United States Patent

Sieghartner

[15] **3,661,474**

[45] **May 9, 1972**

[54] LIQUID BOOSTER DEVICE

[72] Inventor: **Leonard J. Sieghartner**, Rock Island, Ill.

[73] Assignee: **Roy E. Roth Company**, Rock Island, Ill.

[22] Filed: **Feb. 10, 1970**

[21] Appl. No.: **10,279**

[52] **U.S. Cl.** 415/143, 415/501

[51] **Int. Cl.** **F04d 1/00**, F04d 1/06

[58] **Field of Search** 415/143, 203, 501

[56] **References Cited**

UNITED STATES PATENTS

682,939	9/1901	Ivens	415/501
1,004,015	9/1911	Goodner	415/501
2,875,698	3/1959	Roth	415/143
3,247,797	4/1966	Sieghartner	415/143
3,250,440	5/1966	Trout	415/143
3,385,225	5/1968	Hagemann	415/143

FOREIGN PATENTS OR APPLICATIONS

630,998	9/1927	France	415/501

Primary Examiner—Henry F. Raduazo

Attorney—Johnson, Dienner, Emrich, Verbeck & Wagner

[57] **ABSTRACT**

A liquid booster device integrally formed with a turbine pump for delivering a liquid at or near boiling point upwardly from a liquid reservoir to the pump inlet. The tubular casing of the liquid booster device is integrally formed with the case head of the pump and houses at least one booster impeller mounted on a shaft extension of the main pump's shaft.

A circular flange is formed at the main pump's inlet for mounting the combined turbine pump — liquid booster device at the top of the liquid reservoir such that the booster impeller is submerged in the liquid.

2 Claims, 7 Drawing Figures

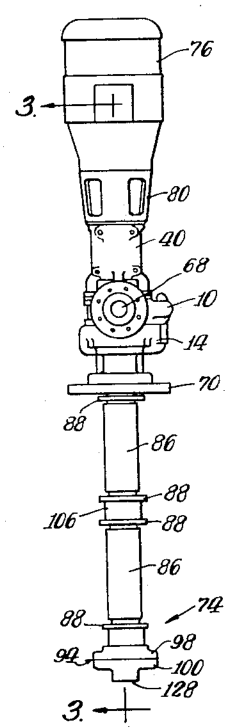


Fig. 3.

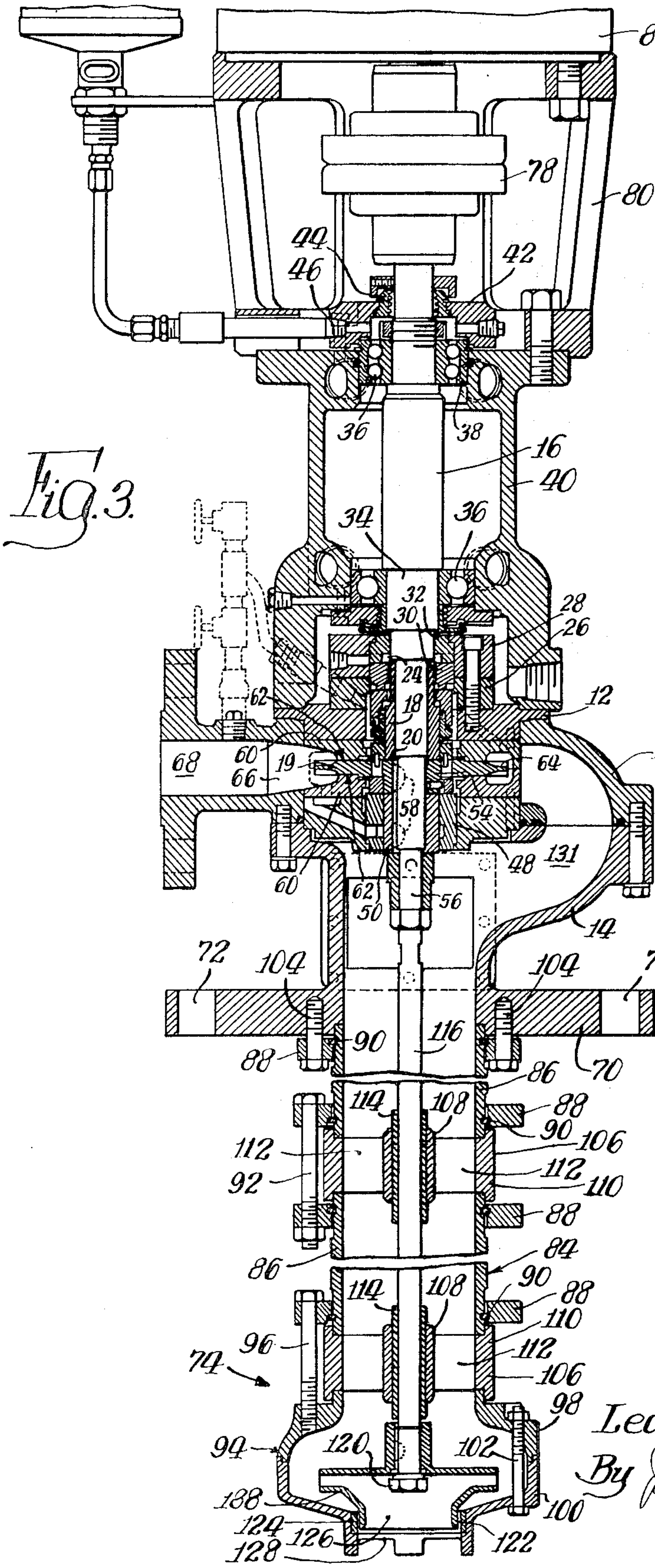
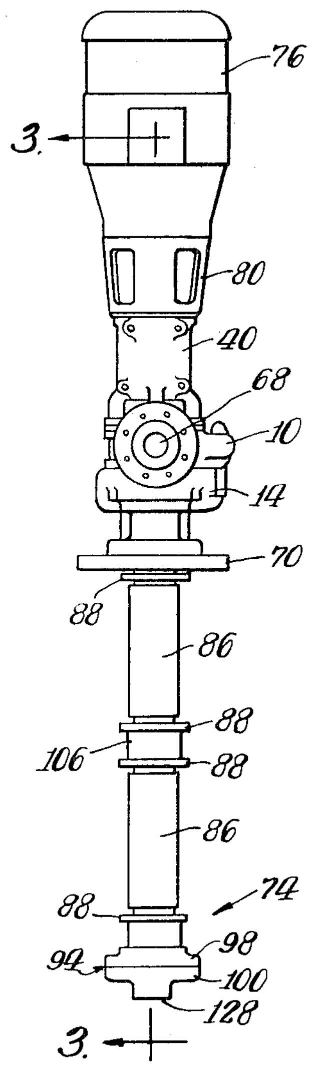


Fig. 1.



Inventor:-
Leonard J. Sieghartner,
By Johnson, Dienner, Emrich, Verbeck & Wagner
Attys.

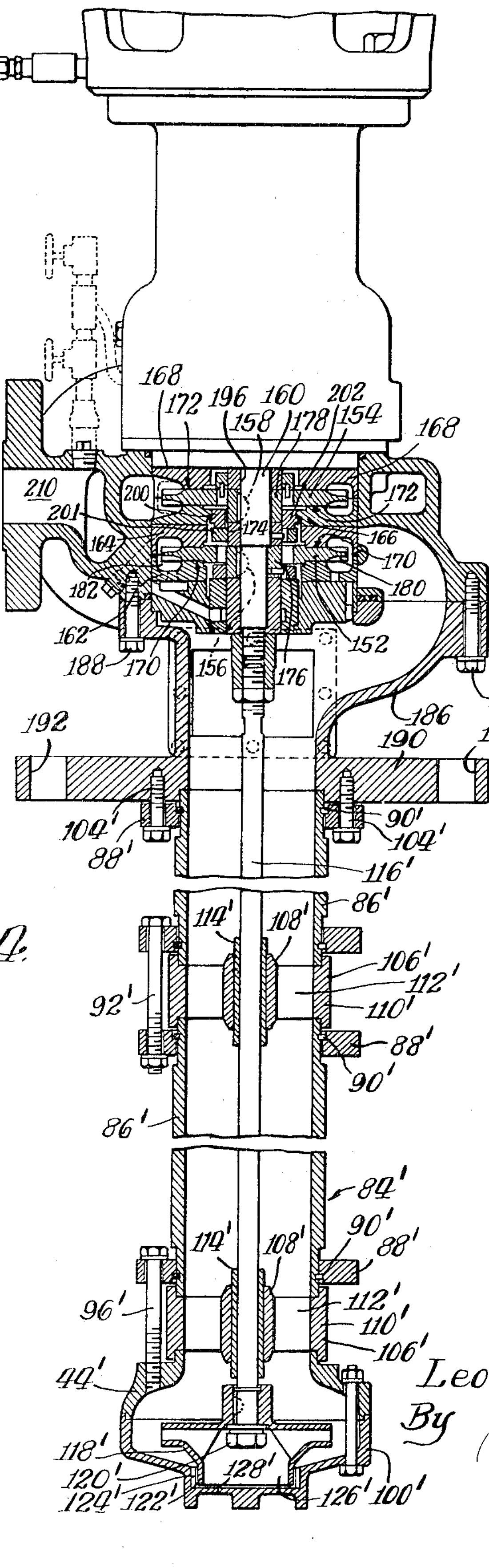
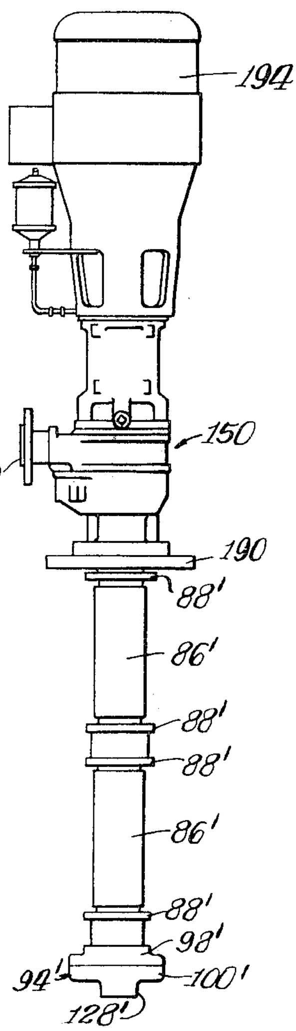


Fig. 4.

Fig. 2.



Inventor:-
Leonard J. Sieghartner
By Johnson, Dienner, Emrich, Verbeck & Wagner
Attys

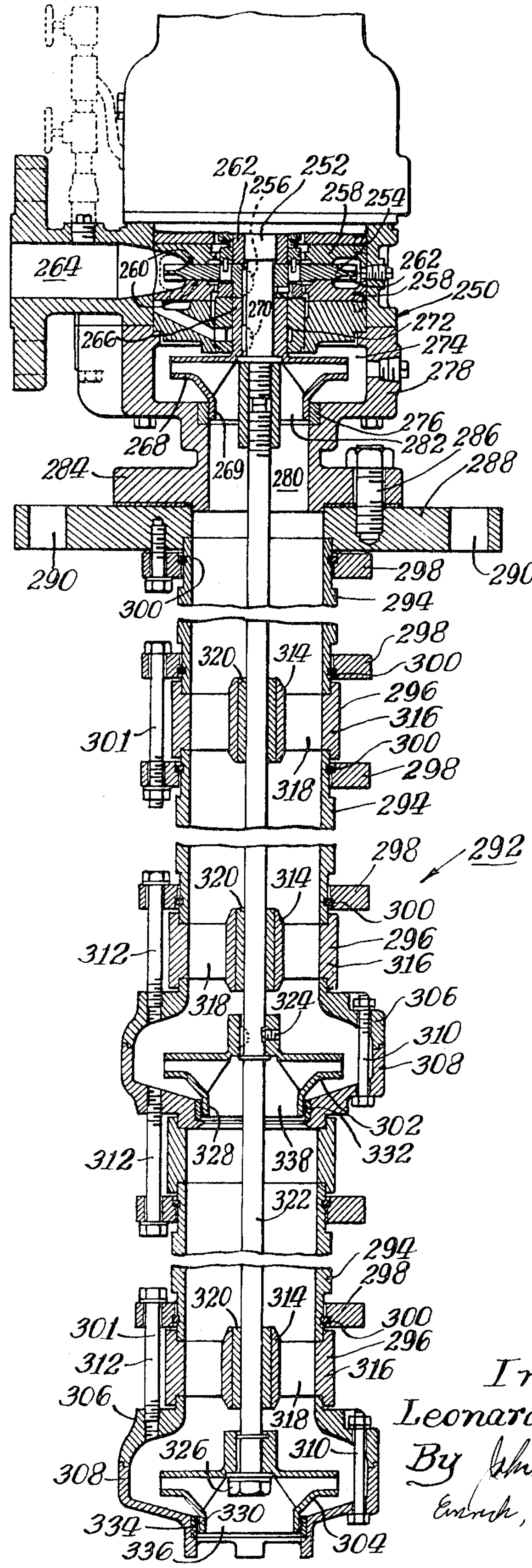


Fig. 5.

Inventor:-
Leonard J. Sieghartner,
By Johnson, Dienner, Emrich, Verbeck & Wagner
Attys.

Fig. 7.

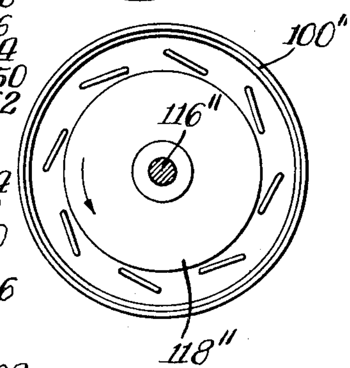
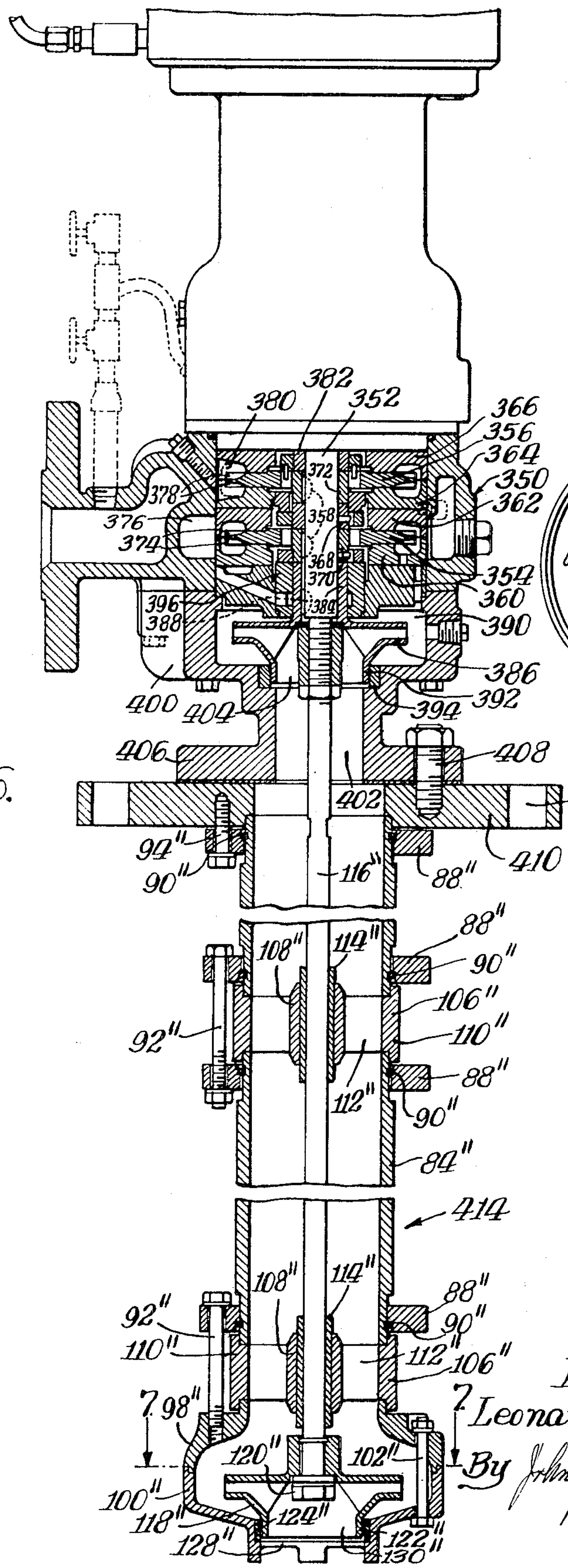


Fig. 6.



Inventor:-
Leonard J. Sieghartner,
By Johnson, Dienner, Emrich, Verbeck & Wagner
Attys.

LIQUID BOOSTER DEVICE

BACKGROUND OF THE INVENTION

This invention relates to pumps designed to handle liquids at or near the boiling point.

Liquids at or near the boiling point have significant vapor pressure which tends to oppose the external forces that move a liquid into the pump suction. Thus, it is necessary to apply an external force on the liquid greater than its opposing vapor pressure. One way of providing this external pressure is by elevating the storage tanks above the level of the pump.

However, for safety and other considerations it is desirable to have the storage tanks underground or at a lower elevation than the level of the pump. In the past, many arrangements, such as submersible pumps, foot valves, jets or self-priming pumps, have been tried to raise the liquid to the pump suction with only partial success.

This invention is intended to satisfy the need for a liquid booster device to raise a liquid at or near the boiling point from a storage tank to a pump at the required pressure without changing the liquid to a vapor and to operate in a consistent and dependable manner.

SUMMARY OF THE INVENTION

This invention is directed to a liquid booster device for raising a liquid at or near boiling point from a storage tank to a main pump, where the main pump is any conventional liquid pump capable of developing the higher heads required to deliver liquids for processing. The liquid booster device is integrally formed with the main pump, and comprises a tubular casing extending from the main pump's inlet and one or more booster impeller stages having impellers rotatably mounted on a shaft extension of the main pump's shaft.

A mounting flange is provided between the pump's inlet and the tubular casing for mounting the combined unit of the main pump and liquid booster device in such a manner that the liquid booster device will extend downwardly into the storage tank.

The required number of booster impellers spaced at selected intervals along the shaft extension to raise the liquid smoothly up the tubular casing is determined by volatility of the liquid and the depth of the storage tank.

BRIEF DESCRIPTION OF DRAWING

For a better understanding of this invention, reference is made to the accompanying drawing, in which:

FIG. 1 is a side elevational view of the First Embodiment of this invention;

FIG. 2 is a side elevational view of the Second Embodiment of this invention;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 1;

FIG. 4 is a partial sectional view of the Second Embodiment of this invention;

FIG. 5 is a partial sectional view of the Third Embodiment of this invention;

FIG. 6 is a partial sectional view of the Fourth Embodiment of this invention; and

FIG. 7 is a sectional view taken along the line 7—7 of FIG. 6.

FIRST EMBODIMENT

In FIGS. 1 and 3, the first embodiment of this invention is illustrated and includes a one-stage turbine pump having a casing 10 with an inboard head 12 and a case head 14, and a shaft 16. The one-stage turbine pump of FIGS. 1 and 3 is shown to illustrate one use of the present invention and forms no part of this invention.

A shaft sleeve 18 surrounds the shaft 16 and at 20 abuts the inboard end of the impeller 19. The opposite end of the sleeve abuts a shoulder 24 on the shaft 16. A stuffing box 26 and a gland 28 are positioned about shaft 16, and are fastened to in-

board head 12. A carbon stationary seat is provided at 30 and a quench bushing is provided at 32.

An enlarged diameter portion 34 of shaft 16 is journalled for rotation in an inboard bearing 36. The outer housing cap 42 holds the shaft-impeller assembly rigidly in an axial position by clamping the outer race through this snap ring against the end of the frame 40. A cap seal 44 is disposed about the shaft 16 within the cap 42. A lubrication fitting is provided at 46.

An annular stationary bushing 48 is disposed within the case 10 and surrounds an impeller spacer 50. The impeller spacer 50 abuts between the outer end of hub 54 of impeller 19 and the inner end of shaft coupler 56.

The turbine impeller 19 and impeller spacer 50 are fixed by Woodruff keys 58 or splines to rotate with the shaft 16. The impeller 19 rotates between wear rings 60 which cooperate with the opposite sides of the impeller 19 to form sealing surfaces 62. The impeller 19 has vanes or blades 64 opening from the opposite sides and peripherally from the impeller 19 and are operable in channel 66 where the liquid is discharged through pump outlet 68.

The lower end of case head 14 is provided with a circular mounting flange 70 with spaced mounting apertures 72 which may be readily fastened to a support in a storage tank or pipe such that the liquid booster device 74 extends downwardly and its lower portion submerged in the liquid stored in the tank.

The motor 76 which, for example, could be a standard Nema flange mounted type, is flexibly connected to the pump shaft 16 by means of a standard flexible coupling.

By having the pump bearings separate from the motor bearings, positive coupling alignment is easily obtained by the machined rabbet of adapter bracket 80 which interconnects pump frame 40 to motor frame 82.

The liquid booster device 74 of this invention is housed in a generally tubular casing 84 constructed by joining a plurality of column sections 86 together by means of clamp ring 88, snap ring 90 combination and clamp bolts 92, and by joining a bowl section 94 to the lowermost column section 86 by means of bolts 96. Bowl section 94 is made up of upper and lower members 98, 100 held together by clamp bolts 102. The uppermost column section 86 is secured to the mounting flange 70 by means of threaded bolts 104.

Intermediate the column sections 86 are bearing support members 106 having a tubular center portion 108 interconnected to the outer tubular portion 110 by a plurality of radial ribs 112. Mounted in the tubular center portion 108 of each bearing support member 106 is a bushing 114 positioned at spaced intervals along shaft extension 116 to prevent shaft whip.

An impeller 118 which is widely separated from the turbine pump inlet as depicted in FIG. 3, is mounted at the lowermost end of shaft extension 116 by means of lock nut 120. The hub 122 of impeller 118 rotates in bushing 124. Bowl section 94 has an inlet 128 which opens into the suction inlet 126 of the centrifugal impeller 118.

The impeller 118 can be any of a number of known impeller designs that will ease the liquid into motion and drive it up to the turbine inlet 131. The criteria in selecting the impeller 118 is that it should have a low disturbance on the liquid at or near boiling point (i.e. low pressure creating characteristics) so that the liquid will not be vaporized prior to entering the turbine inlet 131. A suitable impeller design which could be used for impeller 118 is disclosed in U.S. Pat. No. 2,875,698 to Leo C. Roth, which is assigned to the same assignee as this invention.

The embodiment of FIGS. 1 and 2 is mounted to the top of a liquid storage tank such that the lower end of liquid booster device 74 is submerged in the liquid. It is noted that it is not essential that the liquid booster 74 be mounted in a vertical orientation.

In the operation of the embodiment shown in FIGS. 1 and 2, the liquid enters the suction inlet 126 of impeller 118, where the liquid is smoothly stirred into motion and pushed up tubular casing 84 to the turbine stage constituted by turbine impeller 19 and is discharged through outlet 68.

SECOND EMBODIMENT

The second embodiment shown in FIGS. 2 and 4, depicts the invention combined with a two-stage turbine pump having a casing, generally designated by the reference numeral 150.

Turbine impellers 152, 154 are fixed by Woodruff keys or splines 156 and 158, respectively, to rotate with shaft 160. The impeller 152 rotates between outer and inner liners 162, 164 and the impeller 154 rotates between outer and inner liners 166, 168. The liners 162, 164 cooperate with the opposite sides of the impeller 152 to form sealing surfaces 170, and liners 166, 168 cooperate with the opposite sides of impeller 154 to form sealing surfaces 172.

An annular impeller spacer 174 is disposed between the hubs 176, 178 of the impellers 152 and 154, respectively. Impeller 152 has vanes or blades 180 in a liquid channel 182 opening from the opposite sides and peripherally from impeller 152.

The casing 150 has an outboard cover 186 secured to casing 150 by cap screws 188. Integrally formed with outboard cover 186 is a mounting flange 190 having mounting holes 192.

The inboard end of the two-stage turbine pump of FIGS. 2 and 4 is identical in construction to the one-stage turbine pump of FIGS. 1 and 3, and consequently, a description and showing of the inboard end has been omitted. Likewise, the two-stage turbine pump of FIGS. 2 and 4 could use the same coupling arrangement between the shaft 160 and the shaft of a motor 194 (FIG. 2) as is disclosed in the FIGS. 1 and 3 embodiment.

A shaft sleeve 196 surrounds the shaft 160 and abuts the inboard end of hub 178 of impeller 154. An annular stationary bushing 200 surrounds the hub 174 of impeller 154 and is disposed within the outer liner 166 for impeller 154. The bushing 200 has an external annular flange 202, which abuts endwise in an inboard direction against an internal annular flange of the liner 166. Bushing 200 cooperates with a floating ring 201 to seal off the turbine high pressure liquid from the low pressure stage, as fully disclosed in U.S. Pat. No. 3,154,020 to Leonard J. Sieghartner, which is assigned to the same assignee as this invention.

The liquid booster device 74′ shown in FIGS. 2 and 4 is identical in construction and operation to the liquid booster device 74 of FIGS. 1 and 3, and like parts in FIGS. 2 and 4 are identified by prime numbers. The tubular casing 84′ is supported downwardly from mounting flange 190 to form an integral unit with the two-stage turbine pump.

In operation of the pump shown in FIGS. 2 and 4, the liquid enters the suction inlet 126′ of impeller 118′ where the liquid is smoothly stirred into motion and pushed up tubular casing 84 to the first turbine stage constituted by impeller 152. The liquid passes to the second stage constituted by impeller 154 and exits through outlet 210.

THIRD EMBODIMENT

The third embodiment illustrating this invention is depicted in FIG. 5, which includes a centrifugal-turbine pump having a casing 250 and a shaft 252.

A turbine impeller 254 is fixed by a Woodruff key 256 to shaft 252 and rotates between wear rings 258, which cooperate with the opposite sides of the impeller 254 to form sealing surfaces 260. The impeller 254 has vanes or blades 262 opening from the opposite sides and peripherally from the impeller 254 for discharging the liquid under a high head through pump outlet 264.

The inboard end of the centrifugal-turbine pump of FIG. 5 is identical in construction to the one-stage turbine pump disclosed in the First Embodiment (FIG. 183) and consequently, the details of the inboard end have been omitted.

A shaft sleeve 262 surrounds the shaft 252 and abuts the inboard end of impeller 254. Abutting the outboard end of impeller 254 is the hub 266 of centrifugal impeller 268, which is fixed to shaft 252 by Woodruff key 270. The centrifugal impeller 268 rotates within the channel 274 and the hub 269 rotates in bushing 276. An annular stationary bushing 272 surrounds the hub 266 of impeller 268.

A case head 278 is attached to the main casing 250 and has an inlet 280 which opens into the suction inlet 282 of the centrifugal impeller 268.

The lower end of case head 278 is provided with a circular flange 284 which is fastened by bolts 286 to a circular mounting plate 288, having spaced mounting apertures 290 for mounting to a support at the top of liquid storage tank or reservoir in such a manner that the lower portion of liquid booster device 292 would be submerged in the liquid stored therein.

The liquid booster device 292 differs in construction from the liquid booster device 274 of the First and Second Embodiments by having an additional booster stage. The housing for liquid booster device is similarly constructed by joining together a plurality of column sections 294, bearing support members 296 and two bowl sections 298. The bearing support members 296 are sandwiched between adjacent column sections 294 and secured together by means of the combination clamp ring 298, snap ring 300 and clamp bolts 301. The bowl sections which house the pair of booster impellers 302 and 304, have two half members 306, 308 held together by clamp bolts 310, and are attached to the adjacent clamp rings 298 by bolts 312.

The bearing support members 296 comprise a tubular center portion 314 interconnected to the outer tubular portion 316 by a plurality of radial ribs 318. In the center tubular portion 314 is a bushing 320 positioned at spaced intervals along shaft extension 322 to prevent shaft whip.

The upper impeller 302 is mounted on shaft extension 322 at its approximate mid-length and is fixed thereto by set screw 324. The lower impeller 304 is secured on the lower end of shaft extension 322 by lock nut 326. The upper end of shaft extension 322 is secured to the lower end of shaft 252 and thus rotates therewith. When shaft extension 322 is driven, upper and lower impellers 302, 304 are likewise driven and their respective hubs 328, 330 rotate in bushings 322, 334, respectively.

The upper and lower impellers 302, 304 could be any of a number of known impeller designs that will ease the liquid into motion and drive it up to the centrifugal impeller inlet 282, for example, see Roth U.S. Pat. No. 2,875,698. **The criteria for designing such an impeller is that it has low pressure creating characteristics to avoid vaporizing the liquid being pumped. The impellers** 268, 302 **and** 304 **are widely separated and the spacing between impellers** 268, 302 **and** 304 **is determined by the volatility of the liquid being handled, for it is essential that the vaporization of the liquid be avoided.**

In the operation of the Third Embodiment as shown in FIG. 5, liquid enters the suction inlet 336 of lower booster impeller 304, where it is delivered up to suction inlet 338 of upper booster impeller 302, where it is boosted up to suction inlet 282 of centrifugal impeller 268. The liquid then passes from the centrifugal stage to the turbine stage constituted by Turbine impeller 254 and is discharged through outlet 264.

FOURTH EMBODIMENT

The fourth embodiment illustrating this invention is depicted in FIG. 6, which includes a two-stage turbine pump having a casing 350 and a shaft 352.

Turbine impellers 354 and 356 are fixed by Woodruff keys 358 to rotate with shaft 352. Impeller 354 rotates between outer and inner levers 360, 362, and impeller 356 rotates between outer and inner liners 364, 366. An annular impeller spacer 368 is disposed between the hubs 370, 372 of the respective impellers 364, 366. The impeller 354 has vanes or blades 374 opening from the opposite sides which operate within channel 376. The impeller 356 has vanes or blades 378 opening from the opposite sides which operate within channel 380.

The inboard end of the two stage turbine pump of FIG. 6 is identical in construction to the one-stage turbine pump disclosed in the First Embodiment (FIGS. 1 and 3) and consequently, the details of the inboard end have been omitted.

A shaft sleeve 382 surrounds the shaft 352 and abuts the inboard end of hub 372 of impeller 356. Abutting the outboard end of impeller 354 is hub 384 of centrifugal impeller 386, which is fixed to shaft 352 by Woodruff key 388. The centrifugal impeller 386 rotates within the channel 390 and hub 392 rotates in bushing 394. An annular stationary bushing 396 surrounds the hub 384 of impeller 386.

A case head 400 is attached to the main casing 350 and has an inlet 402 which opens into the suction inlet 404 of the centrifugal impeller 386. The lower end of case head 400 is provided with a circular flange 406 which is fastened by bolts 408 to a circular mounting plate 410, having spaced mounting apertures 412 for mounting to a support at the top of a liquid storage tank or liquid reservoir.

Extending downwardly from mounting plate 410 is a liquid booster device 414, which is identical in construction and operation as liquid booster device 74 depicted in the FIGS. 1 and 3 embodiment. Consequently, a description of its construction would be repetitive and like parts will be identified by using double prime numbers.

Although this invention is not limited to a particular type of impeller, it is important that the impeller 118'', like impellers 118 and 118', be of a design which will ease the liquid smoothly into motion and deliver it up the tubular casing 84'' to the outside integrally mounted turbine pump.

FIG. 7 depicts a suitable design for the casing 100'' for impeller 118'', namely a diffuser type, that can be used in practicing this invention. Alternatively, circular type or volute type casings could be used.

It is to be understood that if the material handled is sufficiently volatile or the storage tank is quite deep, a multiplicity of booster impeller stages will be used.

I claim:

1. A liquid booster device for delivering a liquid upwardly from a liquid reservoir to the inlet of a turbine pump, comprising a shaft extension coupled to the shaft of a turbine pump, an impeller having low pressure creating characteristics fixedly mounted on said shaft extension in a widely separated relation with said turbine pump inlet, a tubular casing disposed about said shaft extension and said impeller and having its upper open end secured to the inlet of the turbine pump to form an integral housing therewith, and means for mounting said integral housing in an upright orientation such that said tubular casing extends downwardly into the liquid reservoir, where said tubular casing includes at least one bearing support member for rotatably supporting said shaft extension disposed between said impeller and the coupling between said shaft extension and the shaft for the turbine pump.

2. A liquid booster device as defined in claim 1, wherein said tubular easing further includes a bowl section surrounding the periphery of said impeller and having a bushing for rotatably supporting the hub of said impeller.

* * * * *