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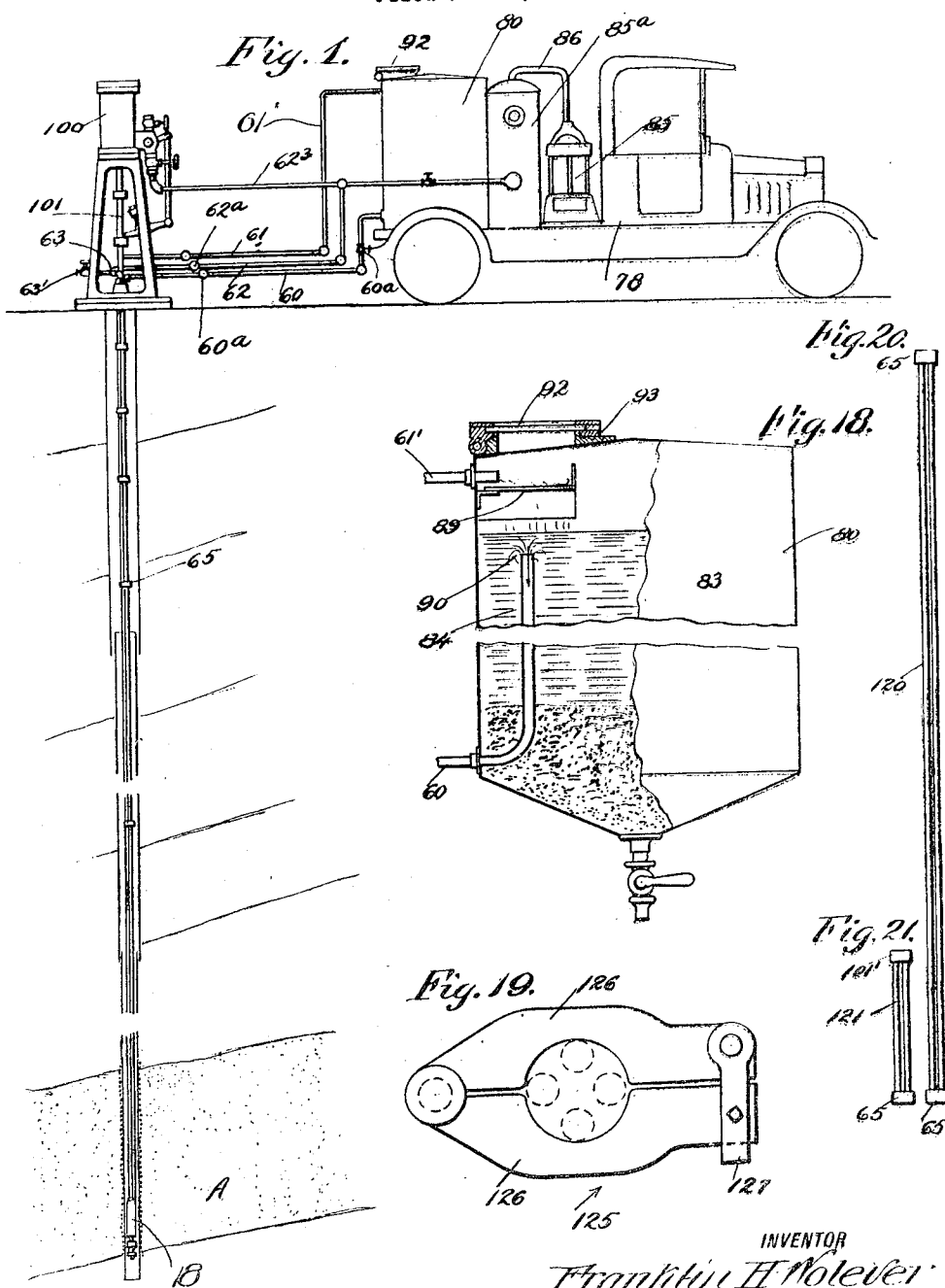
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F. H. WOLEVER

METHOD OF AND APPARATUS FOR RENEWING OIL WELLS

Filed Jan. 2, 1920

5 Sheets-Sheet 1



INVENTOR

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BY

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Dec. 11, 1923.

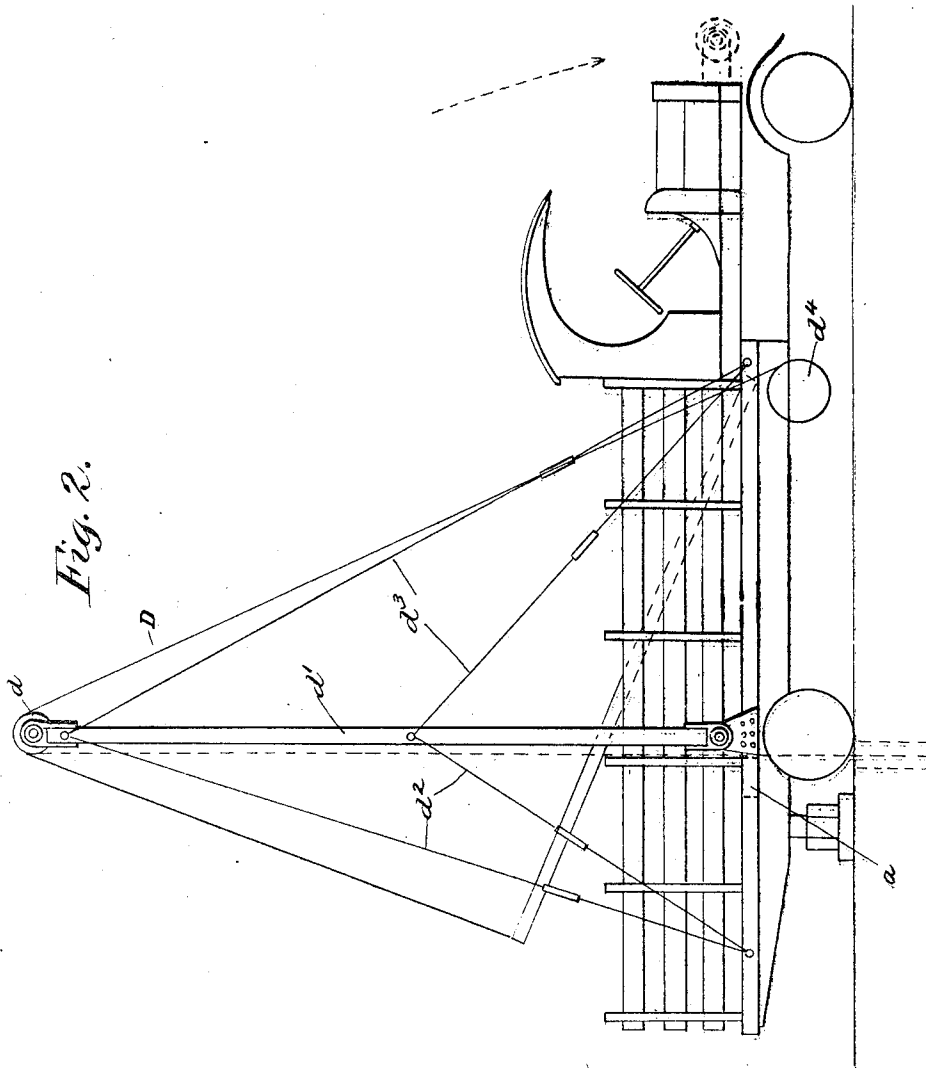
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METHOD OF AND APPARATUS FOR RENEWING OIL WELLS

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5 Sheets-Sheet 2



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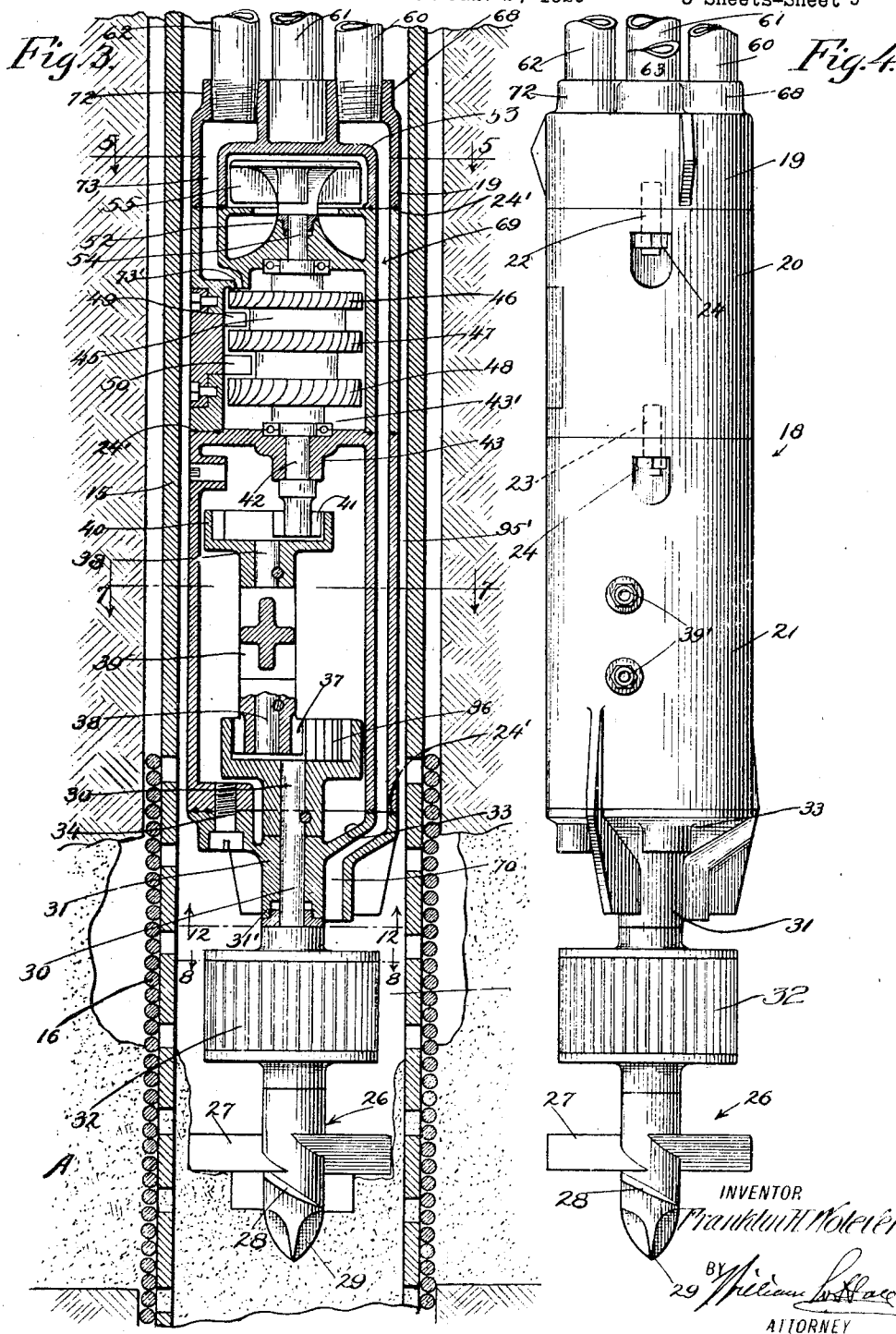
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METHOD OF AND APPARATUS FOR RENEWING OIL WELLS

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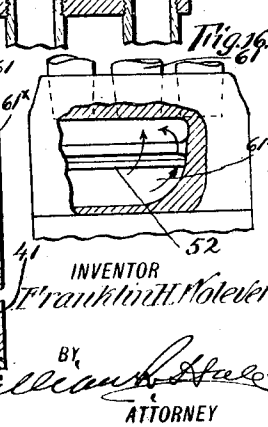
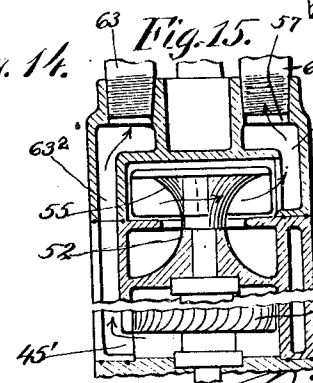
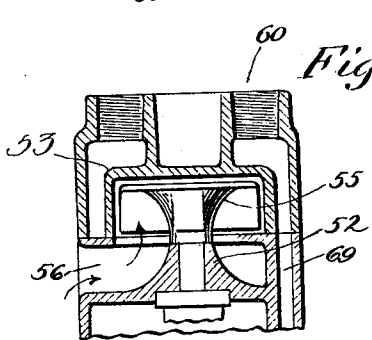
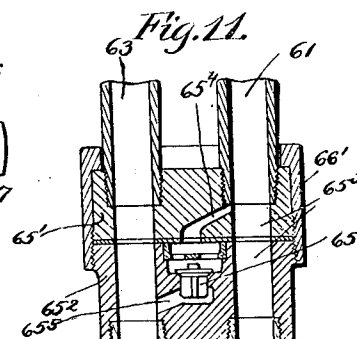
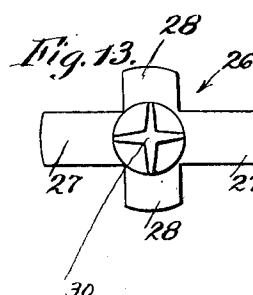
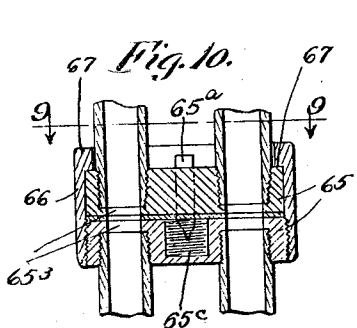
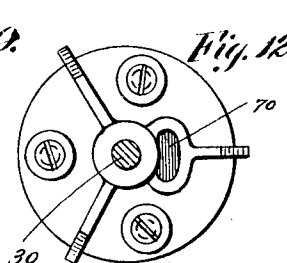
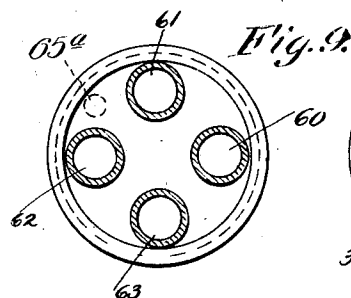
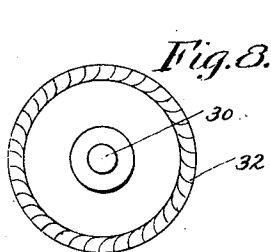
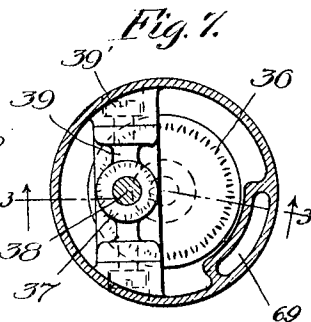
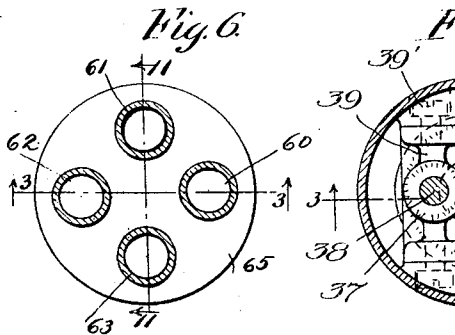
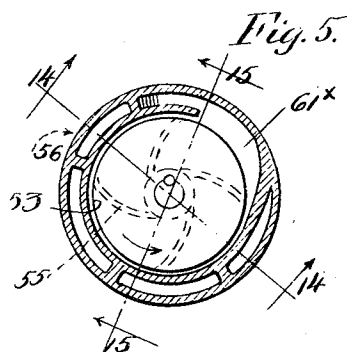
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METHOD OF AND APPARATUS FOR RENEWING OIL WELLS

Filed Jan. 2, 1920

5 Sheets-Sheet 4



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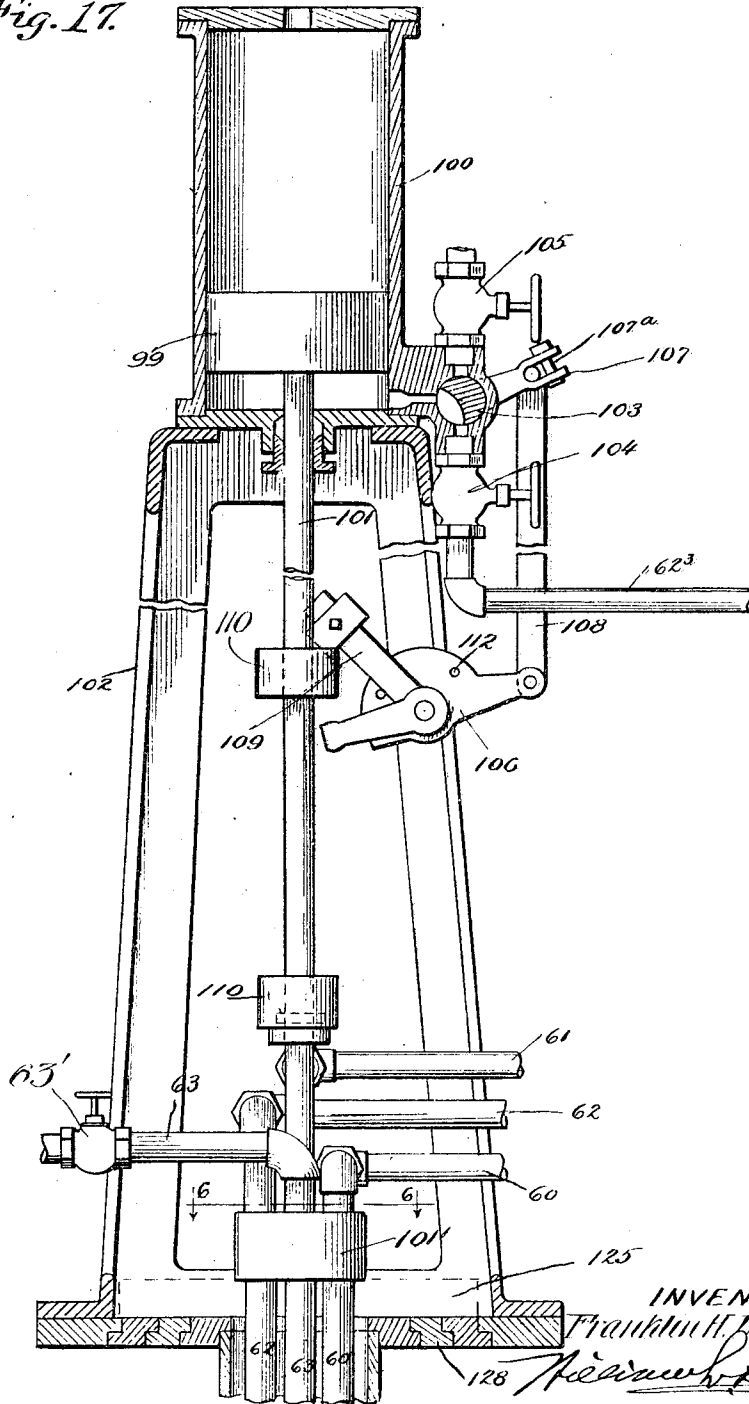
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METHOD OF AND APPARATUS FOR RENEWING OIL WELLS

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Fig. 17.



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UNITED STATES PATENT OFFICE.

FRANKLIN H. WOLEVER, OF CHICAGO, ILLINOIS.

METHOD OF AND APPARATUS FOR RENEWING OIL WELLS.

Application filed January 2, 1920. Serial No. 348,949.

To all whom it may concern:

Be it known that I, FRANKLIN H. WOLEVER, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Methods of and Apparatus for Renewing Oil Wells; and I do hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, and to the characters of reference marked thereon, which form a part of this specification.

This invention relates to a novel method of and apparatus for renewing oil wells which have been clogged by compacted sand mixed with hydrocarbon constituents of petroleum oil, such as shale, paraffin, bitumen, and other mineral binders, and refers to a method to remove from the casing and the area surrounding the same such clogging deposits to permit a free flow through the casing screen within the casing, and relates also to a novel apparatus for practicing the method.

It has been found in practice that sand, mingled with the mineral hydrocarbon, waxy constituents of the oil, such as paraffin, bitumen, and the like, packs in a very solid mass within and exterior to the casing in a manner to obstruct the oil flow, and heretofore it has been a practice to shoot the well to break up this mass. Such operations are attended with varying, and usually small, success.

In accordance with the present method, it is proposed to deliver to the obstructing, packed sand deposit a solvent of such nature as will act upon and dissolve the binder which holds the sand particles together and to agitate this dissolved mass in such a way in the presence of the solvent and in the presence of air so that the specific gravity of the mass will be lowered to such extent that the commingled sand, fluid, and air may be readily raised to the level of the top of the well and discharge therefrom, this operation continuing until all of the sand has been removed. The solvent used is preferably of a character which is neutral to the material of the mechanism by which the sand is agitated. Carbon tetra chloride

mixed with gasoline in proper proportions is such a solvent agent, and by reason of its heavier specific gravity may be employed in wells containing more or less water. In some cases where the packed sand forms some distance around the casing, it may be desirable to remove the entire mechanism from the well and thereafter deliver a strong solvent of such character as will dissolve the sand itself and then remove the mixture from the well.

After the sand has been removed and no trace of oil appears, or should water be found to flow for some long period of time through the bottom of the casing, it is generally known that the well is not productive.

The principal novelty of the present method resides in the means for delivering the solvent to the bottom of the casing, excavating the packed sand and agitating it in and mixing it with the solvent so as to dissolve the binder and to thereby decrease the specific gravity of the solution mass so as to enable it to be raised to the top of the well, as by means of a suitable pump, or otherwise.

The mechanism for practicing the process embraces an operating head or unit which is lowered to the bottom of the casing, abreast the casing screen, and it embraces in its construction, in general terms, a suitable excavator, a motor for driving the excavator, such as an air, steam, water, or electric motor, a device for mixing the solvent with the loosened sand, and a lifting pump into which the mass of commingled solvent and sand is discharged and by which the mass is raised, the raising of the mass being assisted by the exhaust motive fluid from the motor which operates the entire unit, when such a motor fluid as steam, air, or water is used.

Auxiliary features of the invention reside in means at the top of the well for circulating the solvent fluid through pipes that are connected to the head of the operating unit at the bottom of the casing so as to maintain a continuous flow of the fluid through the head, and the circuit through which the solvent flows is preferably associated with means to separate the sand from the fluid mixture raised from the well so that the

solvent fluid may be used over and over again.

In the following description it is assumed that the operating head is driven by air, and for sake of clearness of description corresponding terminology will be employed, but it is understood that said terminology is not intended to limit me with respect to the motive power.

As shown in the drawings;

Figure 1 illustrates the manner in which the device is inserted into the well, with the operating unit abreast the oil bearing sand stratum, and with the solvent circulating mechanism and compressed air delivering mechanism at the top of the well.

Figure 2 is a side elevation of a motor carried derrick for initially lowering the device into the well.

Figure 3 is an enlarged axial sectional view of the operating head at the bottom of the casing, showing the perforated casing section and illustrating the screen therearound.

Figure 4 is a side elevation of the head.

Figure 5 is a cross section on the line 5—5 of Figure 3.

Figure 6 is a cross section on the line 6—6 of Figure 17.

Figure 7 is a cross section on the line 7—7 of Figure 3.

Figure 8 is a cross section on the line 8—8 of Figure 3.

Figure 9 is a cross section on the line 9—9 of Figure 10.

Figure 10 is a detail of the joints for connecting the sections of the pipes for the circulating solvent fluid and the motive agent.

Figure 11 illustrates a modified cross over joint hereinafter to be described.

Figure 12 is a section on the line 12—12 of Figure 3, looking upwardly.

Figure 13 is a detail of the excavator at the lower end of the operating head or unit.

Figures 14 and 15 are vertical sections of the lifting pump on the lines 14—14, 15—15, respectively, of Figure 5.

Figure 16 is a detail of the lifting pump hereinafter described.

Figure 17 is a fragmentary vertical section illustrating the manner of bringing the solvent and motive agents out of the top of the well, and the manner of controlling the rise and fall of the operating head or unit to control its attack on the sand.

Figure 18 illustrates one form of settling device by which the sand may be settled out of the solvent fluid so that the latter may be used over and over.

Figure 19 is a detail of a shackle hereafter described.

Figures 20 and 21 are details of the long and short pipe sections of the fluid solvent and motive agent circulating pipes.

Referring, first, to Figures 3 to 16, inclu-

sive, which illustrates the operating unit or head at the bottom of the casing, 15 designates the usual casing which is perforated at its bottom and is surrounded by a screen 16 at the oil bearing sand stratum A of the well (Figure 1).

The operating unit or head embraces a hollow casing designated as a whole by 18 (Figure 4) which, for convenience of assembling, comprises four sections 19, 20, 21, and 33 (Figure 4) that are fixed together by studs 22, 23, and 34, threaded in certain of the sections and extending into lugs of other sections. The joints between all the sections of the shell are reliably packed, as shown at 24' in Figure 3, to prevent passage of water into the shell from the casing exterior to the head.

At the bottom of the unit is located an excavator designated as a whole by 26. It is shown as a four blade spiral excavator, with two long spiral blades 27 and two shorter spiral blades 28, herein shown as located beneath the blades 27, and said excavator terminates below the shorter blades 28 in a cutting point 29. Said excavator is fixed to a shaft 30 (Figure 3) that is rotatably mounted in a bearing 31 near the lower end of the operating unit 18. The shaft also carries just above the excavator a hollow multi-blade centrifugal pump 32 (Figures 3 and 8). Said bearing is formed in the lower section 33 of the shell that is fixed to the section 21 by the screws 34. The said bearing 31 is formed with a stuffing box 31' (Figure 3) to prevent leakage of water into the shell around the shaft 30.

The shaft 30 carries at its upper end an internally toothed gear 36 that meshes with a pinion 37 that is carried by the lower end of a shaft 38 which is rotatably mounted in a suitable bearing 39 fixed by the studs 39' (Figure 4) to the section 21 of the shell 18. To the upper end of the shaft 38 is fixed a second internal spur gear 40 with which meshes a pinion 41 that is carried by the lower end of a shaft 42 which is mounted in a suitable bearing 43 fixed to the section 21 of shell 18 and is equipped with a step bearing 43'.

45 designates as a whole a motor which, as herein shown, is a three stage air motor operated by compressed air. It comprises the three sets of spiral blades 46, 47, 48, and fixed blades 49, 50. While a three stage turbine motor is herein shown, it will be understood that any other suitable form of motor of sufficiently high velocity may be employed, and, furthermore, that the special design of the motor and the manner of mounting it in the shell may be varied.

52 designates a spirally bladed lifting pump that is located in a suitable casing 53 above the motor 45, and the shaft 54 of said pump is directly connected to the shaft

of the turbine 45. In Figure 5 is illustrated the general arrangement of the blades 55 of the lifting pump and of the casing 53 thereof. The pump casing is provided with an inlet opening 56 shown best in Figure 14 and with an outlet opening 57 best shown in Figure 15.

The section 19 of the shell 18 of the operating head or unit is provided at its top with openings to receive four pipes 60, 61, 62, 63, the former two of which respectively constitute the solvent solution supply and solution discharge pipe, and the latter two of which respectively constitute the motive agent supply pipe and motive agent discharge pipe. The said pipes extend from the operating head upwardly through the well casing and are connected at suitably spaced points by coupling discs or members 65, shown best in Figures 6 and 10, and other coupling members 65', 65², shown best in Figure 11, the ends of said pipe sections being threaded to enter through registering connecting opening 65³ of the coupling discs. The discs are held in proper register, as by a stud 65^a of one disc entering an aligned socket in the other disc, indicated in Figures 9 and 10. Some of said discs are externally threaded to engage hollow coupling sleeve 66, each of which is shouldered at 67 to engage over an upper coupling disc of a pair and is threaded at its other end to engage the threads of the lower coupling disc of said pair. The lower disc of each pair has a threaded socket 65^c to receive the threaded shank of a lifting hook (not shown) to assist in lowering the sections into the well.

In Figure 11 is shown a modified coupling in which there is introduced a cross-over from the air outlet pipe 63 to the solution discharge pipe 61. Said coupling comprises mating apertured discs 65', 65² to receive the threaded ends of the pipes, which are locked together by a coupling sleeve 66'. The discs 65', 65² are provided with oblique passages 65⁴, 65⁵, respectively, that communicate with their respective connecting conduits 65³ and are brought into register at the center of the coupling where the cross-over conduit or channel is equipped with a check valve 65⁶ that closes towards the passage 65⁵ which is in communication with the air discharge pipe.

The cross-over coupling will alternate with the couplings shown in Figure 10 in such a way as to locate the cross-over couplings at proper stages or levels to introduce air under pressure from the air discharge or supply pipe to the fluid discharge pipe to thereby relay or boost the lifting effect of the centrifugal pump 52 at proper stages and at proper times, and thus aid in lifting the solution of mixed solvent sand, and air. Fluid pressure on the check valve

65⁶ normally holds the valve seated, and when air is to be forced through the cross-over air couplings, into the fluid discharge pipe 61, the air discharge pipe may be throttled by a suitable valve 63¹ (Figures 1 and 17) or the pressure in the air supply increased until pressure therein is sufficient to lift the valve 65⁶, as hereinafter more fully described.

The solvent solution is supplied to the operating unit or head 18 through the pipe 60 which connects with a nipple 68 (Figures 3 and 4) at the upper end of the head casing. Said nipple communicates with a vertical passage 69 that leads downwardly inside the casing and is provided at its lower end with an internal nozzle 70 which directs the solvent into the centrifugal pump 32. The pipe 61 communicates with the outlet or discharge passage 61^x, of the lifting pump 52. The pipe 62 is a supply pipe for the motive agent, and directs the motive agent, as air, steam, water, or the like, to the turbine motor 45, said pipe being threaded to a nipple 72 that communicates with a channel 73, the nozzle 73' of which is directed to the intake side of the turbine 45 (Figure 3). The pipe 63 is connected through a channel 63² to the outlet port 45' of the turbine 45 (Figure 15).

At the top of the well is located a motor truck 78 (Figure 1) which carries a settling chamber 80 that is connected by the pipe 61' in any suitable manner with the solution discharge pipe 61. Said pipe 61' discharges onto a plate 89 of the settling chamber, and the sand and solids of the mixture collect in the bottom of the chamber 80 (Figure 18). The pipe 60 leads from the tank 80 at a point above the bottom thereof to draw clean solvent solution therefrom. The air supply pipe 62 is connected to an air tank 85^a supplied with compressed air from an air compressor 85 on the motor truck through the medium of a pipe 86. The air outlet pipe 63 from the turbine motor discharges to the atmosphere, as shown in Figure 1, and is shown as provided at its upper end with a throttle valve 63'.

Preferably the operating unit or head 18 and its connecting pipe sections, comprising the pipes 60 to 63, inclusive, are slowly reciprocated during the rotation of the excavator 26 so as to cause the excavator to more efficiently attack the hardened sand. The operating head and connected pipes are raised by a piston 99 in a cylinder 100 (Figures 1 and 17), the piston being connected by the stem 101 to an upper coupling 101', to which the upper ends of the pipes 60, 61, 62, 63 at the top of the well are connected in the manner shown in Figure 17. The cylinder 100 is supported on a stand 102 at the top of the well. The piston 99 is lifted in said cylinder by air delivered to the cylinder through a branch 62³ of pipe 62, a

controlling valve 103 being placed between branch 62³ and the bottom of the cylinder 100. A restricting valve 104 is interposed between the branch pipe 62³ and the controlling valve 103, and a like restricting valve 105 discharges from said controlling valve 103 to the atmosphere. These restricting valves determine the speed of travel of the piston 99 in the cylinder 100 and of reciprocation of the operating head by determining the rate of speed of the flow of air to and from the cylinder.

The controlling valve 103 is operated to alternately connect the cylinder to branch pipe 62³ and to the atmosphere by a valve gear comprising a loosely mounted rocker 106 connected to an arm 107 of said valve by a link 108. The rocker is actuated at each limit of the piston travel by a weighted trip lever 109 which is acted upon by tripping collars 110 on the piston stem 101, motion being communicated from the trip lever to the rocker through pins 112 on the rocker.

The construction of the separator is shown in Figure 18. The solvent fluid discharges from the pipe 61' directly on a distributing or spreader plate 89 from whence it falls into the bottom of chamber 83 where the heavy sand, et cetera, settles. The clean fluid is drawn off from settling tank through pipe 84 that discharges into the pipe 60. A glass 92 is placed across the swinging cap 93 of the separator and enables the character of the material discharged on the plate 89 to be observed.

In the operation of the device, air, at suitably high pressure, is delivered through the pipe 62 to the turbine motor 45. The power of said motor is communicated through the pinions 41, 37, and gears 40, 36, to the shaft 30 of the excavator 26 and centrifugal pump 32. The excavator serves to loosen the body of sand within the bottom of the casing and the solvent material is directed from the pipe 60 through the channel 69 and its nozzle 70 centrally to the centrifugal pump 32. By the action of said pump, rotated at a speed lower than the turbine 45 due to the gear ratio between them, the solvent is thrown outwardly against and down into the loose sand and binder material broken up by the excavator 26. The binder in the sand is dissolved by the solvent material, so that the mixture rises through the annular passage 95' between the well casing and the shell 18. This solvent material is delivered through the inlet passage 56 (Figure 14) to the spirally bladed lifting pump 52, which forces the liquid upwardly through the pipe 61 and into the top of the filter. The mass of solvent laden material is lightened by air from the discharge pipe 63. The circulation of said solvent thus freed from the sand is established through the circuit comprising the pipes 60, 61, and the proper pas-

sages in the operating head unit so that when the sand and heavy materials are thus settled out of the solvent, the relatively clean solvent fluid may be used over and over again, it being circulated in the closed circuit thus afforded. If desired, the solvent material may be directed to the operating unit and afterwards discharged together with the sand therein to a sump. The provision, however, for settling the solids from the solution and using the clean solvent over and over again is preferred by reason of economy.

The attack of the solvent on the sand is not necessarily limited to the area within the well casing but may extend outwardly beyond, as indicated in Figure 3, so that thereby the screen 16 is thoroughly cleaned.

In Figure 20 is shown the length of the pipe sections 120 comprising the nest of pipes 60, 61, 62, and 63 which extend upwardly from the operating head or unit 18, said sections being connected by the couplings 65. These pipe sections which constitute the principal lengths of piping upwardly from the head may, in practice, be in the neighborhood of twenty-foot lengths. They are lowered into the well and connected until the operating head reaches to or about the level of the compacted sand area A. Thereafter shorter pipe sections 121, shown in Figure 21, are successively attached to the upper ends of the pipe sections, as the excavation of the compacted sand proceeds.

The sections 120 are placed in the well, by the use of the wheeled motor propelled derrick D shown in Figure 2. Thereafter the shorter lengths of pipes are added at the top of the well by the use of an operated lowering and raising device (see Figure 17) as the excavation through the sand proceeds.

The pipe sections and operating head are supported in the well while an additional section is attached to the upper sections of pipe by the clamp 125 (Figures 17 and 19) said clamp comprising pivoted jaws 126, 126 adapted to encircle the nest of pipes below the uppermost coupling 65, 65', or 101' and adapted to be locked about the nest of pipes by the clasp 127. The clamp 125 rests on a plate 128 surrounding the top of the well, and effectively holds the pipe lengths below and the operating head or unit when the piston stem 101 and the pipes 60 to 63, inclusive, are disconnected from the topmost coupling. After the operating head has been lowered, through the proper number of sections 120 and the excavation of the hardened sand proceeds, the shorter pipe sections 121 (which may preferably be of a length of four or five feet) are successively added at the top of the well, the operating head and the connected sections being sup-

ported by the clamp 125 during the time the piston stem 101 and the pipes 60 to 63, inclusive, are disconnected and until said parts are again connected.

5 In applying the improved apparatus to a well to remove the compacted sand, the following procedure is generally observed:

The cap is removed from the well and a sounding tape is lowered into the well 10 to establish the depth at which sand and other detritus is located and a note of this depth is taken. All lengths of pipe sections 120 and 121 are labeled in numerical order, as, for instance, 1, 2, 3, et cetera, and when 15 fastened together have a depth mark placed at each point to show the exact length for connection to the point where the clamp 125 is fastened. The portable derrick D (Figure 2) is then moved abreast of the well and 20 is blocked up in rear of rear axle and in a position to bring the head sheave d of the head of derrick column d' and an opening at bottom of derrick truck in line with the well, the opening being guarded so as to 25 keep the pipe section from covering it. The derrick column d' which, when not in operation, lies horizontally along the bed of the truck is now raised to a vertical position and the head frame embodying the head 30 sheave d placed thereon. The guys d^2 , d^3 are now placed to hold the column in vertical position.

Mounted beneath the truck bed on the chassis is a geared steel cable winch d^4 35 which is clutch connected to the engine of the derrick truck and so arranged that the drive to the rear axle can be cut out and the winch cut in and operated from the seat of the truck. A cable from this winch is 40 threaded through sheave d at the top of the derrick column and the apparatus is ready for lowering the sections in numerical order into the well.

In thus lowering the sections in the well 45 number 1 section, with its operative head placed thereon, is raised by the cable and winch mechanism to a vertical position and lowered in the well casing. When this section is almost within the casing, the clamps 125 are clamped onto the upper end of the 50 pipe section while the cable is disconnected from the said section now placed. Thereafter section number 2 is lifted out of the truck and lowered in position and fastened to the section number 1 with the proper coupling, and the entire load of two sections 55 is now lifted slightly by the winch and the clamp 125 is removed and the second section is lowered in the well. These successive operations are repeated until the longer sections have been so placed and connected as to give the nearest approach of the operating head or unit 18 to the sand and detritus 60 level. The clamp 125 now holds all the connected sections in place. The derrick truck

is now removed and the operating unit, shown in Figure 17, consisting of the lifting cylinder and its support is placed centrally above the well casing and the piston rod or stem 101 is connected to the upper 70 coupling 101'. Thereafter the truck 78, together with the settling tank, the air tank, and compressor, is moved up in operative position to the cylinder 100 and the coupling 101' and the pipe connections are made 75 with air and solvent supply and discharge.

The air pump 85 is started until sufficient air pressure is obtained in the tank 85^a for operation. Thereafter a short pipe section 121 is fastened to the piston rod of the air 80 operated reciprocating mechanism and connected with the last section of pipe placed into the well casing. Air under sufficient pressure to raise the entire line and head is now admitted to the bottom side of the 85 piston through the valve 103 by removing pins 107^a and manually operating the valve, and the entire column in the well casing lifted so as to release the clamp 125. Thereafter the column is slowly lowered into the 90 well. Should this length of section be not sufficient to reach the sand level, other shorter sections must be attached and lowered until the last section brings the excavator of the head in position to strike the 95 sand level.

At this point of operation, the valve 62^a is opened to admit air under pressure into turbine 45 and cause it to operate. The 100 valve 60^a is opened to permit the solvent to flow through the pipe 60 and passage 69 to the agitator 32 which forces the solvent, under considerable pressure, against the side wall of the well casing, thus cleaning the 105 surface completely and assisting the excavator to thoroughly mix the solvent with the sand and detritus.

When sufficient solvent has entered the well casing to reach a height to enter the 110 inlet 56 of the turbine pump 52 (Figures 14 and 15), the solvent, laden with sand, detritus, et cetera, is lifted through the pipe 61 to the top of the well and is discharged on the plate 89 and thence into tank 80 (Figure 18). The sand and other detritus 115 is now settled out and after the fluid has again risen to sufficient height to flow into pipe 84 and thence to pipe 60 (Figure 18), it again returns to the operative head or unit when the cycle is again repeated. 120

If the fluid head be too great for the pump to lift the solvent mixture to the top of the well, the column of solution in the pipe 61 is boosted by passing turbine exhaust air 125 over to the pipe 61, either through the cross-over couplings described or otherwise. This air thus allowed to escape into the solvent discharge line serves to lighten the mass specific gravity of the solvent and its sand and detritus, so that the solvent mixture may 130

be pumped to a higher level than may be attained by the pump 52, with a heavier fluid mass.

When a solvent solution circulation has been attained it may be observed flowing on plate 89 through sight glass 92. The link 108 is now connected at its upper end to the valve 103 and pin 107^a inserted and the valve 103 slowly opened so as to produce a very slow reciprocating motion to the entire column.

This column when slowly lowered causes the operating head 18 to be gradually forced into the sand and detritus and the different length cutter vanes 27 and 28 and the pointed cutter 29 cause an easier cutting operation, and, in the event of hard sand, the point 29 prevents a too rapid entry of the cutting head.

The sand, et cetera, which is thus removed is thrown upwardly and comes in contact with the rapidly agitated solvent and becomes very finely divided and in good condition to be raised to the surface through the mechanism already described.

When the sand is thoroughly pumped out this fact may be readily noted by observing the character of the solvent through the sight 92 as it flows over the plate 89 (Figure 18).

When there is no more sand coming with the solvent, the intake pipe from the solvent tank should be shut off by a proper valve and the solvent entirely pumped out and machine stopped and another section of column placed in the manner as previously described; the cycles of operation being repeated until the well has been properly cleaned. When the screen level is attained, the reciprocation of the machine must be made to operate slower so as to not only remove all sand and the like from the well casing, but from the holes in the screen and as far back from the screen as the power of the agitator 32 will cover, as shown in Figure 3.

I claim as my invention:

1. The method of cleaning obstructed oil wells which comprises the steps of delivering a hydrocarbon solvent of higher specific gravity than water to the compacted obstructive mass of the oil bearing stratum and thereafter raising the mixture of solvent and obstructive material to the top of the well.

2. The method of cleaning obstructed oil wells, set forth in claim 1, characterized further in separating by filtration and gravity the solid matter from the solvent and using the solvent over again.

3. The method of cleaning obstructed oil wells set forth in claim 1, characterized further in that the mass is mechanically broken up concurrently with the delivery of the solvent above said broken mass.

4. The method of cleaning obstructed oil wells which consists in the steps of excavating the obstructive mass, mixing a hydrocar-

bon solvent of higher specific gravity than water with the excavated mass and thereafter raising the mixture of solvent and solid obstructive articles to the top of the well.

5. The method of cleaning obstructed oil wells set forth in claim 4, characterized further in that the solvent is violently mixed with and thrown radially into the obstructive particles.

6. The method of cleaning obstructed oil wells set forth in claim 1, and embracing the additional step of mixing air or other fluid with the ascending mixture column at a point well above the mixture of said solvent and the particles of said mass.

7. The method of cleaning obstructed oil wells set forth in claim 1, and including the further step of injecting into the rising mixture column at different stages a lighter fluid.

8. The method of cleaning obstructed oil wells which comprises the steps of excavating the obstructive mass at the casing screen, delivering a hydrocarbon solvent to said excavated mass, agitating the solvent in the presence of the excavated obstructive mass and thereafter raising the mixture of solvent and solid particles to the top of the well.

9. The method of cleaning obstructed oil wells which comprises the steps of delivering a hydrocarbon solvent solution to the obstructive mass, dissolving thereby the binder by which the solid particles of the obstructive mass are bound together, raising the mixture of solvent and solid particles to the top of the well and directing lifting air into the rising column of the mixture at vertically spaced stages.

10. The method of cleaning obstructed oil wells which comprises the steps of delivering a hydrocarbon solvent solution to the compacted obstructive mass at the oil bearing stratum to dissolve the mass binder, raising the mixture of the solvent solution and solid particles by the use of a pump operated by an air-driven motor and delivering the air at vertically spaced stages along the column of the rising mixture of solvent and solid particles to assist in lifting said mixtures.

11. The method of cleaning obstructed oil wells which comprises the steps of delivering a hydrocarbon solvent to the compacted obstructive mass, excavating the mass in the presence of said solvent, slowly reciprocating the excavating mechanism towards and from the obstructed mass during the operation of the excavator, and raising the mixture of the solvent solution and the solid particles of the excavated mass to the top of the well.

12. Mechanism for cleaning obstructed oil wells comprising an excavating device for attacking the obstructive mass in the well a motor to drive the same, means for deliv-

ering a solvent to the well casing at the level of its screen and forcibly outwardly therebeyond to dissolve the binder element of the solid obstructive mass, and means for raising the mixture of the solvent and solid particles of the obstructive mass.

13. Mechanism for cleaning obstructed oil wells comprising means to deliver a solvent to the level of the obstructive mass in the well to dissolve the binder of said mass, means to agitate solvent solution at said mass and to throw it radially beyond the well screen into the obstructive mass therebeyond, and means to raise the mixture of solvent solution and solid particles of said mass.

14. Mechanism for cleaning obstructed oil wells comprising means to deliver a solvent to the level of the obstructive mass in the well to dissolve the binder of said mass, means to agitate the solvent solution at said mass and to throw the solvent radially beyond the well casing screen, and means to raise the mixture of solvent solution and solid particles of said mass, combined with means for admitting to the rising mixture column fluid of lesser specific gravity.

15. Mechanism for cleaning obstructed oil wells comprising means to deliver a solvent to the level of the obstructive mass in the well to dissolve the binder of said mass and the binder of the mass radially outwardly beyond the well casing screen, means to agitate solvent solution at said mass, and means to raise the mixture of said mass, combined with means for admitting to the rising mixture column at different elevations boosting fluid of lesser specific gravity.

16. Mechanism for cleaning obstructed oil wells comprising an operating head which embraces an excavating device for attacking the obstructive mass at the bottom of the well casing, an agitator immediately above the excavator for mixing the excavated material with a liquid solvent, and means for delivering a liquid solvent to the agitator to be thereby thrown outwardly against the excavated material.

17. Mechanism for cleaning obstructed oil wells comprising an operating head which embraces an excavating device for attacking the obstructive mass at the bottom of the well casing, an agitator immediately above the excavator for mixing the excavated material with a liquid solvent, means for delivering a liquid solvent to the agitator to be thereby thrown outwardly against the excavated material, a motor in said head for driving said excavating device, and a pump also in said head for raising the mixture of the fluid solvent and solid matter to the top of the well.

18. In a mechanism for cleaning obstructed oil wells, an excavator for attacking the obstructive mass, comprising upper

and lower transversely spiral cutting blades, the lower blades being shorter than the upper blades, and a restricting and guiding point.

19. Mechanism for cleaning obstructed oil wells comprising an operating head which embraces an excavating device formed with longer upper and shorter lower operable blades, a directing point, an agitator above the excavator, means to deliver liquid solvent to the agitator, and means to raise the mixture of solvent and the agitated mixture.

20. Mechanism for cleaning obstructed oil wells comprising an operating head embracing an enclosed fluid proof shell adapted to be inserted into the well casing at the screen level, an excavator carried by said head, a motor within the head for driving the excavator, an agitator driven by said motor near the level of the excavator, means for delivering a solvent below the casing at the level of the agitator, and means for raising the mingled solvent and solid particles to the top of the well.

21. Mechanism for cleaning obstructed oil wells comprising an operating head embracing an enclosed fluid proof shell adapted to be inserted into the well casing at the screen level, an excavator carried by said head, a motor within the head for driving the excavator, an agitator driven by said motor near the level of the excavator, means for delivering a solvent below the casing at the level of the agitator, a centrifugal pump at the top of and enclosed by said casing for raising the mixture of the solvent solution and solid obstructive particles to the top of the well, and means within the head for driving said pump from the motor.

22. Mechanism for cleaning obstructed oil wells comprising an operating head embracing an enclosed fluid proof shell adapted to be inserted into the well casing at the screen level, an excavator carried by said head, a motor within the head for driving the excavator, an agitator driven by said motor near the level of the excavator, means for delivering a solvent below the casing at the level of the agitator, a centrifugal pump at the top of and enclosed by said casing for raising the mixture of the solvent solution and solid obstructive particles to the top of the well, means for driving said pump from the motor, said motor being an air driven motor, and means for directing the exhaust air from said motor to the column of rising mixture at vertically spaced stages.

23. Mechanism for cleaning obstructed oil wells comprising an operating head embracing an enclosed fluid shell adapted to be inserted into the well casing at the screen level, an excavator carried by said head, an agitator near the level of the excavator, a motor within the head geared to the

excavator and agitator to drive the latter, means for delivering a solvent below the casing at the level of the agitator, a centrifugal pump at the top of and enclosed by said casing for raising the mixture of the solvent solution and solid obstructive particles to the top of the well, and means to connect said pump to said motor to drive it at high speed relatively to the speed of the agitator and agitator excavator. 10

In witness whereof I claim the foregoing as my invention, I hereunto append my signature this 19th day of December, 1919.

FRANKLIN H. WOLEVER.