United States Patent

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[73] Assignee **Phillips Petroleum Company**

[54] **PRODUCTION OF OIL FROM A PUMPING WELL AND A FLOWING WELL**
1 Claim, 2 Drawing Figs.

[52] **U.S. Cl.** **166/267,** 166/256, 166/314
[51] **Int. Cl.** **E21b 43/25,** F04f 1/20
[50] **Field of Search** 166/265, 267, 304, 312, 314, 256; 103/232, 233

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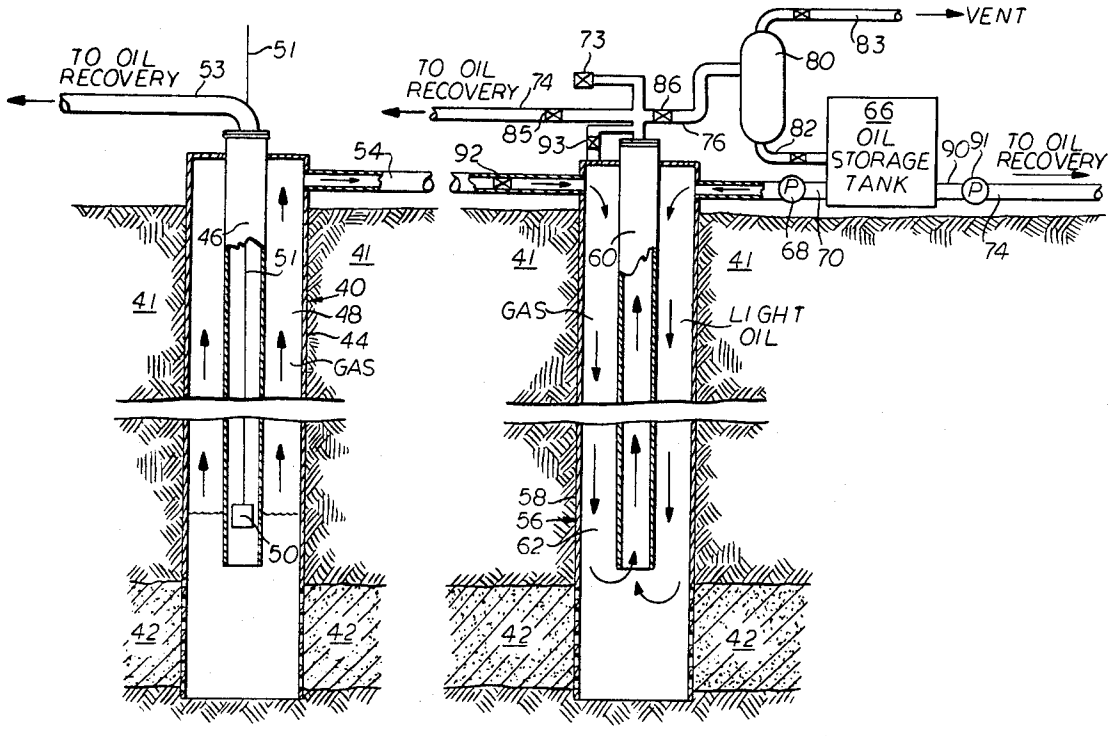
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ABSTRACT: Production of oil from a pumping well and a flowing well wherein gas which is produced in the pumping well is conveyed to and utilized to facilitate production of oil from the flowing well. Flow from the flowing well may be initiated by pumping a light oil into the annulus. The method may be utilized with wells produced by fire flooding.

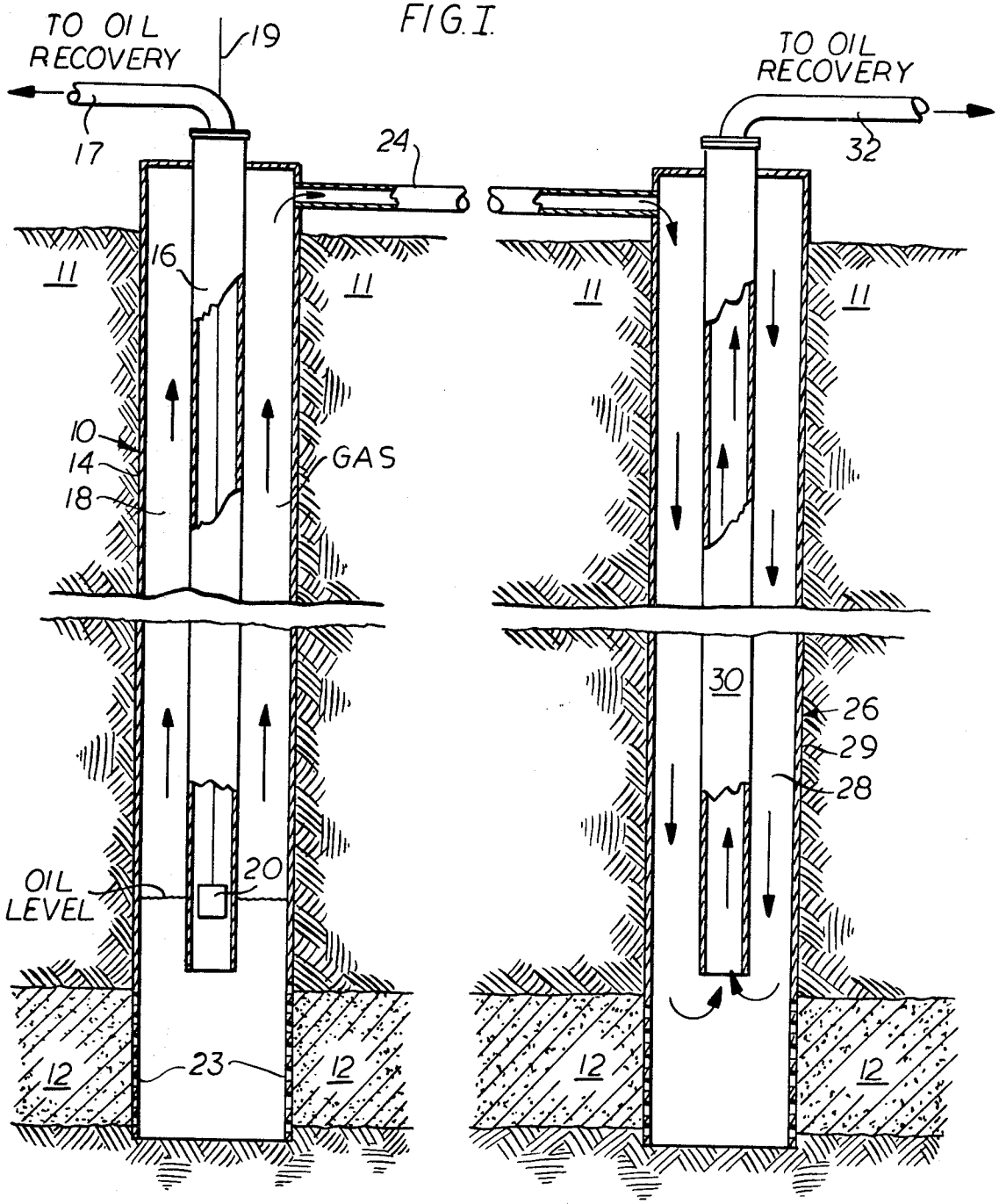


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SHEET 1 OF 2

FIG. I.



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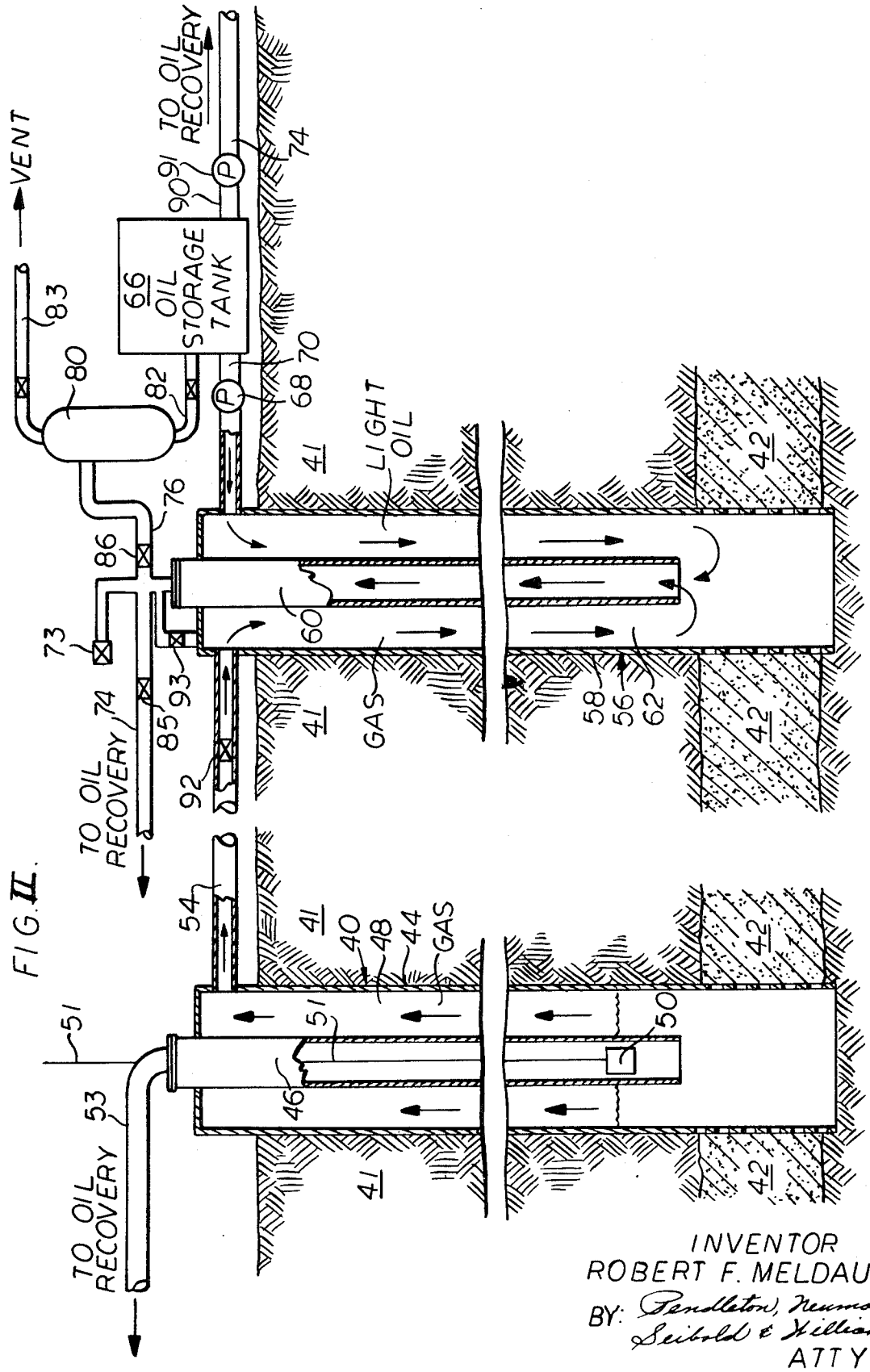


FIG. II.

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PRODUCTION OF OIL FROM A PUMPING WELL AND A FLOWING WELL

This invention relates to the recovery of oil from a subterranean oil-bearing stratum. More particularly, this invention relates to producing oil from wells by a gas lift system.

It is appreciated in the art that frequently higher oil production can be achieved by flowing a well rather than by pumping a well. Thus, for example, a comparison between pumping and flowing a typical oil-producing well is tabulated below:

	Pumping	Flowing
Oil rate, b.o.p.d.	350	590
Water cut, percent	20	20
Gas rate, M s.c.f./d	1,300	1,500
Wellhead pressure, p.s.i.g.	360	85
Bottom hole pressure (3,170')	700	530

Because of the advantages of flowing a well it has been heretofore proposed to produce wells by employing a gas lift system. It is a principal object of this invention to provide a new and improved process for producing oil utilizing a gas lift technique.

SUMMARY OF THE INVENTION

Oil is produced from both a pumping well and a flowing well by a process wherein gas which is produced in the pumping well is conveyed to the flowing well to assist in the flowing thereof.

The oil production process of this invention is described in detail in conjunction with the accompanying drawings in which:

FIG. I is a schematic drawing showing one arrangement of apparatus for producing oil in accordance with the invention.

FIG. II is a schematic drawing showing arrangement of apparatus for producing oil in accordance with another embodiment of the invention.

Referring to FIG. I, well **10** penetrates an earth formation **11** in which there is located an oil-bearing stratum **12**. The well is provided with a casing **14** and a tubing string **16**, the upper portion of which is joined to the production or flow line **17**. The casing **14** and tubing string **16** form annulus **18**. Pump **20**, suspended on rod **19**, is disposed within the lower portion of tubing **16**. By means of pump **20** oil is pumped to the surface and recovered via line **17**. Pumping is preferably conducted at a rate sufficient to maintain the oil level in the well at substantially the depth of pump **20**. The oil enters the well **10** through perforations **23** in the lower portion of casing **14**.

Gas which is produced with the oil flows up annulus **18** and is sent via conduit **24** to a second well **26**. The gas flows down into well **26** through annulus **28** which is formed between casing **29** and tubing **30**. In this manner the gas intermingles with the oil within well **26**, thereby "aerating" or lightening the oil and carrying it to the surface through tubing **30** and through recovery or flow line **32**. The gas used in the gas lift system requires no compression and as long as the pressure at the bottom of the tubing **30** in flowing well **26** is equal or less than the pressure at pump in pumping well **10**, there is no increase in the bottom hole pressure in well **10** and there is no restriction in oil production therefrom. However, even if the bottom hole pressure in pumping well **10** does increase to some extent, the increased oil recovery from flowing well **26** generally results in an overall increase in oil production from wells **10** and **26**.

This method of oil production possesses considerable flexibility. Thus, a number of pumping wells can be connected to one or more flowing wells. The method is particularly advantageous for use in connection with wells which are produced by means of fire flooding or in situ combustion processes since in such instances a high gas to oil ratio exists due to formation of carbon dioxide. At the same time, in the flowing well **26** a high gas-oil ratio is maintained so that the pressure at the bottom of the well is low resulting in what is referred to as "good drawdown." The expression "good drawdown" refers to a condition where the bore hole pressure is such as to facilitate greater oil flow into the bore hole.

FIG. II of the drawing shows apparatus for producing oil by the method of this invention and wherein oil flow from a flowing well is initiated or "kicked off" by use of a light oil such as diesel oil. In this embodiment of the invention pumping well **40** penetrates earth formation **41** in which there is an oil-bearing stratum **42**. Well **40** is provided with casing **44** and tubing **46** with annulus **48** being formed therebetween. Pump **50** is suspended on rod **51** to a depth near the oil-producing stratum **42**. By means of pump **50** oil is pumped to the surface and recovered via line **53**. Pumping is preferably conducted at a rate sufficient to maintain the oil level in well **40** at substantially the depth of pump **50** but not to permit produced gas to flow up tubing **46**.

Conduit **54** connects annulus **48** with a second well **56** which is to be flowed rather than pumped. Well **56** is provided with casing **58** and tubing **60** with annulus **62** being formed therebetween. Since the casings of pumping well **40** and flowing well **56** are connected by means of conduit **54**, the casing pressure in both wells will build up to a value substantially equivalent to the reservoir pressure with both being filled with gas.

Before initiating flow from well **56**, valve **93** is opened so that the liquid level in tubing **60** will fall to the liquid level in annulus **62**. This level is the same as the oil level in well **40**. Valve **93** is then closed. Next a light oil such as diesel oil from storage tank **66** is pumped by high pressure pump **68** through line **70** into annulus **62** in well **56**. The light oil is pumped into annulus **62** at a moderate rate, say of from 300 to 700 barrels per day. After sufficient light oil has been pumped into well **56** to displace the oil or water back into formation **42**, valve **86** is opened to initiate flow from tubing **60** through line **76** and into a low-pressure separator **80** in which the light oil is separated from other materials which may be present therewith. The light oil separated in separator **80** is recycled via line **82** into storage tank **66** while volatile materials can be vented through line **83**. Control valves **85** and **86** are employed to control flow through conduits **74** and **76** respectively.

Pumping of the light oil into annulus **62** is continued until natural flow from well **56** is established or until the viscosity of the returning oil increases significantly due to mixing with the produced crude oil. At this time pump **68** is shut down and the oil and gas flowing up the tubing will usually be diverted directly to oil recovery conduit **74** by closing valve **86** and opening valve **85**. However, if natural flow is not well established it will sometimes be desirable to continue production to low-pressure separator **80**. This is done by using transfer pump **91** to pump oil from the storage tank **66** through conduit **90** to oil recovery conduit **74**.

In accordance with the invention, gas produced in well **40** flows via line **54** controlled by valve **92** into the annulus **62** of well **56**. The gas so introduced mixes with the oil in well **56** thereby exerting an aerating or lightening effect and stimulating flow up through tubing **60** and through oil recovery line **74**.

In some wells natural flow can be more readily initiated if 50 to 200 barrels of light oil are pumped into formation **42** before valve **86** is opened to flow the well.

Again, when this invention is utilized with wells produced by fire flooding the gas introduced into annulus **62** via line **54** will contain a substantial amount of carbon dioxide. The light oil, such as diesel oil, which is introduced into well **56** will absorb carbon dioxide. When pressure is released, i.e., when high pressure pump **68** is shut down, carbon dioxide comes out of solution reducing the density of the oil and facilitating flow of well **56** through tubing **60**. Moreover, even before well **56** starts to flow some of the carbonated light oil may be displaced into the earth formation thereby stimulating initial productivity. Likewise, after the well starts to flow the carbonated light oil in annulus **62** mixes with the produced crude oil thereby reducing its viscosity and aiding flow.

Those modifications and equivalents which fall within the spirit of the invention are to be considered a part thereof.

I claim:

1. A process for producing oil from a pumping well which penetrates a gas and oil-bearing subterranean stratum and a flowing well which penetrates an oil-bearing subterranean stratum, each of said wells provided with a casing and produc-

tion tubing, which process comprises establishing the liquid level in said flowing well at the liquid level in said pumping well, introducing a light oil into the annulus of said flowing well, recovering said light oil from the tubing of said flowing well, passing said light oil to a separation zone in which it is separated from accompanying materials, recycling the separated light oil from the separation zone to a storage tank, pumping oil up the tubing of said pumping well and passing gas produced in said pumping well to said flowing well to comingle with fluids produced therein and to facilitate flow of such fluids from said flowing well.