

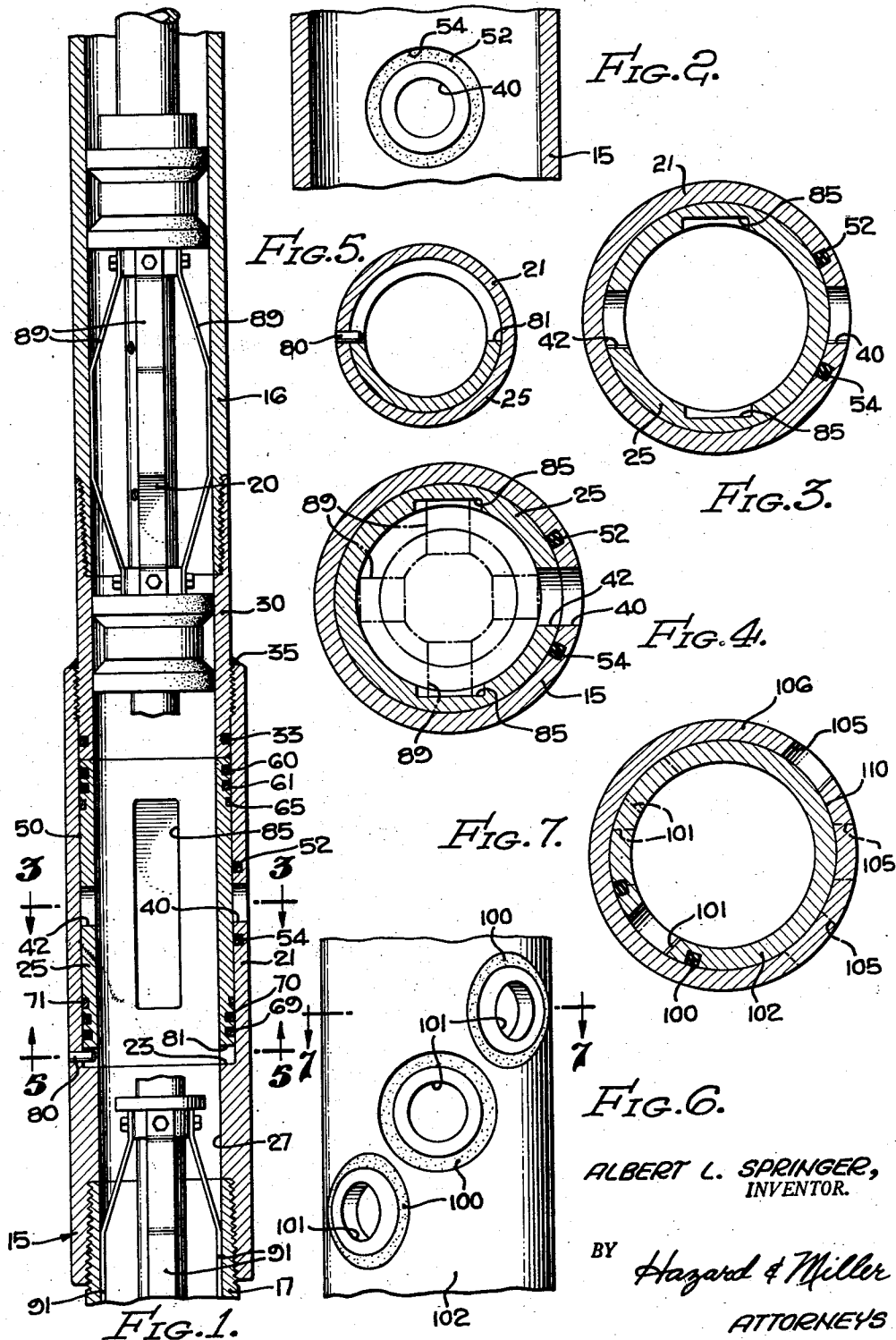
April 20, 1954

A. L. SPRINGER
WELL APPARATUS

2,675,874

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

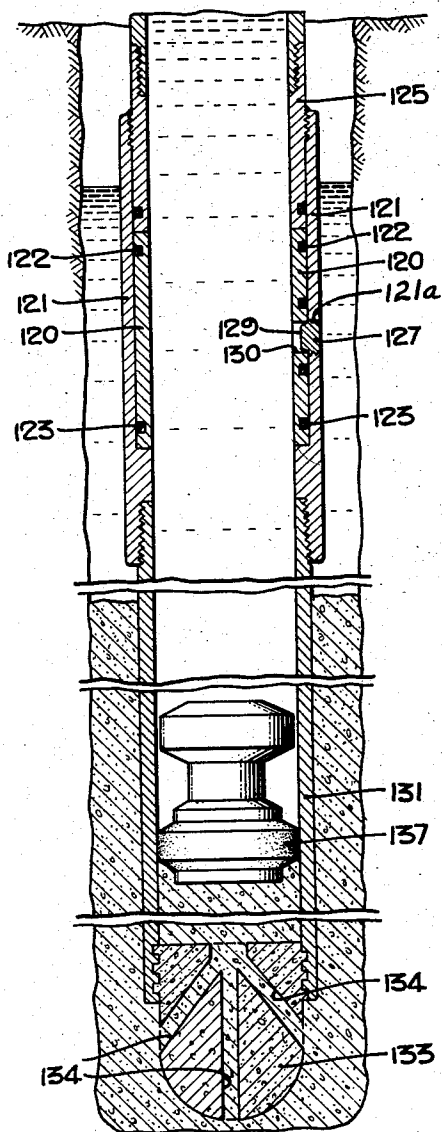


FIG. 8.

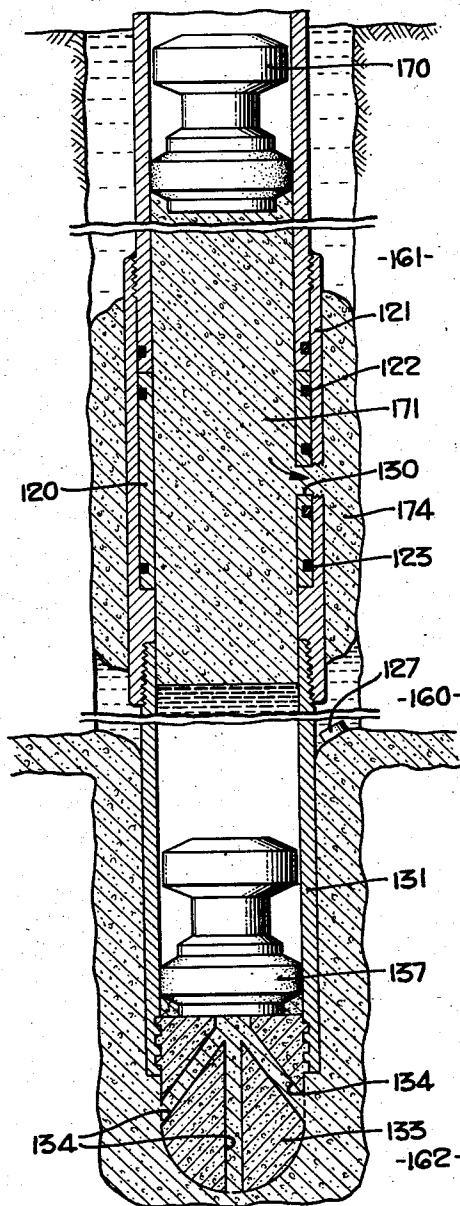


FIG. 9.

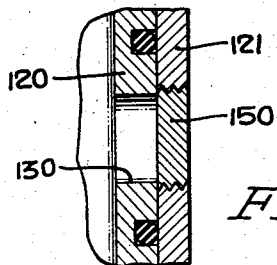


FIG. 10.

ALBERT L. SPRINGER,
INVENTOR.

BY *Hazard & Miller*
ATTORNEYS

UNITED STATES PATENT OFFICE

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WELL APPARATUS

Albert Lamont Springer, Long Beach, Calif.

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10 Claims. (Cl. 166—1)

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This invention relates to well apparatus, and in particular to an assembly adapted to be interposed in a string of casing, pipe, or the like, which assembly provides a port for communication between the inside of the casing, pipe, or the like and the outside thereof.

A main object of the present invention is to provide a port-providing assembly adapted to be interposed in a string of casing or the like which assembly is sealed in a manner to prevent fluids under pressure from entering into the casing from the outside or passing from inside the casing through the assembly to the outside of the casing. One type of such device or assembly takes the form in the present invention of a cylindrical valve sleeve for opening and closing a port provided in a collar which is interposed in a string of casing. The sleeve valve is rotated to open and close the port in the collar and it is extremely important that fluids under pressure be prevented from leaking or passing between the sleeve valve and the collar in which the sleeve valve is mounted for several reasons. Gas or other fluids under extremely high pressure can permanently damage such an apparatus if there is leakage through the device and in some instances gas under high pressure can actually cut through portions of the device damaging the device and not only making the device inoperable but making its removal from the well necessary. Furthermore, it is extremely desirable to prevent water or other fluids from passing outside the casing into the casing as this water not only contaminates the oil being pumped or removed, but also has to be removed from the well necessitating the additional expense of removing the pumping apparatus and furthermore, the water has to be thereafter separated from the oil which requires an additional expense. Therefore, it can be seen that it is extremely important in such a ported device to have perfect sealing between the movable valve member and the collar or supporting member in which the valve is mounted.

Another main object of the present invention is to provide a ported device in which there is provided a blowout plug initially closing the port in the casing or collar as the case may be, and which blowout plug will remain in place during normal and usual operations through the casing and which blowout plug can be blown out or removed by sufficient increase in pressure.

Another object of the present invention is to provide novel sealing arrangements for sealing a ported device.

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provide a ported device having a movable valve member so sealed that it may be moved at any time after it has set in the well without danger of rusting or the like.

5 With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

10 Figure 1 is a sectional view in plan showing a device embodying the present invention being interposed in a string of casing;

15 Fig. 2 is a view showing the inner cylindrical surface of the collar with the sealing annular O-ring around the port in the collar;

Fig. 3 is a sectional view along lines 3—3 of Fig. 1, showing the valve as closing the port in the collar or casing;

20 Fig. 4 is a sectional view similar to Fig. 3 with the valve being shown as moved to open the port in the collar or casing and the valve operating apparatus is shown in phantom lines;

25 Fig. 5 is a sectional view along lines 5—5 of Fig. 1, showing the means for limiting movement of the valve member;

Fig. 6 is a fragmentary view in elevation of a sleeve valve having a plurality of ports therein;

30 Fig. 7 is a sectional view along lines 7—7 of Fig. 6, showing the arrangement of the ports in the collar or casing and the ports in the valve member with the ports in the casing or collar being closed;

35 Fig. 8 is a sectional view in plan showing a ported device incorporating a blowout plug and showing one step in a method of using such a device;

Fig. 9 is a sectional view in elevation showing another use of the blowout plug apparatus; and

40 Fig. 10 is a fragmentary sectional view showing the details of the blowout plug.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, the ported device is generally indicated at 15 in Fig. 1 and is secured at its upper end to an upper portion 16 of the casing and its lower end to a lower portion 17 of the casing. There is a valve operating device generally indicated at 20 within the casing which valve operating device may be of any suitable construction. The ported device 15 shown in Fig. 1 comprises a collar member 21 having internal threads at its lower end to receive lower portion 17 of the casing. Collar 21 is internally recessed to provide an upwardly facing shoulder

23 and there is a sleeve valve 25 rotatably received by collar 21 and resting on shoulder 23. The portion 27 of collar 21 has the same internal diameter as that of the casing and the sleeve valve 25 has the same internal diameter as the casing and therefore the ported device can be attached to or interposed between casing sections without varying the internal diameter of the casing. There is an adjusting sleeve member 30 which is threadedly received by the upper end of collar 21 and serves to determine the end thrust on sleeve valve 25, it being understood that the end thrust is such as to allow rotation of sleeve valve 25 and yet restrict undue axial movement of sleeve valve 25. Adjusting sleeve member 30 is provided with an annular groove in which is received an O-ring 33 for sealing between the collar 21 and the adjusting sleeve member 30. The adjusting sleeve member 30 is preferably welded at 35 to the upper end of collar 21 thereby preventing rotation of adjusting member 30 after it has been set. Adjusting sleeve member 30 threadedly receives the upper portion 16 of the casing and member 30 has an internal diameter the same as that of the casing, thereby not varying the bore of the casing.

A very important part of the present invention is the provision of sealing means between the sleeve valve 25 and the collar 21 to prevent fluid under pressure from passing through a port 40 provided in collar 21 and between the sleeve valve and the collar and either through a port 42 provided in sleeve valve 25 or up or down between the sleeve valve and the collar and out the ends thereof and into the casing. It is obviously desirable to prevent gas, water, and other fluids from entering into the casing and mixing with the oil, drilling mud, and the like. However, there is an additional reason for preventing gas and fluids from passing between the sleeve valve 25 and the collar 21 and around the ends of the sleeve valve and that is to prevent rusting between the sleeve valve and the collar 21 and also to prevent the removal or sweeping away of a water-resistant lubricant 50 which is provided between and on the surfaces of the sleeve valve 25 and the collar 21.

There are two major ways in the present invention of providing sealing means between the sleeve valve 25 and the collar 21 and the first of these ways shown in Figs. 1 through 5 is where a sealing means 52 is provided on the interior of the collar 21 about the port 40 therein. The other major way is shown in Figs. 6 through 10 in which sealing means is provided about the port in the sleeve valve. The difference, therefore, between the two constructions is that in one the collar carries the sealing means about the port therein and in the other the sleeve valve carries sealing means about its port.

The provision of sealing means 52 on the interior of the collar 21 has the most operating advantages in that at all times fluids are prevented from entering between the sleeve valve 25 and the collar 21. However, it has been found that it is more difficult mechanically to provide the sealing means on the exterior of the collar and it is easier to provide the sealing means on the exterior of the sleeve valve 25. Therefore, in determining which type of arrangement to use the various operating conditions of the well must be kept in mind. If extremely severe conditions are involved, it is best to incur the additional expense by providing the sealing means on the interior of the collar and

this is especially so where it is desired to reopen the port in the collar over long periods of time. On the other hand, where the operating conditions in the well are not so great and where the length of time over which it is desired to reopen the port is somewhat less, then the sealing means should be provided on the sleeve valve, thereby lessening the initial machining operations of providing the sealing means on the various parts.

The sealing means around port 40 in Fig. 1 is preferably of the O-ring type and there is an annular groove 54 provided on the interior of collar 21 about port 40 and the sealing means which preferably takes the form of an O-ring fits within annular groove 54. Various tables are supplied by O-ring manufacturers for determining the amount of initial compression on the O-ring and the amount of side clearance which should be provided between the sides of the O-ring and the groove in which it fits, and therefore the particular construction of the groove 54 with reference to the O-ring can easily be determined for a particular case. It is important that the annular groove 54 be of uniform depth so that the contact of the O-ring 52 with the sleeve valve 25 will be uniform so that the operation of the O-ring will be uniform.

Upper sealing means are provided on valve sleeve 25 and this sealing means may comprise a single O-ring 60 fitting within an annular groove in valve sleeve 25 but preferably there is provided another O-ring 61 fitting within an annular groove to serve as a safety factor. There may be also provided a metallic seal 65 in another annular groove below the annular groove containing O-ring 61.

There are also sealing means provided on the lower end of valve 25 and these sealing means may comprise a single O-ring 69 fitting within an annular groove in valve 25 but preferably there is another O-ring 70 and a metallic seal 71 as shown in Fig. 1 similar to the sealing means for the upper end of the valve member 25. By these various sealing means fluid under pressure is prevented from passing through port 40 and up or down between the valve 25 and the collar 21 and thereby the lubricant 50 between the sleeve valve and the collar 21 is preserved intact thereby preventing rusting and insuring that the valve 25 may be rotated to open and close port 40 at any time after the device is installed in a well. The various sealing means also prevent the passage of fluid through a port 40 and around through port 42 and into the casing thereby preventing the mixture of the fluids outside the well with the fluids inside the well.

There is a stop pin 80 provided in collar 21 which extends into a semi-circular slot 81 in sleeve valve 21 and pin 80 provides a stop so that when valve 21 is moved to one extreme position ports 40 and 42 are aligned, and when the valve member is moved to its other extreme position the ports 40 and 42 are out of alignment and therefore port 40 is closed. Fig. 3 shows a cross-sectional view in which port 40 is closed, and Fig. 4 shows port 40 and port 42 in alignment, and therefore port 40 is open.

There are longitudinal grooves 85 provided in sleeve valve 25 which serve as means whereby the valve can be rotated. Any suitable means for operating the valve member may be provided and the device 20 is merely one illustrative form. The apparatus 20 may provide valve-operating elements 89 which fit within slots 85 in the valve member for rotating the same. Member 20 may

also be provided with a lower belly spring 91 to center and support device 20 within the well casing.

Another form of the invention is shown in Figs. 6 and 7, wherein there are sealing means 100 provided in annular grooves about ports 101 in a sleeve valve 102, there being three ports 101 in the valve member 102 and three corresponding ports 105 in collar member 106, collar member 106 being similar in construction to the device shown in Fig. 1 except for the number of ports 105 and the sealing means about the ports and valve member 102 is similar in construction to valve member 21 with the exception of the number of ports and sealing means about the ports. In such a device as shown in Figs. 6 and 7, there of course will be upper and lower sealing means on the sleeve valve 102 similar to the upper and lower sealing means on sleeve valve 25. As before mentioned, the modification shown in Figs. 6 and 7 has an advantage and also a disadvantage. The advantage is that it is less expensive to provide O-rings about ports on the exterior surface of the valve 102 than it is to provide annular grooves and O-rings on the interior of the collar 106. However, the disadvantage of this type of construction is that when the ports 105 are closed fluid under pressure may to some extent force itself between valve member 102 and collar 106 and to an extent displace the lubricant 110 between the valve member 102 and the collar 106. However, this displacement in some wells is not serious enough to prevent the use of this modification of the invention. However, if the pressure conditions in the well are severe and if a long-time operation of the ported device is desired, the form of the invention disclosed in Fig. 1 should be used. It is pointed out that satisfactory operation with the modification shown in Figs. 6 and 7 has been achieved and can be achieved in a certain percentage of the wells, but in certain other of the wells it is best to use the modification shown in Fig. 1.

Another modification of the invention is shown in Figs. 8 through 10, wherein there is shown a ported device similar to that shown in Fig. 1 with the exception that the sealing means about the ports is provided on sleeve member 120 instead of collar 121 and there is a single O-ring 122 around the upper end of valve 120 and a single lower O-ring 123 about the lower end of valve 120. There is a suitable adapter 125 similar in construction and purpose to adapter-adjustment member 30 shown in Fig. 1. In this form of the invention the collar 121 has a threaded portion 121a to receive a blowout plug 127 which may have a protuberance 129 to align port 130 in valve member 120 with the port closed by the blowout plug. The device shown in Fig. 10 is one in which the blowout plug is not equipped with a protuberance but reliance is placed on the frictional contact between the valve 120 and collar 121 to maintain alignment of port 130 with brass plug 150.

The blowout plug may be constructed of brass or similar material and is so held by collar 121 that under normal usage it will not blow out but it can be blown out or removed by increasing the pressure to a predetermined value. There are obvious advantages to this form of construction in that a port can be provided in a casing by merely increasing the pressure without the necessity of lowering any special tool as is usually necessary. There are numerous ways in

which the blowout plug of the present invention can be used, but in general, the methods will comprise first forcing a fluid down the casing and beyond the blowout plug with a pressure less than sufficient to blow the plug. This will be followed by a sealing off operation below the blowout plug performed in any suitable manner and then the pressure of the fluid within the casing will be increased to a point sufficient to blow the plug and then another fluid can be pumped into the casing and out through the port left by the blown plug without requiring lowering a tool or other device for opening said port. Furthermore, an additional step of closing said port may be obtained by merely rotating the valve 120 after the fluid or material desired has been forced out through the port left by the plug after it has been blown. An obvious use of the blowout plug is shown in Fig. 8 where the casing 131 is provided with a cementing shoe 133 having passageways 134 to permit cement slurry to be forced out through the cementing shoe 133, this operation taking place at a pressure less than sufficient to blow out plug 127. It may be desired in such a case to leave the whole upper portion of the casing free so that the casing may be salvaged and saved, and if this is so, it will be desired to remove any excess cement above and around the portion of the casing where the blowout plug is located. This can easily be accomplished by the present invention by merely increasing the pressure in the casing after the cementing plug 137 has seated on the concrete shoe 133 to an extent such as to blow the blowout plug and then fluid of the desired type forced down into the casing 131 out through the port left by the blowout plug and up through the annular space around the casing, thereby thoroughly washing the whole upper portion of the annular space free of any cement which might have moved upwardly into that zone.

Another method of using the blowout plug is shown in Fig. 9. It may be known in advance that there is an oil zone 160 between a water zone 161 and a lower water zone 162. The ported device can be interposed in the casing in the correct place and lowered in the well. Cement slurry can then be forced out through the cement shoe 133 at the lower end of the well thereby cutting off water zone 162 from the oil-producing zone 160 and thereafter the pressure increased to an extent such as to blow the blowout plug and then a second cementing plug 170 can be forced downwardly into the well forcing cement 171 ahead of it and out through the port left when blowout plug 127 was blown and a bridge 174 established between the casing 131 and shutting off water formation 161 from the oil zone 160.

Fig. 9 is also suggestive of another method and that is when there are horizontal passageways in the formation through which the cement passes instead of moving upwardly in the annular space to thoroughly seal the lower end of the casing. In such a case where this is contemplated, or is likely to happen, a brass plug ported device can be inserted in the casing in an appropriate place before the casing is lowered into the well and after such a condition is encountered the brass plug blown and a second batch of cement slurry forced down the well and out through the port left by the blowout plug either establishing a bridge or even forcing cement from the ported device up to the surface if this is desired. It can be seen that all the methods of

using the ported device with the blowout plug comprises an initial fluid operation in which the blowout plug remains in place and a second fluid operation in which the blowout plug is blown.

It will be appreciated that by the present invention not only has a novel ported device been provided but also a novel ported device incorporating sealing means which completely seal the ported device and exclude fluids under pressure outside the casing from entering into the casing.

Throughout the specification the ported device has been described as being inserted or interposed in a string of casing but it is obvious that it can be attached to the lower end of a casing above a liner or that such a device can be attached to or inserted in any kind of tubing, pipe, casing, or the like, and that one or more of these ported devices can be placed in pipe, tubing, casing or the like for various operations which will be carried out.

The methods disclosed in the present invention in connection with the blowout plug construction and the blowout plug construction itself are extremely useful in recovering expensive drilling muds when a cement water shutoff is to be provided for a water string. In such case, the water string is cemented around the lower portion thereof between the well bore and the annular space and to a point below the location of the blowout plug after which the pressure is increased to blow out the plug and a suitable fluid can be forced down into the casing and out through the port left by the blown plug and the expensive drilling mud in the annular space between the remaining portion of the casing and the well bore can be easily recovered by forcing the drilling mud up through the annular space. This whole operation can be performed without the necessity of lowering any instrument into the tool for the purpose of forming a port in the casing or opening a port in the casing since the port is provided by merely increasing the pressure of the fluid within the casing.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims:

I claim:

1. A device of the class described comprising a tubular sleeve valve supporting member provided with means enabling its incorporation in a string of pipe, said sleeve valve supporting member having ports therein, a sleeve valve member concentrically arranged with respect to the sleeve valve supporting member and movable therein, said sleeve valve member having a port adapted to be moved into and out of registration with the ports in the sleeve valve supporting member upon movement of the sleeve valve member relatively thereto, means by which the sleeve valve member may be moved relative to the sleeve valve supporting member, and an annular seal recessed in a groove of uniform depth in one of said members surrounding the port therein engageable with the other of said members to prevent leakage between the members from the ports therein.

2. A device of the class described comprising a tubular sleeve valve supporting member provided with means enabling its incorporation in a string of pipe, said sleeve valve supporting member having ports therein, a sleeve valve member concentrically arranged with respect to the sleeve valve supporting member and movable

therein, said sleeve valve member having a port adapted to be moved into and out of registration with the ports in the sleeve valve supporting member upon movement of the sleeve valve member relatively thereto, means by which the sleeve valve member may be moved relative to the sleeve valve supporting member, and an annular seal recessed in a groove of uniform depth in the exterior of the sleeve valve member surrounding the port therein engageable with the interior of the sleeve valve supporting member.

3. A device of the class described comprising a tubular sleeve valve supporting member provided with means enabling its incorporation in a string of pipe, said sleeve valve supporting member having ports therein, a sleeve valve member concentrically arranged with respect to the sleeve valve supporting member and movable therein, said sleeve valve member having a port adapted to be moved into and out of registration with the ports in the sleeve valve supporting member upon movement of the sleeve valve member relatively thereto, means by which the sleeve valve member may be moved relative to the sleeve valve supporting member, and an O-ring recessed in a groove of uniform depth in the exterior of the sleeve valve member surrounding the port therein engageable with the interior of the sleeve valve supporting member, and O-rings recessed in the exterior of the sleeve valve member and surrounding said member engageable with the interior of the sleeve valve supporting member and disposed above and below the port therein and the O-ring thereabouts.

4. A device of the class described comprising a tubular sleeve valve supporting member, attaching means at the ends thereof enabling its incorporation in a string of pipe, a sleeve valve member rotatable in the sleeve valve supporting member, means on the interior of the sleeve valve member by which it may be rotated relative to the sleeve valve supporting member, ports in said sleeve valve member and sleeve valve supporting member adapted to be brought into and out of mutual registration when the sleeve valve member is rotated relatively to the sleeve valve supporting member, and an annular seal recessed in a groove of uniform depth in one of said members and surrounding the port therein and engageable with the other member.

5. A device of the class described comprising a tubular sleeve valve supporting member, attaching means at the ends thereof enabling its incorporation in a string of pipe, a sleeve valve member rotatable in the sleeve valve supporting member, means on the interior of the sleeve valve member by which it may be rotated relative to the sleeve valve supporting member, ports in said sleeve valve member and sleeve valve supporting member adapted to be brought into and out of mutual registration when the sleeve valve member is rotated relatively to the sleeve valve supporting member, an annular seal recessed in a groove of uniform depth in one of said members and surrounding the port therein and engageable with the other of said members, and annular seals between said members surrounding the inner member above and below the ports therein and the mentioned seal.

6. A device of the class described comprising a tubular sleeve valve supporting member, attaching means at the ends thereof enabling its incorporation in a string of pipe, a sleeve valve member rotatable in the sleeve valve supporting member, means on the interior of the sleeve valve

member by which it may be rotated relative to the sleeve valve supporting member, ports in said sleeve valve member and sleeve valve supporting member adapted to be brought into and out of mutual registration when the sleeve valve member is rotated relatively to the sleeve valve supporting member, an annular seal recessed in a groove of uniform depth in one of said members and surrounding the port therein and engageable with the other of said members, annular seals between said members and surrounding the inner of said members above and below the ports therein and the mentioned seal, and means permitting but limiting rotation of the sleeve valve member relative to the sleeve valve supporting member.

7. A device of the class described comprising a tubular sleeve valve supporting member, attaching means at the ends thereof enabling its incorporation in a string of pipe, a sleeve valve member rotatable in the sleeve valve supporting member, means on the interior of the sleeve valve member by which it may be rotated relative to the sleeve valve supporting member, ports in said sleeve valve member and sleeve valve supporting member adapted to be brought into and out of mutual registration when the sleeve valve member is rotated relatively to the sleeve valve supporting member, and an O-ring recessed in a groove of uniform depth in the exterior of the sleeve valve member around the port therein engageable with the interior of the sleeve valve supporting member, and O-rings recessed in the exterior of the sleeve valve member above and below the mentioned O-ring and surrounding said sleeve valve member.

8. A port collar comprising a cylindrical body threaded at its ends and having a port formed through its wall intermediate its ends, an internal shoulder in the body, a sleeve valve rotatable in the body on the shoulder, said sleeve valve having a port adapted to be moved into and out of registration with the port on the body, recesses on the interior of the sleeve valve by which the sleeve valve may be rotated relatively to the body, an O-ring recessed in a groove of uniform depth in the exterior of the sleeve valve surrounding the port therein engageable with the interior of the body, O-rings arranged concentrically with respect to the sleeve valve and disposed above and below the mentioned O-ring, and a sleeve member extending into the top of the body against the top of the sleeve valve, means securing said sleeve member to the body, and an O-ring recessed in the sleeve member engageable with the interior of the body.

9. A device of the class described comprising a tubular sleeve valve supporting member having threads at its ends for incorporation in a string

of pipe, a sleeve valve member movably mounted therein, ports in the sleeve valve member and sleeve valve supporting member adapted to be moved into and out of mutual registration upon movement of the sleeve valve member relative to the sleeve valve supporting member, said sleeve valve member having at least one recess on its interior, means for moving the sleeve valve member to open the ports and permit fluid flow there-through to close the ports comprising a ported member adapted to be attached to a run-in string of pipe, bowed springs thereon adjacent the port therein receivable in the sleeve valve member, one of which is adapted to expand into the recess when opposite the recess so that the sleeve valve member may be moved by the run-in string, and packing means on the ported member above and below the springs and the ports engageable with the interior of the sleeve valve member above and below the port therein.

10. A device of the class described comprising a tubular sleeve valve supporting member having threads at its ends enabling it to be incorporated in a string of pipe, a sleeve valve member rotatably mounted therein, ports in the sleeve valve member and sleeve valve supporting member adapted to be moved into and out of mutual registration upon rotation of the sleeve valve member relative to the sleeve valve supporting member, means limiting rotation of the sleeve valve member relative to the sleeve valve supporting member, said sleeve valve member having a recess on its interior, and means for rotating the sleeve valve member to open or close the ports comprising a ported member adapted to be attached to a run-in string of pipe, bowed springs thereon adjacent the port therein receivable in the sleeve valve member, one of which is adapted to expand into the recess when opposite the recess so that the sleeve valve member may be rotated by the run-in string, and packing means on the ported member above and below the springs and the ports engageable with the interior of the sleeve valve member above and below the port therein.

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