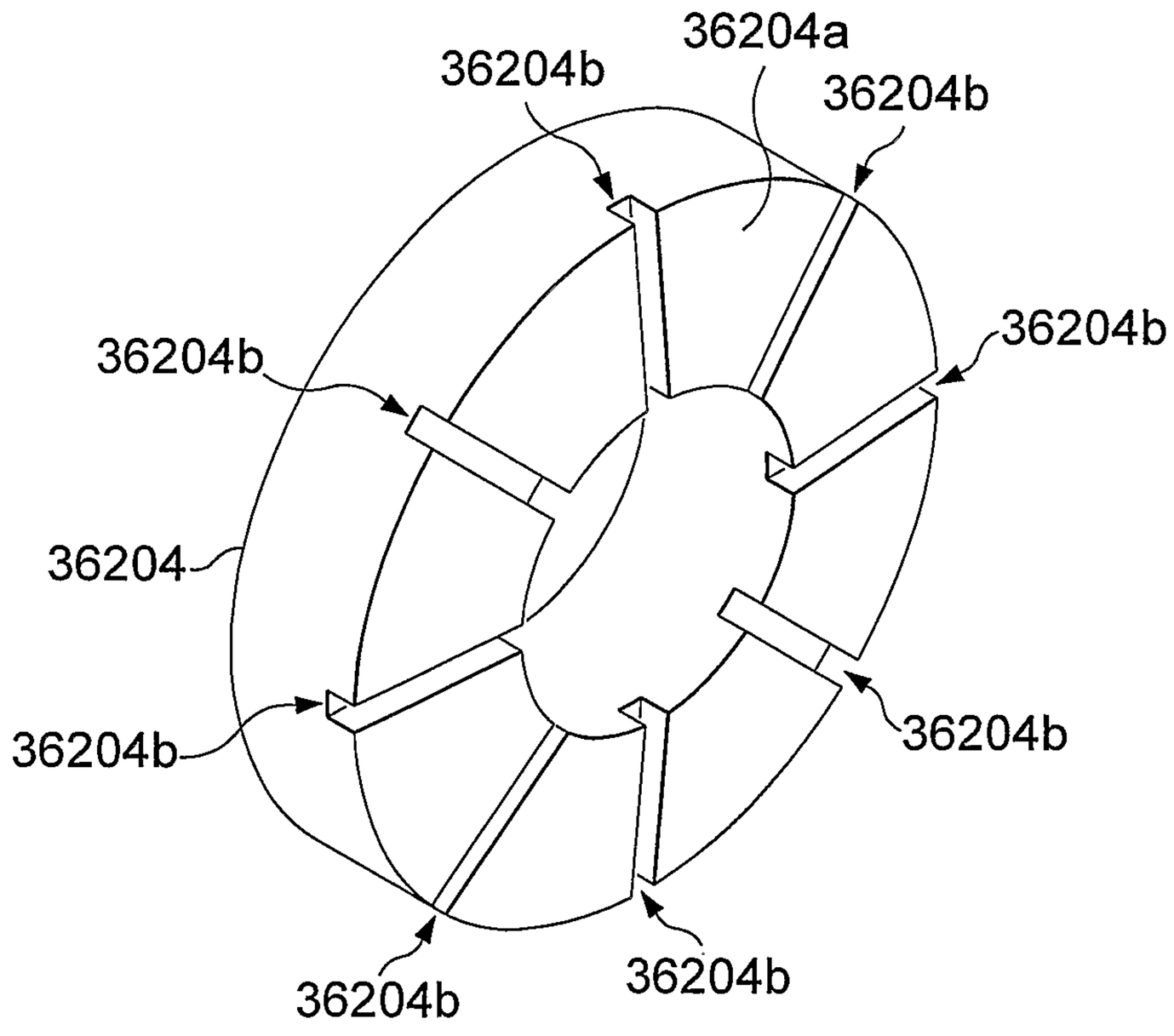


Fig. 21H

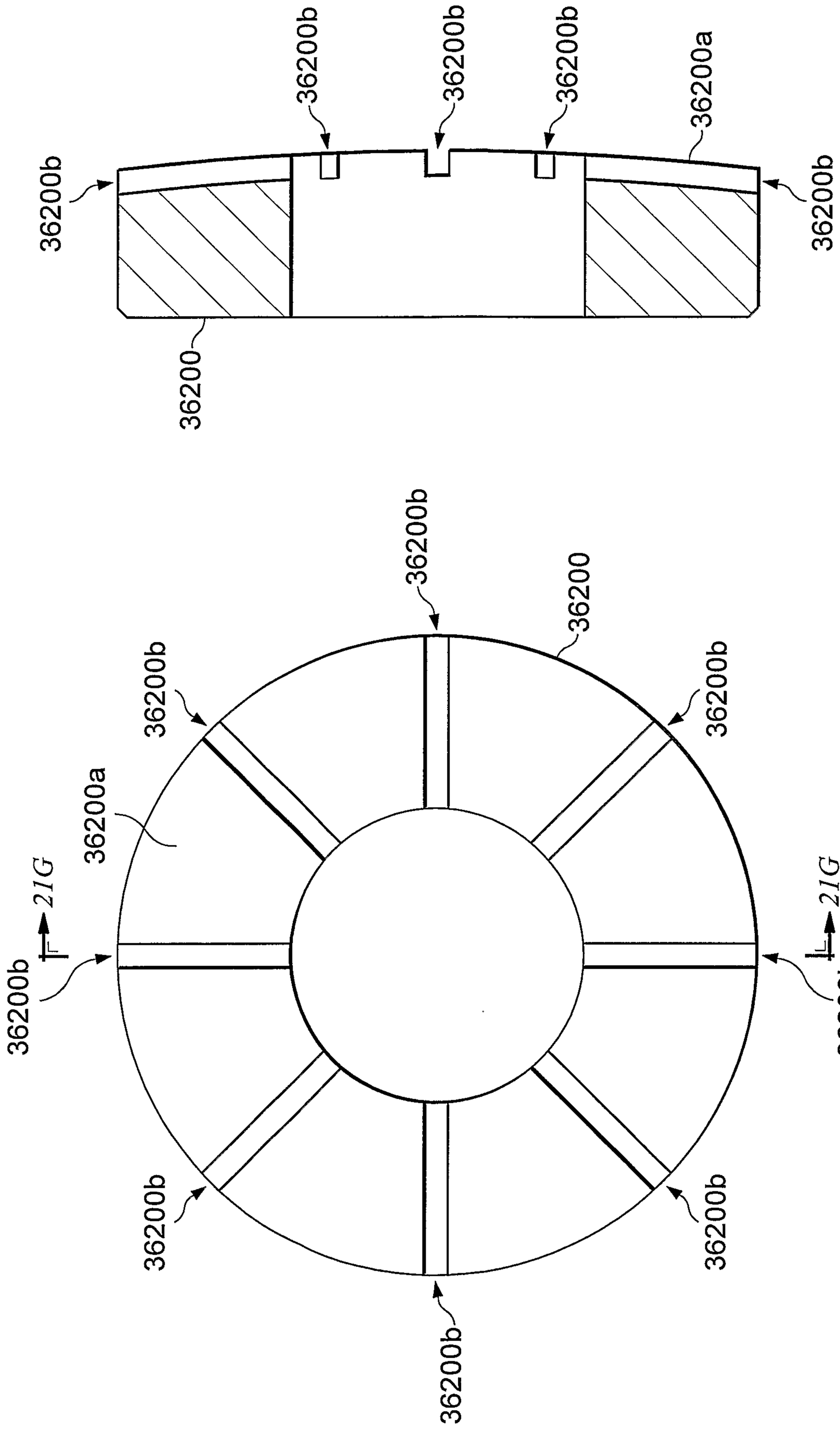


Fig. 21G

Fig. 21F

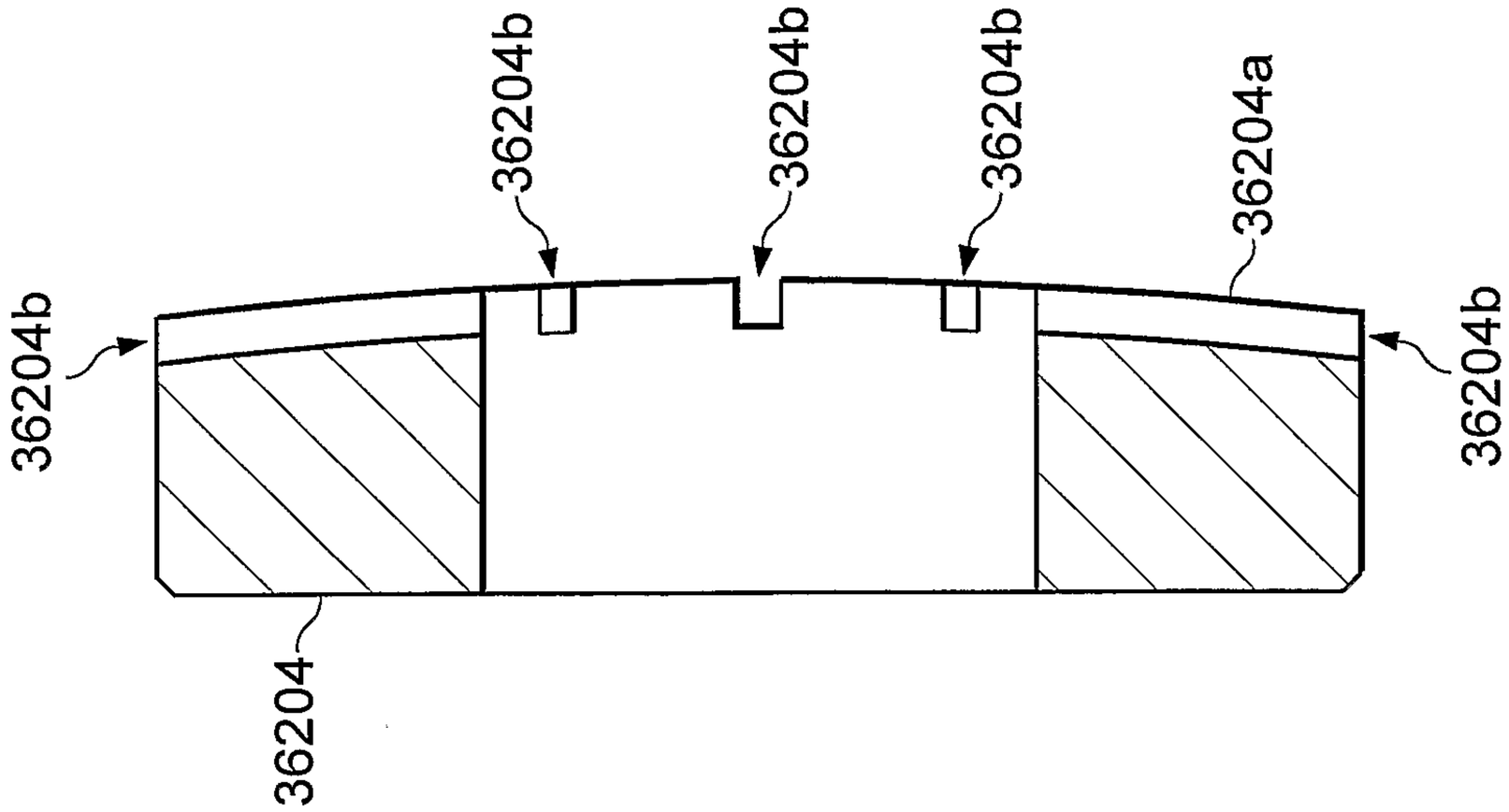


Fig. 21J

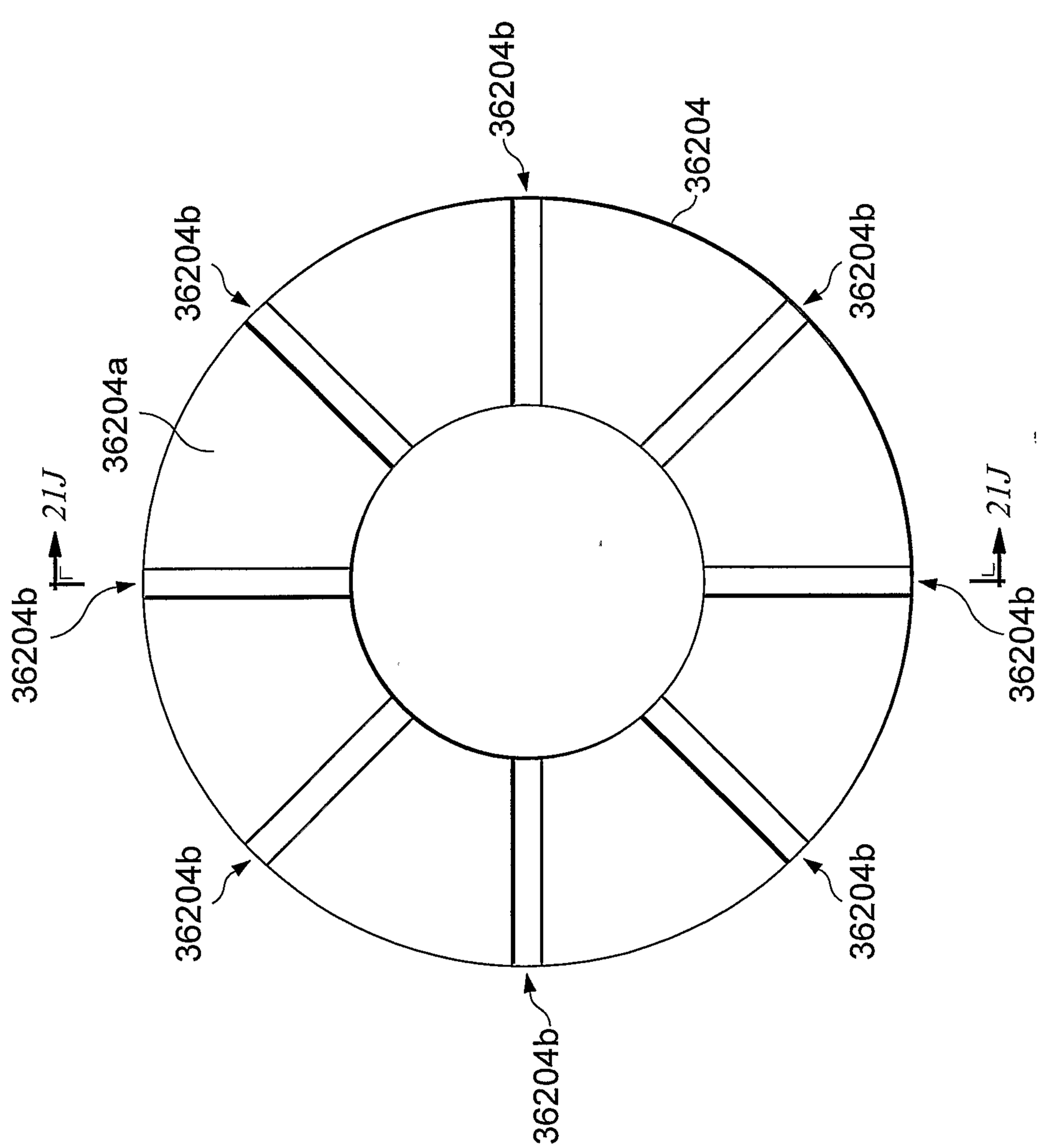


Fig. 21I

Fig. 21K

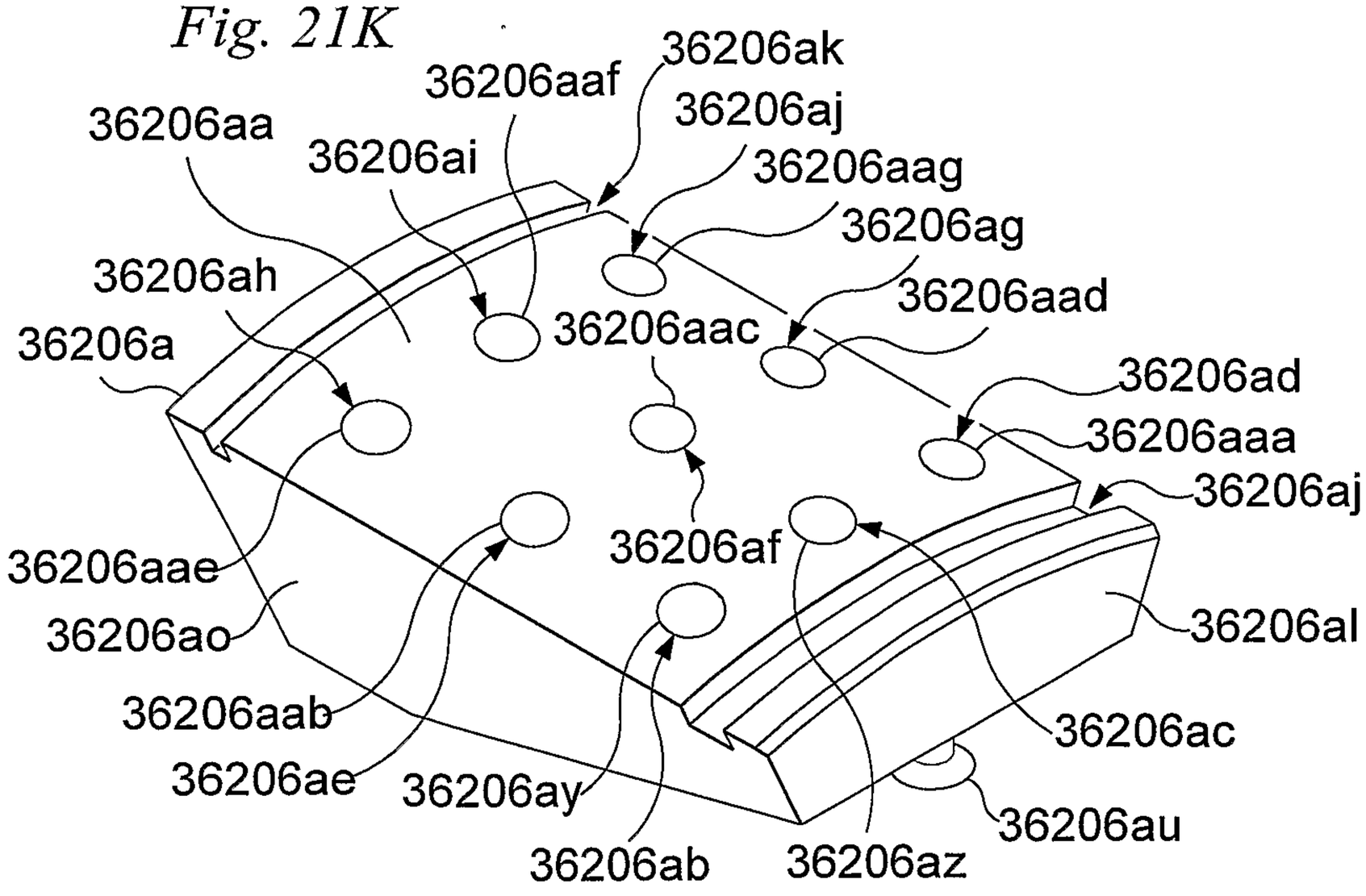


Fig. 21L

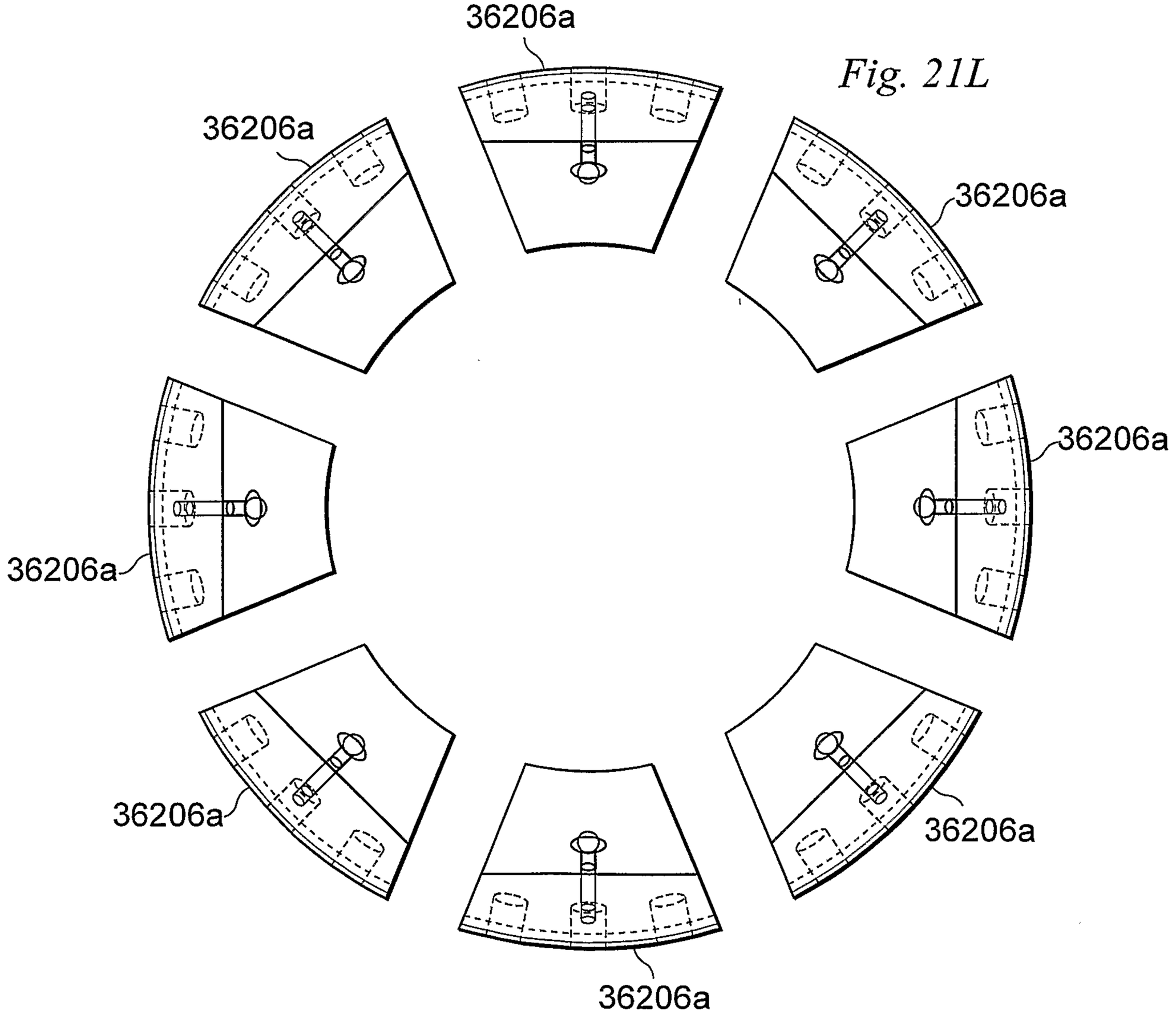


Fig. 21M

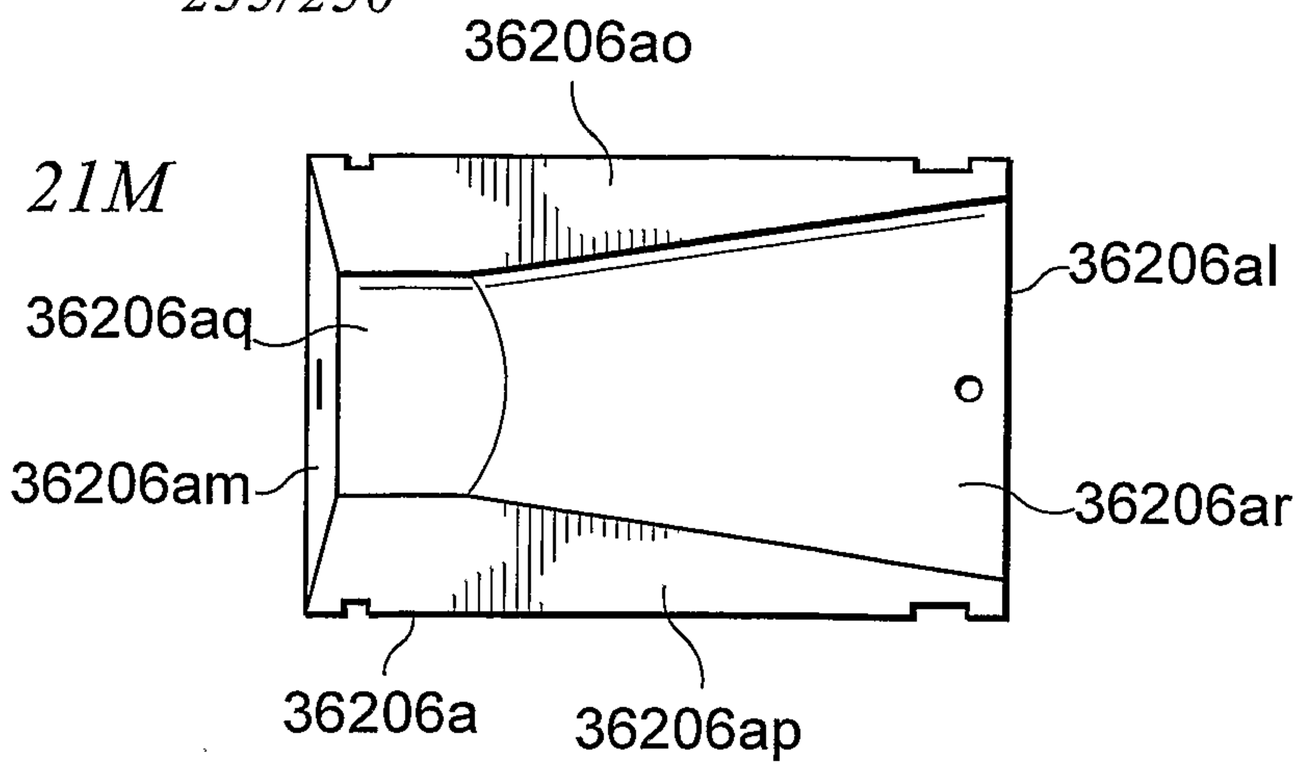


Fig. 21N

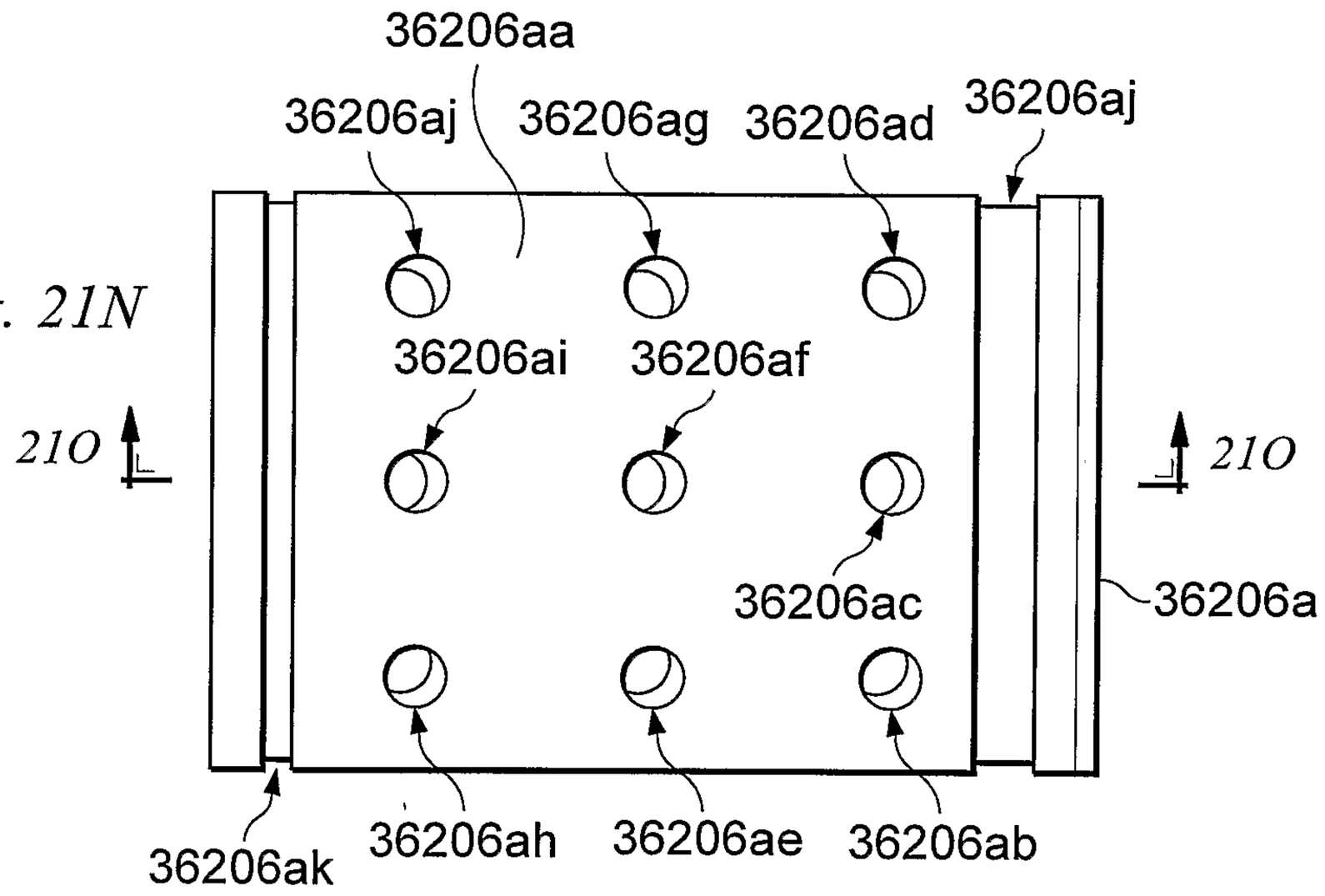
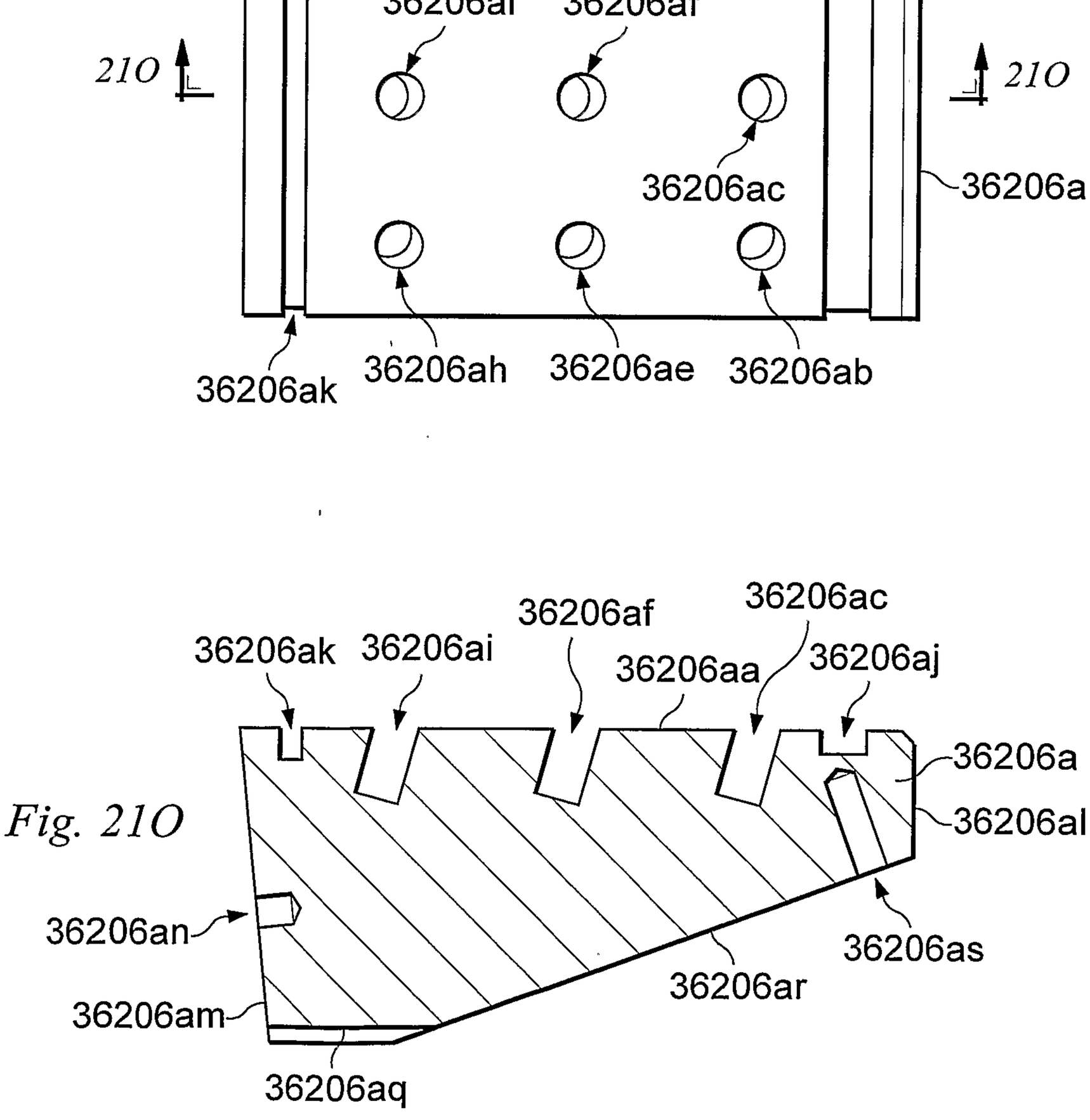


Fig. 21O



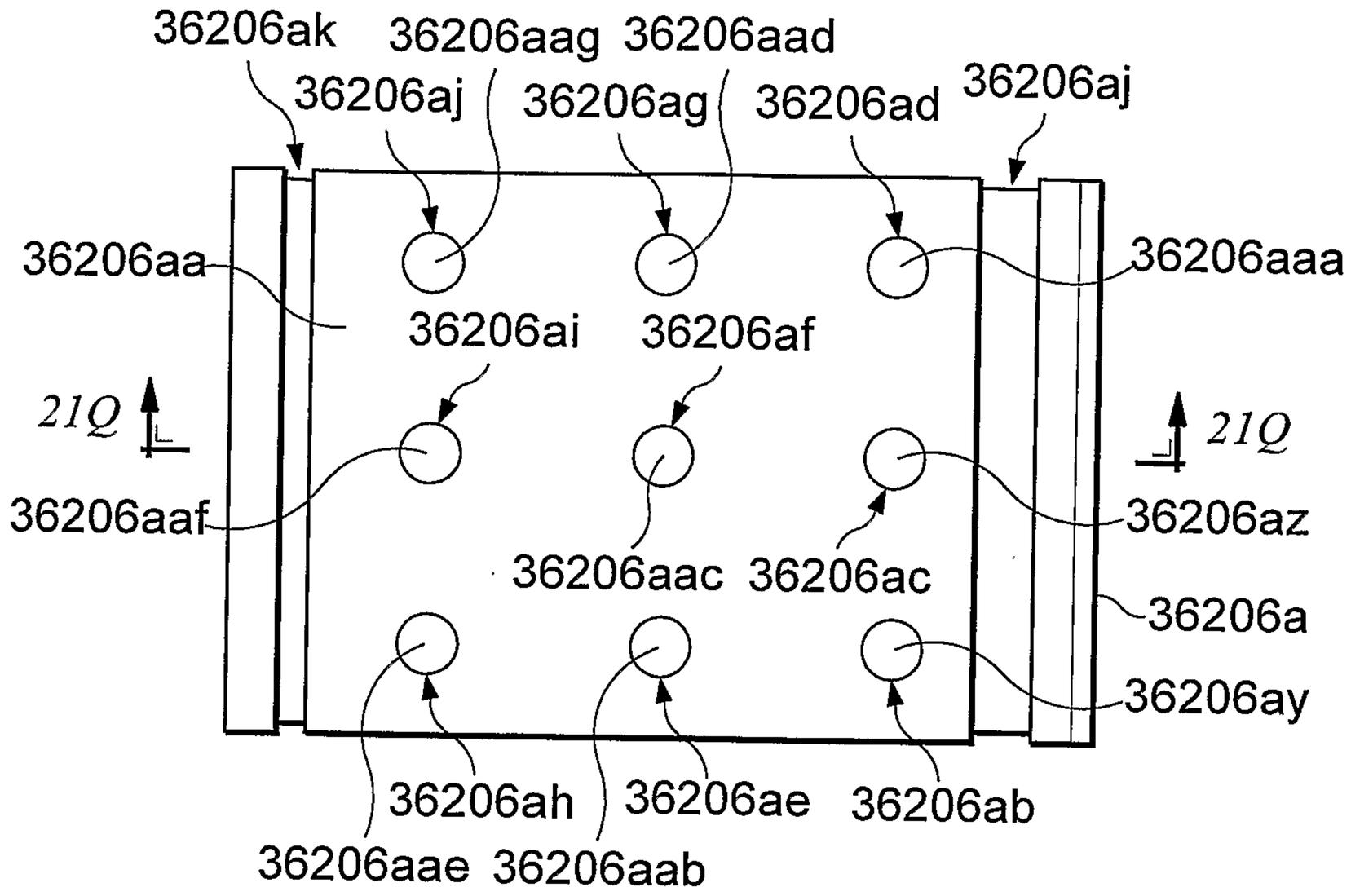


Fig. 21P

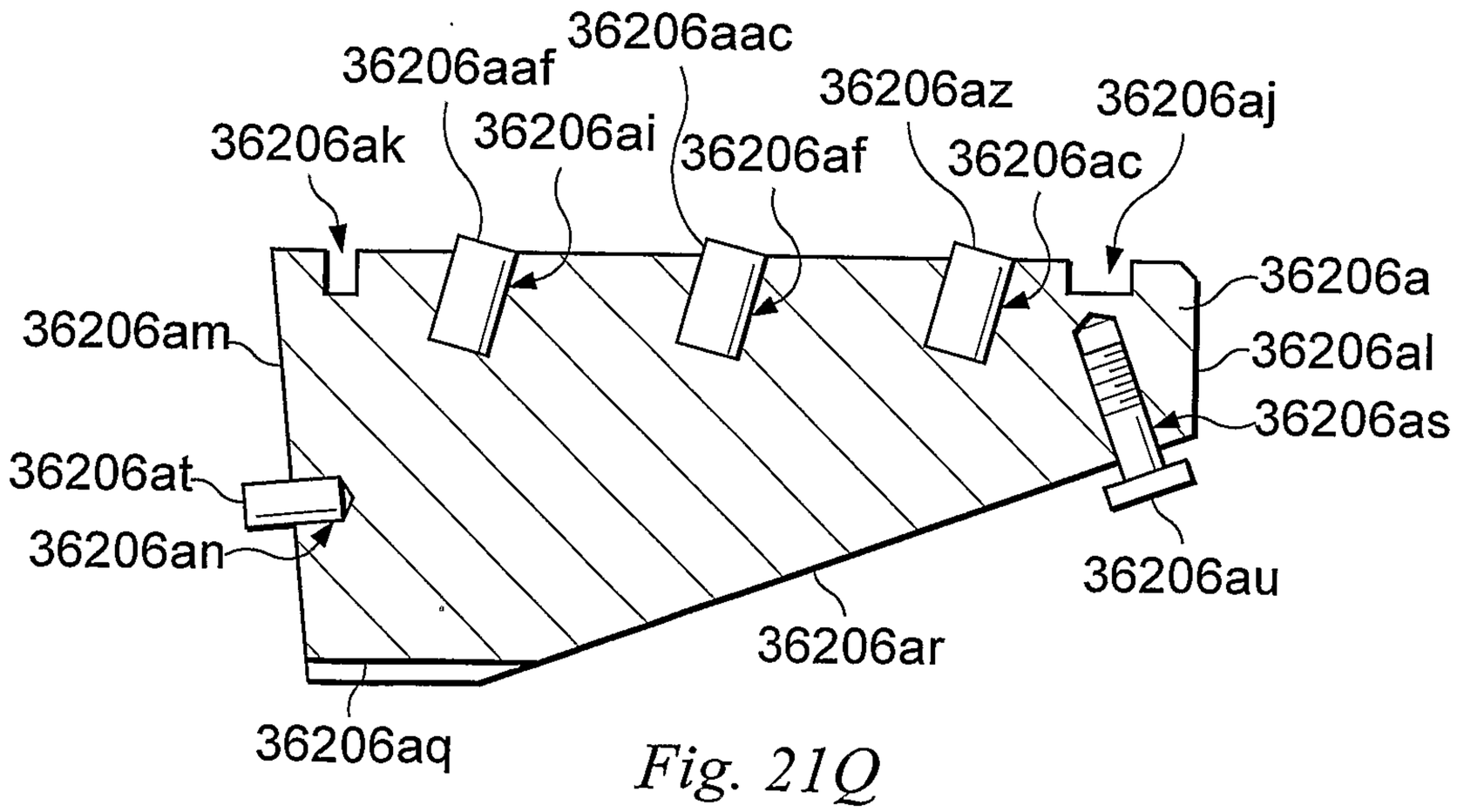


Fig. 21Q

Fig. 21R

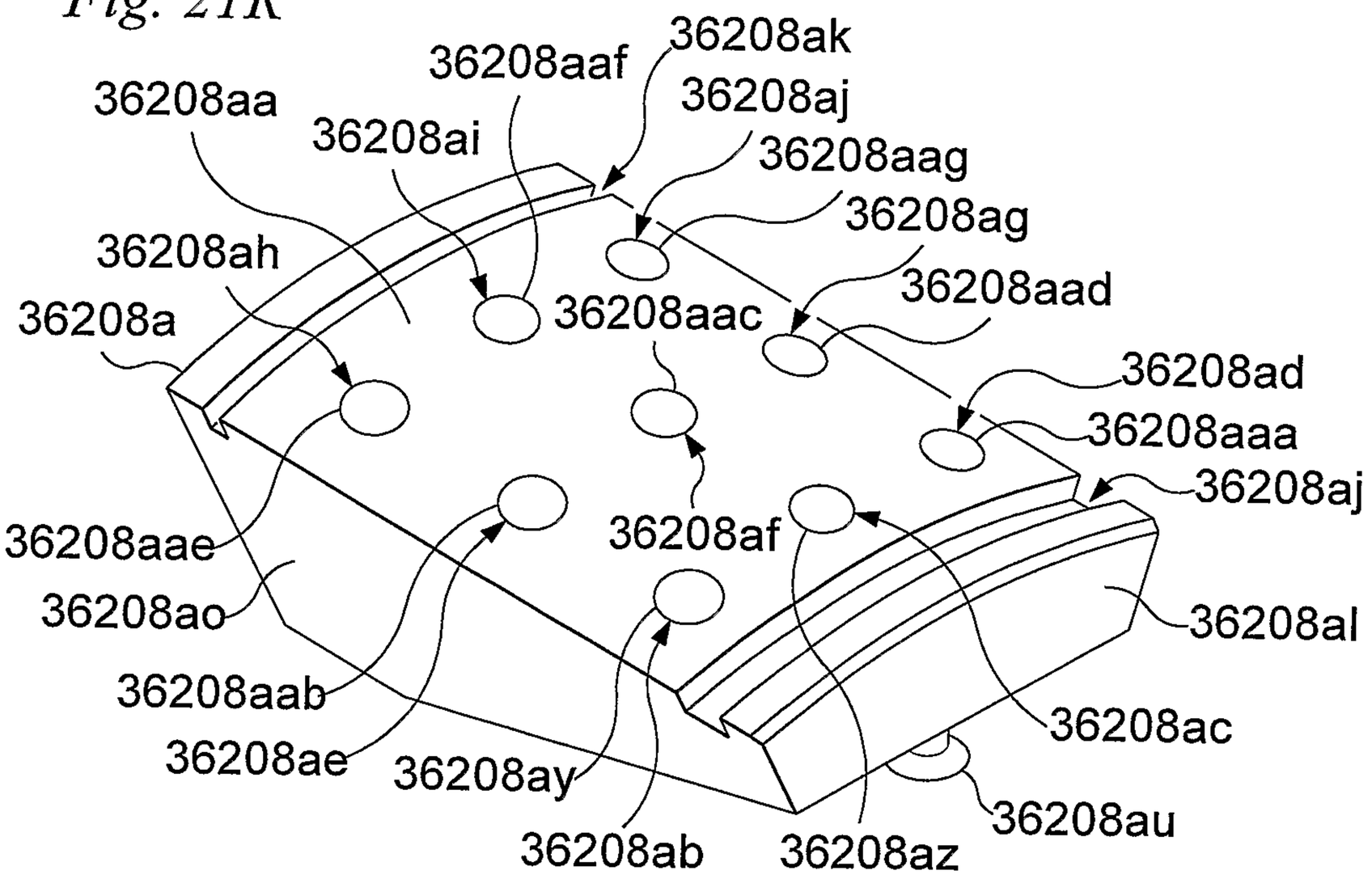


Fig. 21S

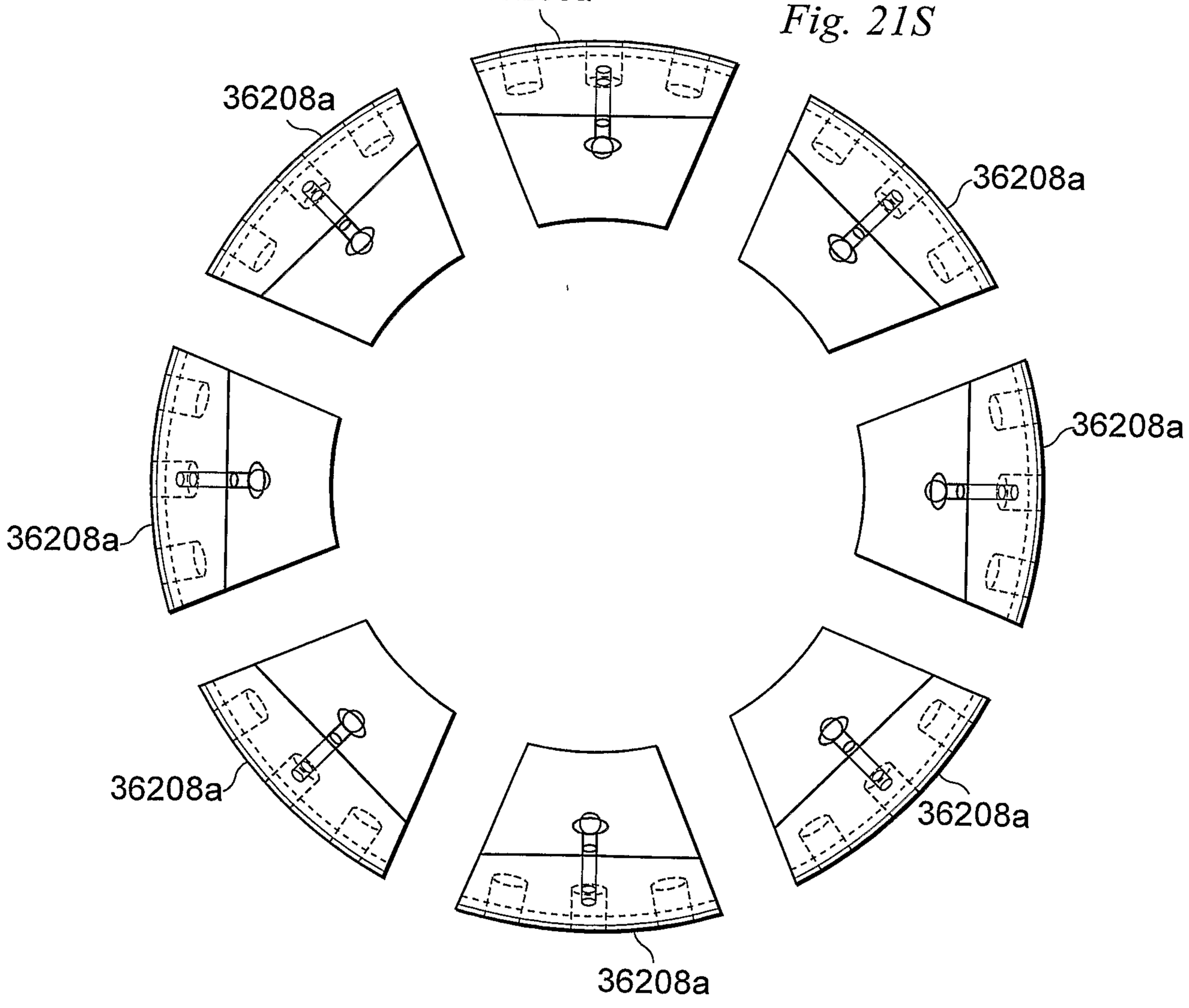


Fig. 21T

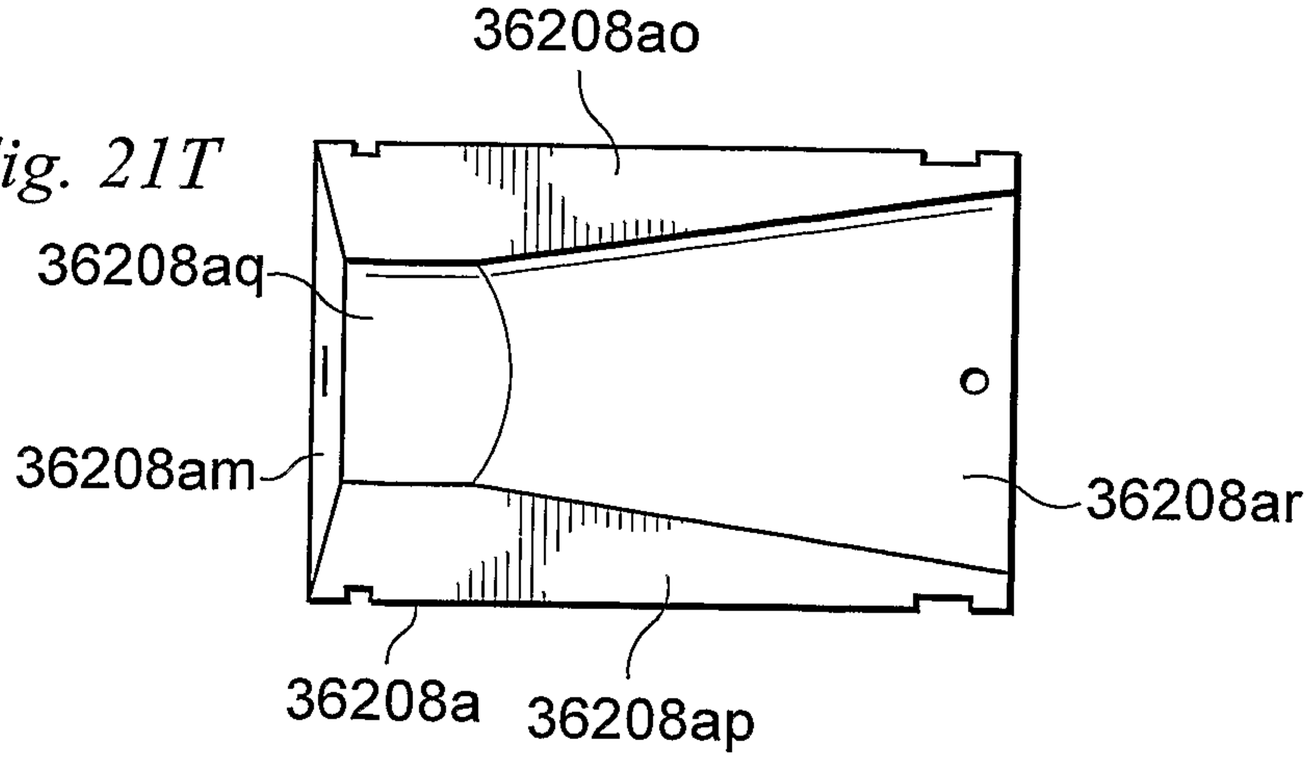


Fig. 21U

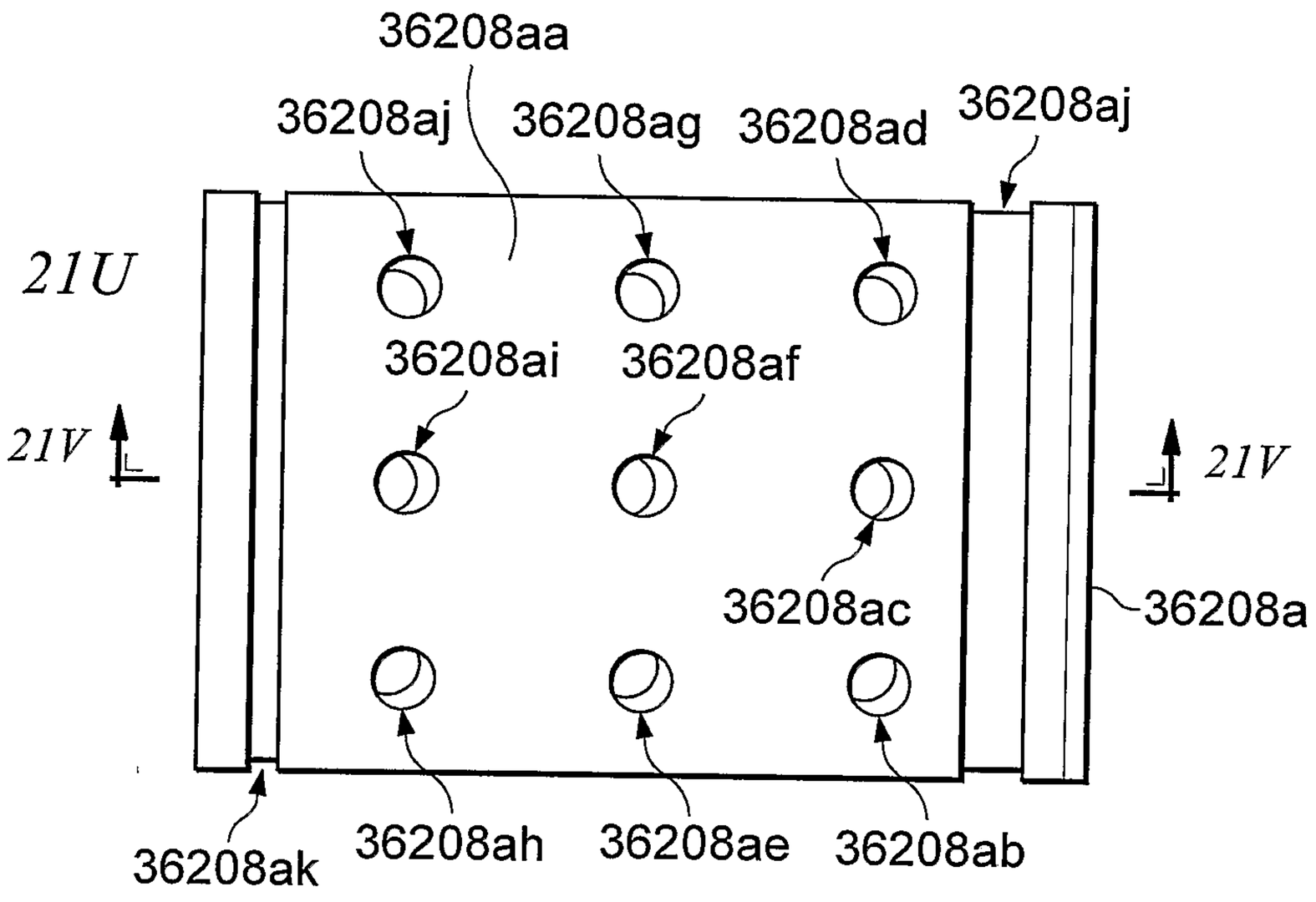
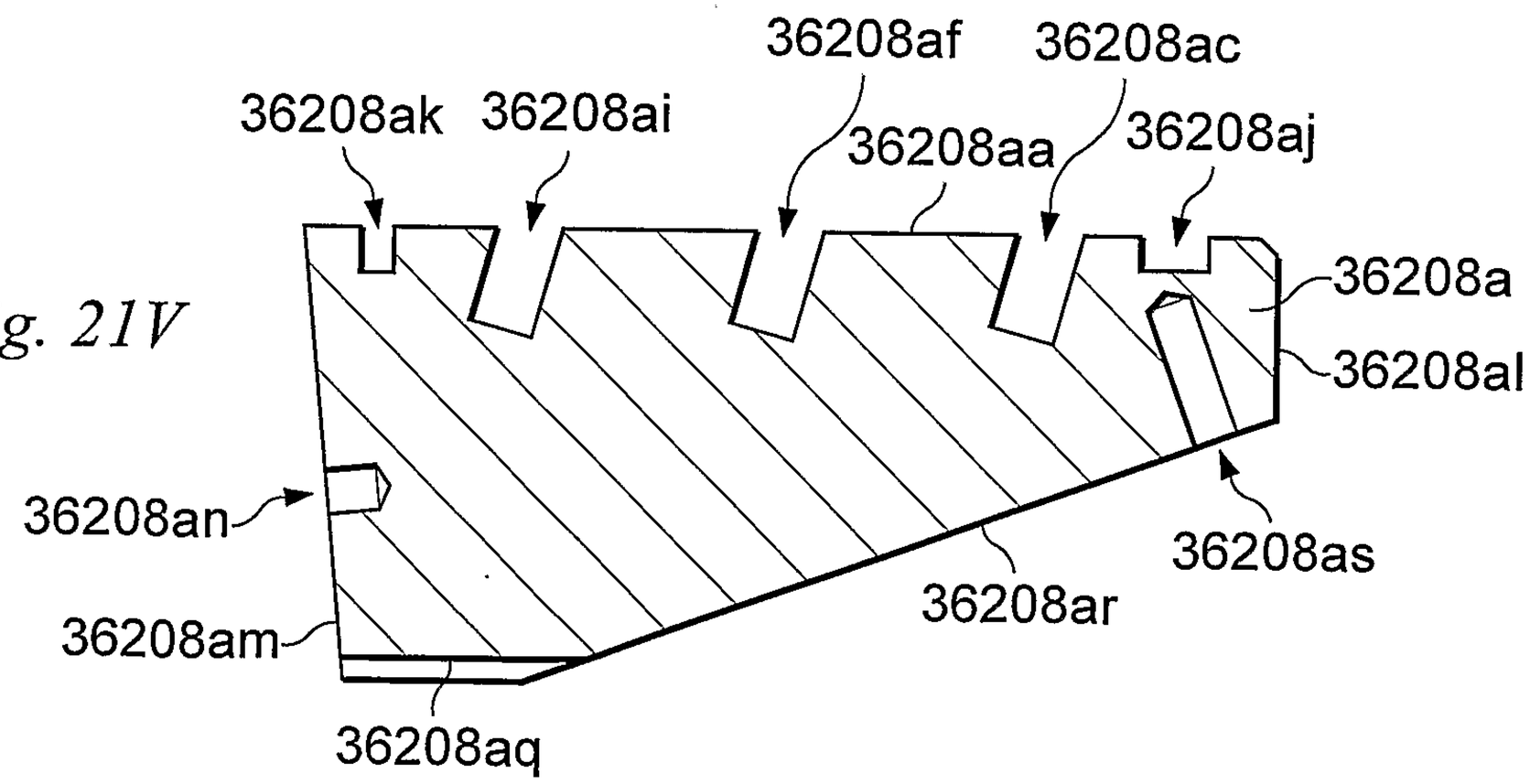


Fig. 21V



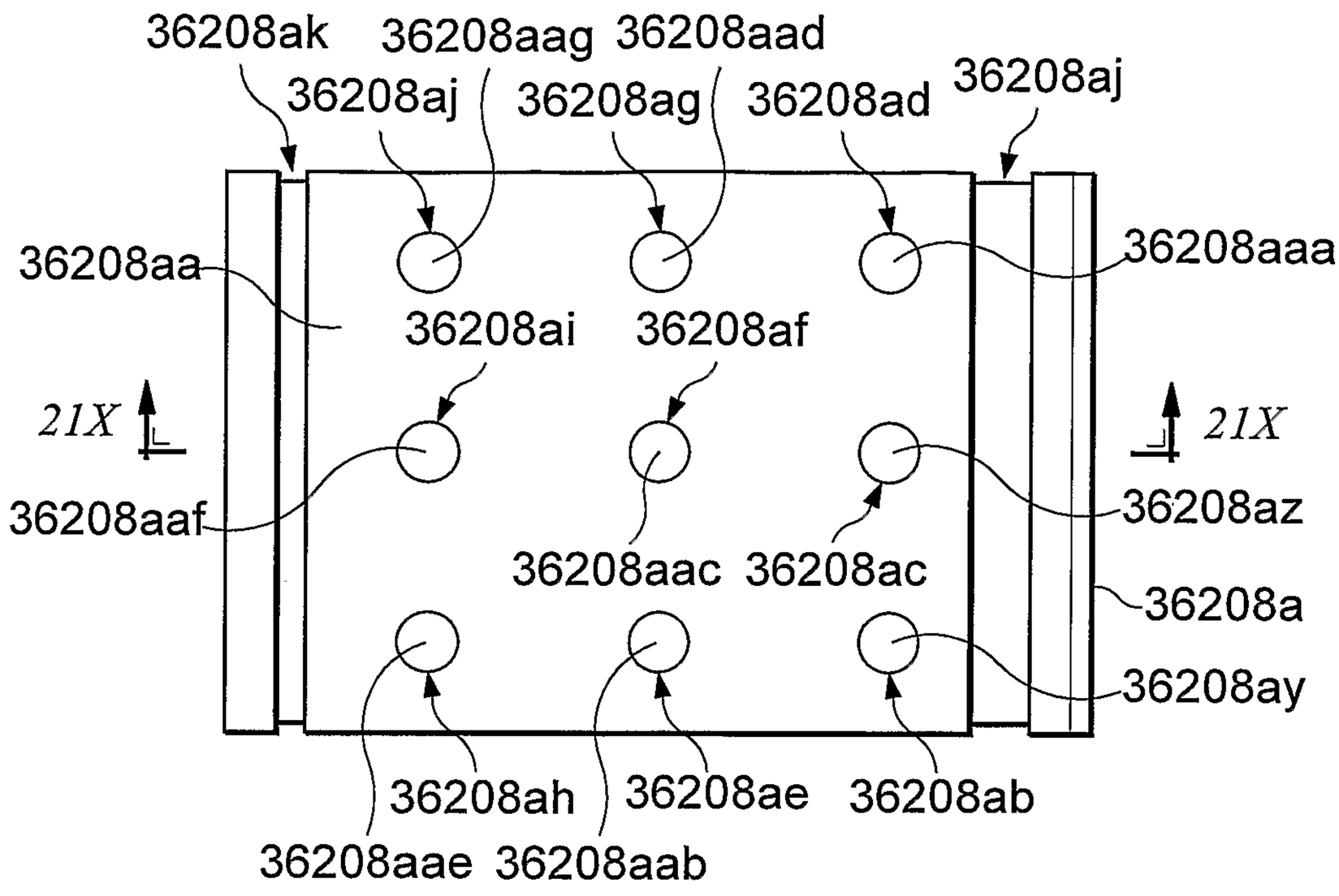


Fig. 21W

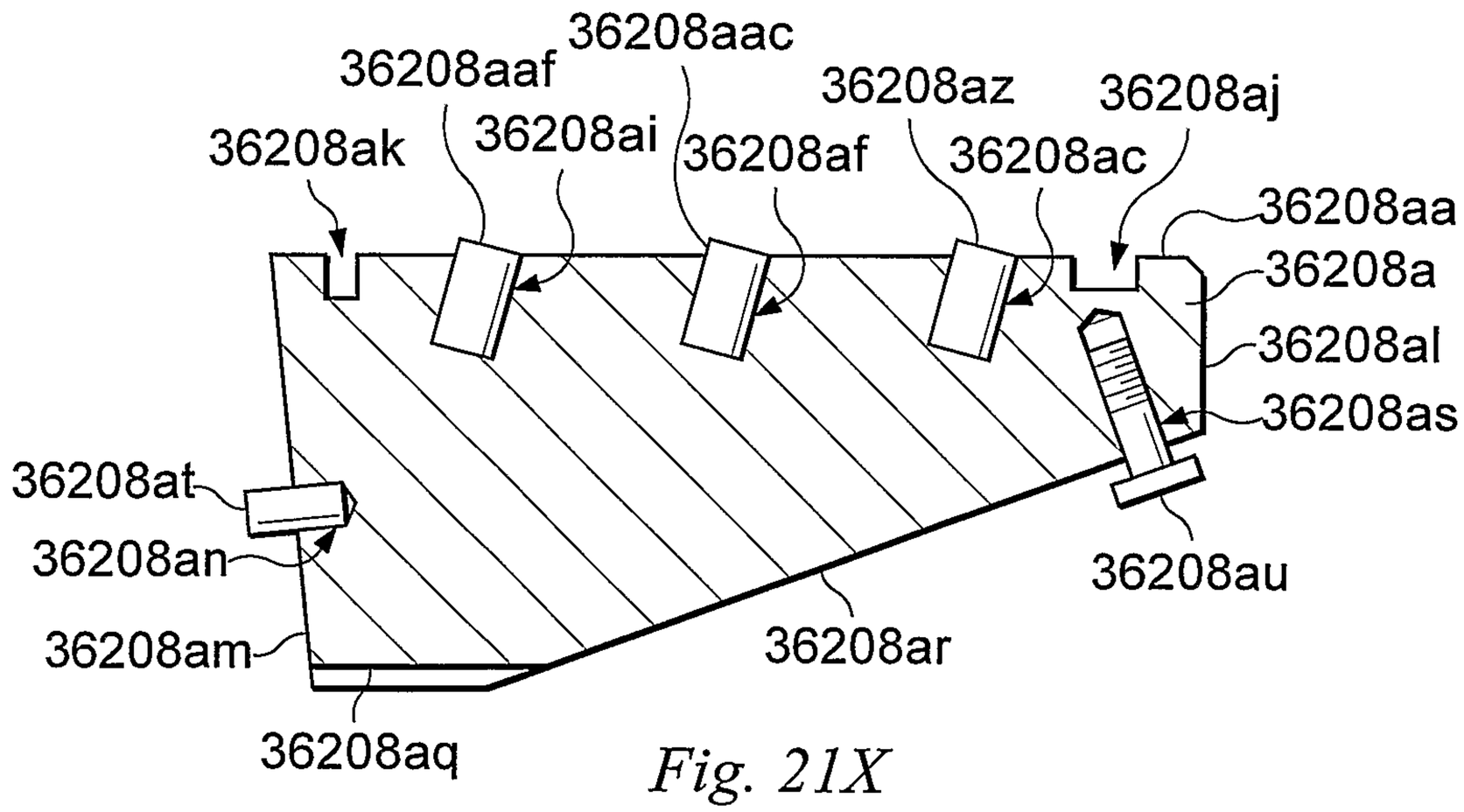


Fig. 21X

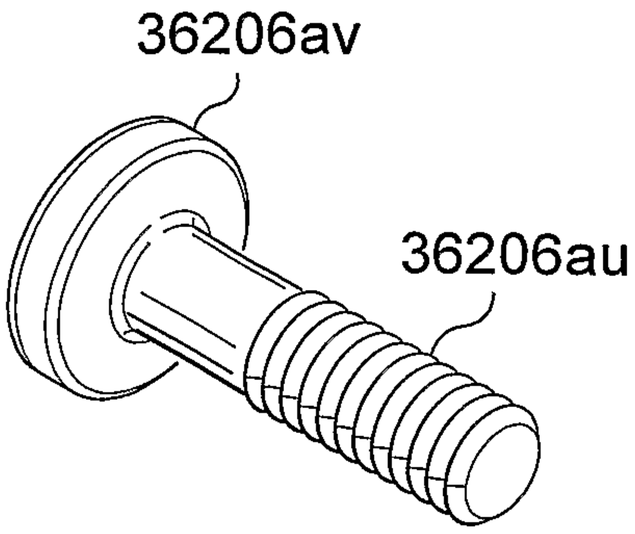


Fig. 21Y

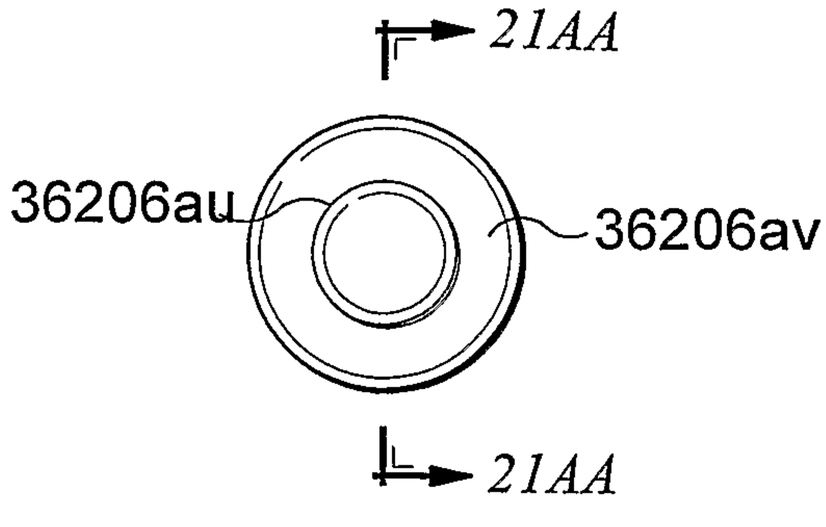


Fig. 21Z

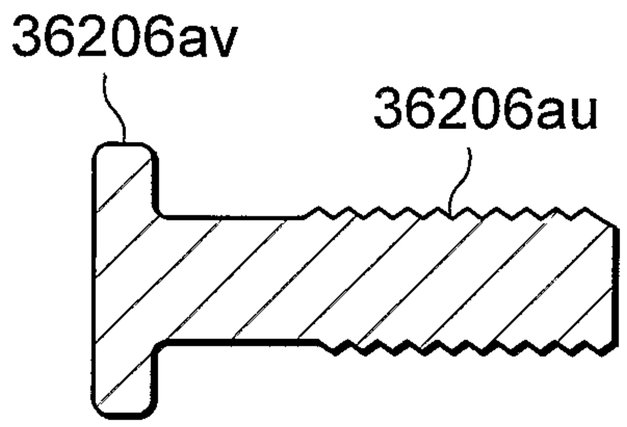


Fig. 21AA

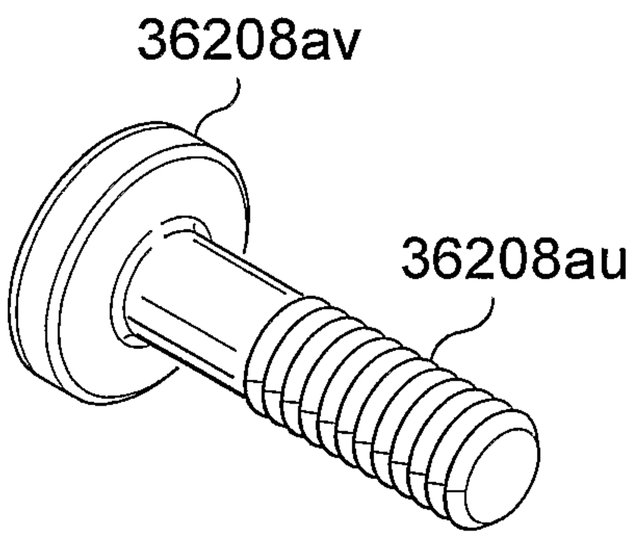


Fig. 21AB

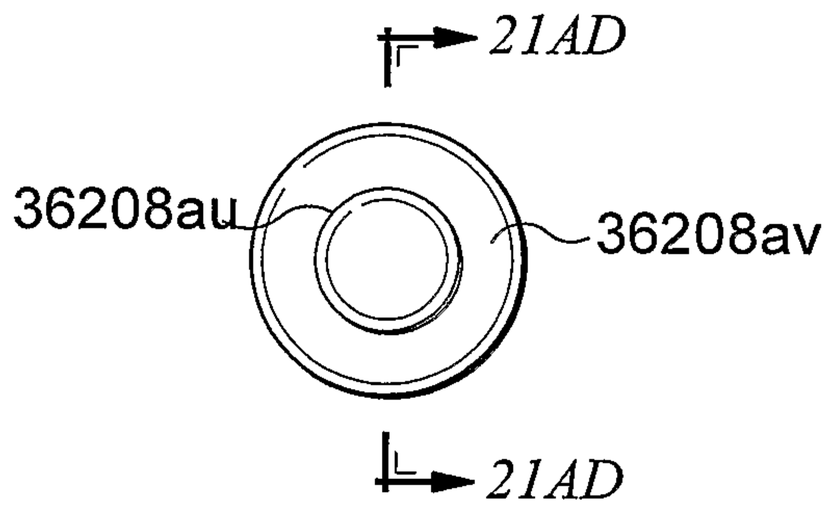


Fig. 21AC

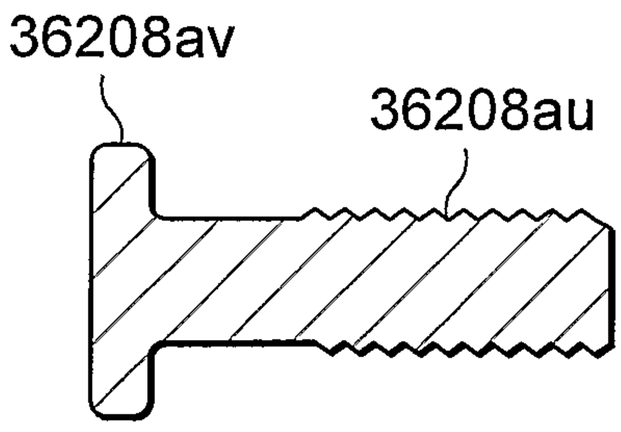


Fig. 21AD

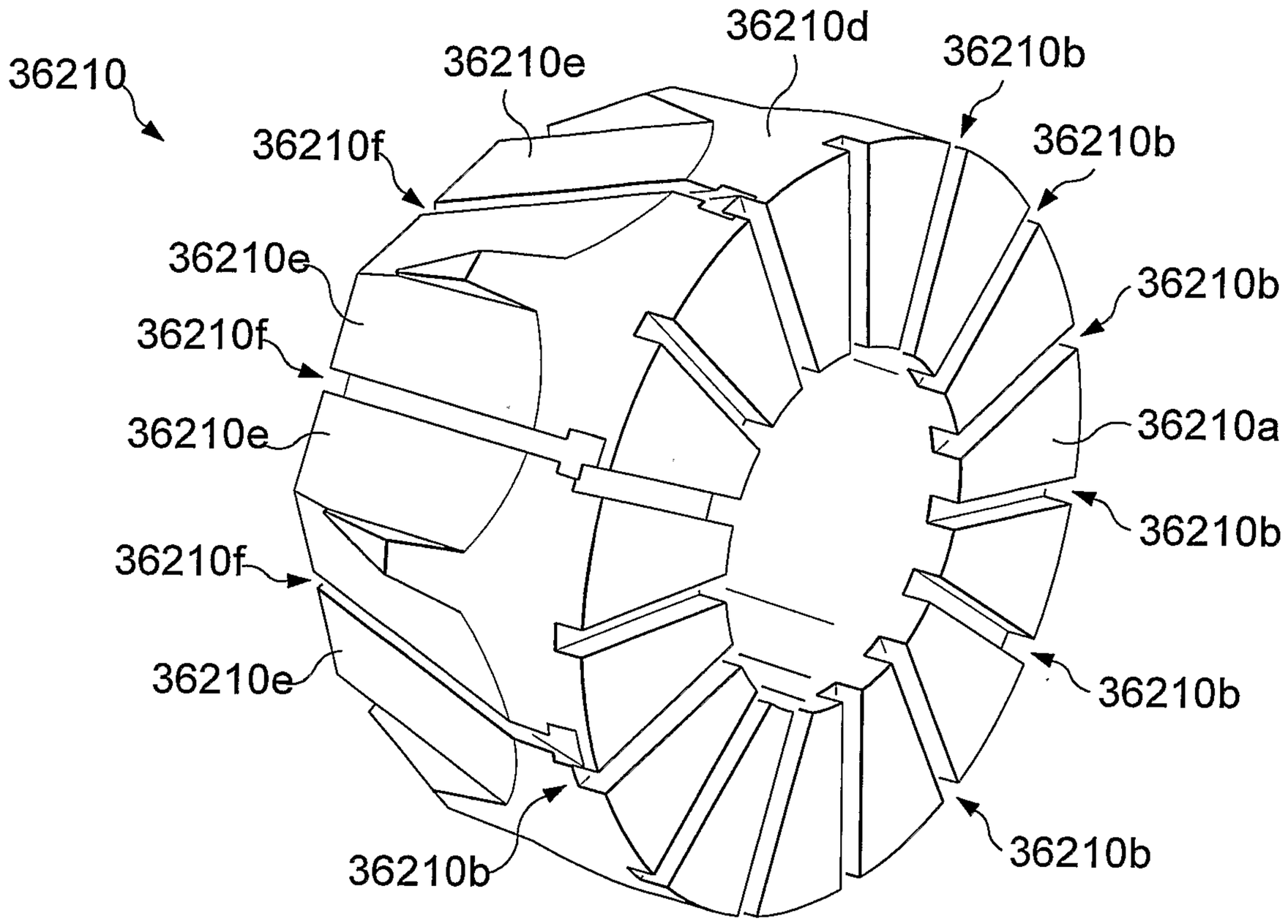


Fig. 21AE

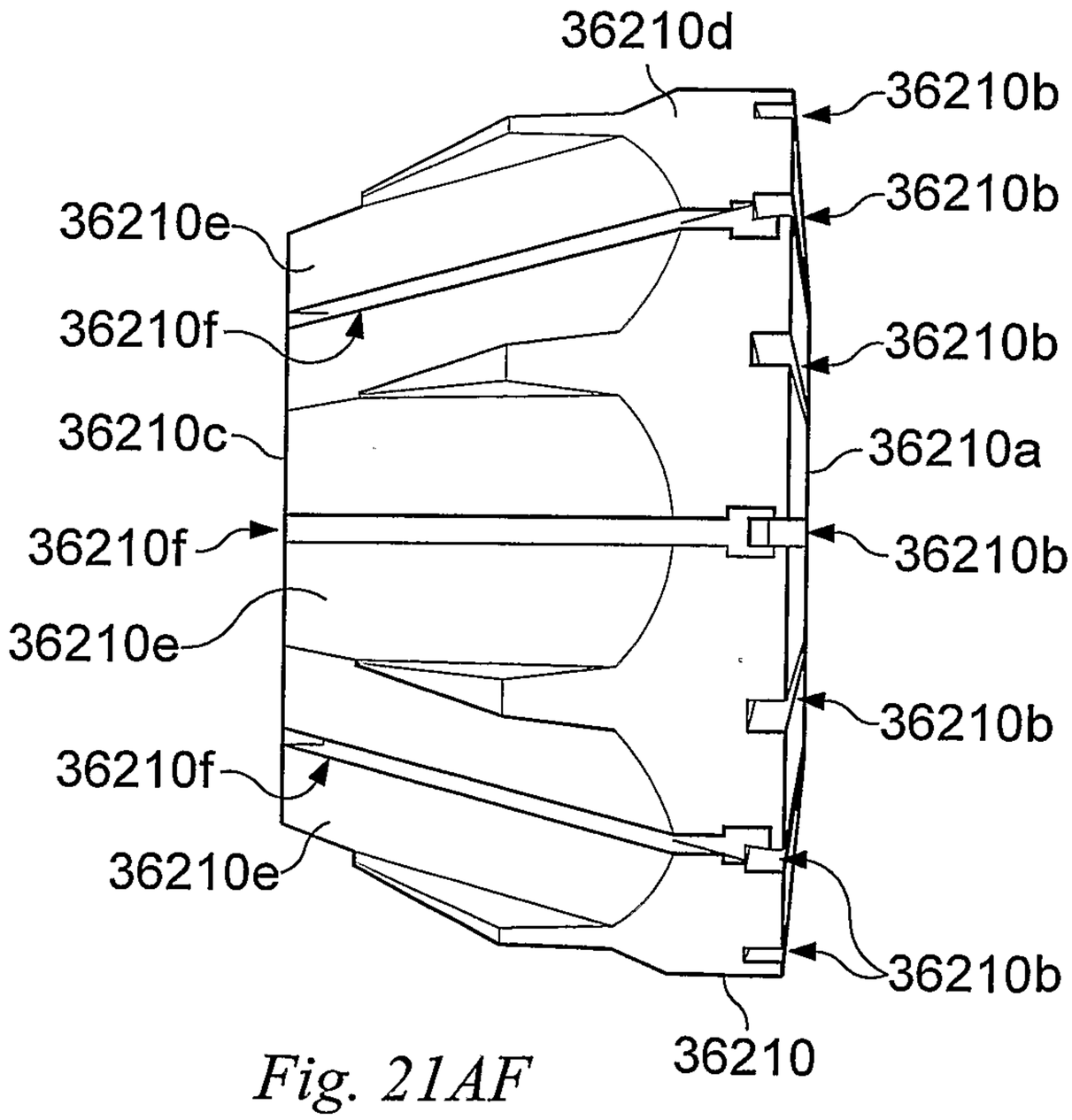


Fig. 21AF

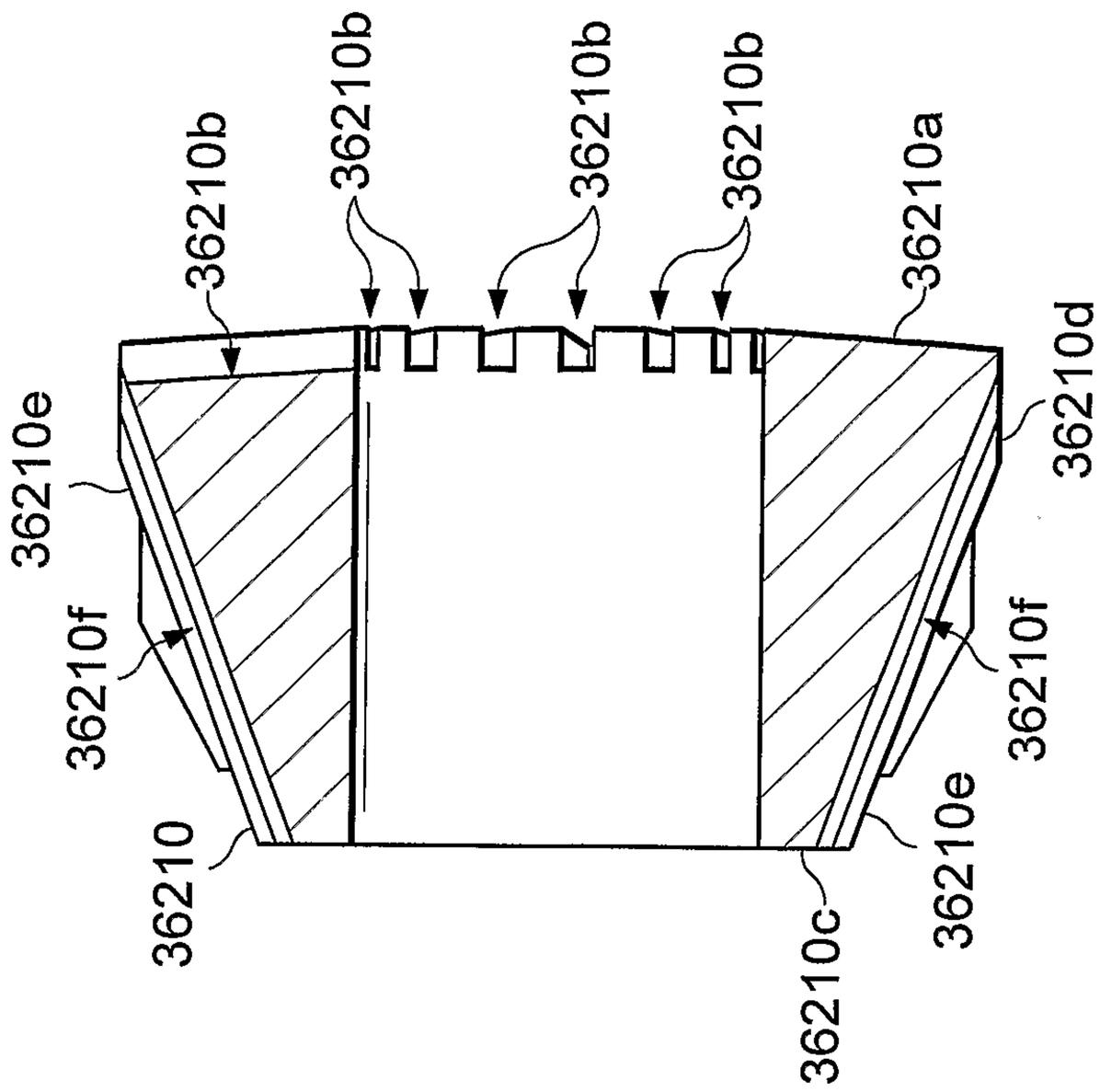


Fig. 21AH

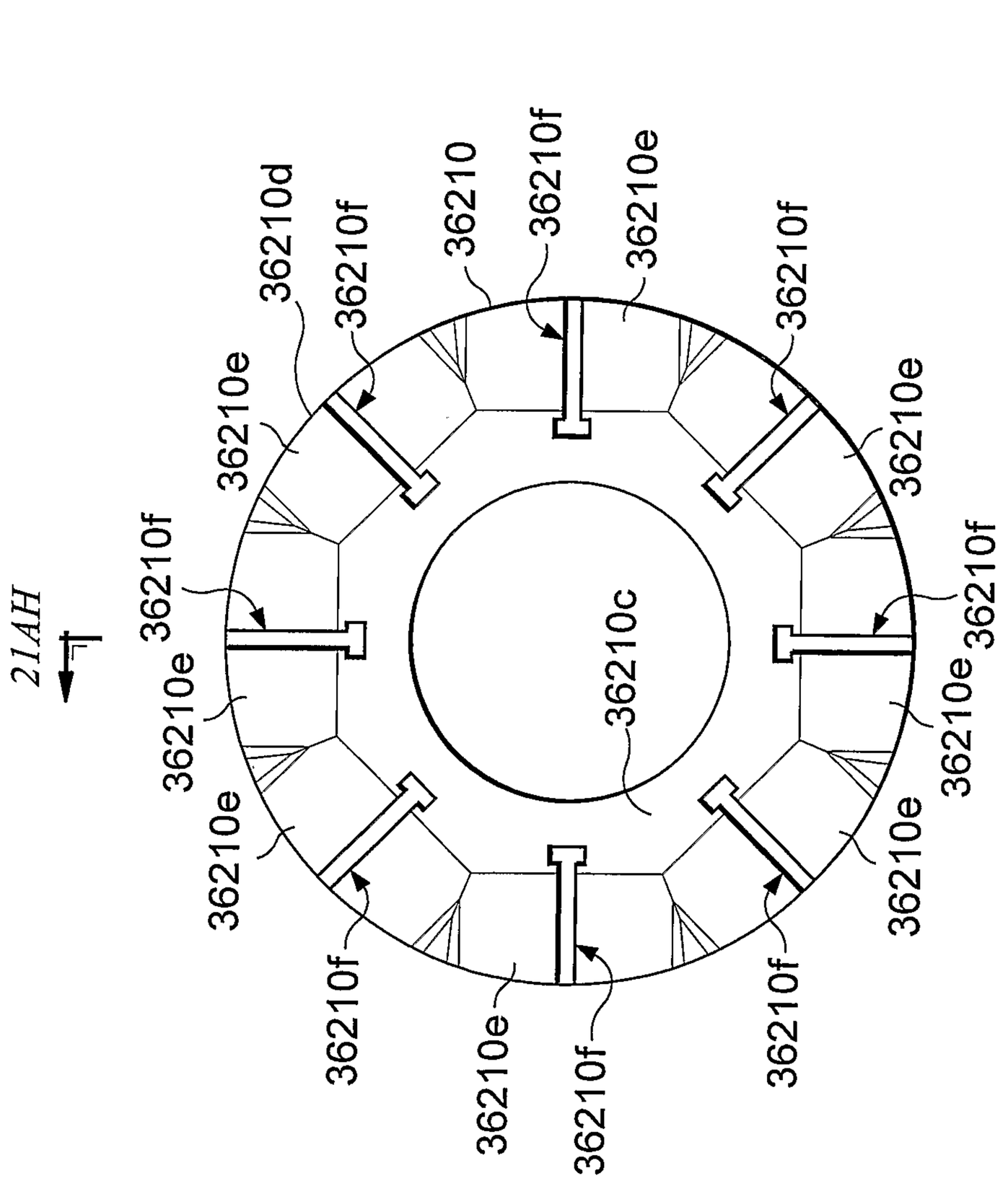


Fig. 21AG

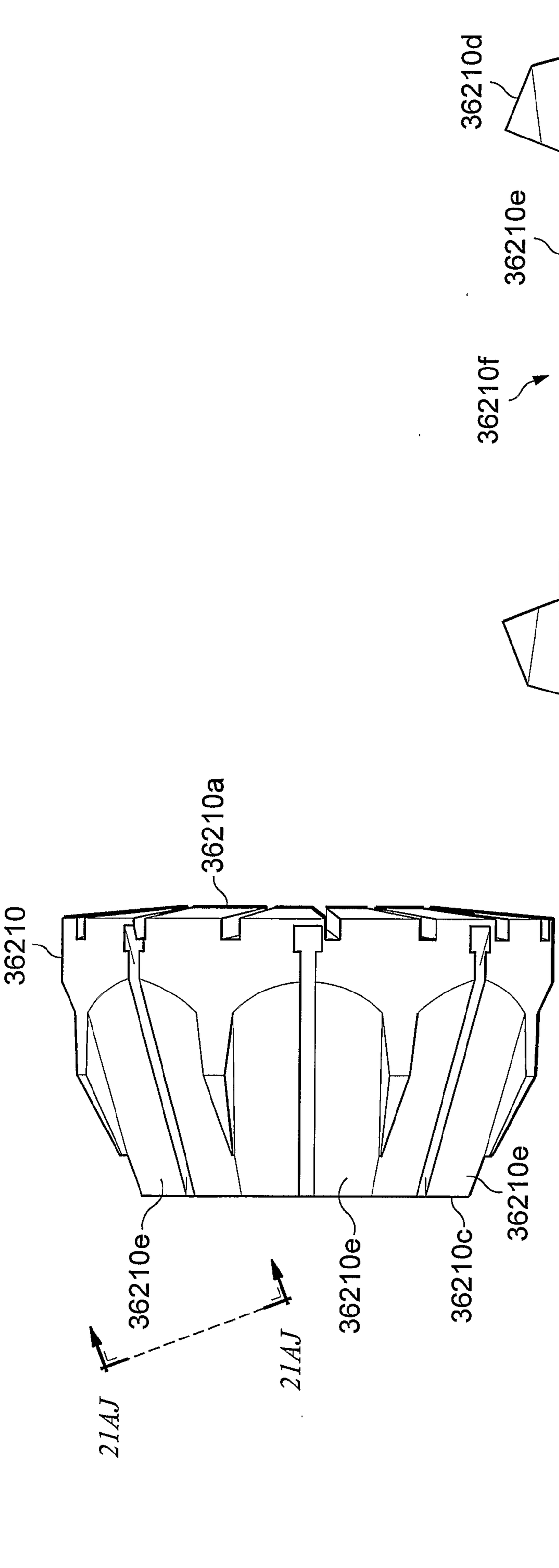


Fig. 21AI

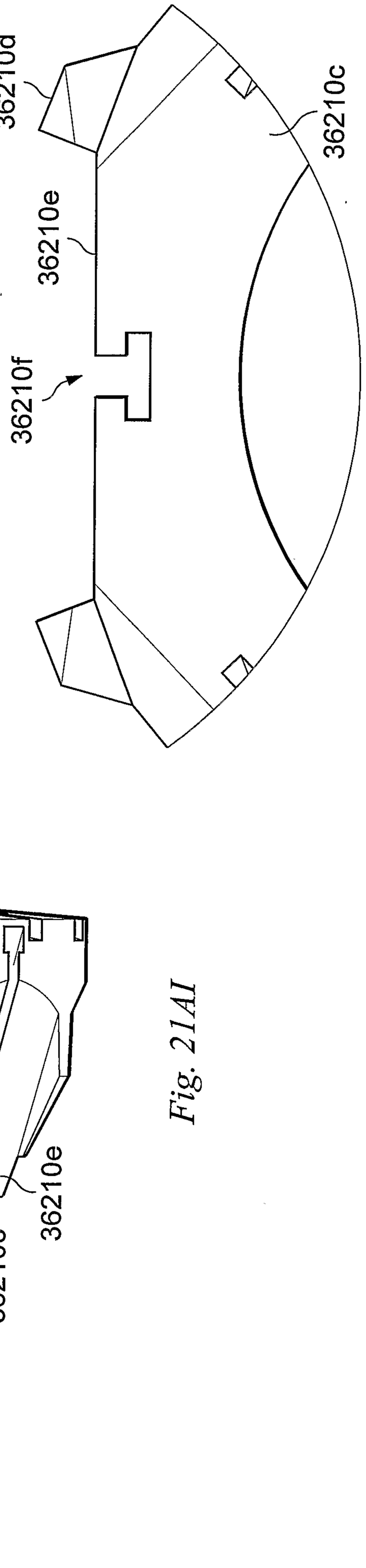


Fig. 21AJ

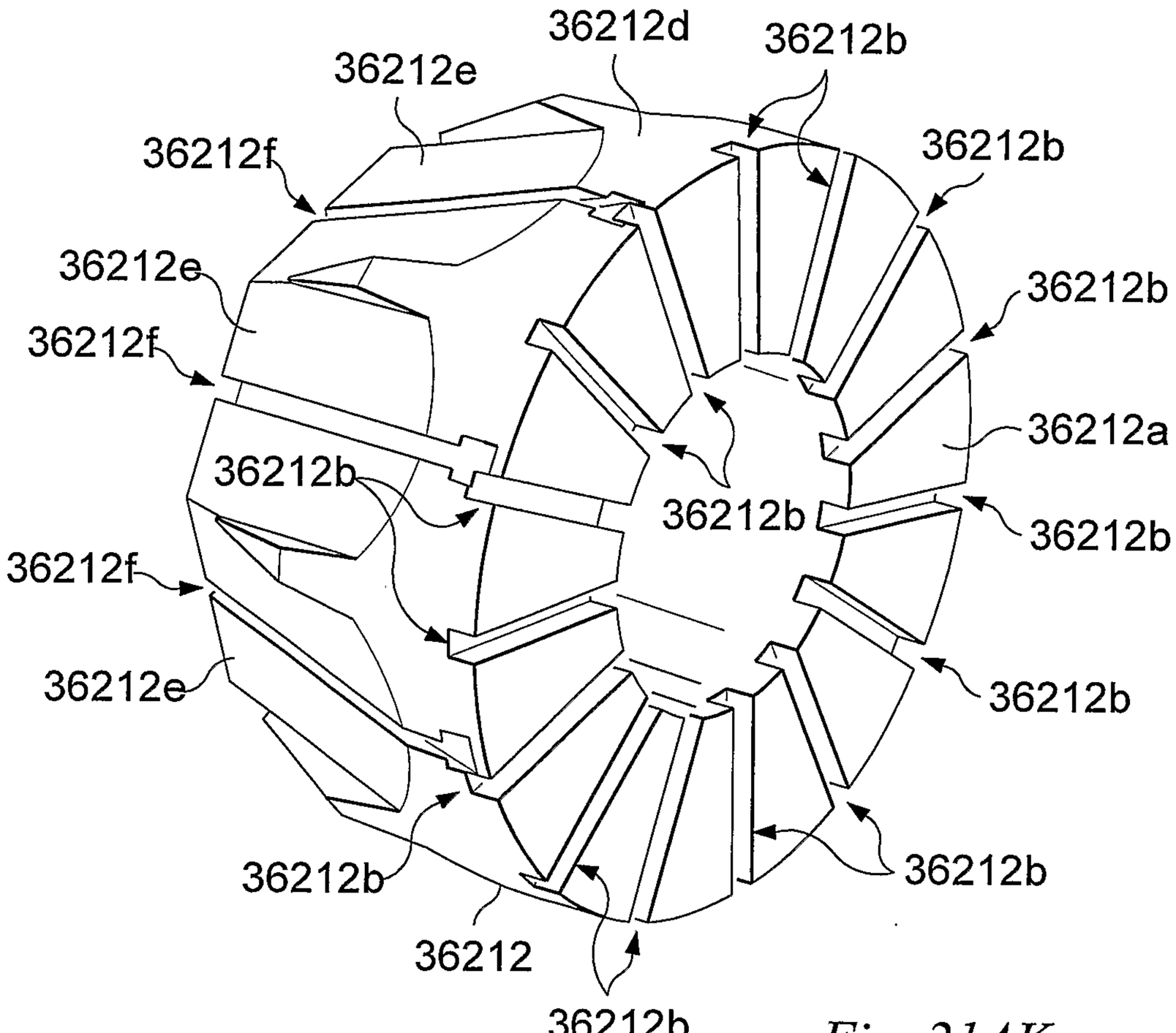


Fig. 21AK

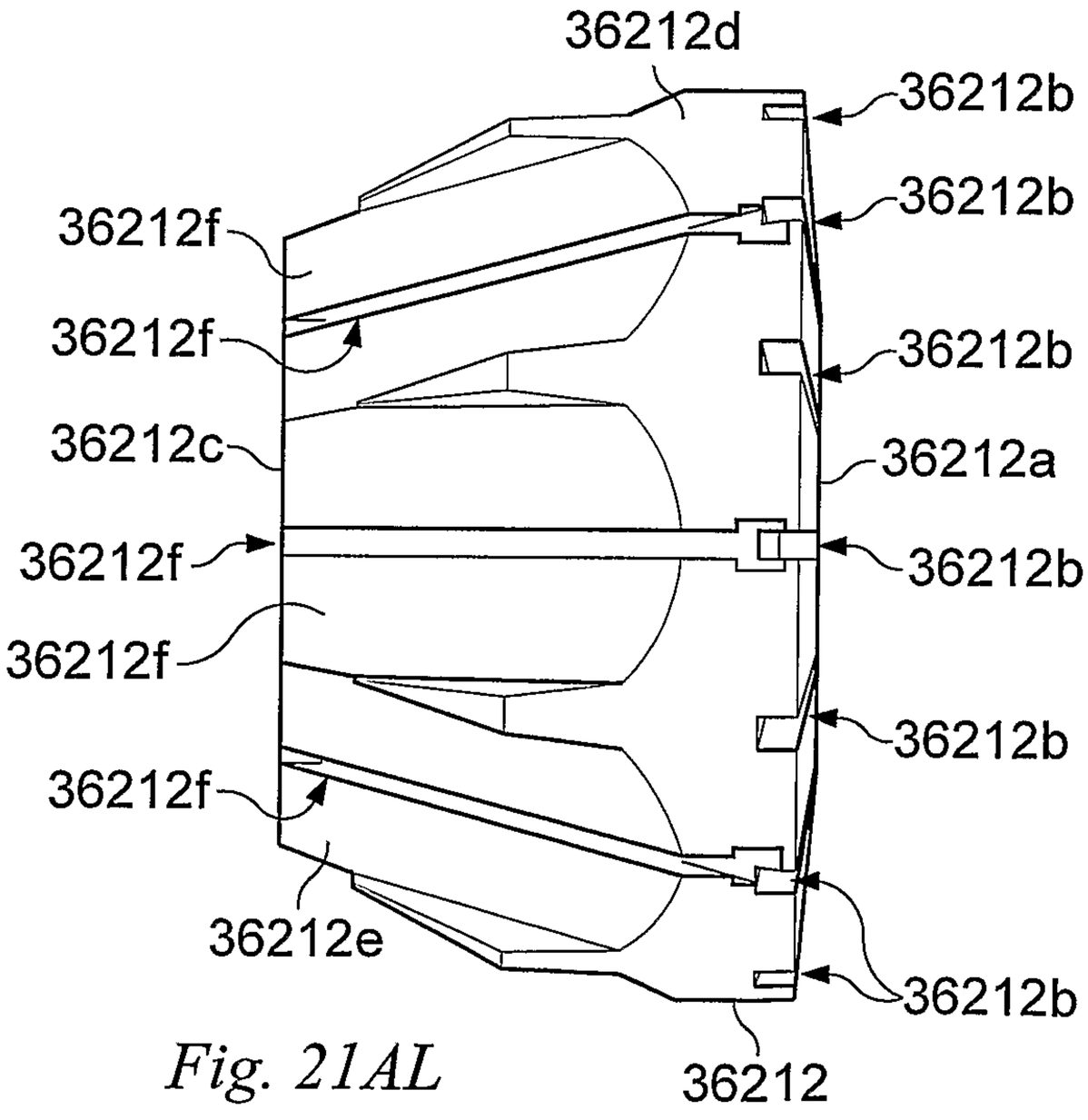


Fig. 21AL

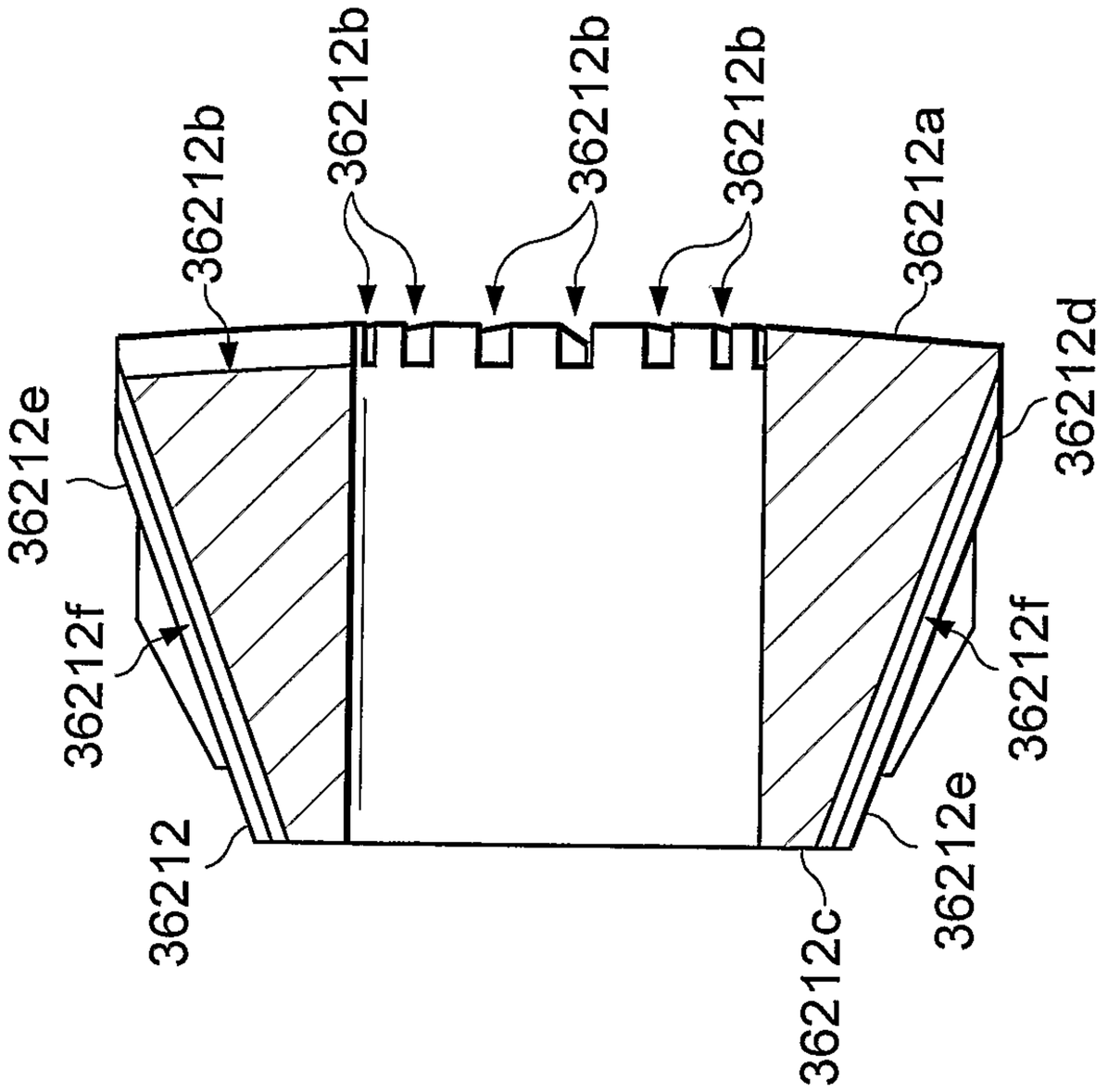


Fig. 21AN

Fig. 21AM

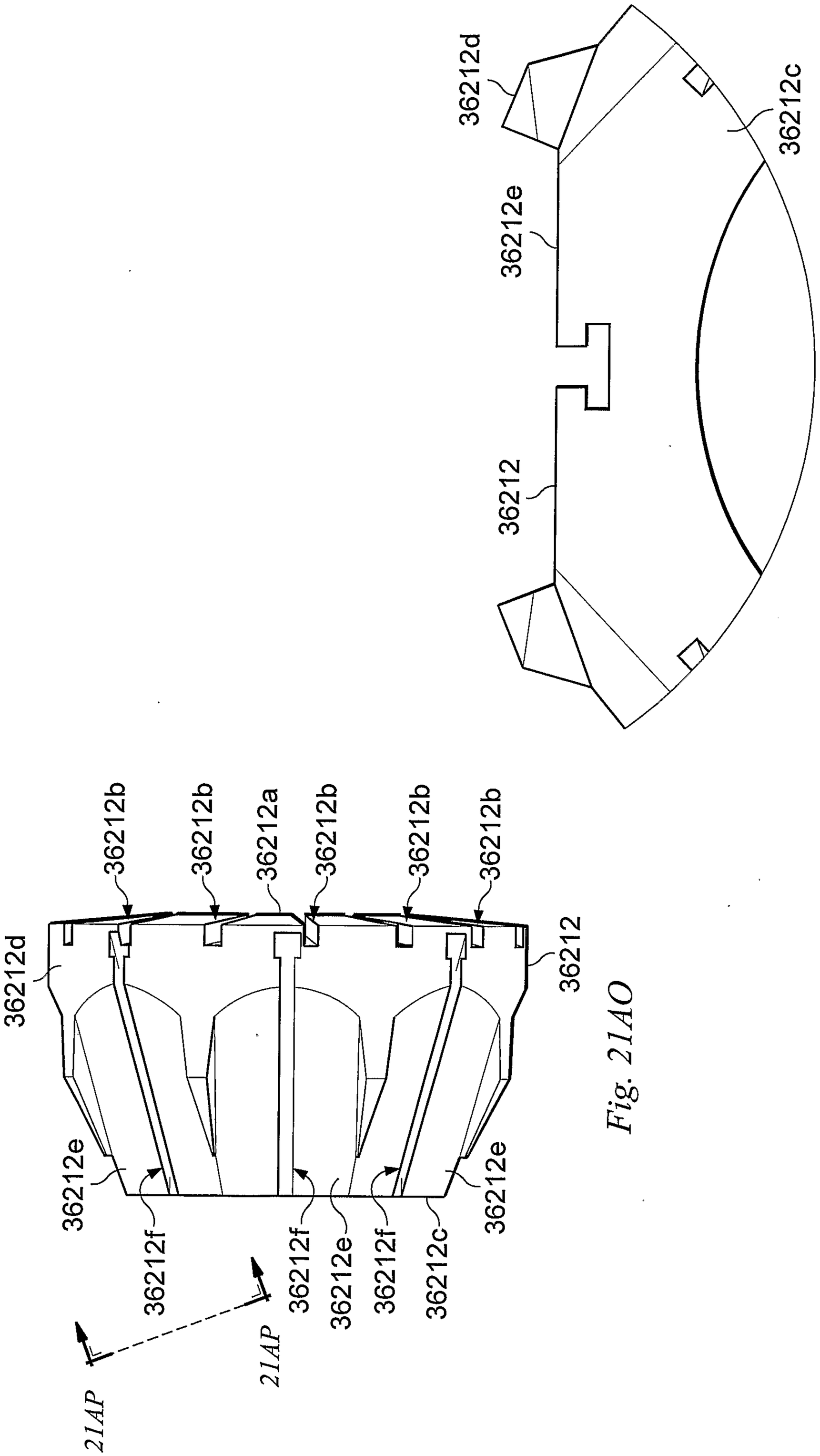


Fig. 21AP

Fig. 21AO

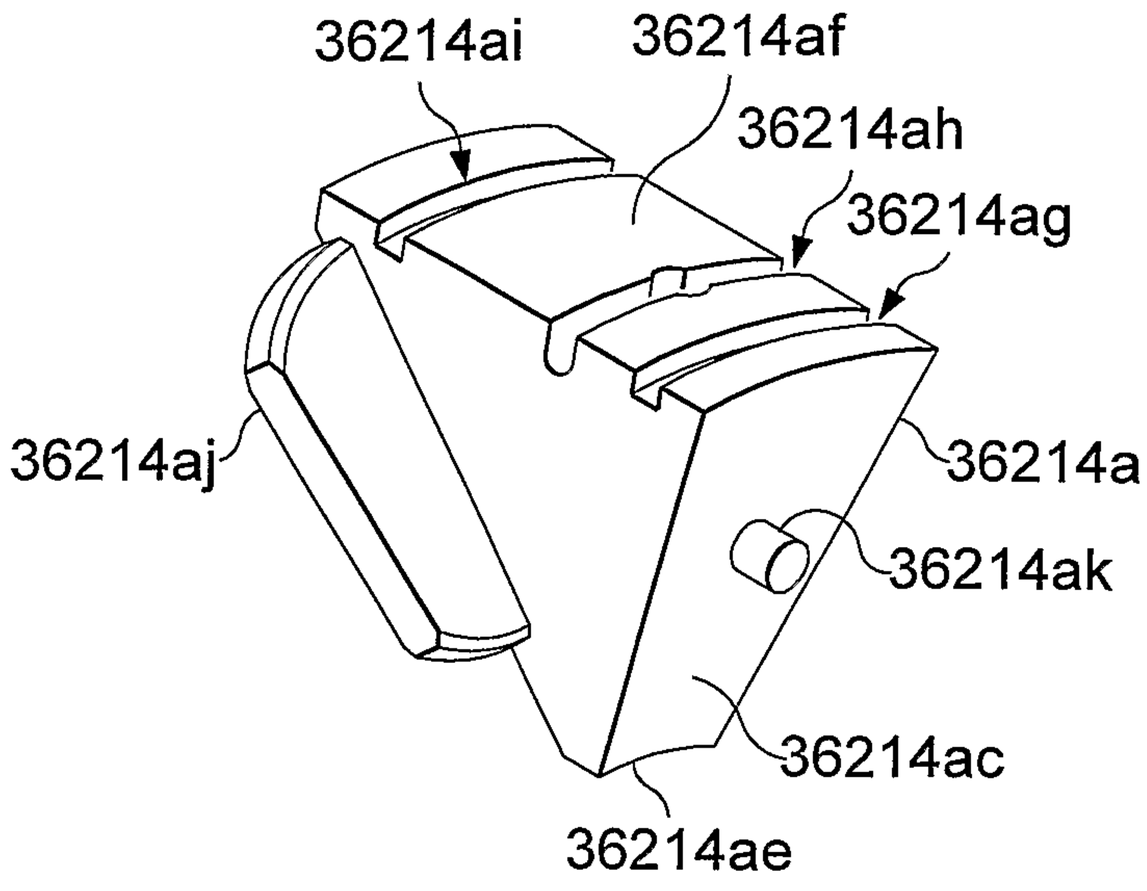


Fig. 21AQ

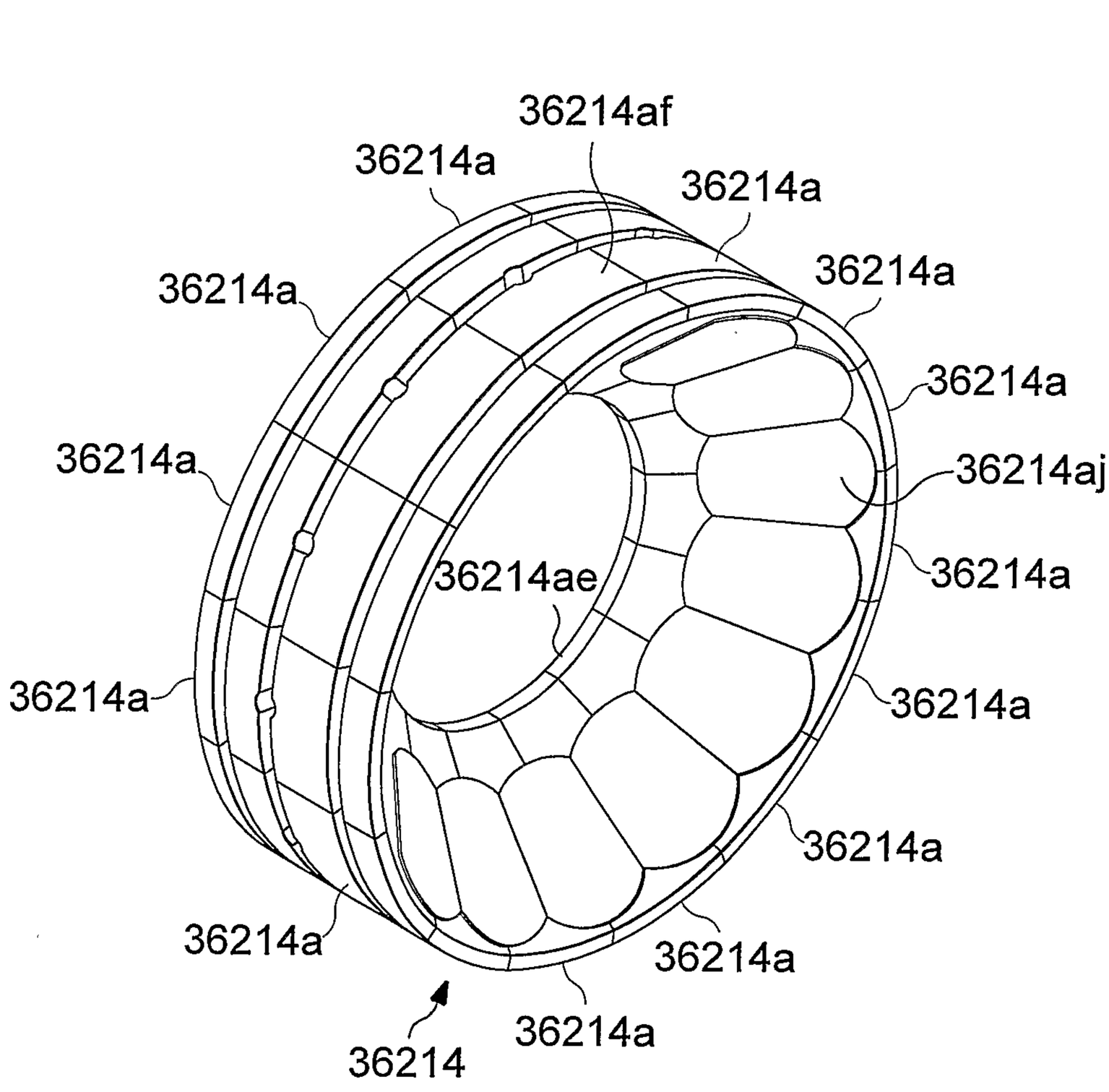


FIG. 21AR

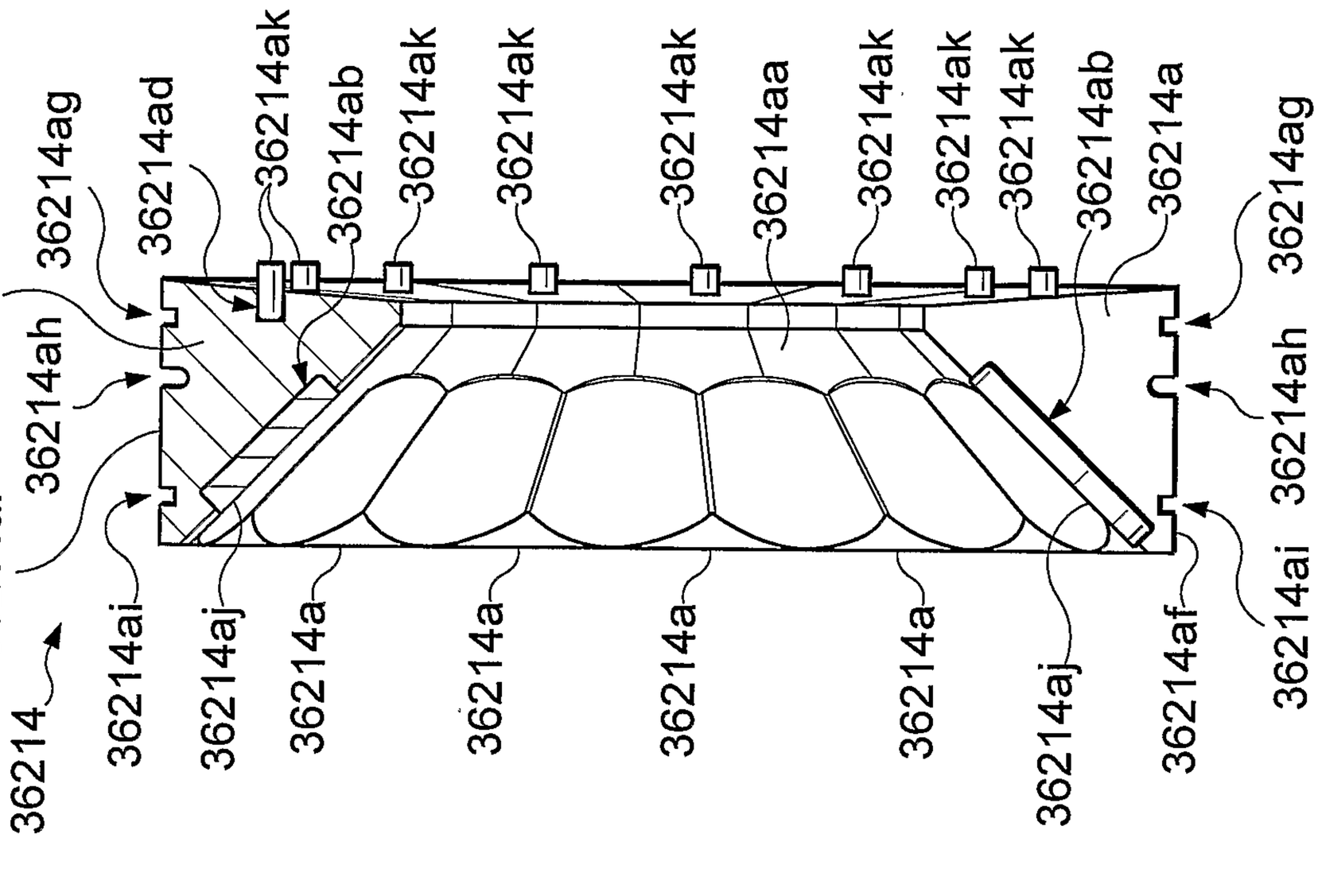


Fig. 21AT

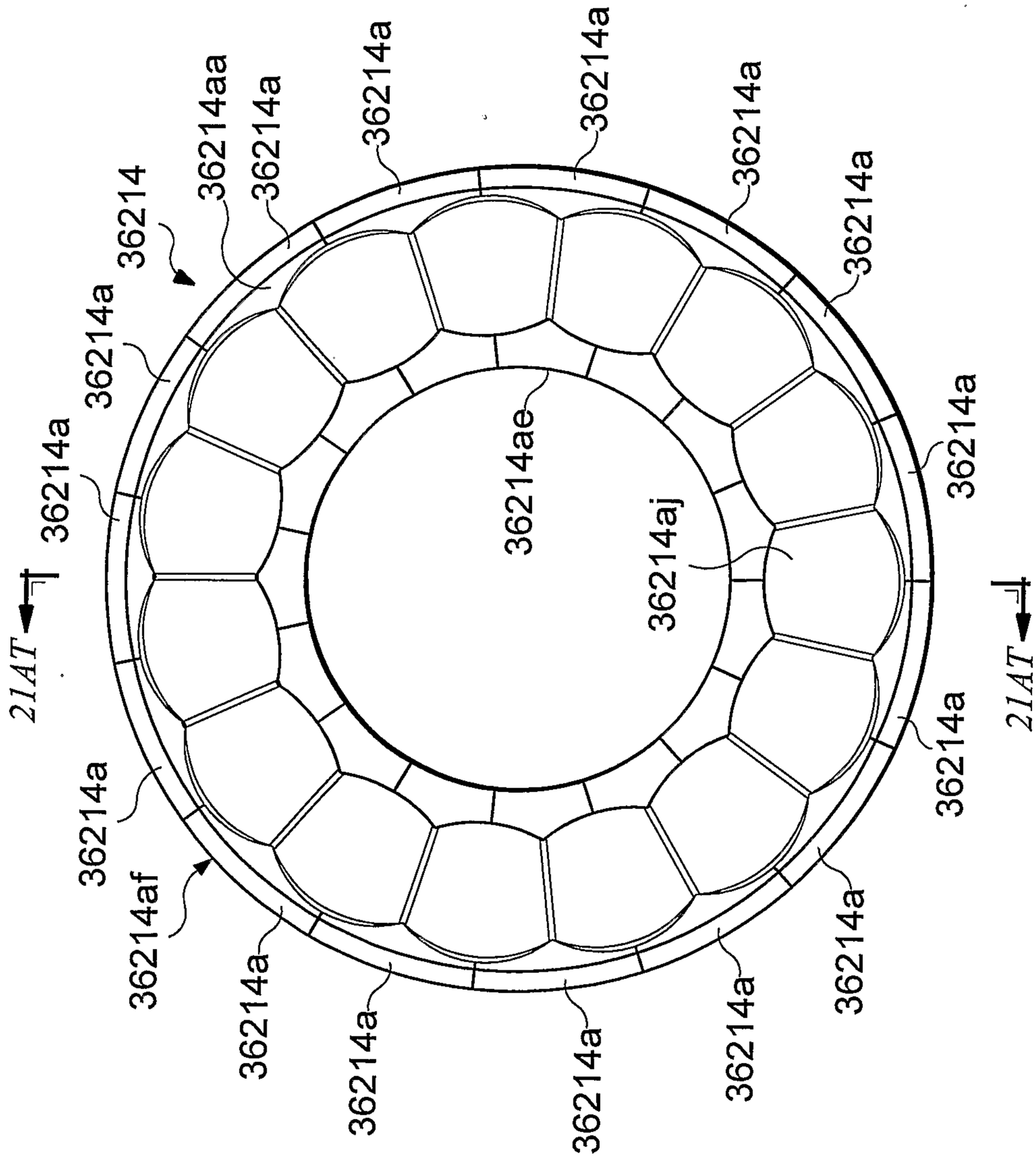


Fig. 21AS

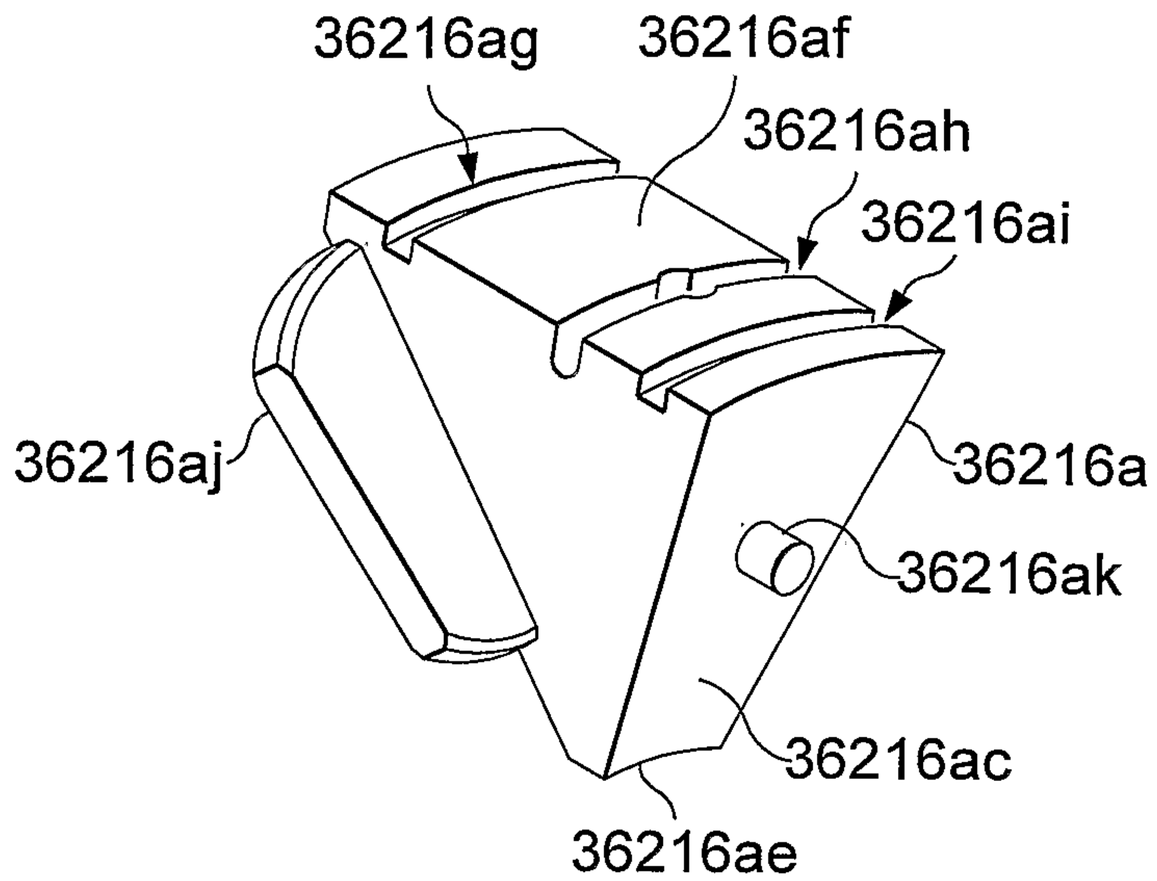


Fig. 21AU

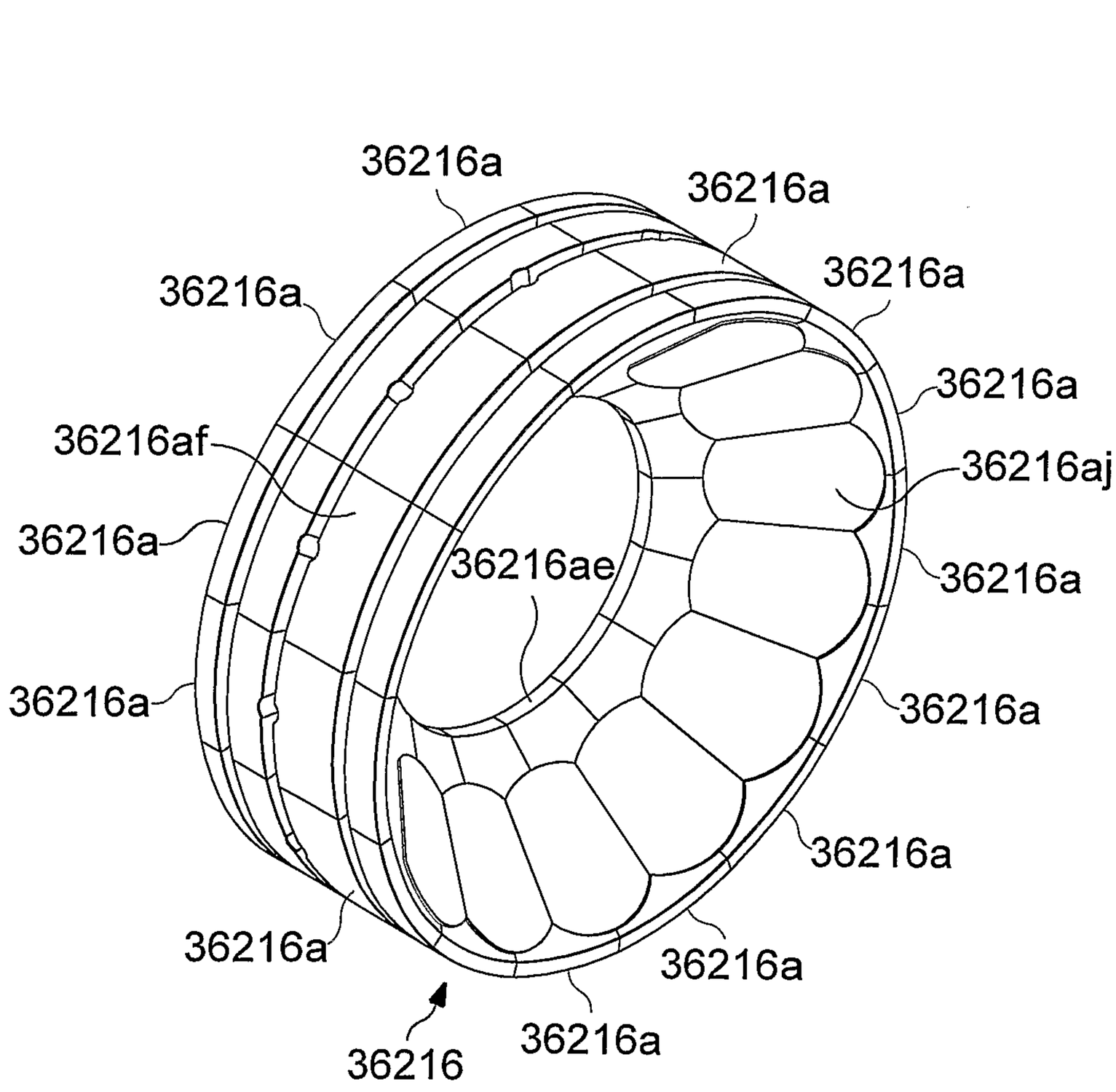


FIG. 21AV

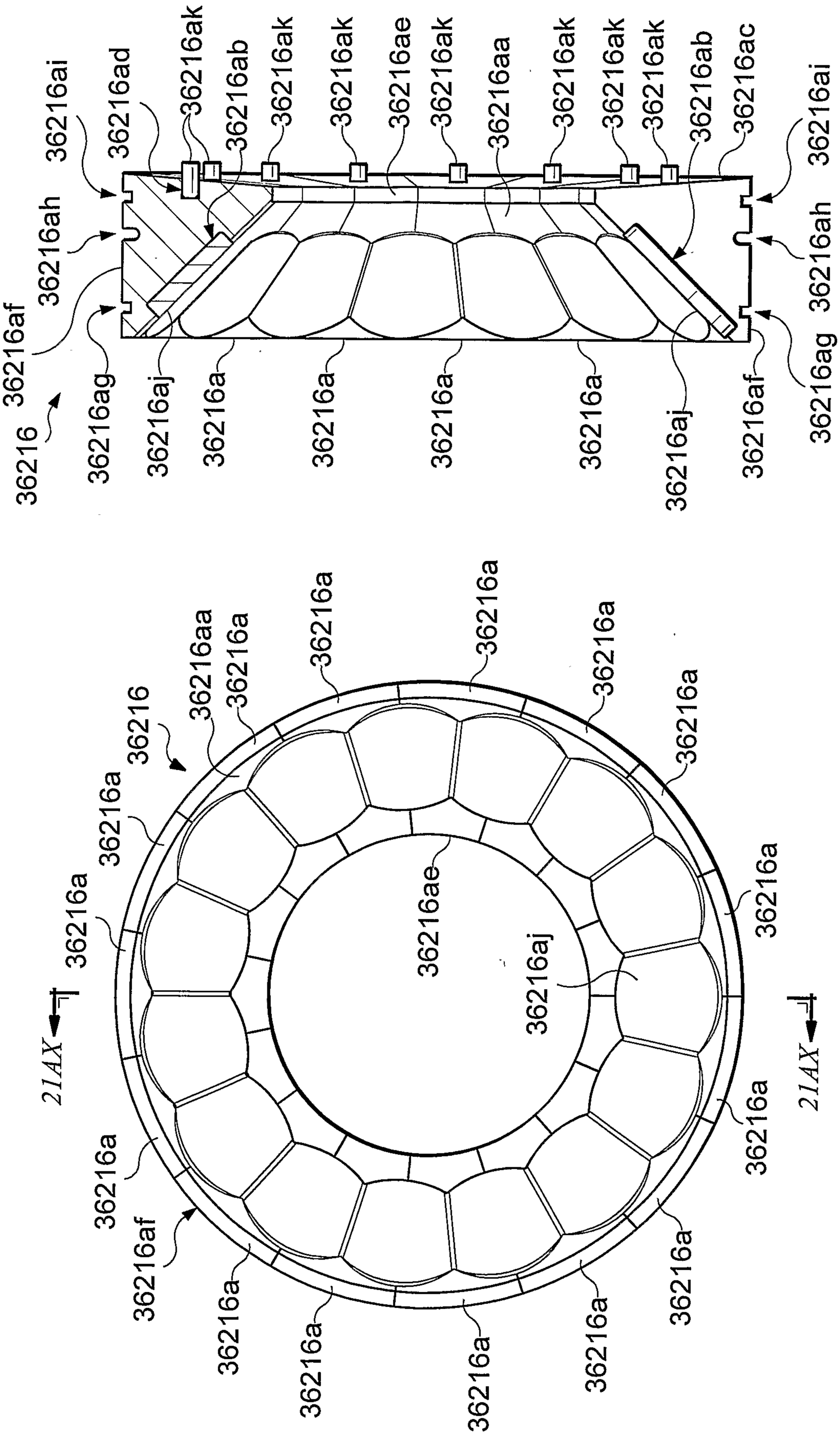
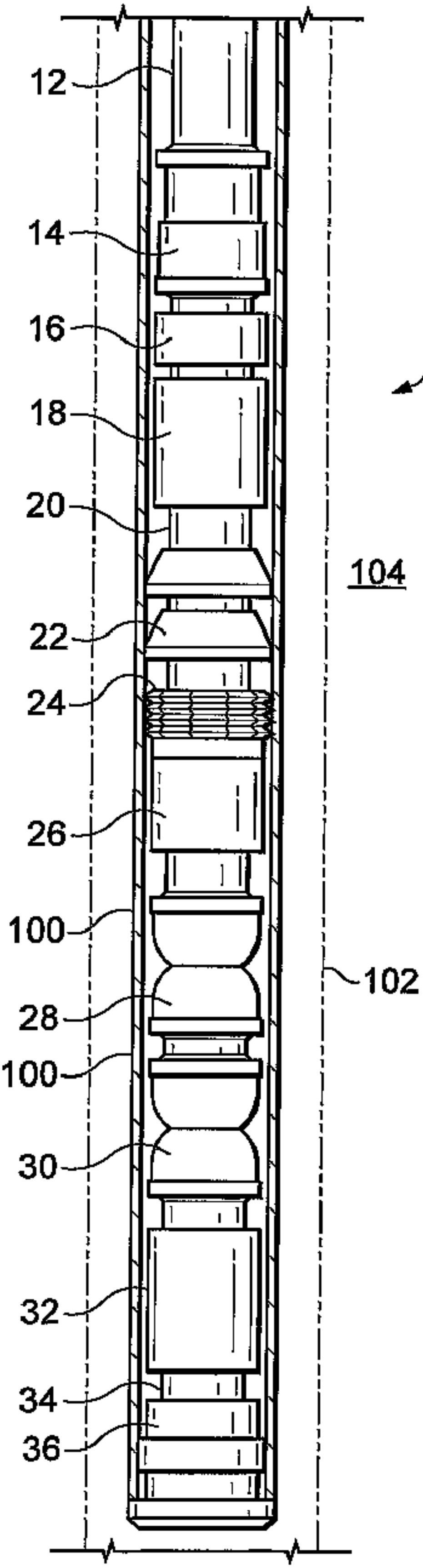


Fig. 21AX

Fig. 21AW


12
14
16
10
18
20
104
22
24
26
100
102
28
100
30
32
34
36