

Feb. 21, 1967

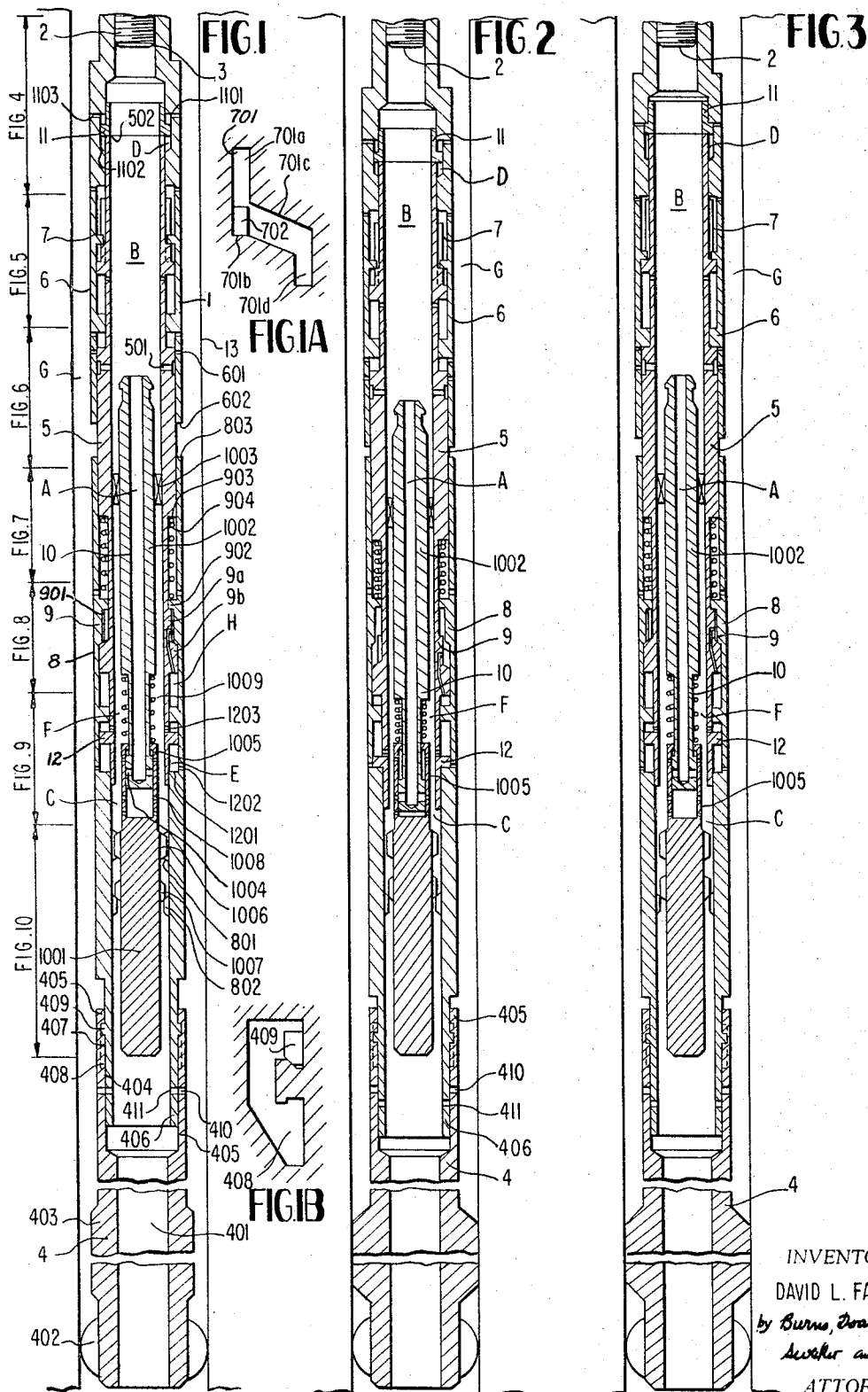
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3,305,023

WELL TESTER WITH HYDRAULIC COUPLING AND RETRIEVABLE VALVE

Filed May 27, 1964

4 Sheets-Sheet 1



Feb. 21, 1967

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WELL TESTER WITH HYDRAULIC COUPLING AND RETRIEVABLE VALVE

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4 Sheets-Sheet 2

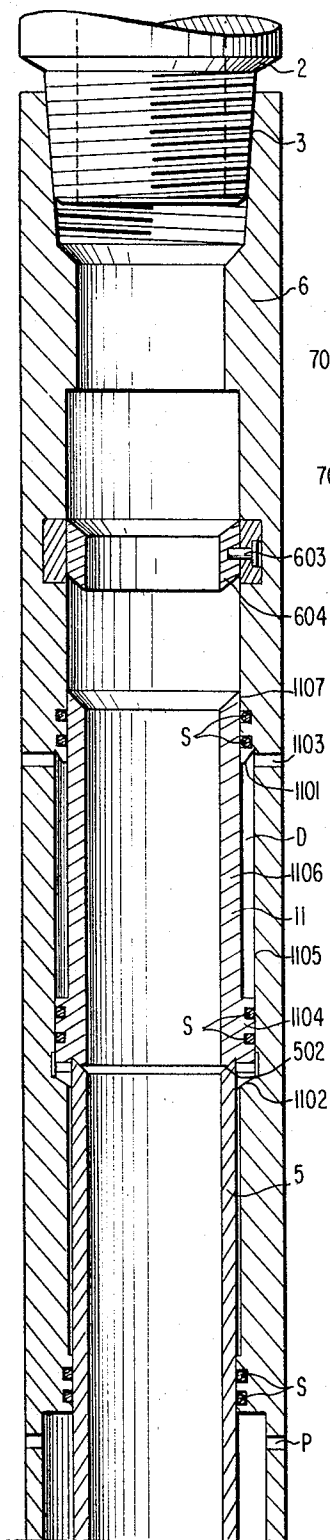


FIG. 4

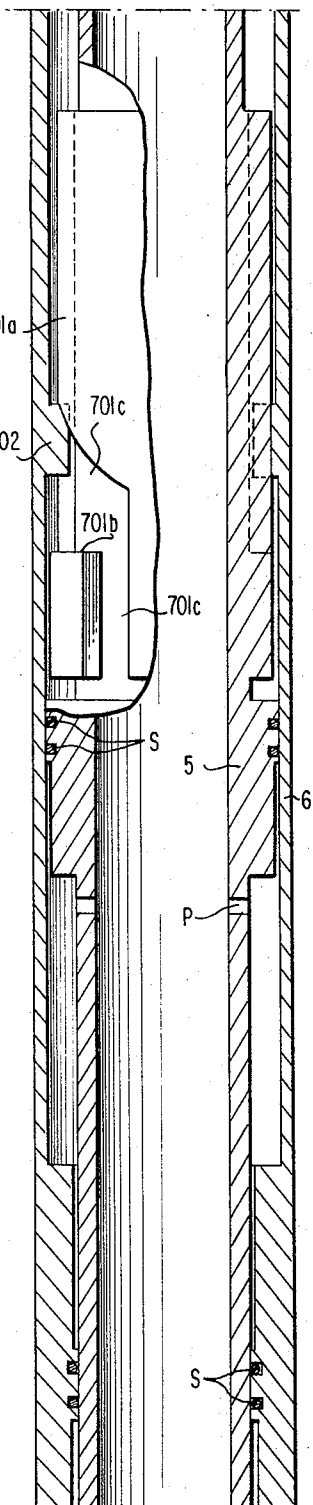


FIG. 5

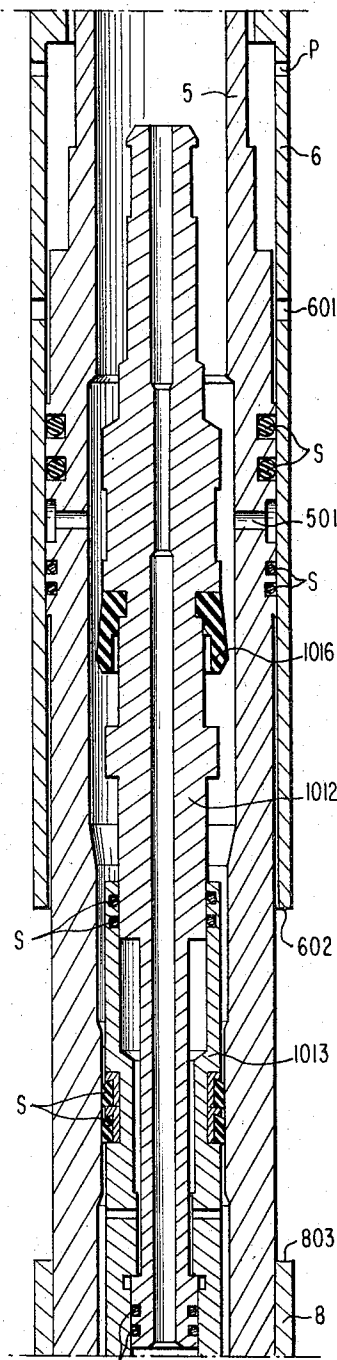


FIG. 6

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4 Sheets-Sheet 3

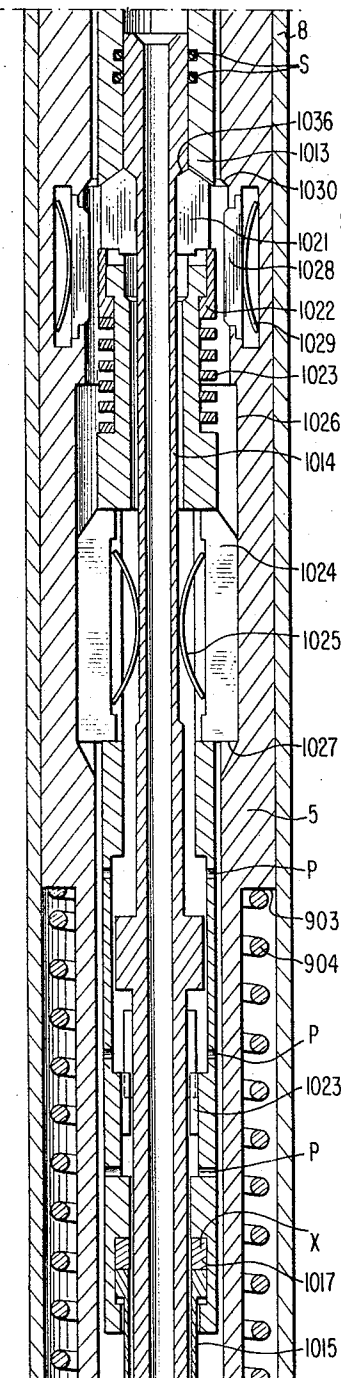


FIG. 7

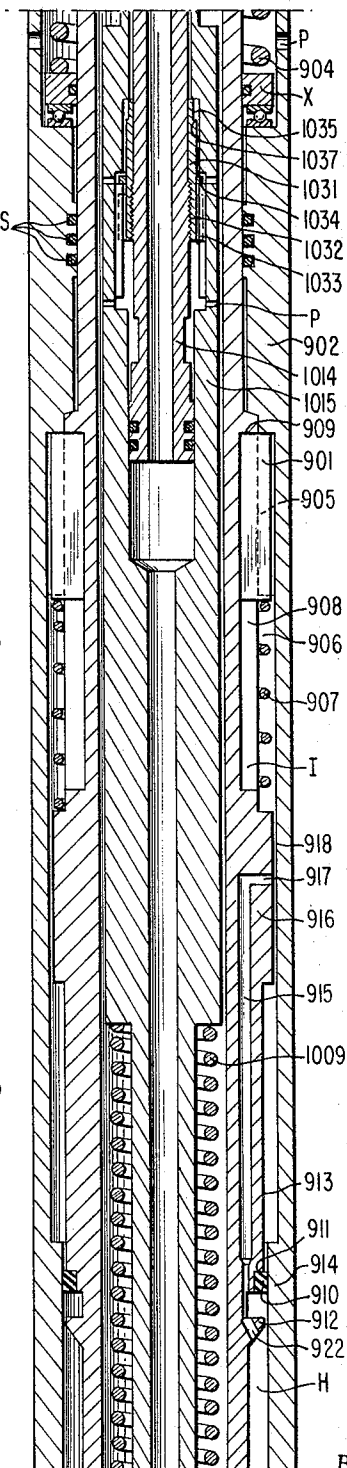


FIG. 8

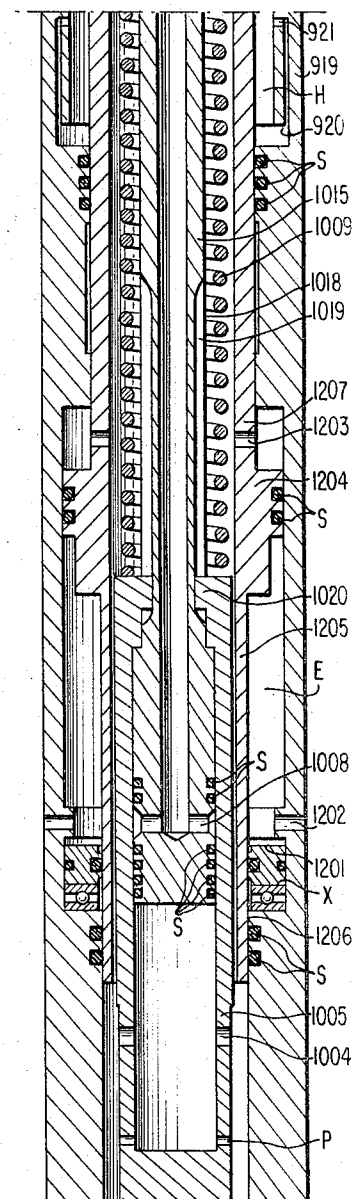


FIG. 9

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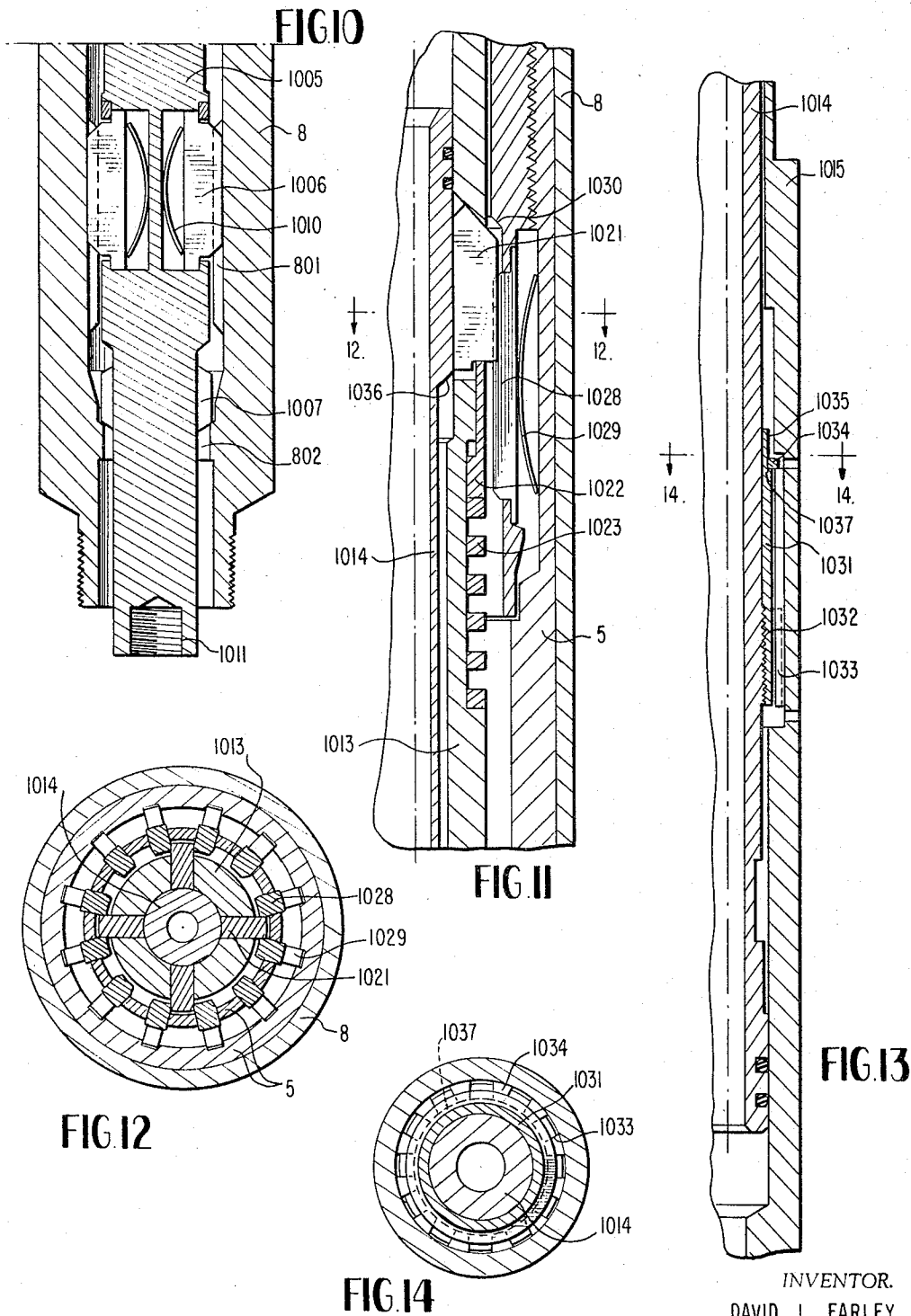
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WELL TESTER WITH HYDRAULIC COUPLING AND RETRIEVABLE VALVE

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4 Sheets-Sheet 4



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1

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WELL TESTER WITH HYDRAULIC COUPLING AND RETRIEVABLE VALVE

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Filed May 27, 1964, Ser. No. 370,603
12 Claims. (Cl. 166-226)

This invention relates to apparatus for use in well bores. In particular it relates to a tester tool for controlling the flow of fluid within a well bore while testing the productivity of formations.

In the operation of well tools including several individually operable components, substantial difficulty has been encountered in obtaining accurate and positive control over the operation of individual components. The inadvertent operation of one component, while trying to operate another component of a tool, occasions problems of substantial magnitude in a well bore environment.

An area of additional concern has related to the provision of reliable means for yielding a well head indication of the successful operation of a tool component.

Other difficulties have involved attempts to maintain a desired force-transmitting relationship between tool components or between various tools of a well string while a force was being exerted on a string opposite to the desired force-transmitting direction.

Of no insubstantial concern has been the maintaining of adequate control over the individual operation of valves in a multi-valved well tool.

Through this invention there are presented well tool features which substantially minimize or obviate well tool problems of the type heretofore described.

It is an object of the invention to provide improved well tool apparatus which enables the maintaining of positive control over the selective or sequential operation of the valves of a plural-valved well tool.

An additional object of the invention is to provide a multi-valved well tool wherein essentially linear movements of a well string effect the controlled operation of the various tool valves. A tester valve may be repeatedly operated by merely lowering and raising the string, and a circulating valve may be operated by the mere manipulation of a lug and slot connection.

Yet another object of the invention is to provide an improved well tool which yields a positive well head indication of the successful operation of individual valve components.

It is also an object of the invention to provide an improved multi-valved well tool wherein the rate of operation of one valve is different than the rate of operation of another valve in response to the same applied operating force so that a desired sequence of valve operation is assured.

It is also an object of the invention to provide a multi-valved well tool in which holding means are associated with one valve to maintain its operating components effectively immobilized while the components of another valve are being operated and to interrupt the immobilizing effect of this holding means by the same force applied to operate the components of other valves.

A still further object of the invention is to incorporate means in a well tool for positively preventing the opening of one valve after another valve has been opened, regardless of the manipulative forces applied to a well string supporting the tool.

A still further object of the invention is to incorporate hydraulic coupling means in a well tool to enable force to be transmitted through the tool even though the conduit string supporting the tool is being moved in a direction opposite to the direction in which force is to be transmitted.

2

It is a specific object of the invention to provide a well tester tool affording positive and reliable control over the sequential or selective operation of a tester and circulating valve.

It is a related specific object of the invention to provide such an improved tester tool wherein the accidental opening of either the tester valve or the circulating valve is effectively prevented.

An additional specific object of the invention is to provide in a single tool an effectively integrated combination of a retrievable tester valve and a circulating valve.

The apparatus presented through this invention, in part, involves a basic combination comprising a first tool portion, a second tool portion upon which the first portion is mounted for limited telescoping movement, and a third portion upon which the second portion in turn is mounted for limited, telescoping movement. First slide valve means are carried by these first and second tool portions. Second slide valve means are carried by the second and third tool portions.

In the context of this basic combination means may be interposed between the second and third tool portions to impede, without preventing relative telescoping movement of the second and third portions. Thus, an axial force imposed upon the first tool portion and directed toward the third tool portion will tend to cause the relative telescoping movement of the first and second tool portions at a more rapid rate than the relative telescoping movement of the second and third portions induced by this imposed force.

In the context of the basic combination previously described, the second slide valve means may comprise a telescopable slide valve assembly detachably secured within the second and third tool portions.

Another aspect of the invention, in the context of the basic combination described above, involves the interposing of a hydraulic, force-transmitting coupling between the second and third tool portions. An additional aspect of the invention, in this context, concerns the disposing of mutual facing and axially spaced end portions of the first and third tool portions so as to prevent the operation of the second slide valve means after the first slide valve means has been operated.

Yet another aspect of the invention relates to a well tool comprising a first portion and a second portion mounted for reciprocating movement relative to the first portion. Piston means are mounted within the first portion. Abutment means are carried by the first portion and adapted to limited axial movement of this piston means. A pressurized fluid chamber is provided which is adapted to contain pressurized fluid tending to urge the piston means toward the abutment means and the second tool portion. Aperture means are carried by the first tool portion and adapted to admit pressurized fluid to this chamber. The piston means is adapted to engage the second tool portion during an initial portion of movement of the first tool portion in one direction and be engaged by the abutment means and moved out of engagement with the second portion during a terminal part of this movement of the first tool portion.

In describing the invention, reference will be made to a preferred tester tool embodiment illustrated in the accompanying drawings.

In these drawings:

FIGURE 1 is a schematic, sectional and elevational view of a portion of a well string including a preferred tester tool structure in association with a well packer. FIGURE 1 generally reflects the position of the tester tool and packer components as they may be arranged while the tool is being moved through a well bore toward a test site;

FIGURE 1a provides a schematic and enlarged illustration of a lug and slot connection which may be employed between mandrel and upper casing components of the FIGURE 1 tester tool;

FIGURE 1b provides an enlarged and schematic illustration of another lug and slot connection which may be employed between valving components associated with the packer unit of the FIGURE 1 assembly;

FIGURE 2 is a schematic, elevational and sectional view of the FIGURE 1 assembly illustrating the arrangement of tester tool components with the tester valve in the open position;

FIGURE 3 is a schematic, elevational and sectional view of the FIGURE 1 assembly illustrating tool components as they would be disposed with the circulating valve of the tester tool open;

FIGURES 4 through 10 provide enlarged and additionally detailed illustrations of portions of the FIGURE 1 assembly generally corresponding to the labeled portions of FIGURE 1, but with FIGURES 7 and 8 showing a detachable slide valve assembly unengaged with the tool mandrel;

FIGURE 11 is a still further enlarged fragmentary view of a portion of the FIGURE 1 assembly shown in FIGURE 7 which reflects the disposition of latching components of the detachable slide valve assembly when these components are lockingly engaged with the mandrel portion of the tool;

FIGURE 12 is an enlarged, transverse, sectional view of the FIGURE 1 assembly as viewed along the section line 12—12 generally indicated in FIGURE 11;

FIGURE 13 is an enlarged, fragmentary and sectional view of the portion of the FIGURE 1 tool shown in FIGURE 8 illustrating a releasable mechanism employed to secure the latching components of the slide valve assembly, with this mechanism arranged to hold these latching components engaged with the tool mandrel as shown in FIGURE 11; and

FIGURE 14 provides an enlarged, transverse, and sectional view of a portion of the FIGURE 1 tool as viewed generally along the section line 14—14 shown in FIGURE 13.

Major components

FIGURE 1 illustrates a tester tool 1, the upper end of which is adapted to be supported upon a conduit string 2 by coupling means such as a conventional threaded connection 3. A packer and valve and assembly 4 is carried on the lower end of the tester tool 1.

In referring to the drawings and describing the basic structural components, it will be understood that these well tool components possess the usual, generally cylindrical or annular well tool configurations.

Tester tool 1 includes central mandrel means 5. Upper or first casing means 6 are telescopically mounted over mandrel means 5. First connecting means 7 extend between the mandrel means 5 and the upper casing means 6. This connecting means is of the so-called J-slot type and may include a plurality of mandrel-means-carried slots 701 within each of which is disposed an upper casing-means-carried lug 702.

In the elevational view of a representative slot 701 as shown in FIGURE 1a, it will be seen that each slot comprises a longitudinally extending, elongate upper portion 701a, an intermediate shoulder 701b, a laterally extending portion 701c, and a relatively, short, longitudinally extending portion 701d. As illustrated, longitudinal slot portion 701d is displaced in a generally counterclockwise direction from slot portion 701a when the tool is viewed from its upper end.

As will be apparent, the lug and slot connection 7 permits limited telescoping movement of the upper casing means 6 relative to the mandrel means 5.

A lower or second casing means 8 is telescopically

mounted over mandrel means 5 and axially spaced from the upper casing means 6 as shown in FIGURE 1.

Second connecting means 9 extend between the mandrel means 5 and the casing means 8. As schematically shown in FIGURE 1, connecting means 9 may comprise an upper portion 9a including mandrel-means-carried lugs 901 disposed abuttingly beneath a casing-means-carried shoulder 902. Shoulder 902 is disposed, as shown in FIGURE 1, between the mandrel lugs 901 and a mandrel means shoulder 903. A coil spring 904 may be interposed between shoulders 902 and 903 to tend to hold the casing means 8 and mandrel means 5 in the extended position shown in FIGURE 1, with the engagement of lugs 901 and shoulder 902 limiting downward, axial movement of casing means 8 on mandrel means 5.

Slide valve means 10 are detachably secured within the mandrel means 5 so as to be capable of telescoping movement through the tester tool interior when disconnected from the mandrel means 5. This slide valve means 10 may carry a conventional pressure recorder 1001 as shown.

Slide valve means 10 corresponds generally to the detachable valve assembly described in my issued United States Patent 3,190,360, issued June 22, 1965, and entitled "Well Tester with Retrievable Valve Assembly."

Slide valve means 10 includes an upper portion 1002 adapted to be secured by selectively releasable coupling means 1003 to mandrel means 5 for unitary movement with the mandrel means. This coupling 1003, hereinafter described in detail, prevents axial movement of the upper slide valve portion 1002 relative to mandrel means 5.

First port means comprising one or more ports 1004 are carried by slide valve portion 1002. Ports 1004 extend generally radially of the tool axis.

A second slide valve portion 1005 is contained within lower casing means 8 as shown in FIGURE 1. Lower slide valve portion 1005 may be provided with blocks 1006 which intermesh with casing-means-carried splines 801 so as to prevent relative rotation of the slide valve portion 1005 and casing means 8. Additional lugs 1007 may be provided to rest upon axially grooved, casing means 8 carried shoulder means 802 relative to the casing means 8.

Second port means comprising one or more ports 1008 are carried by the slide valve portion 1005 and extend generally radially of the tool axis.

The upper and lower slide valve portions 1002 and 1005 are urged apart by a coil spring 1009 and are splined together for relative telescoping movement as hereinafter described. Slide valve portions 1002 and 1005 define the centrally disposed and axially extending first fluid passage means A.

As will be apparent by reference to FIGURE 1, downward telescoping movement of valve portion 1002, relative to valve portion 1005, induced by downward telescoping movement of mandrel means 5 within casing means 8 will serve to move ports 1004 and 1008 into mutually communicating alignment.

With ports 1004 and 1008 aligned, fluid communication will be established between axially extending passage means A and the exterior of slide valve portion 1005.

Third port means comprising one or more ports 501 are carried by the mandrel means 5 and extend generally radially of the tool axis.

Fourth port means comprising one or more ports 601 are carried by the upper casing means 6 and also extend generally radially of the tool axis.

Upper casing means 6 and mandrel means 5 define second, centrally disposed and generally axially extending, fluid passage means B. Second fluid passage means B, as shown in FIGURE 1, communicates with first passage means A of the slide valve means 10 and the third port means 501 of mandrel means 5.

Downwardly directed telescoping movement of first casing means 6 relative to mandrel means 5, as permitted by appropriate manipulation of J-slot connecting means

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6

7, is effective to bring ports 601 into communicating alignment with ports 501.

Lower casing means 8 defines third, generally centrally disposed and axially extending, fluid passage means C. Fluid passage means C provides fluid communication between the interior 401 of packer 4 and second port means 1008. In a conventional fashion, blocks 1006, splines 801, lugs 1007, and shoulder means 802 are configured so as to provide for fluid flow around recorder 1001 and between the packer interior 401 and port means 1008.

Packer assembly 4, as schematically shown, may conveniently include packer setting drag springs 402, a radially expandable seal portion 403, and a slide valve portion 404. Slide valve portion 404 may comprise a radially ported outer sleeve portion 405 telescopically connected to an inner, radially ported sleeve portion 406 by lug and slot connecting means 407.

As shown in FIGURE 1b, lug and slot connecting portion 407 may comprise one or more slots 408 formed on outer sleeve portion 405. Within each slot there is received a lug 409 carried by sleeve portion 406. With a lug 409 positioned in slot 408 as shown in FIGURE 1b, sleeve ports 410 and 411 are held in communicating alignment. In order to move ports 411 axially downward and out of communicating alignment with ports 410, it would be necessary to first rotate the lug-carrying sleeve 406 clockwise when viewing the tool from the top, and then move sleeve 406 downwardly.

Connecting means 9 may further include an hydraulic, impedance coupling 9b interposed between the mandrel means 5 and the lower casing means 8. This hydraulic mechanism functions somewhat like a check valve in combination with a restricted bypass as described in U.S. Schwegman Patent 2,740,479. When a downwardly directed force is transmitted from upper casing means 6 through the lug and slot connection 7 to mandrel means 5, mandrel means 5 tends to telescope downwardly within casing means 8. However, the interposed coupling 9b impedes, without preventing, this telescoping movement as described in the aforesaid Schwegman patent. Thus, a downwardly directed axial force imposed through string 2 upon upper casing means 6 will tend to induce relative telescoping movement of casing means 6 and mandrel means 5 at a more rapid rate than relative telescoping movement of mandrel means 5 within casing means 8. With lugs 702 disposed in slot portions 701d, a downward force imposed upon upper casing 6 will move ports 601 and 501 into communicating alignment before mandrel means 5 telescopes within casing means 8 sufficient to bring ports 1004 and 1008 into communicating alignment and before mandrel means 5 has moved sufficiently to bring the lower end 602 of upper casing means 6 into abutting engagement with the axially spaced and mutually facing upper end 803 of lower casing means 8.

It should be noted that the axial space between casing end portions 602 and 803 is so limited as to prevent the alignment of ports 1004 and 1008 subsequent to the alignment of ports 601 and 501. Thus, telescoping movement of upper casing means 6 over mandrel means 5 sufficient to bring ports 601 and 501 into communicating alignment will bring casing end portions 602 and 803 into such close proximity as to prevent telescoping movement over mandrel means 5 within casing means 8 sufficient to align ports 1004 and 1008.

Piston means 11 are mounted within and slidably carried by the upper portion of upper casing means 6 as shown in FIGURE 1. The slidable movement of piston means 11 is limited by an upper-casing-means-carried shoulder 1101 and abutment means 1102.

An annular pressurized fluid chamber D is defined by piston means 11 and upper casing means 6. Pressurized fluid contained within chamber D will tend to move piston means 11 toward abutment means 1102 and the upper end 502 of casing means 5. Radially extending aper-

ture means comprising one or more ports 1103 carried by casing means 6 are adapted to admit pressurized well fluid to chamber D.

When casing means 6 has been telescoped downwardly over mandrel means 5 as shown in FIGURE 1 with lugs 702 on slot shoulders 701b, the upper end 502 of the mandrel means 5 will engage and displace the piston means 11 relatively upwardly and slightly away from abutment means 1102. During the initial part of a subsequent upward telescoping movement of casing means 6 relative to mandrel means 5, piston means 11 will remain in engagement with the upper mandrel portion 502. While thusly engaged, a hydraulic force will be transmitted from the well fluid exterior of the casing means 6 to the piston means 11, tending to cause upward movement of casing means 6 with reference to mandrel means 5. Upward movement of casing means 6 sufficient to bring abutment means 1102 into engagement with piston means 11 will hold piston means 11 out of engagement with mandrel end portion 502 during a terminal part of upward movement of casing means 6.

As will be appreciated, the hydraulic force transmitting effect of piston means 11 will tend to immobilize casing means 6 and mandrel means 5 in their relative positions shown in FIGURE 1 with the ports 601 and 501 displaced out of communicating alignment. Thus, while an upward pull is being exerted on string 2 to move ports 1004, upwardly out of communicating alignment with reference to ports 1008, piston means 11 will tend to maintain ports 501 and 601 in the displaced relationship shown in FIGURE 1. After the upper limit of telescoping movement of slide valve portion 1002 relative to slide valve portion 1005 has been reached such that mandrel means 5 becomes anchored against further upward movement, continued upward movement of string 2 will bring abutment means 1102 into engagement with the piston means 11 and move this piston means out of force transmitting relationship in connection with mandrel end portion 502. Owing to the interruption of the immobilizing effect of piston means 11 and the thus induced loss of the pressurized fluid coupling between mandrel end portion 502 and the upper casing means shoulder 1101, a noticeable loss of hydraulic lifting force imposed against the casing means shoulder 1101 and thus the spring 2 will result.

The annular, reactive area of piston means 11 within pressurized chamber D is preferably of such a magnitude that when piston means 11 engages casing end 502 a net, overall hydraulic force is provided acting upon upper casing means 6 and mandrel means 5, which would tend to move casing means 6 upwardly and mandrel means 5 downwardly if these components were unrestrained.

Desirably, the other areas of casing means 6 and mandrel means 5 exposed to well bore fluid pressure and to internal tool fluid pressure for equalizing or venting purposes are such as to provide a net hydraulic force insufficient to tend to move the casing means 6 upwardly relative to the mandrel means 5. However, with the piston means 11 in force transmitting engagement with the upper mandrel end 502, the net hydraulic reactive forces imposed upon the exposed surfaces of the casing means 6 and the mandrel means 5 are sufficient to result in a force tending to raise casing means 6 relative to mandrel means 5.

An additional or second piston means 12 may comprise an integral portion of the lower end of mandrel means 5 as shown in FIGURE 1. Piston means 12 is mounted within lower casing means 8 in force transmitting relation with mandrel means 5. This force transmitting relation, in the illustrated embodiment, results from the integral incorporation of the piston means 12 with the mandrel means 5.

Piston head means 1201 are formed in casing means

7

8 as illustrated in FIGURE 1. An annular pressurizing fluid chamber E is defined between piston means 12 and piston head means 1201. Radially extending aperture means comprising one or more ports 1202 intersect the wall of lower casing means 8 to provide fluid communication between the chamber E and the exterior of the casing means 8 and to admit pressurized well bore fluid to the chamber E.

Additional, radially extending aperture means comprising one or more ports 1203 may extend through the portion of mandrel means 5 adjacent and above piston means 12.

Piston means 12, pressurized chamber E and piston head means 1201 define a hydraulic force transmitting coupling between mandrel means 5 and lower casing means 8. Pressurized well bore fluids admitted through ports 1202 into chamber E will exert an upward lifting or balancing force against mandrel means 5. Even though mandrel means 5 is being moved upwardly, this hydraulic coupling will enable force to be transmitted between the mandrel means 5 and the casing means 8 to other well bore components such as the packer assembly 4. During downward movement of mandrel means 5, fluid displaced within the annular zone F may be vented through ports 1203 into the gradually enlarging portion of the chamber E lying above the piston means 12.

Mode of operation of tool

FIGURE 1 illustrates the disposition of tool components as they would generally be arranged while running the tester tool 1 into a well bore 13.

In the running-in position, the packer seal 403 would be in its unexpanded condition and the packer drag spring 402 would be in frictional engagement with the wall of the well bore 13. In all probability, the ports 410 and 411 would be aligned, as shown, when the slide valve assembly 10 was latched within the tester tool interior during the running-in operation.

While the tester tool assembly is being moved downwardly through a well bore, it should be noted that the upper piston means 11 exerts a hydraulic separating force between the upper casing means 6 and mandrel means 5. This force tends to maintain these tool components in the position shown in FIGURE 1, even apart from the lug and slot control imposed by connecting means 7. This, of course, immobilizes port means 501 and 601 out of mutually communicating alignment and thus holds the circulating valve closed.

While tester tool 1 may be moved into position with the slide valve assembly 10 already mounted within its interior, it would also be feasible, where desired, to pump the valve assembly 10 downwardly into the tester tool 1 after it has been disposed at a well bore test site. Such pumping-in of the valve assembly 10 will effect the automatic operation of the connecting means 1003 so as to latch valve portion 1002 for non-axial movement with the mandrel means 5. The general manner in which this automatic latching operation is accomplished is described in detail in Farley Patent 3,190,360, previously referred to, and is hereinafter summarized.

After a test site has been reached, the packer 4 may be set and expanded by conventional operating techniques, well known in the art, and not relevant to this invention. In order to prepare for the testing operation, the packer seal 403 would be radially expanded into sealing engagement with the wall of the well bore 13. Additionally, the string would be turned clockwise and moved downwardly to move port means 411 out of communicating alignment with port means 410 as shown in FIGURE 2.

It should be noted that in the running-in position, the tester slide valve as defined by ports 1004 and 1008 would also be closed, with the impedance coupling 9b tending to prevent inadvertent tester valve opening.

The initiation of a testing operation is illustrated in FIGURE 2. As there shown, the tester valve ports 1004

8

and 1008 have been moved in communicating alignment. This alignment was achieved by exerting downward force on the string 2, with the connecting lugs 702 engaging slot shoulders 701b as shown in FIGURE 1a. This downward force was thus transmitted through lugs 702 and casing slot shoulder portions 701b and through connecting means 1003 to slide valve portion 1002. This force, of a magnitude sufficient to overcome the various hydraulic reactive forces imposed upon the tool and the biasing effect of coil springs 904 and 1009, serves to move the slide valve portion 1002 telescopically into the slide valve portion 1005 to which it is joined by splined connecting means as hereinafter described.

Proper alignment of test valve ports 1004 and 1008 may be assured by appropriate axial spacing between piston head defining shoulder 1201 and piston means 12. When mandrel means 5 has been moved downwardly sufficiently to bring piston means 12 into abutting engagement with shoulder 1201, port means 1004 will have been brought into radially communicating alignment with port means 1008.

As described in the previously mentioned Schwegman Patent 2,740,479 and as hereinafter summarized, an appropriate bypass may be incorporated near the lower end of the travel path in impedance coupling 9b. This bypass will effect a sudden interrupting of the movement impeding effect of the impedance coupling 9b and allow the mandrel means 5 to suddenly move downwardly at an increased velocity. The resulting sudden downward jarring of the string 2 will be reflected at the surface so as to provide an indication of the alignment of the piston port means 1004 and 1008, i.e., the opening of the tester valve. As will be appreciated, of course, this bypass must be disposed so as to effect the aforesaid jarring action just prior to the time that the piston means 12 engages the casing shoulder 1201.

With the tester valve ports 1004 and 1008 aligned and the circulating valve ports 501 and 601 misaligned as shown in FIGURE 2, well fluids which have entered the interior 401 of the packer assembly 4 from beneath the expanded seal 403 will move through passage means C, into the passage means A and upwardly into passage means B.

While moving around the pressure recorder 1001, the pressure of the same fluids will be recorded by conventional pressure recording arrangements, not illustrated.

With the tester valve open, casing means end portions 602 and 803 will have converged sufficiently to prevent inadvertent opening of the circulating valve by telescoping movement of upper casing means 6 downwardly over mandrel means 5.

After an appropriate interval of time, the tester valve may be closed. The closing of this tester valve is effected by merely raising the string 2.

During the initial part of the raising of the string 2, the piston means 11 will exert a hydraulic separating force against the upper casing 6 and mandrel means 5, tending to hold the ports 601 and 501 out of communicating alignment as heretofore described. Piston means 11, during this initial raising of the string 2, in being spaced above and out of engagement with the abutment shoulder 1102, will enable a hydraulic force from adjacent well annulus fluids to be transmitted against the casing means, piston head defining shoulder 1101.

During the upward movement of the string 2, the coil springs 1009 and 904 will assist in restoring the mandrel means 5, slide valve 10 and lower casing means 8 components to the positions shown in FIGURE 1. Continued upward movement of string 2 will thereafter take place with the mandrel means 5 limited against further axial upward movement, resulting, for example, from engagement of the upper ends of blocks 901 of connecting means 9a with a lower casing means shoulder 902. With the mandrel means 5 stabilized against further upward movement resulting from its interconnection with

lower casing means 8 and anchoring packer assembly 4, additional upward movement of string 2 will bring abutment means 1102 into engagement with piston means 11 and lift piston means 11 upwardly away from the upper end 502 of mandrel means 5.

When piston means 11 separates from mandrel end 502, the hydraulic lifting force imposed upon string 2 through the action of piston means 11 will be interrupted and thus provide a noticeable surface indication of a change of load on the string 2. The elongate character of the slot portions 701a will provide a substantial period of travel for the string 2 at this changed load value so as to provide a sustained surface indication that the tester valve has been successfully closed and that the connecting lugs 707 are moving upwardly within the elongate slot portions 701a.

As will be appreciated, the opening and closing of the tester valve may be easily repeated as often as desired by merely moving the testing string linearly, down and up.

After a sample has flowed into the passage means B and the tester valve has been closed, the circulating slide valve may be opened so as to allow the received sample to be circulated to the surface. Thus, with port means 601 and 501 of the circulating valve in communicating alignment as shown in FIGURE 3, fluid may be circulated from a well head downwardly through the annular well space G to move through the aligned circulating valve ports 501 and 601 and displace sample fluid upwardly through the string 2.

The opening of the circulating valve, with the tester valve closed, is accomplished by rotating the string 2 counterclockwise so as to move the lugs 702 off of the shoulders 701a so that they may move downwardly through the slot portions 701c and 701d.

After the string 2 has been sufficiently rotated to enable the lugs 702 to move downwardly, a downward force exerted on the string 2 will cause the upper casing means 6 to telescope downwardly over mandrel means 5. The movement impeding action of the coupling portion 9b will tend to impede relative telescoping movement of mandrel means 5 within lower casing means 8. As a result, telescoping action of upper casing means 6, sufficient to bring ports 601 and 501 into communicating alignment will occur prior to any movement of mandrel means 5 sufficient to bring casing means end portions 602 and 803 into abutting alignment or to bring the tester ports 1004 and 1008 into communicating alignment. With the circulating ports 601 and 501 aligned, the upper casing means end portion 602 will have converged toward the lower casing means end portion 803 to such an extent as to prevent subsequent opening of the tester valve.

With the circulating valve open, fluid may be circulated downwardly through the annular space G for a period of time sufficient to displace the sample fluids from the passage means B, upwardly through the interior of the string 2.

The relative positions of the tester tool components with the circulating valve open and the tester valve closed are shown in FIGURE 3.

At the completion of a testing operation it may be desirable to then remove the entire tester tool and packer assembly from a well bore. This may be accomplished by conventional manipulations effective to retract the packer seal 403. An upward force exerted on the string 2 will then move the entire tester tool and packer assembly upwardly and out of the well. It should be noted that during such a withdrawal, the upward force exerted upon the string 2 will tend to hold the tester valve and the circulating valve in closed valve positions, i.e., the circulating valve ports 601 will be held above and out of communication with the circulating valve ports 501 and the tester valve port means 1004 will be held above and out of alignment with the tester valve ports 1008.

If additional well operations are to be performed such as the injection of treating fluids or cement, the slide valve

assembly 10 may be disconnected from the mandrel means 5 and moved upwardly through the interior of the mandrel means 5 and string 2 by conventional circulating techniques as described in Farley Patent 3,190,360. To effect this circulating out of the slide valve assembly 10, the connecting means 1003 would be disengaged, the packer assembly ports 410 and 411 placed in communicating alignment, and fluid circulated downwardly through the annular space G and into the packer assembly interior 401.

The manner in which connection 1003 may be released, in addition to being described in Farley Patent 3,190,360, is hereinafter briefly reviewed.

Structural details

FIGURES 4 through 10 illustrate, in enlarged and somewhat greater detail, the principal components of the tester tool shown in FIGURES 1 through 3. FIGURES 6 through 9 additionally illustrate details of the slide valve assembly 10 and structure pertinent to its operation.

FIGURE 4 illustrates structural details of the upper end of the upper casing means 6. As there shown, a shear ring 603 may be secured by shear pins 604 to the interior of the casing means above the piston means 11.

Shear ring 603 functions to prevent inadvertent or undesired downward movement of casing means 6 relative to mandrel means 5 sufficient to effect the moving of circulating ports 601 into communicating alignment with circulating ports 501. When operation of the circulating valve is desired, a downward force may be exerted upon casing means 6 sufficient to shear the pins 604 and allow the casing means 6 to telescope downwardly over piston means 11 and mandrel means 5.

Piston means 11 as shown in FIGURE 4 comprises a radially enlarged piston portion 1104 sealingly engaged with a radially recessed casing wall portion 1105. A sleeve 1106 of piston means 11 projects upwardly from piston portion 1103, in spaced relation with wall portion 1105, to terminate in slidable and sealing engagement with casing means wall portion 1107.

Thus, as will be apparent, pressurized chamber D is defined, in part, by the annular space between sleeve 1104 and the cylindrical casing wall 1105.

FIGURE 8 illustrates details of connection 9a which extends between lower casing means 8 and mandrel means 5. This axially releasable, clutch connection comprises a plurality of blocks 901 which are mounted for longitudinal sliding but non-rotary movement within longitudinal grooves 905 formed on the inner periphery of casing means 8 as shown in FIGURE 8. The lower ends of grooves 905 terminate and open into an annular recess 906. With the blocks 901 moved down into recess 906, casing means 8 becomes rotatable relative to the mandrel means 5. A coil spring 907 biases the blocks 901 upwardly into the grooves 905.

Each block 901 is slidingly received within a longitudinally extending groove 908 formed on the outer periphery of mandrel means 5 as generally shown in FIGURE 8. When mandrel means 5 is telescoped downwardly within sleeve means 8, an annular shoulder 909 will engage blocks 901 and move these blocks axially downwardly out of grooves 905 and into annular recess 906. With the blocks 901 disposed in the annular recess 906, the mandrel means 5 may be rotated relative to the casing means 8 to effect the releasing operation of the connection 1003 as hereinafter described. It will be understood, of course, that rotary force is transmitted to mandrel means 5 through casing means 6 by virtue of lug and slot connection 7.

Hydraulic impedance coupling 9b, as shown in FIGURES 8 and 9, comprises an O-ring type, elastomeric, check valve member 910 confined for movement between annular shoulder 911 and generally axially apertured shoulder 912. While the outer diameter of mandrel wall portion 913 provides some annular clearance between it and the adjacent wall portion 914 of casing means 8, when the valving ring 910 is disposed as shown, fluid flow be-

tween this annular clearance is prevented. With the valving ring in this position, fluid contained within the space H, in order to move into the space I when mandrel means 5 moves downwardly relative to casing means 8, must pass through flow restricting passages 915. Flow restricting, bypass passages 915, as described in the previously noted Schwegman Patent 2,740,479, may be provided with metering pins to effectively restrict the flow of fluid between the annular spaces H and I. As will be appreciated, the diameter of the mandrel portion 916 adjacent the exits 917 of the restricted flow passages 915 should be such as to be spaced from the adjacent inner wall portion 918 of mandrel means 5 so as to provide an adequate flow passage leading into the chamber I.

At the lower end of space H, an additional fluid bypass passage 919 may be provided in the wall of casing means 8, including an entrance 920 and an exit 921.

With the arrangement of components of impedance coupling 9b as described, and with the chamber H containing previously inserted hydraulic fluid, a hydraulic impedance coupling action will result as described in the aforesaid Schwegman patent. Downward movement of the mandrel means 5 will cause the valving ring 910 to move into the seat 911 and cause fluid to flow through restricted passage means 915 from the space H to the space I. The flow impeding effect of the bypass passage means 915 will tend to delay or impede telescoping movement of mandrel means 5 until the valving ring 910 is moved between entrance 920 and exit 921 of bypass passage 919. With the valving ring 910 disposed between the entrance 920 and exit 921, sufficient additional bypassing of the ring 910 will occur as to enable a sudden relatively rapid downward movement of the mandrel means 5.

Upward movement of mandrel means 5 will not be effectively impeded by the check valving ring 910 to the resulting movement of the ring 910 against the shoulder 912. This movement of ring 910 will enable fluid to bypass the ring 910 and move from space I through the space between surface 918 and mandrel portion 916, through the space between surfaces 913 and 914, and through the ring ports 922 into the space H as generally described in the aforesaid Schwegman patent.

Structural details of piston means 12 are illustrated in FIGURE 9. Piston means 12 is defined by a radially enlarged portion 1204 of mandrel means 5. As illustrated, enlarged piston portion 1204 is adapted to reciprocate axially within the limits of annular recess E formed in the lower end of casing means 8. A sleeve-like portion 1205 of mandrel means 5 projects downwardly from piston portion 1204 into slidable, telescoping and sealing engagement with a wall portion 1206 of lower casing means 8.

As further shown in FIGURE 9, ports 1203 intersect an upper sleeve-like portion 1207 of mandrel means 5 to communicate with the annular space E above the enlarged piston portion 1204.

The structural characteristics of the slide valve assembly 10 correspond in several basic aspects to the structure of the detachable slide valve assembly featured in my copending application Serial No. 189,822. Accordingly, the components of this slide valve assembly, which are illustrated in FIGURES 6 through 9 and 11 through 14, and their mode of operation need here be only briefly described.

The lower slide valve portion 1005, as previously noted, includes tester valve ports 1004 and is adapted to be mounted for non-rotary movement within the lower end of lower casing means 8 by virtue of the cooperating relationships which exist between blocks 1006, lugs 801, and between lugs 1007 and shoulder 802. As illustrated, blocks 1006 may be spring-biased outwardly into grooves between lugs 801 by conventional means such as the schematically shown leaf springs 1010.

Portion 1005 may include a conventional threaded coupling 1011 for attachment to pressure recorder 1001.

Upper portion 1002 of slide valve assembly 10 includes as its principal components a stem 1012, a tubular body portion 1013, a setting mandrel 1014, and a valve plunger 1015. Stem 1012 is telescopically mounted for limited reciprocation within tubular body portion 1013 and carries an inverted, resilient cup 1016. Body portion 1013, in turn, connected by a swivel mounting 1017 to the generally tubular valve plunger 1015. Valve plunger 1015, which carries tester valve ports 1008, includes rib-like portions 1018 circumferentially alternating with longitudinally extending grooves 1019. Circumferentially spaced, spline-like ribs 1020 carried by lower valve portion 1002 are disposed within grooves 1019 so as to provide a splined interconnection between valve portions 1002 and 1005.

Setting mandrel 1014 is mounted for limited axial reciprocation within tubular body portion 1013. A plurality of latching dogs 1021 are supported by a retainer collar 1022 and a biasing coil spring 1023 on body portion 1013 and are shown in their radially retracted position in FIGURE 7. A plurality of abutment defining blocks 1024 carried by body portion 1013 are biased outwardly by means such as the schematically shown leaf springs 1025 into an annular recess 1026 formed in mandrel means 5 above an abutment defining mandrel means shoulder 1027.

Relative rotation between setting mandrel 1014 and tubular valve body portion 1013 is prevented by a spline connection 1023 which allows relative telescoping movement of these components.

A plurality of circumferentially spaced, spline-like blocks 1028 are carried by mandrel means 5 and biased radially inwardly toward valve assembly 10 by means such as the schematically shown leaf springs 1029. These blocks 1028 are carried beneath a downwardly facing, mandrel means shoulder 1030.

Dogs 1021, blocks 1028, shoulder 1030, blocks 1024, and shoulder 1027 may be viewed as the principal components of detachable connection 1003.

A rotary nut 1031 is connected by a conventional threaded connection 1032 to setting mandrel 1014. Threaded nut 1031 is mounted for limited sliding but non-rotational movement relative to valve plunger 1015 by the schematically shown spline connection 1033. A self-constricting snap ring 1034 is mounted above spline connection 1033, and is secured on plunger 1015, as shown, so as to be substantially immovable in an axial direction on this plunger. A snap ring receiving groove 1035 is formed on the upper end of rotary nut 1031 as shown.

FIGURES 6 and 7 illustrate the disposition of the aforementioned components as they would be disposed prior to a latching of the slide valve assembly to the mandrel means 5 through connection 1003. As is generally described in Farley Patent 3,190,360, this latching is achieved by exerting a downward force through either mechanical or hydraulic means on stem 1012. Stem 1012 transmits this downward movement to the setting mandrel 1014. Downward movement of the setting mandrel, induced by this force, causes a cam surface 1036 on the setting mandrel to cam the latching dogs 1021 radially outwardly into spaces between the blocks 1028 and into locking position beneath the mandrel means shoulder 1030. This radially extending position of latching dogs 1020 in latching engagement with mandrel means 5 is illustrated in FIGURE 11.

With the latching dogs 1021 thus disposed, both upward and rotary movement of the slide valve elements 1013 relative to the mandrel means 5 is prevented. Downward movement of the valve elements 1013 relative to mandrel means 5 is prevented by engagement of the blocks 1024 with the mandrel means shoulder 1027.

When setting mandrel 1014 is displaced sufficiently to expand dogs 1021 into latching engagement with mandrel means 5, recessed groove portion 1035 of rotary

13

nut 1031 will have moved opposite snap ring 1034. Snap ring 1034, at this point, will constrict into the groove 1035 and engage nut shoulder 1037 so as to prevent upward movement of setting mandrel 1014. This disposition of the snap ring 1028, which secures the nut 1031 and the setting mandrel 1014 in their lowermost positions is illustrated in FIGURE 13.

As described in my aforesaid Patent No. 3,190,360, the release of the latching dogs 1021 from locking engagement with mandrel means 5 may be effected by rotating the mandrel means 5 relative to the lower casing means 8. This rotation is effected by moving the mandrel means downwardly so that the blocks 901 are moved into the annular recess 906.

With the mandrel means 5 thus free to rotate relative to the packer-anchored lower casing means 8, with the valve plunger 1015 splined to valve portion 1005, with valve portion 1005, in effect, splined to casing means 8, with valve tubular body portion 1013 swivel connected by joint 1017 to valve plunger 1015, and by virtue of the spline connection 1023 provided between valve body portion 1013 and setting mandrel 1014, rotation of mandrel means 5 in an appropriate direction will tend to rotate the setting mandrel 1014 so as to advance it upwardly out of the rotary nut 1031. Sufficient rotation of the mandrel means 5 will restore the setting mandrel to the elevational position shown in FIGURE 7 to enable the retraction of the latching dogs 1021.

With the release of the latching dogs 1021 of the connection 1003, the slide valve assembly 10 is freed for telescoping movement upwardly out of the mandrel means 5 and through the supporting conduit string 2.

Included throughout the tester tool 1 may be a number of equalizing and/or venting ports P of a conventional nature, some of which are shown in the drawings. Also included and schematically illustrated are a variety of conventional ring type seals S of differing sizes and types, depending upon the components with which they are associated. Additional conventional components included in the tool are schematically illustrated, rotary or thrust bearing assemblies X.

It will be understood, that, in describing structural details of the tool, many components which would ordinarily be fabricated from multiple, rotatably interconnected sections are merely illustrated as unitary components so as to avoid obscuring the main aspects of the invention.

Advantages

In describing the structure and mode of operation of the preferred tested tool embodiment, several major advantages of the invention have been demonstrated.

For example, through the utilization of the mandrel in combination with upper and lower, separately telescoping, casing sections, a uniquely effective double slide valve tester tool structure has resulted.

The incorporation of a hydraulic impedance coupling between the mandrel and one of two separately telescopic, casing sections affords positive and reliable means for attaining the controlled operation of one slide valve while another slide valve remains, in effect, substantially immobilized.

Through the utilization of a unique, detachable slide valve assembly, a structurally and functionally improved detachable tester valve unit has resulted.

The novel utilization of piston means to provide a releasable hydraulic coupling between the upper casing means and the mandrel means, in and of itself, affords several significant advantages. After the tester valve has been closed, the movement of the piston means out of engagement with the mandrel means yields a positive and sustained surface indication of the successful closing of the tester valve.

The piston means which provides a hydraulic coupling between the lower casing means and the mandrel means

14

is also particularly noteworthy. It exerts an upward hydraulic balancing force against the mandrel means. It provides a continuously effective force transmitting coupling between the mandrel means and the lower casing means to enable the transmission of force to tool components disposed beneath the tester tool. In addition, it provides an expanding chamber to receive trapped fluid being compressed during downward movement of the mandrel means.

In particular, it should be noted that the operation of the tester valve may be accomplished as often as possible by merely repeating linear upward and downward movements of the conduit string supporting the tester tool. When the tool is being moved upwardly out of a well, the arrangement of the slide valve components are such as to insure that both the tester valve and the circulating valve are closed. The upper casing means are critically spaced on the mandrel means so as to insure that while the tester valve is open the circulating valve is closed, and while the circulating valve is open the tester valve is closed.

To those skilled in the art and familiar with this invention, additions, deletions, substitutions, and modifications with respect to the disclosed structure and operation techniques may readily occur. Such alterations, falling within the overall purview of this invention, are deemed to be encompassed within the scope of the appended claims.

I claim:

1. An apparatus for controlling the flow of fluid in a well bore, said apparatus comprising:
 - mandrel means;
 - first casing means telescopically mounted on said mandrel means;
 - first connecting means between said mandrel means and said first casing means adapted to permit limited telescoping movement of said first casing means relative to said mandrel means;
 - second casing means telescopically mounted upon said mandrel means;
 - second connecting means between said mandrel means and said second casing means adapted to permit limited telescoping movement of said mandrel means relative to said second casing means;
 - slide valve means adapted to be detachably mounted within said mandrel means and including
 - a first portion adapted to be detachably secured to said mandrel means for axial movement therewith;
 - first port means carried by said first portion;
 - a second portion adapted to be secured within said second casing means;
 - second port means carried by said second portion;
 - said first portion and said second portion defining first fluid passage means communicating with said first port means;
 - relative telescoping movement of said mandrel means and said second casing means being adapted to induce relative telescoping movement of said first and second portions of said slide valve means to move said first and second port means into communicating alignment; and
 - selectively releasable coupling means adapted to connect said first portion to said mandrel means for unitary axial movement therewith;
 - third port means carried by said mandrel means;
 - fourth port means carried by said first casing means;
 - said first casing means and said mandrel means defining second fluid passage means communicating with said first fluid passage means of said slide valve means and said third port means of said mandrel means;
 - relative telescoping movement of said first casing means and said mandrel means being adapted to bring said third and fourth port means into communicating alignment; and

said second casing means defining third fluid passage means communicating with said second port means of said slide valve means.

2. An apparatus as described in claim 1 wherein said second connecting means comprises means interposed between said mandrel means and said second casing means adapted to impede, without preventing, relative telescoping movement of said mandrel means and said second casing means whereby an axial force imposed upon said first casing means and directed toward said second casing means will tend to cause relative telescoping movement of said first casing means and said mandrel means which is more rapid than relative telescoping movement of said mandrel means and said second casing means induced by said imposed force.

3. An apparatus as described in claim 1 wherein said first and second casing means include axially spaced and mutually facing end portions, said end portions being disposed so that relative telescoping movement of said first casing means and mandrel means sufficient to bring said third and fourth port means into alignment will prevent relative telescoping movement of said mandrel means and second casing means sufficient to bring said first and second port means into alignment.

4. An apparatus as described in claim 1 including: piston means mounted within and carried by said first casing means;

abutment means carried by said first casing means and adapted to limit axial movement of said piston means;

a pressurized fluid chamber adapted to contain pressurized fluid tending to urge said piston means toward said abutment means and said mandrel means; aperture means carried by said first casing means and adapted to admit pressurized fluid to said pressurized fluid chamber;

said piston means being adapted to engage said mandrel means during an initial portion of telescoping movement of said first casing means, relative to said mandrel means, in a direction away from said second casing means and be engaged by said abutment means and held out of engagement with said mandrel means during a terminal portion of said telescoping movement of said first casing means away from said second casing means.

5. An apparatus as described in claim 1 including: piston means mounted within said second casing means in force transmitting relation with said mandrel means;

piston head means carried within said second casing means;

a pressurized fluid chamber between said piston means and said piston head means; and

aperture means carried by said second casing means and adapted to admit pressurized fluid to said pressurized fluid chamber.

6. An apparatus for controlling the flow of fluid in a well bore, said apparatus comprising:

mandrel means; first casing means telescopically mounted on said mandrel means;

first connecting means between said mandrel means and said first casing means adapted to permit limited telescoping movement of said first casing means relative to said mandrel means;

second casing means telescopically mounted on said mandrel means;

second connecting means between said mandrel means and said second casing means adapted to permit limited telescoping movement of said mandrel means relative to said second casing means;

said second connecting means comprising means interposed between said mandrel means and said second casing means adapted to impede, without preventing, relative telescoping movement of said mandrel means

and said second casing means whereby an axial force imposed upon said first casing means and directed toward said second casing means will tend to cause relative telescoping movement of said first casing means and said mandrel means which is more rapid than relative telescoping movement of said mandrel means and said second casing means induced by said imposed force;

slide valve means adapted to be detachably mounted within said mandrel means and including

a first portion adapted to be detachably secured to said mandrel means for axial movement therewith;

first port means carried by said first portion;

a second portion adapted to be secured within said second casing means;

second port means carried by said second portion;

said first portion and said second portions defining first fluid passage means communicating with said first port means;

relative telescoping movement of said mandrel means and said second casing means being adapted to induce relative telescoping movement of said first and second portions of said slide valve means to move said first and second port means into communicating alignment; and

selectively releasable coupling means adapted to connect said first portion to said mandrel means for unitary axial movement therewith;

third port means carried by said mandrel means;

fourth port means carried by said first casing means;

said first casing means and said mandrel means defining second fluid passage means communicating with said first fluid passage means of said slide valve means

and said third port means of said mandrel means;

relative telescoping movement of said first casing means and said mandrel means being adapted to bring said third and fourth port means into communicating alignment;

said second casing means defining third fluid passage means communicating with said second port means of said slide valve means;

first piston means mounted within and carried by said first casing means;

abutment means carried by said first casing means and adapted to limit axial movement of said first piston means;

a first pressurized fluid chamber adapted to contain pressurized fluid tending to urge said first piston means toward said abutment means and said mandrel means;

first aperture means carried by said first casing means and adapted to admit pressurized fluid to said first pressurized fluid chamber;

said first piston means being adapted to engage said mandrel means during an initial portion of telescoping movement of said first casing means, relative to said mandrel means, in a direction away from said second casing means and be engaged by said abutment means and held out of engagement with said mandrel means during a terminal portion of said telescoping movement of said first casing means away from said second casing means;

second piston means mounted within said second casing means in force transmitting relation with said mandrel means;

piston head means carried by said second casing means;

a second pressurized fluid chamber between said second piston means and said piston head means; and

second aperture means carried by said second casing means and adapted to admit pressurized fluid to said second pressurized fluid chamber.

7. An apparatus for controlling the flow of fluid in a well bore, said apparatus comprising: generally annular mandrel means;

first, generally annual casing means telescopically mounted over said mandrel means;
 first connecting means between said mandrel means and said first casing means adapted to permit limited telescoping movement of said first casing means relative to said mandrel means, said first connecting means comprising slot means carried by said mandrel means and lug means carried by said first casing means which project into said slot means;
 second, generally annular casing means telescopically mounted over said mandrel means;
 second connecting means between said mandrel means and said second casing means adapted to permit limited telescoping movement of said mandrel means relative to said second casing means, said second connecting means comprising hydraulic coupling means interposed between said mandrel means and said second casing means adapted to impede, without preventing, relative telescoping movement of said mandrel means and said second casing means whereby an axial force imposed upon said first casing means and directed toward said second casing means will tend to cause relative telescoping movement of said first casing means and said mandrel means which is more rapid than relative telescoping movement of said mandrel means and said second casing means induced by said imposed force;
 slide valve means adapted to be detachably mounted within said mandrel means and including
 a first, generally annual portion adapted to be detachably secured to said mandrel means for unitary axial movement therewith;
 first port means carried by said first portion;
 a second portion adapted to be secured within said second casing means in splined relationship therewith and telescopically receiving said first portion in splined relationship therewith;
 second port means carried by said second portion;
 said first portion and said second portion defining first fluid passage means communicating with said first port means;
 relative telescoping movement of said mandrel means and said second casing means being adapted to induce relative telescoping movement of said first and second portions of said slide valve means to move said first and second port means into communicating alignment; and
 selectively releasable coupling means adapted to connect said first portion to said mandrel means for unitary axial movement therewith;
 third port means carried by said mandrel means;
 fourth port means carried by said first casing means;
 said first casing means and said mandrel means defining second fluid passage means communicating with said first fluid passage means of said slide valve means and said third port means of said mandrel means; and
 relative telescoping movement of said first casing means and said mandrel means being adapted to bring said third and fourth port means into communicating alignment;
 said second casing means defining third fluid passage means communicating with said second port means of said slide valve means;
 first piston means mounted within and carried by said first casing means;
 abutment means carried by said first casing means and adapted to limit axial movement of said first piston means;
 a first pressurized fluid chamber adapted to contain pressurized fluid tending to urge said first piston means toward said abutment means and said mandrel means;
 first aperture means carried by said first casing means

and adapted to admit pressurized fluid to said first pressurized fluid chamber;
 said first piston means being adapted to engage said mandrel means during an initial portion of telescoping movement of said first casing means, relative to said mandrel means, in a direction away from said second casing means and be engaged by said abutment means and held out of engagement with said mandrel means during a terminal portion of said telescoping movement of said first casing means away from said second casing means;
 second piston means mounted on said mandrel means within said second casing means in force transmitting relation with said mandrel means;
 piston head means carried by said second casing means; a second pressurized fluid chamber between said second piston means and said piston head means;
 second aperture means carried by said second casing means and adapted to admit pressurized fluid to said second pressurized fluid chamber; and
 said first and second casing means including axially spaced and mutually facing end portions, said end portions being disposed so that relative telescoping movement of said first casing means and mandrel means sufficient to bring said third and fourth port means into alignment will prevent relative telescoping movement of said mandrel means and second casing means sufficient to bring said first and second port means into alignment.

8. A well tool comprising:
 a first portion;
 a second portion mounted for reciprocating movement relative to said first portion;
 piston means mounted within said first portion;
 abutment means carried by said first portion and adapted to limit axial movement of said piston means;
 a pressurized fluid chamber adapted to contain pressurized fluid tending to urge said piston means toward said abutment means and said second portion;
 aperture means carried by said first portion and adapted to admit pressurized fluid to said chamber;
 said piston means being adapted to engage said second portion of said tool during an initial portion of movement of said first portion in one direction and be engaged by said abutment means and moved out of engagement with said second portion during a terminal part of said movement of said first portion in said one direction.

9. A well tool as described in claim 8 wherein at least one of said tool portions comprises a slide valve member.

10. An apparatus for controlling fluid flow within a well bore, said apparatus comprising:
 a first portion;
 a second portion upon which said first portion is mounted for limited telescoping movement;
 a third portion upon which said second portion is mounted for limited telescoping movement;
 first slide valve means carried by, and operable in response to telescoping movement of, said first and said second portions;
 second slide valve means carried by, and operable in response to telescoping movement of, said second and said third portions;
 means detachably securing said second slide valve means within said second and third portions, with said second slide valve means, when detached from said second and third portions, being axially movable from said second and third portions through said first portion; and
 means interposed between two telescopically assembled portions of said first, second and third portions and adapted to impede without preventing relative telescoping movement of said two telescopically assembled portions.

19

11. An apparatus as described in claim 10:
 wherein said last-named means is interposed between
 said second portion and said third portion and
 adapted to impede without preventing, relative telescoping
 movement of said second portion and said third portion whereby an axial force imposed upon
 said first portion and directed toward said third portion
 will tend to cause relative telescoping movement
 of said first and second portions at a more rapid
 rate than relative telescoping movement of said second
 and third portions induced by said imposed
 force; and
 wherein said apparatus includes means carried by said
 first and third portions operable to limit relative
 movement of said first and third portions and prevent
 opening of said second valve means after the
 opening of said first valve means.
 12. An apparatus for controlling fluid flow within a
 well bore, said apparatus comprising:
 a first portion;
 a second portion upon which said first portion is mounted
 for limited telescoping movement;
 a third portion upon which said second portion is mounted
 for limited telescoping movement;
 first slide valve means carried by, and operable in

20

response to telescoping movement of, said first and
 said second portions;
 second slide valve means carried by, and operable in
 response to telescoping movement of, said second
 and said third portions;
 means carried by said first and third portions operable
 to limit relative movement of said first and third portions
 and prevent opening of said second valve means
 after the opening of said first valve means; and
 means interposed between two telescopically assembled
 portions of said first, second and third portions and
 adapted to impede without preventing relative telescoping
 movement of said two telescopically assembled
 portions.

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