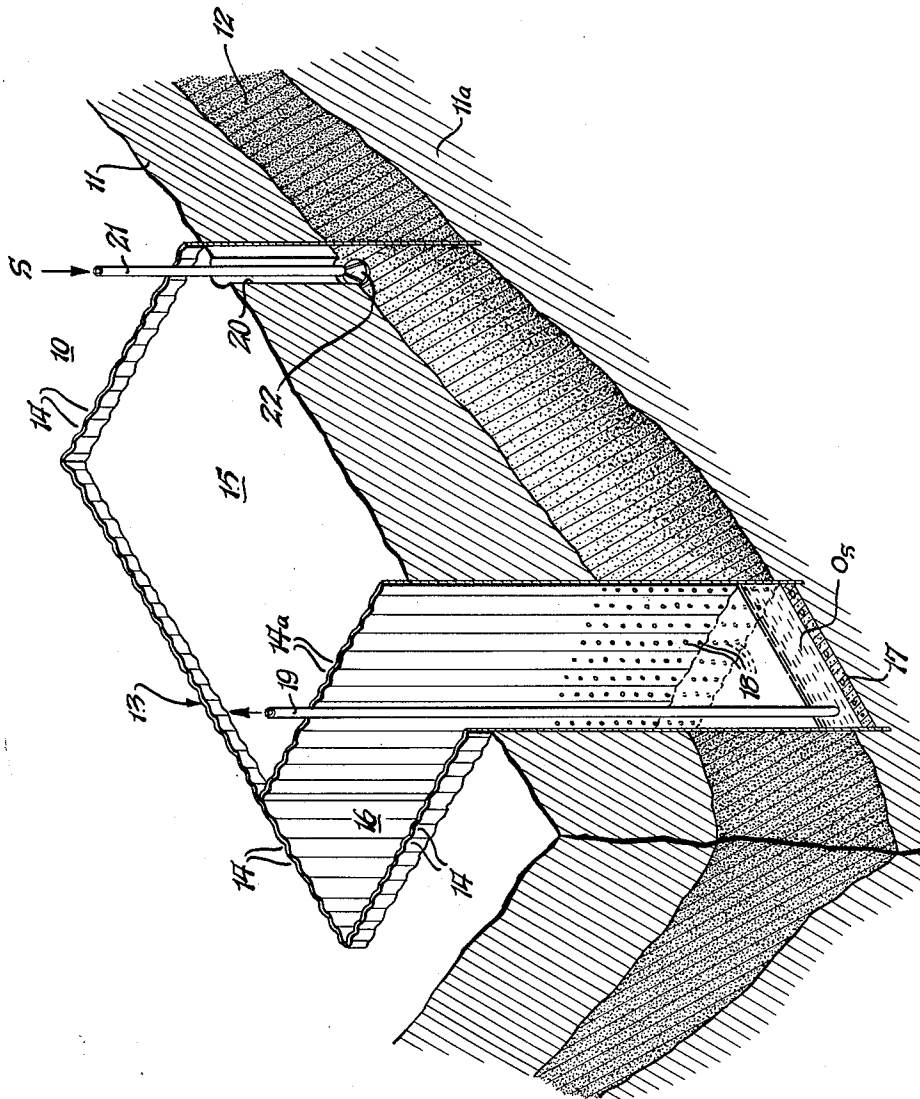


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PROCESS AND APPARATUS FOR EXTRACTING AND
RECOVERING OIL IN SITU
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3,157,231 PROCESS AND APPARATUS FOR EXTRACTING AND RECOVERING OIL IN SITU

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This invention relates to the extraction and recovery of oil, and more particularly to a new and improved process and apparatus for economically extracting and recovering oil in situ from the sand of a productive sub-stratum deposit.

The present invention is particularly adapted for use in extracting and recovering oil from the now famous Athabaska oil-sand deposit located in Alberta, Canada. For the most part, this sand is located underground, but some does outcrop to the surface. Somewhat like coal, the sand is arranged in veins which vary from approximately five to two hundred feet in depth and from about five to two hundred feet below the surface of the earth. This deposit is huge; the maximum surface area has been estimated to be about 30,000 square miles, and the maximum crude oil potential has been estimated to be about three hundred billion barrels. This represents an amount of crude oil almost three times as great as all the crude oil produced in the world since 1895.

Unlike oil deposits in other areas, such as the United States, the oil in the above Canadian deposit is not merely suspended or admixed with the sand, but the oil actually adheres intimately to and encapsulates each grain of sand. Physically, the deposit looks and feels like tar into which has been thrown and intimately mixed a large amount of sand. It is gummy and sticky to the touch, and will not support its own weight to permit conventional mining methods, as by drilling and shoring up mine shafts. At the same time, the deposit is not sufficiently fluid to be force-pumped or piped by gravity. Thus, mechanical removal of the oil-rich stratum from beneath an earth overburden too deep for open pit mining methods has so far been economically unfeasible.

Therefore, up to the present time, only those portions of the deposit lying above or adjacent to the surface of the earth have been mined. A typical process currently being used involves mechanical removal of the oil-sand deposit, similar to strip mining of coal. Following this, the removed masses are mechanically conveyed to an oil extracting plant on the earth's surface. Here, the oil is separated from the sand by mixing the oil with a diluent such as water and then heating the slurry to a high temperature, such as 180 degrees Fahrenheit. The batch is then flooded with an excess of hot water which brings the oil to the surface in the form of froth. This froth is then skimmed off and is either pumped or shipped to a refinery in the usual manner.

From a practical standpoint, the aforescribed conventional extraction and recovery process is limited to surface or near-surface deposits, and while the above surface separation of the oil from the sand is relatively economical, the cost of the overall operation is substantially increased by requiring the mechanical transportation of the mined oil-sand masses to the separation plant.

In contrast, by following the teachings of the present invention the oil can be readily extracted from the sand in situ, thereby making feasible the extraction of such oil from underground deposits. Furthermore, it is but a simple matter to pump the extracted oil directly from its underground location to the surface, whence it can be transported directly to a refinery. This eliminates the mechanical mining and transportation methods formerly required, as well as the necessity for a separate above ground extraction plant.

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Accordingly, it is a primary object of the present invention to provide a new and improved process and apparatus for economically extracting and recovering oil in situ from the sand of a productive sub-stratum deposit.

Another object is to provide such a process which can be completely performed at the site of the oil-sand sub-stratum deposit, thereby economically producing the desired crude oil for direct transmittal to an oil refinery.

Another object is to provide such a process which is sufficiently economical, effective and efficient in extracting and recovering the oil so as to make such process commercially feasible.

A further object is to provide such an apparatus which is economical to construct from known materials, which is effective and efficient in operation, and which can be easily assembled and disassembled for movement from one extraction site to another.

Other objects and advantages of the invention will become apparent upon consideration of the following detailed description and the accompanying drawing, wherein the single figure is a perspective view partially in section of a typical inventive apparatus located at a typical extraction site for carrying out the inventive oil extraction and recovery process.

In practising the invention, an area of the desired size is initially selected from the oil-sand deposit; a typical area being generally indicated at 10, the overlying layer of earth being indicated at 11; the oil-sand sub-stratum deposit at 12, and the underlying earth strata at 11a. Out of this area 10, the desired physically contained area, generally indicated at 13, is formed by driving a series of steel piles or caissons 14 to a depth below the bottom of deposit 12 to form the desired enclosure. These piles 14, which are commonly used in a variety of construction projects are interconnected in a manner similar to tongue and groove boards (not shown). When the contained area 13 is completely formed, it is next subdivided into a working extraction area 15 and a recovery area 16 by driving additional piles 14a to a depth below the bottom of deposit 12, as shown.

Next, the recovery area 16 is completely excavated to the bottom of the particular oil-sand deposit to form a reservoir, it being preferred that the bottom of the reservoir be located at the deepest point of such deposit, as shown, to facilitate flow from the working area 15. If necessary, the piles 14, 14a may be reinforced by suitable cross braces (not shown) to prevent collapse of the reservoir by the surrounding earth. This reservoir 16 is then preferably provided with a concrete floor 17 to prevent loss of the extracted and recovered oil-reagent generally located at O_s. Preferably following this operation, the piles 14a dividing the reservoir 16 and the extraction area 15 are drilled to form a large number of outlet holes 18 of the desired size and spacing in order to permit passage of the oil into the reservoir, and an outlet pipe 19 leading from near the bottom of the reservoir to a pump above the ground (not shown) is provided. It is also preferred that holes 18 be of such a size, e.g. about 1/16 inch in diameter, so as to permit free passage of the oil-reagent, while acting as a barrier to the passage of sand in any significant amount. As the sand is cleaned, it tends to settle both away from the bottom of the overlying earth layer 11 and the piles 14a, so the problem of sand passage through holes 18 is not troublesome. Furthermore, if any small amount of sand does pass into reservoir 16, it will readily settle to concrete floor 17 and not be pumped out through pipe 19 which is spaced a sufficient distance above the floor to prevent this.

Next, at least one well 20 is drilled through the overlying earth layer 11 at a remote portion of the working area 15 until the upper surface of the oil-sand vein or

deposit 12 is reached, and an inlet pipe 21 is then inserted into the well for supplying an oil extracting reagent S of any suitable type, but preferably a solvent such as naphtha. It is also preferred that the reagent S be supplied under pressure by a suitable pump and compressor (not shown) located at the extraction site in order to facilitate flow of the reagent across the deposit and into the reservoir 16. Moreover, the reagent may be heated to further facilitate such flow, especially when working in frozen areas. However, it is not always necessary to supply such reagent under pressure, as in many instances the force of gravity will be sufficient, especially where the upper surface of the vein or deposit 12 slopes down toward the bottom of the reservoir, as shown. In addition, the open lower end of the inlet pipe 21 is preferably provided with a deflector 22 so that the reagent S will be dispersed laterally over the surface of the vein or deposit 12, and will not be initially directed vertically downwardly therethrough.

After the solvent passes downwardly through pipe 21 and is dispersed by deflector 22, it initially travels along the path of least resistance which is the upper surface of the vein or deposit 12, picking up the entrapped oil in the process, and then the oil-carrying reagent O_s flows in the reservoir 16 after it passes through the openings 18 in the piles 14a. This process is continuous, because the solvent S will progressively penetrate through the previously cleaned or washed upper layers of sand and pick up the oil in the underlying areas as it flows toward the reservoir, and thereby extract the practical maximum amount of oil therefrom.

As the recovered oil-reagent O_s accumulates in the reservoir 16, it may be readily pumped out through the outlet pipe 19, from whence it can be readily fed directly to a nearby refinery (not shown), where it is but a simple matter to distill off the solvent S for reuse prior to subjecting the crude oil to further refining processes. In addition, by following the teachings of the present invention, it can reasonably be expected that at least 50 to 60% of the oil can be extracted from a vein such as 12.

All of this makes the aforesaid in situ extraction process sufficiently economical, effective and efficient so as to be commercially feasible. Moreover, the aforescribed apparatus for carrying out the inventive extraction process readily forms the desired physically contained area, and is composed of simple and economical components which are commercially available, which are effective and efficient in performing the inventive process, and which are readily assembled and disassembled for ease of movement from one extraction site to another, if desired.

While the invention has been described and illustrated herein with respect to a single preferred embodiment for both the process and apparatus, it is to be understood that various changes and modifications may be made in the invention, without departing therefrom, and that the scope of the invention is to be determined by the appended claims.

For example, the contained area 13, working area 15 and reservoir 16 are illustrated as being generally rectangular in shape. Obviously, such areas could take a variety of shapes, for instance the shape of a circle. In such instances, the reservoir could also be generally circular in shape and constitute the central portion of the

enlarged contained area, while the working or extraction area could constitute the outer annular portion thereof. Moreover, this extraction area could be further subdivided into sectors and one or more wells drilled for each sector, if so desired. It will also be apparent that once the oil has been extracted from one or more working or extraction areas of the desired size or shape, these may, in turn, be excavated to form one or more reservoirs, and further extraction areas may be formed adjacent thereto for continuing the inventive process over the entire deposit or available portion thereof.

What is claimed is:

1. A process of extracting and recovering oil in situ from the oil encapsulated sand of a productive substratum deposit and which comprises: forming a contained area enclosing said deposit by driving interconnected piles into the earth to a depth below the bottom of said deposit; subdividing said contained area and deposit into an extraction area and a recovery area by driving additional interconnected piles into the earth to a depth below the bottom of said deposit; excavating said recovery area to the bottom of said deposit to form a reservoir; providing limited communication between said reservoir and said deposit in said extraction area by means of holes through said additional piles with said holes being of such a size as to permit free passage of oil but not any significant amount of sand; drilling a well in a remote portion of said extraction area in communication with the upper surface of said deposit therein; and introducing an oil extracting reagent into said well and creating a flow of said reagent across said upper surface and progressively down to the bottom of said deposit in said extraction area through said holes and into said reservoir, whereby oil extracted from the sand and carried by said reagent is recovered in said reservoir.

2. Apparatus for extracting and recovering oil in situ from the oil encapsulated sand of a productive substratum deposit and which comprises: interconnected piles driven into the earth to a depth below the bottom of said deposit and forming a contained area enclosing said deposit; additional interconnected piles driven into the earth to a depth below the bottom of said deposit and subdividing said contained area and deposit into an extraction area a remote portion of which is drilled to provide a well in communication with the upper surface of said deposit therein and a recovery area which is excavated to the bottom of said deposit to form a reservoir; said additional interconnected piles having holes therethrough and providing limited communication between said reservoir and said deposit in said extraction area, with said holes being of such a size as to permit free passage of oil but not any significant amount of sand; and means for introducing an oil extracting agent into said well and for creating a flow of said reagent across said upper surface and progressively down to the bottom of said deposit in said extraction area through said holes and into said reservoir, whereby oil extracted from the sand and carried by said reagent is recovered in said reservoir.

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