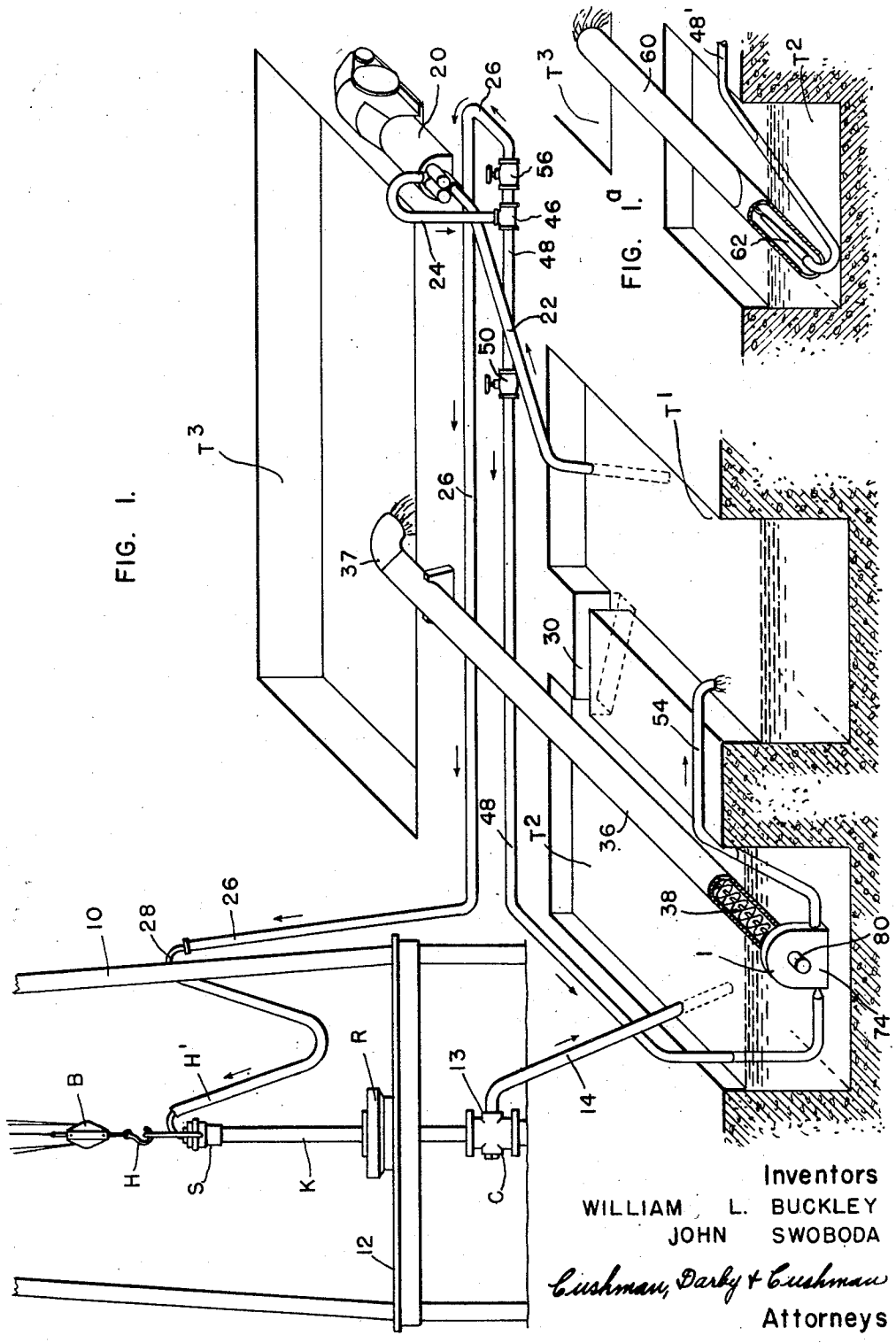
June 5, 1951 W. L. BUCKLEY ET AL 2,555,314

MUD DRIVEN APPARATUS FOR TREATING MUD

Filed July 10, 1946 3 Sheets-Sheet 1



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MUD DRIVEN APPARATUS FOR TREATING MUD

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FIG. 2.

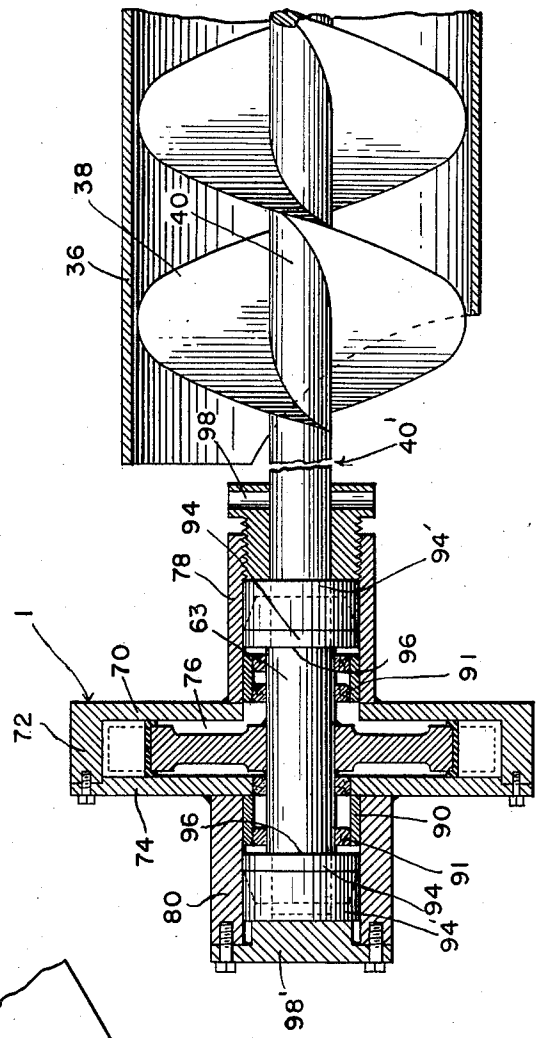
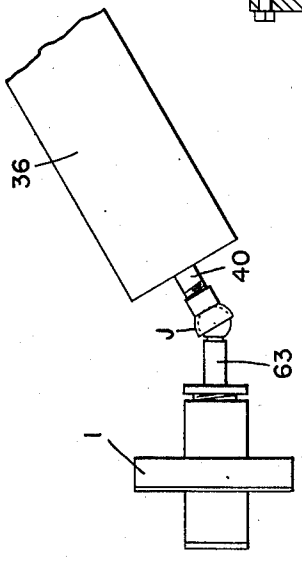


FIG. 2a.



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FIG. 4.

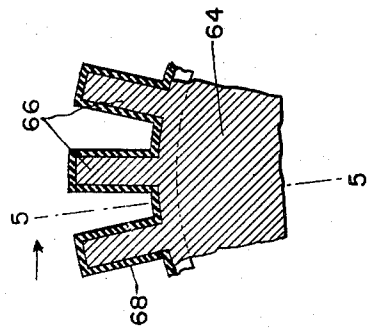


FIG. 6.

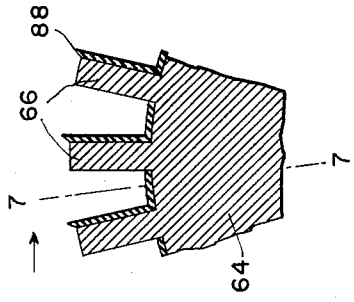


FIG. 5.

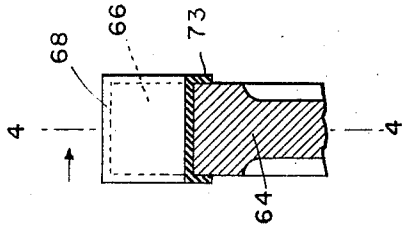


FIG. 7.

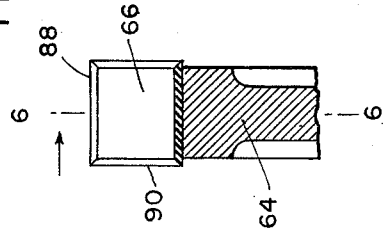
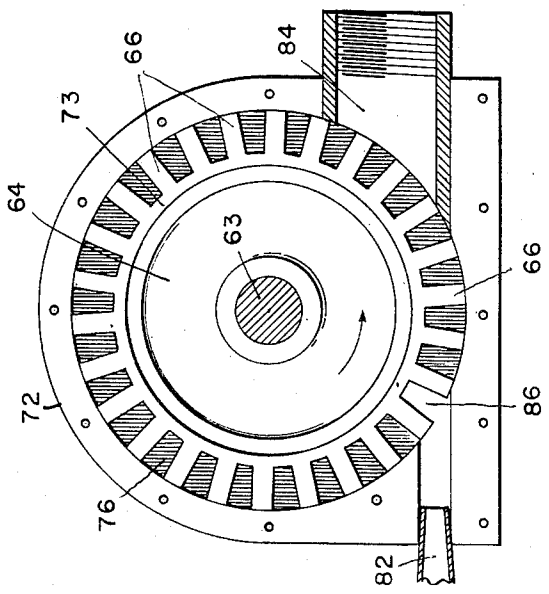


FIG. 3.



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UNITED STATES PATENT OFFICE

2,555,314

MUD DRIVEN APPARATUS FOR TREATING MUD

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Victoria, Tex.

Application July 10, 1946, Serial No. 682,546

3 Claims. (Cl. 255—24)

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The present invention relates to oil or gas well equipment, and particularly to a system of apparatus or equipment for use adjacent a well to treat or convey oil well mud, which, as is well known, must be maintained in considerable quantity and in regulated proper condition adjacent the well. Certain features of the apparatus are useful for other purposes at such a well.

As is known to those skilled in the art, there are considerable hazards to life and property involved in the drilling and completing of high-pressure wells. Much time and though has been given to the development of many fine pieces of control equipment for use in safely handling the pressures involved. In spite of these developments, no operator can safely afford to be without the available use of oil well mud, which is essential in drilling and analogous operations. As is well known in the art, oil well mud (a fluid which is usually now artificially weighted with such as barium compounds) is pumped down through the drill string as the bit is penetrating various formations, and is permitted to circulate through the bit and upwardly through the well, thence being discharged from the casing head into convenient pits from which it may be again circulated through the well as just described. The mud pumped downwardly through the drill string serves to lubricate the bit during the drilling operation, and many other advantages are claimed for the use of such mud during the drilling of wells. For instance, circulation of the mud upwardly through the drilled hole serves to line its walls, thus resisting entrance of gas and oil into the hole until the desired stratum from which oil is to be produced is reached. Furthermore, the hole being drilled is completely filled with the heavy mud from the drilling point to the surface of the well, the head of this heavy fluid serving to hold the high-pressure of the formation in check during drilling and analogous operations. No responsible producer would be without the available presence of mud during high-pressure operations which require its use, even though various pieces of mechanical control equipment are available at the well. In any case, it is essential to have a quantity of this mud available at the well to be pumped into the hole to kill the well in the event that a blow-out is imminent. The history of oil well drilling is replete with instances where expensive wells have been saved from blowing out by pumping mud into the hole, and where blow-outs have occurred, many thousands of dollars have been spent for mud to check blow-outs after the pressure from the oil and gas sands has gotten out of control.

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Because of the expense of this product, it is customary to re-use the mud which has been pumped into the hole, and oil well surface equipment therefore includes necessary pumping and circulating equipment to return the mud into the hole for re-use, but various treatments of the mud once used are desirable in order to keep it in effective working condition. For example, it may be necessary at a particular location, to employ mud of regulated condition, such as a regulated specific gravity, viscosity and desired walling qualities. A quantity of mud once used may have picked up cuttings of rock, shale, lime or cement, or sand, and this undesirable heavy material should be removed from the quantity of mud once used before it is re-circulated into the hole. For this reason, the storage arrangements adjacent the derrick may include various treating instrumentalities to re-active the mud and to purify it by removal therefrom of undesirable ingredients and the purifying processes involved may include various mechanical operations on the mud, including agitating, churning, mixing and conveying the same, in order to restore the mud to a well balanced condition. At a given well, it may be required to change the character of the mud as the hole is deepened with resulting increase of the head of liquid above the stratum being penetrated.

In order to properly treat the mud adjacent the well, some source of power is essential. As even the simplest equipment for drilling a well is quite expensive, it is desirable to utilize for purifying the mud, agencies which are required to be available at the well for other purposes. Almost all wells are equipped with a relatively expensive pumping system for circulating the clean mud through the well as referred to above. It has been the practice to employ the pressure of a steam or mud jet to remove undesirable materials from a mud pit in which mud which has already been used is stored. However, steam may not always be available, and as will be brought out in more detail below, present mud-jet methods involve the waste of a considerable quantity of pure mud. In view of the price of present-day mud materials ($26.00 a ton for one well-known type), this is a very expensive method. A mud cost of approximately $50,000.00 for one deep well is not unusual. The word "mud" is used herein in a broad sense, for the fluid circulated in a well may include ingredients which are supplied for other purposes in the treatment of the formation,

such as acids, and these likewise are so expensive that other than wealthy operators cannot afford their waste. In fact, the present invention does have in mind providing means whereby expense can be reduced by utilizing the standard mud circulating devices to the greatest advantages.

In order to solve the problem outlined above in an economical way, we have devised a system whereby the standard mud pump for forcing the mud through the well and the pure mud itself may be employed as a convenient agency to provide the power for purifying the used mud in a storage pit adjacent the well, or to transfer this used mud to any other pit, as desired. Furthermore, we have devised such a system wherein the pure mud used is not wasted, but is maintained in a pure and uncontaminated state even though employed for the above purposes. It will be apparent that the apparatus disclosed, or parts thereof, may be usefully employed for other purposes at the well, with corresponding economy for the operator, and at least some of these uses will be mentioned or suggested as the specification progresses.

Referring to the drawings, which illustrate one arrangement of equipment which may be employed to carry out the invention, and certain mechanical elements which may be found useful in the practice:

Figure 1 is a diagrammatic view portraying an arrangement of elements at the surface of the well showing how the system of the present invention may operate.

Figure 1(*a*) is a similar view illustrating a prior art practice.

Figure 2 is a vertical sectional view through a mud-driven impeller wheel which may be used as an important element of the system and showing one possible manner of associating a conveyor such as a screw conveyor, for processing the mud or for removing and transferring undesirable materials therefrom to another tank or pit.

Figure 3 is a side elevational view of the impeller of Figure 2, with one of the side plates thereof removed in order to show the impeller blades and the relative arrangement of the mud inlet and outlet.

Figure 4 is an enlarged sectional view of a portion of the preferred form of the impeller blade, taken along the line **4**—**4** of Figure 5.

Figure 5 is an enlarged partial sectional view taken laterally through the impeller wheel of Figure 4, for instance along the line **5**—**5** thereof.

Figure 6 is a view similar to Figure 4 of a modified form of the impeller wheel,

Figure 7 is a view similar to Figure 5, being a partial sectional view taken, for instance, along the line **7**—**7** of Figure 6, and

Figure 2(*a*) is a diagrammatic view illustrating that the impeller may be detachably connected with the mud treating device.

Referring to Figure 1, the side frame of an oil well derrick is shown at **10**, same extending upwardly from the derrick floor **12** on which is mounted the conventional rotary drilling table R. The Kelley joint is shown at K, same being the upper-most section of the drill pipe and being of polygonal cross-section in order to engage and be turned through a suitable bushing carried in turning relation with the rotary table R, the latter being driven by mechanical power in a manner well-known in the art. The

drill string which is connected with the Kelley joint K extends downwardly to the bottom of the well, being supported from the top of the derrick by the traveling block B, (which is in turn carried by the wire lines shown), there being a hook H which engages the bail of a swivel S. The swivel supports the Kelley joint and the drill pipe while permitting the same to turn therein, and has the well-known goose neck connection to attach with a flexible hose H' which conveys the mud into the drill string, as is well known in the art.

In the cellar of the derrick, there is a casing head or tubing head C, the drilling being performed through this casing head and through any of the pieces of mechanical control equipment previously mentioned, but which are not shown here. The casing head has a conventional side outlet **13**, and from this outlet extends a discharge conduit **14** for the oil well mud.

Diagrammatically illustrated at the side of the derrick, in Figure 1, are three mud tanks or pits T^1, T^2 and T^3, although it will be understood that fewer or more of such pits may be provided, the benefits of the invention not being dependent on the number of storage or processing containers in use at the well. The tank T^1 is illustrated as the primary reservoir for the pure mud, which may be made up or mixed in this pit and kept available for use as required during the drilling or other operations. As is conventional at almost all oil wells, a high powered mud pump **20** is provided to circulate the mud through the well, this pump being driven from whatever source of power is available. In the instance shown, the pump is such as the well-known Fairbanks-Morris mud pump. There is a conduit **22** leading from the tank T^1 to the inlet side of the high-powered pump **20** and the mud is drawn in the direction indicated by the arrows into and through the pump and is discharged through the pipe **24** and thence into the connecting pipe or conduit **26** which connects with the hose H' at a union **28** usually attached to the side structure of the derrick.

As will be apparent from the above description, mud is thus pumped from the primary reservoir T^1 and forced downwardly through the drill pipe, and after ascending in the well between the drill pipe and the wall of the drilled hole or within any casing set below the casing head C, the mud discharges and returns through the pipe **14** to the reservoir. In the present system, this discharge is shown leading into a separate pit T^2 for the used mud. The surface portion of mud which is found in proper condition for re-use, may be permitted to flow through an overflow inclined connecting flue **30** from the pit T^2 into the primary pit T^1 although, in a simple system, a single reservoir could be used. It will be further understood that the illustration of circulation of mud in association with the drill pipe is not intended as a limitation, for the system under discussion herein will be equally applicable in any situation where mud is pumped into and circulated through any other pipe in the well, for example, in such instances where it might be necessary to fill the well with mud or circulate mud in the well when tubing is in the hole.

As previously mentioned, the mud which has been circulated through the well in the manner described may have accumulated cuttings and various other undesirable and heavy materials which should not be recirculated into the well,

and for this reason, it is desirable to provide the separate return pit T^2 in which the mud is permitted to rest for a time in order that these undesirable materials may settle therefrom.

In order to remove the settled undesirable materials from the mud in the pit T^2, or to otherwise process this mud, a cleaning conduit **36** is provided leading from the bottom of the pit T^2 and extending from said pit to a spout **37** which discharges the material into the refuse pit T^3, or, the cleaning conduit might well lead to any point remote from the area of the derrick to simply discharge the undesirable material onto the ground. Within the conduit **36**, there is a mud processing element in the form of a screw conveyor **38**, of any well known design such as shown in Figure 2. The conveyor has flights of threads fixed on a shaft **40**, which threads are designed to be turned to agitate the mud in the pit or to convey the heavy material upwardly through the conduit **36** to the point of discharge, thus processing the mud in the pit by reducing its weight. It will be understood that the conduit **36** need not be straight as shown, but may have various bends therein, and the screw conveyor **38** may have various flexible or universal couplings in its shaft **40** at spaced points in order to provide for bends in the conduit **36**. In fact, we have shown all apparatus referred to herein in its simplest form, it being the intention to make available the advantages of the invention to those who must derive the meximum from a limited investment both in mud and steel. For this reason, a simple casing section may be used for the conduit **36**. If the point of discharge is remote, additional casing sections may be attached, it being necessary only to provide the transfer screw in the first section which will be long enough to lift the material from the bottom of the pit, which may have mud to a depth of three to five feet therein. Therefore, the spout **37** is not essential, nor is the cut-out part of the casing on its lower inlet side, as shown in Figure 2, although these and other expedients may be adopted if special pipe is used.

The end of the shaft **40** extends into an impeller housing **1**, and as hereinafter described, impeller blades fixed to said shaft and driven by a closed circulation of pure mud under pressure turn the shaft **40** and thus the screw conveyor **38** in order to carry the undesirable material from the bottom of the tank T^2 and discharge the same into the refuse pit T^3. The inner end of the conduit **36** is open to receive the heavy material therein, this being the left hand end shown in Figure 2.

In order to supply pure mud under pressure for operation of the impeller, a T connection may be provided at **46** on the discharge side **24** of the pump **20**, and in addition to the connection with the mud pipe **26**, the T provides an opposite connection for attachment with a pipe **48** leading to the inlet of the impeller **1**. A valve **50** may be provided in the pipe **48** to close the same during occasions when the mud processing system of the present invention is not in use.

With the arrangement thus described, and when the valve **50** is open, the mud pump **20** forces pure mud from the tank T^1 through the pipe **48** and through the impeller housing **1** thus turning the screw conveyor **38** to process the mud in the tank T^2 or convey undesirable materials from said tank to the refuse pit T^3, the pure mud passing through the pipe **48** being entirely isolated from the used mud in the pit T^2 and discharging from the impeller through a pipe **54** back into the primary tank T^1. Any necessary valve arrangements in the system may be provided. For example, the primary mud line **26** leading to the well may be equipped with a closure valve **56** which can be closed in order to operate the purifying or processing system described at a time when mud is not being pumped into the well, and of course, the valve **50** may be closed to discontinue the mud processing or purification while mud is being pumped into the well with the valve **56** open. It will also be understood that both of said valves may be left open so that purification and processing may be carried out simultaneously with the circulation of mud through the well.

It will be apparent from the above that we have provided a convenient arrangement utilizing conventional sources of power at the well for purifying and processing mud stored near the well, and utilizing the pure mud under pressure as the medium for applying power. It will also be apparent that none of the pure mud is wasted or contaminated in this system, as it is simply pumped through the impeller **1** and thereafter returned to the primary pure mud pit T^1.

The advantages of such a system may be emphasized when compared with prior practices in the oil fields, as illustrated in Figure 1 (*a*). In that figure, the return mud pit T^2 is diagrammatically indicated, as is the refuse pit T^3, and there is a discharge conduit **60** shown diagrammatically as connecting these two pits. In the past, it has been the practice to use a hose or pipe **48'** leading from a source of steam or from the mud pump **20** and to employ a jet **62** forming the termination of the pipe **48'**, this jet extending into the open inlet end of the conduit **60**, the pressure of steam or mud discharged through the jet serving to draw undesirable materials from the bottom of the pit T^2 through the open end of the conduit **60** and to convey and discharge same into the refuse pit T^3. If mud is used in this practice, as compared with the system of our invention, a considerable quantity of pure mud is thus wasted, for it is mixed with the refuse material as the same is being discharged through the conduit **60**. As to steam, those experienced in practical oil well operations will understand that it may not be available at the well. In fact, water is often a scarce item at many wells, for often the available quantity may have to be used for mud.

In the case of our system, it will be understood that the pure mud circulated through the pipes **48** and **54** traverses an entirely self-contained and closed system, including a closed path through the impeller housing, and merely serves to turn the impeller in the housing **1**, not being permitted to mix with the mud in the tank T^2 or with the materials being discharged through the conduit **36**.

Referring to Figure 3, the end of the conveyor shaft **40** may be connected with a shaft **63** in the impeller housing. The screw conveyor **38** may be adjacent to or somewhat remote from the impeller housing, this being indicated by the break **40'** in the shaft **40**. In any case, shaft **40** forms an extension of shaft **63**, and at the break **40'** there may be any conventional detachable shaft connection, and the connection may be made at a universal joint in the shaft if necessary. For example, Figure 2*a* diagrammatically illustrates the connection between shaft **63** of the impeller and shaft **40** of the treating device by a detach-

able flexible joint J of any well-known universal type.

Keyed or welded on shaft 63 is a wheel 64, the outermost part of said wheel being cut to provide a plurality of impeller blades 66. The impeller housing comprises a circular plate 70 having an outwardly extending rim 72 which forms with a circular front plate 74 a circular impeller chamber 76. Plates 70 and 74 carry respective welded cylindrical extensions 78 and 80. These extensions are provided with any suitable bearing and sealing mechanisms to support the extension of the shaft 40.

Referring to Figure 3, there is a tangential inlet through the lower widened portion of the rim 72 to the chamber 76 for the pure mud, said inlet providing for connection with pipe 48 through the fitting 82. This inlet may be of relatively reduced size. On the opposite side of the housing there is an outlet 84 from the chamber 76 of somewhat greater size. Any suitable means may be provided to connect the ends of the pipes 48 and 54 to the inlet and outlet of the impeller housing, respectively, such as by screw threads, flanged connections, or the like. As will be apparent from Figure 3, when the pure mud is forced under high pressure through the inlet 82 it exerts pressure against the blades 66 on the impeller and drives the impeller rotor 64 continuously in a counter-clockwise direction, thus turning the shaft 63 and its extensions 40 and the flights of the screw conveyor 38. The mud is permitted to discharge through the outlet passage 84 and back to the primary mud pit as previously described.

It will be understood that the impeller housing and wheel may be of various forms, so long as means are provided to turn the shaft or operate any other mechanical element to process the mud or perform other operations, while confining the pure mud in a closed path and preventing its waste or contamination.

The precise construction of the impeller may, of course, vary in accordance with the requirements of the system, but it should be adapted for operation immersed in the return pit of used mud. In order to most effectively use the pressure of the mud, some sealing engagement of the impeller blades with the walls of the chamber 76 is desirable, although perhaps not essential, but this sealing engagement need not be so tight as to result in undue retardation of the rotation of the shaft 63.

As shown in Figures 4 and 5, sufficient sealing contact may be made by coating or covering the blades 66 with a rubber composition as shown at 68. The coating may be molded or cast on the teeth 66 and along the rim of the disc 64 within the teeth, and then ground off for proper contact with the walls of the chamber 76 to provide closed chambers to translate pressure of incoming mud to turning movement of shaft 63. As shown, the rubber covering may extend not only over the outer and side faces of each tooth 66, but also along the rim of the rotor proper, as at 73 where the teeth connect with the main body of the rotor. With this arrangement, and referring now to Figure 3, each pocket 86 formed by the teeth 66 will be substantially closed when said pocket passes the inlet opening 82, and substantially full effect of the pressure of the inlet mud will be had in turning the rotor and thus the shaft 63. The outlet 84 permits free outward flow of the mud resulting from the centrifugal force of the turning rotor, as previously described.

As a modification, and referring to Figures 6 and 7, each tooth 66 may simply be provided with suitably secured end and side flexible vanes of rubber as at 88 and 90 merely to provide sufficient resistance to the inlet flow of high-pressure mud to cause the rotor to turn. These vanes are in the nature of swab rubbers used in the oil well art, and as a tooth passes the inlet 82, the swab rubbers are expanded against the walls of chamber 76 along the top and sides of the tooth, and along the rim of the disc 64 on each side thereof and between a tooth and the following tooth to impart turning movement to the wheel. It will be understood that various means may be adopted to provide the proper seal, as referred to.

The incoming pressure of mud will resist any tendency of the wheel to reverse if the load on the processing apparatus being used becomes great enough to stall the impeller. The inlet pressure of mud will be maintained constant by the mud pump 20.

While as stated, the precise details of the impeller, its shaft, housing and bearings may vary, we have disclosed a representative arrangement in Figure 2. Within the cylinders 78 and 80, respective bushings 96 may be provided, and packing rings in the form of grease sealers 91 may be provided at appropriate points around the enlarged part 63 of the shaft on which the impeller wheel is secured, these packing rings serving to seal off the interior of the impeller chamber from the exterior thereof. Against shoulders 96 on the shaft, additional bearings may be provided to absorb end thrusts on the shaft. A closure ring 98 may be threaded into the outer end of the cylinder 78 around the shaft 40, and a disc 98' may be bolted to the outer end of the cylinder 80 to further close the chamber. The thrust bearings provided may be of any conventional type and are only indicated diagrammatically in Figure 2. For instance, well known Timkin bearings comprising tapered members 94 fitted in cup members 94' may be provided to absorb end thrusts in both directions. Any play in these thrust bearings can be taken up by adjustment of the caps 98 and 98' which may engage the cup members. As shown; cap 98 is adjustable by its threads, and cap 98' may be adjusted in any well known way, as by the use of shims.

It will be understood that the invention may not be confined to the precise uses discussed herein, nor to the specific type of apparatus illustrated, although the use of circulated pure mud to process and/or transfer other mud is an outstanding feature of the invention.

It will be apparent that not only is the mud under pressure a convenient source of power, by its presence, but it is also convenient in that it provides a medium for variation of the speed of movement of the mechanical means used in the particular treating device for the mud. That is, the speed of operation of the mechanical devices can be varied by the mud pressure exerted on the wheel of the mud turbine. For example, the R. P. M. of the screw conveyor shown herein is governed by the mud pressure applied to the Pelton wheel, and by suitable control of the mud pumps and associated mechanism, the screw conveyor could be driven at any R. P. M. up to approximately 1500.

It will also be understood that the device wherein the circulating mud applies the useful power may vary in design with various uses, as long

as the important economy provision of having a closed path therethrough to preserve the purity of the mud is maintained. However, the processing of mud is most important, and it may be expedient to use the invention in mixing mud in a single pit, or circulating it therein, or in transferring it from one pit or tank to another or through any type of processing device. It is apparent that we have made available a device of great usefulness and power, with little expense, as the pressure applied at the impeller may be on the order of 300 to 1000 lbs. per square inch.

We claim:

1. For use at oil wells, apparatus for transferring heavy material from oil well mud comprising a driven conveyor adapted to be positioned to lead from the bottom of a mud return pit and including a driven power shaft for said conveyor, a device for constantly rotating said shaft comprising a housing, said housing having a closed conduit therethrough for passage of oil well mud under pressure, a drive shaft in said housing having impeller blades thereon responsive to the movement of the mud in said conduit, said drive shaft having means for connection with said driven power shaft, means on said housing for connection with a mud line from the conventional oil well mud pump at one end of said conduit, and means on said housing for connection with a discharge line leading to the pure mud pit adjacent the well, said last-named means being positioned at the opposite end of said conduit.

2. For use at oil wells, mud transfer and purifying apparatus comprising a conveyor and a driven power shaft for operating said conveyor, said apparatus being adapted to be immersed in a mud return pit, a device for constantly rotating the driven power shaft on said apparatus comprising a housing, said housing having a closed conduit therethrough for passage of oil well mud under pressure, and having an impeller wheel chamber therein, a drive shaft in said housing, an impeller wheel on said drive shaft having pockets which move through said conduit and are rotated by the mud passing therethrough, means on said impeller wheel for forming a seal with the wall of the chamber as said teeth pass through said conduit whereby the pressure of the mud is applied to turn said wheel without substantial loss of mud pressure by movement of the mud past said wheel, means on said housing for connection with a mud line from the conventional oil well mud pump at one end of said conduit, and means on said housing for connection with a discharge line leading to the pure mud pit adjacent the well, said last-named means being positioned at the opposite end of said conduit, said drive shaft having means for detachably connecting same with said driven shaft, and said device being self-contained and adapted to be completely immersed in the mud when connected with the mud processing apparatus at the bottom of a return pit.

3. Apparatus for handling mud at an oil well comprising a pure mud tank and a return mud tank and a connecting flue between said tanks for permitting flow of settled mud from the return tank to the pure mud tank, a well circulating system comprising a pump having pipe connections with said pure mud tank and with the well, and a return pipe leading from the casing head of the well to said return tank, whereby said pump may circulate pure mud through the well and thence to the return mud tank, and apparatus for processing the mud in the return mud tank comprising a conveyor leading from the bottom of said tank having a driven element for transferring settled material from said tank to a point of discharge, and fluid driven means for operating said conveyor comprising a housing adapted to be immersed in the return mud tank having a chamber with an impeller wheel therein connected to said conveyor, and a second circulation system for driving said impeller comprising a closed fluid path through said chamber for pure mud, a pressure line leading from said pump to said chamber and a mud pipe leading from said chamber to said pure mud tank, whereby said pump may circulate pure mud through said chamber to drive said conveyor without contaminating the pure mud.

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