Jan. 31, 1939. J. M. HAIT 2,145,598

CENTRIFUGAL PUMP

Filed June 1, 1937 2 Sheets-Sheet 1

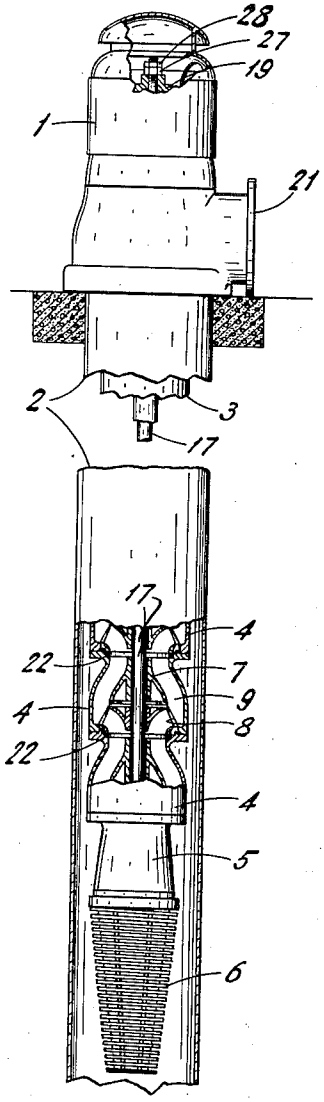


Fig. 1.

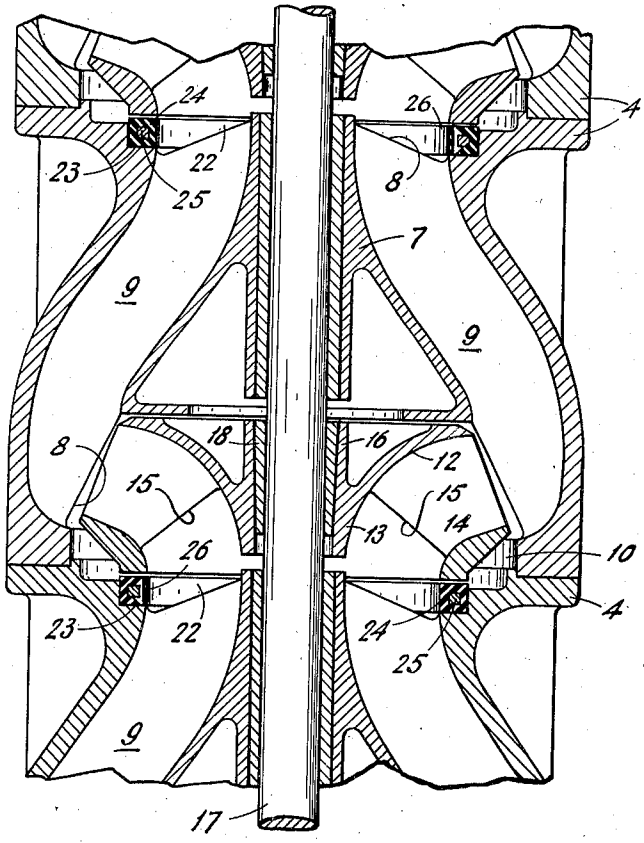


Fig. 2

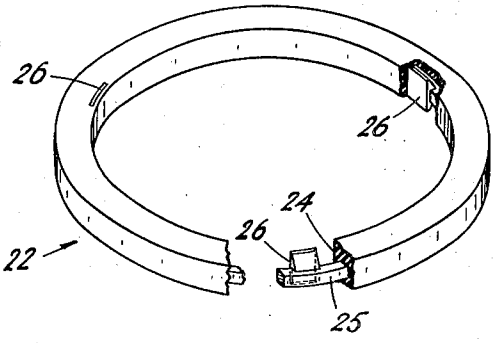


Fig. 3.

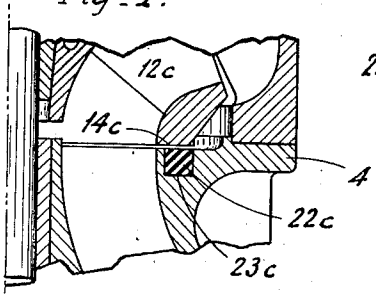


Fig. 6.

INVENTOR.
JAMES M. HAIT.
BY Philip A. Minnis
ATTORNEY.

Jan. 31, 1939. J. M. HAIT 2,145,598

CENTRIFUGAL PUMP

Filed June 1, 1937 2 Sheets-Sheet 2

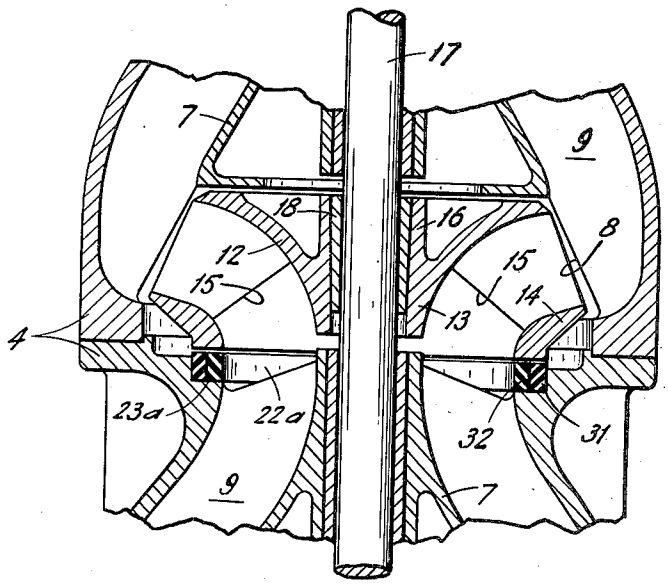


Fig. 4.

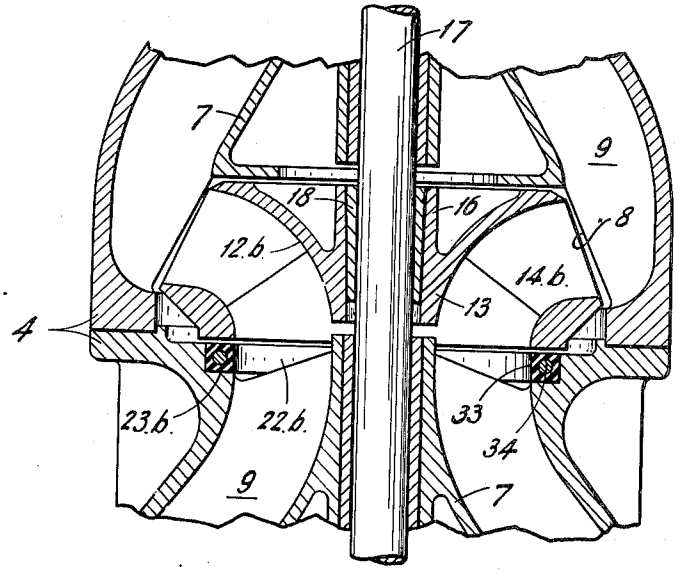


Fig. 5.

INVENTOR.
JAMES. M. HAIT.
BY Philip G. Minnis.
ATTORNEY.

Patented Jan. 31, 1939 2,145,598

UNITED STATES PATENT OFFICE

2,145,598

CENTRIFUGAL PUMP

James M. Hait, Los Angeles, Calif., assignor to Food Machinery Corporation, San Jose, Calif., a corporation of Delaware

Application June 1, 1937, Serial No. 145,674

10 Claims. (Cl. 103—102)

The present invention relates to centrifugal pumps of the type having sealing means for minimizing wear and limiting certain characteristic hydraulic losses, and more particularly to the provision in such pumps, of improved sealing means of the character noted which resists wear effectively and which facilitates assembling of the pump. This application is filed as a continuation in part of my application Serial No. 67,779, filed March 9, 1936.

Centrifugal pumps having such sealing means are illustrated in my co-pending application Serial No. 62,265 filed February 4, 1936, wherein I have pointed out the advantages of employing a sealing ring of resilient material in closely cooperative relation with the end of the impeller skirt to form a hydraulic seal. I have found however, that certain difficulties may be met with under some circumstances in such pumps, particularly where a series of impellers are employed, in connection with the assembly and adjustment of the impellers in their proper cooperative relation to the respective sealing rings associated therewith, and further that such difficulties may not only be avoided but the life of the rings increased as well, by the employment of the improved type of sealing ring in accordance with the present invention.

It is desirable in centrifugal pumps that the impellers be attached rigidly to the line shaft without the possibility of becoming loose, and an efficient and economical construction to obtain this end is provided by a wedge which is driven between the impeller and the line shaft. In driving these wedges into place during assembly of pumps employing a series of impellers, considerable difficulty may be experienced in obtaining uniform positioning of the several impellers with respect to their respective sealing rings because of the resiliency of the rings. This may be explained by the fact that during assembly the impellers are driven into engagement with the rings so as to bear against them with more or less pressure, and because the rings readily deform under such pressure, it is difficult to ascertain the extent of the deformation. As a consequence, after the pump has been assembled, it may be found either impossible to adjust the gang of impellers so as to prevent one or more of them from dragging on their seals, or if they can be so adjusted, some of the clearances may be so great as to result in excessive hydraulic losses, and such conditions may necessitate disassembly of the pump to correct them.

It is well known that during operation of centrifugal pumps, as for example when used for pumping water from wells, the line shaft tends to lengthen because of the hydraulic load thereon and also tends to shorten as a result of the twisting caused by the driving torque. These reactions offset each other to a greater or less extent during operation of the pump, however, when the pump motor is stopped and the torque is eliminated, the "hydraulic stretch" present because of the head of water supported by the impellers still exists and causes the impellers to bear against the sealing rings. The subsequent reverse rotation of the impellers in returning the column of water above the impellers to the well may cause some degree of galling and wearing away of the resilient sealing rings, particularly the lowest ring.

It is an object of my invention to provide an improved centrifugal pump in which the above noted conditions are substantially eliminated.

Another object of my invention is to provide an improved centrifugal pump which is constructed to promote economical assembly and to afford accurate adjustment between the impeller structure and the sealing means associated therewith.

Another object is to provide improved sealing means in a centrifugal pump of the character referred to which will increase the life and efficiency of the pump.

Other objects and advantages will appear from the description of preferred embodiments of my invention as illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is a side elevation of a deep well pump embodying my invention, certain portions being broken away to show a part of the structure in section.

Fig. 2 is an enlarged sectional view of a portion of the pumping units shown in Fig. 1, showing a preferred form of sealing ring.

Fig. 3 is a perspective view of the sealing ring shown in Fig. 1 with certain portions broken away to illustrate the details of construction more clearly.

Fig. 4 is a sectional view similar to Fig. 2, but illustrating another form of sealing ring.

Fig. 5 is a sectional view similar to Fig. 2, but illustrating a modified construction.

Fig. 6 is a fragmentary sectional view similar to Fig. 2, but illustrating another modified construction.

Referring to Fig. 1, the centrifugal pump shown is a conventional deep well turbine pump, and in-

cludes pump head 1 of conventional construction mounted in any convenient manner at the ground level and secured to the upper end of well casing 2 which extends downwardly into the ground to form the soil retaining wall for the well. Discharge column 3 of conventional construction depends from pump head 1 and carries at its lower end one or more similar pump bowls 4. Intake pipe 5 and strainer 6 are mounted below pump bowls 4.

Each of the pump bowls 4 has in the upper portion thereof a central bearing 7 which is joined to the wall of bowl 4 by integrally formed vanes 8 to form annular liquid passage 9 which leads upwardly from impeller chamber 10 (Fig. 2) below bearing 7. Rotary impeller 12 is mounted in chamber 10 of the bowl, and as illustrated, is of the double shroud type comprising an inner or upper shroud 13 and an outer or lower shroud 14 joined together by integrally formed impeller vanes 15 to form a liquid passage between the shrouds. Impeller 12 has hub 16 formed integrally with shroud 13 to provide for a connection of the impeller to line shaft 17. Impeller 12 is provided with a rigid connection to line shaft 17 by annular wedge 18 which is driven between hub 16 and line shaft 17. Line shaft 17 is journalled by suitable bushings in bearings 7 of the various pump bowls 4 and is driven by electric motor 19 housed within pump head 1.

The above described structure is conventional and operated in the usual manner so that the well water entering strainer 6 and intake pipe 5 is lifted by impellers 12 through bowl passage 9 and discharge column 3 to pump head 1 from which it is discharged through elbow 21.

Sealing means are mounted in each of the various pump bowls closely beneath the lower end of the impeller skirt to minimize hydraulic losses and increase the life and efficiency of the pump. The sealing means disclosed herein comprises sealing ring 22 which is seated in annular recess 23 milled adjacent the top of the bore of each pump bowl and forming a seat into which the ring is pressed for cooperation with the impeller in an adjacent pump bowl. Sealing ring 22 is composed of two parts, one part being resilient to perform the sealing function and prevent the grinding action of any abrasive material, and the other being rigid to reinforce the ring and maintain its position in the pump bowl as well as to aid in assembly of the pump and to increase the life and efficiency of the ring. As illustrated in Figs. 2 and 3, ring 22 comprises an annular body 24 of suitable resilient material such as soft rubber and a ring or core 25 having a plurality of lugs 26 which may be integrally formed, as by casting, therewith, and extending between the upper and lower surfaces of the resilient body 24, which is bonded to the core 25 and the lugs 26. It will be noted that lugs 26 taper inwardly at each end to provide a relatively narrow end surface in the respective planes of the upper and lower surfaces of the ring body. In manufacture, the rings 22 are preferably molded and lugs 26 serve to position core 25 accurately in the mold so that the core is centered relative to the resilient body 24.

It is to be noted that ring 22 cooperates with the lower end of the impeller skirt to form a hydraulic seal to minimize the circulation loss from the high pressure zone above the impeller to the low pressure zone below the impeller. The clearance between the impeller and the seal is just enough to permit free movement of the impeller without dragging. A clearance of approximately 1/64" is usually desirable and the selected clearance is maintained by the adjustment of line shaft 17 with respect to pump bowls 4 and discharge cloumn 3 which is afforded by means of nut 27 (Fig. 1) and associated lock nut 28 which secure line shaft 17 to the rotor of motor 19.

As explained in greater detail in my application No. 62,265 referred to above, sealing rings of the general character referred to minimize wear and limit the characteristic circulation loss by avoiding the grinding action of any particles of sand, gravel or like which are carried between the impeller and the sealing ring. However, certain conditions may arise in the use of such sealing rings with respect to assembly and adjustment of the impeller on the line shaft with respect to the sealing ring, particularly where a series of impellers are employed and where the wedge method of fastening the impellers on the line shaft is used to obtain a permanent rigid connection therebetween. In this method of assembly in driving the wedge between the impeller and the line shaft, a resilient sealing ring may be deformed by the associated impeller so that it is difficult to ascertain when the impeller is positioned correctly with respect to the sealing ring. In long series of pump bowls, it has been found that sometimes an impeller will be positioned too far from the associated sealing ring so that the pump efficiency is decreased because of increased circulation loss, or an impeller will be forced into engagement with its sealing ring deforming the ring and placing an unnecessary load on the motor and causing unnecessary wear on the ring. Frequently, it has been found necessary to tear down and reassemble a series of pump units when such conditions existed.

Another condition may occur with the resilient sealing rings heretofore employed when motor operation is stopped and the hydraulic stretch existing in the line shaft is no longer counteracted by the opposing force of torque, so that the impellers are lowered into contact with their sealing rings. At this same time the return of the column of water above the impellers to the well causes the impellers to rotate quite rapidly in a reverse direction while forced against the sealing rings by the hydraulic stretch of the line shaft. As substantially all water is expelled from between the engaged surfaces, the friction of the surfaces causes galling of the sealing ring as well as some degree of deterioration because of the excessive heat generated.

Sealing ring 22 is constructed to provide against the contingencies referred to above, while retaining in a high degree the advantageous results obtained by presenting a resilient sealing surface to particles of abrasive material. Resilient body 24 of ring 22 effectively avoids the undesirable effects of abrasive material in the water being pumped, while core 25 and lugs 26 cooperate in overcoming the conditions noted above.

In assemblying the pump, lugs 26 provide a support for impeller 12 when wedge 18 is being driven in place so that no deformation of the sealing ring occurs and an impeller 12 can be assembled readily in the correctly adjusted position with respect to the associated sealing ring 22 irrespective of the number of impellers placed in series. Thus, not only can the pump be assembled more easily, but when assembled, the parts are positioned properly to obtain the desired minimum clearance between the impeller

skirts and sealing rings. Also, when the reverse rotation occurs after the motor is stopped and the hydraulic stretch of the line shaft forces the impellers against the sealing rings, the load on said sealing ring is borne by lugs 26 which not only prevent galling effectively and will not cause a large amount of heat to be generated, but also protect resilient body 24.

It is to be noted also that because the resilient and rigid parts of sealing ring 22 have portions of the same axial thickness, a more complete reinforcing action is obtained which effectively prevents collapsing of the ring and displacement thereof from its seat in the pump bowl. In addition to the advantages noted above, the construction of ring 22 also provides for economical manufacture.

In the form of the invention shown in Fig. 4, the sealing ring 22*a* comprises outer annular part 31 of suitable resilient material such as soft rubber, and inner annular part 32 of suitable rigid material such as hardened rubber, the two parts being bonded together. In manufacture, a plurality of sealing rings are made in cylindrical form on a mandrel or the like, the individual rings being cut off with the desired thickness. It is to be noted that in the assembled position of ring 22*a*, resilient outer part 31 is supported on three sides by rigid surfaces, only the sealing surface thereof being exposed. Also, rigid inner part 32 forms part of the bore of the pump bowl providing the liquid passage therethrough.

This sealing ring is also constructed to provide against the contingencies referred to above, while retaining in a high degree the advantageous results obtained by presenting a resilient sealing surface to particles of abrasive material. Outer resilient part 31 of ring 22*a* effectively avoids the undesirable effects of abrasive material in the water being pumped, while inner rigid part 32 cooperates therewith in the sealing function and in overcoming the conditions noted above.

In assembling the pump, inner rigid part 32 provides a support for impeller 12 when wedge 18 is being driven in place so that no deformation of the sealing ring occurs and an impeller 12 can be assembled readily in the correctly adjusted position with respect to the associated sealing ring 22*a* irrespective of the number of impellers placed in series, as noted in the description of the form of invention illustrated in Fig. 2. Also, when the reverse rotation occurs after the motor is stopped and the hydraulic stretch of the line shaft forces the impellers against the sealing rings, the load on said sealing ring is borne by hard inner ring 32 which not only resists galling effectively and will not cause a large amount of heat to be generated, but also protects resilient ring 31.

It is to be noted also that because the resilient and rigid parts of sealing ring 22*a* are of the same axial thickness throughout, a more complete reinforcing action is obtained which effectively prevents collapsing of the ring and displacement thereof from its seat in the pump bowl. In addition to the above advantages, the construction of ring 22*a* also adapts itself to economical manufacture.

In the form of the invention illustrated in Fig. 5, the sealing ring, the impeller, and the pump bowl are so related that any end thrust is taken directly between the bowl and the impeller. For this purpose, the sealing ring 22*b* is seated in a milled recess 23*b* of the bowl 4 with its upper surface substantially in the plane of an end surface of the bowl, and the impeller 12*b* has the end surface of its lower skirt 14*b* of a size to cause the outer portion thereof to overlap and face the bowl end surface, while the inner portion of the impeller end surface is in sealing relation with respect to the sealing ring. The sealing ring may be constructed as disclosed in my said co-pending application, Serial No. 62,265, and comprises a body portion 33 which may be molded about an inner core or hoop 34.

The operation and function of the structure shown in Fig. 5 are similar to those described in connection with the embodiments illustrated in Figs. 2–4.

The modified construction shown in Fig. 6 is generally similar to that illustrated in Fig. 5, in that the sealing ring, the impeller, and the pump bowl are so related that any end thrust is taken directly between the bowl and the impeller. The sealing ring 22*c* is seated in an annular recess 23*c* formed in an end surface of the bowl 4 with its upper surface substantially in the plane of the end surface, so that the sealing ring is supported at both sides and the bottom by the walls of the bowl defining the recess 23*c*. The impeller 12*c* has the end surface of its lower skirt 14*c* of a width to cause the inner portion thereof to overlap and face the bowl end surface, while the remainder of the impeller skirt end surface is in sealing relation with the ring 22*c*. The ring 22*c* is formed of soft rubber, and preferably has no reinforcing means as it is retained in place and in shape by the bowl. This type of structure enables economical manufacture and assembly and obtains the advantages noted with respect to the other constructions disclosed herein.

Having now described the principles of my invention as illustrated in the preferred embodiments thereof, it will be appreciated by those skilled in the art that various modifications and variations may be resorted to without departing from the spirit of my invention. It is to be understood, therefore, that I consider myself entitled to all such modifications and variations as fall within the scope of the claims appended hereto.

I claim:

1. In a deep well turbine pump, a vertically adjustable line shaft, a series of impellers carried by said line shaft, a series of pump bowls operatively associated with said series of impellers, sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween, and rigid stop means associated with each sealing ring and arranged to permit each impeller to contact its associated ring without substantially compressing the same, whereby said sealing ring is relieved from end thrust of said impeller, the vertical adjustment of said line shaft enabling simultaneous adjustment of said clearances.

2. In a deep well turbine pump, a vertically adjustable line shaft, a series of impellers carried by said line shaft, wedge means for securing each of said impellers on said line shaft, said wedge means being driven between the associated impeller and said line shaft to fasten the impeller to said line shaft by virtue of its wedging action, a series of pump bowls operatively associated with said series of impellers, sealing means associated with each of said impellers comprising

opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween, and rigid stop means associated with each sealing ring and arranged to permit each impeller to contact its associated ring without substantially compressing the same to relieve the sealing ring from end thrust of said impeller, whereby said stop means serve as gauges to facilitate initial individual setting of each of said impellers to thereby enable uniform clearances to be obtained, the vertical adjustment of said line shaft enabling simultaneous adjustment of said clearances.

3. In a deep well turbine pump, a vertically adjustable line shaft, a vertically arranged series of pump bowls, a series of impellers operatively mounted on said shaft in said bowls, sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween, said ring including rigid stop means arranged to permit each impeller to contact its associated ring without substantially compressing the same, whereby said sealing ring is relieved from end thrust of said impeller, the vertical adjustment of said line shaft enabling simultaneous adjustment of said clearances.

4. In a deep well turbine pump, a vertically adjustable line shaft, a vertically arranged series of pump bowls, a series of impellers operatively mounted on said shaft in said bowls, sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween, said sealing ring comprising an annular body of resilient material, and rigid thrust transmitting lugs extending between the end surfaces of said resilient body to permit each impeller to contact its associated ring without substantially compressing the same, whereby to absorb end thrust between said faces, the vertical adjustment of said line shaft enabling simultaneous adjustment of said clearances.

5. In a deep well turbine pump, a vertically adjustable line shaft, a series of impellers carried by said line shaft, a series of pump bowls operatively associated with said series of impellers, sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween, said sealing ring including an annular part of resilient material and an annular part of rigid material bonded together and having substantially the same axial thickness whereby said end face of said ring is in part resilient and in part rigid to permit each impeller to contact its associated ring without substantially compressing the same, whereby to transmit end thrust between the associated impeller and bowl, the vertical adjustment of said line shaft enabling simultaneous adjustment of said clearance.

6. In a deep well turbine pump, a vertically adjustable line shaft, a series of impellers carried by said line shaft, a series of pump bowls operatively associated with said series of impellers, sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween, and rigid stop means associated with each sealing ring and arranged to permit each impeller to contact its associated ring without substantially compressing the same to absorb endwise thrust between said faces, said stop means comprising overlapping rigid end surfaces of an associated impeller and bowl and serving as a gauge to facilitate initial individual uniform adjustment of said impellers, the vertical adjustment of said line shaft enabling simultaneous adjustment of said clearances.

7. In a deep well turbine pump, a vertical adjustable line shaft, a series of impellers carried by said line shaft, wedge means for securing each of said impellers on said line shaft, said wedge means being driven between the associated impeller and said line shaft to fasten the impeller to said line shaft by virtue of its wedging action, a series of pump bowls operatively associated with said series of impellers, sealing means carried by each of said bowls and comprising a resilient sealing ring having an end face presented to and normally spaced from its associated impeller to provide a flow restrictive clearance therebetween, and rigid stop means associated with each sealing ring and arranged to permit each impeller to contact its associated ring without substantially compressing the same to absorb endwise thrust between said faces, said stop means comprising overlapping rigid end surfaces of an associated impeller and bowl and serving as a gauge to facilitate initial individual uniform adjustment of said impellers, the vertical adjustment of said line shaft enabling simultaneous adjustment of said clearances.

8. In a deep well turbine pump; a vertically arranged series of pump bowls, a series of impellers operatively mounted in said bowls, sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween, and rigid stop means arranged to engage with and limit endwise movement of each impeller to prevent any substantial end thrust of said impeller against said sealing rings.

9. In a deep well turbine pump, a line shaft, a series of impellers individually mounted on said line shaft, a series of pump bowls operatively associated with said series of impellers; sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween; and rigid stop means arranged to engage with and limit endwise movement of each

impeller in the direction of said sealing means to prevent any substantial end thrust of said impellers against said sealing rings whereby to serve as gauges to facilitate initial individual uniform adjustment of each of said impellers, and to enable said impellers to be individually positioned on and secured to said line shaft in accurate positions to enable uniform clearances to be obtained.

10. In a deep well turbine pump, a line shaft, a series of impellers, wedge means mounting each of said impellers on said line shaft, said wedge means being driven between the associated impeller and said line shaft to fasten the impeller to said line shaft by virtue of its wedging action, a series of pump bowls operatively associated with said series of impellers, sealing means associated with each of said impellers comprising opposed faces formed respectively on adjacent impeller and bowl surfaces, one of said faces being rigid, a resilient sealing ring carried by the other of said faces and having an end face presented to and normally spaced from said rigid face to provide a flow restrictive clearance therebetween; and rigid stop means arranged to engage with and limit endwise movement of each impeller to prevent any substantial end thrust of said impellers against said sealing rings, whereby to serve as gauges to facilitate initial individual setting of each of said impellers and thereby enable uniform clearances to be obtained.

JAMES M. HAIT.

CERTIFICATE OF CORRECTION.

Patent No. 2,145,598. January 31, 1939.

JAMES M. HAIT.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, second column, line 2, claim 5, for the word "clearance" read clearances; line 25, claim 7, for "vertical" read vertically; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of June, A. D. 1939.

(Seal)

Henry Van Arsdale
Acting Commissioner of Patents.