**Sept. 15, 1931.** A. R. WEIS **1,822,945**

CENTRIFUGAL IMPELLER LOCATING AND LOCKING MEANS

Filed Dec. 27, 1927

Fig. 1.

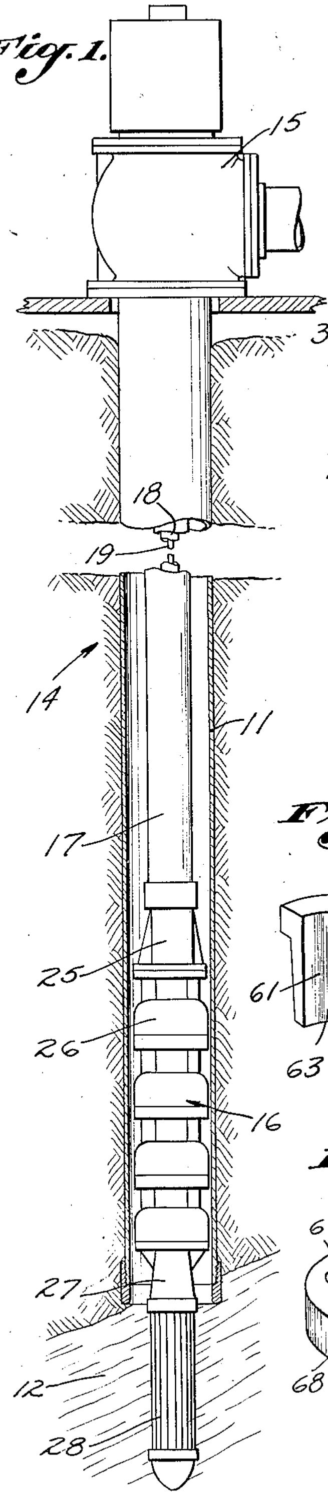



Fig. 2.

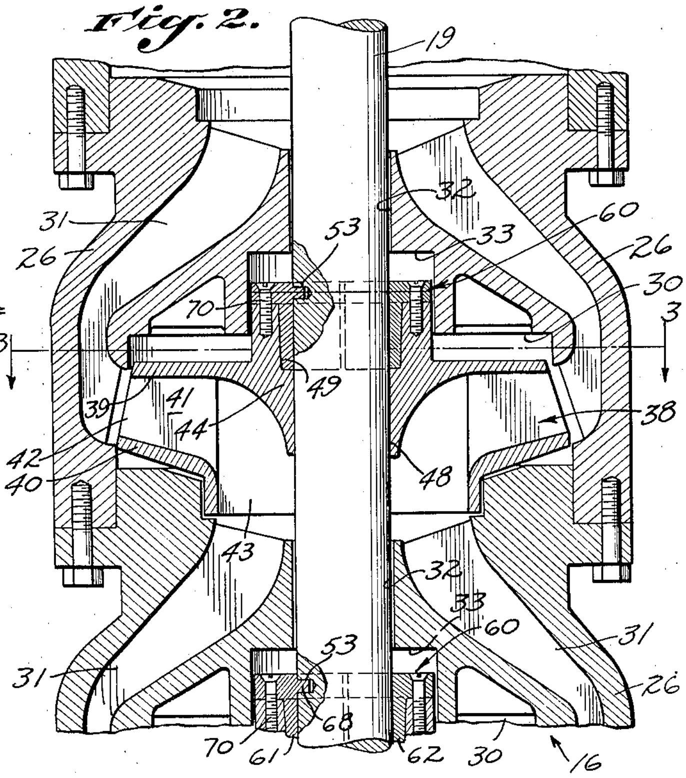



Fig. 5.

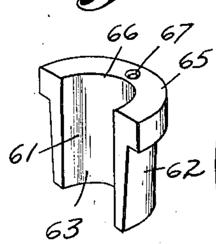



Fig. 3.

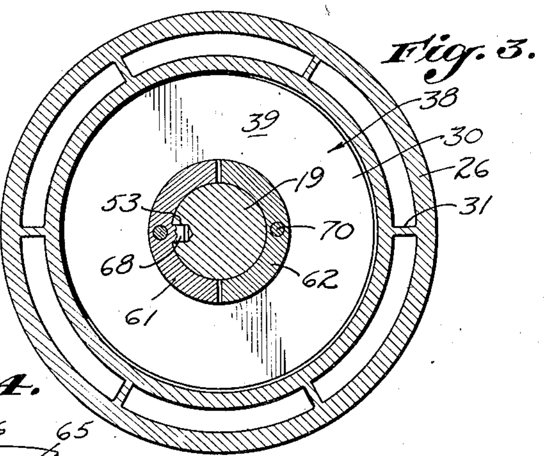
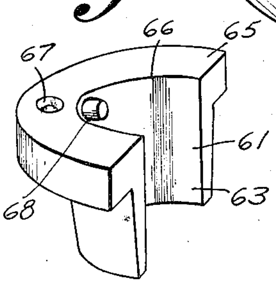



Fig. 4.

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# UNITED STATES PATENT OFFICE

ARTHUR R. WEIS, OF HUNTINGTON PARK, CALIFORNIA, ASSIGNOR OF ONE-HALF TO PACIFIC PUMP WORKS, OF HUNTINGTON PARK, CALIFORNIA, A CORPORATION OF CALIFORNIA

## CENTRIFUGAL IMPELLER LOCATING AND LOCKING MEANS

Application filed December 27, 1927. Serial No. 242,908.

My invention relates to deep well turbine pumps and particularly to the construction of the pump sections thereof.

In the type of deep well turbine pump in common use, the pump includes a pump head located on the surface of the ground at the upper end of a well, a pump section disposed in a lower portion of the well, and a column pipe connecting the pump head with the pump section and in which pipe a shaft is disposed by which the pump section is driven by the pump head to raise well fluid through the column pipe to the surface of the ground.

The pump section generally comprises a plurality of pump bowls connected together end to end, there being a continuous passage provided upward through the pump section, this passage being formed by connecting a series of impeller chambers, one of which is formed in each bowl by passages which connect the outer portion of each impeller chamber with the central portion of the chamber formed in the bowl thereabove. Disposed in each of the impeller chambers is one of a series of impellers through which the pump shaft extends and which is non-rotatably secured to the shaft so that the impellers are rotated when the upper end of the shaft is rotated by the pump head. The rotation of the impellers centrifugally impels well liquid upward through each of the bowls so as to form a multi-stage centrifugal pump. Owing to the small diameters of casing in which such pumps have to be installed, the design of these pumps must be made with constant consideration of the space limitations thus imposed.

Heretofore, the method generally followed for securing the impellers to the shaft has been to cut key-ways in both the shaft and the impeller hub and insert a Woodruff key in these key-ways to lock the impeller against rotation on the shaft. I have found that frequently such key-ways are inaccurately formed so as to cock the impeller on the shaft, causing an unbalanced rotating assembly which greatly shortens the life of the pump.

It is correspondingly an object of my invention to provide a means of securing a centrifugal impeller to a pump shaft in which the impeller will have an accurate axial alignment with the shaft.

I have found, further, that warping of the shaft with consequent whipping and fracture due to crystallization has been due to the cutting of key-ways in the shaft.

It is another object of my invention to provide a means of fastening a centrifugal pump impeller to a pump shaft which eliminates the necessity of cutting key-ways in the shaft.

As the shaft in deep well turbine pumps is vertically disposed and proper positioning of the impellers in their respective chambers, so as to properly clear the upper and lower walls thereof, is necessary, it has been common practice to use a gib head key in the key-ways, formed in the shaft and the impeller, so that the head of the key is disposed downward and supports the impeller by contact of the lower end of the impeller hub therewith. In the operation of a deep well turbine pump, the shaft is rotated at exceedingly high speeds which sometimes reach 4.000 R. P. M., and I have further found that a projection such as the head of a gib head key into the lower portion of the impeller passageway causes cross currents and disturbances which lower the efficiency of the pump.

It is therefore a still further object of my invention to provide a means of securing a centrifugal pump impeller to the pump shaft in which any irregular projections into the pump fluid passageway are eliminated.

In past practice, an effort has been made to do away with the use of gib head keys for the reasons outlined above, and this has been done by using a feather key for non-rotatably securing the impellers to the shaft and determining the axial position of the impellers upon the shaft by spacing adjacent impellers by the use of exceedingly thin tubular sleeves disposed about the shaft and forcing the entire assembly of impellers and spacers against a shoulder formed on the shaft above the uppermost impeller by the application of a nut to the lower end of the shaft. In addition to being comparatively expensive, this plan has failed owing to the exposure of these sleeves to streams of pumped fluid entering the various impeller chambers from the pump bowls immediately therebeneath at an exceedingly high rate of speed. Sand and other abrasive substances are usually carried by the pumped fluid and, in many cases, have been known to wear these spacing sleeves entirely through so that the impellers were allowed to drag upon the walls of the impeller chambers, resulting in a quick destruction of the pump.

It is, therefore, a further object of my invention to provide a means for securing a centrifugal pump impeller upon the pump shaft so that axial displacement of the impeller upon the shaft may be prevented in a manner so that such means may not be rendered inoperative by the abrasive action of fluid handled by the pump.

In the former practice of deep well turbine pump construction, the use of keys to secure impellers to the shaft required that the impeller hubs be of considerable thickness so as to provide sufficient material in which to form a key-way, and the lower end of the impeller hub was thus of such a diameter as to materially restrict the lower end of the passage formed through the impeller.

It is a yet further object of my invention to provide a means for securing a centrifugal pump impeller to the pump shaft in which the necessity for the lower end of the impeller hub being of large diameter is eliminated, permitting a material increase in the size of the lower portion of the passage formed through the impeller.

However, my invention is not limited to use with a deep well turbine pump, although it finds particular utility in this combination, and it is correspondingly an object of this invention to provide a novel means for securing an element to a shaft whether or not this element is an impeller.

Still another object of the invention is to provide as an article of manufacture a novel impeller having a bore therein adapted to receive an element which clamps the impeller to the shaft.

Further objects and advantages will be made apparent in the following description and accompanying drawings in which a preferred embodiment of my invention is illustrated. In the drawings:

Fig. 1 is a diagrammatic view illustrating the installation of a pump, embodying my invention, in a deep well.

Fig. 2 is an enlarged fragmentary vertical sectional view illustrating the inner structure of the pump section of the pump shown in Fig. 1.

Fig. 3 is a horizontal sectional view taken on the line 3—3 of Fig. 2.

Fig. 4 is a perspective view of one of the halves of the split sleeve of my invention.

Fig. 5 is a perspective view illustrating a half of another type of a split sleeve which may be used in my invention.

Referring specifically to the drawings:

Fig. 1 shows a well 10, provided with a casing 11 which connects at its lower end with a water bearing stratum 12. A deep well turbine pump 14 is installed in the well 10. The pump 14 includes a pump head 15, a pump section 16, and a column pipe 17 connecting the pump head to the pump section. Extending through the length of the column pipe 17 is a shaft tube 18 having line shaft bearings in which is journalled a line shaft 19 which is supported at its upper end on the pump head 15 and driven thereby. The lower end of the line shaft 19 extends through the pump section 16 so that when the shaft is thus rotated, the pump section 16 is caused to force water from the stratum 12 upward through the column pipe 17 so that this water is discharged from the pump head 15 in a continuous stream.

The structure of the pump section 16 includes an upper main bearing 25 which is connected to the lower end of the column pipe 17 and a series of impeller bowls 26 connected together, the upper of these bowls being connected to the upper bearing 25 and the lower of these bowls being connected to a lower main bearing 27, which is provided with a suitable screen pipe 28 through which well fluid is drawn from the stratum 12 into the pump.

The construction of the pump bowls 26 follows standard practice, each of these bowls having an impeller chamber 30 formed in its lower end, and a series of passages 31 connecting the outer portion of the impeller chamber 30 with the space immediately above that bowl. Formed centrally through each bowl is a shaft bore 32, having a counterbore 33 formed in its lower end. As clearly shown in Fig. 2, when the bowls 26 are assembled, the passages 31 of each bowl connect the outer portions of the impeller chamber in that bowl with the central portion of the impeller chamber in the bowl thereabove. Also, the upper end of each bowl forms a closure of the lower end for the impeller chamber in the next bowl thereabove.

Disposed in each of the impeller chambers 30 is one of a series of impellers 38. Each of the impellers 38 includes an upper shroud 39 and a lower shroud 40, which are connected by walls 41 to form radial discharge passages 42. Connected with the inner ends of the passages 42, is a central space 43 which communicates with the upper ends of the passages 31 formed in the bowl immediately therebeneath.

Provided on the upper shroud 39 is a hub 44 which extends upward into the counterbore 33. Formed centrally in each hub 44 is an opening 48 which is adapted to fit the shaft 19. Formed in the upper end of the bore 48 is a tapered bore 49.

Formed in the shaft 19, opposite the upper ends of the hubs 44 of each of the impellers 38 in the pump section 16, is one of a series of shallow holes 53.

The impeller securing means of my invention includes a split sleeve 60, comprising a pair of sleeve segments 61 and 62, each having a lower semi-tubular portion 63, the outer surface of which tapers to correspond with the taper of the bore 49 in the hub 44. At the upper end of the semi-tubular portion 63 of each sleeve segment, is formed an external flange 65, there being a counter-sunk screw hole 67 formed in the flange 65, and a locking stud 68 is formed on the upper edge of the portion 63 to extend inward therefrom.

The sleeve segment 62 is identical with the sleeve segment 61, with the exception that the stud 68 is absent therefrom. In assembling an impeller 38 upon the shaft 19, the sleeve segments 61 and 62 are placed about the shaft 19, with the stud 68 of the sleeve 61 extending into one of the holes 53 formed in the shaft 19. The impeller 38 is now moved toward the sleeve 60 so that the semi-tubular portions 63 of the sleeve segments 61 and 62 extend into the tapered counterbore 49 of the impeller hub 44. Screws 70 are now extended through the counter-sunk holes 67 into suitably threaded apertures in the hub 44 so as to draw the impeller 38 tightly upon the split sleeve 60 so as to keep this tube tightly contracted against the shaft 19. A high frictional engagement is thus made between the split sleeve 60 and the shaft 19, which is effective in securing the impeller 38 to the shaft 19 so as to prevent rotation of the impeller upon the shaft. However, the stud 68, extending into the hole 53, provides additional means for locking the impeller 38 against rotation on the shaft 19.

In addition to preventing rotation between the shaft and the impeller, the sleeve 60 gives the impeller 38 a definite axial position relative to the shaft 19. This positioning is accomplished entirely by the securing means, per se, without the use of any spacing tubes as is common in the art. Thus, it is possible for the lower end of the hub 44 to be formed so as to taper downward to a relatively thin edge at its lower end, which permits the space 43 to be much larger than was possible in the impellers designed to be attached to a shaft by the use of keys. This thick lower portion of the hub in common use is dispensed with by my invention, as well as any need for the use of a key having a gib head. It will thus be clearly seen that a much superior construction over those previously in use is provided by the impeller securing means of my invention.

I claim as my invention:

1. In a turbine pump, the combination of: a pump bowl having an impeller chamber therein and inner and outer walls forming passages extending from said impeller chamber, there being a shaft opening extending through said inner wall and a counterbore axially aligned with said shaft opening and communicating with said impeller chamber; a shaft extending through said pump bowl; an impeller mounted on said shaft in said impeller chamber, said impeller having a hub extending upwardly into said counterbore, there being a tapered counterbore in said hub; a sleeve around said shaft having a tapered external surface adapted to engage the tapered walls of said counterbore in said hub and having a flange at its outer end adapted to project outwardly over the end of said hub: and means extending through said flange into engagement with said hub for drawing said impeller over said sleeve.

2. In a turbine pump, the combination of: a pump bowl having an impeller chamber therein and inner and outer walls forming passages extending from said impeller chamber, there being a shaft opening extending through said inner wall and a counterbore axially aligned with said shaft opening and communicating with said impeller chamber; a shaft extending through said pump bowl, there being a depression in said shaft; an impeller mounted on said shaft in said impeller chamber, said impeller having a hub extending upwardly into said counterbore, there being a tapered counterbore in said hub; a sleeve around said shaft having a tapered external surface adapted to engage the tapered walls of said counterbore in said hub and having a flange at its outer end adapted to project outwardly over the end of said hub; means extending through said flange into engagement with said hub for drawing said impeller over said sleeve; and locking means on said sleeve consisting of a projection extending into said depression in said shaft to prevent movement of said sleeve relative to said shaft.

3. In a turbine pump, the combination of: a pump bowl having an impeller chamber therein and inner and outer walls forming passages extending from said impeller chamber, there being a shaft opening extending through said inner wall and a counterbore axially aligned with said shaft opening and communicating with said impeller chamber; a shaft extending through said pump bowl; an impeller mounted on said shaft in said impeller chamber, said impeller having a hub extending upwardly into said counterbore and a conoidal shaft-enclosing body extending oppositely from said hub, there being a tapered counterbore in said hub; a sleeve around said shaft, said sleeve having a tapered external surface adapted to engage the

walls of said counterbore in said hub and an inner surface adapted to contact the exterior of said shaft; and means for drawing said impeller onto said sleeve.

4. In a turbine pump, the combination of: a pump bowl having an impeller chamber therein and inner and outer walls forming passages extending from said impeller chamber, there being a shaft opening extending through said inner wall and a counterbore axially aligned with said shaft opening and communicating with said impeller chamber; a shaft extending through said pump bowl, there being a depression in said shaft; an impeller mounted on said shaft in said impeller chamber, said impeller having a hub extending upwardly into said counterbore and a conoidal shaft-enclosing body extending oppositely from said hub, there being a tapered counterbore in said hub; a split sleeve around said shaft having a tapered external surface adapted to engage the tapered walls of said counterbore in said hub and having a flange at its outer end adapted to project outwardly over the end of said hub; means extending through said flange into engagement with said hub for drawing said impeller over said split sleeve; and locking means on said split sleeve consisting of a projection extending into said depression in said shaft to prevent movement of said split sleeve relative to said shaft.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 19th day of December, 1927.

ARTHUR R. WEIS.