

Nov. 12, 1929.

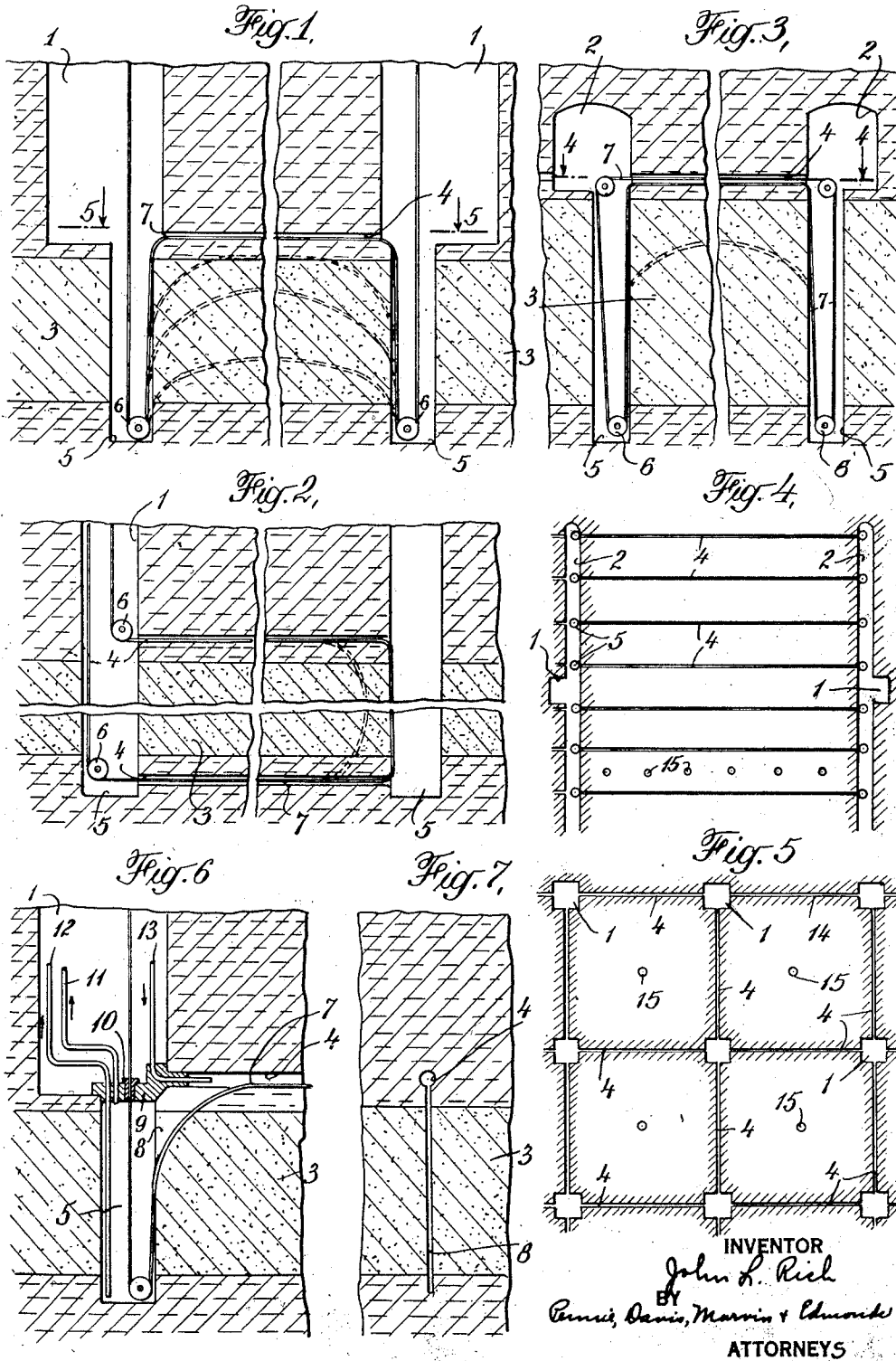
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1,735,012

PROCESS AND MEANS FOR EXTRACTING PETROLEUM

Filed Oct. 5, 1926

2 Sheets-Sheet 1



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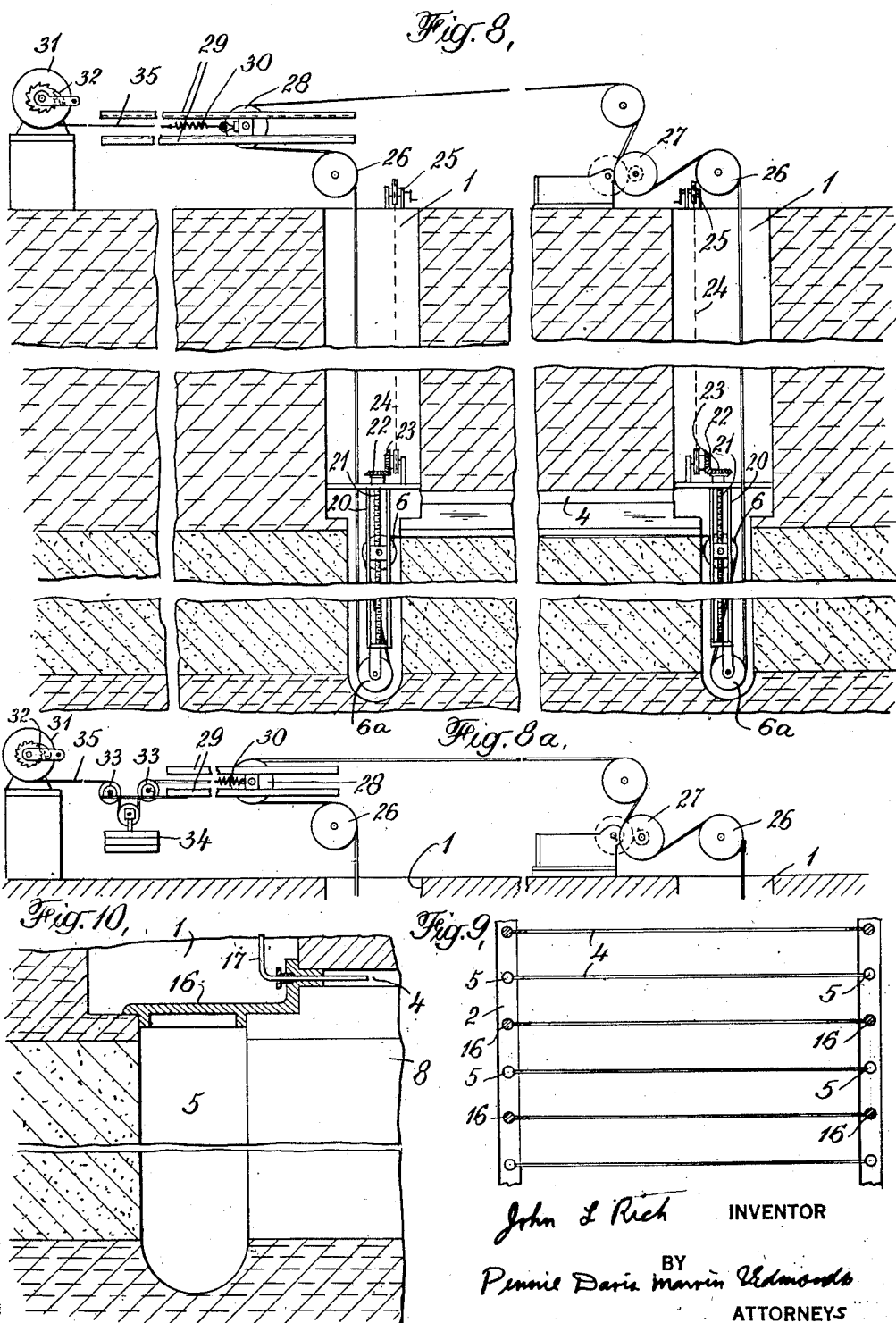
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PROCESS AND MEANS FOR EXTRACTING PETROLEUM

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UNITED STATES PATENT OFFICE

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PROCESS AND MEANS FOR EXTRACTING PETROLEUM

Application filed October 5, 1926. Serial No. 139,723.

This invention relates to improvements in the mining or extraction of petroleum, and includes improved methods of mining or extracting petroleum, as well as improved means and apparatus therefor.

Ordinary methods of extracting petroleum from its underground reservoirs by means of wells and pumps commonly leave a large percentage of oil in the ground.

It has been found possible to recover considerable additional oil from pools which have been nearly "exhausted" by the ordinary pumping methods by sinking mine shafts to the oil sand and driving a network of tunnels or galleries in the oil sand. The oil seeps out of the sand into these galleries or tunnels, is collected in sumps, and pumped to the surface of the ground. While this method enables a considerable amount of additional oil to be recovered, it has a number of disadvantages. Since the tunnels are driven directly in the oil sand, dangerous petroleum vapors are given off and tend to collect in them, the mine timbering becomes oil-soaked, and expensive precautions must be taken to guard against fire, and valuable petroleum vapors are lost by evaporation into the strong current of air necessary to ventilate the mine.

In my prior Patent No. 1,507,717 I have disclosed an improved method of extracting petroleum by underground workings, in which I retain the advantages of the method above described while avoiding much of the gas and fire hazard and evaporation loss inherent in such methods. As disclosed in said patent, the working galleries are driven outside of the oil-bearing stratum, and, from these galleries, long narrow slits or channels are cut through the oil-bearing stratum by means of a suitable channelling machine or other suitable device. These channels drain the oil sand in much the same manner as the mine tunnels driven directly in the oil sand, above referred to, but many of the objections incident to the driving and operation of tunnels directly in the oil sand are avoided. In particular, the process of my said prior patent permits considerable control of the gases, and avoids much of the fire hazard and most of the evaporation loss as compared with

operations where the tunnels are driven directly in the oil sand.

The present invention provides an improved method of operation which not only avoids the objections incident to tunneling directly in the oil sand, but which also avoids certain of the objections incident to the process of my prior patent, and which, in addition, presents other advantages, such as those hereinafter referred to.

According to the present invention, I form drainage channels through the oil-bearing rock between shafts or tunnels by boring drill holes between the tunnels or shafts, threading cutting ropes through such drill holes and cutting the drainage channels therewith in the oil sand.

The present invention avoids not only the driving of tunnels through the oil sand, but also avoids the driving of tunnels outside the oil sand for the operation of channelling machines, etc. According to the present invention, I provide drainage channels without the necessity of driving mine galleries or tunnels either above or below the oil-bearing stratum along the course on which the channel is to be cut. Instead, I form a drill hole between shafts, or between tunnels or galleries and cut the channels therefrom by means of a cutting rope so that the resulting channels, instead of being located along the course of the galleries, are located between galleries, where galleries are provided, or are located between individual shafts, where shafts instead of galleries are provided for the drilling of the holes therebetween.

Where the oil sand is not at too great a depth, the driving of galleries adjacent the oil sand may be eliminated entirely, and a series of shafts driven at suitable distances from each other. Drill holes are then drilled between the shafts to enable the cutting rope to be threaded therethrough and the channel is then cut by the rope operated by suitable mechanism, which may advantageously be above the surface of the ground. By providing a series of such shafts and drilling the holes from each shaft to those surrounding it, the oil-bearing sand can be worked in a systematic manner.

Where the oil bearing sand is at too great a depth so that the cost of a large number of vertical shafts would be prohibitive, tunnels may be driven outside and adjacent to the oil sand, these tunnels being generally parallel with each other and spaced apart at suitable distances. The holes are then drilled between the tunnels or galleries and the cutting rope threaded therethrough and the channels then cut thereby so that these channels are generally at right angles to the galleries. By driving bore holes at suitable distances from each other between the galleries and cutting channels parallel to each other the oil-bearing sand can be worked in a systematic manner, much the same as when a series of vertical shafts are provided for deposits of a less depth.

By forming a series of galleries generally parallel to each other, and cutting the channels between the galleries and at right angles thereto, the oil-bearing sand can be progressively worked, bore holes and channels being made in each direction from each tunnel or gallery and at right angles thereto.

The drill holes can be formed directly in the oil sand, but I consider it more advantageous to form them outside and adjacent to the oil sand. By drilling the holes immediately above the oil sand, escape of oil vapors therethrough is avoided during the drilling operation, while the cutting rope will readily cut down through into the oil-bearing sand when the cutting operation begins. Similarly, by boring holes at the top and bottom, or above and below, the oil-bearing sand, and threading ropes therethrough, or threading the same rope therethrough, cutting may take place at both the top and bottom of the oil-bearing sand simultaneously.

The cutting rope may be operated either with a reciprocal or back and forth movement to saw through the oil sand, or it may be operated continuously by using an endless cutting rope.

The operating mechanism for operating the rope may be located underground in the shafts or galleries, but I consider it far more advantageous to extend the cutting rope to the surface of the ground and to operate it therefrom and it is a characteristic and important advantage of the invention that it permits such operation, thereby avoiding the need of workmen or of operating equipment underground, and avoiding the need of strong air currents for ventilation and resulting fire hazard due thereto and to sparks, which, with a combustible mixture of oil vapors and air, might cause dangerous explosions. By providing the operating mechanism above the ground, and locating only the cutting ropes and necessary pulleys, etc. for supporting it underground, the operations can be controlled by workmen entirely out of the danger zone.

The individual shafts, where a plurality of shafts are provided for drilling the holes for the cutting ropes, should extend down through the oil sand to provide operating room for the cutting rope so that the channel may be cut to the bottom of the oil sand layer. A sump or sumps should also be provided for collecting the oil that drains from the oil sand through the channels and these sumps may advantageously be the bottoms of the shafts through which the cutting rope operates.

Where the channels are cut between galleries, the galleries are provided with walls or pits extending through the oil bearing stratum at points adjacent to the two ends of the bore holes and these wells or pits serve for the pulleys, etc., for operating the cutting rope, and may also serve as sumps to collect the oil.

The cutting rope used for cutting the channels may vary with the hardness and character of the oil sand and may or may not be provided with cutting projections or teeth, etc. Ropes of the general type used for cutting stones in quarrying and stone dressing operations can be used in the improved process of the present invention. The rope may be made of twisted wire or may have cutters or cutting points formed therein or attached thereto to promote the cutting operation.

In order to provide for the progressive lowering of the rope as the channel is progressively cut, suitable means should be provided for taking up the slack in the rope, which may advantageously be done by a mechanism above the surface of the ground, so that the portion of the rope underground is kept under a regulated tension for the cutting operation.

In practice the cutting rope will be supported on pulleys in the wells or sumps at the ends of the channels and these pulleys may be adjustable as to height and be lowered as the cutting through the oil sand progresses.

The driving mechanism for driving the cutting rope, whether reciprocating or continuous, is advantageously located above the surface of the ground. Where the system using vertical shafts is employed, the rope will extend down through the shafts and then through the bore holes between the shafts and up through another shaft to the surface of the ground. Where the bore holes are drilled between galleries the operating mechanism will extend down one or more of the shafts connecting the galleries and each gallery may have mechanism therein, such as a series of driving pulleys for operating the cutting rope for each channel. In the latter case, the power may be applied from the surface of the ground through a single shaft, or through two shafts, one leading to each of two galleries, and the two

galleries may have shafts extending through them between which the individual ropes operate. In such case, the means for taking care of slack would be provided in connection with the underground pulleys in the galleries.

In order to facilitate and promote the cutting operation, an abrasive may be supplied to the cutting rope, for example, sand of suitable size, or sand admixed with water.

Inasmuch as the channels are cut between galleries, (where galleries are employed) instead of above or below the galleries, as disclosed in my prior patent, the individual channels can be sealed from the galleries at their ends where this is desired merely by capping or closing the top of the well or pit at the end of the channel. In this way the gas can be confined in the individual channels or piped away therefrom and kept from the galleries. So also, the sealing of one of the channels enables a compressed gas or fluid to be applied thereto to assist in forcing oil from the oil sand into other adjacent channels. By sealing alternate channels and forcing fluids or compressed air or compressed gas into them the oil can be forced into intermediate channels from which it may be collected and withdrawn. In the case of a series of channels between two parallel galleries, the alternate channels can be sealed at one end and the intermediate channels sealed at the other end, and pressure applied to one gallery and to the channels communicating therewith to force oil into the intermediate channels from which it can be collected in the other gallery.

The channels which are cut by the cutting rope in accordance with the present invention are relatively narrow, but nevertheless sufficient to permit the oil to drain out there-through from the oil sand, adjacent the channel. This oil will collect in the wells or pits at the ends of the channels and may be pumped therefrom to the surface of the ground.

By sealing the channels during the cutting operation and permitting the cutting rope to pass through suitable stuffing boxes or the like, the gas, as well as the oil, can be recovered, suitable connecting pipes being provided therefor.

Instead of applying pressure to certain of the channels to force oil out into adjacent channels, provision may be made for introducing fluids under pressure into the area between the channels so as to force the oil through the sand toward and into the channels, thereby increasing the effectiveness of the drainage into the channels.

The invention will be further described in connection with the accompanying drawings, which are more or less conventional and diagrammatic in character, and which illustrate certain modes of applying the invention and

certain embodiments thereof, but it is intended and will be understood that the invention is illustrated thereby but is not limited thereto.

In the drawings

Figs. 1, 2 and 3 are conventional cross sections through the oil-bearing and adjacent strata illustrating different arrangements for carrying out the invention;

Fig. 4 is a diagrammatic ground plan showing one arrangement of shafts, working tunnels and drainage channels;

Fig. 5 is a diagrammatic ground plan showing a modified arrangement with shafts and drainage channels suitable for operations at shallow depths, where the cost of shafts from the surface of the ground would be less than that of driving tunnels underground;

Fig. 6 is a vertical cross section of one of the working shafts or tunnels, showing its arrangement with the bore holes, etc., and with means for closing off the channel from the shaft or tunnel to recover gas therefrom;

Fig. 7 is a vertical, transverse section of one of the finished channels extending through the oil sand;

Fig. 8 is a view showing one form of mechanism for operating the cutting rope; Fig. 8^a is a modified form.

Fig. 9 is a diagrammatic plan showing an arrangement of channels with alternate channels sealed from the gallery; and

Fig. 10 shows one form of sealing means for sealing a channel from the shaft or the gallery.

In the accompanying drawing the same or similar parts are represented by the same reference characters.

In carrying out the invention I sink a shaft or a series of shafts as indicated at 1 in Figs. 1 and 2, or I sink shafts, such as the shaft 1 of Fig. 4, and drive tunnels 2 from them parallel to each other. The shafts are sunk and the tunnels driven at a point close to the oil-bearing stratum 3. From the shafts or tunnels I then drive bore holes 4, using, for example, a diamond drill, and forming bore holes such as are commonly made therewith, that is, bore holes extending from one shaft or tunnel to another shaft or tunnel situated at a considerable distance from the first.

The bore holes are directed so as to pass more or less parallel with and reasonably close to the oil-bearing stratum. By drilling these holes above the oil-bearing stratum, the workman is protected from escaping oil vapors during the drilling operation; while by drilling these holes immediately adjacent the oil-bearing stratum there is only a small amount of rock to be cut through before the cutting rope enters the oil stratum.

In case the oil bearing stratum lies at an angle to the horizontal, the drill hole may be drilled at the corresponding angle. In the

accompanying drawings I have shown the stratum as being essentially horizontal and have shown the drill holes also as horizontal.

From the working shafts 1 or tunnels 2, I sink wells or pits 5 through the oil-bearing stratum at points adjacent to the two ends of the bore hole 4 of size large enough to accommodate a pulley 6 with its supporting guides, which are omitted in Figs. 1, 2, 3 and 6. This pulley is preferably so disposed to its supporting guides that it can be raised or lowered at will, preferably by operating means extending to the surface of the ground. The guides or the mechanism for raising or lowering the pulleys can be varied in construction. One form is illustrated by way of example in Fig. 8.

Wire rope or cable construction is passed around the pulleys 6 and threaded through the bore hole 4. This sawing strand passes over the pulleys 6 and thence to the operating mechanism by means of which it is operated either reciprocally or continuously. In the case of a continuous cutting strand the ends, after passing over the pulleys 6, are brought together so as to form a closed continuous strand so that the strand will circulate as a continuous belt. Suitable pulleys and driving mechanism (not shown) will be provided for the operation of the cutting strands. Where the strand is not operated continuously the two ends may be connected to its operating mechanism (not shown) capable of giving the strand a back and forth sawing motion through the bore hole. In either case suitable means are provided for maintaining the sawing strand under appropriate tension.

In Fig. 1, the cutting strand 7 is shown as passing over pulleys 6 in wells located at the bottom of the shafts 1 and extending through the drill hole 4 to the position ready to begin the cutting operation. The dotted lines indicate later positions of the cutting strand after the channel has been partly cut by it. The supports and guides for the pulleys and the operating mechanism are omitted from this figure.

In Fig. 2 an alternative arrangement is shown in which bore holes 4 are drilled both above and below the oil-bearing stratum and in which both pulleys 6 are located in the same shaft 1, the shaft being sunk through the oil-bearing stratum in this case. The sawing strand 7 is threaded through the two bore holes and over the pulleys 6 and is then circulated continuously like an endless belt or sawed back and forth with a reciprocating motion so as to cut a slit or channel 8 through the oil-bearing stratum.

In Fig. 3 the wells or pits 5 are sunk from tunnels 2 and the bore hole 4 is made sufficiently large to permit two strands of the cutting rope to pass therethrough or separate bore holes for each strand may be made. This cutting rope passes over pulleys 6 at the bot-

tom of the wells or pits and over other pulleys arranged opposite the bore hole 4. The supporting, adjusting and driving mechanism for operating the cutting strand are omitted from this figure. The sectional view of Fig. 3 is typical of the arrangement of one of a series of channels and means for cutting them as arranged in Fig. 4 which latter is a conventional section taken on the line 4—4 of Fig. 3.

Fig. 4 shows two shafts 1, from which tunnels 2 are driven adjacent to and above the oil-bearing stratum, these tunnels being substantially parallel to each other and a considerable distance apart. A series of bore holes are drilled at suitable distances from each other and a series of wells or pits 5 are sunk opposite these bore holes so that a series of channels can be cut on the general plan illustrated in Fig. 4. In this figure channels are cut between two tunnels in only one direction from each, but in the systematic working of the deposit the channels can be cut from the same shaft or tunnel in both directions as will be readily understood. In the arrangement of Figs. 3 and 4 individual operating devices may be provided for each cutting strand or a series of cutting strands can be driven from a common operating mechanism as by providing pulleys on a common shaft (not shown) in each tunnel and driving the pulley shaft from the surface of the ground through the vertical shaft 1.

Fig. 5 shows an arrangement of vertical shafts spaced apart from each other and with drill holes 4 forming a net work therebetween so that channels may be cut of the kind illustrated in Fig. 1. Fig. 5 is a conventional section with parts omitted taken along the general plane 5—5 of Fig. 1 where the drill holes are located.

The arrangement of Fig. 5 is suitable for mining at relatively shallow depths where it is less difficult or expensive to sink a series of shafts from the surface than to drive working tunnels underground. In working at greater depths it may be more advantageous to drill only a sufficient number of shafts to connect with underground galleries and to form the working tunnels or galleries 2 from these shafts along any desired course, but generally parallel with each other and at a desirable distance apart. In either case the bore holes are formed between the shafts or between the tunnels, and the channels are formed therebetween either in a parallel system as illustrated in Fig. 4 or in a rectangular or other system as illustrated in Fig. 5 so that the deposit can be systematically worked.

The cutting of the channels 8 permits the oil to seep into them and to flow along them to the pits or sumps 5 where it is collected in a suitable system of pipes (not shown) and pumped to the surface. Gas from the chan-

nels and sumps can be similarly collected in a suitable pipe system.

During the cutting of the channels the wells or pits 5 and the ends of the drill holes and of the channels may be cut off from the shafts or tunnels to prevent escape of gas and to permit collection and recovery of the escaping gas. One suitable arrangement for this purpose is illustrated in a diagrammatic way in Fig. 6 in which a cover or portion 9 is provided for closing the top of the well 5 and the end of the bore hole 4. This cover may be of metal or of tar or of concrete, or other construction suitably rooted or cemented to form a gas-tight joint with the surrounding rock. This seal has an opening 10 provided with a stuffing-box through which the cutting strand passes. A pipe 11 is provided for the escape of gas which is led to a suitable place for collection or recovery. A pipe 12 is provided for pumping oil, water and cuttings from the bottom of the well 5. A pipe 13 is provided for introducing water and an abrasive for the cutting strands. By providing closures of this kind for each of the operating wells and bore holes by which the channels are being cut, the galleries or shafts can be kept relatively free from escaping petroleum vapors thus greatly reducing the danger and need of ventilation in case workmen are engaged in the tunnels or shafts; and at the same time permitting the recovery of the escaping gas.

Where little or no gas is encountered, or where the workmen are not required in the underground working during the progress of channel cutting, the use of a seal such as illustrated in Fig. 6 may be unnecessary and can be omitted. Where, however, there is a considerable amount of gas given off which it is desired to recover or which may be objectionable to the workmen in the underground workings during the cutting of the channels such a seal 9 as illustrated in Fig. 6 may advantageously be provided over the mouth of the well or pit 5 and of each bore hole 4 and the exposed part of the channel 8 so as to confine the gas in the bore hole, channel and pit beneath the seal or permit leading of this gas through a gas outlet pipe. The seals at both ends of a single channel need not be provided with pipe connections for the supply of abrasive and the removal of gas. A single gas outlet pipe from one end of the channel will ordinarily suffice and the abrasive will ordinarily be introduced only at the end of the channel at which the rope enters in the case of a continuously operating rope. With a rope having a back and forth movement an abrasive and water mixture may be supplied at both ends.

In Fig. 7 I have shown a cross section of one of the completed channels, the bore hole 4 appearing at the top and the channel 8 ex-

tending downwardly therefrom through the oil-bearing stratum 3.

The natural drainage of oil into and through the channels 8 can be increased or supplemented by applying fluid under pressure to the oil-bearing stratum through wells drilled in the area between the channels as disclosed in my prior Patent 1,507,717. Said wells are shown for the purpose of illustration between two of the channels 8 in Fig. 4 these wells being indicated by the reference numeral 15. Similar wells are shown in Fig. 5. By applying fluid pressure through these wells the oil is forced away from the wells and in the direction of the channel. An alternative method of increasing the effectiveness of the draining is to seal up alternative channels at their ends and applying fluid pressure through the sealed channels to force the oil out into the unsealed channels, for example, by applying seals such as illustrated in Fig. 10 at both ends of the alternating channels and applying fluid pressure through the pipe 17 through such channels. Such an arrangement of channels alternately sealed is illustrated in Fig. 9. The seals are shown conventionally in Fig. 10. They should be weighted or anchored in some suitable way to withstand the pressure which it is found necessary to apply to the alternate channels in order to force the oil out.

One form of pulley supporting operating mechanism is shown conventionally in Fig. 8. The cutting strand passes over the pulleys 6^a in the bottom of the shafts and then up over the pulleys 6 which are adjustably mounted in supports 20. Adjustment screws 21 when rotated cause the pulleys to be raised or lowered. These screws 21 have gears 22 on them driven by other gears 23 which in turn are operated by a wire or cable 24 extending to the surface of the ground and there passing over operating pulleys 25. The cutting cables pass over pulleys 26 at the surface of the ground and then over the driving pulley 27 driven by suitable mechanism (not shown). The cutting cable passes over the pulley 28 which is slidably mounted in horizontal guides 29 and in order to take up slack and keep a proper tension on the cutting cable a windlass 31 with ratchet 32 is provided for keeping a proper tension on the cable 35 which is connected to the pulley 28 through the spring 30. The spring 30 is to safeguard the cable from too tight stretching.

Any suitable arrangement for keeping the cutting cable under tension may be utilized. A possible modification of the arrangement shown in Fig. 8 is shown in Fig. 8^a. A counterweight 34 is provided on cable 35 by any convenient arrangement such as running the cable 35 over stationary pulleys 33-33. In this manner the tension applied to the cutting cable may be semi-automatic. The

counterweight 34 is raised by the windlass and the tension is automatic until the weight has fallen to its limit when it may again be raised by winding the windlass.

5 In the operation of cutting the channels after the shafts and tunnels have been formed and the bore holes drilled, the wells 5 will be sunk, if these have not previously been formed, the pulley supports for the 10 cutting rope will be located and the cutting rope will be threaded through the bore hole and around the pulleys and connected to the operating mechanism. The wells and bore holes may then be sealed if necessary or desirable in the manner above described to prevent the escape of gas or to permit its recovery. Water and abrasive can be supplied to the cutting rope or strand as needed. Fine sand can be used as abrasive. When the 20 sawing strand is operated in the presence of such an abrasive, and in some cases even without an abrasive, it cuts through the oil-bearing stratum and forms the slit or channel 8 which serves to drain the oil from the 25 oil bearing stratum to the pits or wells 5 where it collects and from which it may be pumped to the surface. The cutting or sawing strand 7 may, as hereinbefore stated, be of any suitable composition or design. For 30 all but very hard rock a wire rope such as is used for sawing stone in quarrying and stone working operations can be used. For very hard rock a strand shod with specially prepared cutting points or abrasive surface 35 can be used.

40 In cases of little gas development the operating mechanism may be located underground and workmen may operate underground. It is an important advantage of the invention that it permits operations from the surface of the ground with remote control of the cutting operations, thus, in many cases making it unnecessary for workmen to enter or be present in the underground 45 workings. Where such necessity exists and where considerable gas is given off, the openings from the vertical shafts or horizontal tunnels into the oil-bearing stratum can be sealed off and the gas thereby confined to 50 the oil-bearing stratum or separately drawn off therefrom.

It will thus be seen that the present invention provides an improved method of mining petroleum and of recovering it from underground "exhausted" deposits in which chan- 55 nels through the oil-bearing stratum are formed without requiring the driving of tunnels along the course of such channels to permit their cutting so that the number of tunnels required can be radically reduced as compared, for example, with the arrangement disclosed in my prior Patent No. 1,507,717. It will further be seen that the cutting operation of the present invention does not require 60 the presence of machinery such as a channel-

ing machine and greatly reduces danger from sparks formed by such machinery. The present operation also greatly reduces the danger from petroleum vapors and reduces the need of ventilation and the danger of explosion from explosive mixtures of such vapors with ventilating air. 70

It will further be seen that the invention permits remote control of the channeling operation where this is desired so that the workmen need not be exposed to gas or fire hazard 75 during the cutting of the channels and so that even during such cutting the workmen can readily be protected from such hazards. The invention moreover permits complete control and saving of gases given off not only while the channels are being cut, but also subsequently thereto. The invention also shortens the time required for the mining operations and reduces the cost of the petroleum 80 recovery by eliminating a great deal of unproductive tunneling and replacing it by channels of simpler construction and more readily and cheaply produced, which nevertheless serve the purpose of permitting drainage of petroleum therethrough and with other advantages such as those hereinbefore referred to. 85

It will be understood that variations can be made in the specific construction and arrangement and operation of the different elements and features of the present invention 90 without departing from its spirit and scope.

I claim:

1. The method of extracting petroleum which comprises boring a hole from one underground opening to another through or 100 adjacent to an oil-bearing stratum, threading a sawing strand through said hole, imparting a sawing movement to said strand in said hole and thereby sawing a narrow slit or channel through the oil-bearing stratum, and sealing the ends of said hole and said channel during the sawing operation to prevent escape of gas from the oil-bearing stratum to such underground openings. 105

2. The method of extracting petroleum which comprises boring a hole from one underground opening to another through or adjacent to an oil-bearing stratum, threading 110 a sawing strand through said hole, imparting a sawing movement to said strand in said hole and thereby sawing a narrow slit or channel through the oil-bearing stratum, and sealing the ends of said hole and said channel during the sawing operation to prevent escape of gas from the oil-bearing stratum to such underground openings and separately drawing off and recovering the gas from said channel. 115

3. A petroleum recovery system having an underground passage through which a cutting strand operates to cut a channel through an oil-bearing stratum, and means for sealing the channel being formed by said cutting strands to prevent escape of gas therefrom, 120 125 130

and means permitting passage of the cutting strands through said seal.

4. A petroleum mining system having underground working passages, bore holes connecting the same, means for passing a
5 cutting strand through the bore holes to cut a channel through the oil-bearing stratum, and a seal for sealing the working passage from said bore hole and from the channel
10 while it is being formed, and means permitting the passage of the cutting strand through said seal.

In testimony whereof I affix my signature
JOHN LYON RICH.

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