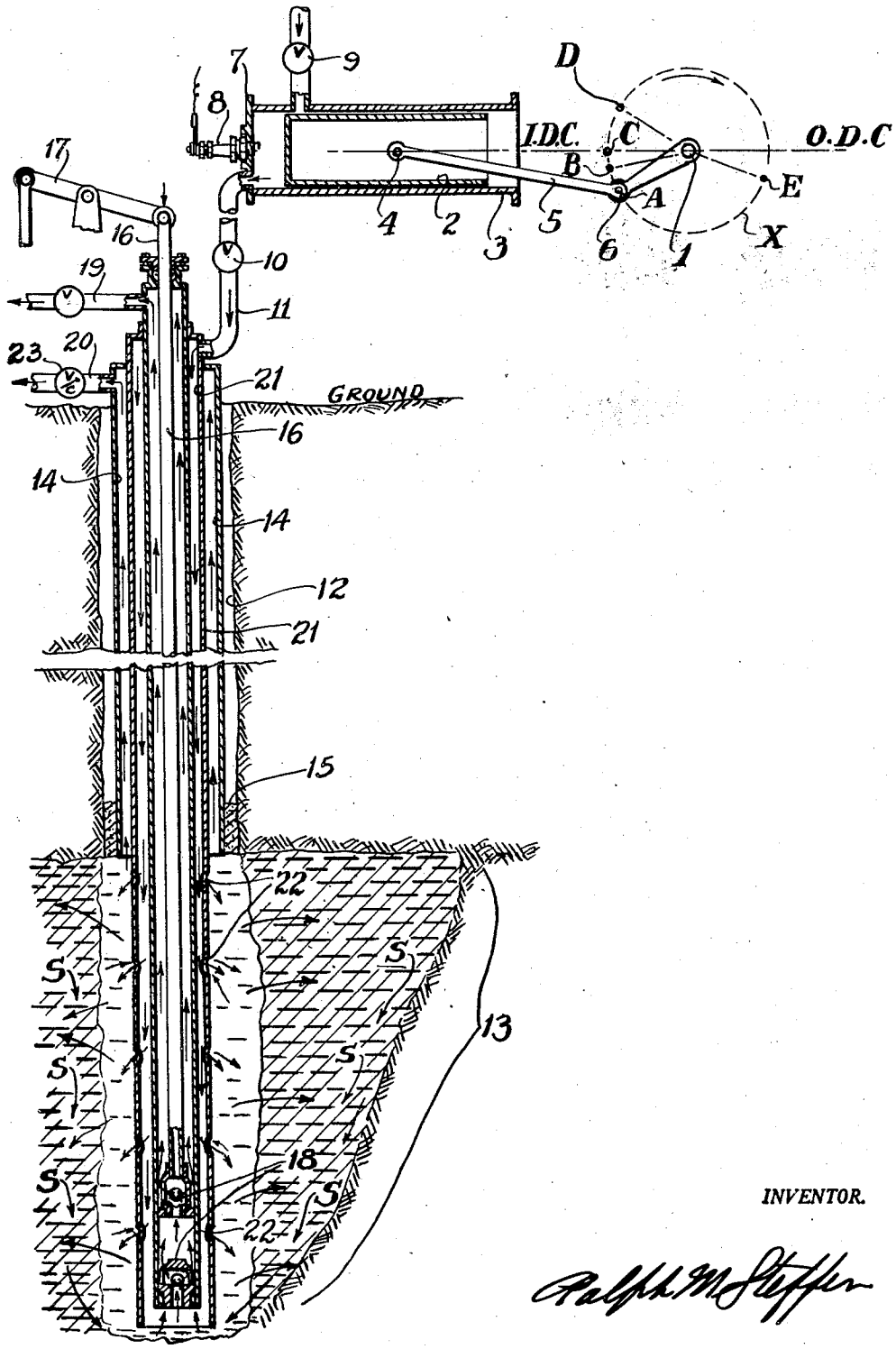
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UNDERGROUND OIL RECOVERY

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UNDERGROUND OIL RECOVERY

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This invention comprises a novel and improved apparatus and process for recovering oil from underground reservoirs and sands. The object of my process and apparatus is to expedite recovery of oil from oil wells which have been drilled into a natural underground oil reservoir.

Particularly an object of my invention is the recovery of oil which does not freely flow from the underground reservoir into wells from which it may be recovered. This reluctance of flow I have found due to the lack of gas in the reservoir, the high viscosity of oils at ordinary underground temperatures and adherence of the oil to materials of the reservoir. By my invention I am able to overcome these inhibiting factors and greatly increase the flow of oil to the well which I use for the initial operation of my process or to adjoining wells.

The nature and advantages of my invention will be understood from the following specification.

The figure on the drawing is a vertical sectional view, more or less diagrammatic, disclosing the apparatus for carrying the process into effect.

In the drawing, 1 is a shaft which is rotated by any powerful prime mover which through connection bearing 6, connecting rod 5, and wrist pin 4, drives piston 2, backward and forward in a compression cylinder 3. Bearing 6 moves in a circular manner as represented by circle X. When the apparatus is in operation before shaft 1 has moved the piston to the full extent forward, for instance when 30 degrees before the initial dead center line shown in the drawing as a dotted line extending through the wrist pin 4, and shaft 1 which makes the inside dead center line marked in drawing I. D. C., the line between 1 and 4, and the outside dead center line O. D. C. the extension of the dead center line beyond shaft 1, an ignited mixture is exploded by spark plug 8 in cylinder head 7. The positioning for explosion time is represented by A. With the shaft 1 rotating so that position A approaches the inside dead center line another timing point B is reached, which is immediately after A and at which time valve 10 is caused to be open and allow the compressed explosion gases to travel into pipeline 11, and be further pushed there by the movement of the piston towards the cylinder head until it reaches positioning C near the dead center line. The explosive mixture drawn into the cylinder 3 is thus ignited so as to burn during the travel in the liner 21 and are exhausted into the lower part of the well for direct action on the oil sands. When the piston has moved

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backward as much as 30 degrees, or thereabouts, to position D, valve 9 is opened allowing the admission of a gaseous explosive mixture behind the piston, which sucks the mixture in continuously until it has passed the outside dead center line a few degrees represented by E, when valve 9 is caused to be closed, and the movement of shaft 1 causes the explosive mixture to be compressed and then an explosion is again initiated at position A, and the operation thereafter repeated. Actuation in this timed relationship is effected by conventional means well known in the art of internal combustion and explosion engines, forming in itself no part of this invention.

12 is an oil well, which reaches into an oil sand 13. The oil well is cased by casing 14 to above the oil sand and may be closed off by cement or other means at 15. Any oil which flows into the oil well is hoisted by conventional means as represented by pump rods 16, moved by pump jack 17, operating a pump in pump barrel 18, whereby the oil is moved upward to the surface through a tubing and conveyed by pipe line 19 to its destination.

The hot explosive gases are introduced to the oil sand face by a tubular means connected with pipe line 11. For instance, where liners are used in a well, containing perforations at its lower end in the vicinity of the oil sand, the hot gases may reach the oil sand through the liner perforations. However, in accordance with the present invention, liner 21 with perforations 22 spaced throughout the length thereof and over the entire vertical face of the oil sand may be any tubing means conducting the hot gases to the oil sand.

The hot gases which do not penetrate and escape through the oil sand are allowed to be withdrawn upwards through the casing 14 through pipe line 20, and back pressure regulating valve 23, to their destination.

From above description it will be readily seen hat in my process I compress an explosive mixture within a cylinder and explode it by ignition thereof, and during the explosion force it from the cylinder by a piston movement. In carrying out the research work of my process and pilot plant operation and commercial installation, I was particularly impressed with the fact that if pipe line 11 was allowed to discharge into the air, the notable thing was the enormous energy and heat that was carried by pipe 11, as flames could be made to shoot more than 10 feet into the air and the sound of the detonations was that of heavy cannonading. As these discharges

through pipe 11 are rhythmic I find that they have a tendency to dislodge obstructions in the perforations of the liner and also within the pores of the oil sand.

As these rhythmic pulsations or surgings of hot gases are driven against the face of the oil sand 13, which for instance in operation is an oil sand of a depth of 100 feet or more, the walls of the oil well in the oil sand region become warm. The pulsating pressure drives the warm gases backward into the oil sand; it also drives oil backward into the oil sand until there is a zone formed which is more or less saturated with oil, and since the oil is warm the saturated oil readily flows downward through a portion of hot oil sand, this radially expanding zone of pulsating heat and pressure in the sands continuously moving away from the well due to the surging action of the gases, but always within gravitational communication with the bottom of the well so that oil is always appearing at the bottom of the well. A saturated zone is shown on each side of the well, marked with the letters S.

The applicant is familiar with the methods of recovering oil by gas and water drive, and he has noticed that in such operations frequently several months or years pass before there are demonstrable commercial accelerated productions in the adjoining and communicating wells.

I find that my invention enables quicker return of oil. I find that I recover oil in accelerated quantities from the well to which I introduce the hot gases, within a few hours or days. Particularly do I find my process and apparatus are of great utility in oil fields containing large residual quantities of heavy viscous oil. For instance, I have found that by raising the temperature of the oil sands in the bottom of a well 100 degrees Fahrenheit, I can increase the rate of flow of oil through the sand as much as 40 times by simple gravity, and that by acceleration from my gas pressure a more rapid movement is easily facilitated.

Be it thoroughly understood that my process does not utilize the exhaust combustion gases of a gas engine after they have been used for power, but that I am able to direct and drive the full calorific result of the explosion towards the useful production of oil. Particularly is my invention of new usefulness because it recovers oil from a single well, as well as facilitating the flow of oil in adjacent wells.

It is quite obvious that I create pressures at the face of and within the underground oil reservoir. It is quite obvious that certain oil sands may so absorb this pressure, that little pressure will be created within the individual well used in my process. In a preferred method of operation I maintain a pressure above or below 20 pounds to the square inch, but find that 20 pounds to the square inch is very efficacious in porous sands. With this in mind, I regulate valve 23 so as to maintain a back pressure of regulatable and predetermined value on the well. This maintained back pressure serves to prevent flow of the sands, released by the lowered viscosity of the heated oil, into the well.

Regarding temperature, I find that raising the temperature of my oil sands 100 degrees Fahrenheit is very effective, and for that reason I may make no endeavor to increase the temperature at the bottom of the well above the boiling point of water, particularly in the black oils of Southern California. In this manner I would be helping to conserve heat as the water does not have to be

boiled. However, on raising the temperature above the normal boiling point of water I can prevent its boiling by raising the pressure within the well, thus conserving heat.

The fundamental purpose of this process and apparatus is to apply a pulsating pressure and temperature directly to the oil sands in a well throughout the entire face thereof above the standing oil level in the well; and to promote the efficiency of the heat and pressure impulse transmission to the oil sands by continuously circulating the burning gases through the well. In addition, a further essential feature of this improvement is to carry out the foregoing treatment simultaneously with and wholly without impairing the pumping of the well and without any hindrance of the treatment by the pumping of oil from the well.

It will be noted separate and concentric tubings are provided for pumping oil from the well, delivering burning high pressure gases into the well and exhausting burnt gases from the well, thus contributing to the lack of interference between treating and pumping the well.

The effectiveness of this treatment is believed due to the continuous application of pulsating pressure and temperature directly to the oil sands by maintaining a circulation of gases during the treatment and pumping. It will be evident that when the treatment starts, regardless of whether the well is pumping oil, a fluctuating zone of pulsating pressure and temperature is initiated in that part of the oil sands above the standing oil level. At each pressure impulse, this zone expands outwardly from the well, the higher pressures and temperatures thereof warming the viscous oil in the sands and the increased pressure driving this warmed, and hence more fluid, oil into the surrounding sands. Upon ebbing of the pressure impulse, the diminution of pressure in this zone tends to suck back the forwardly and to some extent upwardly driven, warmed and thinned oil. The series of pulsations thus produce a working or agitation of heated oil in this fluctuating zone and part of this released or thinned oil flows by gravity into the well and is pumped therefrom.

It should be noted that this "thawing" or "viscosity lowering" process is progressive; and the zone undergoing treatment continually expands as long as the process continues. Since the pumping of the well does not interfere with the treatment, the latter may continue to expand the area or volume treated even as oil accumulates in the well bore as the result of increased flow. In this invention the treatment may be continued, since the entire oil sand face is utilized, until the standing oil level rises to the top of the oil sands in the well.

I claim:

1. Apparatus for recovering oil from underground reservoirs comprising generating means for producing a continuous series of charges of highly compressed burning gases, conduit means for pumping oil from a well, introducing said charges into a well and exhausting said charges from a well, said conduit means for introducing charges into a well having direct communication and impinging engagement with the face of the oil sands throughout the entire vertical face of the latter above the standing oil level in the well.

2. In an apparatus for treating underground oil deposits to recover oil therefrom, means for generating pulsating charges of highly compressed burning gases, a conduit for pumping oil from a

well, a second conduit for directly applying said charges to the oil sands of a well above the standing oil level thereof, a third conduit for discharging burnt gases from said well, said second conduit having a gas outlet means delivering said pulsating charges to the entire vertical sand face of a well above the standing oil level thereof.

3. The combination of claim 2 wherein said outlet means establishes direct communication with said oil sand face above the standing oil level of a well at a plurality of vertically spaced positions.

4. The combination of claim 2 wherein said second conduit extends to the bottom of the well bore.

5. The combination of claim 4 wherein said second conduit surrounds said first conduit, and a plurality of vertically spaced apertures in said second conduit from the top level of the oil sands to the bottom of said second conduit, whereby the apertures below the standing oil level constitute oil inlet means to said first conduit and the apertures above said oil level constitute oil sand treating apertures.

6. The combination of claim 5 wherein said third conduit surrounds said second conduit, said third conduit being sealed to the well bore, and terminating at the upper level of the oil sands.

7. The combination of claim 2 including regulatable valve means for maintaining a predetermined back pressure in said third conduit.

8. The combination of claim 7 wherein said valve means and said generating means are disposed above ground and communicate with said third and second conduits respectively.

9. An apparatus for treating depleted oil sands for increasing the oil flow therefrom comprising a well extending into the oil sands and an oil pumping conduit therein, a second conduit adjacent and contacting said oil pumping conduit and extending into the oil sands of said well, vertically spaced apertures in said second conduit below the top of said oil sands, generating means for producing a continuous series of high pressure, high temperature charges of burning gases and delivering them to said second conduit for the continuous direct application of pressure impulses to the entire vertical face of the oil sands above the standing oil level thereof, and means for causing a constant circulation of said charges in contact with the entire face of the oil sands above the standing oil level of said well comprising a third conduit for releasing said charges from said well.

10. The combination of claim 9 wherein valve means are provided for maintaining a predetermined minimum pressure of said gases in said well.

11. The combination of claim 9 wherein said second conduit is surrounded by said third conduit, the lower end of said third conduit terminating at the upper level of said oil sands.

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