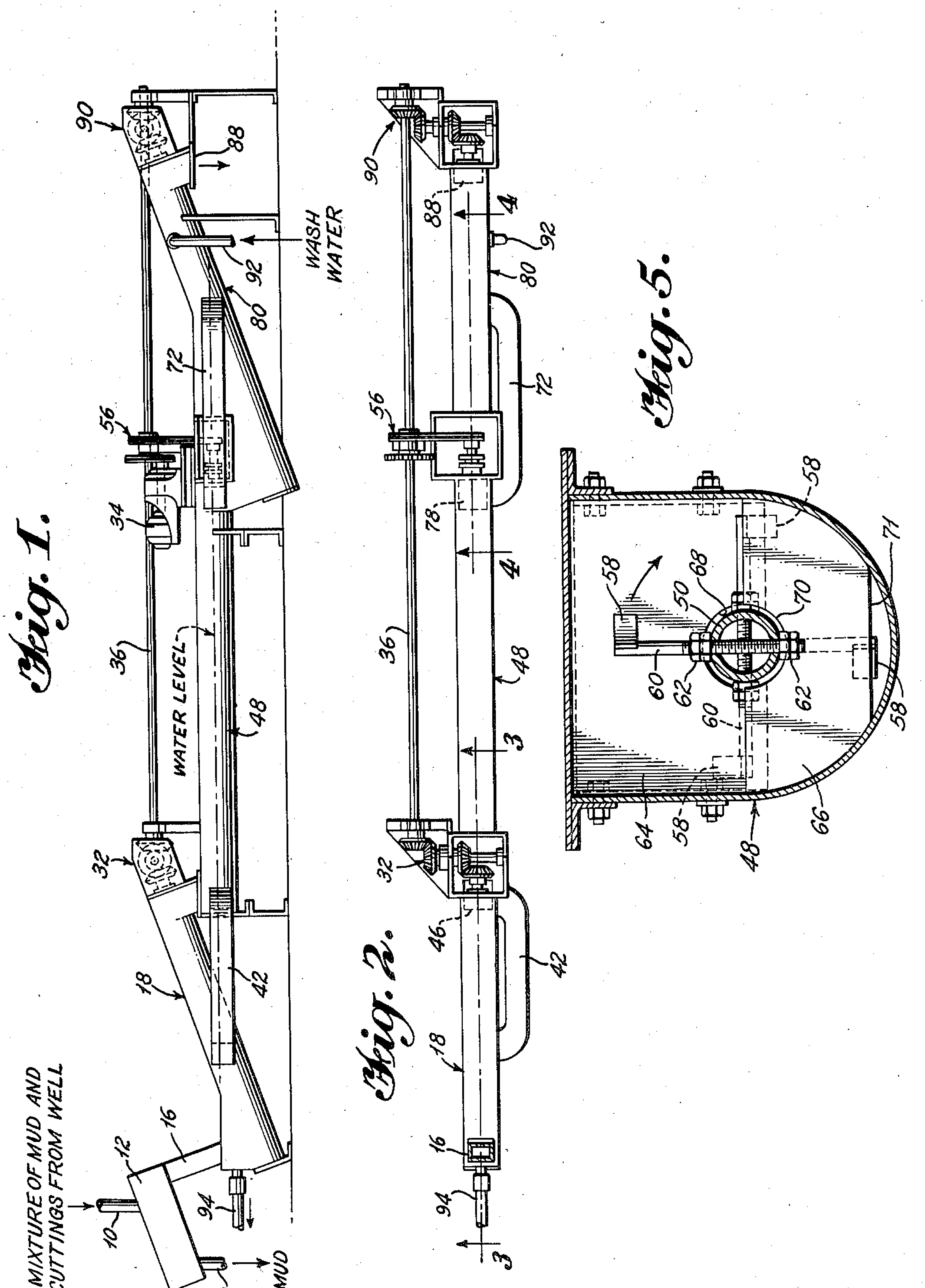
Feb. 10, 1959 R. R. HENRY 2,873,032

APPARATUS FOR WASHING OIL WELL DRILLING CUTTINGS

Filed July 22, 1957 3 Sheets-Sheet 1



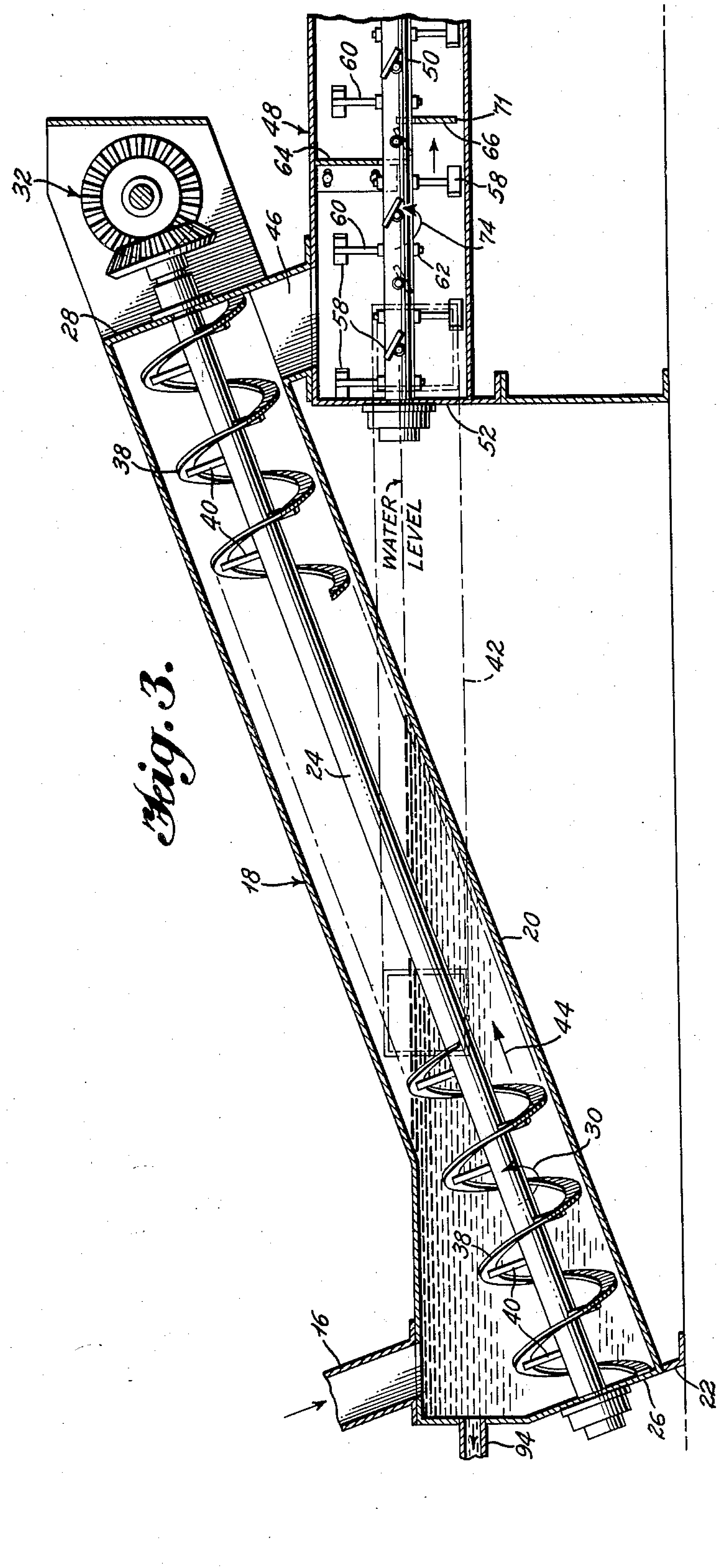

WATER LEVEL
60
50
48
71
64
66
58
32
46
74
62
28
58
52
38
40
42
24
18
20
44
30
38
40
16
22
26
94

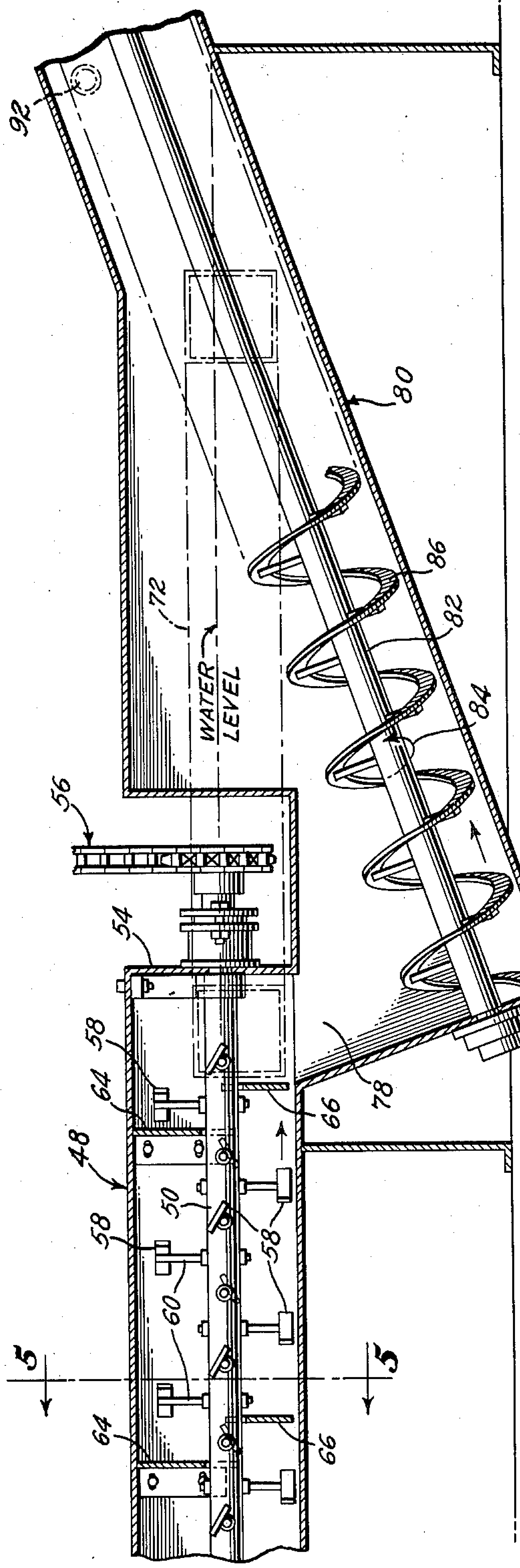
Fig. 3.

Feb. 10, 1959 R. R. HENRY 2,873,032

APPARATUS FOR WASHING OIL WELL DRILLING CUTTINGS

Filed July 22, 1957 3 Sheets-Sheet 3

Fig. 4.



United States Patent Office

2,873,032

Patented Feb. 10, 1959

1

2,873,032

APPARATUS FOR WASHING OIL WELL DRILLING CUTTINGS

Robert R. Henry, Houston, Tex., assignor to Link-Belt Company, a corporation of Illinois

Application July 22, 1957, Serial No. 673,443

1 Claim. (Cl. 210—524)

This invention relates to apparatus for handling oil well drilling cuttings, and more particularly to an apparatus for separating residual drilling mud mixtures from cuttings removed from the well bore.

It is quite customary in the drilling of deep wells, such as oil wells, to employ in the drilling process various mud mixtures. In the usual case, the mud mixture is pumped down through the drill string and is discharged through the drill bit at the bottom of the well bore. The discharged mud then circulates upwardly through the well bore and is discharged from the casing head. The mud performs several functions in the well drilling operation, among which are the lubricating of the drill bit during the drilling operation and the conveying of chips or cuttings upwardly from the bottom of the well bore. The composition of the mud mixture may vary widely, different ingredients being employed to perform various functions or to meet different situations.

As a general rule, mud mixtures are a substantial item of expense and hence it is a common practice to attempt to reclaim mud which has circulated through the well bore by treating the mud to recondition it for further use in the well. Since the mud removed from the well bore contains cuttings created by the passage of a drill bit through various formations, it is necessary to separate the cuttings from the mud before the latter is fit for further employment in the well. Accordingly, the mud removed from the well bore is frequently conveyed to a separator, such as a shale-shaker, which performs the necessary separation of the cuttings from the mud mixture.

In certain well drilling operations, it has been found beneficial to add a small percentage of oil to the mud mixtures. The addition of oil to the mud is especially desirable when drilling wells at depths of 10,000 feet or more, since the oil in the mud mixture reduces the friction between the mud and the rotating drill string. The addition of oil to the mud creates a problem in the disposal of the separated cuttings due to the presence of the oil in the residual mud mixture which clings to the cuttings after the cuttings have been passed through the normal separation processes typified by the conventional shale-shaker. The contamination problem due to the presence of oil in the separated cuttings is especially acute in the case of off shore drilling rigs since the surrounding water quickly becomes contaminated by the oil carried by the separated cuttings.

Accordingly, it is a primary object of my invention to provide an improved apparatus for separating mud mixtures from well drilling cuttings which conditions the cuttings for convenient disposal by removing a maximum amount of the residual mud mixture from the cuttings.

It is a related object of my invention to provide an improved apparatus for separating mud mixtures from well drilling cuttings to obtain a maximum reclamation of the mud mixture.

Another object of my invention is to provide an apparatus for efficiently and continuously separating a mud mixture from cuttings removed from a well bore.

2

In the achievement of the foregoing, and other objects, the mixture of mud and cuttings removed from the well bore is passed through a shale-shaker or other preliminary separating process. The separated cuttings, which are coated with a residual mud mixture, are then passed through a preliminary washing cycle which may conveniently be performed by a dewatering conveyor. In this stage of the operation, the great percentage of residual mud mixture clinging to the cuttings goes into solution with the wash water. The cuttings are then drained or dewatered and fed into an elongated trough containing a water bath. The cuttings are conveyed along the trough through the bath by violently agitating or churning the cuttings within the bath to impart a self-scrubbing action to the cuttings. The cuttings are then discharged from the bath into a second dewatering conveyor. In the second dewatering conveyor, the cuttings receive a final washing and are dewatered in condition for disposal. Wash water is continuously fed through the dewatering conveyors and trough in a direction countercurrent to the direction of conveyance of the cuttings, thus the wash water employed in the first washing cycle contains a substantial amount of the mud mixture. By regulating the amount of wash water employed in the system to an amount which is equal to or less than the amount of make-up water normally required for the mud system, the wash water and separated residual mud mixture may be conducted away from the first washing cycle to the mud system for recirculation in the well bore.

Other objects and advantages of my invention will become apparent by reference to the following specification and the accompanying drawings.

In the drawings:

Figure 1 is a side elevational view of an exemplary apparatus embodying the invention;

Figure 2 is a partial plan view of the apparatus shown in Figure 1;

Figure 3 is a vertical cross-sectional view taken on the line 3—3 of Fig. 2;

Figure 4 is a vertical cross-sectional view taken on the line 4—4 of Fig. 2;

Figure 5 is a transverse cross-sectional view taken on the line 5—5 of Fig. 4.

As stated previously, the purpose of my invention is generally to perform a thorough and efficient separation of a mixture of drilling mud and cuttings which have been removed from a well bore. Referring now to Figure 1, the mixture of mud and cuttings removed from the well by conventional means, not shown, is fed into the inlet **10** of a preliminary separation device **12** which may take the form of a conventional vibrating screen or shale shaker. The mud mixture separated from the cuttings by device **12** is removed through a first outlet **14** while the cuttings, with a residual coating of the mud mixture, are removed from the preliminary separator **12** through outlet **16**.

The cuttings, together with their coating of residual mud mixture, are fed through outlet **16** into the inlet of a ribbon type screw conveyor indicated generally at **18**. As best seen in Fig. 3, conveyor **18** includes an enclosed frame or housing **20** which is supported by suitable fixed frame members, as **22**, to define an upwardly inclined passage. A shaft **24** is rotatably journaled in end walls **26**, **28** of housing **20** and is driven in rotary movement in the direction of arrow **30** through gearing **32** which is driven by line shaft **36** (see Fig. 1). A helical ribbon **38** is fixed to shaft **24** by a plurality of radially extending arms **40**. A water inlet duct **42** (see Figs. 1 and 2) opens into housing **20** to maintain wash water within housing **20** at the approximate water level indicated in Figure 3.

Rotation of shaft **24** in the indicated direction **30** drives cuttings entering conveyor **18** from the separator outlet

16 upwardly through the housing in the direction indicated by the arrow 44 to a discharge outlet 46 located above the water level maintained in conveyor 18. Conveyor 18 thus performs the function of a dewatering conveyor.

Outlet 46 of conveyor 18 is connected to the inlet of a horizontally extending enclosed trough 48. A shaft 50 is rotatably journaled in end walls 52 and 54 of trough 48, and is driven in rotation by means of a suitable chain and sprocket connection, indicated generally at 56, to line shaft 36. A plurality of scrubbing paddles 58 are mounted at the ends of radially extending arms 60 which are fixedly secured to shaft 50 by suitable means such as the threaded bolt coupling 62 shown in Figure 5. As best seen in Figures 3 and 4, paddles 58 are inclined longitudinally of shaft 50 to exert a conveying action on material within trough 48 upon rotation of shaft 50.

The interior of trough 48 is divided into a series of compartments by vertically overlapping upper and lower baffle members 64 and 66, respectively, which extend transversely of trough 48 between certain of the paddles 58. As best seen in Figure 5, the lower edge of upper baffle member 64 and the upper edge of lower baffle members 66 are relieved as at 68 and 70, respectively, to provide a clear passage for shaft 50. Lower baffle members 66 terminate slightly above the bottom of trough 48 at edges 71.

At its inlet end, trough 48 is connected to duct 42 and at its outlet end is connected to a second duct 72. Ducts 42 and 72 serve to maintain water at the level indicated in Figures 3 and 4 within the interior of trough 48, or in other words, trough 48 is normally filled with water to approximately the level of shaft 50.

Rotation of shaft 50 in the direction indicated by arrow 74 in Figure 3 agitates or churns the cuttings within the water bath maintained in trough 48 and because of the direction of inclination of paddles 58, acts to convey the cuttings through trough 48 in a direction from left to right in Figs. 1 through 4. The presence of baffles 64 and 66 tends to prevent the water within trough 48 from being driven in this direction while permitting the cuttings to traverse trough 48.

At the outlet of trough 48, the cuttings are fed into the inlet 78 of a second inclined ribbon type screw conveyor 80 which is substantially identical, in structural details, to conveyor 18 and hence will not be described in detail. Briefly, shaft 82 of conveyor 80 is rotated in the direction of arrow 84 (Fig. 4) to cause the helical ribbon 86 to convey the cuttings upwardly through conveyor 80 to a discharge outlet 88 (Fig. 1) which is located above the level of wash water maintained within conveyor 80. Shaft 84 is driven from line shaft 36 by a suitable gear arrangement 90 (Figs. 1 and 2).

In addition to an outlet connection to duct 72, conveyor 80 is provided with an inlet 92 through which wash water is supplied to the apparatus. An outlet 94 located at the inlet end of conveyor 18 is employed to drain water from the system. For purposes which will be described in greater detail below, flow of water into inlet 92 and outlet 94 is regulated to maintain a predetermined rate of flow of water through the system in a direction countercurrent to the direction in which cuttings are passed or conveyed through the system.

Although it is believed that the operation of the foregoing apparatus is evident from its description, in order to assure a full understanding thereof the operation of the various components will be set forth and the different steps of the cleaning process performed by each will be explained.

The primary purpose of the apparatus under consideration is to receive cuttings which have been separated from a mud mixture by a conventional separation process and to separate from these cuttings the residual mud mixture with which the cuttings are coated.

In my apparatus, cuttings, which have been passed through a preliminary separation process, are passed through a preliminary washing step and are then drained or dewatered. In the disclosed embodiment, this portion of the process is performed by conveyor 18, the rotation of the ribbon type screw agitating the cuttings within the water contained in housing 20 and then conveying the cuttings above the water level to allow the cuttings to drain prior to their entry into trough 48. A large portion of the residual mud clinging to the cuttings is removed in this step, however, as the cuttings are cleaned, the remaining residual mud becomes increasingly difficult to remove.

Accordingly, the next step in the cleaning process is to perform a thorough washing operation upon the cuttings. This particular step in the process might be more aptly described as a scrubbing of the cuttings, since the cuttings are driven, by violent agitation, through a water bath for an extended period of time.

In the disclosed embodiment, the scrubbing step of the cleaning process is performed within trough 48 by the rotating paddles 58. Rotation of paddles 58 violently agitates both the cuttings and the water bath which is maintained within trough 48. Actual passage of the cuttings through trough 48 is achieved by the inclination of paddles 58 relative to the direction in which they are rotated, and this relative indirect conveyance of the cuttings, coupled with the presence of baffles 64 and 66 and the extended length of trough 48 enables a thorough scrubbing of the cuttings to be performed in this particular step.

At the discharge end of trough 48, the cuttings are advanced to a final washing step and, at the completion of the final washing operation are again drained or dewatered in condition for discharge from the apparatus. The final washing step is performed in the illustrated structure by conveyor 80, the final washing being accomplished by the rotation of the ribbon type screw to convey the cuttings upwardly through the water bath and to finally convey the cuttings above the water level to allow them to drain prior to discharge from conveyor 80.

To obtain a more efficient separation, the wash water through which the cuttings pass in the various washing and scrubbing steps is caused to flow in a direction countercurrent to the direction of movement of the cuttings through the system. In other words, the final washing operation is performed in relatively clean wash water while the preliminary washing operation is performed in water which is heavily contaminated with residual mud. In the disclosed apparatus, this countercurrent flow of wash water is achieved by regulating the rate at which the wash water is supplied to the system through inlet 92 and removed from the system through outlet 94. Wash water supplied to conveyor 80 passes from it through duct 72 to the outlet end of trough 48 and hence through the trough 48 and from its inlet end through duct 42 to conveyor 18. As the water flows through the system from inlet 92 to outlet 94, it becomes increasingly contaminated with the separated residual mud as it approaches outlet 94.

By regulating the amount of wash water supplied to the system, the concentration of mud in the water conducted from outlet 94 may be regulated. By limiting the amount of wash water supplied to an amount equal to or less than the normal amount of make-up water used in the mud mixture, the water and mud mixture conducted through outlet 94 may be returned to the mud system of the well, together with the mud separated from the cuttings in the preliminary separation step. Thus, this apparatus not only conditions the cuttings for convenient disposal, but also permits the recovery of a substantial additional amount of mud for further use in the well bore.

While the employment of wash water at normal temperatures has been found to give satisfactory results, it is sometimes desirable to employ heated or boiling wash water since it has been found that such water improves the de-oiling and deodorizing characteristics of the cleaning process. Heating of the wash water may be accomplished in any desired manner.

This apparatus is especially advantageous in off shore well drilling operations, since cuttings which have been passed through this apparatus may be dumped in the surrounding water without fear of contaminating the water with undesirable substances, such as oil, which may be included in the mud mixture. Further, a substantial amount of residual mud is recovered by this apparatus.

Having thus described the invention, I claim:

A washer for well drilling cuttings comprising a first and a second dewatering conveyor, each of said conveyors including an inclined trough for containing a quantity of bath water, said trough having an inlet and an outlet, and a helical ribbon conveyor flight in said trough adapted upon rotation to move cuttings along said trough from said inlet to said outlet, a horizontally elongated enclosed trough of substantially uniform depth throughout the length thereof extending between said conveyors and connecting the outlet of said first dewatering conveyor with the inlet of said second dewatering conveyor, a shaft ro-

tatably supported within said enclosed trough and extending parallel to the longitudinal axis thereof, a plurality of scrubbing paddles secured to said shaft in inclined relationship with the longitudinal axis thereof so as to exert both a scrubbing and a conveying action on the material in said enclosed trough upon rotation of said shaft, a plurality of baffles in said enclosed trough to provide a sinuous flow path therethrough, and means for flowing wash water in sequence through said second dewatering conveyor, said enclosed trough, and said first dewatering conveyor in a direction generally countercurrent to the direction in which cuttings are conveyed therethrough, said baffles tending to prevent the diffusion of muddy water in an upstream direction in said enclosed trough while permitting the flow of cuttings in said upstream direction and the flow of mud and water in the opposite direction.

References Cited in the file of this patent

UNITED STATES PATENTS

1,453,749	Christensen	May 1, 1923
2,276,075	Wuensch	Mar. 10, 1942