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[54] **METHOD OF PRODUCING CRUDE OIL**
7 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **166/250,** 166/313
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[50] **Field of Search** 166/305, 306, 250, 254, 252, 268, 285, 313, 314, 315, 296

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ABSTRACT: A method for efficiently producing hydrocarbons such as petroleum and similar fluids from an underground reservoir having several separated and different hydrocarbon bearing formations or zones in stratified sequence is disclosed herein. The method comprises boring a generally vertical hole through the zones, placing casing in the wellbore, mounting one or more vertical communications tubes alongside the outside of the casing between the zones to be placed in communication, the tubes having vertically spaced perforating devices and extending between all the zones having similar producing characteristics. The casing and the communications tubes are cemented in place in the well hole, and then the communications tube and the adjacent zones are perforated by the perforating device adjacent the similarly characterized producing zones.

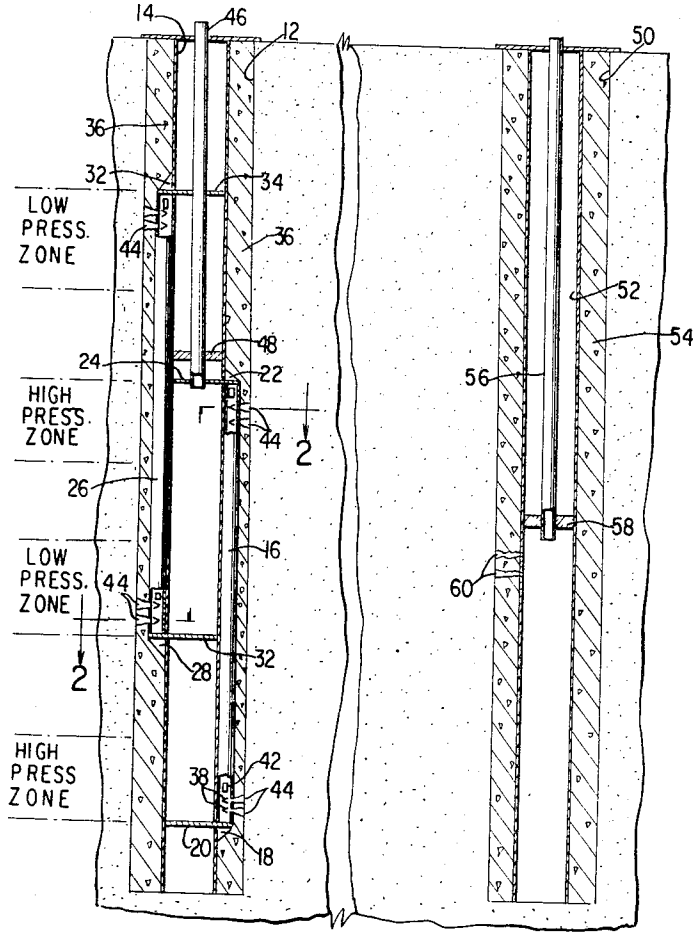
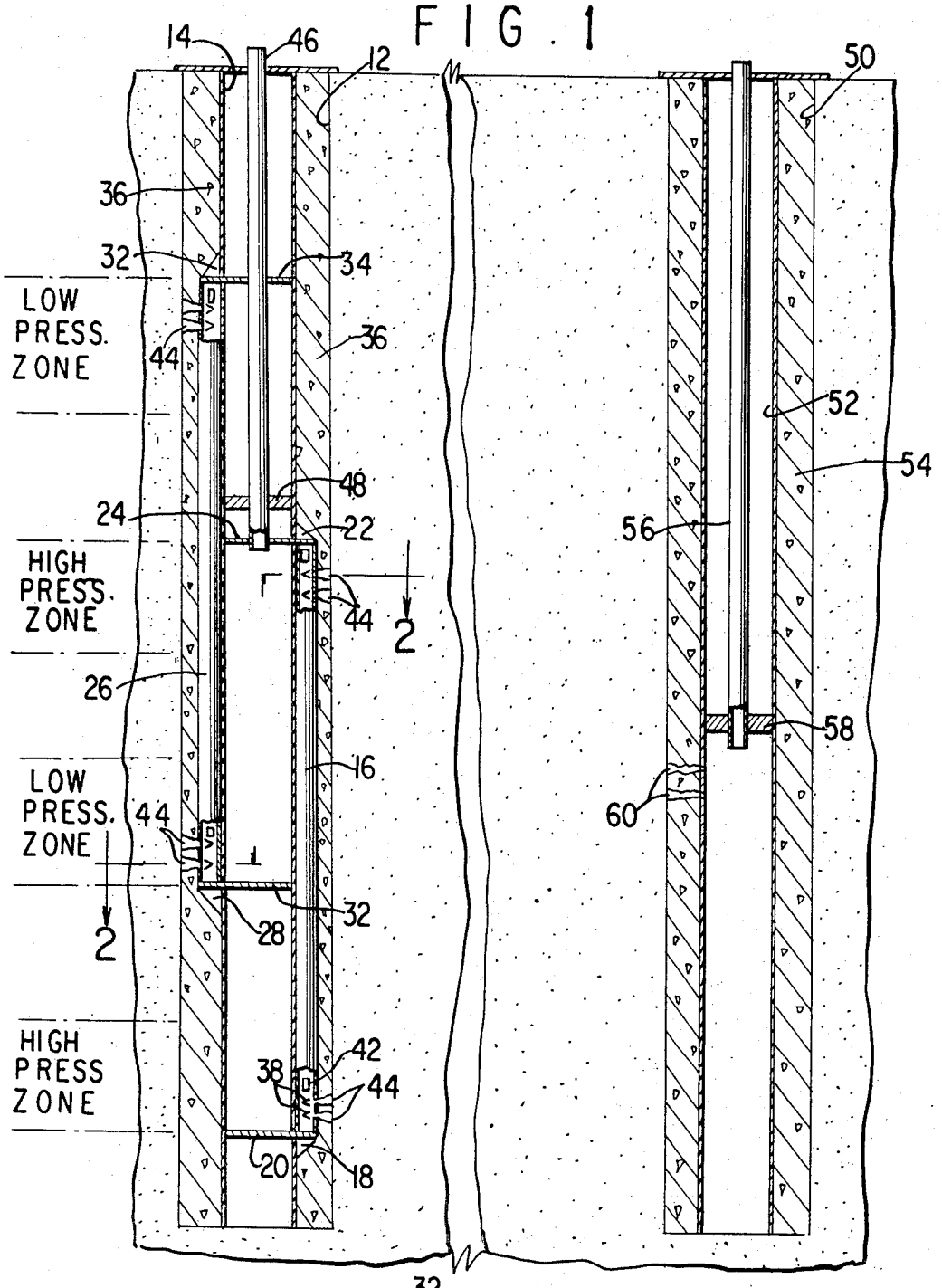


FIG. 1



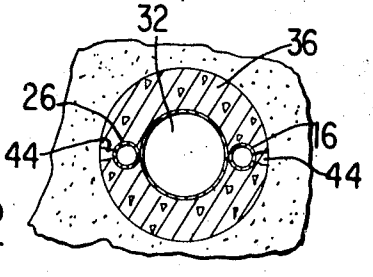


FIG. 2

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METHOD OF PRODUCING CRUDE OIL

BACKGROUND OF THE INVENTION

This invention relates to a method for efficiently producing hydrocarbon fluids principally crude oil from a well which penetrates several producing zones or formations. More particularly, this invention is directed to a method for selectively placing any number of separated producing zones in communication with each other in order to more effectively deplete each producing zone.

As a matter of common occurrence, petroleum bearing formations exist in stratified layers with no communication or crossflow occurring naturally between the various layers. For optimum production from a single well it is necessary to deplete each layer, formation, or zone before abandoning the well. Present completion techniques to accomplish this purpose, require multiple tubing, strings, downhole valves and packers. These act to limit the number of zones which can be produced simultaneously due to equipment requirements and the economics of workover jobs.

In oil producing reservoirs, naturally occurring communication paths or rather crossflow between different layers does occur and as a result numerous advantages are inherently obtained such as shorter payout, higher ultimate production, reduced perforating and completion casts and ease of interpretation of routine reservoir tests. As discussed by D. G. Russel and M. Prats in the June, 1962 Journal of Petroleum Technology (A.I.M.E. N.Y., N.Y.), the only known way to establish artificial communications between reservoir zones is by vertical fracturing. Where the various neighboring oil producing zones or layers do not possess similar characteristics, fracturing is not practical and may result in lost circulation. Even when naturally occurring crossflow does exist it is sometimes difficult to determine its existence without complex and costly evaluation techniques before capitalizing on the operating efficiencies obtainable. It is therefore quite desirable to provide an efficient, yet economical, method to obtain the advantages inherent in crossflow by artificial means.

SUMMARY OF THE INVENTION

Accordingly, we have invented a method for inducing crossflow between multilayered oil bearing zones in order to simultaneously recover crude oil from these previously unconnected oil bearing zones. The method contemplates placing two or more producing zones occurring in a multilayer sequence in communication with each other by attaching at least one sealed communications tube alongside the outside of the well casing and opposite the multiple producing zones; cementing the casing and communication tube in place in the wellbore; and perforating the tubes and the cement liner adjacent the selected producing zones, whereby the selected zones are placed in fluid communication with each other via the sealed communications tube.

It is therefore an object of this invention to provide a method for efficiently producing oil from a multizonal formation.

Another object of this invention is to provide a method for effectively and simply providing fluid communication (crossflow) between oil bearing formations.

Other objects and advantages of the method according to this invention will be apparent from the drawings and description of the preferred embodiments which follow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional elevation view of two oil wells showing a multilayer sequence of oil producing zones, and utilizing the method of this invention; and

FIG. 2 is a top view of the wellbore within which the induced crossflow is produced taken along section 2–2 of FIG. 1.

BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention is particularly applicable to oil reservoirs containing stratified oil bearing formations or zones which are characterized by lack of crossflow, and provides for selectively placing any number of zones in communication with each other. The multizonal oil reservoir is shown in FIG. 1 in a foreshortened view in order to illustrate the various oil bearing zones, and it should be understood that the apparent small vertical distances between the ground and between the various zones are certainly not illustrative of the actual distances, which distances are much greater. The reservoir is shown with a low pressure oil bearing zone having a moderate pressure, and which is the topmost oil bearing formation in the reservoir. For instance, the low pressure topmost zone may be at a depth of about 10,175 feet, have a pressure of about 7,000 p.s.i. and be characterized by a volumetric internally generated reservoir energy. The next lower oil bearing zone, described as a high pressure zone is separated from the uppermost low pressure zone by an impermeable formation preventing crossflow between the two zones. The same is characteristic of all the described oil bearing formations illustrated in the drawings. Below the topmost high pressure zone is another non-oil bearing formation which separates a lower low pressure oil bearing zone from the upper high pressure zone. Finally, a second lowermost high pressure oil bearing zone is located below the lower low pressure zone, separated therefrom by another impermeable formation.

A first wellbore **12** is drilled in the conventional manner through the oil reservoir and through the various oil producing zones.

The location (depth), and the producing characteristics of the various oil bearing zones are established by conventional coring and logging techniques, which techniques are used in determining which zones are to be placed in communications with each other. In the instant case, it is decided that it would be advantageous to place the similarly characterized zones in communication with each other, that is, the uppermost low pressure zone in communication with the other low pressure zone in and the two high pressure zones in communication with each other in order to produce from each set of zones simultaneously.

Casing **14** is then run into the wellbore **12** until the lowest position of casing relative to the lowermost oil bearing zone, i.e., the lower high pressure zone, is reached. A first communications tube **16** is then attached by a mounting clamp **18** to the casing **14**, where an end plate **20** is affixed to the casing and communications tube to prevent them from abrading against the wellbore **12**. Additional casing and communications tube sections are run into the wellbore continually until the length approximates the distance between the oil bearing zones which are to be connected. An upper mounting clamp **22** and an upper end plate **24** are mounted on the casing in order to attach the communications tube **16** at its upper end to the casing.

Similarly, a second length of communications tube **26** is attached alongside the casing **14** starting at a point which corresponds on the casing to the lowermost low pressure producing zone and extending upwardly the distance to the upper low pressure producing zone. The second communications tube **26** is attached to the casing **14** by lower and upper clamps **28** and **20** and lower and upper end plates **32** and **34** respectively. Thereafter running the casing **14** into the wellbore **12** is carried out in the conventional manner until the casing and communications tubes are located at their predetermined depths in the wellbore, and cemented in the usual manner. Each casing string is cemented in place by a cement slurry pumped down the casing and up the annular space between the casing and the wellbore. The cement is allowed to set for several hours before other operations are commenced and forms a cement liner **36** between the casing and the inside of the well-

bore. The cement liner acts to segregate formations behind the casing, prevent interformational flows and permit production from specific zones. Additionally, cementing affords support for and retards corrosion to the casing.

Each of the communications tubes **16** and **26** enclose a number of conventional perforation devices **38** which are so mounted as to be able to perforate the communications tubes, the cement and a portion of the adjacent zone where desired. The perforating devices located in the high pressure zone communications tube are mounted adjacent the high pressure zones and act to perforate the communications tube, and the cement liner adjacent the high pressure zones. Perforation devices are generally classified as either bullet perforation devices or jet perforation devices. As implied by their name, bullet perforating devices are essentially multibarrel firearms designed to be lowered into a well and fired remotely with surface controls. They may be retrievable or expendable and are utilized in many different forms to achieve the desired purpose. Jet perforating devices utilize a number of shaped charges **40** as shown in the drawings to obtain penetration of the tube, the adjacent cement liner and formation by the shaped charge exploding into a directional high velocity jet stream. The jet perforating devices are selectively placed in the communications tube. Their positioning is later checked by logging methods and if properly placed, they are triggered by remotely controlled detonators **42** from the surface. The jet stream forms perforations **44** in the communications tube, the adjacent cement well liner **36** and the adjacent oil bearing zone.

For oil production after completion of wellbore **12** from a single well, a flow string **46** extending coaxially within the casing **14** from the surface to below an upper packer **48** is mounted within the casing. The upper packer **48** is located above the oil bearing zone to be produced, specifically, as illustrated, the connected high pressure zones. The casing **14** adjacent the upper high pressure zone is perforated by a perforating device not shown, and the crude oil allowed to flow out of the well via the flow string **46**. If desired, a multizonal completion, not shown, may be provided in wellbore **12** in order to simultaneously produce from both sets of zones through a single well. A multizonal completion is one in which two or more separate pay zones, in this case separate sets of zones, are produced simultaneously from the same wellbore without commingling of oil from the different zones. Such multizonal completions are shown on page 318 of Petroleum Engineering by Carl Gatlin (Prentice-Hall, Inc., Englewood Cliffs, N.J., 1960). Two zone or dual completions are very common and are usually required for reservoir control. By utilizing such a completion all four noncrossflow zones can be produced by the present inventive method and in practice reduce the number of zones from four to two.

Multizonal completions are generally more expensive and difficult than single zone completions, particularly when the number of zones to be produced in the same wellbore exceed two. Therefore, when other adjacent wells are available, two single completions utilizing the present invention may be preferred. A second wellbore **50** is drilled through the aforesaid reservoir, a second string of casing **52** lowered into the wellbore **50** and cemented in place by cement liner **54**. A flow string **56** is coaxially mounted within the casing **52** in communication with the producing zone, and optionally fixed in position by a packer **58**. To produce from the low pressure zones, a perforating device, not shown, is lowered into the wellbore **50** and the casing **52**, cement liner **54**, and one of the low pressure zones adjacent the liner are perforated with a multiplicity of perforations **60** which extend into the low pressure zone.

In operation, the upper and lower low pressure zones are connected by the low pressure communication tube **26** and oil from these zones pass from the lower low pressure zone into the second wellbore **50** through the perforated completion. The oil from the low pressure zones is then lifted via the second wellbore flow string **56**. Simultaneously oil from the high pressure zones move from the lower high pressure zone via communications tube **16** to the upper high pressure zone into the first wellbore casing **14** along with oil from the upper pressure zone. The oil is lifted via the first wellbore flow string **46**. As is readily apparent, all the oil bearing formations are produced simultaneously from two wells utilizing unitary zone completions rather than dual zone completions. If more than four zones are found in a reservoir it is obvious that utilizing the present invention the problem of simultaneously producing the reservoir is greatly simplified.

By way of further illustration the following example is given, describing the use of the present invention for production from a six zone reservoir. The characteristics of the multizone reservoir are as follows:

	Zone depth, ft.	Reserves, billion cu. ft.	Initial producing capacity, M.c.f./day	Pressure, p.s.i.	Reservoir energy, drive
Productive zone:					
1	10,000	1.0	2,000	10,000	Volumetric.
2	10,150	1.5	5,000	7,000	Complete water drive.
3	10,175	.75	700	7,050	Volumetric.
4	10,200	3.0	6,000	7,100	Partial water drive.
5	10,250	.9	800	7,200	Volumetric.
6	10,350	1.5	1,200	10,100	Do.

By conventional completion techniques it is impossible to produce all of the six zones simultaneously. However, utilizing the present inventive method, it is possible to externally connect zones having similar characteristics, and treat the connected zones as a single zone within the wellbore. The abnormally high pressured zones **1** and **6** are connected via one communications tube external to the wellbore casing. Low pressure zones **3** and **5** are also connected via a second communications tube also externally mounted on the wellbore casing. Partial water drive zone **4** is coupled to the low-pressure zones, via the second communications tube. Complete water drive zone **2** cannot be connected to any of the other zones and is separately completed. Thus the six zones have advantageously been reduced to three producing zones. This reduction results in earlier payout of the cost of the well by higher production; yields larger ultimate reserves; and costs less to implement than other methods.

Having fully described the present invention and wishing to cover those modifications and variations which would be apparent to those skilled in the art without departing from both the spirit and scope of the invention,

We claim:

1. A method for recovering underground hydrocarbon by placing a plurality of fluid hydrocarbon bearing zones in a multizonal reservoir in fluid communications with each other, said method comprising:

drilling a wellbore through said plurality of fluid hydrocarbon bearing zones;

placing casing in said wellbore adjacent said fluid hydrocarbon bearing zones;

placing cement between said casing and said wellbore to form a liner thereby sealing said wellbore from said plurality of fluid hydrocarbon bearing zones;

mounting fluid communication means in said wellbore between the casing and the wellbore and adjacent said plurality of fluid hydrocarbon bearing zones; and

placing said communication means and at least two of said plurality of hydrocarbon fluid bearing zones in fluid communication with each other.

2. The method of claim 1 which additionally comprises mounting more than one communications means in said wellbore and placing different sets of fluid hydrocarbon bearing zones in fluid communications means.

3. The method of claim 2 wherein each of said fluid communications means is a communications tube fixedly mounted on the outside of said casing, said communications tubes each have a plurality of internally mounted perforating devices located opposite said plurality of fluid hydrocarbon bearing zones and said step of placing said communications means and at least two of said plurality of fluid hydrocarbon bearing zones in fluid communication with each other comprises, perforating said communications tubes, the adjacent cement liner and said fluid hydrocarbon bearing zone with said perforating devices.

4. The method of claim 3 which additionally comprises drilling the wellbore from the surface through said multizonal reservoir, determining the producing characteristics of each of said plurality of fluid hydrocarbon bearing zones in said multizonal reservoir, and placing fluid hydrocarbon bearing zones having similar producing characteristics in fluid communication with each other.

5. The method of claim 4 which additionally comprises placing said cased wellbore in fluid communication with the surface by mounting a pipe internally in said wellbore between the surface and said cased wellbore adjacent one of said communications tubes, and placing said pipe in fluid communications tube.

6. The method of claim 4 which additionally comprises drilling a second well through said multizonal reservoir, sealing said second well from said fluid hydrocarbon bearing zones and selectively placing one of said fluid hydrocarbon bearing zones in fluid communication with said second well.

7. The method of claim 6 wherein said second well is a multizonal completion having a plurality of flow pipes coaxially mounted in said second well, said pipes being each placed in fluid communication with the surface and a different fluid hydrocarbon bearing zone.