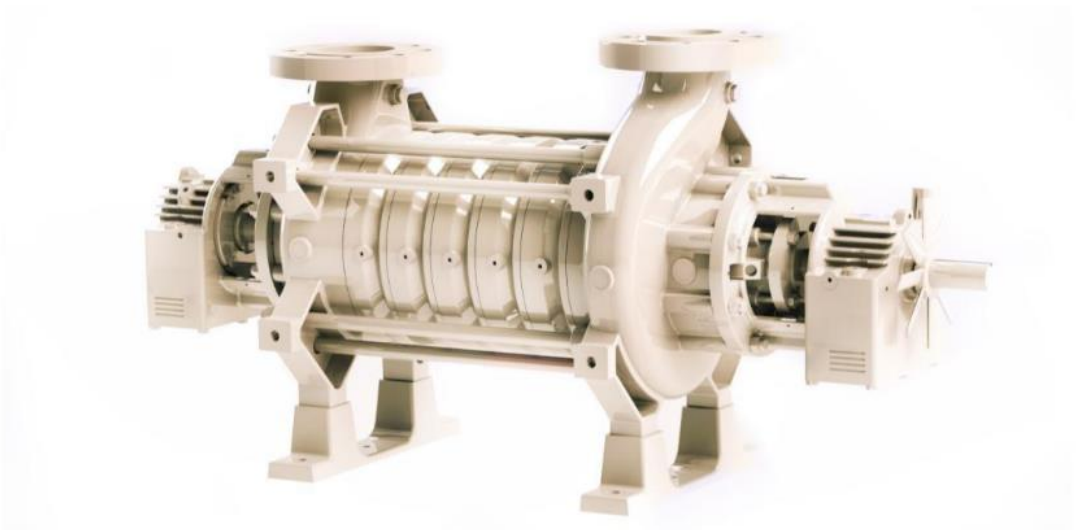
F O M A C

Multi-stage Centrifugal Booster Pumps operation manual



Maintenance

Maintenance precautions

WARNING:

- This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal unless explicitly stated in this manual.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures in order to eliminate the possible exposure to any hazardous or toxic fluids. Wear the proper personal protective equipment. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. You must handle and dispose of pumped fluid in compliance with the applicable environmental regulations.

Maintenance schedule

The preventive maintenance section must be adhered to in order to keep the applicable ATEX classification of the equipment. Failure to follow these procedures will void the ATEX classification for the equipment.

Maintenance inspections

A maintenance schedule includes these types of inspections:

- Routine maintenance
- Routine inspections
- Three-month inspections
- Annual inspections

Shorten the inspection intervals appropriately if the pumped fluid is abrasive or corrosive or if the environment is classified as potentially explosive.

Routine maintenance

Perform these tasks whenever you perform routine maintenance:

- Lubricate the bearings.
- Inspect the seal.

Routine inspections

Perform these tasks whenever you check the pump during routine inspections:

- Check for unusual noise, vibration, and bearing temperatures.
- Check the pump and piping for leaks.
- Analyze the vibration.
- Check the seal chamber and stuffing box for leaks.
  - Ensure that there are no leaks from the mechanical seal.
  - Adjust or replace the packing in the stuffing box if you notice excessive leaking.
- Check that there is no leakage from the mechanical seal.

Three-month inspections

Perform these tasks every three months:

- Check that the foundation and the hold-down bolts are tight.
- Check the shaft alignment, and realign as required.

Annual inspections

Perform these inspections one time each year:

- Check the pump capacity.
- Check the pump pressure.
- Check the pump power.

If the pump performance does not satisfy your process requirements, and the process requirements have not changed, then perform these steps:

1. Disassemble the pump.
2. Inspect it.
3. Replace worn parts.

Bearing maintenance

Bearing replacement

- The end suction arrangement uses a silicon carbide sleeve bearing which is retained in a holder integral with the end suction casing.
- The radial suction arrangement uses a bearing housing identical to the bearing housing on the discharge side but with a single row ball bearing for radial loads.
- The discharge side bearing housing has back to back angular contact thrust bearings and the 5" (125mm) discharge size and larger has a cooling fan mounted on hte pump shaft..
- Clean and check condition of all parts that have been removed. When in doubt, components should be replaced. Wearing parts (ball bearings) and seals must always be replaced.
- If parts or half-open pumps are to be stored for any length of time, they must be protected from dirt and corrosion.

Maintenance of Bearings

OIL LUBRICATED BEARINGS

WARNING:
Make sure that the unit cannot roll or fall over and injure people or damage property.

After the pump has been installed, flush the housing to remove dirt, grit, and other impurities that may have entered the bearing housing during shipment or installation; then refill the housing with proper lubricant.

Note: Do not fill the oil reservoir of the bearing frame through the vent or through the oiler housing without using the oiler bottle. The oil level will be maintained by the Trico oiler.

Acceptable Lubricants

The table below lists some commonly available oils that meet this specification.

Brand	Lubricant Type
Chevron	GST Oil 68
Exxon Mobile	Teresstic EP 68
	DTE 26 300 SSU @ 100°F (38°C)
Shell	Tellus Oil 68
Sunoco	Sunvis 968
Royal Purple	SYNFILM ISO VG 68 Synthetic lube

FM Ball Bearings				
Pump size	65-200	100-250	125-280	150-330
Initial Fill per Bearing Housing - Oil (US pt, l)	3.4 / 1.6	3.4 / 1.6	5.3 / 2.5	5.3 / 2.5
Bearing - Driver End	7408 BCBM	7409 BCBM	7311 BECBM	7214 BECBM
Bearing - Outboard (ES)[2]	SiC/SiC	SiC/SiC	SiC/SiC	SiC/SiC
Bearing - Outboard (RS)	6408	6409	6311	6214
Maximum permissible surface temperature measured at the 12 o'clock (top of bearing housing) position (^{O}F, ^{O}C)	180 / 82	180 / 82	180 / 82	180 / 82

Mechanical-seal maintenance

WARNING:
The mechanical seal used in an ATEX or Ex-classified environment must be properly certified. Prior to startup, make sure that all areas that could leak pumped fluid to the work environment are closed.

CAUTION:
Never operate the pump without liquid supplied to mechanical seal. If you run a mechanical seal dry, even for a few seconds, this can cause seal damage. Physical injury can occur if a mechanical seal fails.

Cartridge-type mechanical seals

Cartridge-type mechanical seals are commonly used. Cartridge seals are preset by the seal manufacturer and require no field settings. Cartridge seals installed by the user require disengagement of the holding clips prior to operation, allowing the seal to slide into place. If the seal has been installed in the pump by KJ, these clips have already been disengaged.

Other mechanical seal types

For other types of mechanical seals, refer to the instructions provided by the seal manufacturer for installation and setting.

Before you start the pump

Check the seal and all flush piping.

Disassembly

Introduction

The section on disassembly will address the bearings, mechanical seal, balance drum and balance drum stator as well as the complete pump. Where the disassembly is the same for end and radial suction pumps, no distinction will be made. When the disassembly is different, it will be identified for either end or radial suction configuration.

1 Product lubricated bearing

Disassembly precautions

WARNING:

- This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal unless explicitly stated in this manual.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures in order to eliminate the possible exposure to any hazardous or toxic fluids. Wear the proper personal protective equipment. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. You must handle and dispose of pumped fluid in compliance with the applicable environmental regulations.
- A small amount of liquid will be present in certain areas like the seal chamber.

NOTICE:

- Avoid injury. Worn pump components can have sharp edges. Wear appropriate gloves while handling these parts.
- Always wear the proper Personal Protective Equipment (PPE).
- Make sure that all replacement parts are available before you disassemble the pump for overhaul.
- Make sure that no damage occurs to any part during disassembly that will impede the removal of other parts. For example, damage to the shaft that makes it difficult to remove a part that must slide over that part of the shaft.

Required Tools

Metric Wrenches (Hex and Open Ended)	Torque Wrench with Metric Socket
Screwdriver	Dial Indicator
Lifting Slings	Metric Micrometers (Inside and Outside)
Soft Faced Hammer	Cleaning Agents and Solvents
Induction Bearing Heater	Feeler Gauges
Brass Drift Punch	Metric Allen Wrenches
Brass Drift Punch	Files
Spanner Wrench	Emery Cloth

Disassembly

WARNING:
Make sure that the unit cannot roll or fall over and injure people or damage property.

1. Shut off all valves controlling flow to and from pump.
2. Drain liquid from piping. Flush pump if necessary.
3. Lock out power to the driver.
4. Disconnect all auxiliary piping and tubing.
5. Remove coupling guard.
6. Disconnect coupling.
7. Unbolt the pump from the piping system and baseplate and remove pump from baseplate.
8. Drain oil from the bearing housing(s) before inverting the pump.

Disassembly of suction end bearing

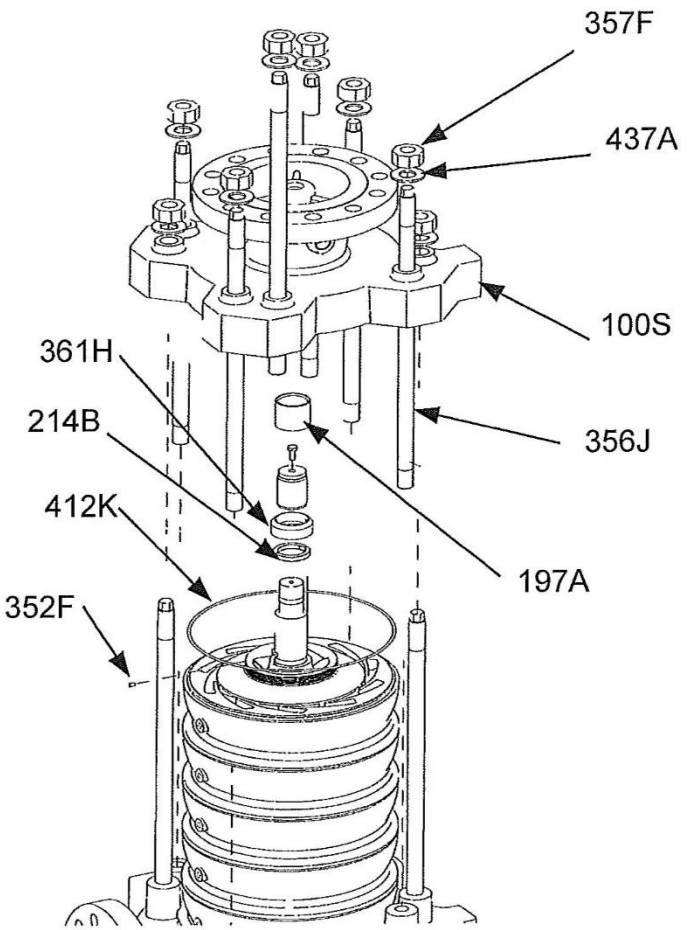
End suction pump - item 117 (sleeve bearing)

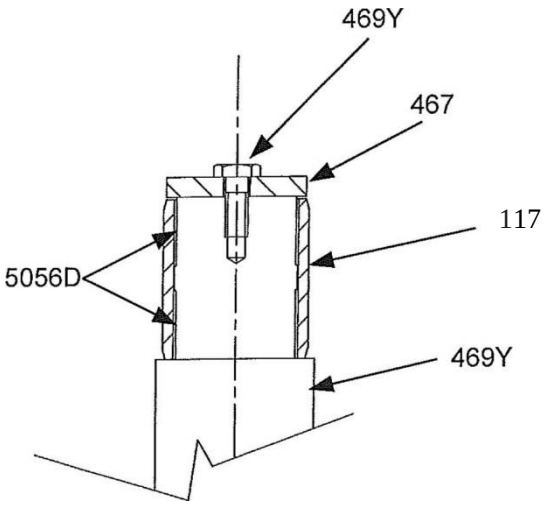
See relevant sectional drawing

NOTICE: It is not recommended to remove the product lube bearing (197A) unless it is worn or damaged.

NOTICE: Replacement of this bearing requires removal of the pump from the pipework and baseplate.

1. Unbolt the pump from the piping system and baseplate.
2. Support the pump vertically with the suction casing uppermost.
3. Remove the balance line and any seal flush piping.
4. Remove the tie rod nuts (357F) and tie rod washers (437A) on the suction end of pump.
5. Remove suction casing (100S). Bearing 197A will be in the suction casing. Remove the o-ring (412K).
6. Remove capscrew (469Y) and retaining plate (467).
7. Remove sleeve bearing (117) and tolerance rings (505D) from the end of the shaft.
8. Inspect the bearing sleeve for damage and check the clearance between the sleeve bearing and the stationary bearing.
9. Unless the stationary bearing (197A) is worn or damaged it should not be removed from the suction casing.
10. If necessary, remove stationary bearing (197A) from the suction casing being careful to avoid damage to the casing..

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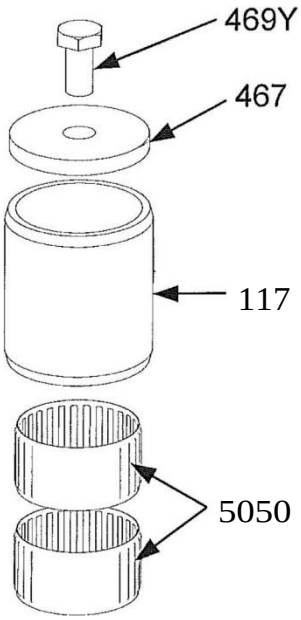
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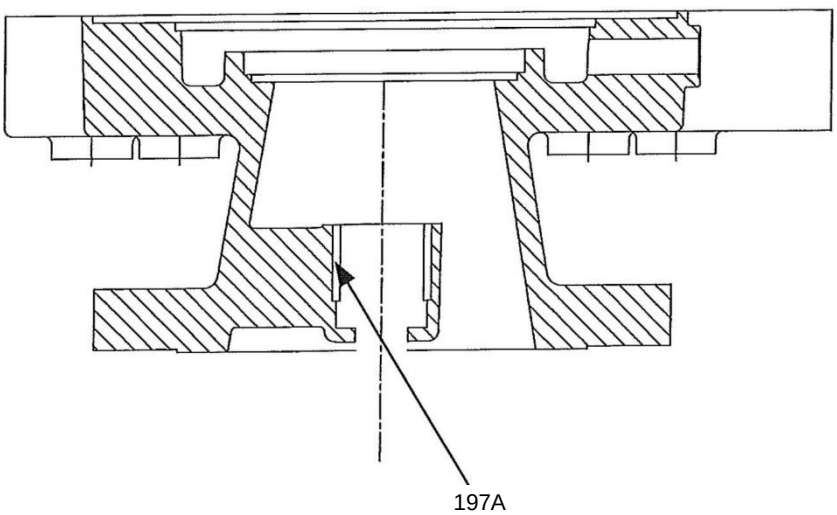
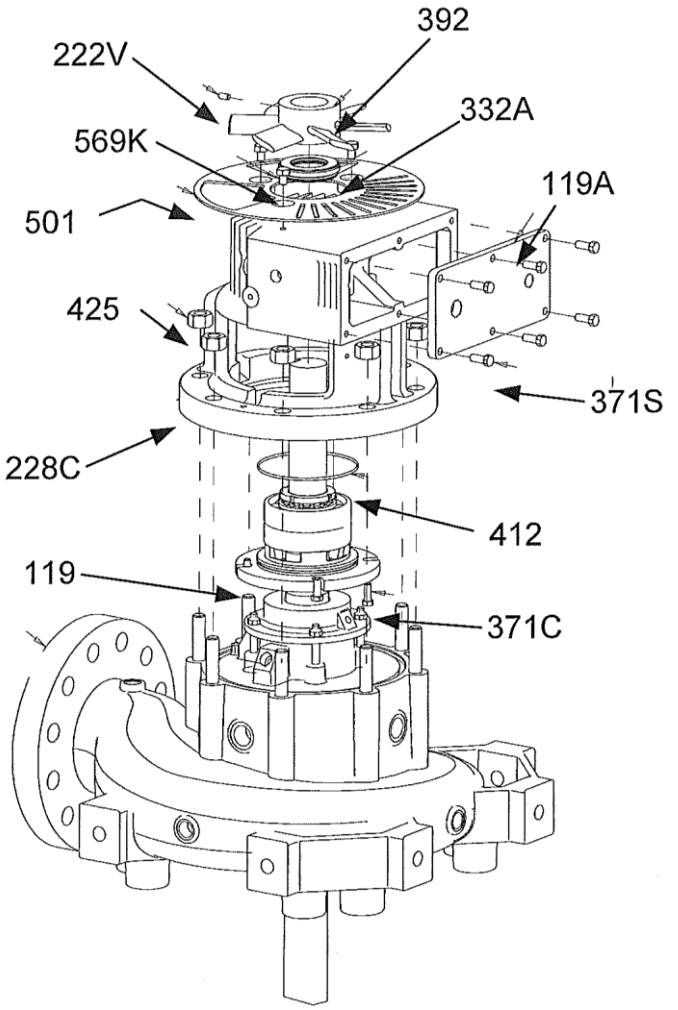

197A

Disassembly of discharge end bearing

End and radial suction pumps - item 409 (ball bearing)

1. Make sure that there is adequate access around the pump for inspection and maintenance. Pump must be properly secured and stable before working on it.
2. Remove coupling halves.
3. Remove seal guards (499).
4. Remove cooling fan (392) if applicable, by loosening set screw (222V).
5. Disconnect any flush piping from the mechanical seal gland.
6. Unscrew nuts (425) and back off the bearing bracket (228C) using the jacking screw (418).
7. Unscrew capscrews (371C) and confirm that the bearing housing cover (119) is free to move.
8. Remove bearing housing (228C).
9. After the bearing bracket (228C) has been removed the shaft can be moved freely in an axial direction (approx. 1/8”). Standard shaft seals can absorb this adjustment without their function being impaired. In the case of special shaft selas, please follow the Operating Instructions of the seal.
10. Remove the bearing housing cover o-ring (412). Do not reuse the o-ring.

11. Bend back the lock washer tab (382) and remove bearing nut (136A) and lock washer (382).
12. Remove ball bearings (409) with the bearing puller.



Disassembly of the mechanical seal - end and radial suction pumps

Mechanical seals are located on the suction side (RS configuration) and discharge side (RS and ES configurations). Mechanical seals are cartridge type seals and these instructions refer to cartridge seals. If other seals are used, refer to the seal manufacturer's instructions.

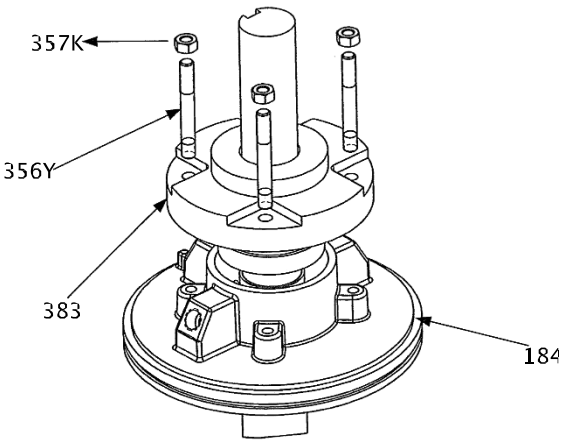
WARNING:
The mechanical seal used in an Ex-classified environment must be properly certified. Prior to startup, make sure that all areas that could leak pumped fluid to the work environment are closed.

CAUTION:
Never operate the pump without liquid supplied to mechanical seal. If you run a mechanical seal dry, even for a few seconds, this can cause seal damage. Physical injury can occur if a mechanical seal fails.

See relevant sectional drawing and mechanical seal vendor's installation instructions.

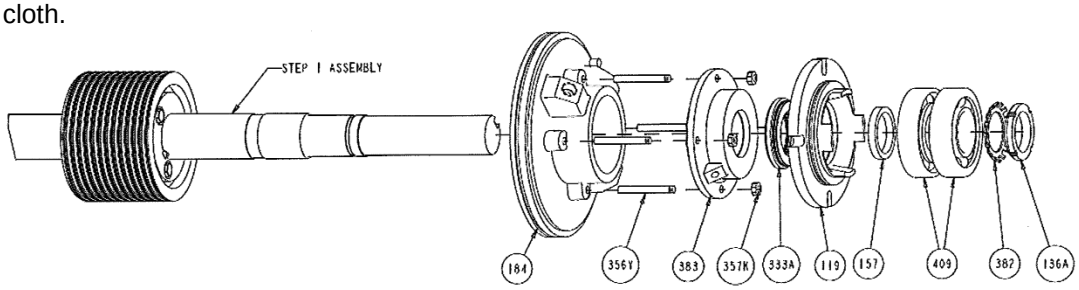
1. Remove the seal guards (499). These are not shown but cover the openings in the bearing frame.
2. Disconnect any seal flush piping connected to the gland.
3. Locate and reinstall setting clips and clip screws from initial installation if seal is to be reinstalled. This is necessary to properly install seal.

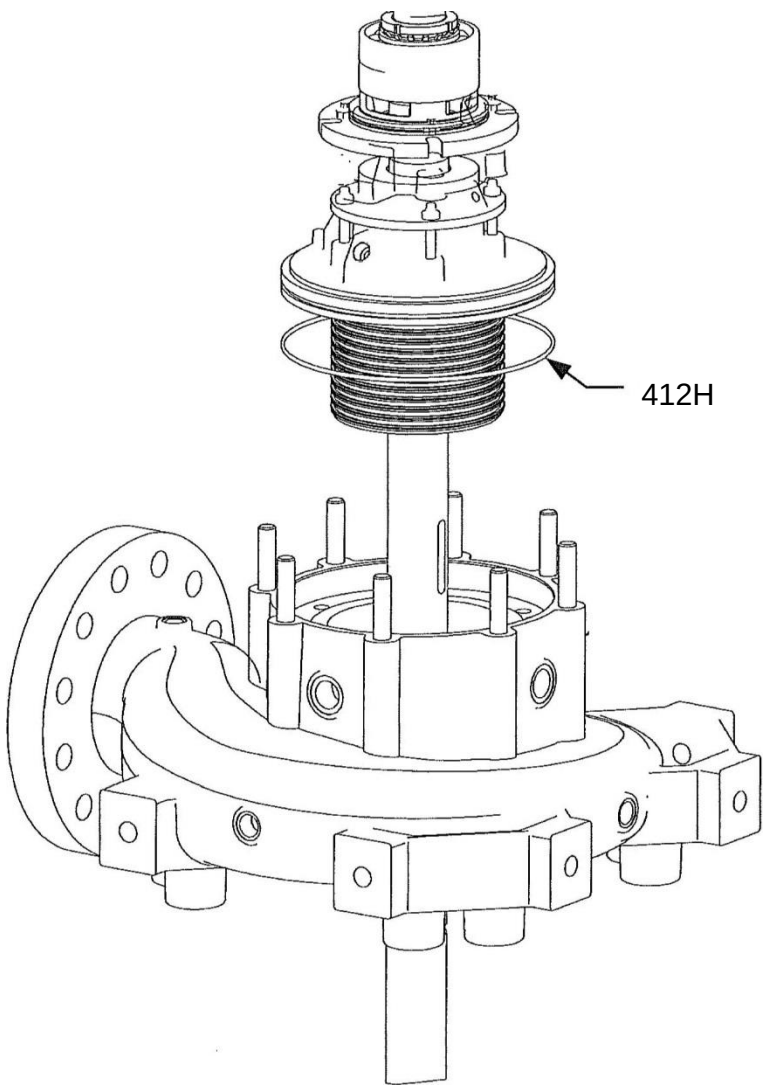
4. Remove the bearings, following appropriate bearing removal instructions above depending on seal location and pump configuration (item 409 and/or item 112).
5. Loosen the set screws holding the seal to the shaft.
6. Remove nuts (357K) holding the mechanical seal (383) to the seal chamber housing (184).
7. Slide entire cartridge seal assembly over the shaft to remove it from the pump.



Disassembly of the balance drum rotor and stator - end and radial suction pumps

1. Make sure that there is adequate access around the pump for inspection and maintenance. Pump must be properly secured and stable before working on it.
2. Remove the thrust end bearing housing as noted in instructions for removal of the thrust bearing (item 409).
3. Remove the mechanical seal and gland as noted in instructions for removal of the mechanical seal.
4. Seal chamber (184) and seal chamber o-ring (412H) can now be removed from the discharge casing (100D). Pull the housing toward the shaft end axially.
5. Remove the capscrews (372H) holding balance drum locking plate (519) to the balance drum (300).
6. Remove balance drum locking plate (519) and balance drum locking plate key (178R).
7. Use a permanent marker to place an alignment mark on the shaft and balance drum.
8. Brace the shaft to prevent it from rotating. Insert threaded rods in the balance drum holes and rotate the balance drum by 30º to clear the locking tabs on the shaft.
9. Remove balance drum and balance drum o-ring (412X) using the threaded rod. Do not reuse balance drum o-ring.
10. Insert threaded rods into the balance drum stator and remove axially. Remove balance drum stator (300A) and balance drum stator o-ring (496U). Do not reuse balance drum stator o-ring.
11. Inspect visible portion of the shaft and remove any burrs or scratches with a file and emery cloth.

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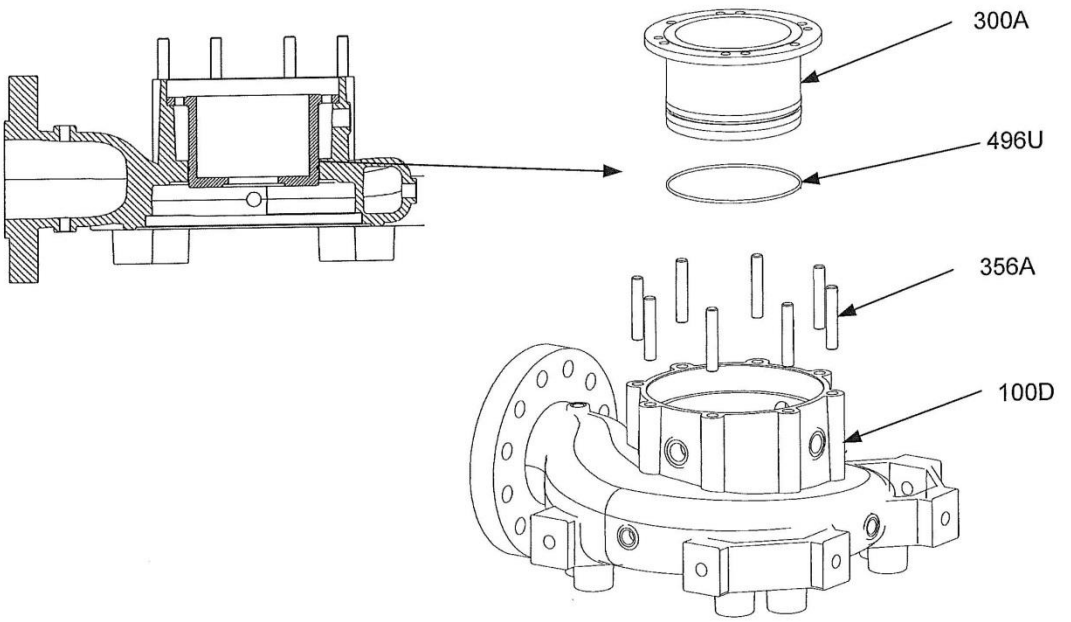
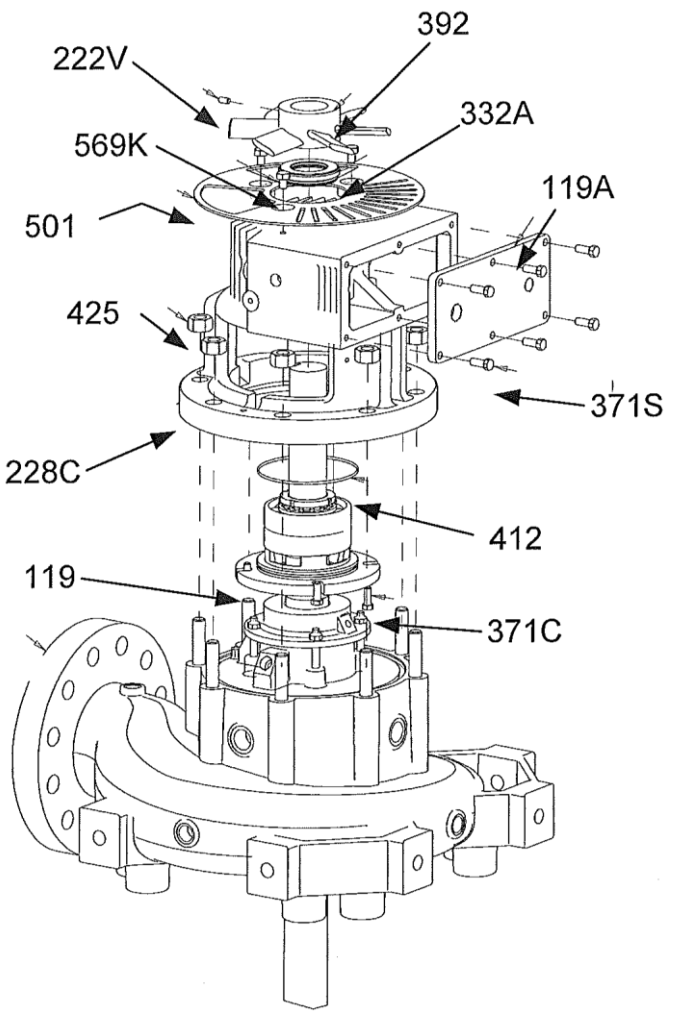




Disassembly of complete pump

End suction pump

See relevant sectional drawing.

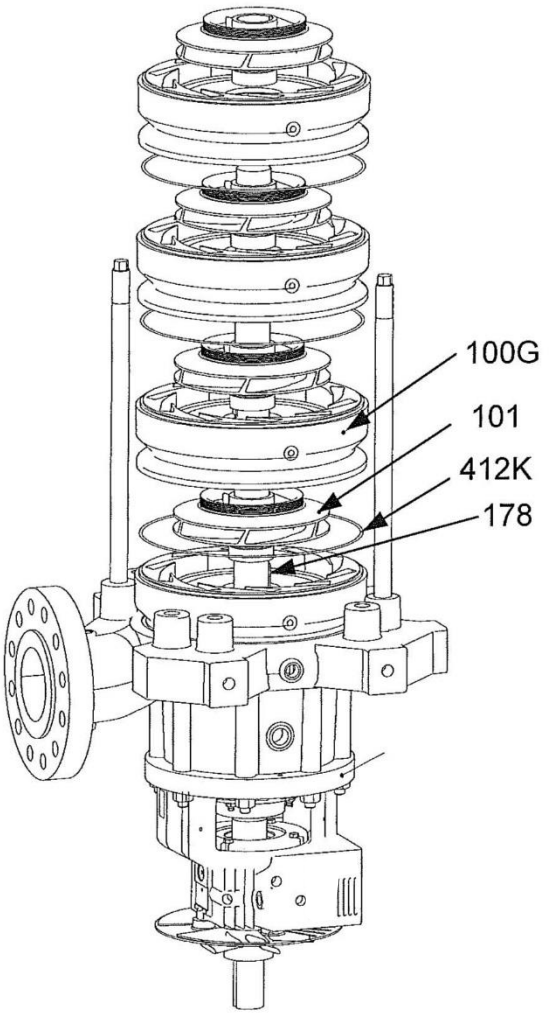
To dismantle the whole pump for maintenance work, place it in a vertical position with the suction nozzle facing upwards. It is important that the pump is secured and stable and supported without damaging the bearing housing. A workbench with a hole approximately 1/2" larger than the shaft is helpful in such cases. A hoist or a second person is required for a safe disassembly.

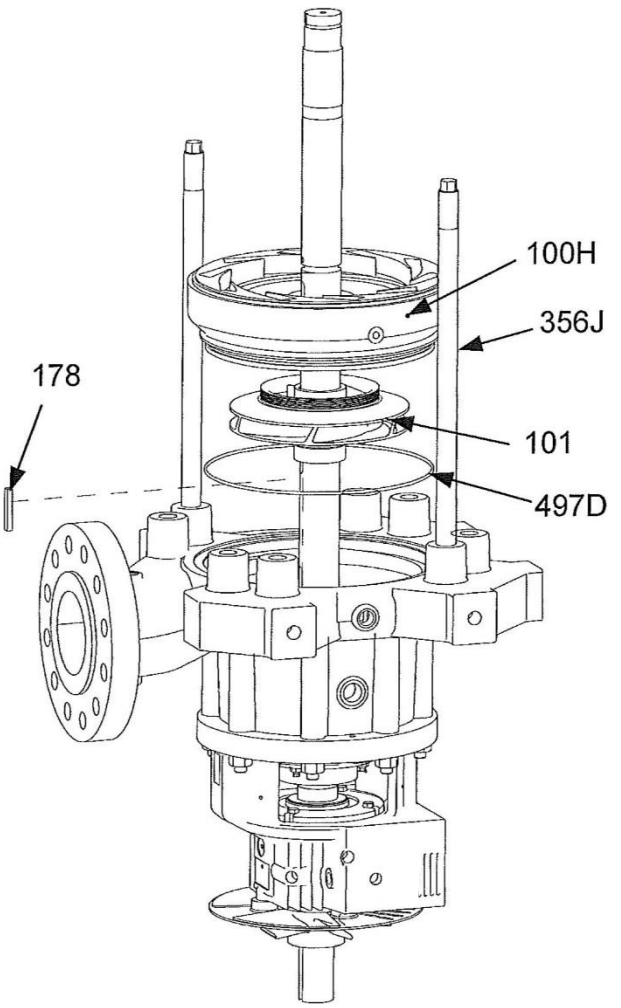
WARNING:
Make sure that the unit cannot roll or fall over and injure people or damage property.

NOTICE:
The pump must be dismantled and assembled in the vertical position.

1. Loosen tie rod nuts (357F) at both ends and remove tie rods (356J). Note: the tie rods are threaded into the discharge casing and must be removed by unscrewing the tie rods using the flats machined into their surface.
2. Remove suction casing (100S) and remove o-ring (412K).
   It is not recommended to remove the product lube bearing unless worn or damaged.
3. Loosen retaining ring set screw (352F) and remove the retaining ring (361H) and split ring (214B).
4. Remove impeller (101), impeller key (178), stage casings (100G) and final stage casing (100H) along with stage casing o-rings (412K) and discharge casing o-ring (497D). This step must be done stage by stage down to the discharge casing (100D). Do not reuse o-rings.
5. Invert the pump so the bearing housing (228C) faces upward position.
6. Remove seal guards (499).
7. Remove cooling fan (392) by loosening set screw (222V) if applicable.
8. Disconnect any flush piping from the mechanical seal gland.
9. Unscrew nuts (425) and back off the bearing bracket (228C) using the jacking screw (418).
10. Unscrew capscrews (371C) and confirm that the bearing housing cover (119) is free to move.
11. Remove bearing bracket (228C).
    IMPORTANT: After the bearing bracket (228C) has been removed, the shaft can be moved freely in an axial direction approximately 1/8". Standard shaft seals can absorb this adjustment without their function being impaired. For special shaft seals, follow the Operating Instructions of the seal.
12. Remove the bearing housing cover o-ring (412). Do not reuse the o-ring.
13. Bend back the lock washer tab (382) and remove the bearing nut (136A) and the lock washer (382).
14. Remove ball bearings (409) with the bearing puller.
15. Remove the mechanical seal and gland as noted in the instructions for removal of the mechanical seal.
16. Remove the seal chamber (184) and seal chamber o-ring (412H) from the discharge casing (100D).
    Pull the housing toward the shaft end axially.
17. Remove cap screws (372H) that hold the balance drum locking plate (519) to the balance drum (300).
18. Remove balance drum locking plate and balance drum locking plate key (178R).
19. Use a permanent marker to place an alignment mark on the shaft and balance drum.
20. Brace the shaft to prevent it from rotating. Insert threaded rods in the balance drum holes and rotate the balance drum by 30º to clear the locking tabs on the shaft.
21. Remove balance drum and balance drum o-ring (412X) using the threaded rod. Do not reuse balance drum o-ring.

22. Insert threaded rods into the balance drum stator and remove axially. Remove balance drum stator (300A) and balance drum stator o-ring (496U). Do not reuse balance drum stator o-ring.

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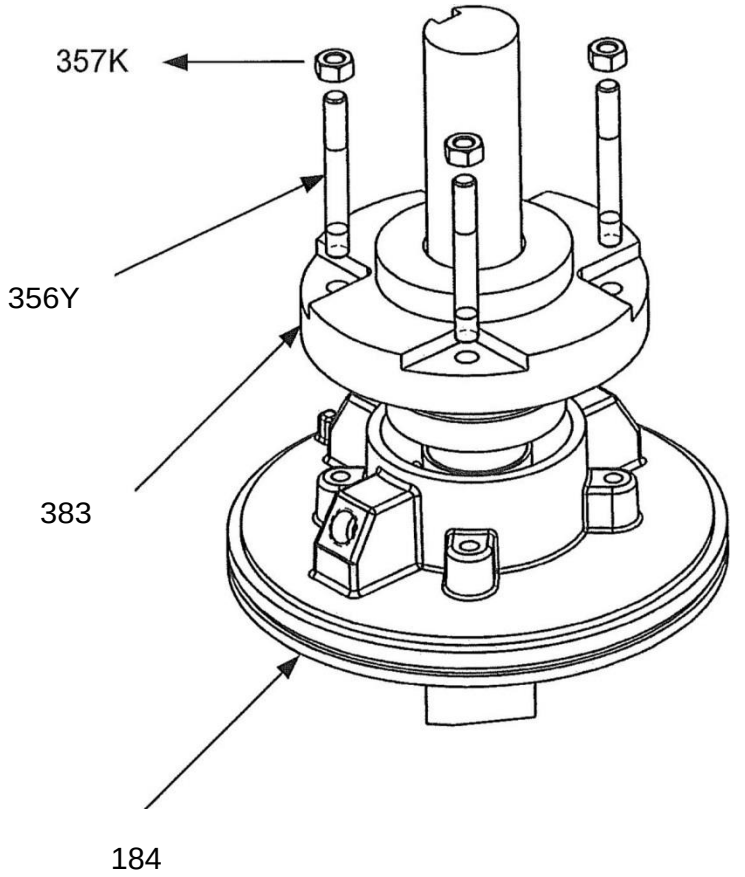
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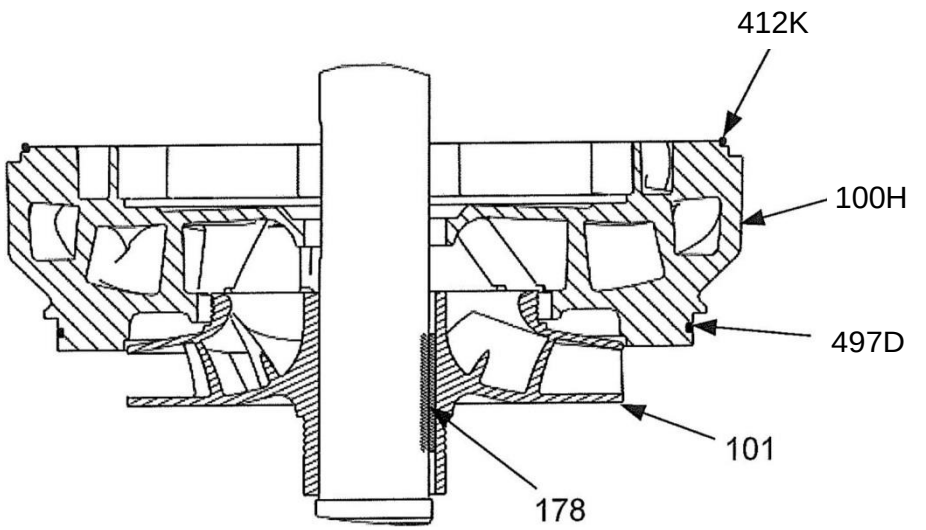
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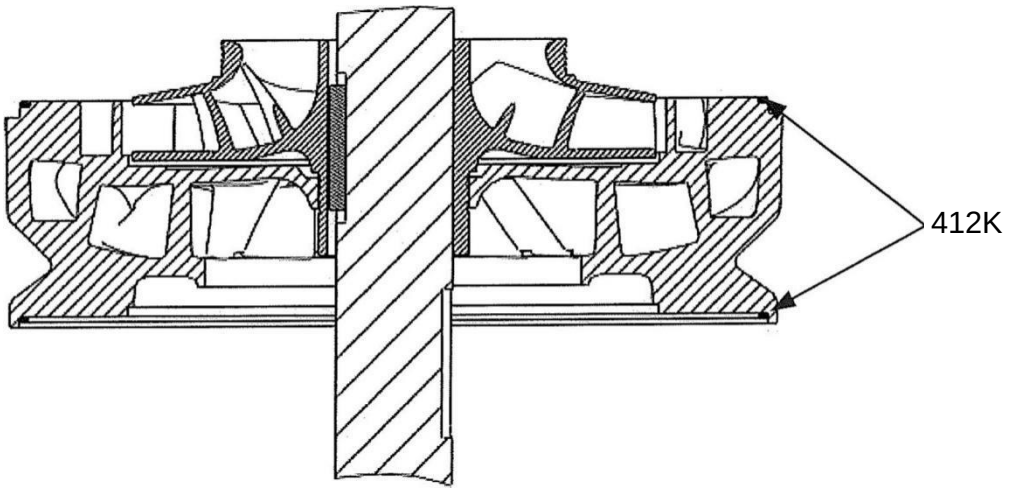
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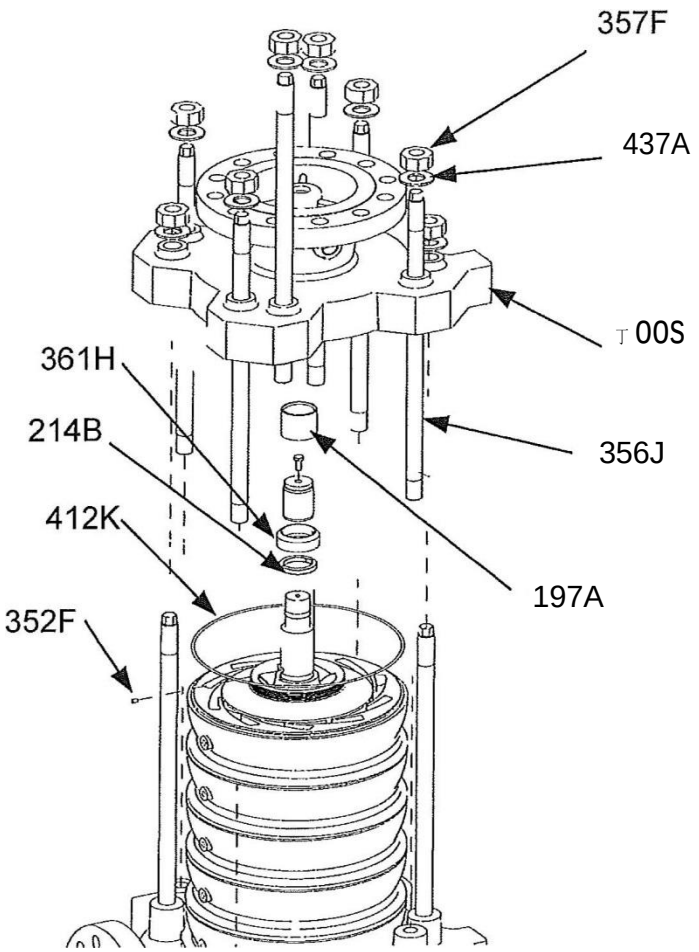
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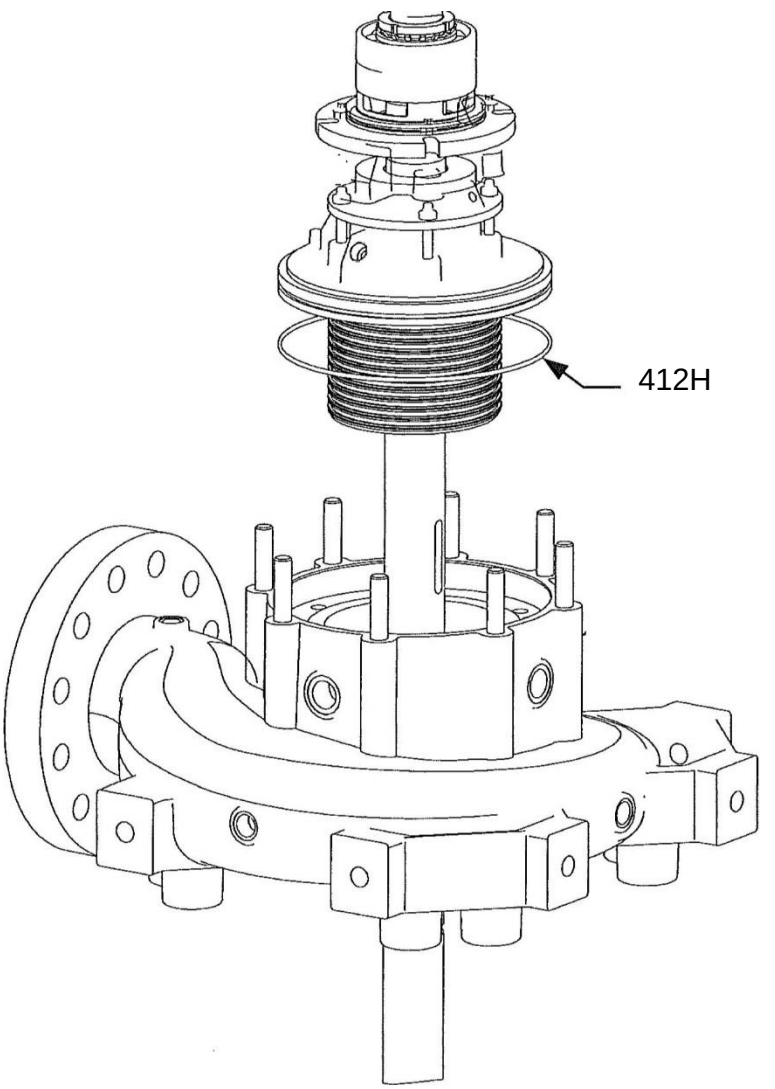
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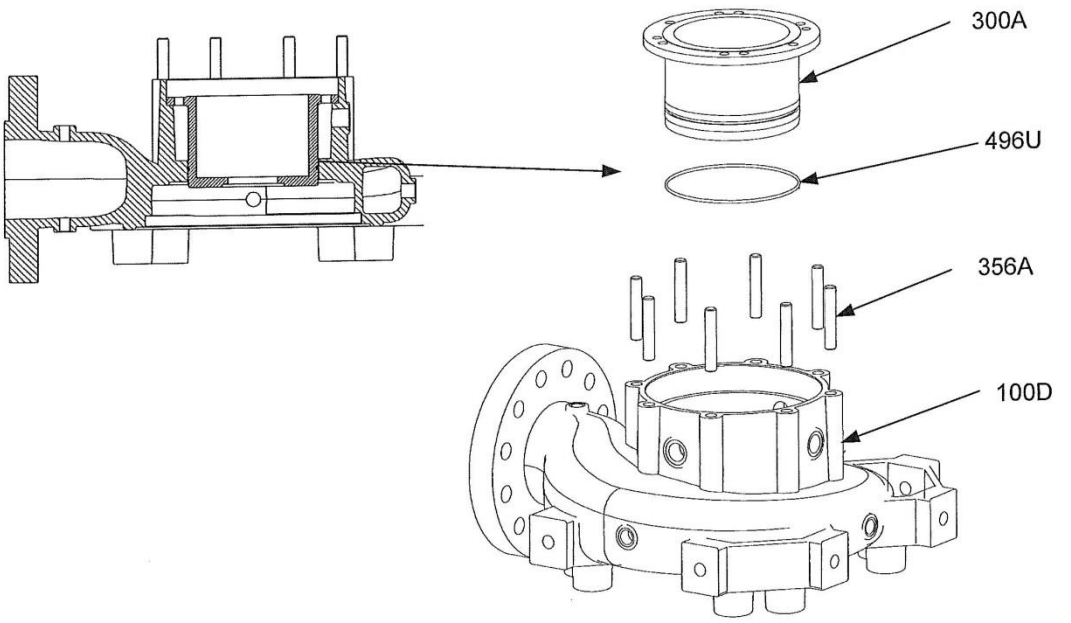


Radial suction pump

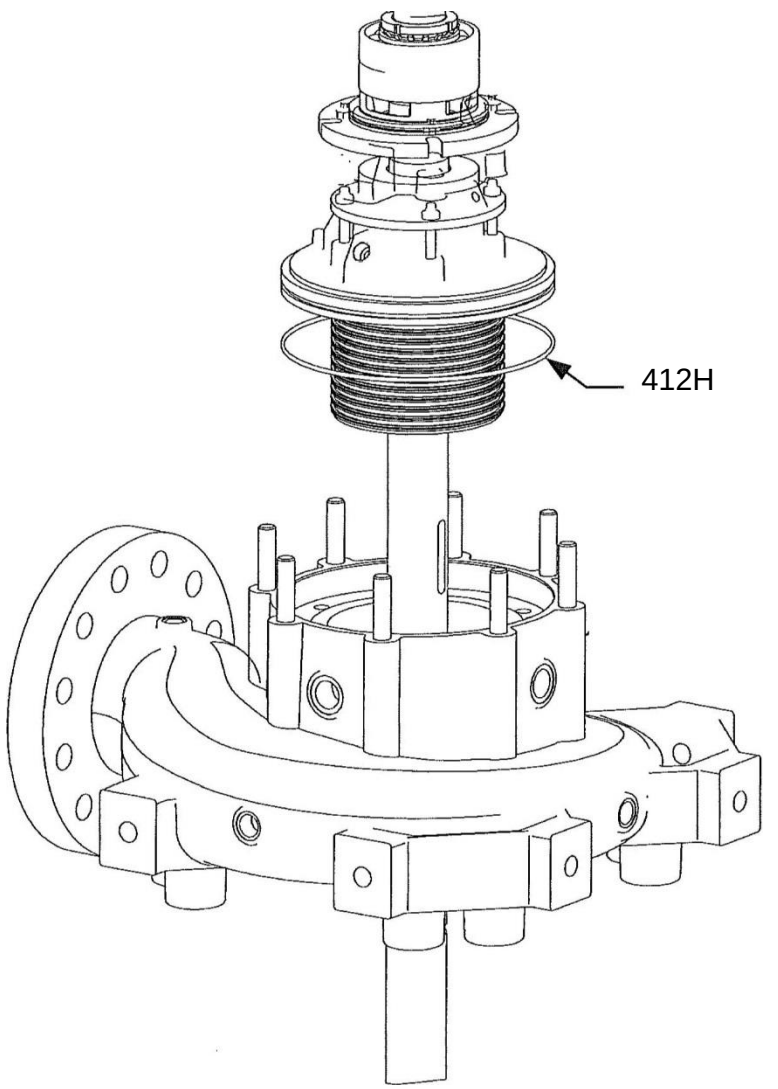
See relevant sectional drawing.

To dismantle the whole pump for maintenance work, place it in a vertical position with the suction nozzle facing upwards. It is important that the pump is secured and stable and supported without damaging the bearing housing. A workbench with a hole approximately 1/2" larger than the shaft is helpful in such cases. A hoist or a second person is required for a safe disassembly.

WARNING:
Make sure that the unit cannot roll or fall over and injure people or damage property.

1. Unscrew nuts (425) and back off the bearing bracket (228C) using the jacking screw (418).
2. 2. Unscrew cap screws (371C) and confirm that the bearing housing cover (119) is free to move.
3. Remove bearing housing (228C)
4. Remove the bearing housing cover o-ring (412). Do not reuse the o-ring.
5. Bend back the lock washer tab (382) and remove bearing nut (136A) and lock washer (382).
6. Remove ball bearings (112) with the bearing puller.
7. Remove the mechanical seal and gland as noted in the instructions for removal of the mechanical seal.
8. Loosen tie rod nuts (357F) and remove tie rods (356J). Note: the tie rods are threaded into the discharge casing and must be removed by unscrewing the tie rods using the flats machined into their surface.
9. Remove suction casing (100S) and remove O-ring (412K).
10. Loosen retaining ring set screw ((352F) and remove retaining ring (361H) and split ring (214B).
11. Remove impeller (101), impeller key (178), stage casings (100G) and final stage casing (100H) along with stage casing o-rings (412K) and discharge casing o-ring (497D). This must be done stage by stage down to the discharge casing (100D).Do not reuse o-rings.
12. Invert the pump so the discharge side bearing housing (228C) faces upward position.
13. Remove seal guards (499).
14. Remove cooling fan (392) if applicable, by loosening set screw (222V).
15. Disconnect any flush piping from the mechanical seal gland.

16. Unscrew nuts (425) and back off the bearing housing (228C) using the jacking screw (418).
17. Unscrew cap screws (371C) and confirm that the bearing housing cover (119) is free to move.
18. Remove bearing housing (228C).
19. Remove the bearing housing cover o-ring (412). Do not reuse the o-ring.
20. Bend back the lock washer tab (382) and remove bearing nut (136A) and lock washer (382).
21. Remove ball bearings (409) with the bearing puller.
22. Remove the mechanical seal and gland as noted in the instructions for removal of the mechanical seal.
23. Seal chamber (184) and seal chamber o-ring (412H) can now be removed from the discharge casing (100D). Pull the housing toward the shaft end axially.
24. Remove cap screws (372H) holding balance drum locking plate (519) to balance drum (300).
25. Remove balance drum locking plate and balance drum locking plate key (178R).
26. Using a permanent marker, place an alignment mark on the shaft and balance drum.
27. Brace the shaft to prevent it rotating, insert threaded rods in the balance drum holes and rotate the balance drum by 30^{O} to clear the locking tabs on the shaft.
28. Remove balance drum and balance drum o-ring (412X) using the threaded rod. Do not reuse balance drum o-ring.
29. Insert threaded rods into the balance drum stator and remove axially. Remove balance drum stator (300A) and balance drum stator o--ring (496U). Do not reuse balance drum stator oring.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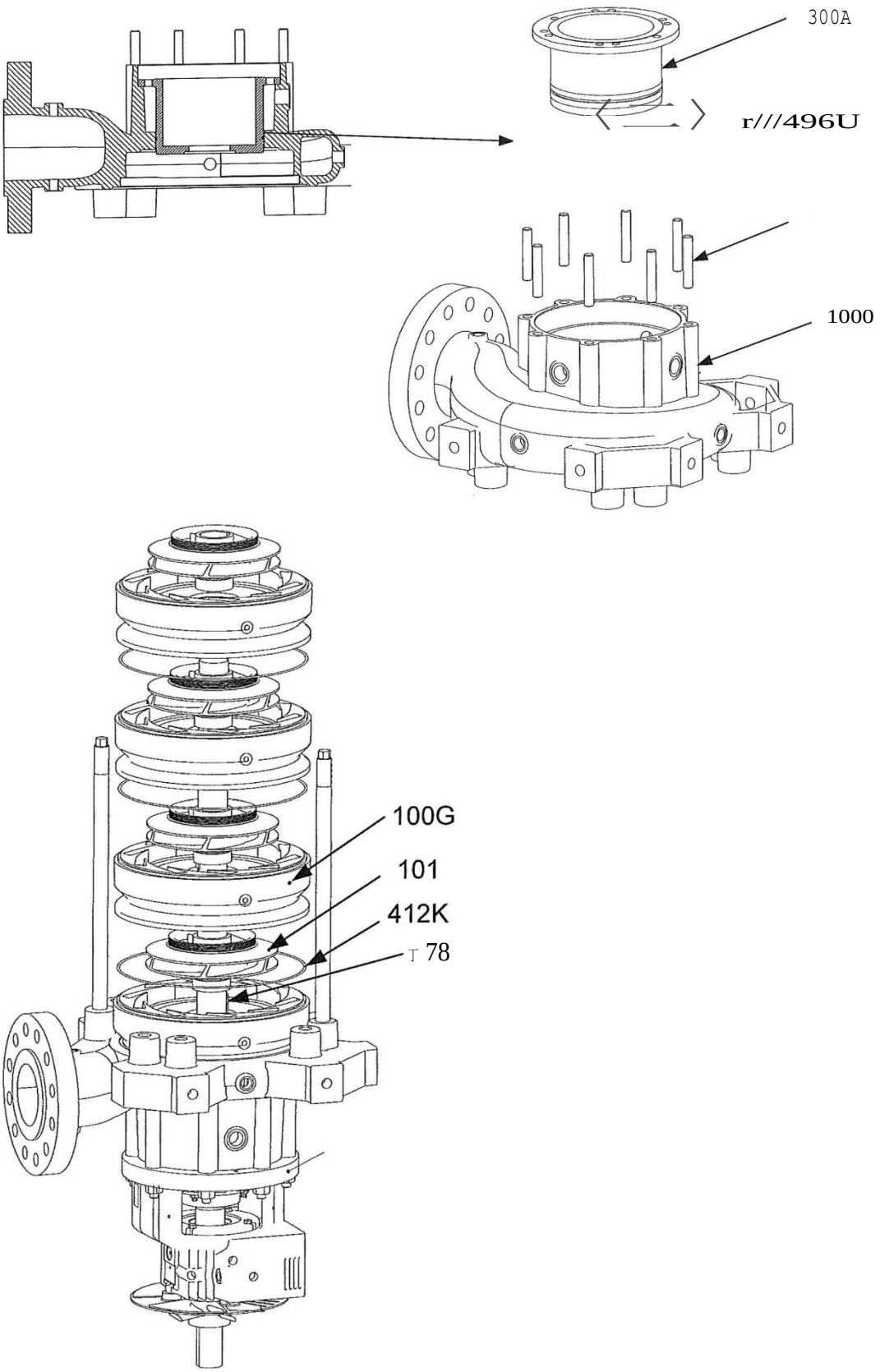
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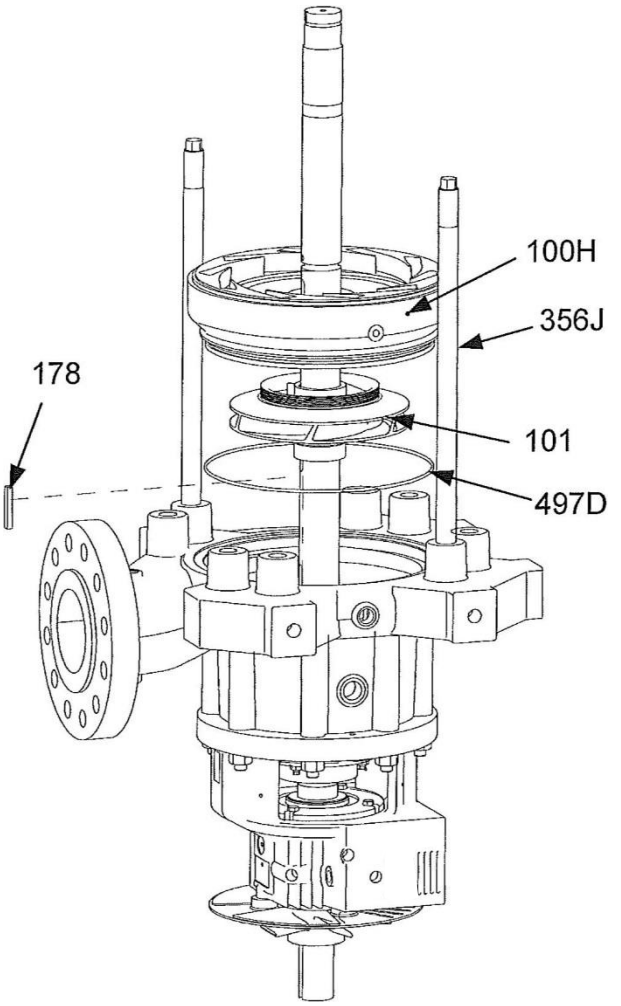
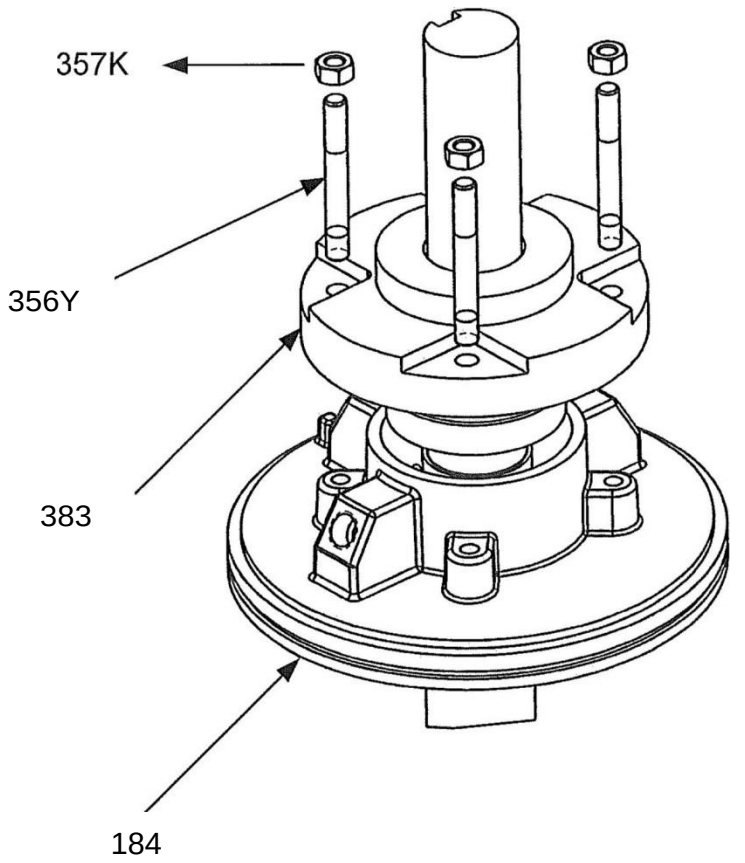
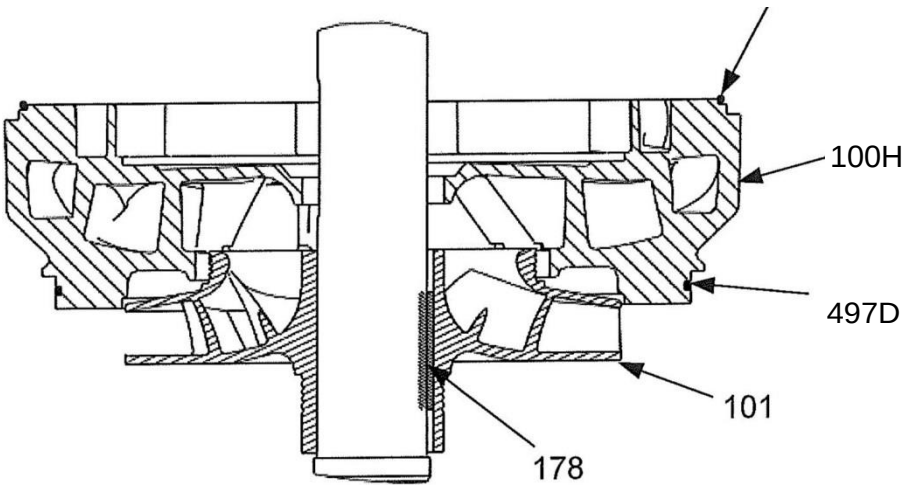

100H
356J
178
101
497D


357K
356Y
383
184
412K


100H
497D
101
178

Parts Listings and Cross-Sectionals

Parts

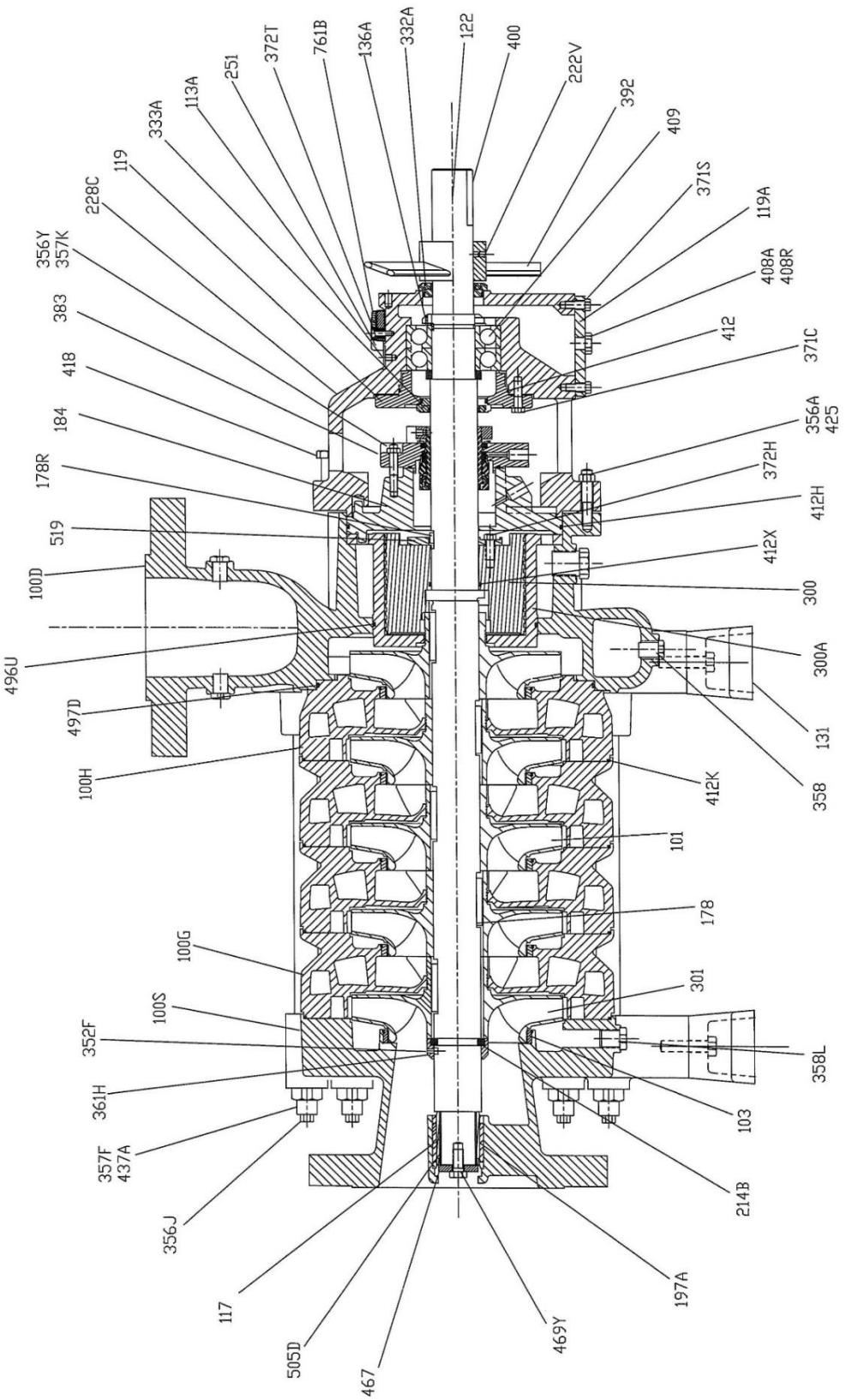


Figure 12: End Suction Pump

Table 7: Parts List

Item Number	Description	Quantity
100B	1st Stage Remachine for Plan 11 takeoff (optional)	1
100D	Casing (Discharge)	1
100G	Diffuser Stage Casing	stage dependent
100H	Diffuser Final Stage Casing	1
100S	Casing (Suction)	1
100X	Casing (Destaging and Takeoff - Optional)	stage dependent
101	Impeller (Series)	stage dependent
103	Case Wear Ring (Standard Clearance)	stage dependent
112	Ball Bearing (Radial)	1
113A	Breather	1 ES / 2 RS
117	Bearing Sleeve (End Suction Only)	1
119	Cover (Bearing Housing)	1 ES / 2 RS
119A	Cover (Bearing Housing Sump)	1 ES / 2 RS
122	Shaft	1
131	Foot	2
136A	Bearing Lock Nut	1
142	Impeller Wear Ring (Optional)	stage dependent
157	Bearing Spacer	2
178	Key (Impeller)	stage dependent
178R	Key (Balance Drum)	1
184	Seal Chamber	1
197A	Bearing Bushing (End Suction Only)	1
214B	Split Ring	1
222V	Set Screw (Fan) On 5"(125) and 6"(150) pumps only	1
228C	Bearing Housing	1 ES / 2 RS
251	Oiler (Constant Level)	1 ES / 2 RS
300	Balance Drum	1
300A	Balance Drum Stator	1
332A	Bearing Isolator (Outboard)	1
333A	Bearing Isolator (Inboard)	1 ES / 2 RS
352F	Set Screw (Retaining Ring)	1
356A	Stud (Bearing Housing to Suction/Discharge Casing)	8 ES / 16 RS
356J	Tie Rod	8
356Y	Stud (Seal Chamber)	8
357F	Nut (Tie Rod)	8
357K	Nut (Seal Chamber)	8
358	Drain Plug (Casing)	3
358A	Plug (Seal Chamber Flush)	2
358C	Plug (Destage Casing - optional)	stage dependent
358K	Plug (Bearing Housing Opening)	1 ES / 2 RS
358L	Plug (Balance Return)	4
358M	Plug (Casing Branch Tapping)	4
361H	Retaining Ring	1
371C	Cap Screw (Bearing Housing Cover)	8
371S	Cap Screw (Bearing Housing Sump Cover)	12
372H	Cap Screw (Balance Drum Locking Plate)	3
372T	Cap Screw (i-ALERT to Bearing Housing)	2
382	Bearing Lock Washer	2
383	Mechanical Seal	1 ES / 2 RS
392	Fan (Brg. Cooling) On 5"(125) and 6"(150) pumps only	1
400	Key (Coupling)	1
409	Ball Bearing (Thrust)	1

Item Number	Description	Quantity
412	O Ring (Bearing Housing Cover)	2
412H	O Ring (Seal Chamber)	1
412K	O Ring (Diffuser Stage Casing)	stage dependent
412X	O Ring (Balance Drum)	1
418	Cap Screw (Bearing Housing Jacking)	4
424	Screw (Shaft Guard - Optional)	2 ES / 4 RS
425	Nut (Bearing Housing to Suction/Discharge Casing)	8 ES / 16 RS
437A	Washer (Tie Rod)	8
467	Retaining Plate (Bearing Bushing) End Suction Only	1
469Y	Cap Screw (Retaining Plate to Shaft) End Suction Only	1
477	Sleeve (Destaging and Takeoff - optional)	stage dependent
496Y	O Ring (Balance Drum Stator)	1
497D	O Ring (Discharge Casing)	1
499	Guard (Shaft - Optional)	2 ES / 4 RS
505D	Tolerance Ring (Bearing Sleeve) End Suction Only	2
519	Locking Plate (Balance Drum)	1
534C	Bolt Retainer (Guard to Bearing Housing)	3
569F	Cap Screw (Guard to Bearing Housing)	3
761B	*i-ALERT*™	1 ES / 2 RS

SPARE AND REPAIR PARTS

Spare parts stock should be based on customer's operating experience, risk assessment, cost of downtime and part lead times. In the absence of this information, the following is offered as a guideline. The quantities shown are on a per pump basis. Items with an asterisk should be multiplied by the number of stages. For multiple pump installations, the total quantity can be reduced.

Part Name	Start Up Spares	1 year operation	2 year operation	Export
Mechanical Seal	1	1	1	1
Impeller*	1	1	1	1
Case Wear Ring*	1	1	1	2
Stage Piece*	-	-	(# stages -2) / 3	(# stages -2) / 2
Final Stage Piece	-	-	1	1
Radial Bearing	1	1	1	1
Thrust Bearing	1	1	2	2
Balance Drum	1	1	1	1
Sleeve Bearing (ES)	1	1	1	1