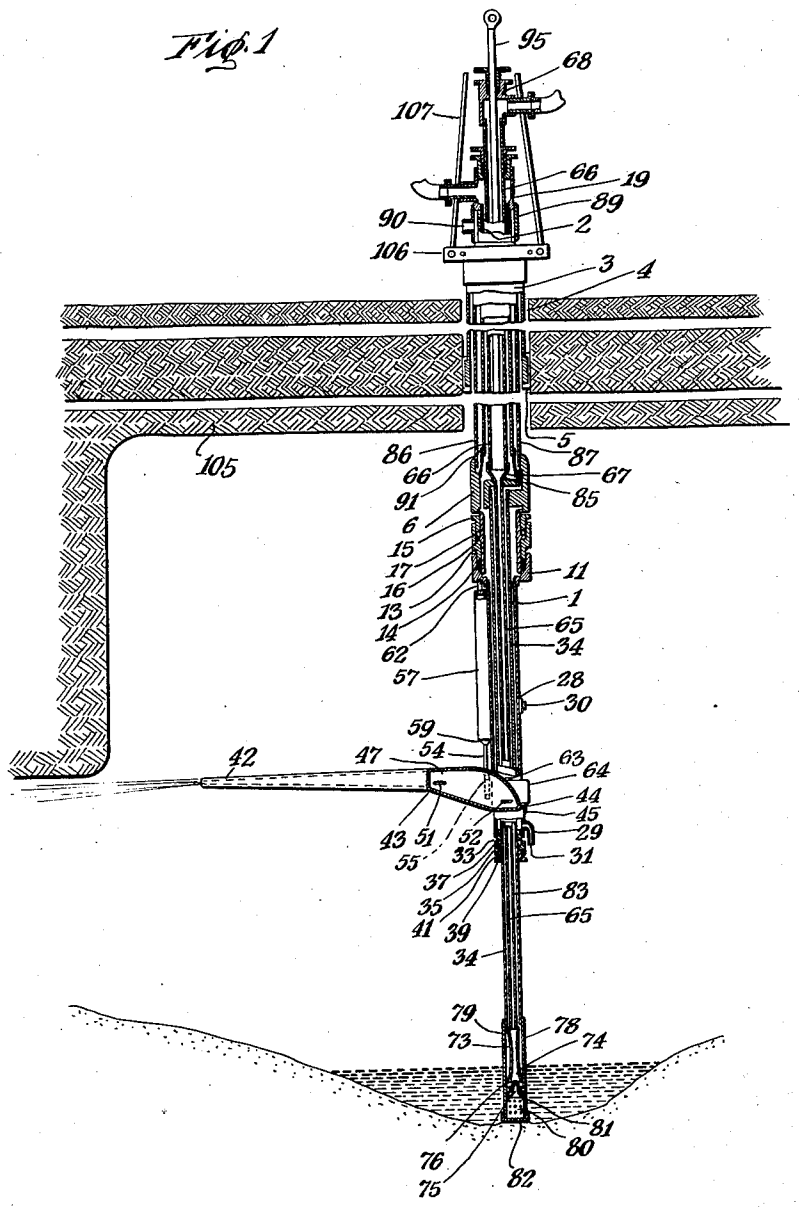
March 29, 1932. E. E. CLAYTOR 1,851,565

PROCESS AND APPARATUS FOR MINING

Original Filed Oct. 1, 1924 5 Sheets-Sheet 1

Fig. 1



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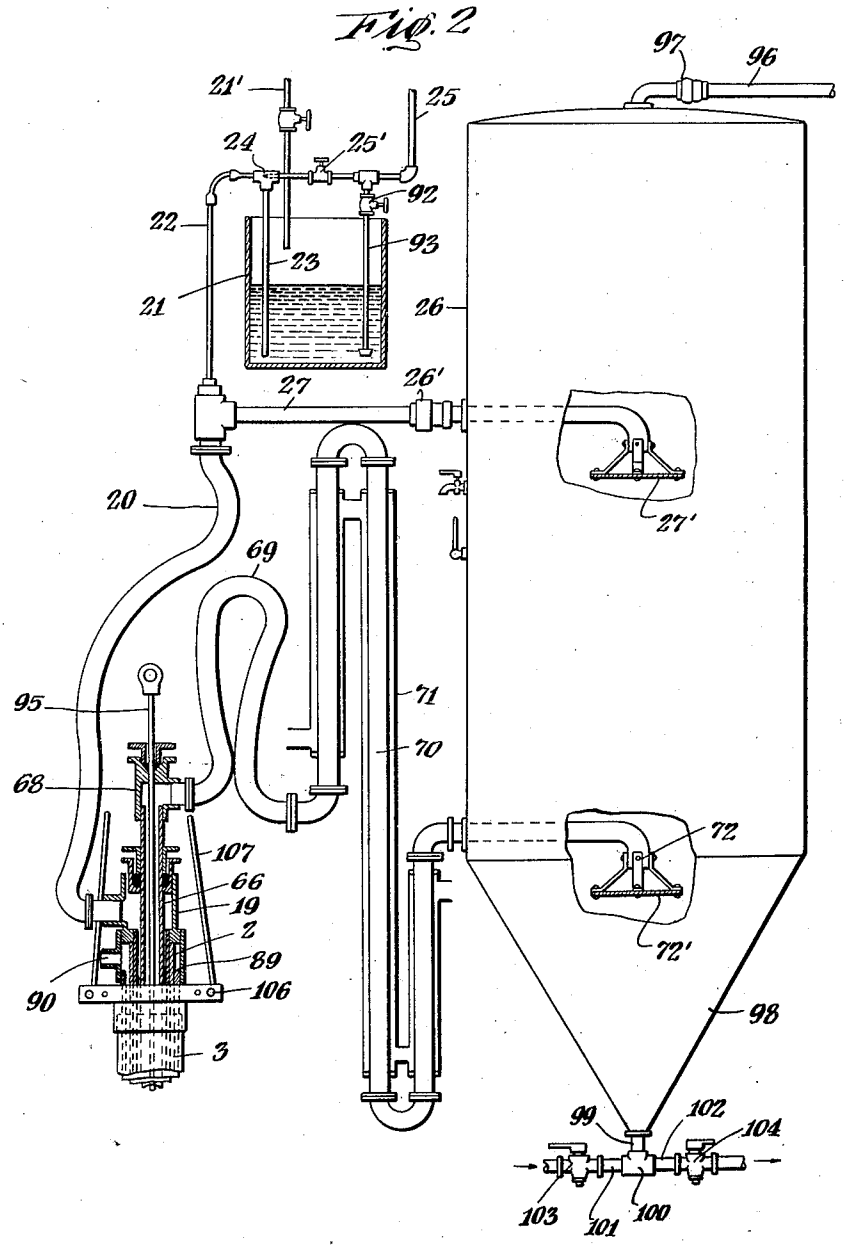
PROCESS AND APPARATUS FOR MINING

Original Filed Oct. 1, 1924 5 Sheets-Sheet 2

Fig. 2



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PROCESS AND APPARATUS FOR MINING

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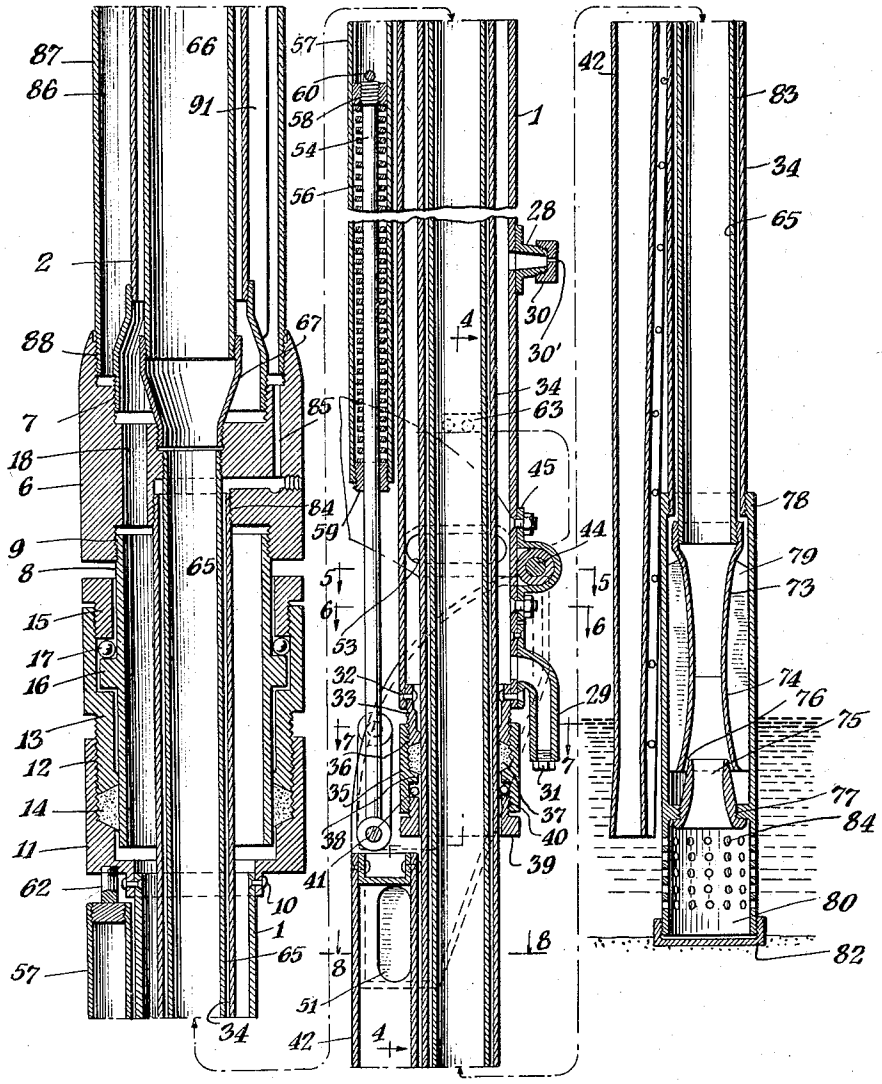
Fig. 3



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March 29, 1932. E. E. CLAYTOR 1,851,565

PROCESS AND APPARATUS FOR MINING

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Fig. 4

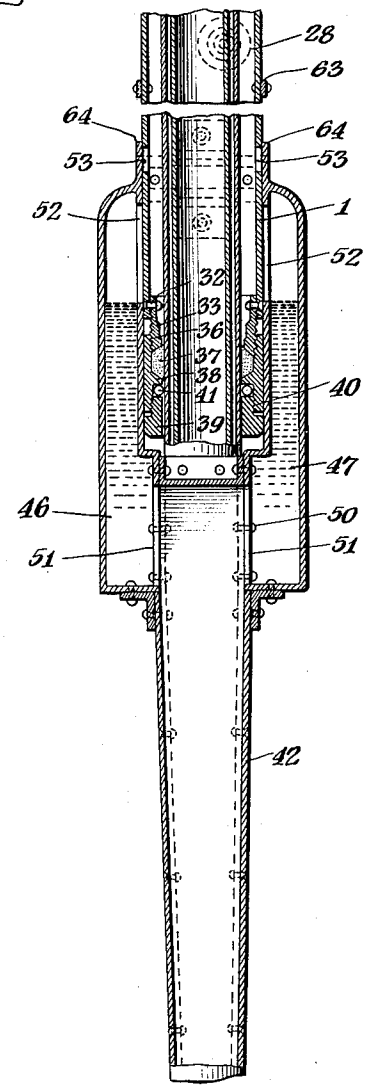


Fig. 5

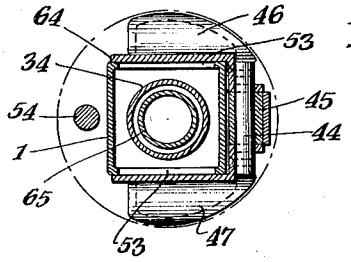


Fig. 6

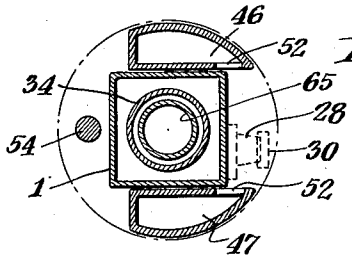


Fig. 7

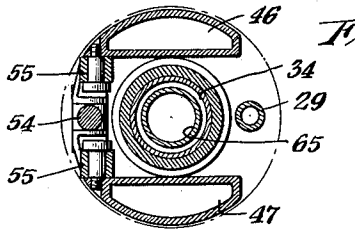
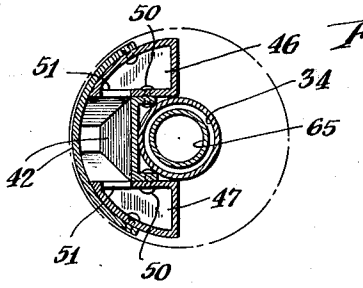


Fig. 8



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PROCESS AND APPARATUS FOR MINING

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Fig. 9

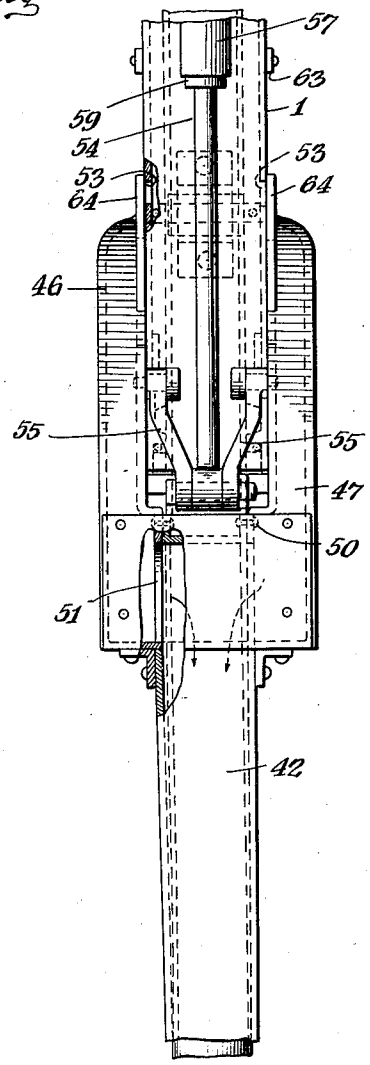
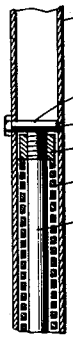


Fig. 10



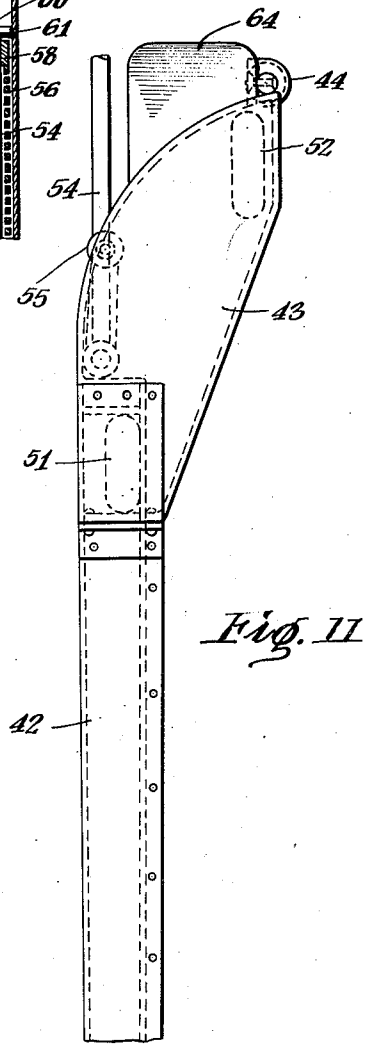


Fig. 11

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UNITED STATES PATENT OFFICE

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PROCESS AND APPARATUS FOR MINING

Original application filed October 1, 1924, Serial No. 740,911. Divided and this application filed April 13, 1925. Serial No. 22,912.

This invention relates to the mining and treatment of minerals and particularly to the recovery of minerals which may be reduced to a fluid state during the mining operation as described in Patent No. 1,607,586, the present application being a division thereof.

The particular object of the invention resides in the recovery either from beneath or above the surface of the ground of minerals which can be resolved into a fluid state during the mining operation and in the separation of the thus mined minerals from the inert material with which they are always associated.

In describing the invention I will first show its application to the mining of bituminous materials such as oil bearing sands from beneath the ground, but it is to be understood that the invention is not limited to this particular application as it will later appear.

In the drawings, which illustrate a mechanism for carrying out the method of mining the oil bearing sand,

Fig. 1 is a sectional view of a portion of one form of the apparatus illustrating the giant, including tubings and the casing head.

Fig. 2 is a semi-diagrammatic view, partly in section, showing the apparatus which is associated with the parts illustrated in Fig. 1 and directly connected to the casing head,

Fig. 3 is an enlarged sectional view of a portion of the apparatus shown in Fig. 1, the casing and casing head being omitted,

Fig. 4 is an enlarged sectional view of the nozzle and its associated parts,

Fig. 5 is a horizontal sectional view on line 5—5 of Fig. 3 looking in the direction of the arrows,

Fig. 6 is a similar view on line 6—6 of Fig. 3.

Fig. 7 is a similar view on line 7—7 of Fig. 3,

Fig. 8 is a similar view on line 8—8 of Fig. 3,

Fig. 9 is an enlarged elevational view partly broken away, of the nozzle shown in Fig. 4 and the apparatus for operating the same,

Fig. 10 is a detailed sectional view illustrating the elevating means for the nozzle and the means for retaining the elevating means in its inactive position, and

Fig. 11 is a side elevational view of the nozzle shown in Fig. 9, the view being taken at right angles to Fig. 9.

The mechanism consists broadly of means for injecting a mining agent into the underground source of the oil, the elevation of the fluid oil, the separation of the oil from the mining agent and from the sand, and the separation of the mining agent from the sand.

The apparatus, in the form illustrated, includes what I term a giant. This giant includes a tube 1 which is preferably, although not necessarily, quadrangular in cross section and which communicates with a tube 2 extending through the casing 3 which is placed in the ground to line the well 4 and sealed therein by casing shoe 5. The tube 1 communicates with the tube 2 in the following manner:

The adapter 6 is attached to the tube 2 by suitable means such as screw threads 7. This adapter carries at its lower end a sleeve 8 which forms in effect an extension of the tube 1 and is attached to the adapter by means such as screw threads 9. Attached to the tube 1 at 10 is a packing ring 11 which in turn is adjustably attached as at 12 to a second packing ring 13, there being suitable packing material 14 between the rings 11 and 13. The packing ring 13 at its upper end carries an adjustable raceway 15 between which, and an annular shoulder 16 on the sleeve 8, anti-friction bearings 17 are located, which shoulder 16 acts as the opposing raceway for the anti-friction bearings. Thus the tube 1 is supported on the sleeve 8 which depends from the adapter 6 so that it is free to revolve upon the tube for a purpose which will later appear.

The adapter 6 is provided with a series of ports 18 so designed that the pressure of the mining agent after passing therethrough will not exceed the desired working head for the nozzles 42, 29 and 31 when the tube 2 is filled with the mining agent completely to

the surface of the ground, which establish communication between the interior of the tube 2 and the interior of the tube 1 so that the mining agent may be conveyed through the former into the latter.

The tube 2 is attached at its upper end to a tubing head 19 to which is attached a flexible pipe 20 extending to a source of supply or the mining agent. I have illustrated this source as being two-fold, the agent being originally obtained from a tank 21 which is connected to the flexible pipe 20, by a relatively smaller pipe 22, the solution being raised through a pipe 23 and forced into the pipe 22, and consequently into the pipe 20 by a steam injector 24 from which steam is injected from a suitable source, (not shown), through a pipe 25, having a control valve 25′ therein. This tank 21 may be used as a mixing tank and the liquid, for instance, sodium carbonate, prepared within the tank in which case water will be supplied to the tank through valve control pipe 21′. However, it is to be understood that the tank 21 may simply be used as a storage tank and the mining agent supplied to the tank through pipe 21′, having been prepared elsewhere.

The other source of supply of the mining agent is the heretofore referred to separation tank 26 from which the agent, after having been separated from the oil and the sand, is conducted to the pipe 20 through a pipe 27 having a baffle plate 27′ spaced from the end thereof.

In order that the mining agent may be projected against the walls of the well I have located nozzles 28 and 29 adjacent the lower end of the tube 1, the former extending outwardly from the tube and the latter, located below the former, extending downwardly. These nozzles are adapted to be closed by suitable closures 30 and 31, closure 30 of the nozzle 28 having a central opening 30′ therein for a purpose which will later appear. The nozzle 28 (see Fig. 6) is offset or tangential with respect to the longitudinal axis of the tube 1 so that when the mining agent is projected from the nozzle the tube will be given a rotative movement by the reactive force of the agent leaving the nozzle, so that the agent will be automatically projected against the wall of the well in a progressive circle.

The lower end of the tube 1 is closed and guided on anti-friction bearings in the following manner: Secured to the tube 1 at 32 is a packing ring 33 which fits within the tube 1 and is, at its upper end, of a cross section similar to that of the tube. At its lower end, however, it is of a circular cross section so as to snugly fit the tube 34 which is likewise circular in cross section and extends upwardly through the tube 1. A second ring 35 is attached adjustably at 36 to the ring 33 and disposed between these packing rings is suitable packing material 37. The packing ring 35 is provided with an annular shoulder 38 between which and a raceway 39 which is adjustably attached at 40 to the packing ring 35, anti-friction bearings 41 are disposed. Thus it will be seen that the tube 1 is supported at its upper and at its lower ends by anti-friction bearings and is packed so as to prevent the escape of the mining agent except through the ejection nozzles.

This tube 1 is provided with a relatively larger nozzle 42. This nozzle 42 is provided with a head 43 which head is mounted for pivotal movement at 44 on a bracket 45 carried by the tube 1.

Referring particularly to Figures 4 to 8 inclusive, it will be seen that the head 43 is formed of two chambers, 46 and 47. These chambers 46 and 47 are disposed upon the opposite sides of the tube 1 and are attached at 50 to the nozzle 42 having permanent communication with the same through openings 51.

In order that communication may be established between the chambers 46 and 47 of the nozzle when the latter is in its raised position, such as shown in Fig. 1, I have provided each of the chambers with openings 52 which openings are adapted to register with openings 53 in the tube 1 (see Fig. 5).

In order that the nozzle 42 may be automatically raised into its operative position as shown in Fig. 1, I have provided a lifting rod 54 which is attached pivotally to the chambers 46 and 47 by means of a yoke 55 and is normally urged upwardly by a spring 56 mounted within a housing 57 and disposed between an abutment 58 on the end of the rod 54 and a permanent abutment 59 on the lower end of the housing. The spring 56 is, when desired, maintained under compression and in an inoperative position, that is to say, inoperative to raise the nozzle 42, by a removable pin 60 which extends through the housing 57 and in the form illustrated is shown as in screw threaded attachment therewith at 61. This housing 57 is carried by the packing ring 11 as at 62.

In order that the nozzle 42 may be limited in its upward movement under the action of the spring 56 so as to be arrested in the proper position to project the mining agent, I have provided a pair of stops 63 (shown in Fig. 1 and in dotted lines in Fig. 3) which stops are disposed on opposite sides of the tube 1 and adapted to engage the upper surfaces of wings 64 which project from the chambers 46 and 47 of the head 43 of the nozzle 42 and which, when the nozzle is in its lowered or inoperative position, cover the openings 53 in the tube 1 as shown in Fig. 5 of the drawings.

In order that the mined material and the mining agent may be raised to the surface of the ground, I have mounted a tube 65 in the

adapter 6, which tube and its upper end communicates with tube 66 having a reducing nipple 67 at its lower end above the end of the tube 65, for a purpose which will later appear, and which tube 66 is, at its upper end, provided with a tubing head 68 having connection to a flexible pipe 69 which in turn is connected to a heat exchanger 70 having a jacket 71 for the circulation of water to the boiler and having communication with the tank 26 through its open end 72. A baffle plate 72′ is placed from this open end 72 of the pipe 70.

The tube 65 extends downwardly to a point beyond the lower end of the tube 1 and to the extent desired and is provided at its lower end with a steam injector 73 including a Venturi tube 74 and a nozzle 75 which latter extends into the Venturi tube and is relatively smaller than the same to provide the steam space 76 and is carried at 77 by a housing 78 which is attached at its upper end to the lower end of the tube 34. This housing 78 carries the Venturi tube 74, the latter being mounted therein by means of suitable vanes 79 in the usual manner. The lower end of the housing 78 is provided with a chamber 80 having perforations 81 therein, which chamber is closed by a cap 82 at its lower end and through which perforation the material to be raised passes to the nozzle 75.

In order that the steam may be supplied to the injector, the tube 34 is provided; which tube has a slightly greater diameter than the tube 66 and provides the steam space 83 therebetween. This tube 34, as hereinbefore stated, is carried by the adapter 6 being attached thereto at 84 and having communication with a series of steam ports 85 in the adapter which ports establish communication with the steam space 86 between the tube 2 and an outer tube 87 which is attached at 88 to the adapter and at its upper end is provided with a tubing head 89 having a steam inlet 90 from any suitable source (not shown).

It will be noted that the tube 2 is provided with heat insulation 91 to prevent the communication of heat from the steam passing through the steam space 86 between the tubes 2 and 87 to the mining agent passing through the tube 2. This is most clearly shown in Fig. 3.

It has hereinbefore been stated that the agent when in the form of an alkaline liquid such as soda ash and water, is obtained from the tank 21 in a heated condition. This liquid may be heated by the steam which supplies the injector 24 by simply opening a valve 92 which is located in a pipe 93 having communication with the steam supply pipe 25 and extending into the tank 21.

A pump, of the type usually used in the oil wells, and a rod 95 is mounted to operate within the tube 66 for a purpose which will later appear.

As hereinbefore stated, the tank or container 26 is mounted above the ground and is adapted to separate the oil from the mining agent and the solid or inert material, and the mining agent from the inert material. This container has, in addition to the pipe 27 for taking off the mining agent and the pipe 72 for conveying the mixture of the mined material and mining agent to the container, a pipe 96 which extends from the upper end of the container and is provided with a pressure regulating valve 97. This pipe 96 is adapted to carry off the oil preferably to a heat exchanger which will reduce the oil to a convenient temperature for handling.

In order that the inert material may be continuously carried off from the container 26, I have provided the same with a Spitzkasten separator which includes the tapered lower end 98 of the container 26 which is connected by a pipe 99 to the T 100, from which latter nipples 101 and 102 extend. These nipples are connected to valves 103 and 104. Water, preferably cold, is admitted through the valve 103 into the nipple 101 and some of this water will pass out through the valve 104 when the later is open, while the remaining part will pass upwardly through the pipe 99 into the container 26.

The water thus entering, is slightly in excess of the pressure within the container 26. This slow entering of the water prevents the solution in the container 26 from passing out while it permits the sand or inert material to drop downwardly under the action of gravity through the pipe 99 and into the water which flows through the nipple 102 and the valve 104 from which it escapes.

The function of the mining agent, which in the instance disclosed is sodium carbonate, is to free the material which is capable of assuming a liquid state from the material which is incapable of assuming such a state, and this is accomplished by the breaking down of the surface tension between the two materials, or where oil is being recovered from sand by the breaking down of the surface tension between the sand and the oil. This breaking down of the surface tension is accomplished by projecting the mining agent against the agglomeration of the two materials and results in the releasing of all of the oil from the inert material of the sand.

While sodium carbonate is disclosed in this application the invention is not limited to its use, for it is contemplated that other materials which are capable of breaking down the surface tension between the two materials, such for instance as other alkaline liquids having this property, may be employed.

In operation, when oil or bitumen are being mined, and after the well casing and shoe have been put in place, the giant and tubes

to which it is attached are lowered into the well, the nozzle 42 at this time lying in the position shown in Figure 3 of the drawings, that is to say, substantially parallel with the longitudinal axis of the giant, being held in position by the locking pin 60. It will be realized that at this time the diameter of the well is substantially equal to that portion in which the casing 4 fits. Assuming that the giant has been lowered to the desired extent within the well, with the nozzle 28 adjacent the top or bottom of the productive strata 105, the closures 30 and 31 of the nozzles 28 and 29 having been previously removed, the mining agent, which for the purpose of illustration has been designated as a solution of water and carbonate of soda, is forced down through the tubing head 19 from the pipe 20 and the source to which the latter is connected, that is to say, the tanks 21 and 26, into the tube 1 from whence it escapes under pressure so as to be flexibly projected against the wall of the well from the nozzle 28. At the same time part of the solution escapes downwardly from the casing 1 to the nozzle 29, it being ejected under considerable pressure. The impact of the solution passing from the nozzle 28 with the wall of the well, will excavate the oil bearing sand from the productive strata 105, which sand will drop to the bottom of the well, the excavated sand at the bottom of the well being continuously agitated by the solution which is ejected from the nozzle 29. The range of the nozzle 28 is such that it will excavate the oil bearing sand from the productive strata to an extent sufficient to produce an opening of a radius greater than the length of the nozzle 42. It is here pointed out that the container 26 before the operation is started is, like the container 21, filled with the mining agent so that the supply even at the beginning of the operation may come from both sources. As the oil bearing sand is excavated the tubing and giant are lowered or raised in the manner usual in the operation of oil wells by means of the clamp 106 and the links 107. As heretofore stated, the excavated material passes to the lower end of the well and is raised by the injector 73 to which steam is supplied through the tubing head 89, the steam space 87, the ports 85, and the tube 34, the housing 78 through which it passes between the vanes 79, the steam passing through the space 76, into the Venturi tube 74. The action of this injector draws the material, which includes the mining agent, the sand and oil, through the openings or perforations 81, and raises it through the tube 65 and thence into the tube 66. This material ascends within the tube 66 because of the steam pressure which urges it upwardly. Inasmuch as it is impracticable to inject steam under sufficient pressure to raise the material completely from the well, except in comparatively shallow wells, the raising action of the steam can be supplemented by auxiliary means such, for instance, as a plunger pump, air lift, swabbing, or baling, or the like, the particular method shown being a plunger pump. Thus by the combined action of the steam and the auxiliary lifting means, the liquid and material is lifted from the well.

After the oil bearing strata has been recessed, to the extent sufficient to accommodate the nozzle 42, the apparatus is withdrawn from the well to an extent sufficient to permit the release of the locking pin 60. This being released, and the closure 30 having been placed upon the nozzle 28, the apparatus is again lowered into the well. During its passage through the upper strata into the oil bearing strata which latter has been recessed, the nozzle 42 is retained in its inoperative or folded position by the casing 4 and wall of well. When, however, it reaches the recess created by the previous excavation it automatically moves into its operative position as shown in Figure 1. Having assumed this position the mining agent is again forced into the tube 1 and the steam into the injector through pipes as hereinbefore stated. The major portion of the mining agent escapes from the nozzle 42 while a considerably smaller portion escapes through nozzle 29 and the reduced orifice of the nozzle 28 which is affected by the presence of the closure 30 having the smaller opening 30′ therein. At this time, that is to say, when the operation of the nozzle 42 begins, the nozzle is located so that it projects the mining agent against the wall of the previously formed cavity adjacent the bottom of the oil bearing strata. The reactive force developed by the escape of the mining agent from the reduced orifice of the nozzle 28 causes the rotation of the tube 1 which carries the nozzle 42 so that the latter excavates the oil bearing sand from the productive strata in a progressive circle and from the bottom toward the top of the strata, the giant being gradually raised as the excavation takes place. The nozzle 29 serves to agitate the oil and sand accumulated at the bottom of the joint so that the mixture may be raised initially to free the well from a portion of sand which is brought down from the wall.

The excavated material is removed from the well as in the previous operation of recessing with the small nozzle 28, and excavation is continued until the cooling effect of the sands is great enough to dispense with the heat exchanger. When this is possible, the apparatus is again withdrawn from the well to an extent sufficient to permit the closing of nozzle 29 with closure 31 which incidentally will increase the pressure in nozzle 42, and the tube 66 is unscrewed from its seat in the adapter 6 and is raised a short distance and maintained in this position, and

then the apparatus is again lowered into the well.

It is pointed out that when the apparatus is lowered into the well and the nozzle 42 assumes its operative position, the cap 82 on the lower end of the housing 78 will be raised a short distance above the surface of the sand. This may be accomplished by the operator's lowering the apparatus until the cap rests upon the sand and subsequently raising the same to the desired extent. This will insure the elevation of the liquid without sand or inert material. As the excavated sand and oil flows into the lower part of the well the sand of course seeks an angle of repose sloping towards the center of the well and the liquid accumulates above the same. The injector 73 raises the liquid through the tube 65 into the tube 66 to an extent dependent upon the pressure of the steam. This forms a working head for the nozzle 42 and the liquid flows past the bottom of the raised tube 66 and then through the ports 18 back to the nozzles. When, however, a sufficient amount of oil has accumulated on the surface of the pool and above the mining agent and sand, which are separated from the oil by gravity, the steam is shut off and the tube 66 is lowered and screwed into its seat in the adapter 6 and the giant is raised slightly so that the apertured end of the housing 78 extends into the accumulation of oil in the pool and the steam turned on through the pipe 90. This steam, operating the injector 73, raises the oil through the tube 65 into the tube 66 and the oil thus raised is drawn from the tube 66 by the auxiliary raising means which in the case illustrated in the drawings is a plunger pump.

When during the initial portion of the operation of the apparatus, that is to say when the sand, oil and mixing agent are being raised, they are together discharged into the container 26 through the heat exchanger and the open end 72 of the pipe 70. The greatly reduced velocity which is the result of the discharge of the material into the greatly enlarged container 26, facilitates the arrangement of the sand, mining agent and oil, according to their specific gravities, the sand falling to the bottom and being removed by the Spitzkasten, the mining agent arranging itself above the sand and the oil above the mining agent.

Then again when the oil alone is being raised it need not be discharged into the container 26, but may be by-passed to the pipe line. If, however, it is discharged into the container 26 it, and the mining agent, will arrange themselves according to their specific gravities so that oil may be drawn off from the top of the container through the pipe 96, the pressure reducing valve 26′ in the pipe 27 being closed.

It will be seen that by this method of operation the major portion of the oil contained in the productive strata and oil bearing sand is separated from the sand within the well and is raised from the well free of the mining agent and of the sand.

It is of course to be understood that the mining agent when it reaches the injector 73 must be at a comparatively low temperature in order to have the injector properly operate and for this reason the agent, which is forced through the pipe 20, is kept at the desirable temperature. It is of course realized that when the mining agent is conveyed to the container 26 through the tubes 69 and 70, it is at a greatly elevated temperature owing to the absorption of heat from the steam in its passage in the tubes 65 and 66. This temperature is so high that should it again be circulated through the pipe 27 and the pipe 20 back to the injector, the latter would not successfully operate: therefore the presence of the heat exchanger 71 either on the pipe 70 or on the pipe 27 or some place in the circuit before the injector is reached, is eminently desirable.

Of course it is to be understood that the heat insulator 91 which has been hereinbefore described, is desirable so as to prevent the absorption of heat from the steam in the space 86 by the mining agent in its movement downwardly through the tube 2.

In the above description I have given as an example the mining of oil from beneath the ground, but it is to be understood, as hereinbefore stated, that the invention is equally applicable to the mining of oil and bitumen from outcrops or surface deposists in which case of course the giant and the mechanism which adapts the apparatus for use beneath the ground may be omitted and the mining agent projected from a suitable mechanism connected with the supply so as to free the material which can assume a fluid state from the inert material which cannot assume such a state.

Furthermore, the invention is admirably applicable to the mining of sulphur and in fact other minerals which will assume a fluid state. When sulphur is mined, for instance, from beneath the ground, the apparatus illustrated in the drawings may be used, but the method will differ to some extent in that instead of the particular mining agent which is adapted to resolve the oil into the fluid state, a mining agent which is particularly adapted to put the sulphur into a fluid state is used. In this instance I contemplate the use of steam preferably superheated, to act upon the sulphur deposit to resolve it into a fluid state; instead of depending upon steam to operate the injector I depend upon compressed air, preferably in a heated state, to raise the melted sulphur to the surface. The separation tank 26 and other apparatus at the casing head is dispensed with, as well as the pipe insulation 91. Otherwise, the opera-

tion of the apparatus when used in the mining of sulphur is the same as when oil is mined, except that after an opening of sufficient size to accommodate the nozzle 42 has been reamed, the automatic rotary movement of the giant is stopped. This may be accomplished by tightening the packing rings 15 and 39 so that the tube 1 is locked to the stationary tube 34. The operator may change the direction of the large nozzle 42 occasionallly as desired by turning the tubing slightly at the casing head. At this time the nozzle 28 may be closed. Nozzle 29 will remain open to maintain the sulphur accumulation at the bottom of the giant in a fluid state for raising.

It will be seen from the foregoing description that I have provided a method and an apparatus for freeing material which is capable of assuming a fluid state from material which is incapable of assuming such a state and for raising the fluid material from the ground to the surface when such material is mined from beneath the surface of the ground.

What I claim is:

1. The method of recovering oil from under ground strata in a well which includes projecting a stream of liquid capable of breaking down the surface tension between the oil and the inert materials to free the oil from the inert material against the oil bearing strata in the well, accumulating said oil and inert material in the well, constantly agitating the same by directing a stream of said liquid under pressure into the accumulation, lifting a portion of all of the constituents of the accumulated mixture above the ground and separating the constituents of the mixture, thereafter permitting the remainder of the accumulated materials to separate in the well by gravity, and lifting the oil from said accumulation.

2. The method of recovering oil from under ground strata in a well, which includes projecting a stream of liquid capable of freeing the oil from the inert material under pressure, against the oil bearing strata in the well, accumulating said oil and inert material in the well, constantly agitating the same by directing a stream of said liquid under pressure into the accumulation, lifting a portion of all of the constituents of the accumulated mixture above the ground and separating the constituents of the mixture by gravity.

3. The method of recovering the oil from the underground strata in a well which includes projecting a warm alkaline liquid capable of breaking down the surface tension between said materials against the strata under pressure to separate the oil and inert material from the strata and the oil from the inert material, permitting the mixture to accumulate in the well, constantly agitating said mixture by injecting a stream of said liquid into the same, lifting a portion of all of the constituents of said mixture by the pressure-lift principle, separating the constituents of said mixture, thereafter permitting the constituents of the remainder of the accumulated mixture to arrange themselves in the well according to their specific gravities and lifting the oil from said mixture.

4. The method of recovering the oil from the underground strata in a well which includes projecting a warm solution of sodium carbonate against the strata in the well under pressure to separate the oil and inert material from the strata and the oil from the inert material, permitting the mixture to accumulate in the well, constantly agitating said mixture by injecting a stream of said liquid into the same, lifting a portion of all of the constituents of said mixture by the pressure-lift principle, thereafter permitting the constituents of the remainder of the accumulated mixture to arrange themselves in the well according to their specific gravities, and lifting the oil from said mixture.

5. The method of recovering the oil from the under ground strata in a well which includes projecting a warm alkaline liquid against the strata in the well under pressure to separate the oil and inert material from the strata and the oil from the inert material by breaking down the surface tension between said materials, permitting the mixture to accumulate in the well, constantly agitating the said mixture by injecting a stream of said liquid into the same, and lifting a portion of all of the constituents of said mixture by the pressure-lift principle.

6. The method of recovering oil from underground strata in a well which includes projecting a stream of liquid capable of freeing the oil from the inert material against the oil bearing strata, accumulating said oil and said inert material in the well, agitating the accumulation, and lifting a portion of all of the constituents of the accumulated mixture above the ground and separating the constituents of said mixture.

7. The method of recovering oil from underground strata in a well which incudes projecting a stream of liquid capable of freeing the oil from inert material against the oil bearing strata, accumulating said oil and said inert material in the well, agitating the accumulation, and lifting a portion of all of the constituents of the accumulated mixture above the ground and separating the constituents of said mixture, and thereafter permitting the accumulated mixture to settle, and lifting the oil from said mixture.

In testimony whereof, I have signed my name to this specification this 26th day of March, 1925.

EDWIN E. CLAYTOR.