Aug. 19, 1952 W. D. ROSE 2,607,426

PUMPING TECHNIQUE TO PREVENT EXCESSIVE WATER CONING

Filed Sept. 4, 1947 2 SHEETS—SHEET 1

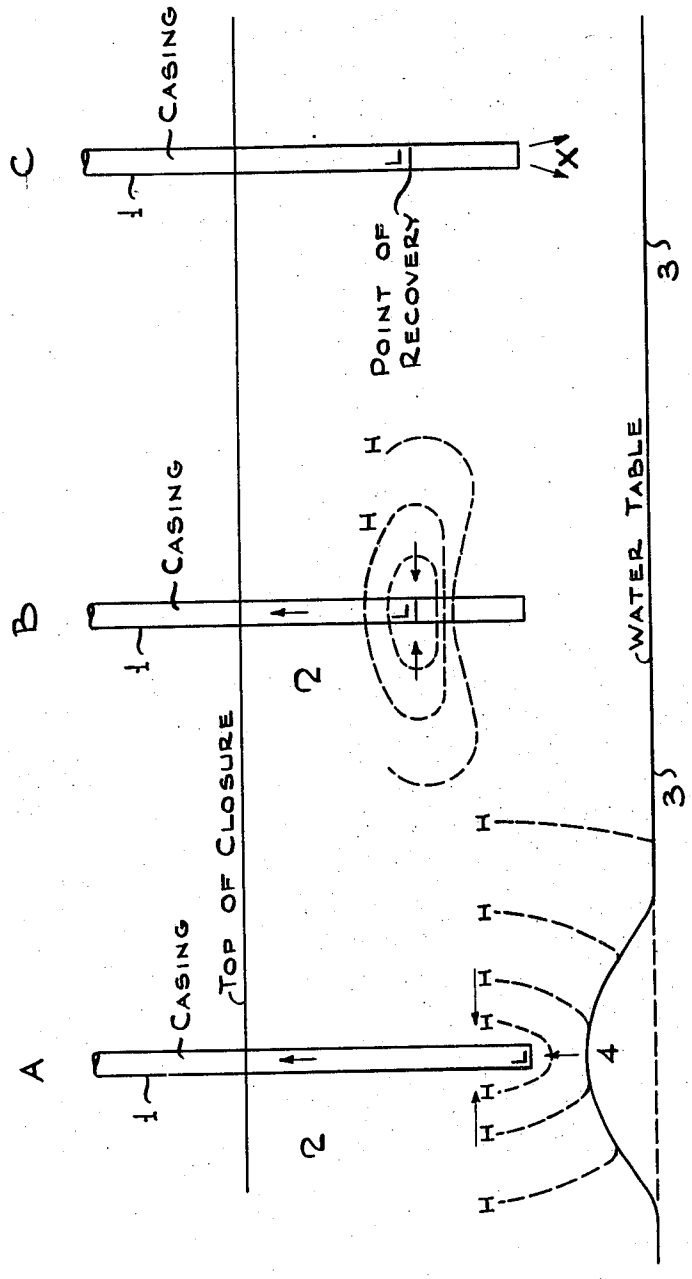


FIG. 1

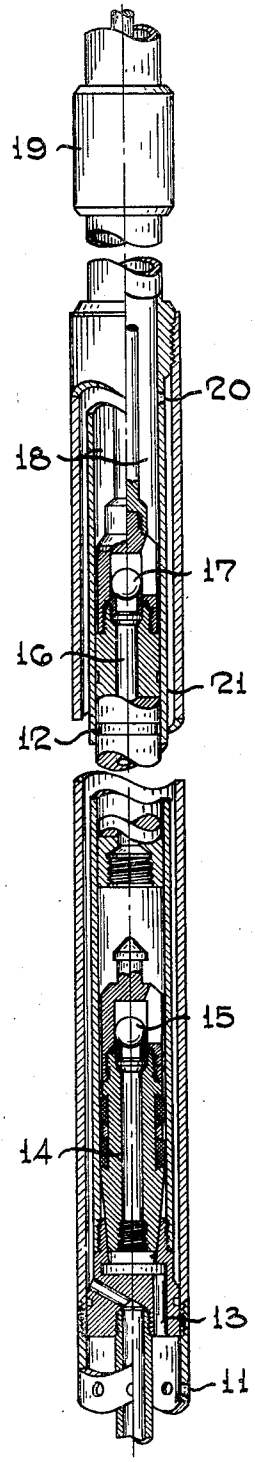
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PUMPING TECHNIQUE TO PREVENT EXCESSIVE WATER CONING

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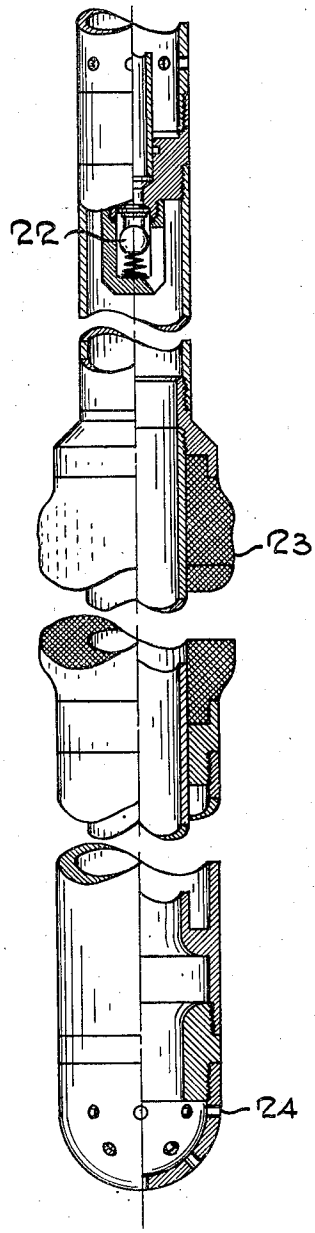


FIG.-2

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PUMPING TECHNIQUE TO PREVENT EXCESSIVE WATER CONING

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2 Claims. (Cl. 166—21)

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The present invention is concerned with an improved pumping technique to reduce water coning in the production of petroleum crude oil. The invention is specifically directed to an improved technique by which a certain proportion of the produced oil is injected back down into the bottom-hole formation at a point between the water-oil contact zone and the effective point for the production of the oil.

It is well known in the art to recover petroleum crude oils from subterranean areas, as for example, from oil-saturated sands and the like. These areas of oil-saturated permeable sands are usually found below overlying impermeable formations. In the production of oil, the impermeable formations are pierced by a well hole reaching into the area of oil-saturated permeable sands. Furthermore, in many instances the oil-saturated permeable sands exist above a permeable sand of the same character which contains water. Thus, a water level or water table exists in the permeable sand formation wherein the oil comprises the upper area and the water comprises the lower area. As the oil is withdrawn from the oil-containing sand from a point in the closure between the water table and the top of the formation, i. e., the closure, coning of the water toward the point of withdrawal of the oil tends to result. This is particularly the situation in areas of high vertical permeability wherein the production rates are also high.

This coning of water is very undesirable since it results in the pumping or passing of water to the surface along with the produced oil. Production costs are increased due to the cost of pumping valueless water to the surface, which costs must be borne by the units of oil produced. Furthermore, additional costs are incurred due to the necessity of separating water from the produced oil and the disposal of the same. A more serious result which may be encountered due to the coning of water in the producing area is that it may completely shut off the flow of oil itself.

I have now discovered a process which will substantially eliminate the coning of water in an oil-containing area. In accordance with my process I inject a portion of the produced oil back into the bottom-hole formation. This is preferably accomplished by the use of a reverse flow pump at the bottom of the hole which is so designed that the produced oil is drawn in horizontally and the injected oil is pumped vertically into the formation below the bottom-hole. My invention may be readily understood by reference

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to the attached drawings illustrating embodiments of the same.

Figure 1 is a diagrammatic sketch illustrating the broader concept of my process, while Figure 2 illustrates a particularly desirable mechanical device for carrying out the same.

Referring specifically to Figure 1, sketch A illustrates a water coning effect which is secured as outlined hereinbefore. The bore hole 1 extends from the earth's surface downwardly into an oil-producing sand formation 2. Oil is produced from the oil-producing sand at point L and flows upwardly to the surface within the oil well casing. The contours of the equivalent pressures which exist around the point of recovery of the oil at point L from the oil-producing sand are represented by isobaric lines H. When oil is not flowing, the pressure in the entire area is substantially the same and the oil-water table is shown as the dashed section of line 3. However, when oil is being withdrawn at point L which is taken to be the optimum point for oil recovery from the oil-producing sand, the pressure in the area decreases toward the point of recovery L. Under these conditions, particularly when a high rate of oil production is being secured, the oil-water table tends to cone as shown by the cone section 4 of line 3.

A condition which is desirable for recovering oil with a minimum content of water is shown in sketch B of Figure 1. Under these conditions the pressure decreases laterally in the direction of the point of recovery L. Furthermore, under these conditions no coning or doming of the water table 3 is secured. Sketch C of Figure 1 illustrates graphically my process for securing this effect. While recovering the oil at point L the pressure decreases laterally in the direction of the point of recovery. In accordance with my invention I reinject a portion of the recovered oil into the formation at point X, preferably in a vertical direction toward the oil-water table 3.

Referring specifically to Figure 2, 10 designates a preferred pumping means for recovering oil from oil-producing sands and for reinjecting a portion of the recovered oil into the area. Reservoir oil fluids are drawn into the pump through a perforated zone 11 with the upward travel of the piston 12 actuated by a conventional sucker rod system. The piston and the sucker rods are actuated by a prime mover, preferably located on the earth's surface. Reservoir fluids flow through the perforated zone 11 upwardly through port 13 into the area 14 and past standing valve 15. The fluids continue to flow upwardly through

area 16 and past travelling valve 17 into the area 18. The recovered portion of the reservoir fluids pass upwardly through the oil well tubing 19 to the surface.

In accordance with this particular adaptation of my process, a portion of the produced oil passes through orifice 20 in a manner as hereinafter described. It is obvious that the amount of oil segregated from the main stream will, to a large degree, be a function of the size and design of orifice 20. Orifice 20 directs the flow and to a degree controls the volume of flow of injected fluid back into the bottom-hole formation. This is accomplished in the following manner. The fluid which has been left above the travelling valve 17, preferentially flows through the orifice 20 rather than up the tubing 19 to the surface, either because the pressure developed by the fluid column is greater than the bottom-hole pressure or because a surface pressure operated valve makes flow through the orifice 20 the path of least resistance. The flow of fluid through orifice 20 continues until the upward travel of the piston shuts off this opening 20 or until the fluid pressure in the tubular space extending from the pump to the surface causes the surface valve to open. In any event the portion of produced fluid which is caused to flow through orifice 20 constitutes the portion to be injected into the bottom-hole, and the remaining fluid lifted by the pump stroke is the portion of oil which is produced and recovered at the surface. It can be seen that the location of orifice 20 with respect to the position of reversal between the downstroke and upstroke, and with respect to the length of the pump stroke, controls the ratio of injected fluids to produced fluids. The first factor is determined by the design of the pump and the latter factor is determined by surface control of the pump stroke length, as well as by pump design. Other factors which control the ratio of injected fluids to produced fluids are the size of the orifice, the fluid density, the bottom-hole pressure, the bottom-hole permeability characteristics, and the pressure setting on the surface valve.

The fluid after passing through orifice 20 passes down through passageway 21, past spring control valve 22. This fluid continues to pass downwardly within the packed zone 23 and is injected into the oil-producing sands through ports 24 at a point preferably above the oil-water contact area. Under certain conditions this point of injection may be slightly below the oil-water contact area.

As pointed out heretofore, my invention is broadly directed toward the prevention of water coning or doming which causes an excessive amount of water to be produced along with the desirable oil and which may ultimately cut off the flow of oil entirely. I prevent the coning of water by reinjecting a portion of the produced oil back into the oil-producing area. The injected oil is preferably injected from a point below the recovery point in the direction of the oil-water table. The amount of oil reinjected may vary considerably and is a function, to a large extent, of the particular characteristics of the oil-producing area. However, in general I prefer to reinject about 2 to 10% of the recovered oil back into the oil-producing area.

A desirable means of accomplishing my process is to employ a reverse flow pump as described or its equivalent. In the installation of this pump, it is preferred to set casing to the bottom-hole total depth, then to squeeze cement and then to gun perforate both at the recovery and injection levels. The pump assembly is then lowered into place and a packing zone is set between the point of recovery of the oil and the point of injection. The packing will limit to a large degree the channeling of injected fluid back to the point of recovery. The type of packing may be varied considerably and may comprise any suitable packing material.

The process of my invention is not to be limited by any theory as to mode of operation, but only in and by the following claims.

What is claimed is:

1. Process for the recovery of oil from a well bore penetrating an oil containing sand formation positioned above a water table which comprises: sealing off a portion of the said well bore at a point within the said sand formation, pumping oil from said sand formation into said well bore above the sealed portion of the well bore, segregating said oil pumped into the well bore into two portions, passing one of said portions upwardly through the well bore to the surface of the earth, and passing the other of said portions downwardly into the well bore beneath the sealed portion of the well bore, whereby said latter portion is introduced substantially vertically downwardly into the sand formation above the water table.

2. The process defined in claim 1 in which the portion of the oil passed downwardly into the sand formation is about 2 to 10% of the oil pumped into the said well bore.

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