United States Patent

[11] **3,559,740**

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[54] **METHOD AND APPARATUS FOR USE WITH HYDRAULIC PUMP IN MULTIPLE COMPLETION WELL BORE**
3 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **166/313,** 166/106; 417/358, 417/442
[51] **Int. Cl.** **E21b 43/14,** F04b 47/10
[50] **Field of Search** ..... 166/250, 313—315, 68, 105, 106, 224; 103/4W, 46A, (Inquired); 73/155; 417/358, 442

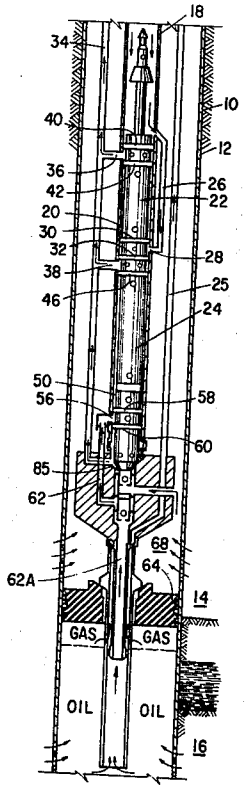
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ABSTRACT: A pump system for removing oil from a well bore which has two vertically spaced-apart production zones. A packer is set in the well between these two zones. Three different selector heads are attachable to the lower end of the pump. A first head is for directing the commingled flow from the two zones to the intake of a single downhole pump. A second selector head is attached when it is desired to produce from the upper zone only and a third head is attached when it is desired to produce from the lower zone only. Each head contains removable chokes for controlling the production from each zone. The entire pump, including its selector head, is pumped in and out by hydraulic fluid.



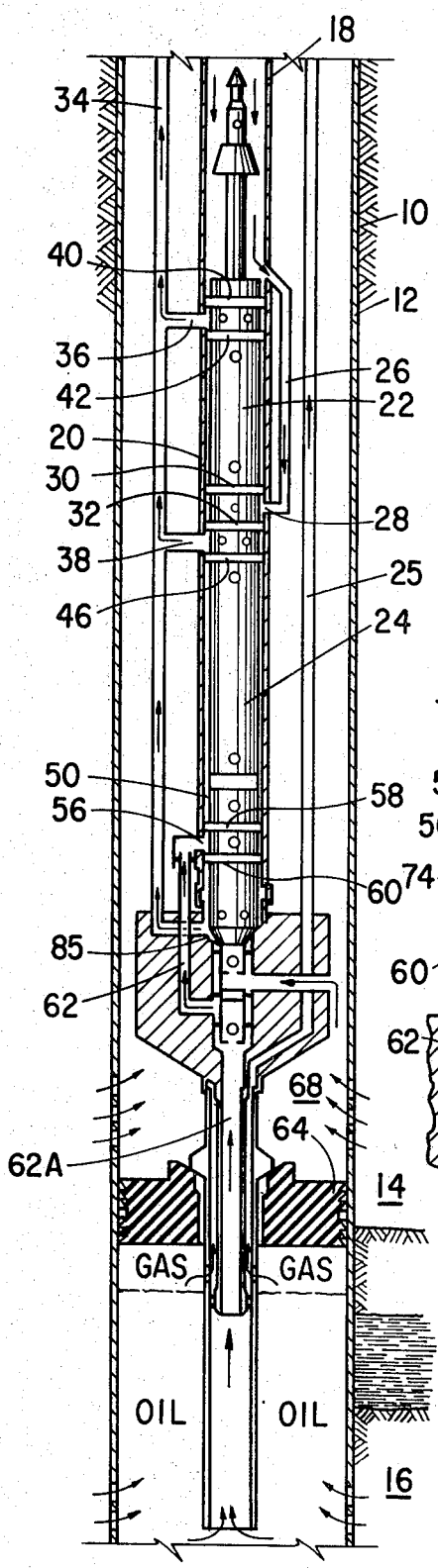


FIG. 1

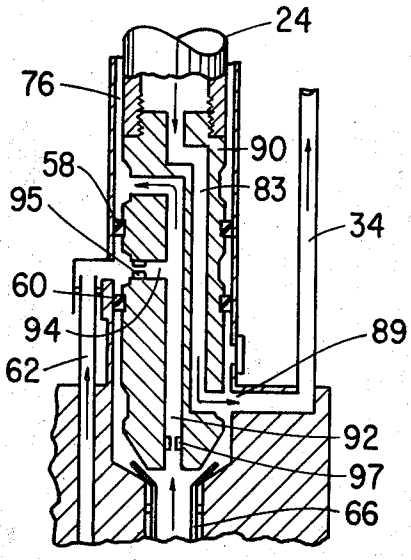


FIG. 4

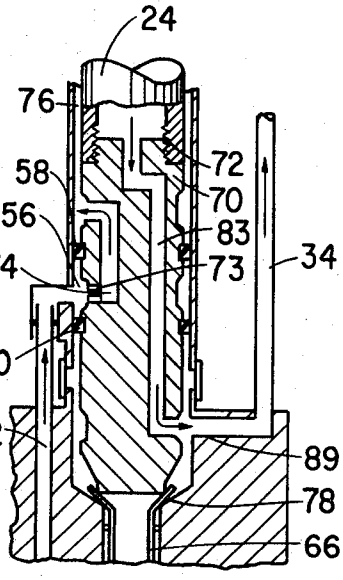


FIG. 2

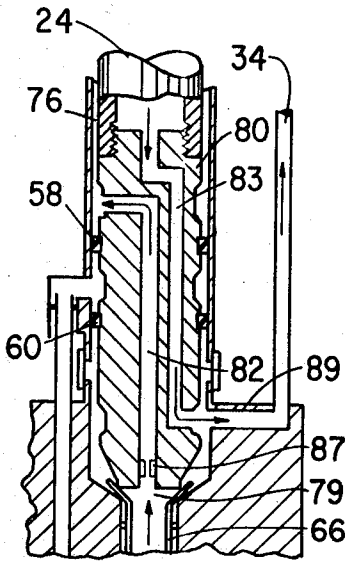


FIG. 3

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METHOD AND APPARATUS FOR USE WITH HYDRAULIC PUMP IN MULTIPLE COMPLETION WELL BORE

BACKGROUND OF THE INVENTION

This invention relates to the pumping of fluid from two vertically spaced-apart underground oil-containing zones or reservoirs penetrated by a well bore. It relates especially to a downhole pump with selector head means having removable chokes so that either the upper or the lower zone, or both, can be produced at a selected rate.

SETTING OF THE INVENTION

Oil and gas wells are drilled into the earth until they encounter one or more petroleum bearing zones or reservoirs. Quite frequently, one well bore will penetrate at least two vertically spaced-apart oil bearing reservoirs. The production of oil and gas from wells is usually governed by governmental regulations. Sometimes such regulations require that the petroleum from each of the vertically spaced zones be produced separately, that is, each has its own channel or production string from the zone to the surface. In other cases, the regulatory agency permits oil to be produced from each zone and commingled in the bottom of the well and the commingled oil pumped to the surface in a single string of tubing. It is with operations under this latter type governmental regulations with which this invention is primarily concerned. When the governmental agency does permit the commingled production from the two zones in the bottom of the well bore, it is frequently required that the two zones be periodically tested independently. Ordinarily, such periodic testing has been done by the use of wireline equipment. This type system does the job satisfactorily except that it is rather expensive. What is needed then is a simpler and less expensive way of doing this. This present invention provides such a system.

BRIEF DESCRIPTION OF THE INVENTION

This concerns a downhole hydraulically-operated pump for pumping oil from one or both subsurface oil reservoirs to the surface. A housing section for receiving the hydraulic pump is provided at the lower end of the string of tubing. This housing has two ports. A first conduit connects the first port of the housing to the lower reservoir, and the second conduit connects the second port to the upper oil reservoir. A selector head is secured to the lower end of a hydraulic pump. The assembly is then pumped down so that the selector head is seated in said housing. The oil passages in the selector heads each contain a removable choke so that the oil flow is controlled. There are three selector heads. However, only one selector head is used at a time. When a first selector head is inserted, both zones are connected to the intake to the pump. When the second selector head is inserted, only the upper zone is connected to the intake, and when the third selector head is inserted, only the lower zone is connected to the intake. The hydraulic pump is pumped in and out of the well by hydraulic fluid; thus the various selector heads and their interior chokes can be interchanged at the surface. The flow of each zone can be tested by proper use of the correct selector head.

DESCRIPTION OF THE DRAWINGS

Various objects and a better understanding of the invention can be had from the following description taken in conjunction with the drawings in which:

FIG. 1 illustrates a hydraulically operated pump positioned at the bottom of a well bore;

FIG. 2 illustrates the selector head part of the pump of FIG. 1, which head is used for pumping oil from the lower zone;

FIG. 3 illustrates the selector head part of the pump of FIG. 1, which head is used for pumping oil from the upper zone;

FIG. 4 illustrates the selector head part of the pump of FIG. 1, which head is used for pumping oil from both the upper and lower zones.

Attention is first directed to FIG. 1. Shown thereon is a well bore **10** which is provided with a casing **12**. The well bore and casing penetrate upper producing oil reservoir **14** and lower producing reservoir **16**.

Positioned in casing **12** is a string of tubing **18** which extends from the surface down to the vicinity of the oil producing zones. The lower end of casing **18** terminates in what can be considered a hydraulic pump housing **20**. A hydraulic pump is shown mounted in this housing against seat **85** thereof. This hydraulic pump includes a hydraulic driving engine **22** on the upper end thereof and a pump section **24** on the lower end thereof. A suitable hydraulic pump is commercially available from Kobe, Inc., 3040 East Slauson Avenue, Huntington Park, Calif., and is designated type B. As such pump is well known, its operations will not be described in detail. Power fluid for this pump is pumped down tubing **18** and a part of it goes in the upper end of the pump. Another portion of the driving fluid is passed through pipe **26** to a lateral port **28** in housing **20** to be in communication with another portion of a driving engine **22**. Seals **30** and **32** isolate this port when the pump is inserted in the housing. The spent power oil is connected to upwardly extending conduit **34** from driving engine **22** through lateral conduits **36** and **38**. Conduit **36** opens into housing **20** between seals **40** and **42**. Outlet conduit **38** opens into housing **20** between seals **32** and **46**. Conduit **34** is also used to convey the oil pumped from zones **14** and **16** to the surface.

The inlet to pump **24** is in fluid communication in a conventional manner with the annulus **50** between pump **24** and housing **20** between seals **46** and **58**. Connecting annulus **50** to the selected zone is the same as connecting that zone to the pump. Means are provided whereby this annulus **50** can be connected to either the upper zone **14** alone, the lower zone **16** alone, or simultaneously to both zones. As will be explained, this depends on which selector head is attached to the lower end of the pump. Housing **20** is provided with two oil inlet ports. One port is connected to the upper reservoir and the other port is connected to the lower reservoir. Housing **20** has a first inlet port **56** between seals **58** and **60**. This inlet port **56** is connected by a conduit **62** which extends downwardly through a packer **64** so that it can convey fluid from lower zone **16** to port **56**. Packer **64** can be any convenient packer which seals the annulus between the lower part of conduit **62A** and the wall of casing **12**. It is to be noted that upper zone **14** and lower zone **16** are each perforated in a conventional manner. The second oil inlet port of housing **20** is an opening **79** in the lower end of housing **20** which is connected to a conduit means **66** which is in communication through annulus **68** with the upper zone **14**. Gas accumulated below packer **64** is conducted to the surface through pipe **25**.

Attention is now directed to FIG. **2** which illustrates a selector head which is connected to the lower end of pump **24**. This particular selector head is used when it is desired to pump oil only from the lower zone **16**. This selector head **70** is connected by thread **72** to the lower end of pump section **24**. It contains a first predominantly vertical fluid passageway **74** which connects inlet port **56** of housing **20** to passage **76** which leads to the intake of pump **24**. Passageway **74** has removable choke **73**. Selector head **70** fits on taper **78** of inlet conduit **66** and thus blocks that conduit. Thus, when selector **70** is installed only fluid from the lower zone **16** is pumped to the surface. This is done by pumping from pump section **24** through vertical conduit **83** in selector head **70**, out port **89** and then upwardly through conduit **34**.

Attention is next directed to FIG. **3**. The selector head **80** in this case has no passage **74** as in FIG. **2**. Thus the conduit from the lower zone **16** is blocked. It does have a vertical conduit **82** which connects conduit **66**, which is from upper zone **14** to conduit **76** which leads to the pump intake. Thus, by use of the selector head of FIG. **3**, only oil from the upper zone **14** is

produced. Conduit **82** has a removable choke **87** which is selected to control the rate of flow from the upper zone.

The outlet from pump **24** passes through a vertical passage **83** in each of the selector heads to outlet **89** which is connected to vertical conduit **34** for conducting the fluid to the surface.

Attention is next directed to FIG. **4** which illustrates a selector head for use when it is desired to pump oil from both zone **14** and zone **16**. In this device, selector head **90** is provided with a vertical passage **92** which connects in the lower end to conduit **66** from the upper zone **14**. Selector head **90** is also provided with a lateral passage **94** which connects vertical passage **92** to inlet conduit **62** from the lower oil reservoir **16**. Lateral passage **94** is provided with a removable choke **95**. Likewise, vertical passage **92**, below the intersection with passage **94**, is provided with a removable choke **97**. These chokes are provided so that the flow can be proportioned between the two zones to meet government regulations, or good oil producing practices in the absence of governmental regulations.

When the well tubing **18** is run, the structure of FIG. **1**, except the pump means and selector head, is run at the same time and in a known manner. The hydraulic pump is run later. The hydraulic pump is provided with the proper selector head selected from those shown in either FIG. **2**, **3** or **4**. The pump with selector head attached is then pumped downwardly by oil in tubing **18** until the device is seated as shown in FIG. **1**. Then hydraulic drilling oil is pumped down tubing **18** to operate the pump. When it is desired to change a selector head, oil is pumped down conduit **34** and this drives the pump means upward. Oil is continued to be driven downward in line **34** until the tool is retrieved at the top of the well. If it is desired to test the lower zone, the selector head **70** of FIG. **2** is connected to the lower end of the pump means and the tool pumped down until in the position of FIG. **1**. At this time a production test is made on the lower zone. Then the pump is retrieved as described above to complete the run. Various size chokes can be used in different runs until the desired flow rate is obtained. If it is desired to test the upper zone, the selector head of FIG. **2** is removed and the selector head of FIG. **3** is placed therein. The tool is again run into the well and the upper zone is tested.

After these tests are completed, it is usually desired to produce both zones simultaneously. However, sound reservoir engineering practices usually dictate that zones be produced in a given ratio. This is accomplished in accordance with my invention by placing chokes **95** and **97** of the proper size in the conduits to the lower zone and upper zone, respectively. These chokes are sized in a known manner to obtain a desired ratio. Then the selector head of FIG. **4** is placed at the lower end of pump **24**. The pump assembly is then pumped down to the well bore.

While the above embodiments of the invention have been described with considerable detail, it is to be understood that various modifications of the device can be made without departing from the scope or spirit of the invention.

I claim:

1. A method of producing oil from an upper oil zone and a lower oil zone penetrated by a well bore and using interchangeable selector heads connectable to the lower end of a hydraulically operated pump having an inlet and an outlet, a first selector head which when seated in the bottom of the well establishes communication between said lower zone only and said pump intake, second selector head which when seated in the lower end of the well establishes fluid communication from the upper zone only to said inlet of said pump and a third selector head which establishes fluid communication between both the lower zone through a first passage and the upper zone through a second passage with the said inlet to said pump, which comprises:

a. placing said first selector head on the lower end of said pump;
b. running said assembly into said well bore;
c. operating said pump to produce oil only from said lower zone through a channel to the surface;
d. removing said pump assembly from the said well bore;
e. removing said first selector head and placing said second selector head thereon;
f. running said pump assembly with said second selector head thereon into said well bore;
g. operating said pump to produce oil from said upper zone only;
h. removing said pump assembly to the surface;
i. placing a first removable choke in said first passage and a second removable choke in said second passage of said third selector head;
j. removing said second selector head and placing said third selector head thereon;
k. running said assembly with said third selector head into said well bore; and
l. thereafter operating said pump unit to simultaneously produce oil from said upper zone and said lower zone at rates controlled by the removable chokes placed in said third selector head.

2. A method as defined in claim **1** including the step of placing a removable choke in said first selector head prior to step (b) and a removable choke in said second selector head before step (e), replacing each removable choke and operating the pump with each choke to determine which choke in each selector head gives the desired producing rate.

3. A system for pumping fluid from a well bore which penetrates an upper and a lower oil producing zone which comprises:

a first tubular member extending from the surface to the vicinity of said producing zones;
a housing means connected to the lower end of said first tubing, said housing having a first port and a second port;
a first conduit connecting said first port to said upper zone;
a second conduit connecting said second port to said lower zone;
a hydraulic pump for insertion into said housing;
conduit means connecting the outlet of said pump to the surface;
power means for operating said pump;
a selector head means connected to the lower end of said pump, said selector head means having a first passage and a second passage therein connecting the intake of said pump to said first port and said second port, respectively; and
a removable choke in each said first passage and said second passage, such removable chokes in the passages of said selector head means regulating independently the flow of fluid from the upper zone and the flow of fluid from the lower zone.