Feb. 9, 1932. J. A. WINTROATH 1,844,830

DEEP WELL TURBINE PUMP HAVING MEANS FOR LOCATING IMPELLERS

Filed Sept. 7, 1926 2 Sheets-Sheet 1

Fig. 1.

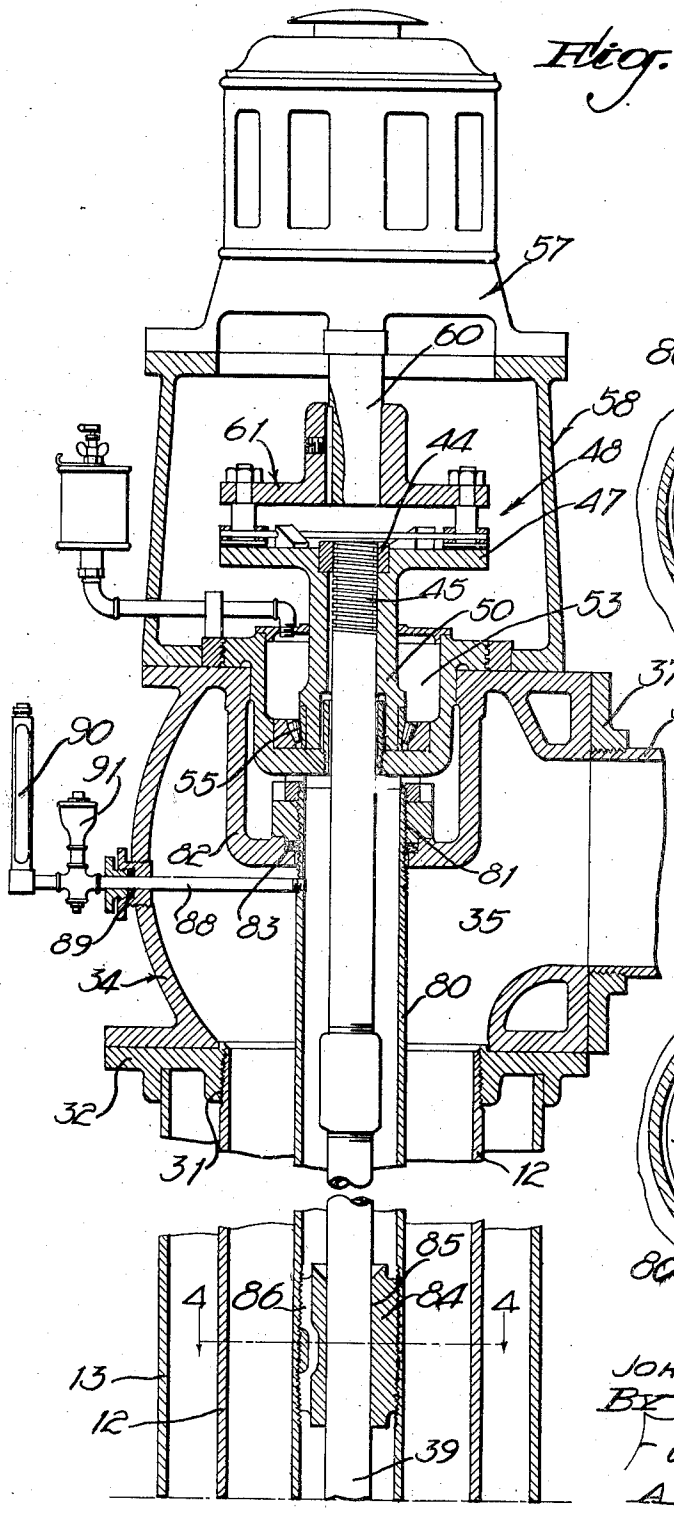


Fig. 4.

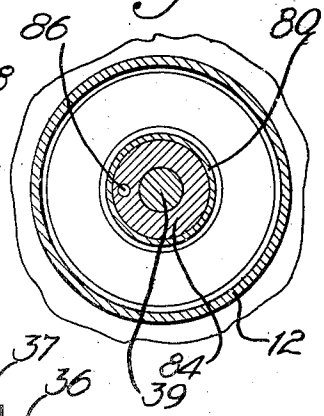
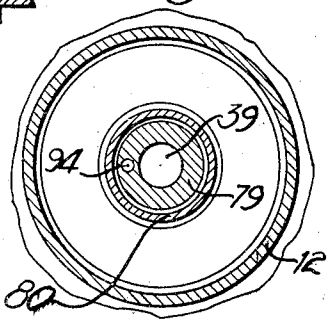


Fig. 5.



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DEEP WELL TURBINE PUMP HAVING MEANS FOR LOCATING IMPELLERS

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Fig. 2.

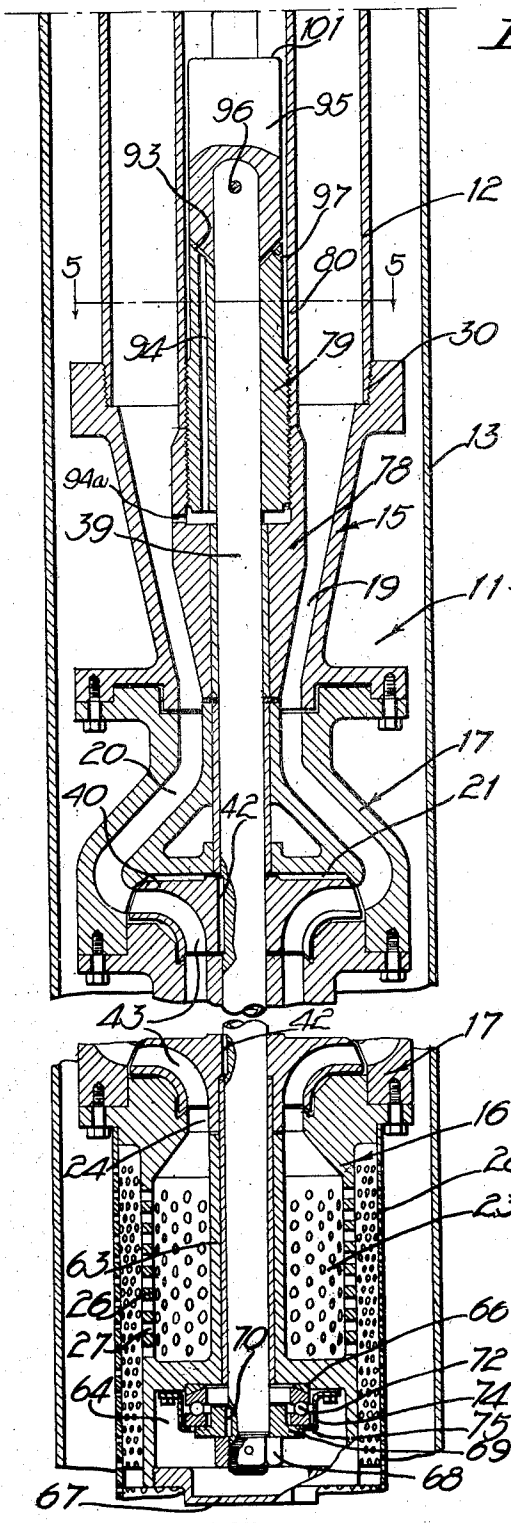
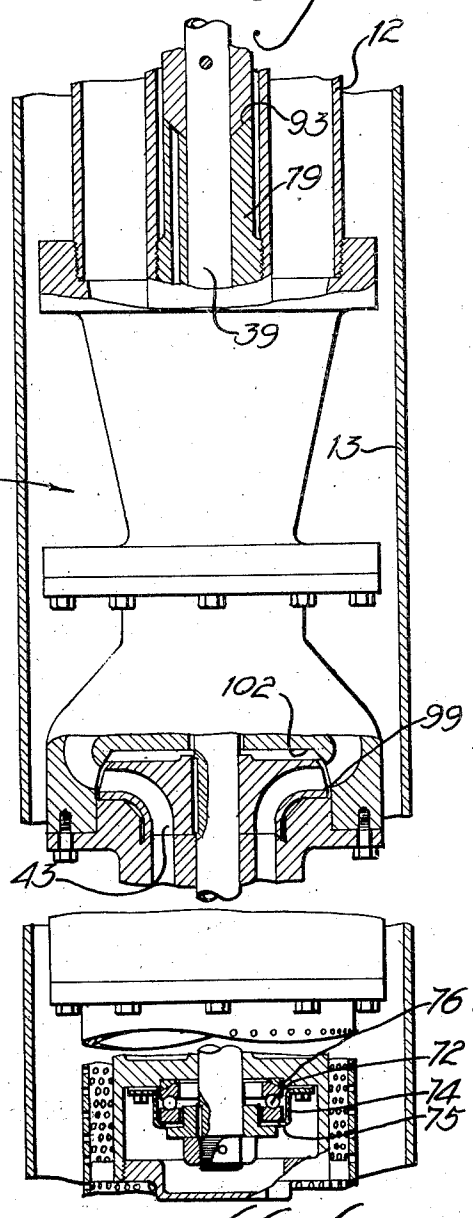


Fig. 3.



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Patented Feb. 9, 1932 1,844,830

UNITED STATES PATENT OFFICE

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DEEP WELL TURBINE PUMP HAVING MEANS FOR LOCATING IMPELLERS

Application filed September 7, 1926. Serial No. 133,877.

My invention relates to a deep well turbine pump having certain novel features which permit its use in very deep wells in which the ordinary form of turbine pump cannot be used.

The common form of turbine pump consists of a pump unit which is situated near the lower end of a well. The pump unit is secured to the lower end of a column pipe which extends upwardly through the well to the surface of the ground. The pump unit includes a number of pump bowls which provide runner chambers in which runners are placed. A pump shaft to which the runners are secured is extended to the surface of the ground through the column pipe and is attached to a pump head by means of which the runners are rotated in order to pump liquid to the surface of the ground. Turbine pumps of this character have been confined to use on the more shallow wells because of problems which will be considered hereinafter, while reciprocating pumps are used on the deep wells which in the oil producing industry are as deep as three to four thousand feet.

One of the greatest reasons why the ordinary turbine pump cannot be used in a deep well is that certain difficulties arise from the stretch in the pump shaft which extends from the pump unit at the bottom of the well to the pump head at the surface of the ground. The runners which operate in the runner chambers formed by the pump bowls must be located in such a vertical position that they will have clearance both above and below. In pumps used in shallow wells of a few hundred feet the stretch of the pump shaft, because of its weight, is not great enough to permit the runners to engage the walls forming the runner chamber. On the other hand, in deep wells the stretch of the pump shaft would be considerable and the runners in the ordinary pump could not be properly positioned so that clearance could be obtained. For example, in a well three thousand feet deep the stretch of the pump shaft, due to its own weight, would be probably twelve or fourteen inches. A stretch in the pump shaft of this amount would allow the runners to engage the lower walls and a portion of the weight of the pump shaft would be supported by the runners, whereas it should be supported by the thrust bearing at the upper end of the pump shaft. In order to remove the runners from engagement with the walls of the runner chamber, it is necessary to lift the upper end of the pump shaft until all of the stretch is compensated for and the pump shaft is supported wholly from its upper end. In other words, the stretch in the pump shaft causes a slack twelve or fourteen inches, and instead of its being entirely supported at the upper end it is partially supported by the runners at the lower end. To support the shaft entirely from the upper end this slack must be removed from the pump shaft.

It is accordingly an object of this invention to provide a deep well turbine pump in which the stretch in the pump shaft may be compensated for, or, in other words, in which the slack produced by the stretch of the pump shaft may be removed so that it will not be supported at the lower end by the runners.

If, in removing the slack from the pump shaft, the upper end thereof was lifted too much, so that the runners would be lifted and caused to engage the upper walls of the runner chambers, probably as much damage would result. It is therefore highly desirable and practically necessary to have a means for determining when the slack has been entirely removed from the pump shaft, so that the liability of lifting the runners into engagement with the upper walls of the runner chambers will be done away with.

It is accordingly another object of this invention to provide a deep well turbine pump in which it may be ascertained when the slack has been entirely removed from the pump shaft.

In addition to the stretch of the pump shaft resulting from the weight of the pump shaft there is a stretch which results from the hydraulic thrust imposed on the runners when the pump is in operation. The down thrust on the runners results from the hydraulic pressure of the fluid being pumped and is commensurate with the differences of

areas of the upper and lower faces of the runners. In the pumps used in shallow wells the hydraulic thrust is not great enough to stretch the pump shaft sufficiently to allow the runners to engage the lower walls of the runner chambers; but in a deep well the liquid must be pumped a great distance, consequently the hydraulic thrust is quite large and is sufficient to cause engagement of the runners. In order to obviate such engagement it is necessary to provide a means for compensating for a stretch in the pump shaft resulting from hydraulic thrust.

It is a further object of this invention to provide a deep well turbine pump in which the pump shaft may be adjusted when the pump is not in operation, so that when the pump is in operation and the hydraulic thrust imposed on the runners the pump shaft will not stretch so that the runners will engage the walls of the runner chambers.

It is plainly evident that the hydraulic thrust is placed on the runners only when there is a hydraulic down pressure and when the pump is in operation. There is no hydraulic thrust on the runners when the pump is not in operation. If the pump shaft is adjusted so that the runners are in proper positions when the hydraulic thrust is on the runners and when the pump shaft is stretched as a result of this hydraulic thrust, the runners will contact the upper walls of the runner chambers when the pump is not in operation. Such being the case the runners will not move into proper operating position until full speed and full hydraulic thrust are obtained.

It is a still further object of my invention to provide a deep well turbine pump in which the runners cannot move into contact with the upper walls of the runner chambers when the pump is not in operation and will occupy proper positions when the pump is in operation and working under full load.

A further object of my invention is to provide a novel manipulative method for installing a turbine pump.

Other objects and particular advantages of my invention will be made evident hereinafter.

Referring to the drawings which illustrate a preferred form of my invention,

Fig. 1 is a vertical section through the upper part of a pump embodying the features of the invention.

Fig. 2 is a vertical section taken through the lower end of the pump embodying the features of the invention, this view showing the parts thereof in proper working positions.

Fig. 3 is a view, partially sectioned, corresponding to Fig. 2 but showing the positions of the different parts before they have been adjusted into proper operating positions.

Fig. 4 is a section taken on the line 4—4 of Fig. 1.

Fig. 5 is a section taken on the line 5—5 of Fig. 2.

The form of my invention shown in the drawings consists of a pump unit 11 which is suspended at the lower end of a column pipe 12 inside a well casing 13. The pump unit 11 consists of an upper section 15 and a lower section 16, and pump bowls 17, which are situated between these upper and lower sections. The parts of the pump unit, just mentioned, are rigidly secured together as illustrated in the drawings. The upper section 15 is provided with passages 19, the upper ends of which communicate with the interior of the column pipe 12 and the lower ends of which connect to passages 20 formed in the upper pump bowl 17. The lower ends of the passages 20 of the pump bowls 17 connect to the peripheral parts of runner chambers 21. The lower section 16 which is connected to the lower pump bowl 17 has a space 23 which communicates with the runner chambers 21 of the lowest pump bowl 17 by means of a mouth 24. The space 23 is provided by cylindrical wall 26 which is provided with perforations 27. Extending downwardly from the upper part of the lower section 16 is a screen pipe 28 through which oil or other liquid must pass in order to enter the pump unit 17. The oil must also pass through the perforations 27 of the lower section 16 on its way through the pump unit 17. The column pipe 12 is threadedly secured at 30 to the upper part of the upper section 15. The upper end of the column pipe 12 is threadedly secured at 31 to a sub-flange 32 of a pump head, as illustrated in Fig. 1. The pump head includes a body 34 which rests on the sub-flange 32 and which has a chamber 35 into which the oil passes from the column pipe 12. An outlet pipe 36 is connected to the body 34 by means of a flange 37 through which outlet 36 the oil may pass from the chamber 35.

Extending through the pump unit 11 is a pump shaft 39 which is rotatably supported in the various bearings of the upper and lower sections of the pump bowls of the pump unit. Runners 40 are situated in each of the runner chambers 21 and are rigidly secured on the pump shaft 39 by keys 42. The runners 40 have passages 43 formed therethrough which communicate with the passages 20 of the pump bowls 17. The passage 43 of the lowest runner 40 communicates with the mouth 24 of the lower section 16. The pump shaft 39 extends upwardly through the column pipe 12 and through the body 34 of the pump head. The upper end of the pump shaft 39 is provided with a thrust nut 44 which is screwed onto an upper threaded end 45 of the pump shaft 39. The thrust nut 44 is supported by a flanged member 47 of a flexible coupling 48. The lower part of the flanged member 47 is provided in the form

of a spindle 50 which surrounds the pump shaft 39. The lower part of the spindle 50 extends into a bearing chamber 53 which is provided by the body 34. Supported at the lower part of the bearing chamber is an upper thrust bearing 55 which supports the spindle 50, and consequently supports the weight of the pump shaft 39. A motor 57 is supported above the body 34 by a frame 58. A motor shaft 60 extends downwardly from the motor general and has a flanged member 61 of the flexible coupling 48 secured thereto. The flanged members 47 and 61 are drivably connected together as illustrated in the drawings or according to any standard practice so that the pump shaft may be driven by the motor 57.

Referring to Fig. 2 the lower end of the pump shaft 39 extends through a bearing 63 of the lower section 16 and into a lower bearing chamber 64 which is formed below a radial wall 66. The bottom end of the lower chamber 64 is closed by a plug 67 which is screwed into the lower end of the lower section 16. The chamber 64 is filled with a lubricating oil. A nut 68 is secured at the extreme lowest end of the pump shaft 39 and a bushing 69 is placed on the pump shaft directly above the nut 68, being secured against movement relative thereto by means of a key 70. Arranged in the lower bearing chamber 64 above the bushing 69 is a lower thrust bearing 72. The lower thrust bearing 72 is retained in the position shown in Figs. 2 and 3 by a bearing retainer 74 having a lower annular lip 75 which extends below the lower race of the lower thrust bearing 72. The upper face of the upper race of this bearing is arranged to engage a centralizing ring 76 which keeps the bearing concentric with the pump shaft 39. In Fig. 2 the pump shaft is shown in operating position; the bushing 69 is in engagement with the lower race of the lower thrust bearing 72 and the lower end of the pump shaft 39 cannot move upwardly beyond the position shown.

Threadedly secured to the upper end of a hub 78 of the upper section 15 is a main bearing 79 which surrounds the pump shaft 39 providing a journal therefor. Secured to the main bearing 79 is an oil tube 80 which surrounds the pump shaft 39 and extends upwardly through the column pipe 12 into the body 34 of the pump head. The upper end of the oil tube 80 is threadedly secured at 81 to a cup 82 provided by the body 34. A packer 83 is provided to prevent a leakage of oil at this joint. The oil tube 80 consists of sections of tubing which are secured together by coupling members 84. These coupling members 84 have bearing openings 85 formed therethrough, and consequently serve as bearings for the pump shaft 39. An opening 86 is provided through each coupling member 85 as illustrated in Fig. 1. The oil tube 80 has an oil pipe 88 secured thereto directly below the cup 82. This pipe 88 extends laterally from the body 34 through a stuffing box 89. A gauge glass 90 is secured to the outer end of the oil pipe 88 and an oil filling cup 91 is also secured to the oil pipe 88 on the exterior of the pump body 34.

Referring to Figs. 2 and 3 the upper end of the main bearing 79 is provided with a valve seat 93. A vertical passage 94 is formed through the main bearing 79 and it communicates with the valve seat 93 and with a passage 94a opening on the passage 19. A valve 95 is rigidly secured as by a pin 96 to the pump shaft 39 directly above the main bearing 79. The lower end of the valve 95 is provided with a valve face 97 which is adapted for engagement with the valve seat 93 as indicated in Fig. 3. When the valve is seated, as shown in Fig. 3, the passage 94 is closed.

As pointed out in the statement of invention of this application, the important part of the invention is the provision of a deep well turbine pump in which the runners may be properly positioned, this proper positioning of the runners being accomplished by the correct adjustment of the pump shaft 39. After all of the parts of the pump have been installed with the exception of the motor 57 and the flanged member 61 of the flexible coupling 48, the pump shaft 39 is adjusted. In Fig. 3 is represented the positions of the parts of the pump unit immediately after the pump has been installed and before the pump shaft has been adjusted. At this time there is a stretch in the pump shaft 39 which, as previously pointed out, results from the weight of the pump shaft itself and there is consequently a slack which permits the pump shaft to be partially supported at the lower end thereof. The valve 95 is in engagement with the valve seat 93 formed at the upper end of the bearing member 79. The runners 40 are in a lowermost position in the runner chambers 21 and are resting in engagement with lower walls 99 of the runner chambers 21. The lower end of the pump shaft 39 is in such a position that the bushing 69 is dropped from engagement with the lower thrust bearing 72, and the lower thrust bearing is entirely supported by the bearing retainer 79.

The adjustment of the pump shaft simultaneously removes the slack from the pump shaft and compensates for the hydraulic thrust which is imposed on the pump shaft when the pump is in operation. In order to simplify the explanation of this adjustment and to make it easily understood I will first consider only that portion of the adjustment which removes the slack from the pump shaft and then afterwards explain the compensation for hydraulic thrust. Previous to adjusting the pump shaft the oil tube 80 is filled with oil either through the upper end of the

oil tube 80 or through the oil filling cup 91. When the tube is full, the level will be indicated in the gauge glass 90. The thrust nut 44 is then rotated so that the upper end of the pump shaft 39 is pulled upwardly. The lower end of the pump shaft 39 will not move until all of the slack has been removed therefrom; therefore, the valve 95 will remain seated and the oil will be retained in the oil tube 80. When the slack has been removed from the pump shaft, the lower end thereof will move upwardly and the valve 95 will be disengaged from the valve seat 93. At this time the passage 94 will be opened and oil will begin to flow from the oil tube 80. This flow of oil is discerned by a drop of level in the gauge glass 90, and the one making the adjustment will know that the slack in the pump shaft has been entirely removed therefrom and that the pump shaft is at this time supported wholly at its upper end and not by the runners at the lower end thereof. Just as the valve 95 moves from engagement with the valve seat 93 the runners 40 are still in a lower position in the runner chambers 21. It is desirable to lift the valve 95 so that there will be a space of about a quarter of an inch between the valve and the valve seat 93. Referring to Fig. 2, when the valve has been lifted to the extent that about a quarter of an inch exists between it and the valve seat 93 the runners 40 will have been moved to a central position in the runner chambers 21 which is a proper running position. When the pump shaft has been raised into this position the bushing 69 comes into engagement with the lower race of the lower thrust bearing 72 and absolutely prevents the lower end of the pump shaft from moving upwardly beyond this point.

The foregoing description clearly describes the adjustment by means of which the slack is entirely removed from the pump shaft so that the runners will be properly positioned in the runner chambers 21. This adjustment also compensates for the hydraulic thrust imposed on the runners when the pump is operating under full load.

Considering the manner in which the hydraulic thrust is compensated for, it is well to point out that the hydraulic thrust, which is a thrust in a down direction, is substantially equal to the difference in the areas of the upper and lower faces of the runners 40 multiplied by the hydrostatic pressure in pounds per square inch. Referring to Figs. 2 and 3 it will be seen that the upper faces of the runners 40 are greater than the areas of the lower faces of the runners 40. This is because of the fact that the passages 43 communicate through the lower faces and consequently reduce its area.

In constructing the pump the valve 95 is formed so that it has an upper face 101 which is of an area substantially equaling the difference in the areas of the upper and lower faces of the runners 40, disregarding the area of the passage 94 which is quite small in cross-section so that the fluid pressure therein does not exert any material upward force on the valve 95 when this valve is against the valve seat 93. The oil which is placed in the oil tube 80 is preferably of the same specific gravity as the oil which is pumped by the turbine pump of the invention. The height of this column of oil, since it extends from the pump unit to the surface of the ground, is equivalent to the distance which the oil being pumped is lifted. The weight of the column of oil above the face 101 exerts a down pressure on the valve 95. Therefore, when the pump shaft 39 is adjusted, the weight of this oil as well as the slack in the pump shaft must be overcome. When the oil drains from the oil tube 80 through the passage 94, this oil pressure is removed from the valve 95 and there is a tendency for the shaft to contract by reason of this release in pressure. Due to the fact that the bushing 69 is engaged with the lower thrust bearing 72 the lower end of the pump shaft cannot move upwardly, and therefore the pump shaft will be retained under a tension which is in measure with the pressure which was exerted on the upper face 101 of the valve 95 by the oil in the oil tube 80. It should be noted that if the lower thrust bearing 72 were not provided, the runners 40 when the oil had drained from the oil tube 80 would move upwardly and engage upper walls 102 of the runner chambers 21, which engagement would probably result in as much damage as engagement of the runners with the lower walls 99. The runners would not move into proper operating position until the pump was running at full speed and there was a maximum hydraulic thrust imposed thereon. After the adjustment, just described, has been made the motor 57 and the upper flanged members 61 are installed as shown in the drawings, and the pump is ready for operation.

The motor 57 is energized and the pump shaft 39 is rotated through the medium of the flexible coupling 48. As the pump gradually accelerates to normal speed the hydraulic thrust imposed on the runners 40 likewise gradually increases to normal. By "normal thrust" is meant that thrust which is imposed on the runners when the pump is operating at normal speed. There is no additional tension imposed on the pump shaft at this time because of the fact that there is no additional thrust placed thereon, but the pressure is merely transferred from the lower thrust bearing 72 to the runners 40.

During the operation of the pump no material flow takes place through the passage between the valve 95 and the seat 93 so that the downward pressure on the upper face 101

is substantially equal to the upward pressure on the lower face 97.

I have found that it is usually desirable to place a slight tension on the shaft in excess to the tension for compensating for the hydraulic thrust, so that the lower thrust bearing 72 will always operate under at least a slight tension.

The placing of a thrust bearing at the lower end of the pump shaft to restrain this end of the shaft from upward movement is important to this invention. The utility of this feature is not, however, limited to a combination with the valve structure shown, as will be apparent from the fact that any desired tension on the shaft may be applied by moving the nut 44 relative to the shaft, this tension being placed thereon independent of the valve structure if no oil is in the tube 80. As long as this tension is greater than the maximum hydraulic thrust plus the normal tension at any section of the shaft due to the weight of the suspended shaft below this section (disregarding any friction in the line shaft bearings), there will be no vertical movement of the runner in the runner chamber when the hydraulic thrust builds up on the runner. Thus, the valve structure is merely used as a convenient means of determining when the slack is removed from the shaft and for placing a desired tension on the shaft in excess of the tension developed by the weight thereof to counteract any hydraulic thrust.

So, also, the valve structure finds utility outside of a combination with a lower thrust bearing, this valve structure, together with the gauge and pipe, being adapted to indicate the relative movement of two members at a distance. In other words, the gauge indicates to the operator any relative movement of the valve 95 and the seat 92.

I claim as my invention:

1. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for removing the slack from said pump shaft; and means independent of the operation of said turbine pump for ascertaining when said slack has been removed from said pump shaft.

2. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for restraining the lower end of said pump shaft from upward movement; means for removing the slack from said pump shaft; and means for ascertaining when said slack has been removed from said pump shaft.

3. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; a lower thrust bearing for restraining the lower end of said pump shaft from upward movement; means for removing the slack from said pump shaft; and means for ascertaining when said slack has been removed from said pump shaft.

4. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for restraining the lower end of said pump shaft from upward movement; an upper thrust bearing permitting the removal of the slack from said pump shaft; and means for ascertaining when said slack has been removed from said pump shaft.

5. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for removing the slack from said pump shaft; an oil tube surrounding said pump shaft; and a valve structure closing the bottom of said oil tube, said valve structure being opened when the slack is removed from said pump shaft.

6. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for restraining the lower end of said pump shaft from upward movement; adjusting means for raising the upper end of said pump shaft to remove the slack therefrom; an oil tube surrounding said pump shaft; and a valve structure closing the bottom of said oil tube, said valve structure being opened when the slack is removed from said pump shaft.

7. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means

connected to the upper end of said pump shaft for driving same; an upper thrust bearing relative to which said pump shaft is movable to remove the slack therefrom; an oil tube surrounding said pump shaft; and a valve structure closing the bottom of said oil tube, said valve structure being opened when the slack is removed from said pump shaft.

8. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for removing the slack from said pump shaft; an oil tube surrounding said pump shaft; a valve seat surrounding said pump shaft; and a valve carried by said pump shaft and adapted to engage said seat, said valve disengaging said seat when the slack is removed from said pump shaft.

9. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for restraining the lower end of said pump shaft from upward movement; adjusting means for raising the upper end of said pump shaft to remove the slack therefrom; an oil tube surrounding said pump shaft; a valve seat surrounding said pump shaft; and a valve carried by said pump shaft and adapted to engage said seat to prevent escape of a liquid in said oil tube, said valve disengaging said seat when the slack is removed from said pump shaft.

10. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; an upper thrust bearing relative to which said pump shaft is movable to remove the slack therefrom; an oil tube surrounding said pump shaft; a valve seat surrounding said pump shaft; and a valve carried by said pump shaft and adapted to engage said seat, said valve disengaging said seat when the slack is removed from said pump shaft.

11. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for removing the slack from said pump shaft; an oil tube surrounding said pump shaft; and a valve structure closing the bottom of said oil tube, said valve structure being operable against a force substantially equivalent to the hydraulic thrust on said runner when said pump is put into operation.

12. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for removing the slack from said pump shaft; an oil tube surrounding said pump shaft; a valve seat surrounding said pump shaft; a valve carried by said pump shaft and adapted to engage said seat, said valve disengaging said seat when the slack is removed from said pump shaft; and means for exerting on said valve a downward pressure equal to the hydraulic thrust which will be imposed on said runner when said pump is put into operation.

13. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for removing the slack from said pump shaft; an oil tube surrounding said pump shaft; a valve seat surrounding said pump shaft; and a valve carried by said pump shaft and adapted to engage said seat, said valve disengaging said seat when the slack is removed from said pump shaft, said valve having an upper surface the effective area of which is a function of the upper and lower areas of said runner.

14. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; an upper thrust bearing relative to which said pump shaft is movable to remove the slack therefrom; an oil tube surrounding said pump shaft; a valve seat surrounding said pump shaft, said valve seat having a passage communicating between the interior and the exterior of said oil tube; and a valve carried by said pump shaft, said valve being adapted to engage said seat to close said passage, but opening said passage when the slack is removed from said pump shaft.

15. In combination: a relatively long shaft extending substantially vertically; supporting means for supporting the lower end of said shaft; means for raising the upper end of said shaft; and flow means operable when said shaft is not rotating for determining

when the stretch has been removed from said shaft and said shaft is no longer supported by said supporting means.

16. In combination: a relatively long shaft extending substantially vertically; supporting means for supporting the lower end of said shaft; means for raising the upper end of said shaft; a tube extending downward along said shaft, said tube being filled with a fluid; and a valve structure in said tube and being operable by said shaft, said structure opening when said shaft is no longer supported by said supporting means.

17. A method of installing and adjusting a turbine pump having a runner supported on a vertical shaft in a well, which comprises: exerting a downward force on the lower end of said shaft which is substantially equal to the maximum hydraulic thrust which would be imposed on said runner when operating; drawing upward on the upper end of said shaft until said downward force is counteracted; and removing said downward force.

18. A method of installing a turbine pump having an impeller secured to a vertical line shaft extending to the surface of the ground, the lower end of this shaft being retained from unrestrained upward movement by a thrust bearing, which comprises: drawing upward on said line shaft until the slack is entirely out; and impressing an additional tension on said shaft which is a function of the hydraulic thrust which will be imposed on said runner when said pump is set into operation.

19. A method of adjusting a turbine pump having thrust bearings spaced on the line shaft of said pump to which a runner is secured, which method includes the step of imposing on that portion of said line shaft adjacent said runner a measured amount of tension which is greater than the maximum tension placed thereon by the hydraulic thrust of said runner.

20. A deep well turbine pump comprising: a pump unit adapted to be placed in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto, said pump shaft extending to the top of said well; drive means connected to the upper end of said pump shaft for driving same; means for exerting a downward force on the lower end of said pump shaft when stationary and independent of the weight of said runner, said force resisting an upward movement of said lower end of said pump shaft; and means for drawing upward on the upper end of said pump shaft until the slack is removed therefrom and said downward force is counterbalanced.

21. A combination as defined in claim 20 in which said first-named means exerts a downward force on the lower end of said pump shaft which is substantially equal to the hydraulic thrust which will build up on said runner when in operation.

22. A deep well turbine pump comprising: a pump unit positioned in a well and including a plurality of runner chambers; a runner in each of said runner chambers; a pump shaft to which said runners are secured, said pump shaft extending to the top of said well; drive means for driving said pump shaft; a lower thrust bearing below said runners for restraining the lower end of said pump shaft from an upward movement which would permit engagement between said runners and the walls of their respective runner chambers; and means including an upper thrust bearing for placing a tension on said pump shaft between said upper and lower thrust bearings whereby a tension is maintained in that portion of said shaft between said upper thrust bearing and said runners regardless of whether or not said pump is in operation.

23. A deep well turbine pump comprising: a pump unit positioned in a well; a runner situated in a runner chamber of said pump unit; a pump shaft having said runner secured thereto and extending to the top of said well; adjusting means for drawing upward on the upper end of said shaft; a lower thrust bearing positioned at said pump unit and preventing any upward movement of the lower end of said shaft sufficient to cause said runner to engage the upper wall of said runner chamber; and means at said pump unit and operating before said lower thrust bearing comes into play for resisting a rise of the lower end of said shaft with a predetermined removable pressure which controls the tension in said shaft between said adjusting means and said lower thrust bearing after said pressure is removed.

24. In a deep well turbine pump, the combination of: a pump unit adapted to be positioned in a well and providing a runner chamber; a runner in said runner chamber; a pump shaft for driving said runner, said pump shaft extending to the top of said well; means for drawing upward on the upper end of said pump shaft to remove the slack therefrom; a bearing means in said pump unit; pipe means in said well for delivering to said bearing means a fluid; and a valve structure opening when the slack is removed from said pump shaft and controlling the supply of said fluid from said pipe means to said bearing means.

25. In a deep well turbine pump, the combination of: a pump unit adapted to be positioned in a well and including a runner chamber; a runner positioned in said chamber; a pump shaft extending downward from the top of said well, said runner being secured thereto; means for drawing upward on the upper end of said shaft to adjust the position of said runner in said runner chamber;

a bearing for journalling said pump shaft relative to said pump unit; pipe means for delivering a fluid to said bearing means; and valve means operated as a function of the relative positions of said runner and runner chamber for controlling the flow of said fluid from said pipe means to said bearing means.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 23 day of August 1926.

JOHN A. WINTROATH.