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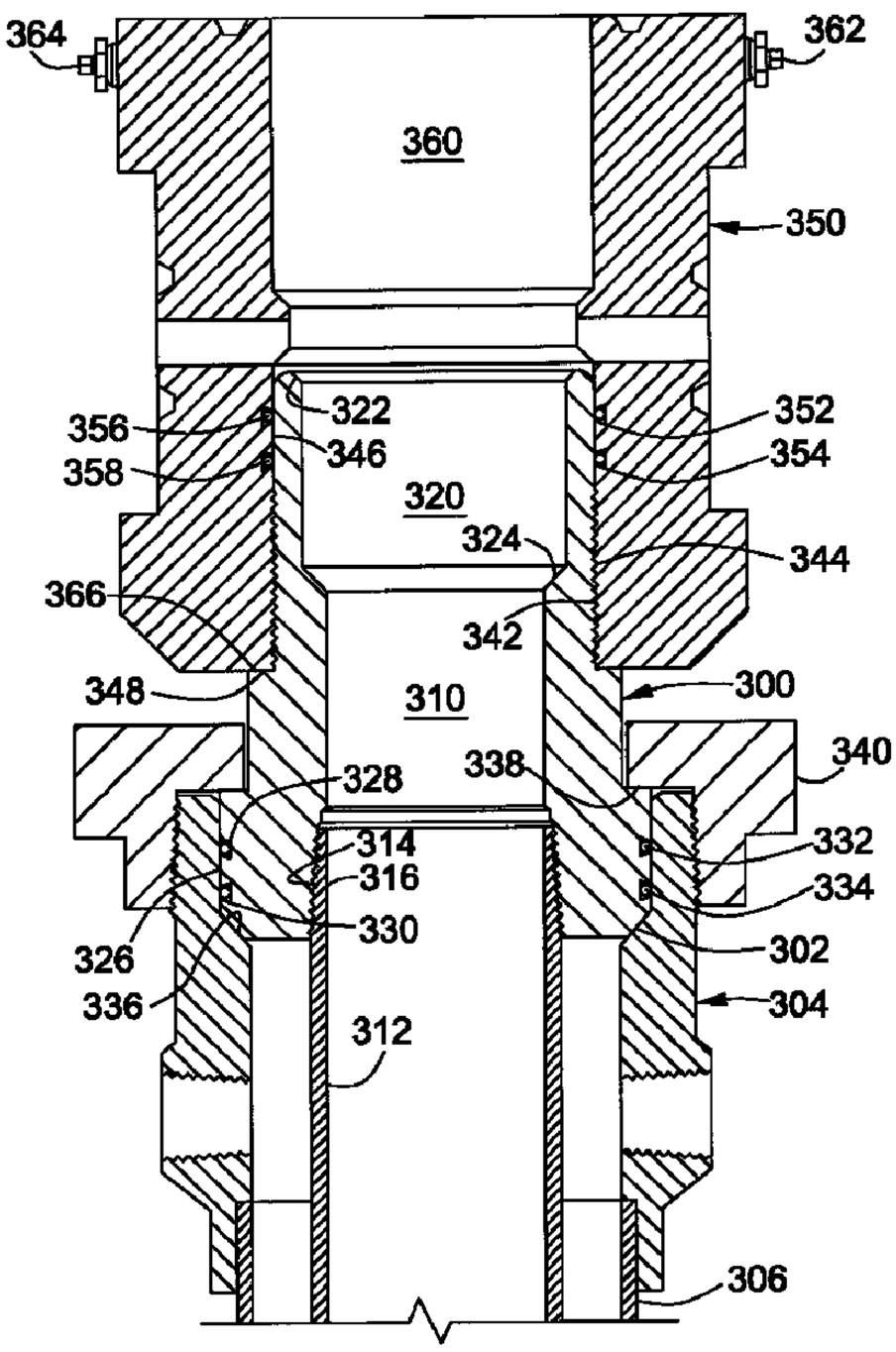
(72) Inventeur/Inventor:
MCGUIRE, BOB, US

(73) Propriétaire/Owner:
STINGER WELLHEAD PROTECTION, INC., US

(74) Agent: WOOD, MAX R.

(54) Titre : MANDRIN DE CUVELAGE PERMETTANT DE FACILITER LA COMPLETION, LA REMISE EN PRODUCTION OU LE RECONDITIONNEMENT DE PUITS

(54) Title: CASING MANDREL FOR FACILITATING WELL COMPLETION, RE-COMPLETION OR WORKOVER



(57) Abrégé/Abstract:
A casing mandrel for an independent screwed wellhead includes a seal bore for receiving a fixed-point packoff connected to a high-pressure mandrel of a pressure isolation tool, and a pin thread adapted for engagement with a box thread of a tubing head supported by the casing mandrel.

ABSTRACT OF THE DISCLOSURE

A casing mandrel for an independent screwed wellhead includes a seal bore for receiving a fixed-point packoff connected to a high-pressure mandrel of a pressure isolation tool, and a pin thread adapted for engagement with a box thread of a tubing head supported by the casing mandrel.

CASING MANDREL FOR FACILITATING WELL COMPLETION, RE-COMPLETION OR WORKOVER

TECHNICAL FIELD

The present invention relates generally to wellhead assemblies and, in particular, to a casing mandrel for facilitating well completion, re-completion or workover procedures on wells equipped with independent screwed wellheads.

BACKGROUND OF THE INVENTION

Independent screwed wellheads are well known in the art and classified by the American Petroleum Institute (API). The independent screwed wellhead has independently secured heads for each tubular string supported in the well bore. Independent screwed wellheads are widely used for production from low-pressure productions zones because they are economical to construct and maintain.

It is well known in the art that low pressure wells frequently require some form of stimulation to improve or sustain production. Traditionally, such stimulation procedures involved pumping high pressure fluids down the casing to fracture production zones. The high pressure fluids are often laden with proppants, such as bauxite and/or sharp sand.

Applicant's Canadian patent 2,428,613 which issued on October 25, 2005 describes casing mandrels for independent screwed wellheads that are assembled using threaded unions. However, certain customers prefer a flanged production tree.

There therefore exists a need for a casing mandrel that provides full-bore access to a casing in a well to be

stimulated, while ensuring that vulnerable wellhead seals are isolated from well stimulation pressures that exceed engineered stress tolerances of the seals, while accommodating a flanged production tree.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a casing mandrel that provides full-bore access to a casing in a well to be stimulated, while ensuring that vulnerable wellhead seals are isolated from well stimulation pressures that exceed engineered stress tolerances of the seals.

The invention therefore provides a casing mandrel for wells completed using an independent screwed wellhead, comprising: a casing mandrel body having a bottom end received in a casing bowl of the independent screwed wellhead, an annular shoulder adapted for mating engagement with a top flange of a casing bowl nut of the independent screwed wellhead, an axial passage that extends from the bottom end to a top end of the casing mandrel body, and a seal bore at a top of the axial passage adapted to receive a fixed-point packoff connected to a high pressure mandrel of a pressure isolation tool that provides full-bore access to a casing supported by the casing mandrel; and the casing mandrel top end includes a pin thread that engages a box thread of a tubing head to support the tubing head.

The invention further provides a casing mandrel for wells completed using an independent screwed wellhead, comprising: a casing mandrel body having an annular shoulder adapted for mating engagement with a top flange of a casing bowl nut of the independent screwed wellhead, an outer contour below the annular shoulder that mates with a

casing bowl of the independent screwed wellhead, an axial passage that extends from a casing mandrel bottom end to a casing mandrel top end of the casing mandrel body, the axial passage having a diameter at least as large as an internal diameter of a casing that the casing mandrel suspends in the well, and a seal bore at a top of the axial passage, the seal bore having a larger diameter than the axial passage and adapted to receive a fixed-point packoff connected to a high pressure mandrel of a pressure isolation tool; and the casing mandrel top end extends above the annular shoulder and includes a pin thread located above a top of the casing bowl nut when the casing bowl nut secures the casing mandrel to the independent screwed wellhead, the pin thread adapted to be engaged by a box thread of a tubing head supported by the casing mandrel.

The invention yet further provides a casing mandrel for an independent screwed wellhead comprising: a bottom end supported in a casing bowl of the independent screwed wellhead, the bottom end including an annular shoulder engaged by a casing bowl nut of the independent screwed wellhead to secure the casing mandrel in the independent screwed wellhead; a top end that extends above a top of the casing bowl nut, the top end comprising a pin thread adapted to support a tubing head, and a smooth cylindrical seal surface above the pin thread engaged by elastomeric seals received in seal grooves in the tubing head; an axial passage that extends from the top end to the bottom end, the axial passage including a seal bore at a top end adapted to receive a fixed-point packoff connected to a high-pressure mandrel of a pressure isolation tool that

provides full-bore access to a casing supported by the casing mandrel.

The invention still further provides a casing mandrel and tubing head for an independent screwed wellhead, wherein: the casing mandrel comprises a bottom end supported in a casing bowl of the independent screwed wellhead, the bottom end including an annular shoulder engaged by a casing bowl nut of the independent screwed wellhead to secure the casing mandrel in the independent screwed wellhead, and a top end that extends above a top of the casing bowl nut, the top end comprising a pin thread and a smooth cylindrical seal surface above the pin thread; and an axial passage that extends from the casing mandrel top end to the casing mandrel bottom end, the axial passage including a seal bore at a top end adapted to receive a fixed-point packoff connected to a high-pressure mandrel of a pressure isolation tool that provides full-bore access to a casing suspended by the casing mandrel; and the tubing head comprises a tubing mandrel bowl that is adapted to support a tubing mandrel, tubing mandrel lockdown screws adapted to lock the tubing mandrel in the tubing mandrel bowl, a bottom end with a box thread that engages the pin thread of the casing mandrel to lock the tubing head to the casing mandrel, and seal ring grooves located above the box thread that support elastomeric seal rings which engage the smooth cylindrical seal surface of the casing mandrel to provide a fluid seal between the tubing head and the casing mandrel.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will become apparent from the following detailed description, taken in combination with the appended drawings, in which:

FIG. 1 is a schematic cross-sectional view of an independent screwed wellhead equipped with a casing mandrel in accordance with another embodiment of the invention;

FIG. 2 is a schematic cross-sectional view of a fixed-point packoff being inserted into the casing mandrel of the independent screwed wellhead shown in FIG. 1;

FIG. 3 is a schematic cross-sectional view of the fixed-point packoff after it has been packed off in the casing mandrel of the independent screwed wellhead shown in FIG. 1;

FIG. 4 is a schematic cross-sectional view of the fixed-point packoff being inserted into the casing mandrel through a well control stack; and

FIG. 5 is a schematic cross-sectional view of the fixed-point packoff being inserted into the casing mandrel through a blowout preventer.

It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The invention provides a casing mandrel to facilitate and improve the efficiency of completing, re-completing or

workover of wells equipped with independent screwed wellheads. Efficiency is improved by providing full-bore access to a casing of the well. Safety is improved by ensuring that wellhead seals are isolated from well stimulation pressures that exceed engineered stress tolerances of the seals.

FIG. 1 is a schematic cross-sectional view of a casing mandrel in accordance with one embodiment of the invention. The casing mandrel 300 is received in the casing bowl 302 of an independent screwed wellhead 304 mounted to a surface casing 306 in a manner well known in the art. The casing mandrel 300 has an axial passage 310 with an inner diameter at least as large as an inner diameter of a production casing 312 that the casing mandrel 300 supports in a well bore. A box thread 314 at a bottom end of the axial passage 310 engages a pin thread 316 on the top of the production casing 312 to suspend the production casing 312 in the well bore. Located at a top of the axial passage 310 is a seal bore 320 sized and shaped to receive a fixed-point packoff connected to a high-pressure mandrel of a pressure isolation tool, as will be explained below in detail with reference to FIGs. 2-5. A top end of the casing mandrel 300 as a beveled shoulder 322 that guides downhole tools into the seal bore 320. A bevel 324 at a bottom of the seal bore 320 guides downhole tools into the axial passage 310.

The bottom end of the casing mandrel 300 received in the tubing bowl 302 includes an upper cylindrical section 326 with O-ring grooves 328, 330 that respectively receive O-rings 332, 334 for providing a fluid seal between the casing mandrel 300 and the independent screwed wellhead

304. The bottom end of the casing mandrel 300 further includes a tapered section 336 that supports the casing mandrel 300 in the casing bowl 302. In one embodiment, the tapered section 336 is tapered at an angle of about 45°.

Located above the bottom end of the casing mandrel 300 is an annular shoulder 338 engaged by a casing bowl nut 340 of the independent screwed wellhead 304. Casing bowl nut 340 secures the casing mandrel 300 in the casing bowl 302. Located above a top of the casing bowl nut 340 on an outer periphery of the casing mandrel 300 is a pin thread 342 engaged by a box thread 344 at a bottom end of a tubing head 350, which is also supported by the casing mandrel 300. Located above the pin thread 342 is a smooth outer cylindrical seal surface 346 of the casing mandrel 300. Located below the pin thread is a second annular shoulder 348 that provides a support for a bottom end 366 of the tubing head 350, to relieve strain on the pin thread 342 and the box thread 344. Seal ring grooves 352 and 354 located above the box thread 344 support elastomeric seal rings that provide a fluid seal between the tubing head 350 and the casing mandrel 300. In this embodiment, the elastomeric seals are O-rings 356, 358 respectively received in the seal ring grooves 352 and 354. The tubing head 350 includes a tubing mandrel bowl 360 that supports a tubing mandrel (not shown) in a manner well known in the art. Tubing mandrel lockdown screws, two of which 362, 364 are shown, lock the tubing mandrel in the tubing mandrel bowl 360.

FIG. 2 is a schematic cross-sectional view of a fixed-point packoff secured to the bottom end of a high pressure mandrel of a pressure isolation tool (not shown) being

inserted into the casing mandrel 300 of the independent screwed wellhead 304 shown in FIG. 1. As will be explained below in more detail with reference to FIGs. 4 and 5 and as well understood by those skilled in the art, the high pressure mandrel 450 with the fixed-point packoff 400 is normally inserted into the independent screwed wellhead through a well control mechanism, which for example may be one of: a frac stack; at least one high pressure valve; or, a blowout preventer. The fixed-point packoff 400 is threadedly connected to a bottom end of the high-pressure mandrel 450. A plurality of elastomeric seal ring grooves 402-408 in an outer periphery of the fixed-point packoff 400 support elastomeric seals 410-416 to provide a high-pressure fluid seal between the seal bore 320 and the fixed-point packoff 400, as shown in FIG. 3. In one embodiment, the elastomeric seals 410-416 are high-pressure O-ring seals capable of containing fluid pressures of up to at least 10,000 psi.

FIG. 3 is a schematic cross-sectional view of the fixed-point packoff 400 after it has been inserted into the seal bore 320 of the casing mandrel 300 shown in FIG. 1. As explained above, the O-rings 410, 412, 414 and 416 provide a high pressure fluid seal in the seal bore 320 that prevents high pressure well stimulation fluids pumped through the high-pressure mandrel 450 into the production casing 312 from migrating upward into the low-pressure rated tubing head 350 and the elastomeric seals 356 and 358, as well as any low-pressure rated equipment mounted to the tubing head 350.

FIG. 4 is a schematic cross-sectional view of the fixed-point packoff 400 being inserted into the casing

mandrel 320 through a frac stack 500. As is well known in the art, the frac stack 500 commonly includes a first high-pressure valve 502 that is mounted to a top of the tubing head 350. Mounted to a top flange of the high-pressure valve 502 is a cross-flow tee 504, generally used for flow-back after a well stimulation procedure. The cross-flow tee 504 includes a pair of side ports to which are respectively connected redundant control valves 506a, 506b and 506c, 506d. Connected to the outermost control valves 506a and 506d are connectors 508, 512 used to connect any one or more of: flow-back lines; a pressure balance line; drain pit lines; or the like. Mounted to a top of the cross-flow tee is a second high-pressure valve 514. Mounted to a top flange of the high pressure valve 514 is a pressure isolation tool 600 that is schematically illustrated. The pressure isolation tool 600 may be any tool/insertion system that can be used to insert the high pressure mandrel 450 with the fixed-point packoff 400 down through the frac stack 500 and into the casing mandrel seal bore 320. Examples of suitable pressure isolation tools 600 include, but are not limited to, tools described in Assignee's United States patents: 6,817,423 which issued on November 16, 2004; 6,817,421 which issued on November 16, 2004; 6,626,245 which issued on September 30, 2003; 6,364,024 which issued on April 2, 2004; 6,289,993 which issued on September 18, 2001; 6,179,053 which issued January 30, 2001; and 5,825,852 which issued February 15, 1994.

FIG. 5 is a schematic cross-sectional view of the fixed-point packoff being inserted into the casing mandrel through a blowout preventer (BOP) 700, which is also well known in the art. The BOP 700 is mounted to a top of the tubing head 350 and used to control well pressure before

the high-pressure mandrel 450 with the fixed-point packoff 400 of the pressure isolation tool 600 is stroked into the seal bore 320 of the casing mandrel 300. The BOP 700 also controls well pressure after the high-pressure mandrel 450 with the fixed-point packoff 400 of the pressure isolation tool 600 is stroked up out of the screwed independent wellhead. As is well known in the art, the BOP 700 includes at least one set of tubing rams 702 and at least one set of blind rams 704.

As will be understood by those skilled in the art, well completion is exemplary of only one procedure that can be practiced using the methods and apparatus in accordance with the invention. The method and apparatus in accordance with the invention can likewise be used for well re-completion, well stimulation, and any other downhole procedure that requires full-bore access to the production casing and/or production tubing of the well.

The embodiments of the invention described above are therefore intended to be exemplary only. The scope of the invention is intended to be limited solely by the scope of the appended claims.

WE CLAIM:

1. A casing mandrel for wells completed using an independent screwed wellhead, comprising:

a casing mandrel body having a bottom end received in a casing bowl of the independent screwed wellhead, an annular shoulder adapted for mating engagement with a top flange of a casing bowl nut of the independent screwed wellhead, an axial passage that extends from the bottom end to a top end of the casing mandrel body, and a seal bore at a top of the axial passage adapted to receive a fixed-point packoff connected to a high pressure mandrel of a pressure isolation tool that provides full-bore access to a casing supported by the casing mandrel; and

the casing mandrel top end includes a pin thread that engages a box thread of a tubing head to support the tubing head.

2. The casing mandrel as claimed in claim 1 further comprising a smooth cylindrical outer surface above the pin thread that is contacted by elastomeric seals supported in a seal bore in the tubing head above the box thread to provide a fluid seal between the casing mandrel and the tubing head when the tubing head is supported by the casing mandrel.

3. The casing mandrel as claimed in claims 1 or 2 wherein the elastomeric seals are O-rings.

4. The casing mandrel as claimed in any one of claims 1-3 wherein the bottom end that mates with the casing bowl of the wellhead includes at least one groove for retaining an elastomeric seal that seals against the casing bowl.

5. The casing mandrel as claimed in claim 4 wherein the elastomeric seal comprises an O-ring.

6. The casing mandrel as claimed in any one of claims 1-5 further comprising a second annular shoulder located above the first annular shoulder and below the pin thread, the second annular shoulder providing a support for a bottom end of the tubing head.

7. A casing mandrel for wells completed using an independent screwed wellhead, comprising:

a casing mandrel body having an annular shoulder adapted for mating engagement with a top flange of a casing bowl nut of the independent screwed wellhead, an outer contour below the annular shoulder that mates with a casing bowl of the independent screwed wellhead, an axial passage that extends from a casing mandrel bottom end to a casing mandrel top end of the casing mandrel body, the axial passage having a diameter at least as large as an internal diameter of a casing that the casing mandrel suspends in a well, and a seal bore at a top of the axial passage, the seal bore having a larger diameter than the axial passage and adapted to receive a

fixed-point packoff connected to a high pressure mandrel of a pressure isolation tool; and

the casing mandrel top end extends above the annular shoulder and includes a pin thread located above a top of the casing bowl nut when the casing bowl nut secures the casing mandrel to the independent screwed wellhead, the pin thread adapted to be engaged by a box thread of a tubing head supported by the casing mandrel.

8. The casing mandrel as claimed in claim 7 further comprising a smooth cylindrical outer surface above the pin thread that is contacted by elastomeric seals supported in a seal bore in the tubing head above the box thread to provide a fluid seal between the casing mandrel and the tubing head when the tubing head is supported by the casing mandrel.

9. The casing mandrel as claimed in claim 8 wherein the elastomeric seals are O-rings.

10. The casing mandrel as claimed in any one of claims 7-9 wherein the outer contour below the annular shoulder that mates with the casing bowl of the wellhead includes at least one groove for retaining an elastomeric seal that seals against the casing bowl.

11. The casing mandrel as claimed in claim 10 wherein the elastomeric seal comprises an O-ring.

12. The casing mandrel as claimed in any one of claims 7-11 further comprising a second annular shoulder located above the first annular shoulder and below the pin thread, the second annular shoulder providing a support for a bottom end of the tubing head.

13. A casing mandrel for an independent screwed wellhead comprising:

a bottom end supported in a casing bowl of the independent screwed wellhead, the bottom end including an annular shoulder engaged by a casing bowl nut of the independent screwed wellhead to secure the casing mandrel in the independent screwed wellhead;

a top end that extends above a top of the casing bowl nut, the top end comprising a pin thread adapted to support a tubing head, and a smooth cylindrical seal surface above the pin thread engaged by elastomeric seals received in seal grooves in the tubing head;

an axial passage that extends from the top end to the bottom end, the axial passage including a seal bore at a top end adapted to receive a fixed-point packoff connected to a high-pressure mandrel of a pressure isolation tool that provides full-bore access to a casing suspended by the casing mandrel.

14. The casing mandrel as claimed in claim 13 further comprising a second annular shoulder located above

the first annular shoulder, the second annular shoulder supporting a bottom end of the tubing head.

15. The casing mandrel as claimed in claims 13 or 14 wherein the top end further comprises a beveled shoulder for guiding downhole tools into the seal bore.

16. The casing mandrel as claimed in claim 15 further comprising a bevel at a bottom of the seal bore that guides downhole tools into the axial passage.

17. The casing mandrel as claimed in any one of claims 13-15 wherein an outer contour of the bottom end supported in the casing bowl comprises at least one groove for retaining an elastomeric seal that seals against the casing bowl.

18. The casing mandrel as claimed in claim 17 wherein the elastomeric seal comprises an O-ring.

19. The casing mandrel as claimed in any one of claims 17 or 18 wherein the outer contour of the bottom end comprises a substantially cylindrical top section and a tapered bottom section.

20. The casing mandrel as claimed in claim 19 wherein the at least one groove for retaining the elastomeric seal is located in the substantially cylindrical top section.

21. A casing mandrel and tubing head for an independent screwed wellhead, wherein:

the casing mandrel comprises a bottom end supported in a casing bowl of the independent screwed wellhead, the bottom end including an annular shoulder engaged by a casing bowl nut of the independent screwed wellhead to secure the casing mandrel in the independent screwed wellhead, and a top end that extends above a top of the casing bowl nut, the top end comprising a pin thread and a smooth cylindrical seal surface above the pin thread; and an axial passage that extends from the casing mandrel top end to the casing mandrel bottom end, the axial passage including a seal bore at a top end adapted to receive a fixed-point packoff connected to a high-pressure mandrel of a pressure isolation tool that provides full-bore access to a casing suspended by the casing mandrel; and

the tubing head comprises a tubing mandrel bowl that is adapted to support a tubing mandrel, tubing mandrel lockdown screws adapted to lock the tubing mandrel in the tubing mandrel bowl, a bottom end with a box thread that engages the pin thread of the casing mandrel to lock the tubing head to the casing mandrel, and seal ring grooves located above the box thread that support elastomeric seal rings which engage the smooth cylindrical seal surface of the casing mandrel to provide a fluid seal between the tubing head and the casing mandrel.

22. The casing mandrel and tubing head as claimed in claim 21 further comprising a second annular shoulder

located above the first annular shoulder of the casing mandrel, the second annular shoulder supporting the bottom end of the tubing head.

23. The casing mandrel and tubing head as claimed in claims 21 or 22 wherein the top end of the casing mandrel further comprises a beveled shoulder for guiding downhole tools into the seal bore.

24. The casing mandrel and tubing head as claimed in claim 23 further comprising a bevel at a bottom of the seal bore that guides downhole tools into the axial passage.

25. The casing mandrel and tubing head as claimed in any one of claims 21-24 wherein an outer contour of the bottom end of the casing mandrel supported in the casing bowl comprises at least one groove for retaining an elastomeric seal that seals against the casing bowl.

26. The casing mandrel and tubing head as claimed in claim 25 wherein the elastomeric seal comprises an O-ring.

27. The casing mandrel and tubing head as claimed in any one of claims 25 or 26 wherein the outer contour of the bottom end comprises a substantially cylindrical top section and a tapered bottom section.

28. The casing mandrel and tubing head as claimed in claim 27 wherein the at least one groove for

retaining the elastomeric seal is located in the substantially cylindrical top section.

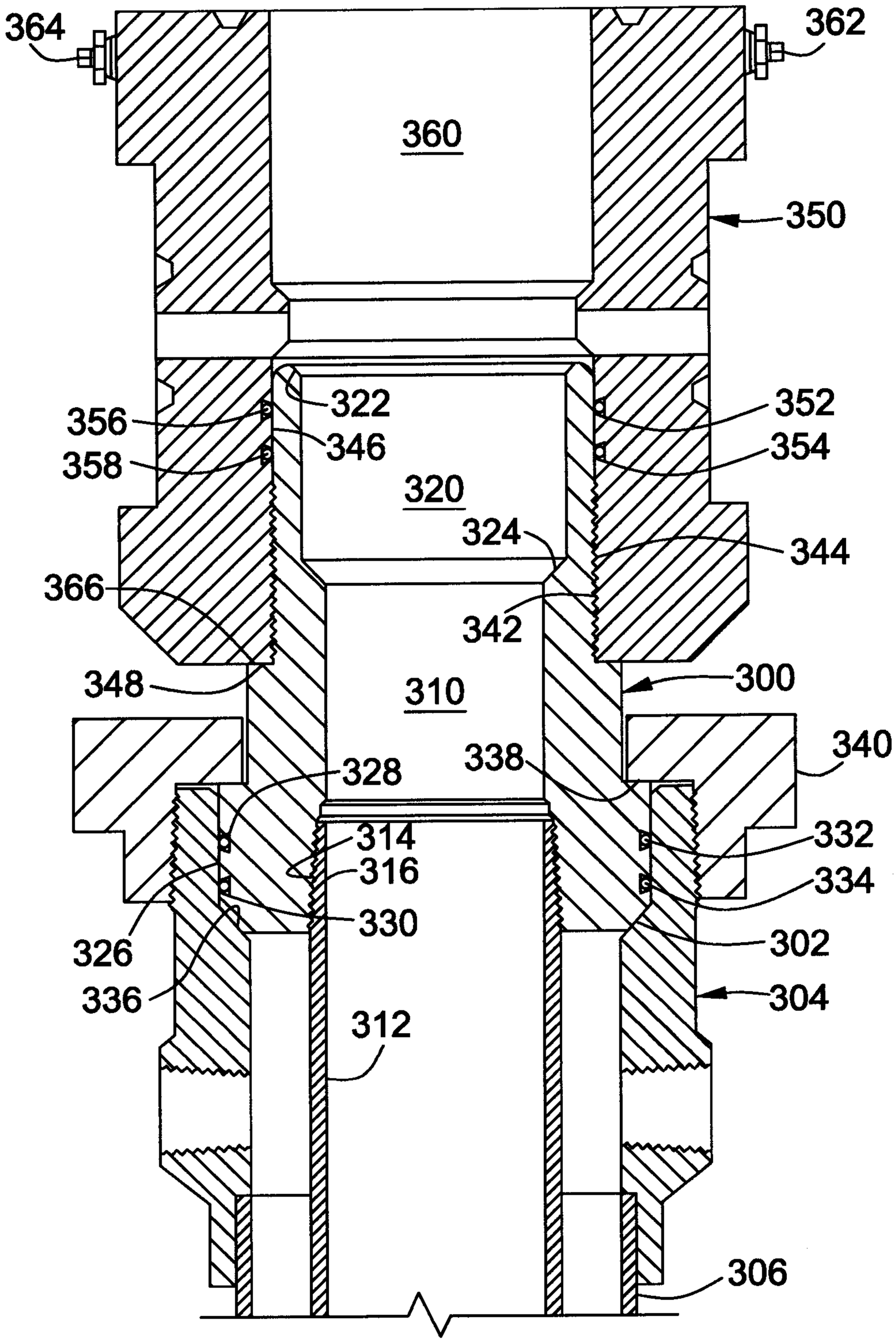

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FIG. 1

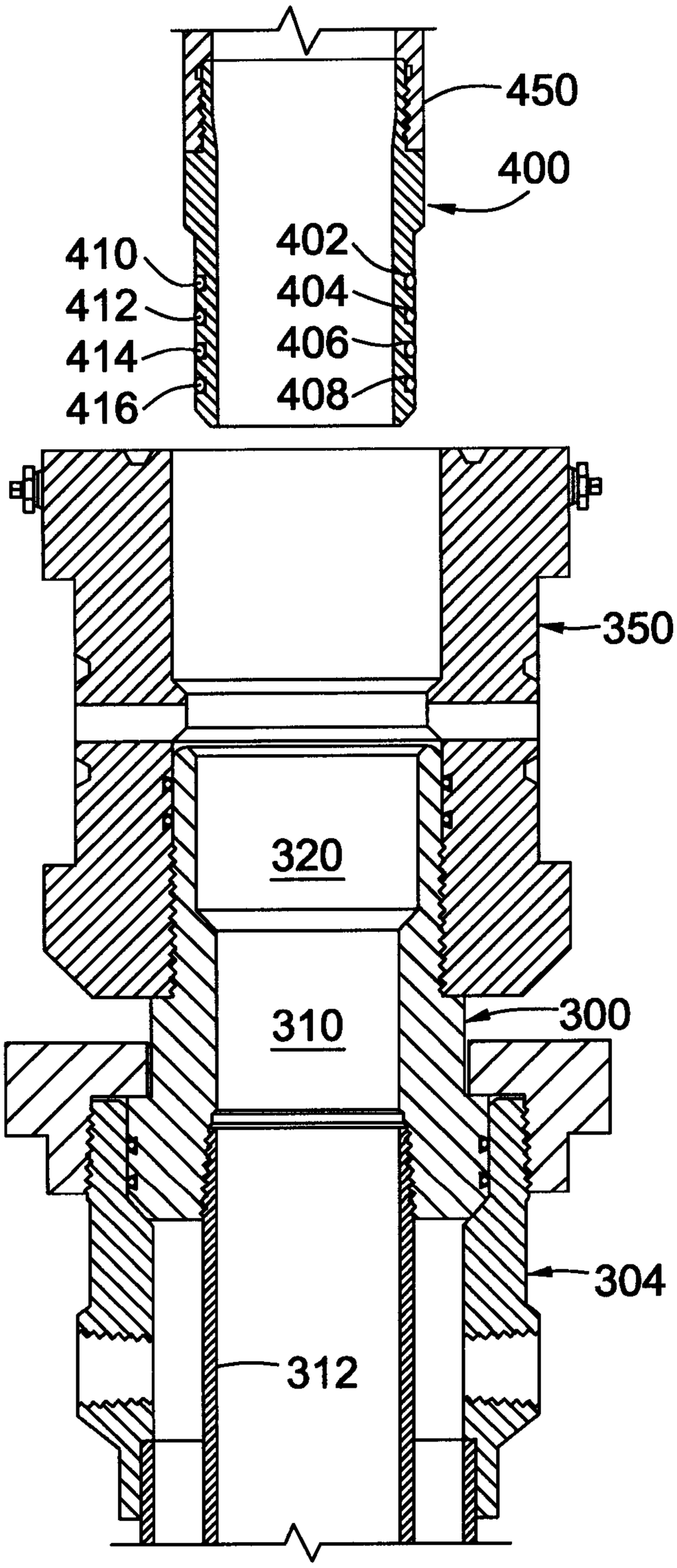

FIG. 2

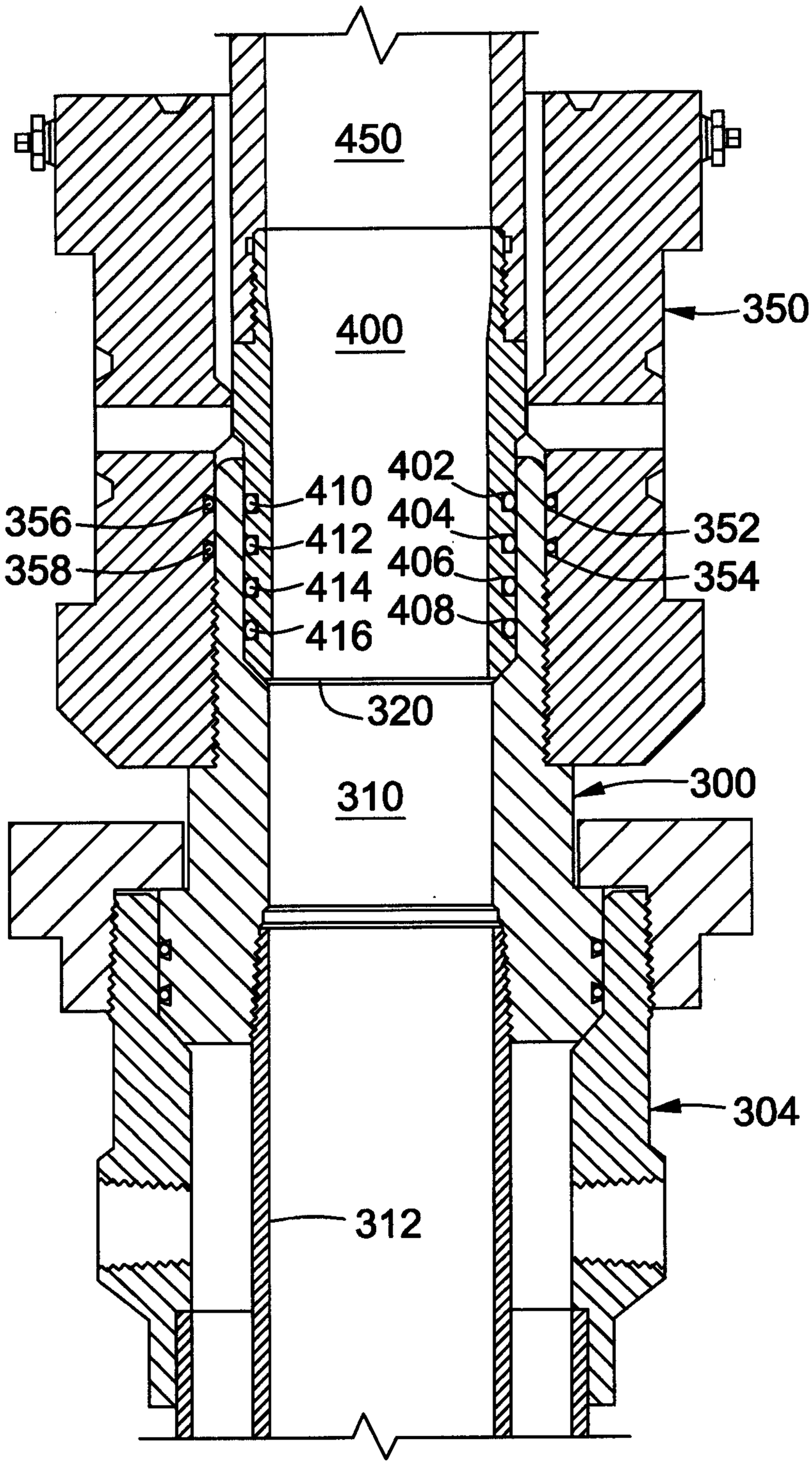
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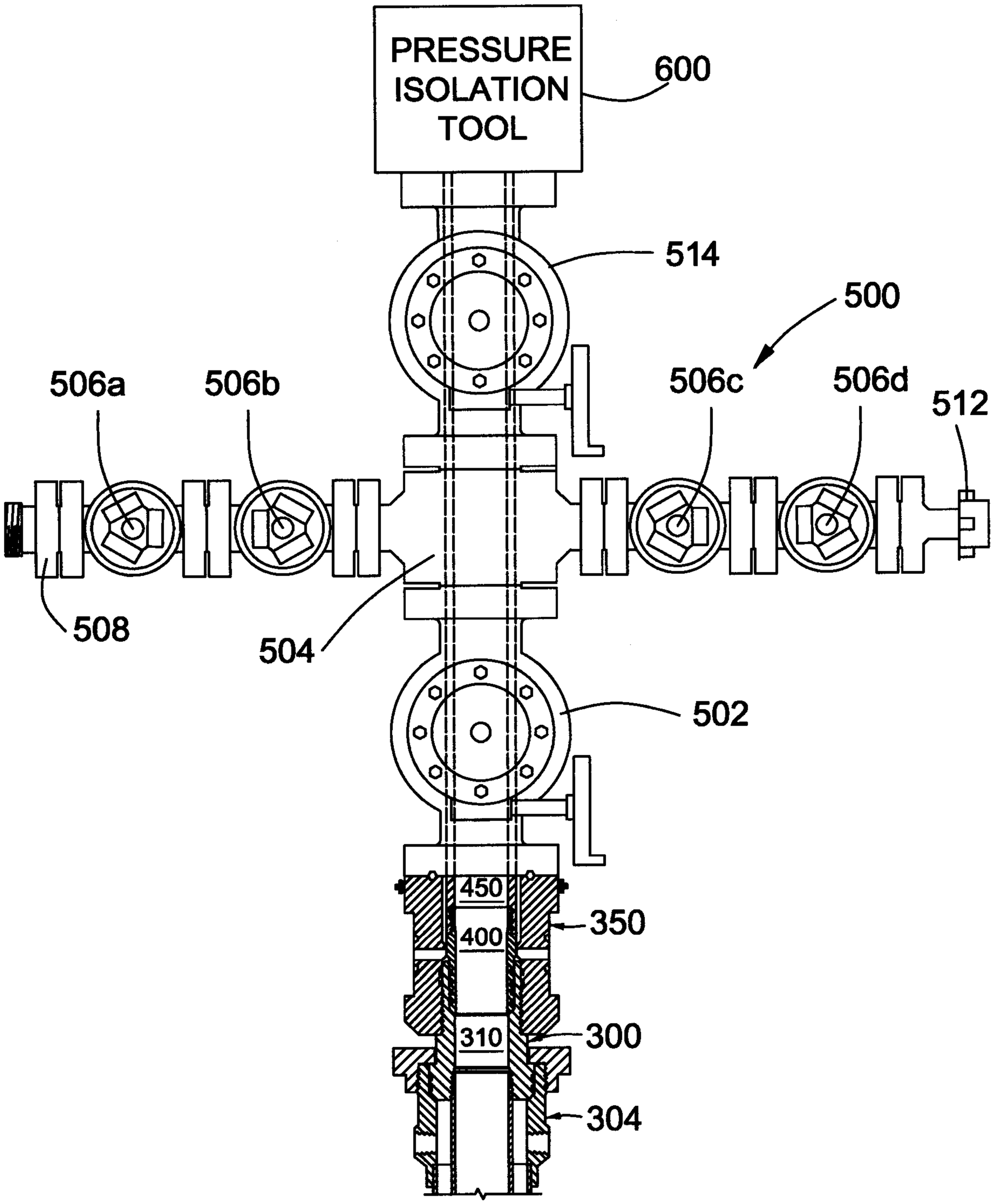
FIG. 3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506d
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FIG. 4

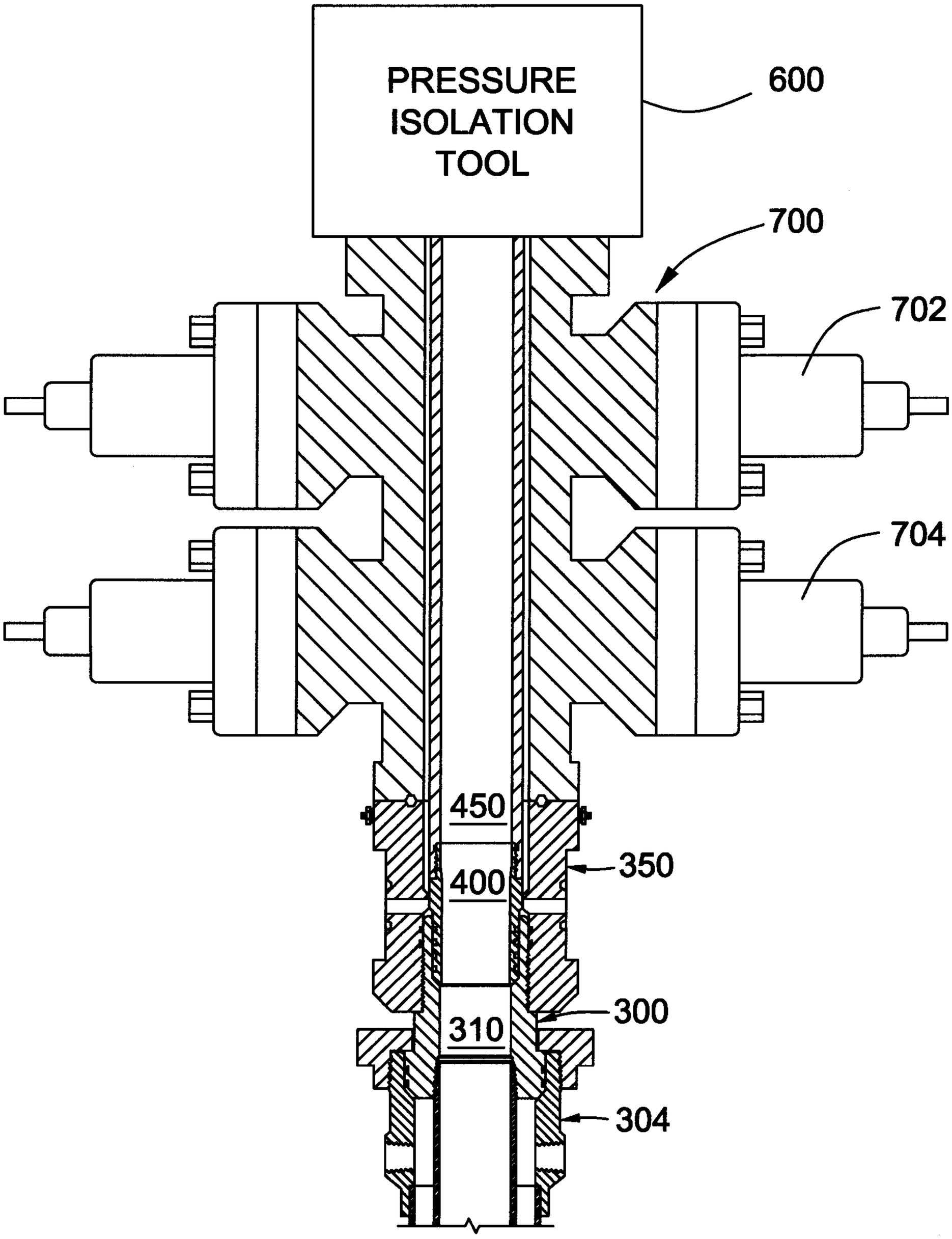
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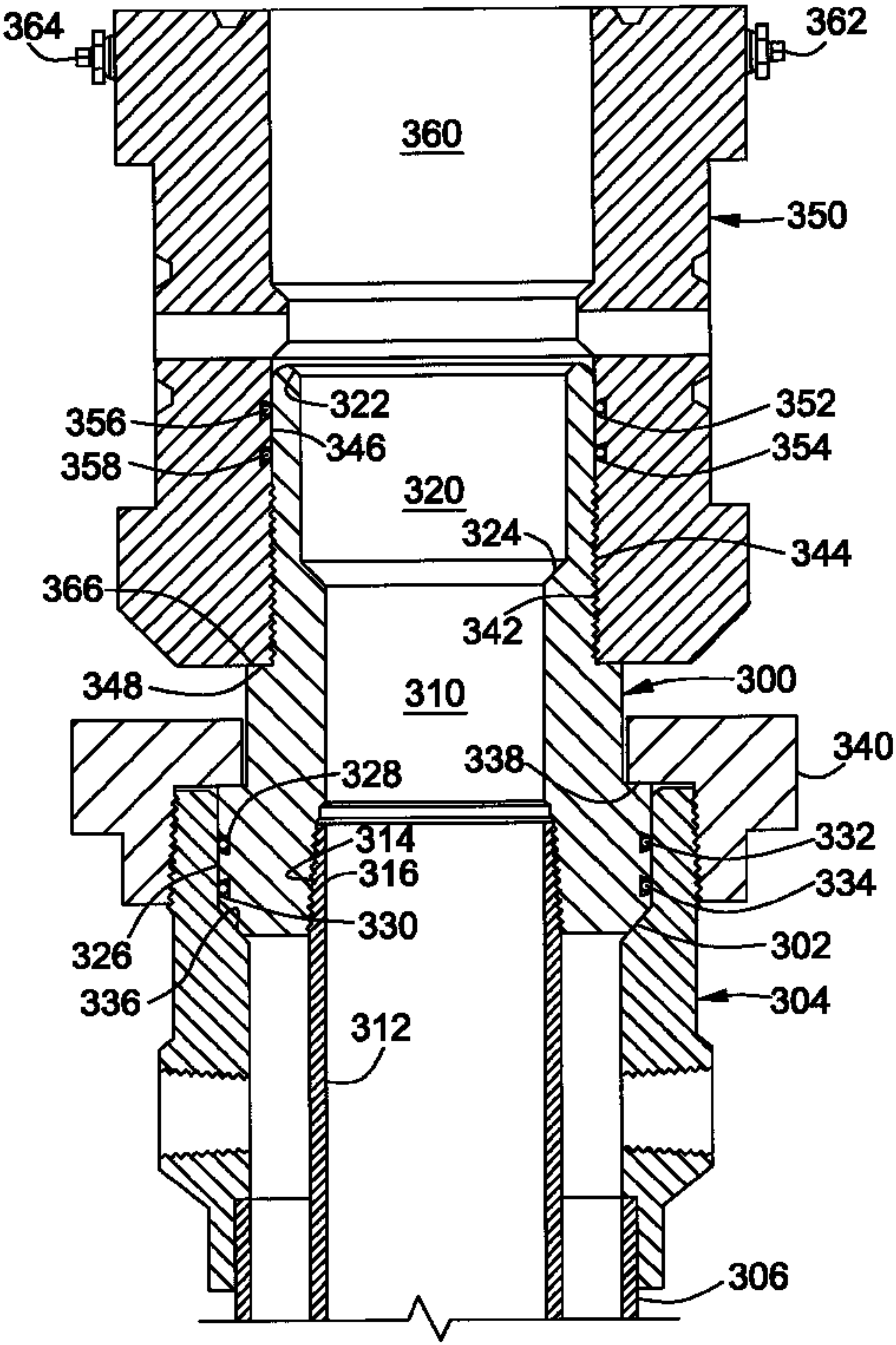
FIG. 5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