

- [54] **METHOD AND APPARATUS FOR SUB-SURFACE DEFORMATION OF WELL PIPE**
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- [52] **U.S. Cl.** **166/298, 166/314, 166/55.2**
- [51] **Int. Cl.** **E21b 29/00, E21b 43/11**
- [58] **Field of Search** **166/298, 100, 314, 315, 166/55-55.8; 175/77**

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- [57]
- ABSTRACT**

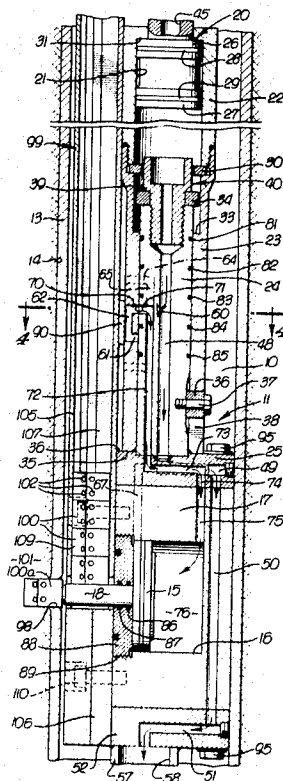
Laterally directed deformation force is applied to structure at a selected location in a longitudinal bore hole, through use of a tool that comprises a pressure responsive actuator having a laterally displaceable plunger, and means to control fluid pressure application to the actuator. The tool is displaced lengthwise of the bore hole to selected location by running of a pipe string carrying the tool, and fluid pressure is transmitted within the string and its application to the actuator is controlled to effect lateral displacement of the plunger toward the structure outwardly of the tool, with resultant deformation of the structure. Flow beams may be selectively placed in the structure, as for example punched through well casing, by operation of the tool; and other deformation operations may be performed at selected locations in a well.

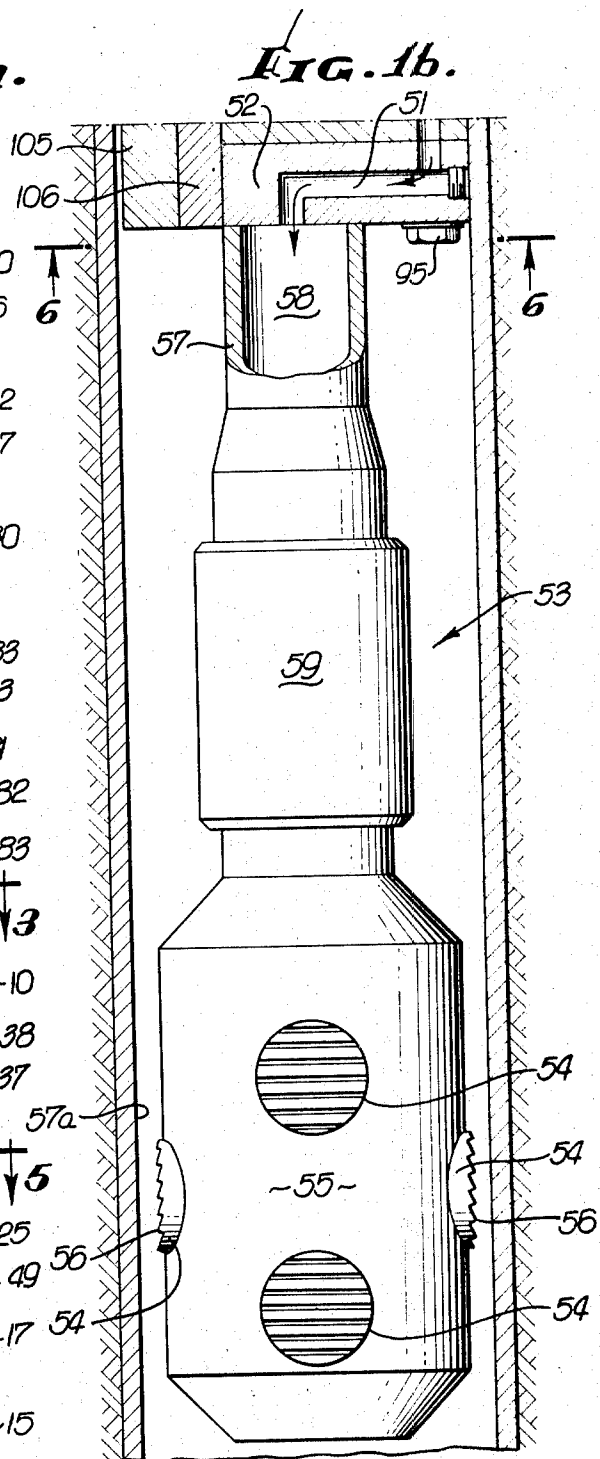
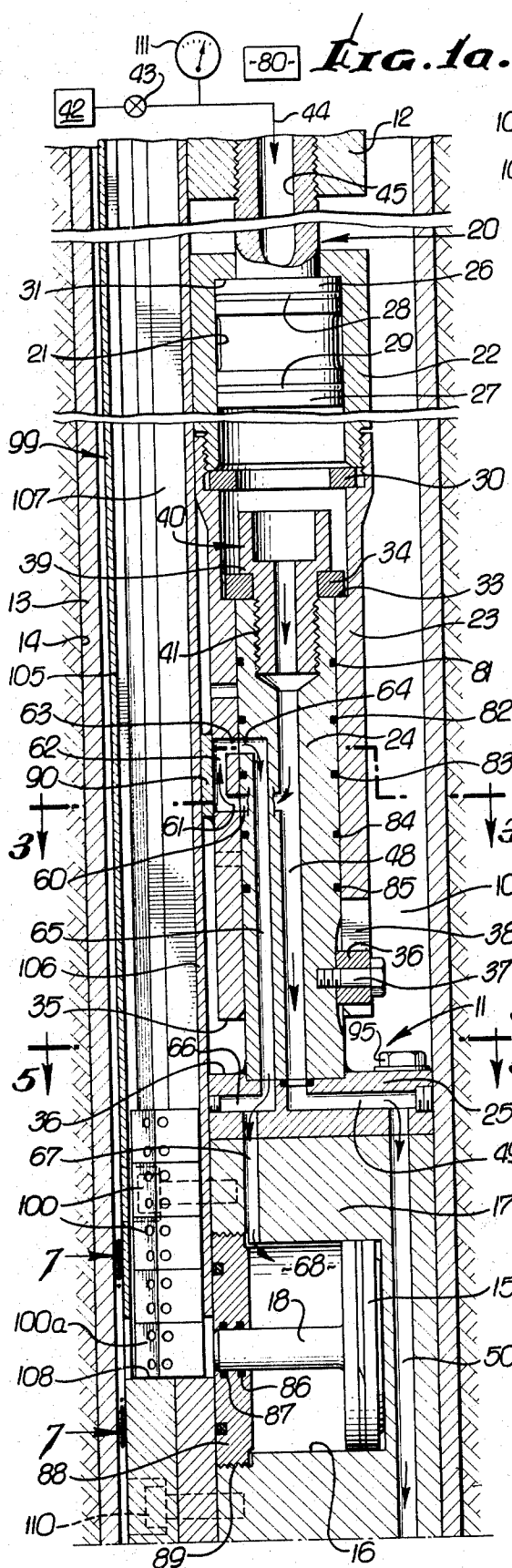
29 Claims, 15 Drawing Figures

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FIG. 2.

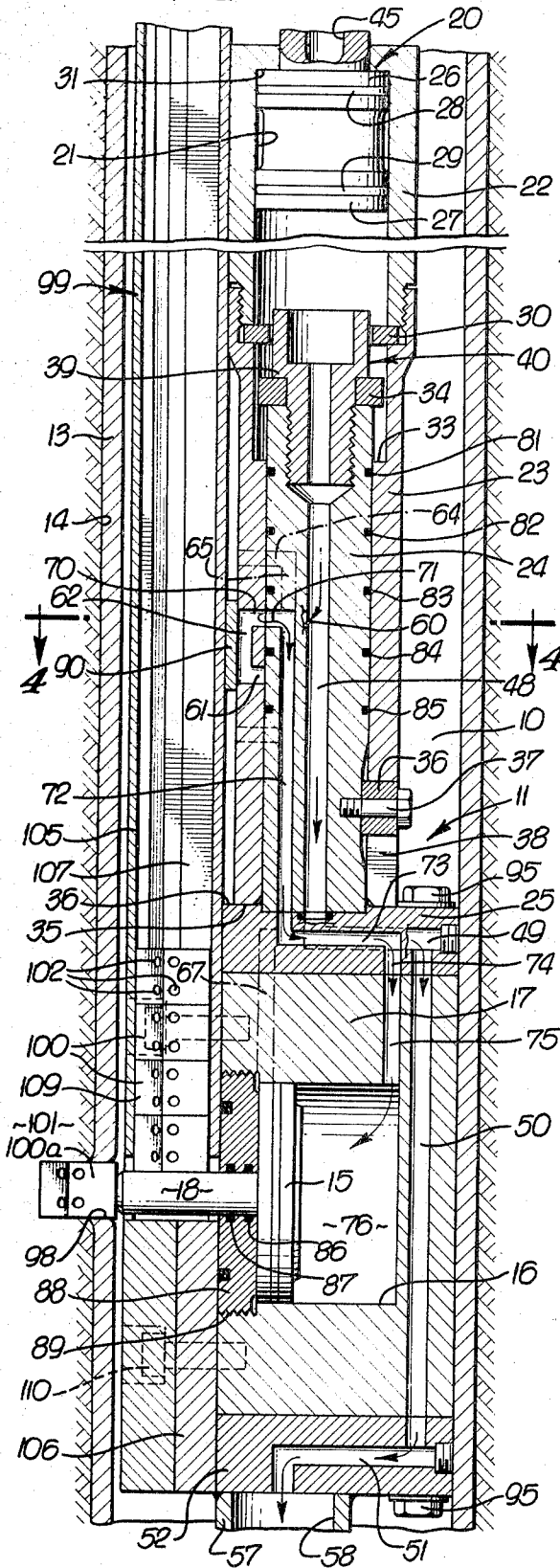


FIG. 3.

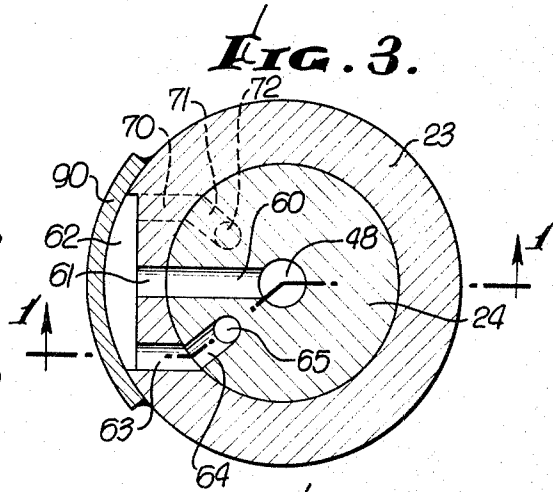


FIG. 4.

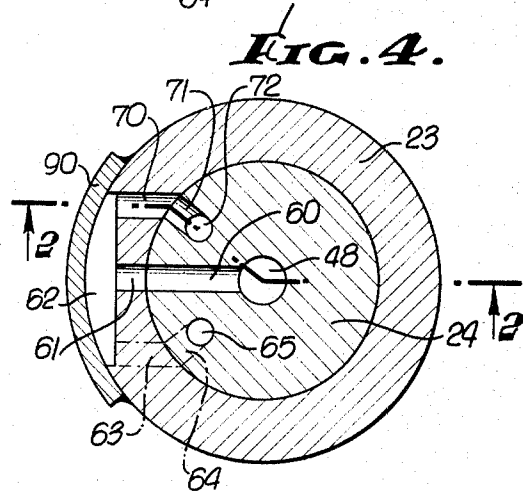
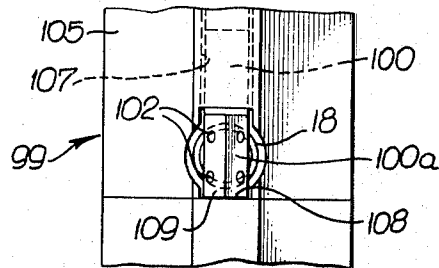


FIG. 7.



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FIG. 5.

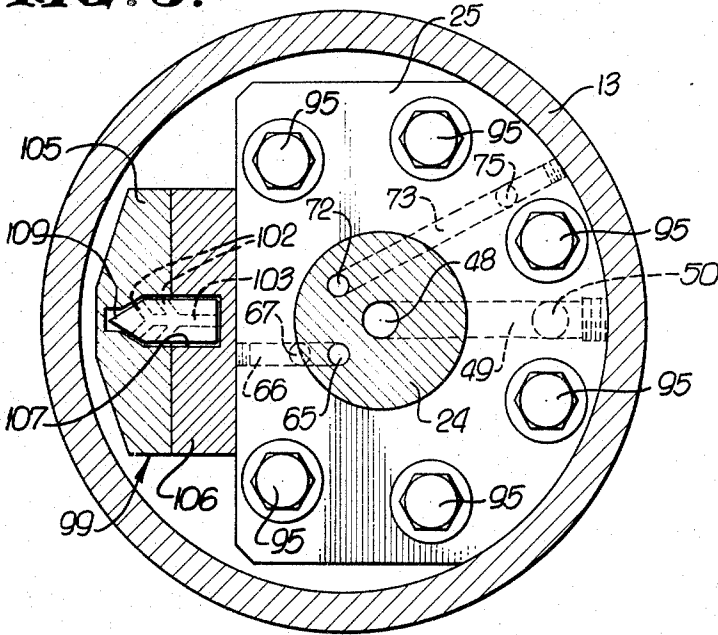


FIG. 12.

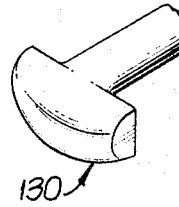


FIG. 11.

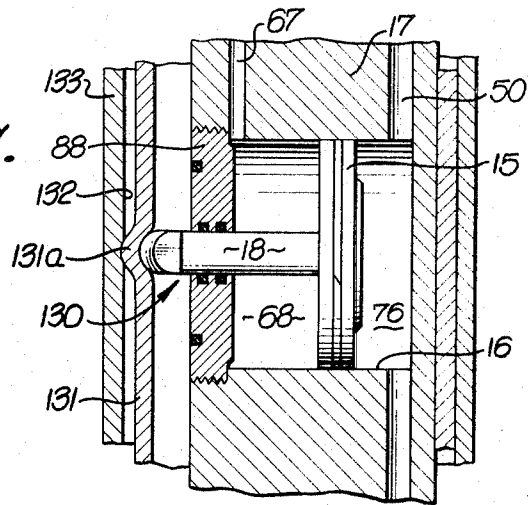
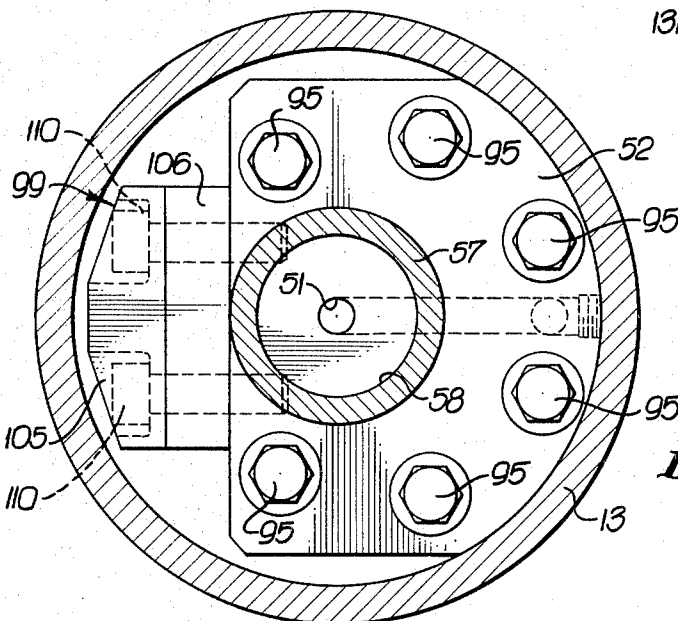
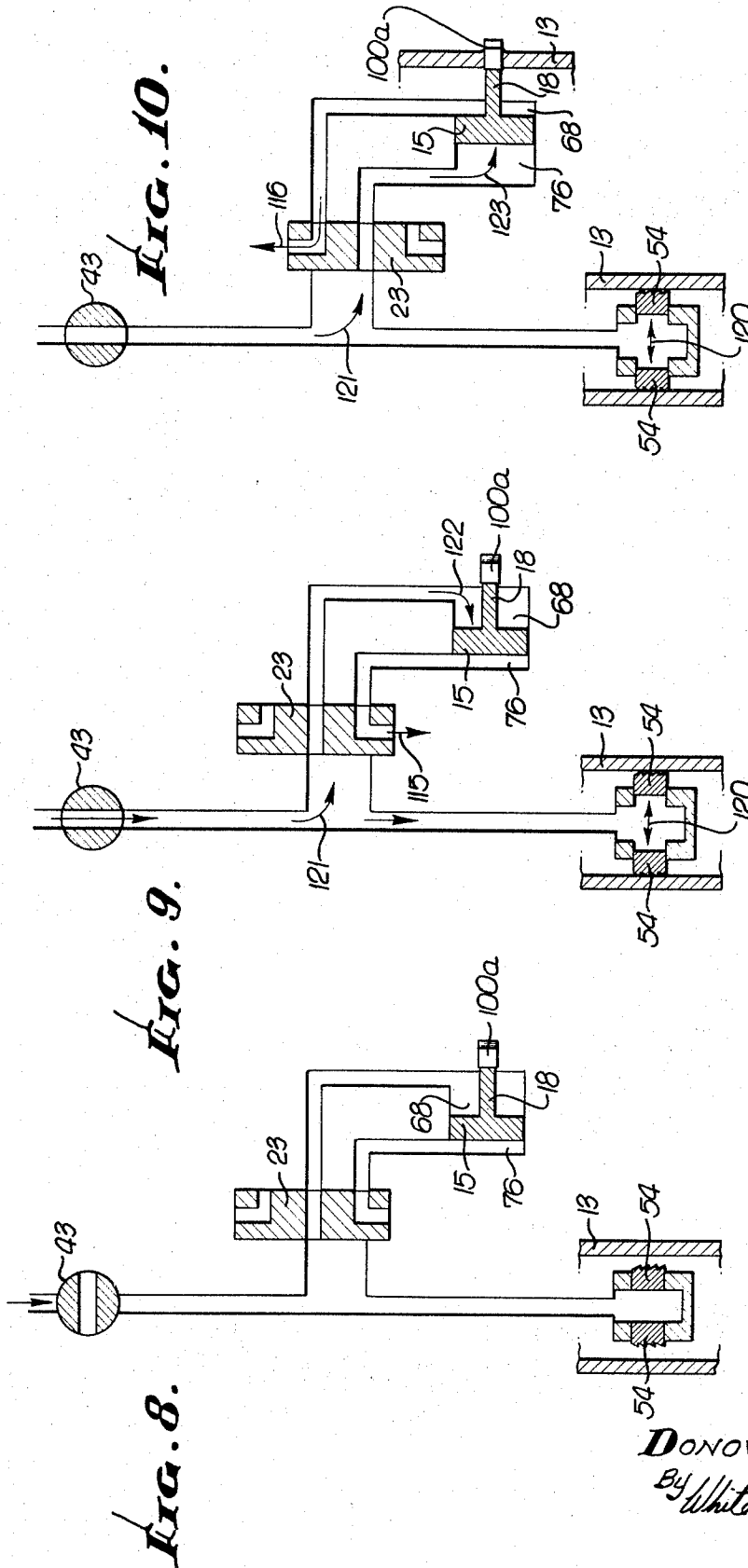


FIG. 6.



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METHOD AND APPARATUS FOR SUB-SURFACE DEFORMATION OF WELL PIPE

BACKGROUND OF THE INVENTION

This invention relates generally to locally controlled application of deformation force in bore holes, and more particularly concerns method and apparatus for utilizing fluid pressure transmitted within a pipe string in the hole to effect application of such force via a tool carried by the string. As will be seen, structure such as an earth formation, pipe or casing surrounding the tool in the bore hole may be controllably deformed in accordance with the invention. As one example, well casing may be perforated, with realization of heretofore unknown advantages.

SUMMARY OF THE INVENTION

In the past, a number of tools and methods of perforating well casing were developed for the purpose of causing the casing to act as a filtering means to pass well fluid into the casing interior while keeping sand and rock at the casing exterior. First, cable tool knives were developed to make elongated gashes in the casing wall; however, such gashed casing had limited use since the openings would permit unrestricted flow of sand and shale into the well bore. Also, if the cuts were placed close together they would undesirably weaken the casing, oftentimes leading to early collapse. Later, punches were developed to perforate casing in the well, but were formed to make holes of too large size so that the above problems remained. Still later, casing perforations were produced by explosively shooting bullets (and later jetting bullets) through the wall. The jet gun became widely used, and many oil producers accordingly altered their well completion methods, as by first setting pipe through the producing zone and then jet gun perforating the casing for production. Only after a number of years passed did the industry come to realize that severe damage to the casing oftentimes resulted from such perforating methods. For example, it was found that bullet formed holes were often too large; and if a sufficient number of such holes were made in an attempt to realize desired drainage of fluid into the casing, the casing tended to become weakened and plugged by entering sand and shale.

SUMMARY OF THE INVENTION

It is a major object of the invention to provide method and apparatus for perforating well casing in a manner as will obviate the above described difficulties and problems. Additionally the invention is directed to the use of fluid pressure within a pipe in a bore hole to effect application, via a tool supported by the pipe of force calculated to controllably deform structure surrounding the tool.

In its method aspects, the invention is directed to the use of such a tool that comprises a pressure responsive actuator having a laterally displaceable plunger and means to control fluid pressure application to the actuator, and involves steps that include displacing the tool lengthwise of the bore hole to a selected location by running of the string; and, transmitting fluid pressure within the string and operating the control means to apply fluid pressure to the actuator thereby to effect displacement of the plunger laterally toward the outer

structure and deformation of such structure to which deforming force is transmitted via the plunger.

As will be seen, a pre-perforated body, referred to as a flow bean, may be carried by the tool to be outwardly displaced by the plunger so as to penetrate into the structure, the latter typically comprising well casing through the wall of which the flow beam penetrates with sealing action. In this regard, one such bean is described in my copending application Ser. No. 47,957 for U. S. Letters Patent. Additional flow beans may be pressure inserted through the casing wall at selected locations, all without undue weakening of the wall since the beans become structurally integrated with the wall. Also, pre-perforation of the beans to desired and controlled hole size assures that sand and shale will not unduly enter the casing.

Another aspect of the method involves the carriage of a cutter to be outwardly displaced by the tool plunger so as to cut surrounding pipe at multiple radial locations, the tool being rotatably indexed between such radial locations at each of which the cutter is outwardly advanced and retracted so that the outer pipe may be completely removed. Instead of a cutter, a swage may be urged outwardly at each of such radial locations to progressively outwardly deform an inner surrounding pipe into annular sealing engagement with an outer surrounding pipe, in the well or bore hole. Still further, a punch may be operated in this manner to form multiple punched out perforations in the surrounding pipe.

Additional steps of the method may, with unusual advantage, include the operation of a fluid pressure control valve in the bore hole by displacing the string relative to the actuator, to control fluid pressure transmission to the actuator in actuating and release modes; and the setting of slip means carried by the pipe string to engage the well bore thereby to enable such string displacement relative to the actuator.

In its apparatus aspects the invention is directed to the provision of a tool sized for lengthwise running in the bore hole on a pipe string and to the selected location, the tool including an actuator as described above; together with means to control application to the actuator of sufficient fluid pressure transmitted within the string to effect plunger displacement laterally toward the outer structure and deformation of that structure to which deforming force is transmitted. Such deformation may be effected by a flow bean, or a cutter, swage, punch or other body, as described above. Also, a magazine may be carried by the tool to sequentially supply flow beans for controlled outward displacement by the plunger, as will be seen.

Additionally, the fluid pressure control means may with unusual advantage include a valve carried by the tool to be operated in response to displacement of the string relative to the actuator to control fluid pressure transmission to the actuator. That valve may typically comprise inner and outer sleeve members with ports movable into and out of registration in response to endwise displacement of the string to control fluid pressure transmission to the actuator in plunger advancing and retracting modes.

Finally, well bore engaging slip means may typically be carried by the string to be set in the well bore for enabling the described displacement of the string rela-

tive to the actuator. Such slips may with unusual advantage be fluid pressure responsive and in communication with pressurized fluid in the actuator.

These and other objects and advantages of the invention, as well as the details of an illustrative embodiment, will be more fully understood from the following specification and drawings, in which:

DRAWING DESCRIPTION

FIGS. 1a and 1b show a tool embodying the invention in vertical section, and as run in a well;

FIG. 2 is a view like FIG. 1a showing the tool in operation to set a flow bean;

FIG. 3 is a horizontal section taken on line 3—3 of FIG. 1a;

FIG. 4 is a horizontal section taken on line 4—4 of FIG. 2;

FIG. 5 is an enlarged horizontal section taken on line 5—5 of FIG. 1a;

FIG. 6 is an enlarged horizontal section taken on line 6—6 of FIG. 1b;

FIG. 7 is a fragmentary vertical side elevation taken on line 7—7 of FIG. 1a;

FIGS. 8, 9 and 10 are schematic views showing coordination of valve, slip and actuator operation;

FIG. 11 is a fragmentary vertical section showing the tool in operation to locally deform an inner pipe toward an outer pipe;

FIG. 12 is a perspective showing of a beading ram to be operated by the tool;

FIG. 13 is a perspective showing of a cut-off pause to be operated by the tool; and

FIG. 14 is a perspective showing of a hole punch to be operated by the tool.

DETAILED DESCRIPTION

In FIGS. 1a and 1b, apparatus for applying laterally directed deformation force to structure at selected location in a longitudinal bore hole 10 typically comprises a tool 11 sized to be run lengthwise in the bore hole and on a pipe string 12. The hole may, for example, be formed by casing 13 set in a well 14 from which petroleum or natural gas is to be produced. Generally speaking, the tool includes a fluid pressure responsive actuator, as for example may comprise a piston 15 slidable in lateral bore 16 formed by body 17, the actuator having a laterally displaceable plunger as at 18. In this regard, means is provided to control application to the actuator of sufficient fluid pressure transmitted within the string to effect displacement of the plunger laterally toward the structure outwardly of the tool and deformation of such structure to which deforming force is transmitted via the plunger.

In the illustrated example, the tubular string 12 integrally suspends a tubular mandrel 20 received in bore 21 of sleeve 22 connected with a tubular sleeve member 23. The latter slidably receives another tubular member 24, the lower end of which is integral with an upper terminal cap 25 on body 17. Mandrel includes flanges 26 and 27 having ring seals 28 and 29 engaging bore 21; also, the mandrel is vertically movable relative to sleeve 22 between an up-position as shown (wherein upper flange 26 engages shoulder 31 on member 22), and down-position (wherein lower flange 27 engages stop ring 30 retained between members 22—23).

Outer tubular member 23 is vertically movable or slidable relative to concentric inner tubular member 24 between an up-position as shown (in which stop shoulder 33 on member 23 engages stop ring 34) and a down-position (in which the lower terminal 35 of member 23 engages the upper face 36 of plate 25). Relative rotation of members 23 and 24 is blocked by guiding of a washer 36 (retained on member 24 as by pin 37) in a vertical slot 38 cut in sleeve member 23. Stop ring 34 may be retained in position by the flange 39 of a concentric tubular retainer 40 attached as at 41 to member 23.

Fluid pressure (for example water or petroleum) applied as at 44 from a surface source 42 via valve 43 and to the tubular string 12 is conducted via passages 45—48 as shown to the passages 49 and 50 in the plate 25 and body 17. In this regard, such pressure may typically be conducted via passage 51 (in lower plate 52) to means generally indicated at 53 for anchoring the tool or body in the bore hole, in order to effect and maintain such anchoring. Means 53 may advantageously include slips in the forms of pressure responsive buttons 54 carried in housing 55 to move laterally outwardly for effecting gripping engagement of the button jaws or serrations 56 with the casing bore wall 57a. Anchor means 53 is shown to include a tubular stem 57 defining a passage 58 to conduct fluid pressure to the slips, and the stem also being attached to plate 52 and to the slip housing 55 via coupling 59. Accordingly, sufficient fluid pressure transmission from the surface serves to effect anchoring of the tool at a selected location lengthwise of the bore hole. Following such anchoring, the actuator piston 15 and plunger 18 may be displaced laterally, for working purposes to be described. Further, such displacement may be controllably initiated as by displacing the string 12 relative to the actuator and body 17 following setting of the slips, and while fluid pressure is applied.

In the example shown, the means to control application of pressure to effect lateral displacement of the plunger may advantageously include a valve carried by the tool to be operated in response to displacement of the string relative to the actuator. For example, the valve may, with unusual advantage as respects operative simplicity, be defined by the inner and outer tubular members 24 and 23 which typically have ports relatively movable into and out of registration in response to string displacement to control fluid pressure transmission to the actuator. Referring to FIGS. 1a and 3, when the tool is being run into the well, as seen in FIG. 1a, fluid pressure in passage 48 in member 24 is applied via registered ports 60 and 61 (in members 24 and 23, respectively) passage 62 in member 23, registered ports 63 and 64 (in members 23 and 24, respectively), longitudinal passage 65 in member 24, and passages 66 and 67 in plate 25 and body 17 to the pressure chamber 68 defined by body bore 16 at the left side of piston 15, for urging the latter to rightwardly retracted position as shown.

When the tool is set in the well and string 12 is lowered sufficiently to allow or effect endwise collapse of the members 23 and 24 to FIG. 2 position, fluid pressure in passage 48 in member 24 is again applied via registered ports 60 and 61 to passage 62. On the other hand, due to the lengthwise relative shifting of mem-

bers 23 and 24, and as shown in FIGS. 2 and 4, pressure is now supplied via passage 62, registered ports 70 and 71, (in members 23 and 24 respectively), longitudinal passage 72 in member 24, and passages 73 and 74 in plate 25 and passage 75 in body 17 to the pressure chamber 76 defined by body bore 16 at the right side of piston 15, for forcibly urging the latter and plunger 18 to leftwardly advanced position as shown. In this regard, as the pressure is increased, both the slips 54 and the plunger 18 are urged toward the well bore. When the string 12 is pulled up sufficiently, the valving returns to the condition shown in FIG. 1a, wherein the plunger is retracted; also, the slip jaws are angled so that the anchor may be pulled free of the casing despite continued application of fluid pressure via the string interior. Surface apparatus to lower and lift the string 12 in the well is schematically shown at 80 in FIG. 1a.

Suitable O-ring seals to seal off between members 23 and 24 are indicated at 81-85. O-ring seals at 86 and 87 seal off between the plunger 18 and a plate 88 threadably connected at 89 into body 17 to close the opening formed upon drilling of bore 16. Passage 62 may be formed between member 23 and a sector plate 90 attached thereto as shown in the drawings. Note that port 61 may be lengthwise elongated to remain in communication with port 60 despite member shifting; that ports 70 and 71 may be angularly offset as shown from ports 60 and 61; and that ports 63 and 64 may be oppositely angularly offset from ports 60 and 61, as shown. Accordingly, ports 70 and 71 are out of registration in FIG. 3, and ports 63 and 64 are out of registration in FIG. 4. Caps or plates 25 and 52 may be retained in assembled relation to body 17 as by fasteners 95 best seen in FIG. 5.

An important aspect of the invention concerns the carriage of so called flow beans on the tool, and the use of the latter to effect forcible penetration of such flow beans into the well structure (as for example the casing) in an outward direction. Example of such flow beans or "projections" are described in my co-pending application Ser. No. 47,957, filed June 22, 1970. In the present application, a magazine 99 is carried by the tool 11 to sequentially supply flow beans 100 for outward displacement by plunger 18. FIG. 1a shows the lowermost bean 100a in a stack in position opposite plunger 18, and in FIG. 2 that bean 100a has been displaced laterally by the plunger through the wall of casing 13 at location 98 to penetrate the surrounding petroleum or gas producing formation 101. In that position, production fluid may flow through branch ports 102 toward central port 103 (seen in FIG. 5) in the flow bean to communicate the surrounding formation with the casing interior. Accordingly, the casing wall itself is not subjected to particle cutting action; instead, the hardened metallic flow bean is subjected to the abrading action of sand particles.

Multiple flow beans may be selectively punched through the wall of the casing, as by repeated vertical and rotary displacement of tool 11 and operation thereof as described, contributing to increased production flow into the casing. Should the beans become clogged, others may easily be installed; and, should any bean wear away by abrasion, the in-flow may continue through the perforation in the casing. As each bean is punched into position and the plunger 18 retracted, a

successive bean in the stack drops into position as seen in FIG. 1a, by gravity action. The magazine may be formed as illustrated in FIGS. 1a and 5 by plates 105 and 106 attached at 110 to the tool and forming a vertical slot 107 for the bean stack. Bottom wall 108 seats the lowermost bean 100a, and each bean may have a tapered or wedge shaped nose, shown at 109 in FIGS. 5 and 7, for aiding penetration through the casing and into the producing formation.

Fluid pressure application against piston 15 may be controlled to effect piston displacement between FIG. 1a and 2 positions, and a sudden dip in that pressure, corresponding to such displacement, may be sensed by a gage seen at 111 in FIG. 1a, to indicate that the bean has been "set". The tool may then be lifted or rotated into position for setting a subsequent bean. Ultimately, the tool may be withdrawn from the well and production fluid recovered from the casing in a conventional manner. An extremely tight fit is formed between the bean and the casing at the penetration location. If desired, the innermost end of each bean may be flanged as described in my copending application referred to above.

FIGS. 8-10 illustrate, schematically, the sequence of operations, using the tool. As the latter is lowered in a well, the top hole valve 43 is closed, the slips 54 are retracted relative to casing 13, the sleeve member 23 is in up-position, and the piston 15 and plunger 18 are retracted, pursuant to FIG. 8. At selected elevation, the top hole valve 43 is opened, as seen in FIG. 9, and the slips 54 are set, engaging the casing. While sleeve member 23 remains up, fluid pressure is not only exerted at 120 against the slips, but is also applied at 121 and 122 to chamber 68 for holding piston 15 retracted. In FIG. 10, string weight has been let down to shift valve member 23 to down-position; accordingly, fluid pressure is now applied at 121 and 123 to chamber 76 to urge the piston 15 and plunger 18 laterally as shown being punched through the casing 13. To reset the tool, top hole valve 43 is closed, string weight lifted, and the slips released to FIG. 8 position. For this purpose, the slips may be returned as by springs, not shown. The tool may then be re-oriented (lifted, lowered, and/or rotatably indexed) for a subsequent operation. In FIG. 9, fluid in chamber 76 is dumped at 115 to the well interior, outside the tool, and in FIG. 10 fluid in chamber 68 is dumped at 116 to the well interior. This also occurs in the FIG. 1 and 2 example, passage 72 being connected to the exterior when passage 65 is pressurized, and vice versa.

In regard to string weight "let down" with respect to the FIG. 1 and 2 tool, the lowering of the mandrel 20 at the lower end of the string after the slips are set allows the outer sleeve member 23 to drop relative to the inner sleeve member 24, i.e. from FIG. 1a to FIG. 2 position without imposing string weight on the slips.

FIGS. 11 and 12 illustrate the use of a pipe beading or swaging ram 130 carried to be outwardly displaced by the plunger 18 against an inner pipe 131. Fluid pressure exerted against piston 15 is controlled to effect local swaging or beading of the inner pipe at 131a outwardly against the bore 132 of outer pipe 133 which recesses the inner pipe in the bore hole. Annular swaging to join or annularly forcibly contact the inner and outer pipes deep in the well or bore hole may be ef-

fectured by repeating such outward displacement of the swage at circularly spaced locations between which the tool is rotatably indexed and operated. This procedure may be used to effect formation of a tight annular seal between overlapping casings, obviating need for cementing off between such casings deep in the hole. Such cementing oftentimes is ineffective to arrest leakage between the casings, especially where the casings extend at a considerable angle from vertical.

FIG. 13 illustrates a punch 140 which may be substituted for the ram in FIG. 11, i.e. to be carried for outward displacement against a pipe for perforating the latter. FIG. 14 shows a cutter 145 which may also be substituted for the FIG. 11 ram. The cutter may be repeatedly displaced to cut through the pipe at circularly spaced locations between which the cutter is rotated and operated by the tool. The cutter is retracted at each such location following penetration through the pipe, and then rotatably indexed to the next circular position for a subsequent cutting operation. In this way, sub-surface pipe may be completely severed at a chosen location.

I claim:

1. The method of applying laterally directed deformation force to structure at a selected location in a longitudinal bore hole and using a tool that comprises a pressure responsive actuator having a laterally displaceable plunger, and means to control fluid pressure application to the actuator, the tool carried by a pipe string to be run lengthwise of and within said hole, said method including

- a. displacing the tool lengthwise of the bore hole to said selected location by running of said string,
- b. transmitting fluid pressure within the string and operating said means to apply said pressure to the actuator thereby to effect displacement of the plunger laterally toward said structure outwardly of the tool and deformation of said structure to which deforming force is transmitted by the plunger, and
- c. sensing a sudden dip in said fluid pressure indicating the occurrence of said deformation.

2. The method of claim 1 wherein a punching head is carried to be outwardly displaced by the plunger against a pipe into which the tool is received in the bore hole and including the step of controlling said fluid pressure transmission to effect local outward punch perforation of the pipe.

3. The method of claim 1 wherein a flow bean is carried to be outwardly displaced by the plunger, and including the step of controlling said fluid pressure transmission to effect penetration of said bean into said structure in an outward direction.

4. The method of claim 3 wherein said structure comprises casing in said bore hole, and said pressure is controlled to effect penetration of the bean through the casing.

5. The method of claim 4 wherein said casing extends generally downwardly in the earth to a hydrocarbon fluid producing formation, and including the steps of withdrawing said tool following said casing penetration and recovering said fluid that flows into the casing via said bean.

6. The method of claim 1 wherein a cutter is carried to be outwardly displaced by the plunger against pipe

into which the tool is displaced, and including the step of controlling said fluid pressure transmission to effect local penetration of the cutter into the pipe in an outward direction.

7. The method of claim 6 that includes the step of circularly cutting said pipe by repeatedly displacing the cutter through the pipe at circularly spaced locations between which the cutter is rotated.

8. The method of claim 7 that includes the steps of retracting the cutter from the pipe at each of said locations following cutter penetration through the pipe, and rotatably indexing the retracted cutter between said circularly spaced locations.

9. The method of effecting local swaging of inner pipe outwardly against the bore of outer pipe at a selected location in a longitudinal bore hole, the inner pipe received within the outer pipe, and using a tool that comprises a pressure responsive actuator having a laterally displaceable plunger, and means to control fluid pressure application to the actuator, the tool carried by a pipe string to be run lengthwise of and within said inner pipe, the tool including a swage carried to be outwardly displaced by the plunger against the inner pipe, said method including

- a. displacing the tool lengthwise of the inner pipe to said selected location by running of said pipe string, and
- b. transmitting fluid pressure within the string and operating said means to apply said pressure to the actuator thereby to effect displacement of the plunger and swage laterally toward said inner pipe, and controlling said fluid pressure transmission to effect local swaging of the inner pipe outwardly against the bore of the outer pipe.

10. The method of claim 9 wherein the inner pipe is annularly swaged outwardly against the outer pipe by repeating said outward displacement of the swage at circularly spaced locations.

11. The method of applying laterally directed deformation force to structure at a selected location in a longitudinal bore hole and using a tool that comprises a pressure responsive actuator having a laterally displaceable plunger, and means to control fluid pressure application to the actuator, said means including a valve operated in the bore hole, the tool carried by a pipe string to be run lengthwise of and within said hole, said method including

- a. displacing the tool lengthwise of the bore hole to said selected location by running of said string, and
- b. transmitting fluid pressure within the string and operating said means to apply said pressure to the actuator thereby to effect displacement of the plunger laterally toward said structure outwardly of the tool and deformation of said structure to which deforming force is transmitted by the plunger, said operation being carried out by displacing the string relative to the actuator to control fluid pressure transmission to the actuator in actuating and release modes.

12. The method of claim 11 including the step of carrying bore engaging slip means on the string, and setting said slip means to engage the bore thereby to enable said displacement of the string relative to the actuator.

13. The method of claim 12 wherein the string is lowered relative to the actuator to effect valve operation to control outward displacement of the plunger in response to fluid pressure application to the actuator.

14. The method of claim 13 wherein the string is raised relative to the actuator to effect valve operation to control retracting displacement of the plunger in response to fluid pressure application to the actuator.

15. Apparatus for applying laterally directed deformation force to structure at a selected location in a longitudinal bore hole, comprising

- a. a tool sized for lengthwise running in the bore hole on a pipe string and to said selected location, the tool including a fluid pressure responsive actuator having a laterally displaceable piston and plunger,
- b. means to control application to the actuator piston of sufficient fluid pressure transmitted within the string to effect displacement of the plunger laterally toward said structure outwardly of the tool and deformation of said structure to which deforming force is transmitted by the plunger, the piston diameter being substantially greater than the plunger diameter, and
- c. means for sensing a sudden dip in said fluid pressure indicating the occurrence of said deformation.

16. The apparatus of claim 15 including a punching head carried by the tool to be outwardly displaced by the plunger through a pipe into which the tool is run in the bore hole.

17. The apparatus of claim 15 including a cutter carried by the tool to be outwardly displaced by the plunger locally against said structure in the form of pipe.

18. The apparatus of claim 17 wherein the cutter has advanced and retracted positions at each of a circularly series of tool locations into which the tool is rotatably indexed during severing of the pipe by said cutter.

19. Apparatus for applying laterally directed deformation force to structure at a selected location in a longitudinal bore hole, comprising

- a. a tool sized for lengthwise running in the bore hole on a pipe string and to said selected location, the tool including a fluid pressure responsive actuator having a laterally displaceable piston and plunger, there being a flow bean carried by the tool to be outwardly displaced by the plunger, the bean being elongated in the bore hole longitudinal direction and having a longitudinally elongated tapered nose to penetrate said structure in an outward direction, the bean containing lateral through porting intersecting said taper,
- b. means to control application to the actuator piston of sufficient fluid pressure transmitted within the string to effect displacement of the plunger laterally toward said structure outwardly of the tool and deformation of said structure by the bean to which deforming force is transmitted by the plunger, the piston diameter being substantially greater than the plunger diameter.

20. The apparatus of claim 19 including said structure in the form of well casing into which said bean penetrates.

21. The apparatus of claim 19 including a magazine carried by the tool to sequentially supply flow beans for outward displacement by the plunger.

22. The apparatus of claim 21 wherein said magazine is carried at one side of the tool to contain a vertical stack of flow beans adapted to drop into position laterally opposite the tip of said plunger.

23. Apparatus for the words applying laterally directed deformation force to structure at a selected location in a longitudinal bore hole, comprising

- a. a tool sized for lengthwise running in the inner pipe on a supporting pipe string and to said selected location, the tool including a fluid pressure responsive actuator having a laterally displaceable plunger, the tool including a swage carried to be outwardly displaced by the plunger against the inner pipe, and
- b. means to control application to the actuator of sufficient fluid pressure transmitted within the string to effect displacement of the plunger and swage laterally toward said inner pipe to effect said local swaging.

24. The apparatus of claim 23 including said inner and outer pipes.

25. Apparatus for applying laterally directed deformation force to structure at a selected location in a longitudinal bore hole, comprising

- a. a tool sized for lengthwise running in the bore hole on a pipe string and to said selected location, the tool including a fluid pressure responsive actuator having a laterally displaceable plunger, and
- b. means to control application to the actuator of sufficient fluid pressure transmitted within the string to effect displacement of the plunger laterally toward said structure outwardly of the tool and deformation of said structure to which deforming force is transmitted by the plunger, and
- c. said means including a valve carried by the tool to be operated in response to displacement of the string relative to the actuator to control fluid pressure transmission to the actuator in plunger advancing and retracting operating modes.

26. The apparatus of claim 25 wherein said valve comprises inner and outer tubular members with ports relatively movable into and out of registration in response to said string displacement to control fluid pressure transmission to the actuator.

27. The apparatus of claim 26 including well bore engaging slip means on the string and settable to engage the bore to enable said string displacement relative to the actuator.

28. The apparatus of claim 27 wherein said tool extends vertically with said slip means extending below the actuator and control means.

29. The apparatus of claim 28 wherein said slip means is fluid pressure responsive and in fluid pressure communication with said actuator.

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