

Oct. 6, 1964

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3,151,680

WELL PRESSURE CONTROL APPARATUS

Filed Nov. 15, 1961

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FIG. 1.

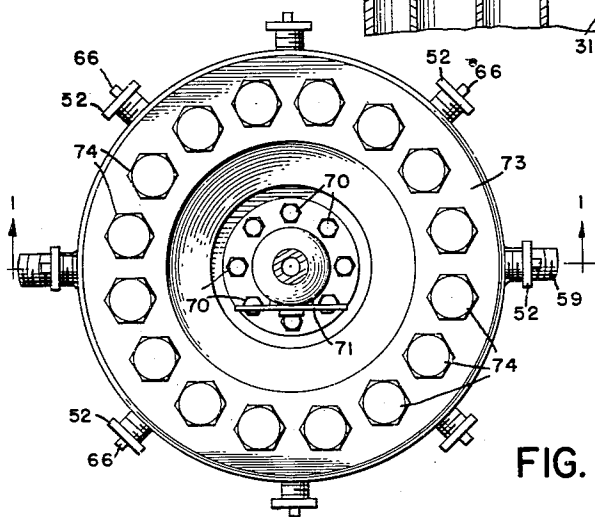
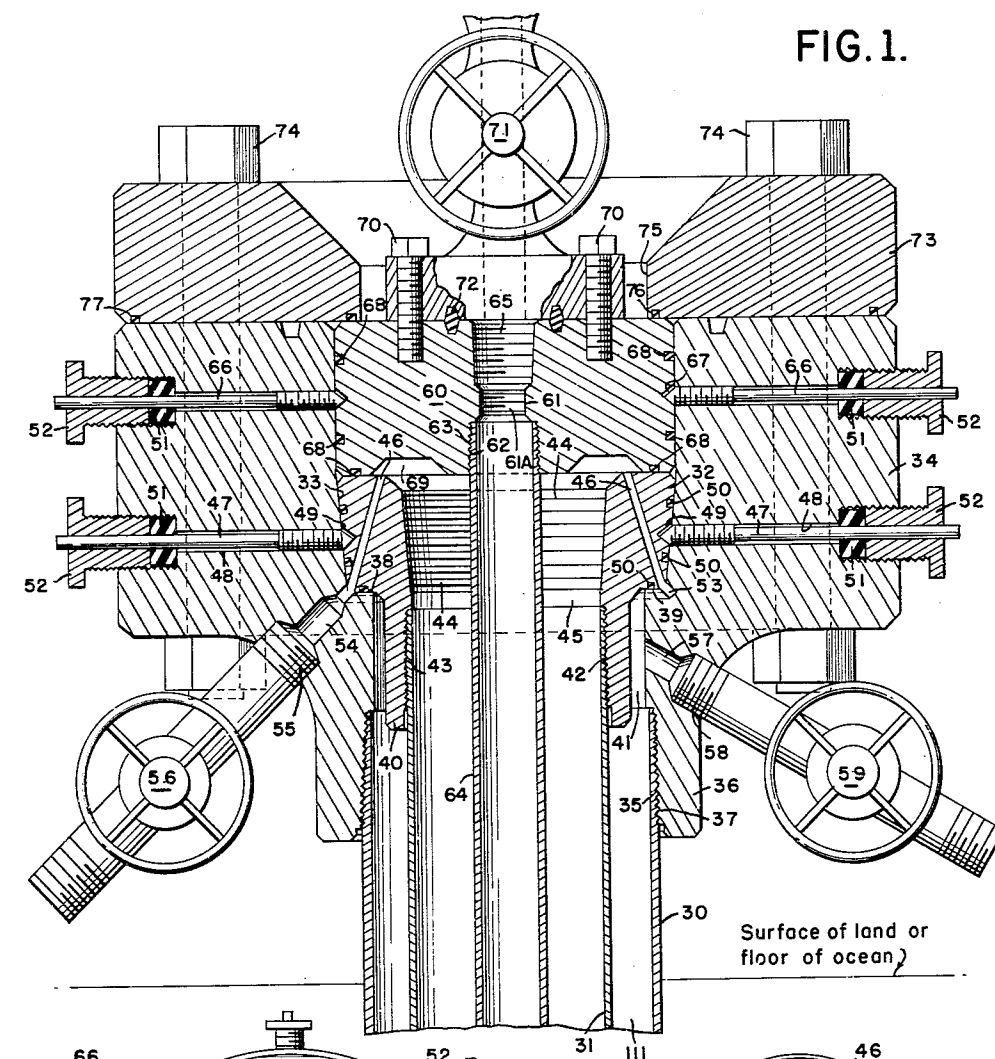
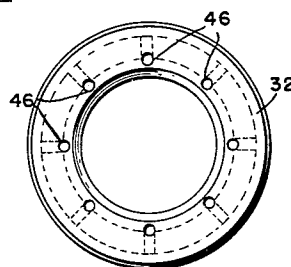


FIG. 6.



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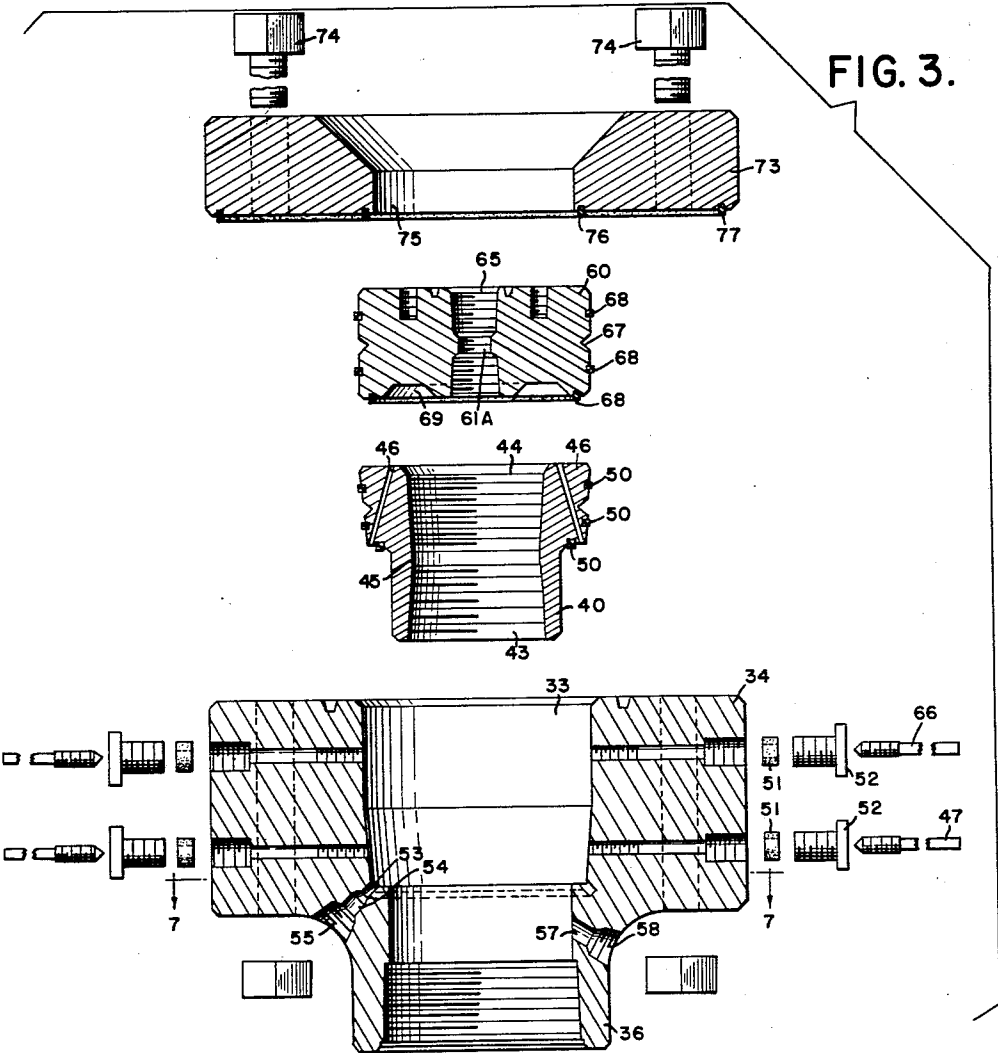


FIG. 3.

FIG. 5.

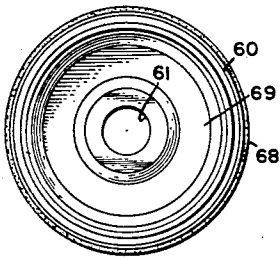
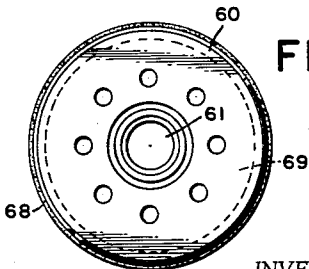


FIG. 4.



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FIG. 8.

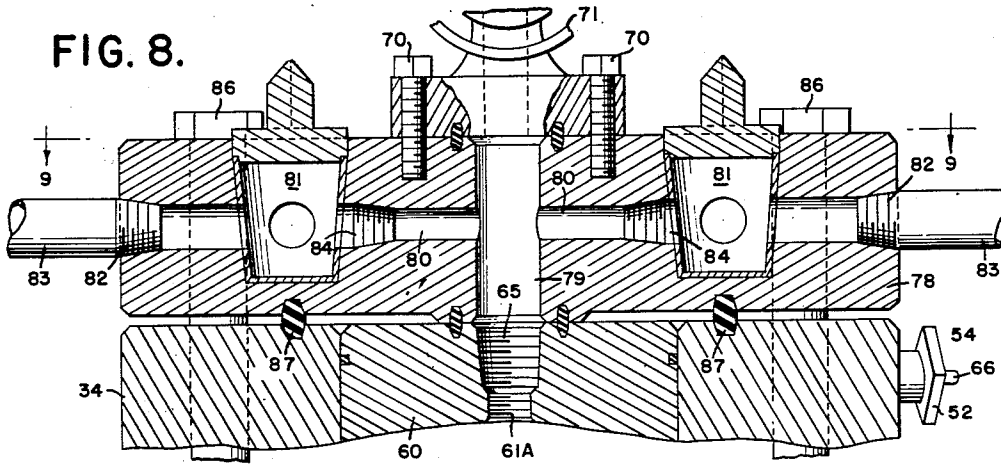


FIG. 9.

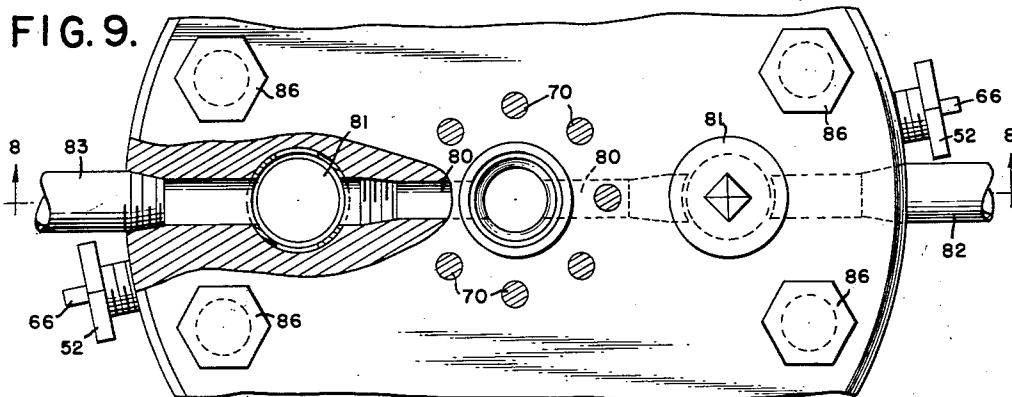


FIG. 7.

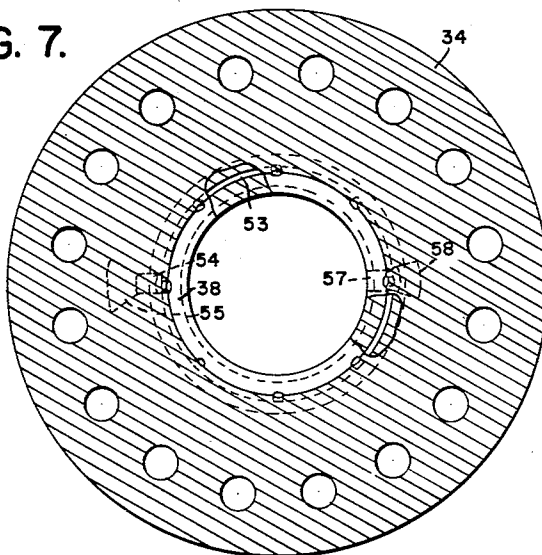
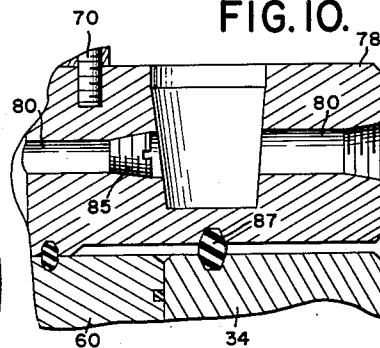


FIG. 10.



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WELL PRESSURE CONTROL APPARATUS

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4 Claims. (Cl. 166—89)

This invention relates to oil and gas wells and it is more particularly concerned with improvements in control apparatus and the installation thereof.

An object of the invention is the provision of such apparatus which can be installed under conditions that are ordinarily difficult, impractical or impossible, due to adverse natural causes, such as in deep water or other technical difficulties.

Another object of the invention is to reduce to a minimum the steps and time required in carrying out installations.

A still further object of the invention is the provision of improvements in well apparatus which result in substantial reductions of space required for a complete well control system.

These and still further objects, advantages and features of the invention will appear more fully from the following description in conjunction with the accompanying drawing showing embodiments of the invention by way of illustration and not by way of limitation.

In the drawing:

FIG. 1 is a vertical sectional view of an assembled well control system in accordance with an embodiment of the invention generally along the line 1—1 of FIG. 2.

FIG. 2 is a top plan view of the embodiment.

FIG. 3 is an exploded sectional view of the principal parts of the embodiment.

FIG. 4 is a top plan view of the upper hanger.

FIG. 5 is a bottom plan view of the upper hanger.

FIG. 6 is a top plan view of the bottom hanger.

FIG. 7 is a sectional view along the line 7—7 of FIG. 3.

FIG. 8 is a sectional view along the line 8—8 of FIG. 9 of a modified form of hold down ring, a fragmentary portion of the upper hanger being shown therewith.

FIG. 9 is a fragmentary plan sectional view along the line 9—9 of FIG. 8.

FIG. 10 is a fragmentary part of the upper right hand portion of FIG. 8 modified to illustrate insertion of the duct plug through the valve to blocking flow of fluid to the duct and allow the valve to be changed while the duct is under pressure.

Referring with more particularity to the drawing in which like numerals designate like parts the invention is illustrated in connection with a conventional outer or surface casing tubing 30 set in the ground in the conventional manner and inner casing tubing 31 within the outer casing tubing 30. The inner casing tubing string is supported by means of a tubular hanger 32 disposed in the lower part of a hollow center section or bowl 33 of a casing head or body 34 mounted on the upper end of the outer casing tubing 30. Inner threads 35 of a dependent flange 36 at the bottom of the body 34 engage external threads 37 of the casing 30.

Above the threads 35 the hollow portion of the body 34 is somewhat restricted to provide an annular upwardly facing shoulder 38 to engage a correspondingly downwardly facing annular shoulder 39 of the hanger 32. The outer surface of the hanger 32 above the shoulder 39 is enlarged and downwardly tapered to register with the adjacent correspondingly shaped surface of the bowl 33.

An annulus 40 of the hanger 32 projects downwardly within the dependent flange 36 and is recessed to provide an annular space 41 between it and the flange. The annulus 40 has interior threads 42 which engage exterior threads 43 of the casing tubing 31. The upper portion of the hanger 32 above the threads 42 is also provided with threads 44 separated from the threads 43 by a median section 45. These upper threads are for the purpose of temporarily engaging the lower end of a pipe (not shown) to facilitate setting the hanger in place after which lock screws 47 are engaged and the pipe is removed.

The wall of the hanger 32 is provided with a series of circumferentially spaced ducts 46 each extending diagonally downward from a point adjacent the inner rim of the wall to the outer edge at the bottom, substantially as shown. Other functionally equivalent positions, however, may be used for the ducts.

The hanger 32 is held in seated position by means of a group of circumferentially spaced lock screws 47 that pass through lateral apertures 48 in the body 34. These lock screws have a conical point at their inner ends and are adapted to engage an annular V-shaped groove 49 on the periphery of the hanger 32 whereby the hanger is wedged into position against high pressure gaskets 50 set in grooves of the hanger to effect a high pressure fluid seal. The lock screws are sealed from fluid leakage after they are set in position by means of conventional glands at the ends of the stems thereof comprising gland packing 51 and gland nuts 52.

An annular groove 53 is provided in the body 34 adjacent the lower ends of the ducts 46 as a discharge manifold. One or more discharge apertures, such as the aperture 54 is provided through the wall of the body 34 in communication with the groove 53. The outer portion 55 of the aperture 54 is enlarged and provided with threads to engage a discharge control valve 56.

Another opening 57 is provided in the body 34 in communication with the annular space 41, an outer portion 58 being enlarged and threaded to receive a valve 59 for the control of material flowing between the casings 30 and 31.

A second hanger 60 is disposed in the upper part of the bowl 33 of the body 34 directly on top of the hanger 32. It is provided with an axial bore 61, the lower end of which contains threads 62 to engage the threads 63 at the upper end of the well tubing 64. The upper end of the bore 61 is provided with a separate threaded section 65 to engage temporarily a threaded stem or pipe (not shown) during manipulation thereof to set the hanger in place after which the stem or pipe is removed. A third set of threads 61A is provided for the installation of a duct plug or similar device to control pressure in the tubing prior to installation of the valve 71. This plug may be removed through the duct of the valve 71. The hanger 60 is held in place by lock screws 66 engaging a circumferential V-groove 67 similar to the lock screws 47. High pressure sealing gaskets 68 are provided in grooves of the hanger 60 adjacent the body substantially as shown.

The bottom of the hanger 60 is provided with an annular recess 69 in communication with the upper ends of the ducts 46 and forming an upper manifold therefor. The recess 69 extends inwardly over the space between the inner casing tubing 31 and the well tubing 64.

Secured directly to the top of the hanger 60 by stud bolts 70 is a conventional outlet control valve 71 for the well in communication with the axial bore 61. A

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conventional sealing ring 72 between the valve and hanger 60 is provided.

A hold down ring 73 encircles the valve 71 and is rigidly secured to the body 34 by means of a group of circumferentially spaced stud bolts 74. The inner edge 75 of this ring overlaps a marginal edge of the hanger 60 and it is there provided with an annular groove for retaining a sealing ring 76. Another annular groove for a sealing ring 77 is located adjacent the outer edge of the ring over the body 34.

The hold down ring 73 is installed after the conventional auxiliary control equipment (not shown) is removed and it serves to retain the hangers 32 and 60 in place against the force of any thrust tending to displace them upwardly relative to the body 34. The seals protect contact surfaces against atmospheric corrosion.

A modified hold down element is illustrated in FIGS. 8 to 10. It comprises a flat cylindrical holding block 78 provided with an axial vertical bore 79 and radial inner ducts or passages 80 extending outwardly from the bore 79 to valves 81 set in the block. From the valves 81 the ducts extend to the periphery of the block and are provided at this point with threads 82 for attaching outlet pipes 83 that may lead to, for example, an oil storage or other facility (not shown).

The ducts 80 are each provided with a threaded section 84 between the bore 79 and its corresponding valve 81 for the reception of a plug 85 (see FIG. 10) for the purpose of blocking one of the ducts for emergency purposes such as where it may be necessary to effect repairs, adjustment, installation changes, etc., without interrupting the flow from the well through the other ducts.

The block 78 is secured in position to the body 34 by means of bolts 86 and sealing rings 87 are provided therebetween in mating grooves as shown.

The actual construction of the well and casing placement prior to the setting of the hangers requires that the casing and tubing strings be passed downwardly through the body 34.

After the inner casing 31 has been installed the hanger 32 is connected to the upper end thereof and lowered into position in the bowl of the body 34. The process of cementing the inner casing string may then proceed. After this cementing process is completed the landing joint is then backed out of the hanger 32 and the well is then ready for completion.

At this point, in a normal completion, according to conventional practice in the art, the auxiliary equipment is removed and an additional tubing head spool (not shown) is landed and attached to the permanent control equipment then in place. This spool then becomes a permanent part of the well control equipment. Then a new set of auxiliary control equipment is installed. This is all being accomplished during a period called "waiting on cement" which means waiting for the cement which has been pumped into annular space 111 between the open hole and the inner casing 31 to develop sufficient strength to resist the stress which necessarily must be imparted to the inner casing in order to suspend this casing in a normal "slip type" casing hanger.

By virtue of the present invention this waiting time can be put to more profitable use since the inner casing 31 has already been permanently set and there is no need to remove the original auxiliary control equipment because all future elements of the completion will pass through the bore of the auxiliary control equipment. This waiting time can, therefore, be used to advantage by employing it to complete the well by picking up and making up the tubing "stands" and downhole equipment long with setting up the casing perforating equipment for the opening of the inner casing 31 opposite the producing formation. Normally, this would not take up the whole waiting on "cement" time. Accordingly, further benefits of the present invention can be derived by immediately backing out the landing joint from the inner

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casing hanger 32, running a wire line and weight into the hole to determine the depth of the plug and whether the bottom of the hole is at a proper depth. The tubing hanger 60 is then attached to the top of the corresponding tubing and if it is desired to save additional time the upper section can be installed at this time and the assembly lowered to its position in the body 34. At this point the tubing hanger will not yet have been locked in place but the perforating operation can be carried out after which the perforating equipment is removed and a check valve installed in the tubing hanger threaded opening 61A. The tubing and hanger 60 may then be lifted sufficiently to open a circulation joint downhole and the well "washed in." The tubing hanger 60 can then be lowered again into position and locked in place with the lock screws 66. The auxiliary control equipment is then removed and the holddown ring 73 installed or, if desired, the control valves 71 may be omitted and after removal of the auxiliary control equipment, a modified holddown ring, as shown in FIG. 8, may be installed.

Having thus described our invention, we claim:

1. In a well having outer casing, inner casing and well tubing, apparatus comprising a body member adapted to be attached to and supported on the upper end of the outer casing, said body member having a vertical opening axially therethrough, said opening having an upwardly facing shoulder between a relatively enlarged upper bowl portion and a restricted lower portion thereof, a first hanger for the inner casing disposed in the bottom of said bowl portion, said hanger having an integral annulus projecting from its bottom into the said lower portion for attaching the upper end of the inner casing thereto, said annulus being spaced from the body to form an annular opening therebetween in communication with the space between the inner and outer casing, said hanger having a vertical axial opening therethrough threaded at either end, a second hanger for the well tubing in the said bowl portion above said first hanger, said second hanger having a vertical opening therethrough threaded at either end; means removably securing said hangers to said body; high pressure fluid sealing means between said body and hangers; said first hanger having a plurality of ducts extending from the top thereof to said shoulder; said first hanger and said shoulder having a channel therebetween forming a bottom manifold for said ducts; said hangers having an annular channel therebetween at the upper ends of the ducts forming a top manifold for said ducts; said last mentioned channel being in communication with the axial opening in said first tubing hanger; said body having passageways therethrough extending to its exterior communicating with said top manifold and with said annular opening, respectively; and control valves connected to said passageways.

2. Apparatus as defined by claim 1 and a holding ring superposed on said body, said ring being rigidly secured to the body and having an inner edge overlying a marginal portion of the upper hanger, fluid seals between said ring and body and separate fluid seals between said inner edge and marginal portion.

3. Apparatus as defined by claim 1 and a holding block superposed on the body and hangers, said block having a vertical central opening axially therethrough in communication with the opening in the adjacent hanger, sealing means between said block and its adjacent hanger and separate sealing means between the block and the body, said block having lateral radial passages extending outwardly from said central opening, valves in said passageways, said passageways having threaded portions adjacent the valves and threaded plugs for removably engaging said threaded portions.

4. Well apparatus as defined by claim 1 in which the outer surface of the first hanger and the corresponding inner surface of the bowl portion taper downwardly.

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