July 14, 1964 F. H. BAILLY 3,140,744

OIL WELL HEATER

Filed May 29, 1961

FIG. 2.

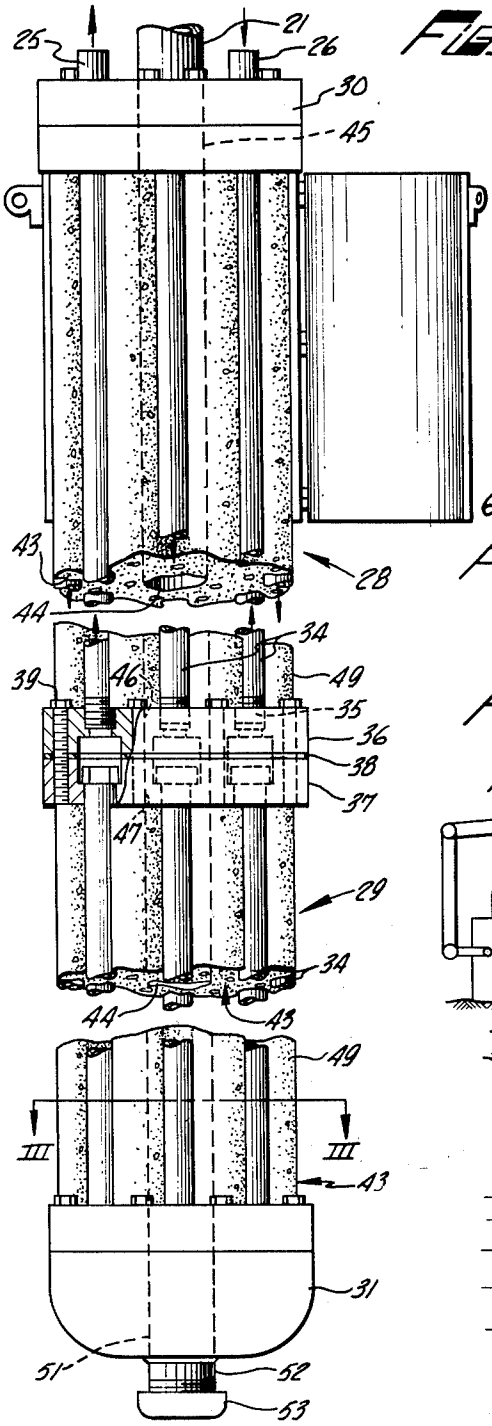


FIG. 3.

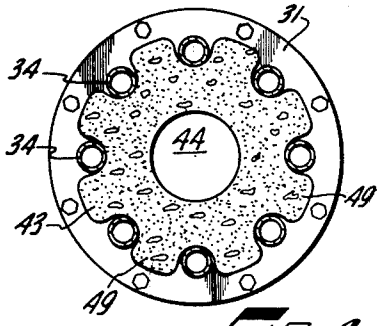


FIG. 5.

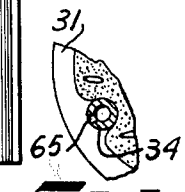


FIG. 4.

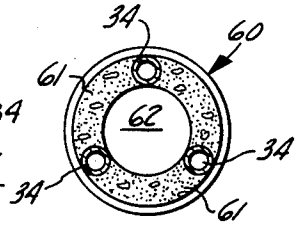
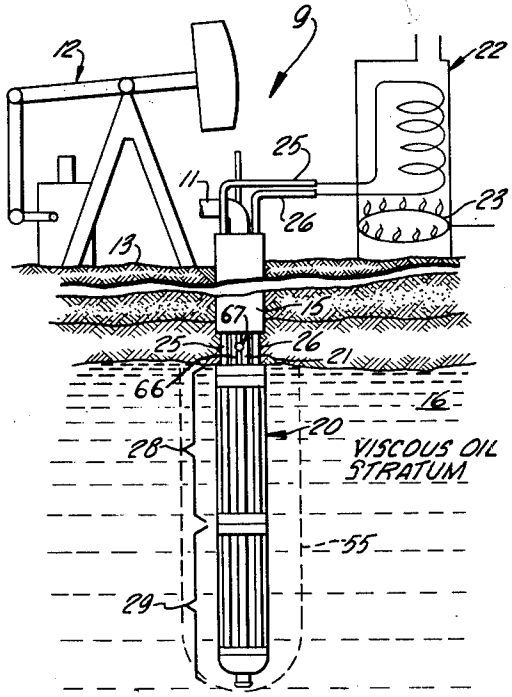


FIG. 1.



United States Patent Office 3,140,744 Patented July 14, 1964

3,140,744

OIL WELL HEATER

Florent H. Bailly, Arcadia, Calif., assignor to Variperm Company, Los Angeles, Calif., a corporation of California

Filed May 29, 1961, Ser. No. 113,305
3 Claims. (Cl. 166—61)

This invention relates to oil well heaters. More particularly, it relates to oil well heaters for use within the well to increase flows of viscous asphaltic crudes.

Flow of crude oil into a well casing is dependent on the pressure differential existing between the formation and the oil well casing. It is further dependent upon the surface area of the casing within the oil producing formation and upon the viscosity of the oil. As the viscosity of the oil increases, the pressure differential required to produce a constant flow increases. In many instances the crude oil has very high asphaltic or paraffin content resulting in a viscosity of such a magnitude that the normal pressure differentials occurring are not sufficient to produce a well flowing naturally to the surface. In such instances high powered pumping stations are required to withdraw the oil from the well. Often the viscosity of such asphaltic crudes is so high and a pumping station of such large capacity is required that the well is impractical and uneconomical for production.

The problem, then, is to provide an economical apparatus for practicing a method for improving the flow of high viscosity ihgh density asphaltic crude oils. Prior methods and attempts to solve this problem include the introduction of miscible solvents into the oil formation and the burning of gas in the ground to increase formation pressure to force the oil from a region adjacent the combustion to another well from which it flows to the surface. Generally, such practices magnify other problems which previously were secondary. These secondary problems are that as flow is increased, especially in loosely consolidated or unconsolidated sand formations, sand is entrained in the oil and erodes the casing. Particularly with the "in-place" burning it is common for the oil to cool during flow upwardly through the casing, to congeal and to clog in the string such that a high-powered large-capacity pumping apparatus is still required.

This invention provides a novel and unique combination of elements in an apparatus which increases the natural flow of high viscosity high density asphaltic crude oil. This invention is particularly useful in unconsolidated sand formations and retards clogging of the production zone of the well by retarding the influx of sand into the well.

Generally speaking, this invention provides a heater and filter for use in an oil well extending from an upper end to a lower end in a viscous oil bearing geological formation. The heater comprises a plurality of spaced apart vertical tubes oriented around a hollow elongated core of permeable concrete disposed centrally of the tubes. A lower tube manifold and an upper tube manifold support the tubes and the core. Means are provided at the upper end of the well for introducing a heated fluid medium into the top manifold for circulation through the vertical tubes by way of the bottom manifold. The result of this apparatus is a lowering of the viscosity of the crude oil in the geological formation by virtue of being increased in temperature. The reduced viscosity crude oil flows through the permeable concrete core for extraction from the well by conventional means.

The following detailed description and explanation of the invention is made in conjunction with the accompanying figures, wherein:

FIGURE 1 is a vertical shortened elevational view showing the heater of this invention located in a viscous oil geological stratum;

FIGURE 2 is an enlarged vertical elevation, with parts broken away, of the heater of this invention;

FIGURE 3 is a cross-sectional view taken along 3—3 of FIGURE 2 of the heater showing the permeable concrete core and the orientation of the heated fluid circulating;

FIGURE 4 is a cross-sectional view of a second modification of the heater of this invention; and

FIGURE 5 is a fragmentary cross-sectional elevation of a third modification of the heater of this invention.

Referring to FIGURE 1, an oil well **9** having a casing **10** and a central oil conductor pipe **11** are illustrated. A conventional pumping unit **12** is shown supported on the surface of the ground **13** adjacent the upper end of the well **9**. The casing **10** extends downwardly through the earth to a lower end **15** adjacent a subsurface formation **16** of a loosely consolidated sand-bearing viscous asphaltic or paraffinic oil. A heater **20** according to this invention is connected to the lower end **21** of the conductor pipe **11**. A boiler **22** is provided adjacent the upper end of the well **9** and is fired by means of the burner **23** in the lower end thereof. The boiler **22** is shown schematically to include a coil **24** connected to pipes **25** and **26** extending downwardly within the interior of the casing **10** to the heater **20**. As illustrated in FIGURE 1, the boiler **20** is preferably a superheated steam generator; however, this invention contemplates the use of high temperature liquids as well.

Referring to FIGURE 2, the formation oil heater and filter device **20** is shown in detail. The heater **20** is divided into an upper portion **28** and a lower portion **29**. An upper manifold **30** is provided in the upper portion **28** and is connected to the lower ends of the heated medium circulating pipes **25** and **26**. A lower or bottom manifold **31** is spaced vertically from the upper manifold **30**. A plurality of hollow heated fluid circulating tubes **34** extend from the upper manifold to the lower manifold. As illustrated in FIGURE 2, the tubes **34** are not continuous between the upper and lower manifolds **30** and **31**, respectively, but are divided into two substantially equal length groups of tubes comprising the heater upper and lower sections **28** and **29**. The tubes **34** extending from the upper manifold are threaded at **35** into an upper tube sheet **36** forming the lower end of the heater upper section **28**. The tubes **34** extending upwardly from the bottom manifold **31** are secured to a lower tube sheet **37** defining the upper end of the lower heater section **29**. The upper and lower tubes sheets **36** and **37**, respectively, abut a gasket **38** and are secured to one another by studs extending from the lower tube sheet **37** through the upper tube sheet **36** which are engaged by nuts **39** on the upper surface of the upper tube sheet **36**. Such a construction provides that the heater may be fabricated in sections convenient for handling. The sections may be assembled into a heater which extends through the entire depth of the subsurface oil producing stratum **16**.

As illustrated in FIGURE 3, the vertical fluid conducting circulating tubes **34** are spaced apart from one another and are arranged in a circular pattern. The diameter of the circle of the tubes **34** is somewhat less than the diameter of the upper and lower manifolds **30** and **31**. An elongated cylindrical core **43** extends between the manifolds and their associated tube sheets. The core is fabricated from permeable concrete of the nature described in United States Patent Reissue 24,570 issued November 25, 1958 and owned by the inventor of this invention. A central longitudinal cavity or hollow portion **44** is formed in the core **43** and serves as a continuation of the oil conductor pipe **21**. Accordingly, a cen-

tral cavity 45 is formed through the top manifold 30 and central apertures 46 and 47 extend through the tube sheets 36 and 37, respectively. The outer surface of the core 43 is formed into projections 49 extending between the spaced apart tubes 34. The projections 49 are within the limits of the diameters of the upper and lower manifolds 30 and 31, respectively.

FIGURE 4 illustrates a second form 60 of the heater of this invention. The permeable concrete is formed into arcuate shell sections 61 which are bonded to the hot fluid circulating tubes 34. The conductor pipe extension 62 is formed by the combined enclosure of the tubes 34 and the concrete sections 61. The heater 60 is particularly advantageous where the diameter of the casing 10 is small. The heater 20 illustrated in FIGURES 2 and 3 is most practical in large diameter well casings.

The lower manifold 31 includes a central pipe length 51 oriented longitudinally of the manifold in line with the core hollow portion 44. The pipe 51 extends to an end 52 below the limits of the manifold 31 and is closed by a threaded cap 53. In operation of the heater in an oil well, as the oil flows through the permeable concrete 43 some sand particles may be carried through the extent of the core into the hollow 44. The pipe 51 and the cap 53 provide means for removing sand particles from the heater when the unit is removed from the oil well 9. In wells which are gravel packed the sand fills the spaces of the gravel and cuts off the flow of oil into the well. This invention provides apparatus which may be removed from the well when and if it becomes clogged with sand, and which may be backwashed while another heater is in use.

In use, the upper and lower manifolded sections 28 and 29 of the heater 20 are secured together as illustrated in FIGURE 2 and are lowered into the oil well after the conductor pipe 11 and the heated fluid pipes 25 and 26 are secured to the top manifold 30. After the heater 20 has been positioned in the desired location within the oil bearing stratum 16, the heated fluid is circulated through the tubes 34 from the boiler 22 via the pipes 25 and 26. In this manner the area of the stratum 16 directly adjacent to the heater 20 is raised in temperature such that the viscosity of the oil within the area affected by the heater 20 (see the idealized representation 55 of the area in FIGURE 1) is reduced. The reduced viscosity permits the oil to flow more readily through the permeable concrete of the core 43 and into the central cavity 44. If the heater tubes 34 were not provided around the exterior of the core 34 the effective diffusion area of the oil in the stratum 16 would be limited to the exposed surface of the core 43. However, because of the presence of the heating tubes 34, the effective diffusion area is extended to the limit 55, i.e., the lower pressure area provided by the central cavity 44 is extended to the limit 55 because of the increased tendency of the heated oil within the limit 55 to flow through the core 43.

The pressure differential existing within the well 9 which causes the diffusion through the core 43 also serves to force the oil within the cavity 44 upwardly through the conductor pipe 11. However, if the length of the casing 10 is great, there is a possibility that the oil in the conductor pipe 11 will cool, become more viscous, and prevent the free flow of the oil in the conductor pipe 11. Accordingly, the pipes 25 and 26 for circulation of the heated fluid from the boiler 22 to the heater 20 are placed directly against the exterior of the conductor pipe 11 to maintain an elevated temperature of the oil in the conductor 11 so that the viscosity does not increase. This has the secondary effect of reducing the power requirements of the pumping rig 12 which may be necessary in conjunction with the oil well. It is also within the scope of this invention that the pipes 25 and 26 may be carried within the conductor pipe 11 between the upper end of the casing 10 and the lower end 15. In such an instance fittings are necessary at the lower end 21 of the conductor pipe 11 to permit the exit of the pipes 25 and 26 from the conductor pipe 11 for connection to the upper manifold 30.

Another advantage inherent in the heater 20 of this invention is that no conductor pipe as such is required within the limits of the oil producing stratum. In sand filters known heretofore, a perforated conductor pipe has been used in conjunction with an exterior packing of filter material. In these situations, sand, especially from unconsolidated sand strata, passes through the filter material and into the conductor pipe. In doing so, the sand passes over the exposed edges of the conductor pipe and rapidly erodes the pipe. After erosion has proceeded to a sufficient degree, the conductor end fitting, in effect, disintegrates. This invention does not utilize a perforated conductor pipe because of the hollow core 43. Also the heating tubes 34 on the exterior surface of the core 43 are smoothly curved and offer resistance to erosion by sand entrained in the oil approaching and passing through the core 43. The projections 49 of the core 43 extending between the tubes 34 serve to further protect the tubes from erosion by sand.

The heater 20 may be modified for use with miscible solvents by the expedient of perforating a pair of the tubes 34 as shown at 65 in FIGURE 5. An additional pipe 66 is provided in the casing 15 and the upper manifold 30 is altered to provide individual connection between the additional pipe and the perforated tubes. These changes make it possible to pump a solvent into the oil stratum 16 to further assist in the flow of crude oil into the core 43. Most desirably the solvent is pumped into the stratum for an interval and then the oil is allowed to flow into the core when the solvent is not being discharged. In this case a check valve 67 is required at the upper manifold 30 so that the high pressure of the oil is not reflected in the additional pipe. The solvent is recovered from the produced oil for subsequent reuse.

While the invention has been described above in conjunction with specific apparatus, it is to be understood that this has been by way of illustration only and is not a limitation to the scope of this invention.

I claim:

1. A heater insertable into an underground oil-bearing stratum through an oil well casing comprising an uppre manifold, a lower manifold, a plurality of vertical fluid circulating tubes extending between the manifolds and fluidly communicating with the manifolds for circulation of fluid between the manifolds, said tubes being disposed about a vertical axis of the heater, arcuate permeable concrete shell sections disposed between the tubes and extending between the manifolds and the tubes to define a central longitudinal cavity axially of the heater extending from the upper manifold to the lower manifold, an oil conductor pipe, means for connecting the oil conductor pipe to the heater for fluid flow communication with the cavity, means for connecting the upper manifold to a source of heated fluid, and means for connecting the upper manifold to heated fluid outlet means.

2. A heater insertable into an underground oil-bearing stratum through an oil well casing comprising an upper manifold, a lower manifold, a plurality of vertical tubes extending between the manifolds and connected thereto for circulation of heated fluid between the manifolds, a second plurality of tubes extending between the manifolds in fluid communication with the upper manifold and perforated along their lengths, a permeable concrete core disposed between the tubes and extending from the upper manifold to the lower manifold, the core defining a central longitudinal heater cavity extending from the lower manifold to the upper manifold for receiving oil passed through the core from the stratum, and oil conductor pipe, means for connecting the oil conductor pipe to the heater for fluid flow communica-

tion with the cavity, means connected to the upper manifold for introduction of heated fluid thereinto for circulation through the first plurality of vertical tubes, and means connected to the perforated tubes for introducing a solvent into the perforated tubes for flow into the stratum ajacent to the heater.

3. A heater insertable into an underground oil-bearing stratum through an oil well casing comprising an upper manifold, a lower manifold, a plurality of spaced apart vertical fluid circulating tubes extending between and communicating with the manifolds for circulation of fluid therethrough between the manifolds, said tubes being disposed in a circular array concentric to the vertical axis of the heater, a hollow elongated cylindrical core of permeable concrete disposed centrally of the pattern of tubes, the core defining a plurality of circumferentially spaced projections extending radially outwardly therefrom, one projection being disposed between each pair of adjacent tubes, the core defining a central cavity axially

of the heater extending from the upper manifold to the lower manifold, an oil conductor pipe having a lower end, means for connecting the lower end of the oil conductor pipe to the upper manifold for fluid flow communication thereof with the cavity through the upper manifold, means for connecting the upper manifold to a source of heated fluid and means for connecting the upper manifold to heated fluid outlet means for circulation of heated fluid through the tubes from the sources of heated fluid via the lower manifold to the heated fluid outlet means.

References Cited in the file of this patent

UNITED STATES PATENTS

1,169,262	Huff	Jan. 25, 1916
2,335,558	Young	Nov. 30, 1943
2,349,536	Bancroft	May 23, 1944
2,385,298	Muskat	Sept. 18, 1945