United States Patent [19]

Weitz

[11] **4,279,306**

[45] **Jul. 21, 1981**

[54] **WELL WASHING TOOL AND METHOD**

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[73] Assignee: **Top Tool Company, Inc.,** Houma, La.

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[58] **Field of Search** 166/127, 147, 151, 191, 166/187, 312, 311

[56] **References Cited**

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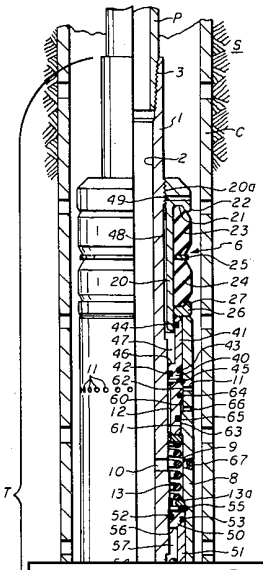
[57] **ABSTRACT**

A well washing tool which may comprise: a tubular mandrel; first and second packer assemblies carried on the mandrel at opposite ends thereof; an outer tubular body surrounding the mandrel between the packer assemblies; an annular chamber between the mandrel and the surrounding tubular body; and a valve assembly carried within the annular chamber. The tubular mandrel is adapted for connecting the tool in a pipe string extending to the surface of the well and the lower end may be adapted for blocking flow of fluids from the pipe string through the mandrel flow passage. Ports are provided in the walls of the mandrel and the tubular body permitting fluid communication between the mandrel flow passage and the exterior of the tool. The valve assembly prevents such fluid communication by blocking one or more of the ports. The packer assemblies are actuated by a predetermined pressure and the valve assembly is responsive to a higher predetermined pressure to unblock the ports permitting fluid communication between the mandrel flow passage and the exterior of the tool through the annular chamber.

19 Claims, 2 Drawing Figures



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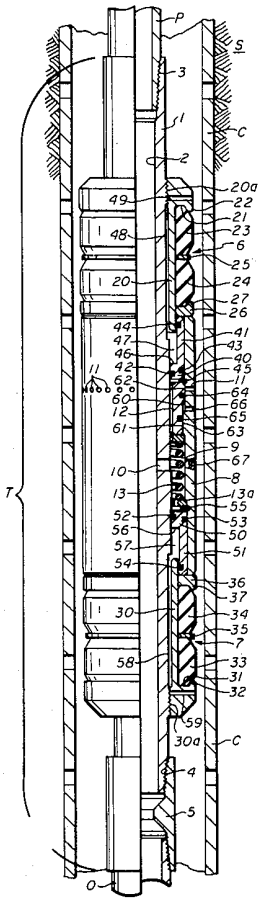
19 Claims, 2 Drawing Figures



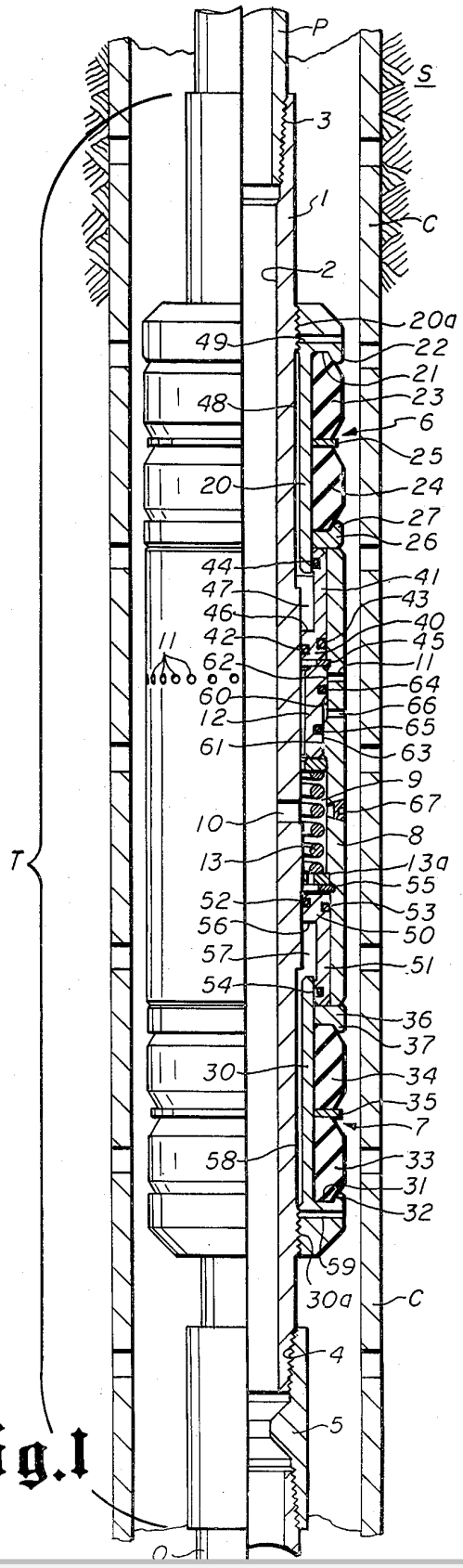


fig.1

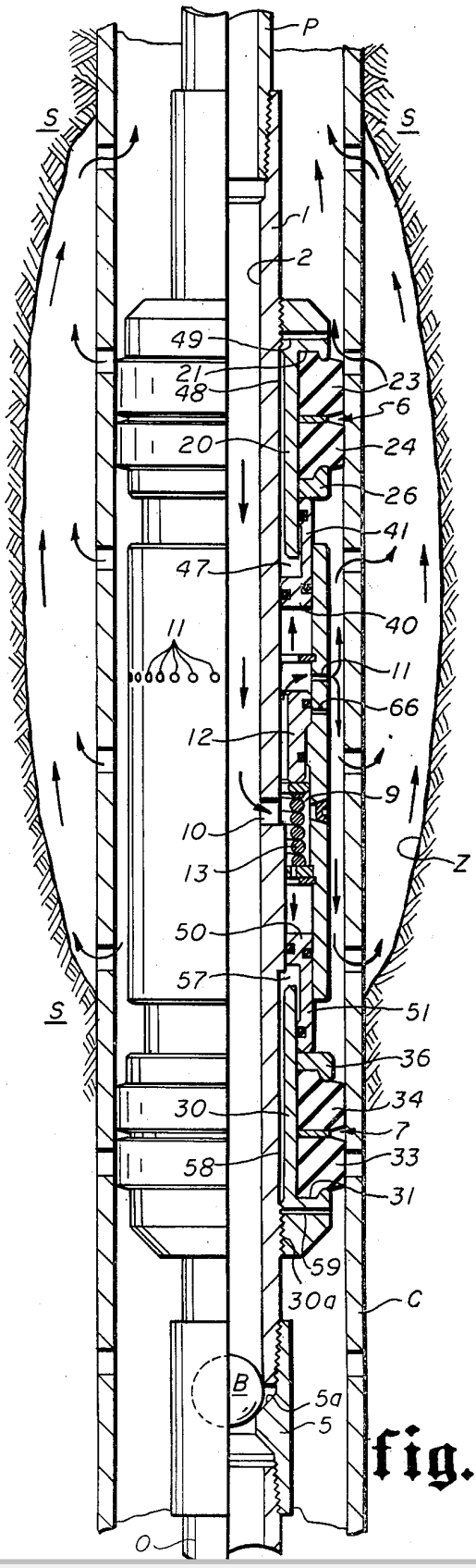


fig.2

WELL WASHING TOOL AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to tools for use in completing oil and/or gas wells. Specifically, it pertains to a washing tool and method suitable for circulating fluid through well conduits and surrounding formations for various treatments thereof.

2. Description of the Prior Art

In completing an oil or gas well after drilling a hole therefor, it is common to install a production casing and to perforate the casing at the producing formation. After completion, the oil and/or gas flows from the formation through the perforations into the production casing where it is usually communicated to the surface of the well through production tubing.

Frequently it is necessary or desirable to treat the formation surrounding the perforated casing in some way to enhance the flow of fluids therefrom. Some methods of treating formations include circulating water or acidized fluid through the formation via the casing perforations and back up the casing string. By such circulation, loose sands may be washed from the formation or consolidated with various materials. Voids may be created for more effective gravel packing, tight formations may be made more susceptible to flow, etc.

In performing such circulating operations, various washing tools have been developed which generally provide some method of packing off an area of the casing for circulation. Such tools are usually attached to the lower end of a washing string, lowered into the casing to the desired depth, packed off and circulating commenced. In most of the tools of the prior art, packing is accomplished by providing packers on the washing tools on opposite sides of the perforations through which the fluid is to flow from the tool. Circulating fluid flows down the circulating string, through the tool, between the packers and out the casing perforations into the formation. Flow then continues back into the casing through perforations above the packers so that the returning fluid flows upwardly through the casing above the tool.

The packers used in washing tools of the prior art are usually of the cup type. Prior art washing tools utilizing cup type packers are made by the Baker Division of Baker Oil Tools, Inc. and Cavins Corporation. Cup type packers leave something to be desired in dependability, failing to adequately seal under many conditions. Furthermore, since the cup type packers engage the casing while the tool is being run into the well or pulled out of it, they are frequently torn or damaged during use.

Upon completion of circulation, it may be desirable to reverse circulate for removing sand or other materials from the bottom of the well hole. This is difficult to effectively accomplish with cup type packers since the packers remain engaged with the casing and since some of them may be flared in a direction which would actually oppose reverse flow. Another problem associated with cup type packers is the possibility of swabbing in the well or pulling sand into the casing when the tool is removed therefrom.

SUMMARY OF THE INVENTION

In the present invention a circulating or washing tool and method are provided which eliminate many of the problems associated with cup type packer washing tools. The tool of the present invention includes a tubular mandrel having a flow passage therethrough and the upper end of which is adapted for connecting the tool in a pipe string extending to the surface of the well, the lower end being provided with means for blocking the flow of fluids from the pipe string through the mandrel flow passage. First and second packer assemblies are carried on the mandrel at the opposite ends thereof and an outer tubular body surrounds the mandrel between the packer assemblies. An annular chamber is provided between the mandrel and the surrounding tubular body. The annular chamber is in fluid communication with the mandrel flow passage through ports in the walls of the mandrel and the tubular body is provided with ports which permit fluid communication between the annular chamber and the exterior of the tool.

A valve assembly is carried within the annular chamber blocking the ports in the tubular body and preventing fluid communication between the annular chamber and the tool exterior. However, the valve assembly is responsive to predetermined pressure communicated to the annular chamber through the mandrel ports to unblock the tubular body ports permitting fluid communication between the mandrel flow passage and the tool exterior through the mandrel ports, the annular chamber and the tubular body ports. The packer assemblies are also responsive to a predetermined pressure communicated to the annular chamber through the mandrel ports for actuation thereof. In fact, the packer assemblies are responsive to a lower predetermined pressure than the valve assembly. Thus, the packer assemblies may first be set and then the valve assembly actuated to provide the fluid communication necessary for circulating fluids through the tool for washing the surrounding formation.

The tool is operated by lowering on a pipe string to the necessary level in a perforated casing. Then the lower end of the mandrel flow passage is closed or blocked by suitable means and pressure applied to the annular chamber through the pipe string. Upon reaching a first predetermined pressure level, the packer assemblies are axially compressed and radially expanded until they sealingly engage the walls of the surrounding perforated casing. A further increase in pressure actuates the valve assembly to open tubular body ports and fluids in the pipe string begin to flow to the exterior of the tool through the perforations isolated by the packing assemblies and into the surrounding well strata. The fluid reenters the casing string through perforations above the packer assemblies for return to the surface of the well. After circulation, pressure in the annular chamber is relieved, allowing the valve assembly to close and the packer assemblies to disengage the casing walls. Reverse circulation may be performed to clean sand or debris from the bottom of the hole.

Thus, the circulating or washing tool of the present invention is simple in construction and operation. Due to the hydraulically set packers, it is more reliable than washing tools utilizing cup type packers. Furthermore, such construction permits the tool to be lowered in the well without interference between the packing elements and the casing string so that the packing elements are not damaged on lowering into the well. The tool is short and compact, allowing it to pass through tight areas or slightly out of line casing sections. In addition, after circulation and release of pressure, the packing

assemblies are radially contracted for reverse circulation and removal so that there is no danger of swabbing in the well or pulling sand into the casing while the tool is being removed.

Many other advantages of the tool will be understood from reading the specification which follows in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional elevation view of casing within a well hole showing the washing tool of the present invention in quarter-section and in the unset or running in position; and

FIG. **2** is a sectional elevation view similar to FIG. **1** but showing the tool in its set position for circulation of fluids through the tool and the casing perforations into the surrounding formation.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring first to FIG. **1**, there is shown the washing tool T of the present invention attached to the lower end of a pipe string P in a perforated casing C of a well having surrounding strata S. The tool T includes a tubular mandrel **1** having a central flow passage **2** therethrough and the upper end of which is provided with means such as threads **3** for connecting the tool to the pipe string P which extends to the surface of the well. The lower end of the mandrel may be threadedly connected at **4** to a ball sub **5** or the like, the purpose of which is to block flow of fluids from the pipe string through the mandrel flow passage when desired. However, in FIG. **1**, there is no blockage and flow is permitted through the mandrel flow passage **2** so that if there is any fluid in the casing C, it may be displaced upwardly through the pipe string P as the tool T is lowered into the well. Other tools O, may be attached to the ball sub if desired.

First and second packer assemblies **6** and **7** are carried at opposite ends of the mandrel. These assemblies **6** and **7** will be more fully described hereafter. An outer tubular body **8** surrounds the mandrel **1** between packer assemblies **6** and **7** leaving an annular chamber **9** therebetween.

The annular chamber **9** is in fluid communication with the mandrel flow passage **2** through at least one port **10**. The tubular body **8** is provided with a plurality of ports **11** which under certain conditions permit fluid communication between the annular chamber **9** and the exterior of the tool T.

Carried within the annular chamber **9** is a valve assembly, including a differential piston member **12** and biasing spring **13**, which in the running position of FIG. **1** blocks the ports **11** preventing fluid communication between the annular chamber **9** and the exterior of the tool. The valve assembly will be more fully described hereafter.

Each of the packer assemblies **6** and **7** includes a tubular packer body **20**, **30**, which is carried on the mandrel **1** having an annular shoulder **21**, **31** and an annular lip **22**, **32**, thereon. A plurality of resilient packer elements **23**, **24**, **33**, **34**, surround the packer bodies **20**, **30** adjacent the annular shoulders **22**, **32**, and may be separated by ring spacers **25**, **35**. Each packer assembly may also be provided with an annular retainer ring **26**, **36** which may also have an annular lip **27**, **37**, thereon.

Each packer assembly also includes an annular piston comprising an annular head portion **40**, **50** and a tubular sleeve portion **41**, **51** extending therefrom. The head portion slidingly and sealingly engages the exterior of mandrel **1** and the interior of tubular body **8**. The sleeve portion **41**, **51** slidingly and sealingly engages the exterior of the respective packer bodies **20**, **30**. Annular seals **42**, **43**, **44** and **52**, **53**, **54** assure sealing at these points of sliding and sealing engagement. It will noted that in the unset position shown in FIG. **1**, the head ends of the pistons rest against snap rings **45**, **55** attached to the tubular body **8** and the sleeve ends **41**, **51** bear against the packer retainer rings **26**, **36**.

The sleeve portions **41**, **51** and the inner diameter of the head portions **40** and **50** of the packer pistons are joined by annular surfaces **46**, **56** which along with the sleeve portions **41**, **51**, mandrel **1** and the ends of packer bodies **20** and **30** form variable annular chambers **47**, **57**. These variable annular chambers **47**, **57** may be vented to the exterior of the tool through longitudinal ports **48**, **58** and radial ports **49**, **59**.

It will also be noted that the packer bodies **20** and **30** are shown attached to the mandrel **2** by threaded connections **20***a* and **30***a* allowing removal of the packer body from the mandrel **1**. This then would also permit removal of all of the elements of the packer assembly including the packer elements and the packer pistons.

In examining the interior of the tubular body **8**, it will be seen that it is provided with a first cylindrical surface **60** and an adjacent second cylindrical surface **61** of slightly smaller diameter. The differential piston **12** of the valve assembly is provided with a corresponding first cylindrical end portion **62** and a second cylindrical opposite end portion **63** of smaller diameter. The end portion **62** slidingly and sealingly engages cylindrical surface **60** of tubular member **8** and the opposite end portion **63** slidingly and sealingly engages a second smaller diameter cylindrical surface **61** of the tubular member **8**. Thus the effective annular area exposed to pressure in the annular chamber **9** is greater at the first end portion **62** than at the second opposing end portion **63**. Annular seals **64** and **65** assure sealing at these points of contact. At least one relief portion **66** is provided through the walls of the tubular member **8** between the first and second annular seals **64** and **65** through which fluids these seals may be displaced to the exterior of the tool. A small bleed port **67** may be provided in the walls of the tubular member **8** in direct communication with annular chamber **9**.

As previously mentioned, the valve assembly includes a biasing spring **13** between the differential piston member and a spring retainer **13***a* at the fixed snap ring **55**. The biasing spring **13** biases the piston **12** toward the position of FIG. **1**, blocking ports **11**.

STATE OF OPERATION

To utilize the tool T for circulating operations, it is attached to the pipe string P and lowered into the perforated casing c to the desired depth in the unset position illustrated in FIG. **1**. Then a resilient ball member B is dropped through the pipe string P through the mandrel passage **2** for engagement with seating surface **5***a* of the ball sub **5**. (See FIG. **2**) This blocks flow at the end of the mandrel flow passage **2**. Then, pressure is increased through the pipe string P, fluid entering the annular chamber **9** through mandrel ports **10**. As pressure is increased to a first predetermined level, the pressure exerted against the packer piston head portions **40**, **50**,

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