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(54) **Downhole seal circulating devices.**

(57) A cup-type seal circulating device (10) or a compression type packer seal circulating device for use in running a string of casing into a well bore, has a connector member (12) for connection to the drilling rig equipment to allow fluid to be pumped into the device ; a seal body member (14) ; a seal assembly (16) and a check valve (18). The circulating device is received in casing (22) and the seal assembly seals between the seal body member and the casing (22).

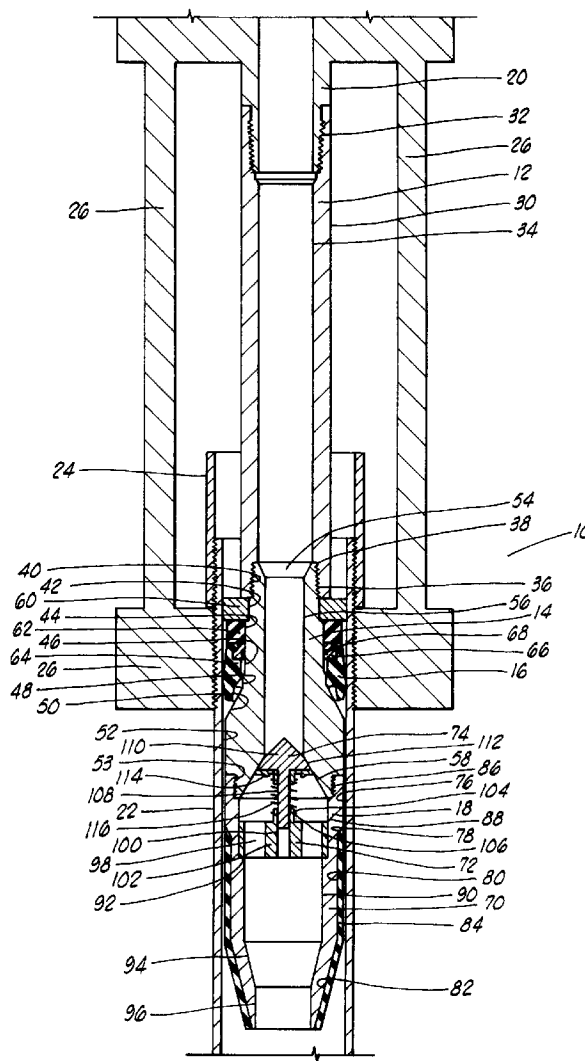


FIG. 1

EP 0 543 642 A2

This invention relates to downhole seal circulating devices useful for filling and circulating well fluids through well casing as it is being run into a well bore prior to the cementing of the casing therein.

After oil and gas wells are drilled, to complete the well for purposes of the production of fluids from various formations of the earth intersected by the well bore, casing is run into the well bore and subsequently cemented therein to isolate various portions of the well bore for purposes of production. The casing in the well bore will vary in size and weight depending upon the size and depth of various portions of the well bore.

Typically, the string of casing is made up and run into the well bore using the drilling rig which drilled the well. While conventional type drilling rigs utilize a rotary table on the drilling rig floor to hold the casing string and rotate the string during running, it is becoming common to use drilling rigs which have a drive mechanism for drilling operations which is integral with the travelling block of the drilling rig. Such top drive drilling rigs also have a conventional rotary table drive on the rig floor so that they can use either type of drive to rotate the casing or drill pipe string as required.

Since a well bore is not drilled along a straight line into the earth and since differing types of formations of the earth are intersected by the well bore, it is not uncommon for casing being run into the well bore to become intermittently stuck therein at some point. Typically, drilling fluid (mud) is circulated through the casing and well bore in an attempt to wash the casing free to continue running the casing string into the well bore.

Also, during casing running operations the casing string must be kept filled with drilling fluid to prevent fluid pressure differentials across the casing string from collapsing the casing and to help ensure that the well is under control in the event of a blow-out or to help prevent a blow-out. Typically, during casing running operations the casing is filled manually with drilling fluid from the drilling rig floor.

While various devices can be installed on the lower end of a string of casing being run into a well bore to automatically fill the casing with fluid from the well bore as the casing is being run therein, such devices may not reliably operate or operate as intended.

If it becomes necessary to circulate drilling fluid during casing running operations to unstick the casing string in the well bore or wash over a portion of the well bore while running the casing string, various techniques can be used to seal the upper end of the casing string. Some typical prior art patents which illustrate some methods and apparatus for use in this area are U.S. Patent Numbers 4076083, 4522430, 4524998, 4718495, 4817724, 4913231 and 4997042.

Each of the prior art methods and devices described previously has various disadvantages. Many of

the devices would have to be installed on the top end of the casing string which may be some distance above the drilling rig floor. Also, many of the devices are not designed for the filling of casing with drilling fluids or the circulating of drilling fluids during the running of a string of casing into a well bore.

One such prior art device is designed for such purposes, and this is shown in U.S. patent specification no 4997042. However, this circulating device requires the removal of a securing bolt prior to the inflation of the packer element to seal the top of the casing thereby allowing circulation of drilling fluids through the casing string or to fill the casing string.

We have now devised certain improved seal circulating devices for filling and circulating well fluids through well casing as it is being run into the well bore prior to the cementing of the casing therein. The circulating devices of the present invention comprise either a cup type seal having a guide nose assembly thereon or a compression type packer seal having a guide nose assembly thereon.

According to the present invention, there is provided a cup type seal circulating device adapted to be connected to a portion of the equipment of a drilling rig to allow fluid to be pumped from said portion through a piece of casing connected to a casing string being run into a well bore filled with said fluid, said cup-type seal circulating device comprising a connector member having one end thereof for connection to said portion of the equipment of a drilling rig to allow fluid to be pumped from said portion thereto; a seal body member connected to the connector member; a cup-type seal assembly connected to the seal body member, the cup-type seal assembly having a portion thereof adapted to sealingly engage a portion of the interior of said piece of casing when inserted therein to and having another portion thereof adapted to sealingly engage a portion of the seal body member, the cup-type seal assembly being insertable into said piece of casing when said cup-type seal circulating device has a portion thereof inserted into said piece of casing, and being removed from said piece of casing when said cup-type seal circulating device has a portion thereof removed from said piece of casing; and a check valve assembly connected to the seal body member to allow the flow of said fluid through said cup-type seal circulating device into said piece of casing but to prevent the flow of said fluid back through said cup-type seal circulating device when said cup-type seal circulating device is inserted into said piece of casing having a portion of the cup-type seal assembly thereof sealingly engaging a portion of the interior of said piece of casing and having another portion thereof sealingly engaging a portion of the seal body of said cup-type seal circulating device.

The invention also provides a compression type packer seal circulating device adapted to be connected to a portion of the equipment of a drilling rig to al-

low fluid to be pumped from said portion through a piece of casing connected to a casing string being run into a well bore filled with said fluid, said compression type packer seal circulating device comprising a connector member having one end thereof connected to said portion of the equipment of a drilling rig to allow fluid to be pumped from said portion thereinto; a seal body assembly having a portion thereof connected to the connector member, the seal body assembly comprising a seal body mandrel and a seal body connector; a compression type seal assembly connected to the seal body assembly, the compression type seal assembly having a portion thereof adapted to sealingly engage the interior of said piece of casing upon being compressed into engagement therewith after being inserted thereinto, the compression type seal assembly comprising a seal mandrel having an annular piston on the exterior thereof; a lower seal support retained on the seal mandrel; an elastomeric annular seal member retained on the seal mandrel; and an upper seal support being connected to the connector member; wherein the elastomeric annular seal member retained on the seal mandrel is caused to be compressed radially outwardly into engagement with the interior of said piece of casing by being compressed between and by relative movement between the lower seal support retained on the seal mandrel and upper seal support being connected to the connector member and a check valve assembly connected to a portion of the seal body assembly to prevent the flow of said fluid when pumped through said compression type packer seal circulating device into said piece of casing to prevent the flow of said fluid back through said compression type packer seal circulating device.

In order that the invention may be more fully understood, two embodiments will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 is a cross-sectional view of an embodiment of cup type seal circulating device of the present invention; and

FIG. 2 is a cross-sectional view of an embodiment of compression type seal circulating device of the present invention.

Referring to drawing Fig. 1, a first embodiment of the present invention is shown. As shown, a cup type circulating apparatus 10 comprises a connector 12, seal body 14, seal assembly 16 and check valve assembly 18. The cup type circulating apparatus 10 is shown connected to a fluid coupling 20 and inserted in a portion of casing 22 having a coupling 24 thereon which, in turn, is being supported by a pair of elevators 26.

The connector 12 comprises an elongated annular cylindrical member having, on the exterior thereof, cylindrical surface 30 and, on the interior thereof, first threaded bore 32 which releasably, threadedly engages fluid coupling 20, bore 34 therethrough and

second threaded bore 36. If desired, the connector 12 may include annular elastomeric seal member 38 at the upper section of second threaded bore 36.

The seal body 14 comprises an elongated annular cylindrical member having, on the exterior thereof, first threaded surface 40 which releasably, threadedly engages second threaded bore 36 of connector 12, first cylindrical surface 42, second cylindrical surface 44, third cylindrical surface 46, fourth cylindrical surface 48, frusto-conical annular surface 50, fifth cylindrical surface 52 and second threaded surface 53 and, on the interior thereof, first frusto-conical bore 54, bore 56 and second frusto-conical bore 58.

The seal assembly 16 comprises annular cylindrical backup member 60 retained on first cylindrical surface 42 of seal body 14, annular cylindrical elastomeric member 62 retained on second cylindrical surface 44 of seal body 14 and annular cylindrical elastomeric cup type seal member 64 having, in turn, back-up ring 66 sealingly engaging second cylindrical surface 44 of seal body 14 by means of annular elastomeric seal 68 located on the inner bore therethrough while a portion of the exterior of cup type seal member 64 sealingly engages a portion of casing 22.

The check valve assembly 18 comprises guide nose member 70, poppet guide support 72 and valve poppet 74.

The guide nose member 70 comprises an elongated annular cylindrical member having, on the exterior thereof, first cylindrical surface 76, first frusto-conical surface 78, second cylindrical surface 80, second frusto-conical 82 and elastomeric covering 84 covering surfaces 78, 80, and 82 respectively and, on the interior thereof, threaded bore 86 which releasably, threadedly engages second threaded surface 54 of seal body 14, first bore 88, second bore 90 creating annular shoulder 92 between first bore 88 and second bore 90, frusto-conical bore 94 and third bore 96.

The poppet guide support 72 comprises an annular cylindrical member having a plurality of axial flow ports 98 therethrough, a central bore 100 in the guide support 102 which is held in position by means of one or more struts (not shown), the guide support 102 having, in turn, a reduced diameter portion 104 on the upper end thereof and shoulder 106.

The valve poppet 74 comprises a valve stem 108, valve poppet 110, elastomeric covering 112 on the valve poppet 110, annular elastomeric seal and back-up ring 114, and spring 116 located on valve stem 108 having one end located on the reduced diameter portion 104 of guide support 102 while the other end biases valve poppet 110 into engagement with second frusto-conical bore 58 of seal body 14.

When the check valve assembly 18 is installed on the seal body 14, the poppet guide support 72 is installed in first bore 88 of guide nose member 70 having a portion abutting shoulder 92 thereof. If desired,

the poppet guide support 72 and valve poppet 74 may be deleted from the check valve assembly 18 and only the guide nose member 70 used.

Referring to Fig. 2, a compression type packer seal circulating device 210 of the present invention is shown.

The compression type packer seal circulating device 210 comprises a connector 212, seal body assembly 214, seal assembly 216 and check valve assembly 218.

The connector 212 comprises an elongated annular cylindrical member having, on the exterior thereof, first cylindrical surface 230, frusto-conical annular surface 232, second cylindrical surface 234 and threaded surface 236 and, on the interior thereof, first threaded bore 238, first bore 240, second threaded bore 242 and second bore 244 having, in turn, annular recess 246 containing elastomeric annular seal 248 therein. The connector 212 also has port 249 therein.

The seal body assembly 214 comprises seal body mandrel 250 and seal body connector 252.

The seal body mandrel 250 comprises an elongated annular member having on the exterior thereof, first threaded surface 254 which releasably threadedly engages second threaded bore 242 of connector 212, cylindrical surface 256 having, in turn, annular recess 258 containing annular elastomeric seal 260 therein and second threaded surface 262 and, on the interior thereon, bore 264.

The seal body connector 252 comprises an annular cylindrical member having, on the exterior thereof, cylindrical surface 266 and threaded surface 268 and, on the interior thereof, threaded bore 270 which threadedly releasably engages second thread surface 262 of seal body mandrel 250, first frusto-conical bore 272, bore 274 and second frusto-conical bore 276.

The seal assembly 216 comprises seal mandrel 278, lower seal support 280, seal spacer 282, upper seal support 284, and elastomeric annular seal members 286.

The seal mandrel 278 comprises an elongated annular cylindrical member having, on the exterior thereof, cylindrical surface 288 having, in turn, annular piston 290 having annular recess 292 therein containing annular elastomeric seal 294 therein and threaded surface 296 and, on the interior thereof, bore 298. The seal mandrel 278 further includes a plurality of apertures 299 therethrough below the annular piston 290.

The lower seal support 280 comprises an annular cylindrical member having threaded bore 300 therethrough which releasably threadedly engages threaded surface 296 of seal mandrel 278.

The seal spacer 282 comprises an annular cylindrical member having bore 302 therethrough.

Upper seal support 284 comprises an elongated

annular cylindrical member having, on the exterior thereof, cylindrical surface 304 and, on the interior thereof, threaded bore 306 which releasably threadedly engages threaded surface 234 of connector 212, first bore 308 in which annular elastomeric seal 294 on piston 290 of seal mandrel 278 sealingly engages and second bore 310.

Each elastomeric annular seal member 286 comprises an annular elastomeric member having a bore 312 therethrough.

The check valve assembly 218 comprises guide nose member 320, poppet guide support 322 and valve poppet 324. The check valve assembly 218 is constructed and operated in the same manner as check valve assembly 18 previously described herein.

Operation Of The Invention

Referring to Fig. 1, the cup-type circulating device 10 of the present invention is shown.

In use, the cup-type circulating device 10 is connected to the top drive fluid coupling 20 of similar connection on a conventional drilling rig. As the elevators 26 are lowered to engage the casing 22 and casing connector 24 to be run into the well bore the cup-type circulating device 10 is inserted into the casing 22 with the cup-type seal member 64 of the seal assembly 16 sealingly engages the interior of the casing 22. If it is desired to pump fluids into the casing 22, fluid is pumped through connector 12, seal body 14 and check valve assembly 18 into the casing 22. Upon the cessation of the pumping of fluid through the cup-type seal circulation device 10, the check valve assembly 18 prevents the flow of fluid back through the seal body 14 and connector 12 as well as the flow of fluid from the top drive unit of the drilling rig. As the cup-type seal 64 sealingly engages the interior of casing 22, fluid is prevented from flowing upwardly past the seal 64 out the upper end of the casing 22 and casing connector 24.

To remove the cup-type seal circulating device 10 from the casing 22 and casing connector 24, the elevators 26 are disengaged from the casing 22 and casing connector 24 thereby allowing upward movement thereof with the subsequent upward movement of cup-type circulating device 10 being removed from the casing 22 and casing connector 24.

Referring to Fig. 2, the compression type packer seal circulating device 210 of the present invention is shown.

The insertion of the compression type packer seal circulating device 210 into the casing 22 and casing coupling 24 is the same as previously described.

Once inserted into the casing 22, the seal assembly 216 is actuated by connecting a fluid line to 249 in connector 212 and fluid pumped into the annular cavity between the connector 212 and seal body

mandrel 250, through apertures 299, and into the annular cavity between the seal mandrel 278 and upper seal support 284 causing annular piston 290 to move upwardly in upper seal support 284 thereby compressing elastomeric annular seal members 286 into sealing engagement with the casing 22. As the elastomeric annular seal members 286 sealingly engage the interior of casing 22, fluid is prevented from flowing upwardly past the seal members 286 out the upper end of the casing 22 and connector 24.

Since connector 212 is connected to top drive 20 or a suitable fluid conduit, if it is desired to pump fluids into casing 22, fluid is pumped through connector 212, seal body assembly 214 and check valve assembly 218 into the casing 22. Upon the cessation of the pumping of fluid through the packer type seal circulating device 210, the check valve assembly 218 prevents the flow of fluid back through the seal body assembly 214 and connector 212 as well as prevents the flow of fluid from the top drive unit of the drilling rig.

To remove the compression type packer seal circulating device 210 from the casing 22, fluid pressure being maintained through port 249 of connector 212 is released thereby causing the seal members 286 which have been compressed into engagement with the interior of casing 22 to relax and push downwardly upon lower end seal support 284 thereby moving seal mandrel 278 downwardly. The elevators 26 are disengaged from the casing 22 and casing connector 24 thereby allowing upward movement thereof with the subsequent upward movement of packer type seal circulating device 210.

It will be clear to those skilled in the art that various changes and modifications can be made to the embodiments of the invention. For instance, any number of sealing elements may be used on the circulating devices, the check valve assemblies may be deleted if desired, or different types of check valve assemblies may be used.

Claims

1. A cup type seal circulating device (10) adapted to be connected to a portion of the equipment of a drilling rig to allow fluid to be pumped from said portion through a piece of casing (22) connected to a casing string being run into a well bore filled with said fluid, said cup-type seal circulating device comprising a connector member (12) having one end thereof for connection to said portion of the equipment of a drilling rig to allow fluid to be pumped from said portion therein; a seal body member (14) connected to the connector member; a cup-type seal assembly (16) connected to the seal body member (14), the cup-type seal assembly having a portion (64) thereof adapted to sealingly engage a portion of the interior of said piece of casing (22) when inserted therein and having another portion (66) thereof adapted to sealingly engage a portion of the seal body member (14), the cup-type seal assembly being insertable into said piece of casing when said cup-type seal circulating device (10) has a portion thereof inserted into said piece of casing, and being removed from said piece of casing when said cup-type seal circulating device (10) has a portion thereof removed from said piece of casing; and a check valve assembly (18) connected to the seal body member (14) to allow the flow of said fluid through said cup-type seal circulating device (10) into said piece of casing (22) but to prevent the flow of said fluid back through said cup-type seal circulating device when said cup-type seal circulating device is inserted into said piece of casing (22) having a portion (64) of the cup-type seal assembly thereof sealingly engaging a portion of the interior of said piece of casing and having another portion (62) thereof sealingly engaging a portion of the seal body of said cup-type seal circulating device.
2. A device according to claim 1, wherein the connector member (12) comprises an elongated annular cylindrical member.
3. A device according to claim 1 or 2, wherein the seal body member (14) comprises an elongated annular cylindrical member.
4. A device according to claim 1,2 or 3, wherein the cup-type seal assembly (16) comprises an annular cylindrical back-up member (60) retained on a portion (42) of the exterior of the seal body (14); an annular cylindrical elastomeric member (62) retained on a portion (44) of the exterior of the seal body (14); an annular cylindrical elastomeric cup-type seal member (64) retained upon a portion of the exterior of the seal body, the annular cylindrical elastomeric cup-type seal member (64) having a back-up ring (66) in a portion thereof.
5. A device according to claim 1,2,3 or 4, wherein the check valve assembly (18) comprises a guide, nose member (70), a poppet guide support (72); and a valve poppet (74).
6. A compression type packer seal circulating device (210) adapted to be connected to a portion of the equipment of a drilling rig to allow fluid to be pumped from said portion through a piece of casing (22) connected to a casing string being run into a well bore filled with said fluid, said compression type packer seal circulating device com-

prising a connector member (212) having one end thereof connected to said portion of the equipment of a drilling rig to allow fluid to be pumped from said portion thereof; a seal body assembly (214) having a portion thereof connected to the connector member, the seal body assembly comprising a seal body mandrel (250) and a seal body connector (252); a compression type seal assembly (216) connected to the seal body assembly (214), the compression type seal assembly having a portion thereof adapted to sealingly engage the interior of said piece of casing upon being compressed into engagement therewith after being inserted therein, the compression type seal assembly comprising a seal mandrel (216) having an annular piston (290) on the exterior thereof; a lower seal support (280) retained on the seal mandrel; an elastomeric annular seal member (286) retained on the seal mandrel; and an upper seal support (284) being connected to the connector member (212); wherein the elastomeric annular seal member (286) retained on the seal mandrel (216) is caused to be compressed radially outwardly into engagement with the interior of said piece of casing by being compressed between and by relative movement between the lower seal support (280) retained on the seal mandrel and upper seal support (284) being connected to the connector member and a check valve assembly (218) connected to a portion of the seal body assembly to prevent the flow of said fluid when pumped through said compression type packer seal circulating device into said piece of casing to prevent the flow of said fluid back through said compression type packer seal circulating device.

7. A device according to claim 6, wherein the connector member (212) comprises an elongated annular cylindrical member.
8. A device according to claim 6 or 7, wherein the seal body mandrel (250) comprises an elongated annular cylindrical member.
9. A device according to claim 6,7 or 8, wherein the seal body connector (252) comprises an annular cylindrical member.
10. A device according to claim 6,7,8 or 9, wherein the check valve assembly (218) comprises a guide nose member (320), a poppet guide support (322) and a valve poppet (324).

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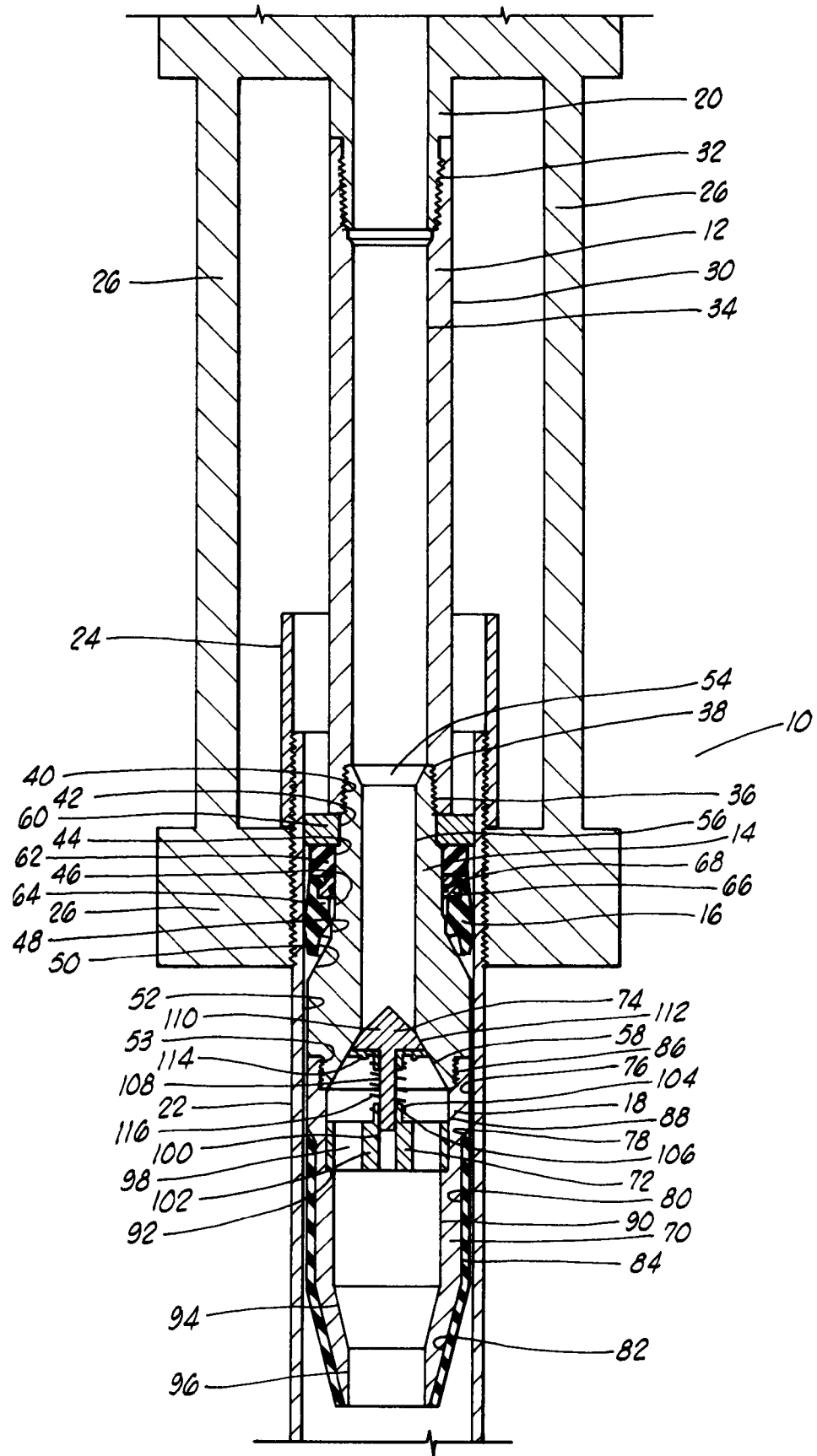


FIG. 1

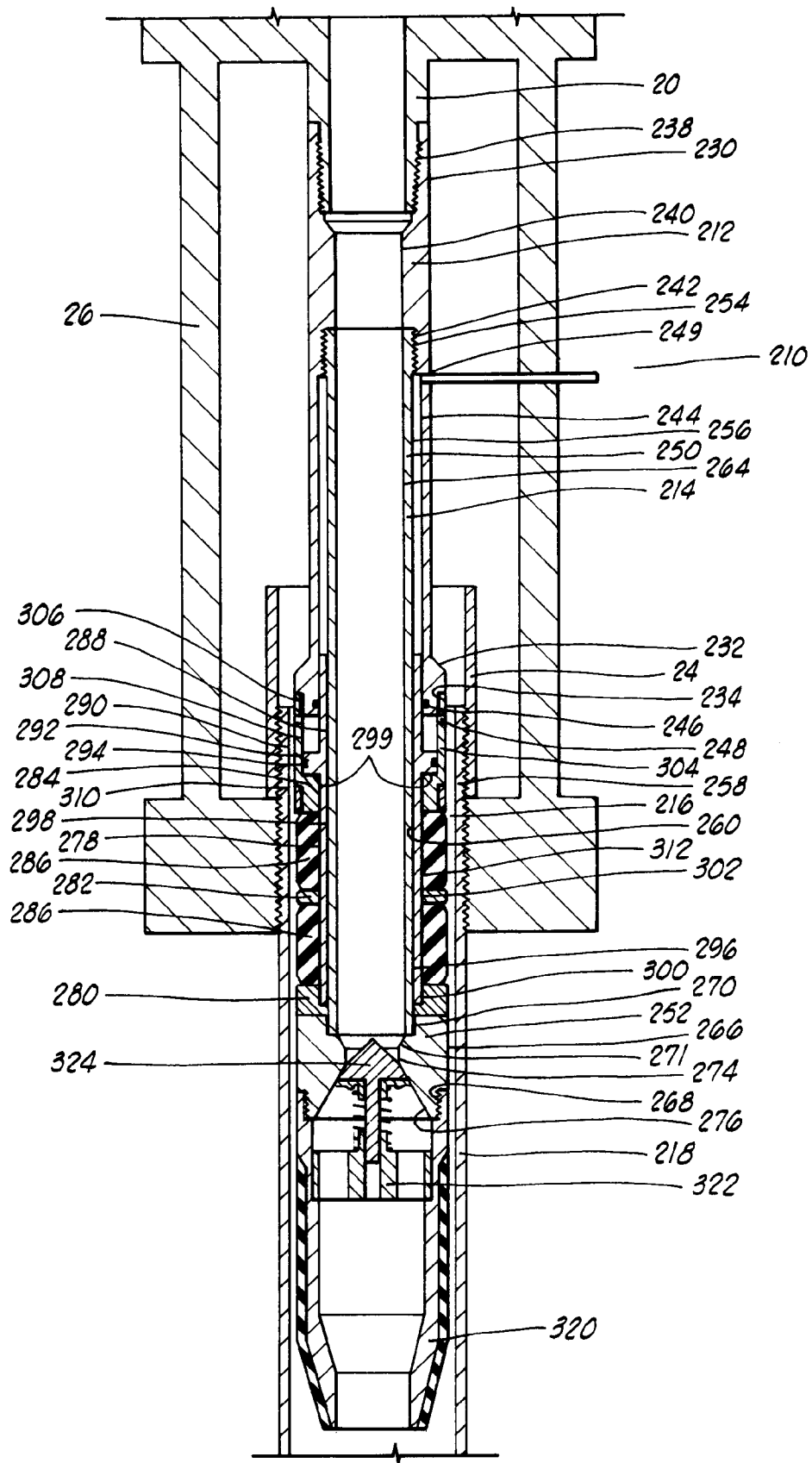


FIG. 2