March 23, 1954 A. F. EADIE 2,672,815

APPARATUS FOR PUMPING VISCOUS CRUDE

Filed Sept. 4, 1948 2 Sheets-Sheet 1

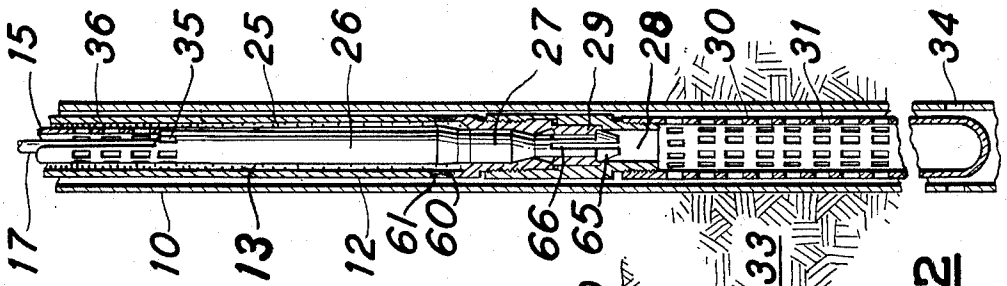


FIG. 2

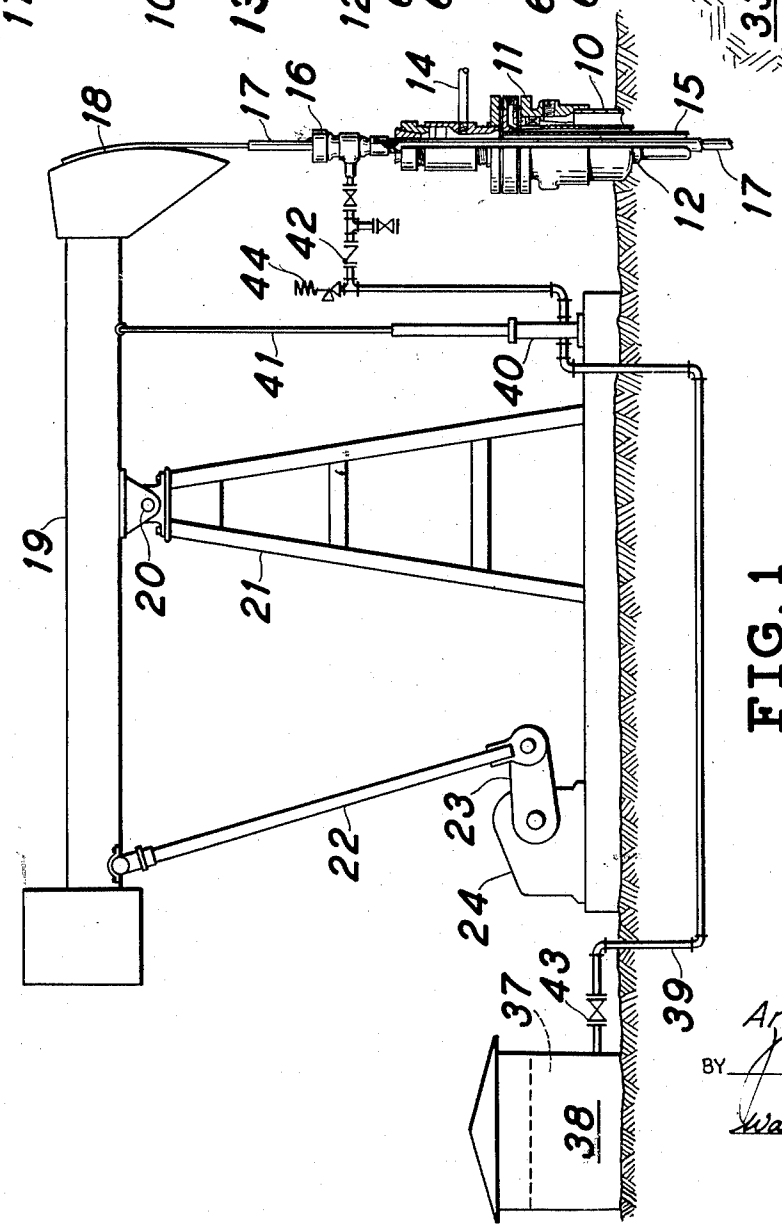


FIG. 1

INVENTOR

Arthur F. Eadie

BY Mhdawa

Walter G. Miller

ATTORNEYS

March 23, 1954 A. F. EADIE 2,672,815

APPARATUS FOR PUMPING VISCOUS CRUDE

Filed Sept. 4, 1948 2 Sheets-Sheet 2

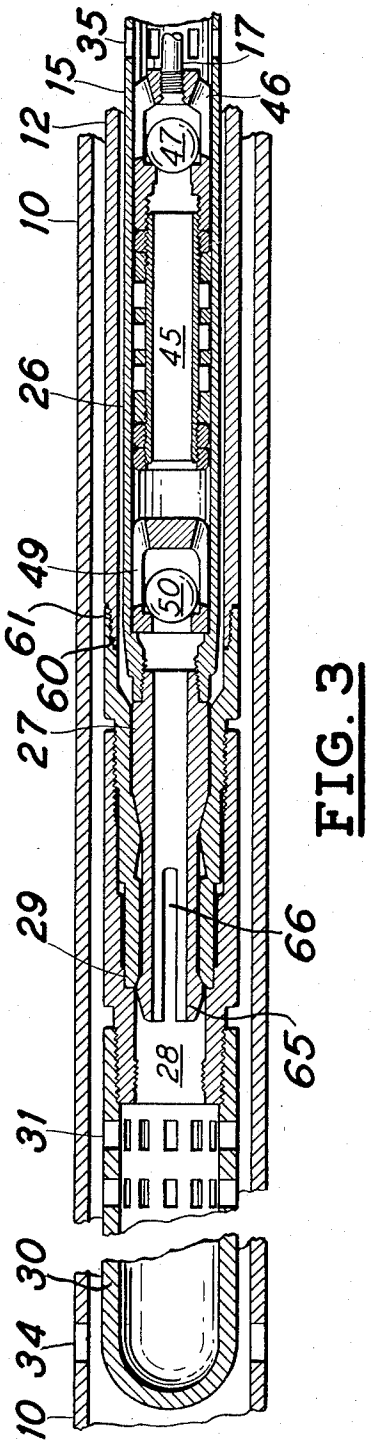


FIG. 3

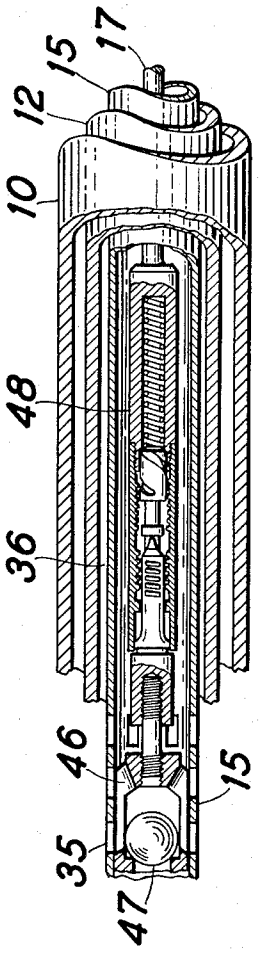


FIG. 4

INVENTOR

Arthur F. Eadie

BY J. Madamo

Walter G. Miller

ATTORNEYS

Patented Mar. 23, 1954

2,672,815

UNITED STATES PATENT OFFICE

2,672,815

APPARATUS FOR PUMPING VISCOUS CRUDE

Arthur F. Eadie, San Leandro, Calif., assignor, by mesne assignments, to California Research Corporation, San Francisco, Calif., a corporation of Delaware

Application September 4, 1948, Serial No. 47,867

1 Claim. (Cl. 103—1)

1

This invention relates to an apparatus for improving the operation of wells producing heavy or viscous crude oil, for example 8–10° API, by a pump having an elognated actuating member extending to the top of the well and particularly refers to means for surrounding said member with a relatively low viscosity fluid to facilitate its motion, and an improved arrangement of well tubings which surround the elongated member used to actuate the pump. This is a continuation-in-part of my abandoned application Serial Number 781,854, filed October 24, 1947, entitled, "Method and Apparatus for Pumping Viscous Crude."

In the production of heavy viscous crude oils the usual practice is to install means such as a reciprocating type of pump at a point below the fluid level in the well and operate that pump by an elongated member or sucker rod extending throughout the production tubing leading upwardly from the pump to the surface of the ground. At the upper end of the sucker rod a motor or engine is provided to impart to it a reciprocating motion at a relatively low speed and with a stroke four to six feet or more in length. The means for translating the motor rotation to reciprocating motion is usually a lever or walking beam supported upon a suitable fulcrum and driven by a crank from the slow speed motor or gear reduction unit.

It has been found that an arrangement of this kind where the heavy or viscous oil produced surrounds the sucker rod throughout its entire length, will impose on the rod an upper limit to its rate of travel below that rate which will develop the actual production capacity of the well. Due to the retarding effect of the heavy oil, which may have a viscosity of 10,000 S. S. U. at 100° F., the sucker rod string has been found to fall under the influence of gravity at a slower rate than the desired or optimum speed of the down stroke of the reciprocating surface mechanism. In the example which will be discussed this rate was found to be at a rate of about one stroke of 55 inches in length in about six seconds of elapsed time.

This invention comprehends broadly the provision of introducing a low viscosity liquid, for example an oil of about 22–28° API gravity, and having a viscosity of about 100 S. S. U. at 100° F., into the well to surround the movable member or sucker rod string which actuates the pump so that it may be driven at a higher rate of speed than heretofore and thus increase the output of the well beyond that which could otherwise be obtained. One procedure which is contemplated for

2

doing this is to install a small diameter tubing inside of the regular production tubing to enclose the sucker rod, and introducing into the top of the small diameter tubing a relatively steady but not necessarily continuous stream of low viscosity oil which moves downwardly around the sucker rod and escapes through passageways at the lower end of the inside tubing to mingle with the heavy oil produced by the well, the mixture of both fluids then being pumped upwardly in the annulus between the inner tubing and the normal production string of tubing. In practice, the required rate of introduction of the low viscosity fluid has been found to be very low, usually just enough to overcome the tendency of the more viscous material to be drawn upward into the inner tubing by its adherence to the vertically reciprocating sucker rod.

A further advantage of this invention is its application to the modification of the nature of the fluids produced by the well by blending them with other fluids of different characteristics; for example, reducing the overall viscosity by injecting a desired proportion of a lower viscosity fluid, or increasing the A. P. I. gravity of the fluid produced, or any desired combination of such operations.

A still further advantage of this invention resides in the arrangement of the pump barrel, plunger and sucker rod which permits the independent removal from the well of the sucker rod and pump plunger without disturbing the inside tubing or the pump barrel. This is accomplished by providing an unobstructed passage within the inside tubing of sufficient diameter to accommodate the pump plunger. Desirably but not necessarily a detachable connection may be provided between the lower end of the sucker rod and the top of the pump plunger mechanism. The advantages of such an arrangement will be obvious to those skilled in this art and result in a greatly simplified procedure for maintaining the well and pumping apparatus in proper condition, particularly when one or more of the several concentric strings of tubing require removal from the well.

It is an object of this invention to provide an improved apparatus for operating a well producing a heavy or viscous crude oil or similar liquid by providing a bath of low viscosity liquid in which the sucker rod is adapted to move, said bath being isolated throughout its length from the heavy oil pumped inwardly by the reciprocating pump at the bottom of the well, and being replenished by low viscosity liquid to replace that

lost by commingling with the heavy oil at a point just above the pump.

Another object is to provide an improved arrangement for connecting the pumping means at the bottom of a well of this kind with the actuating means extending to the surface so that the introduction and removal of the several parts may be made consecutively and selectively instead of simultaneously.

These and other objects and advantages will be further apparent from the following description and the attached drawings, which form a part of this specification and illustrate one example of the application of this invention to a pumping well.

In the drawings, Figure 1 is a vertical sectional view of the apparatus at the top of a well to which this invention has been applied;

Figure 2 is a vertical sectional view to an enlarged scale of the lower end or pumping section of the arrangement shown in Figure 1;

Figure 3 is an enlarged vertical sectional view of the lower end of the arrangement shown in Figure 2; and

Figure 4 is an enlarged vertical sectional view of the upper end of the arrangement of Figure 3, illustrating particularly the connection between the pump plunger and the sucker rod.

Referring to the drawing, reference numeral 10 illustrates the casing of a well provided with suitable closure means or casinghead 11 adapted to support a first or production tubing 12 in which the fluids 13 produced by the well flow upwardly and are discharged through outlet 14 to any suitable storage (not shown). Supported within the first or production tubing 12 is a second tubing 15 of smaller diameter and provided at its upper end with a stuffing box 16 through which the sucker rod 17 extends and is sealed from leakage by a conventional packing material.

At its upper end sucker rod 17 is attached to an arcuate member 18 at one end of a walking beam 19, the latter being pivoted at 20 upon a suitable post or support 21. At the opposite end of beam 19 a connecting rod 22 is adapted to be oscillated by means of a crank 23 driven by a suitable prime mover, motor or engine 24.

Referring now to Figure 2, which represents the lower end of the well casing 10, together with the first and second tubings 12 and 15 and the sucker rod 17, there is illustrated generally a pump 25, the moving displacement element or plunger of which is adapted to be reciprocated by the sucker rod string 17 within a suitable cylinder or barrel 26 which is positioned at the lower end of the second or inner tubing 15. The lower end of barrel 26 is provided with a suitable shoe or anchor means 27 adapted to be removably positioned within the bore 28 of a bushing or connector 29, the latter being secured by threads 60 to the lower threaded end 61 of the first or outer tubing 12. Below bushing 29 a length of pipe 30 which is perforated at 31 permits crude oil and other fluids to flow through bore 28 to the inlet of pump 25. Outer casing 10 serves to exclude the sand or other formation 33 from the well bore at this point and is generally perforated as at 34 to permit the desired formation fluids to enter the well so that they may be lifted to the surface by means of pump 25.

The lower end of the second or inner tubing 15, immediately above its connection to pump barrel 26, is provided with ports or passageways 35 to permit the crude oil or formation fluid 32 which has been lifted by pump 25 to pass outwardly into the annulus 36 between tubings 12 and 15 and rise therethrough to emerge from casinghead 11 through outlet conduit 14.

Referring back to Figure 1, the upper end of the second or inner tubing 15 is supplied with a liquid 37 of relatively low viscosity, for example 22–28° API crude or other oil, from a storage tank 38 by means of flow line 39, and a small pump 40. Desirably, but not necessarily, pump 40 may be driven by a suitable mechanical connection 41 from walking beam 19. Means may be provided for controlling the pressure and rate of flow of this oil 37, such as check valve 42 and throttle valve 43, as well as a safety release valve 44 to regulate it in accordance with the requirements of operation. The low viscosity oil 37 flowing downwardly at a slow rate, for example 5 to 10 barrels per day, surrounds sucker rod 17 substantially throughout its entire length and then flows outwardly from the inner or second tubing 15 through ports 35 to mingle with the heavy or viscous formation fluid so that both are pumped upwardly by means of pump 25 to flow directly outwardly through the same ports 35 to rise to the surface in the annulus 36 formed between the first or outer production tubing 12 and the inner tubing 15.

Figures 3 and 4 illustrate in some detail a preferred arrangement of the lower end of inner tubing 15, the pump 25 and particularly the connection arrangement between the plunger of the pump and sucker rod 17. In order to be able to remove the pump plunger, or displacement member, including plunger 45 with its accompanying top valve cage 46 and top valve 47, from pump barrel 26 without simultaneously removing from the well the inner tubing 15, it is essential that the bore of tubing 15 should be unobstructed throughout its entire length, instead of containing rod-packing elements and the like that have been proposed and used heretofore in well pumping systems of this kind. Under certain conditions it may also be desirable to provide a rod "hook-off" attachment 48 at the lower end of sucker rod 17 so that rod 17 may be selectively disengaged from the upper end of the top valve catch 46 and withdrawn from the well without removing that element and plunger 45.

Pump barrel 26 is illustrated in Figures 3 and 4 as being merely a continuation of inner tubing 15, but it is obvious that some type of threaded coupling would be provided to connect these elements. The lower end of pump barrel 26 is provided with the usual standing valve cage 49 and standing valve 50, the former being removably secured in barrel 26 by any desired means, not shown. The lower end of barrel 26 is provided with a shoe or anchor 27 which is removably positioned within the bore 28 of bushing 29 by protuberance 65 on the lower end of anchor 27 engaging the lower end of bushing 29. The lower end of anchor 27 is also provided with slots 66 to permit the anchor to be snapped into and out of the illustrated position. Bushing 29 is secured to the lower end of the first or outer tubing 12 by threads 60 and 61 as illustrated in Figures 1 and 3. As described above, a tail pipe 30 perforated at 31 permits crude oil and other fluids to flow through bore 28 to the lower end of pump 25 where it is picked up by the displacement member, plunger 45, and lifted to the surface in the manner set forth.

Figures 3 and 4 also illustrate the means by which the lower viscosity oil 37, which surrounds sucker rod 17 substantially throughout its entire

length flows directly outwardly through ports 35 at the lower end of inner tubing 15 to mingle with the heavy or viscous formation fluid so that both fluids are pumped upwardly by means of pump 25 to flow outwardly through the same ports 35 to rise to the top of the well in the annulus 36 formed between the first or outer production tubing 12 and the inner tubing 15.

By the practice of this invention the output of a well in California which originally produced a highly viscous crude of about 8–10° API gravity with a viscosity in the neighborhood of 10,000 S. S. U. at 100° F., at the rate of about 30 barrels per day, was increased to about 340 barrels per day with the introduction of oil of about 22–28° API and having a viscosity of about 100 S. S. U. at 100° F., at rates as low as five barrels per day.

From the foregoing description it will be appreciated that this invention comprehends broadly an improved apparatus for pumping a deep well producing a viscous material, such as a heavy crude oil, by providing a body of low viscosity liquid surrounding the movable member which actuates the pump, said body of liquid being continuously replenished from the surface and permitted to escape into the normal production fluid of a well at a point adjacent the lower end of said body. A particular feature of the invention is considered to reside in the provision of an unobstructed inner tubing extending substantially throughout the length of the sucker rod or elongated member which actuates the plunger of the pump mechanism, so constructed and arranged that the sucker rod and plunger may be removed from the well without simultaneously removing the inner tubing string. Although a single example has been described and illustrated, it is obvious that numerous changes and modifications could be made without departing from the invention, and all such changes as are included within the scope of the appended claim are embraced thereby.

I claim:

Apparatus for pumping liquids from wells comprising the combination of a production tubing extending from the surface down into the well, a rod-actuated pump including a reciprocating displacement member and a pump barrel associated with the production tubing and adapted

to raise a column of well fluid through that tubing to the surface, a pump-actuating rod extending down within the production tubing from a power source at the surface and connected to the displacement member of said pump to operate it by vertical reciprocation, said pump-actuating rod being solid throughout that portion of its length between said displacement member and said power source, an inner tubing having an unobstructed bore immediately surrounding said rod throughout a substantial portion of its vertical length, said pump barrel forming a lower extension of said unobstructed bore to receive said displacement member, means for introducing a low-viscosity liquid into the upper end of said inner tubing to reduce the resistance of said rod to reciprocating motion, port means in the lower end of said inner tubing above the upper end of the stroke of said displacement member of said pump and above the barrel of said pump communicating directly with said production tubing to permit said low-viscosity liquid to commingle directly with the well fluids as said fluids are raised in said production tubing by said pump, said port means forming the outlet of said pump, and means for anchoring said pump barrel and said inner tubing in said production tubing, said anchoring means being located below the lower end of the stroke of said displacement member and adjacent the lower end of said production tubing so that said rod and said displacement member may be removed from said well through said unobstructed bore without removing either said inner tubing or said pump barrel.

ARTHUR F. EADIE.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
753,828	Hahn	Mar. 1, 1904
1,246,543	Carmichael	Nov. 13, 1917
1,282,921	Norris	Oct. 29, 1918
1,376,877	Herron	May 3, 1921
1,530,624	Smith	Mar. 24, 1925
1,614,865	Boden	Jan. 18, 1927
2,530,673	Zinszer	Nov. 21, 1950
2,567,513	Haines	Sept. 11, 1951