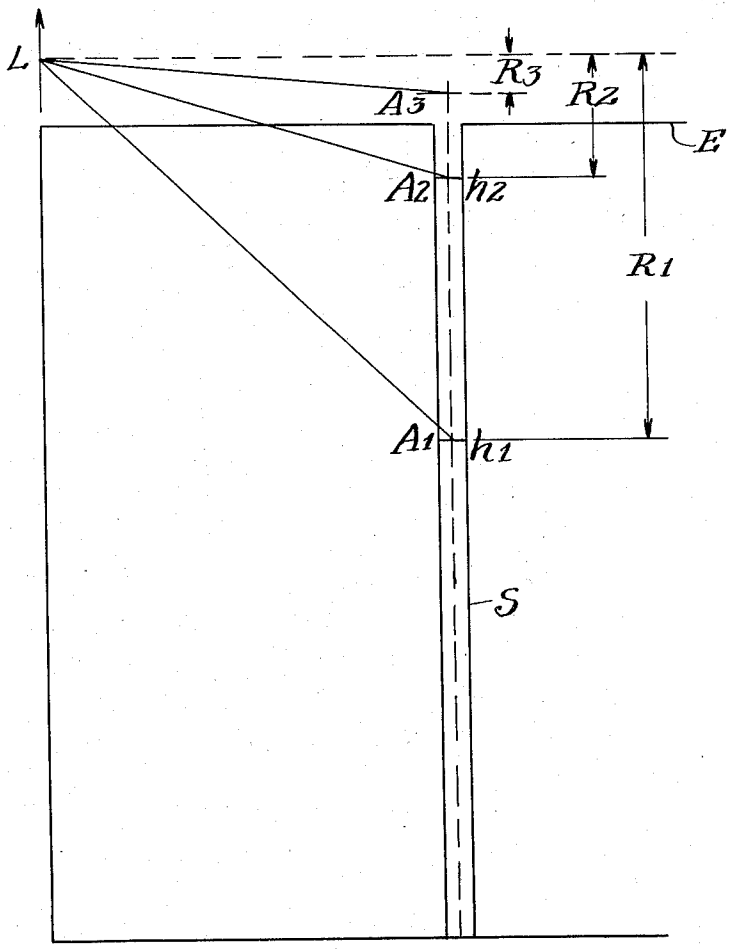
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PROCESS FOR THE EXPLOITATION OF PETROLEUM DEPOSITS

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PROCESS FOR THE EXPLOITATION OF PETROLEUM DEPOSITS

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The present invention relates to a process for the exploitation of petroleum and like deposits by transmitting thereto vibrations in the sonic and sub-sonic ranges.

More specifically, the invention relates to the transmission of such vibrations by means of immersion pumps which are introduced into the deposits by way of wells. The invention is particularly adapted to the exploitation of oil deposits and the following disclosure is directed primarily to this field of usefulness.

The principal object of the invention is to increase the oil separation factor and the economy of exploiting a deposit by diminishing the resistances which impede the passage of the petroleum through the layers of rock.

The accompanying drawing is a graph which schematically presents the effect of the process of the present invention.

Before describing the invention, the following background should be kept in mind. As a general rule it has been possible heretofore to exploit petroleum deposits or similar formations only up to approximately 40%. Apparently the main cause of this low percentage and, therefore, uneconomical exploitation, is that the petroleum droplets, due to electric charges, are combined with water particles and this greatly impedes the passage of the petroleum through the layers of rock. The water particles which accumulate on the petroleum droplets prevent the latter from coalescing, as occurs in the case of an emulsion, with the result that a considerable increase in the resistance to drawing is developed. In addition to the electrostatic forces just mentioned, other phenomena which determine the oil separation factor of the oil carrier, are reduction of the surface stress and the viscosity of the oil. The factors just mentioned are responsible for the fact that the pressure of the oil deposit cannot exert its full effect because the phenomena described represent a frictional resistance which causes the pressure to drop in the direction toward the well.

In carrying out my invention, I employ short-stroke pumps with an electro-magnetic or electro-motive impulsion or driving means therefor adapted for the transmission of sonic and sub-sonic vibrations to the deposit. The sound energy so transmitted causes the water-combined droplets to vibrate so that, in an extremely short time, even if the amplitudes are small, they can free themselves from the adhering water and coalesce with other similarly freed oil droplets. The oil threads which thus come into existence have much smaller resistance in the rock formation and can freely flow toward the well.

Another advantage resulting from the process of the present invention arises by virtue of the reduction in the viscosity of the oil which is known to be a consequence of the sound irradiation of substances of high molecular weight.

My experiments have shown also that in order to obtain the improvement in yield which is characteristic of the invention, it is also important to prevent the flowing movement of the oil which is set up by the sound irradiation referred to from being again interrupted because,

otherwise, it could easily happen that the viscosity will again increase and an emulsification be brought about. Therefore, in order to achieve uniform and uninterrupted flow of oil from the well, it is preferable to employ rapidly reciprocating pumps of essentially continuous drawing performance because, in the conventional long-stroke and lever-system pumps, interruption of the flow during the discharge stroke is too long.

Rapidly oscillating movements of the drawing apparatus in a direction axially of the oil well have the effect of transmitting the sound energy to the oil column, and this acts as a coupling liquid to the oil-bearing rock where it causes the aggregation of the oil droplets. Where the drawing or pumping apparatus is equipped with a rapidly reciprocating plunger the action, apparently, is as follows: the plunger face radiates the energy mainly in the direction of the longitudinal axis of the well, and the sole or foot of the well (generally reinforced with concrete) has the effect of a reflector and makes possible the formation of standing or slowly progressing waves.

When struck by sound waves, the oil particles flow together and rise to the surface and this aggregation of the particles takes place essentially in the antinodes of oscillation. Even protected emulsions and dispersions are destroyed in this manner. Therefore, it is safe to assume that sound waves are capable of piercing adsorbed films of emulsifiers.

By cavitation, sound has the property of causing the formation of an emulsion at the surface contact of two non-mixable liquids. On the other hand, it also brings about the destruction of said emulsion when the liquid is under great pressure corresponding in magnitude to a mercury column of 2000 mm. This condition is encountered in a petroleum well because of the high pressure of the deposit. The frequencies most suitable for sound irradiation of oil carriers according to the present invention lie within the boundaries of sub-sonic waves which have the property of expanding over wide areas without losing in intensity as the result of damping. It is a well known physical phenomenon that sound vibrations of low frequency have a larger range than those of high frequency. The frequencies of greatest importance for the present process lie between 12½ and 60 C. P. S. (cycles per second). These are obtainable by electromagnetic, sub-sonic pumps.

In addition to said fundamental frequency (sub-sonic) it is also advantageous to employ pumping apparatus for the present invention which will radiate frequencies within the range of 500 to 10,000 C. P. S.

By way of example, in order to demonstrate the efficacy of my new process, rapidly reciprocating piston diaphragm pumps were introduced into certain oil wells and these pumps were arranged so that their oscillating masses moved upward and downward in the direction of the longitudinal axis of the well. The oscillating body and the electro-magnetic or electro-motive means for driving it were combined in a cylindrical casing of almost the same diameter as that of the well and this unit was suspended in the well riser. The sound was radiated primarily from the bottom face of the cylindrical body in a direction toward the foot of the well and included components lying in the aforesaid supplemental range, whose frequencies were determined by the fundamental frequency, the number of slots in the driving motor, the number of teeth in a transmission gear, and the speed ratio between the impeller and pump frequency.

As explained above, the reduction in pressure drop resulting from this method of sound irradiation can be effectively utilized only when continuous movement of the oil is assured. Otherwise, the resistance to flow will again increase so that the sound irradiation becomes ineffective. This continuity of oil flow is best secured if the rapidly

reciprocating short-stroke pump employed has the further characteristic of being able to adapt itself automatically to the quantities of petroleum flowing in any given moment toward the well; in other words, the pump should operate in a manner which conforms directly to the quantity of petroleum flowing, that is, the smaller the rate of flow, the smaller should be the volume drawn or pumped.

Based on tests, it has been determined that the stroke frequency of the pump, preferably, should be more than 750 strokes per minute, and also, that the length of the stroke should be less than 6 mm. Furthermore, this is also advisable because of the undesired degasification in the bore of the pump.

The process described above will often stimulate the yield of a well to such a degree that, even in cases where the well has ceased flowing, it will again become productive. Such renewal of the flow of a well cannot be explained or attributed merely to a sudden increase in the pressure in the oil deposit. Indeed, quite the contrary is the fact, namely that as the result of clogging of the pores and other influences, the resistance to passage of the oil in the carrier has become greater while, at the same time, the pressure in the deposit has diminished. This condition may become so great that an eruptive discharge ceases earlier than if it were influenced merely by the pressure still existing in the deposit. With my invention, however, the resistances are diminished and this to such an extent that the available pressure remaining in the deposit becomes fully effective even to a degree where a renewal of flow can again take place. Nevertheless such flow will again recede or cease unless the oil, at the same time, is continuously pumped from the well. If the stimulation incident to the process of the invention leads to a renewal of the flow of the well it may be quite possible to obtain a yield of oil without pump operation by means of diaphragms or throttling devices deposited in the well head above ground. In any event, the final result is the attainment of an oil separation factor of the oil carrier and the deposits respectively which is much greater than that which is obtainable from conventional drawing or pumping procedures.

The accompanying drawing is a graphic presentation explaining the effect of the process of the present invention. Beside an ordinate on which the pressures are plotted, the drawing shows an oil well S, bored vertically, starting from the earth surface E in a deposit. The deposit pressure is marked L; it would under normal conditions suffice to cause an eruption of the well.

After the well has been exploited by the methods known in the past, the oil level has dropped to the line h_1, and the practically existing discharge pressure in the well is marked A_1. The greatest part of the deposit pressure L has diminished on its way to the well, because of the resistance R_1 to such an extent that no more oil can be drawn.

The application of the process according to the invention causes the discharge resistance R_1 to decrease to the resistance R_2 which brings about the increase of the discharge pressure to A_2 and the rising of the oil level to h_2. By this method it is possible to fully utilize the difference between the oil levels h_1 and h_2.

Under certain circumstances the process according to the invention may reduce the resistance R_1 even to the resistance R_3, in which case an eruption will take place, because the discharge pressure A_3 is greater than would correspond to a height of drawing up to the earth surface E.

I claim:

1. The method for exploiting deep well petroleum deposits which comprises simultaneously generating vibrations of two different frequencies within the bottom region of the well riser through which the petroleum is pumped, and coupling the vibrations generated to the oil bearing strata surrounding said riser, one of said frequencies being in the range of from 12 to 60 c. p. s. and the other being in the range of from 500 to 10,000 c. p. s.

2. The method for exploiting deep well petroleum deposits which comprises utilizing submerged pumping means for simultaneously generating vibrations of two different frequencies within the bottom region of the well riser through which the petroleum is pumped, and coupling the vibrations generated to the oil bearing strata surrounding said riser, one of said frequencies being in the range of from 12 to 60 c. p. s. and the other being in the range of from 500 to 10,000 c. p. s.

3. A process according to claim 2 in which the submerged pumping means includes a pump having a stroke of not more than 6 mm., the stroke frequency being not less than 750/min.

4. A process according to claim 3 wherein the pump delivery increases in proportion to the pressure of flow.

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