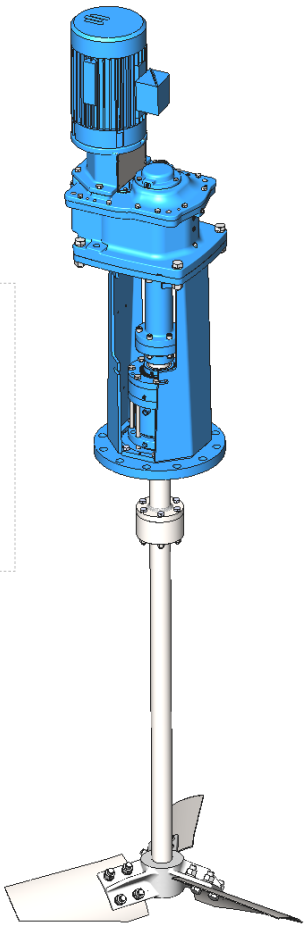
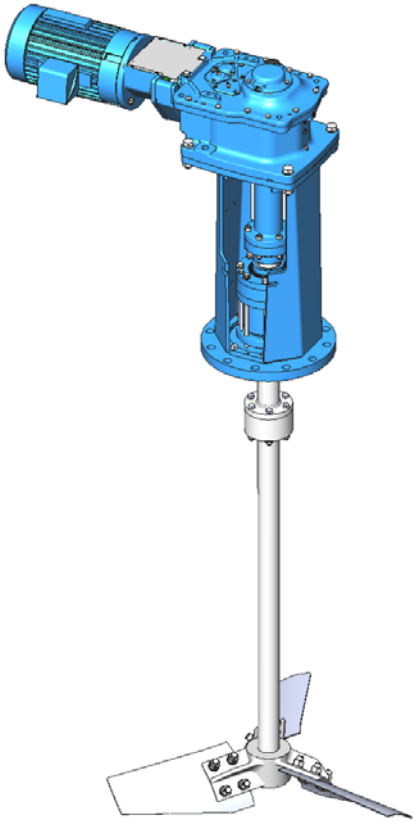
Manual No. 731.02

Installation, Operation and Maintenance Manual
Model 20 GTN and HTN Agitators
(Case Size 21, 22, 23)

Equipment Reference:





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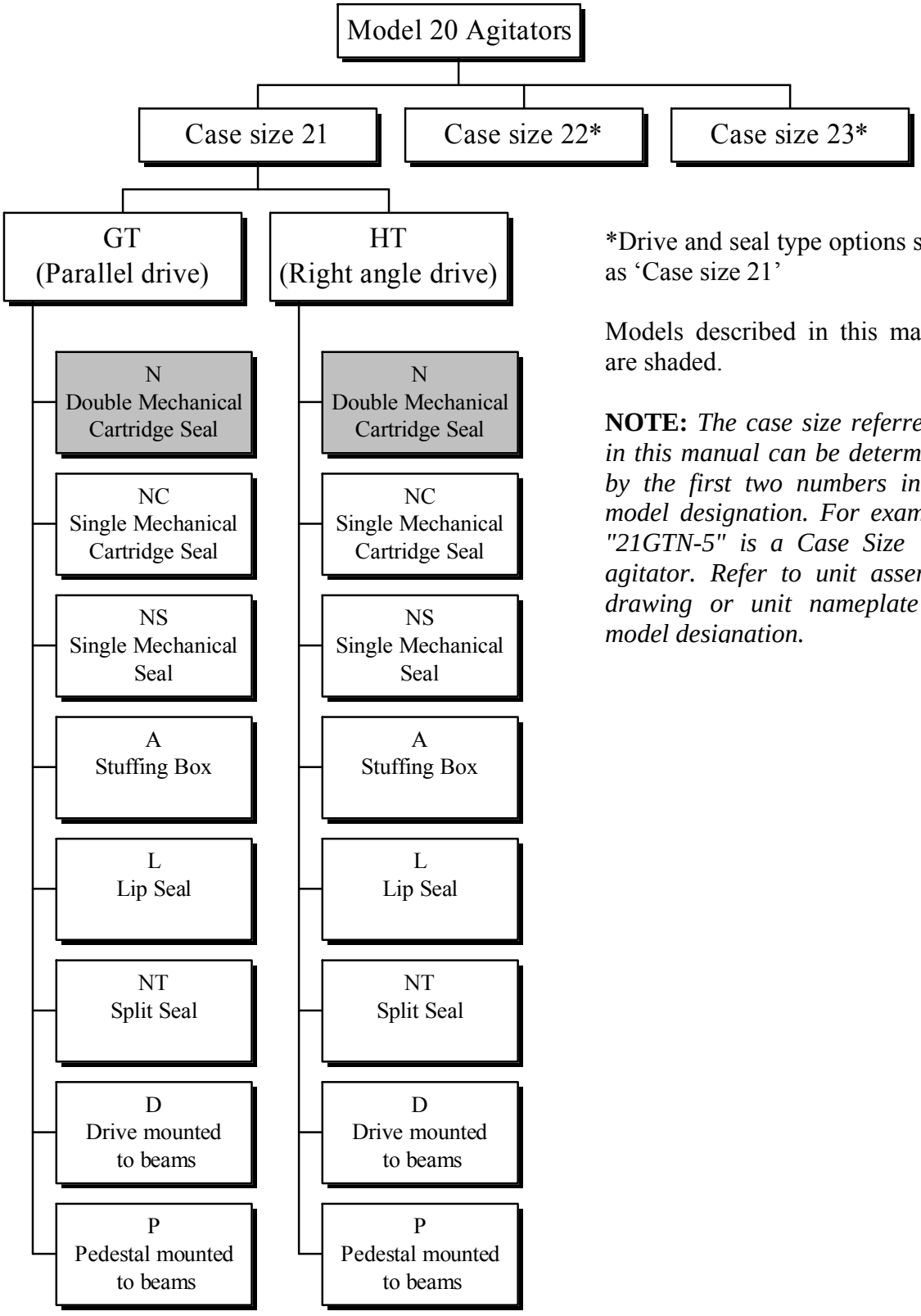

*Drive and seal type options same as 'Case size 21'

Models described in this manual are shaded.

NOTE: *The case size referred to in this manual can be determined by the first two numbers in the model designation. For example: "21GTN-5" is a Case Size "21" agitator. Refer to unit assembly drawing or unit nameplate for model desianation.*

B. INITIAL INSPECTION

Step 1: Inspect crates. Upon receipt, inspect all crates and equipment for any damage during shipping. If you observe any damage, please report it to your local Chemineer office or to the factory of origin. A claim should be filed immediately with the carrier involved.

Step 2: Uncrate. Check the contents. Do not un-crate the unit until you have read all the Installation instructions and viewed the assembly drawing shipped with the unit. Be careful in uncrating and handling. Before discarding the crating, make sure that all agitator parts have been removed. Correct assembly of this unit requires referring to both the unit assembly drawing and this manual.

Step 3: Questions? Call Chemineer. If the shipment is not complete or you do not understand what you have received, please contact your local Chemineer office immediately.

C. CHEMINEER ASSISTANCE

Chemineer maintains a fully staffed Parts and Field Service Department ready to help you with any service requirement. When in doubt contact your local Chemineer office, or Parts/Field Service department at the Chemineer Factory:

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For your convenience, Chemineer offers the following services:

- Installation and maintenance training seminars
- Installation and start-up supervision
- Preventative maintenance planning
- Parts order service

D. SAFETY

D.1 VESSELS

All types of vessels either open or closed pose special safety challenges. It is essential that Installers, Operators and Maintainers of the equipment understand these special hazards.

Particular safety hazards arise because the vessel is typically defined as a "Confined Space". This creates a number of special hazards, including the risk of having oxygen shortages. Never enter a confined space unless you are fully trained on the procedures and have the correct safety equipment and procedures in place.

One must not enter a confined space unless fully assured that it is safe. Typically, before entering a vessel you should require proof of power and process fluid lock out. Always carry with you an oxygen sensor (in order to verify a safe atmosphere), a suitable safety harnesses and lifting equipment. Typically, a shoulder lift harness and a man-lifting crane are required (a man on the end of a rope or a center back lift offers no safety protection). A suitable safety cover must be provided at all time.

In cases where a vessel has been in service, tests must be made to ensure that no hazardous products or product residues are present.

The work site is often within a designated hazardous area. Where potentially explosive conditions exist, all efforts must be made to make the area safe before proceeding with work. Where this is not possible, a detailed, individual hazard assessment is vital. Special working procedures and tooling are required.

D.2 FASTENERS

Important: Critical fasteners should not be reused. Critical fasteners are all those that are used with torque control, for example blade bolts, shaft coupling bolts, pedestal fixing bolts, etc. When a fastener is disturbed, always replace it with a new one. Dispose of used fasteners.

D.3 CE MARKING (WHERE APPLICABLE)

Any CE marking and associated documentation applies to the mixer only on the basis that it is an individual product. After installation of the mixer into the mixing system, it becomes an integral part of a larger installation. **Chemineer is not responsible for the CE marking once the mixer has been installed into the mixing system.**

D.4 SAFETY CHECKLIST

- ☑ This Installation, Operation and Maintenance Manual, assembly drawings, and any supplements must be reviewed and understood before commencing installation and operation.
- ☑ All site rules must be observed for the installation and operation of this mixer.
- ☑ Ensure all external connections are made in accordance with applicable codes of practice.
- ☑ The mixer must be earthed (connected to ground).
- ☑ Correct rotation must be checked prior to operation.
- ☑ **Do not** exceed the operating pressures, temperatures, and other conditions for which the machine has been designed.
- ☑ **Do not** operate the agitator unless all guards are securely fixed. Do not modify any guarding. Open tanks fitted with agitators must be provided with suitable guarding to prevent personnel contacting agitator-moving parts. The user is responsible for providing these guards.
- ☑ Ensure mechanical seal setting clips are disengaged before operation. These clips should be retained for future use.
- ☑ Ensure gas supply system, (if applicable) is correctly installed, pressurized and ready for operation.
- ☑ **Do not** touch rotating components.
- ☑ During servicing of the mixer, the motor must be isolated from the power supply and the supply locked out.
- ☑ **Do not** operate the mixer for applications other than for its intended use.
- ☑ **Do not** modify the mixer without reviewing the change with Chemineer. It is unsafe to use non-standard parts without Chemineer's approval. When in doubt, ask your local Chemineer office.

WHEN IN DOUBT, ASK!

E. STORAGE

Do not remove protective packaging, desiccant, or any protective coatings applied to the wetted parts until the agitator is to be put into service. If the equipment is to be stored, do not stack crates. Store in a clean dry indoor location, which is free from wide variations in temperature. The storage area should be free from vibration and excessive heat.

Inspect for external rust at three-month intervals. Apply a rust preventative to unpainted carbon steel surfaces to prevent corrosion during storage. If the unit has been in storage for more than three months or subjected to adverse moisture conditions, the motor windings may have to be dried prior to operation.

E.1 SHORT-TERM INDOOR STORAGE

Agitators should be stored indoors in areas with no vibration and relatively constant temperatures and humidity. The factory storage preparations should be acceptable for up to six months storage. If the storage period will exceed six months, see the Long-Term Indoor Storage section.

E.2 OUTDOOR OR LONG-TERM INDOOR STORAGE

Storage of agitators and motors outdoors is not recommended. Unless specially prepared, our equipment is supplied with the intent that it will be immediately installed and commissioned or subject to short-term indoor storage only.

Equipment subject to long-term storage can suffer extensive damage due to corrosion. Unlike during operation, during storage the gearbox surfaces are not covered with oil and the moisture due to condensation inside the gearbox does not evaporate. This can rapidly lead to severe rust of the precision components causing extensive damage.

The method employed for long-term storage is to prevent the humidity/temperature changes and airborne chemicals from making contact with the internal components of the equipment.
The methods described below provide protection but cannot avoid some level of degradation of the equipment.

E.2.1 To prevent from corrosion:

Oil Flooding
Filling the gearbox completely with oil and then sealing it off provides excellent protection against the environment. Refer to Table 1, page 9. This will ensure that all the internals are covered and thus protected against corrosion. Note that when this is done, oil enters the dry well area so the gearbox will need to be turned upside down to fully drain it at the end of the storage period. Motor engine oils contain higher levels of corrosion inhibitors than most industrial gear oils and so can be a good choice. However, these engine oils may not be suitable for use in the mechanical seal. Always use new oil. It is recommended that a new charge of grease be added to the lower bearing after a short time of operation due to the oil being in contact with this grease during the storage period.

Extremes temperatures can cause the oil volume to change. To prevent oil leakage through the seals, it is recommended to reduce the oil capacity if it is known the temperature will vary greatly throughout the storage period.

Fill the mechanical seal housing and mechanical seal lubricators with a rust preventative/lubricant which is compatible with the sealing fluid to be used in service.

Motor space heaters, if installed, should be energized during the storage period.

Vapor Phase Inhibitor (VPI)
VPI as an additive to oil can provide excellent protection against corrosion. For maximum benefit, it is used in conjunction with desiccant bags. Typically, the desiccant bags should be changed periodically as the environmental humidity dictates. Follow the product manufacturers instructions. It is essential to seal up the gearbox as much as possible and to take all reasonable steps to protect against temperature fluctuation and excess moisture.

Inert Gas Purging
Any inert environment provides excellent protection of the equipment for an indefinite period. Nitrogen is one inert gas usually available at any refinery or chemical plant. Nitrogen also absorbs humidity when it is dry and carries it away when permitted to flow.

- Completely drain the oil from the gearbox
- Install a nitrogen supply line and vent to each subassembly. Typically to the gearbox breather port and the mechanical seal barrier fluid inlet port.
- Install a vent plug in a port farthest from the Nitrogen inlet. Typically, at the oil drain fitting in the gearbox /seal. This plug must have a 1/8” / 3 mm diameter hole drilled through to allow the gas to vent.
- Oil may be left in any external lube oil piping.
- Grease the input shaft and coupling areas with rust preventative grease and wrap the greased area with waterproof barrier paper.
- Pressurize the gas purge system. Store on an elevated surface.

NOTE: The pressure in the gearbox must not exceed 5 psig. Allow the gas to flow through for several minutes by releasing the vent plug. Then adjust the gas flow rate to a minimum of 1 cubic foot per hour (0.5 litre / min).

- Completely enclose the entire unit with a heavy plastic, tarpaulin, or similar type of protective cloth. Do not allow the weight of the covering to be carried by any instrumentation.
- Place a few desiccant bags inside the covering. Allow the nitrogen to leak out from underneath the covering.

CAUTION! Nitrogen gas can be a hazard. Ensure that suitable safety precautions are in place.

E.2.2 To protect elastomers:

Elastomers will age, can stick or take set. In order to prevent the elastomers from sticking, regularly rotate shafts in order to redistribute lubricants. Protect the equipment from direct sunlight and from ozone to minimize the rate of aging of the elastomers.

E.2.3 To avoid false brinelling:

Rotate the motor and gear drive shafts 10 to 15 revolutions at least once per month to reduce the possibility of false brinelling of the bearings and to re-distribute bearing grease.

Other problems include vibration related damage. Do not store equipment in a manner that subjects it to vibration.

E.3 CUSTOMER RESPONSIBILITY

Note: When the equipment is to be stored in a strong chemical environment or near salt-water, protection procedures should be executed immediately upon receipt of the equipment.

To ensure the original quality of the Chemineer equipment prior to commissioning after storage, all components must be inspected by an authorized Chemineer Service Engineer. Any sub assemblies not manufactured by Chemineer must be inspected by that part supplier/manufacturer's authorized service personnel. Chemineer is not responsible for the cost of such a service.

Because storage location and other unknown site factors are beyond Chemineer's control, Chemineer will not accept any liability for damage to the equipment during the storage period.

Table 1. APPROXIMATE STORAGE OIL CAPACITY

MODEL	TYPE	QUARTS (US)	GALLONS (US)	LITRES
21	**GT**	5.6	1.4	5.3
	HT	5.6	1.4	5.3
22	**GT**	11	2.75	10.4
	HT	11	2.75	10.4
23	**GT**	25	6.25	23.6
	HT	25	6.25	23.6

CAUTION! *Before placing an agitator into service, the storage oil must be completely drained from the gear drive.* ***Turn the gear drive upside down to completely drain.*** *Failure to do this will result in oil being trapped in the "drywell" around the output shaft and could result in leakage at the output shaft seal. The gear drive should be filled with new oil and re-greased as indicated in the* ***Lubrication*** *section of this manual.*

F. VESSEL MOUNTING

The Model 20 GT/HT N style agitators are designed to mount on an ANSI, DIN, or other standard flange, nozzle or pad located on the vessel top head. See Figure 1, page 12, and Figure 2, page 13.

The most frequent cause of mechanical difficulty with an agitator is improper mounting. It is imperative to heed the following guidelines:

1. The agitator extension shaft is designed to run in a true vertical position.
2. Do not angle or side mount the agitator unless it was specifically designed for angle mounting by Chemineer.
3. The agitator drive assembly must be **level within 1/2°** (8.8 mm/m). Any angular misalignment may be corrected by machining the nozzle or pad level and flat, or shimming in the case of non flange-mounted units. Steady bearing units or units with close internal clearances are required to be **level within 1/4°** (4.4 mm/m)
4. Start up of the agitator with the turbine impacted in solids is beyond the scope of these recommendations.
5. The mounting structure must be rigid enough to meet the requirements described in section F.1 below.

F.1 DESCRIPTION OF AGITATOR LOADS

During operation of the agitator, the fluid motion in the vessel produced by the rotation of the turbine impeller can exert significant forces and moments on the agitator extension shaft. The forces and moments produced by the turbine rotating in a fluid are; torque, turbine thrust (up or down) and turbine hydraulic (side) force.

The hydraulic forces acting on the turbine generate moments, which act on the shaft and are transmitted to the agitator drive. Because of the random nature of the forces and the rotation of the shaft, the direction of these forces is constantly changing.

A pitched blade or axial flow turbine will impart an upward or downward thrust depending on if it is a down or up pumping turbine, respectively. The thrust force is generally less than the weight of the unit.

The agitator has been designed to accommodate all of the forces mentioned, and as a result, the forces are transmitted directly to the mounting support. The support structure must be rigid enough to support the agitator weight and the live agitator reactions resulting from the torque, thrust and bending moment. The structure should be sufficiently rigid that, ***assuming a perfectly rigid agitator extension shaft***, the vessel deflection will not cause the impeller end of the shaft to deflect more than 2.6 mm per meter of shaft length. For high-speed units a greater level of stiffness should be achieved. An agitator mounted on a structure that is adequately rigid should typically have a vibration velocity of less than 9 mm / sec measured at the furthest end from the drive shaft.

The nozzle or pad and vessel top head must be rigid enough to support the agitator weight and limit the angular displacement of the agitator drive to 0.05 degrees as a result of the torque and bending moment. Refer to the agitator assembly drawing for the nozzle or pad design loads.

See Table 2 and Table 3, page 14, for the recommended vessel head thickness vs. vessel diameter, agitator case size and mounting nozzle or pad size. These tables are to be used as a guide for determining when vessel head reinforcement is required.

The tables are based upon the use of the ASME flanged and dished heads, atmospheric design pressures and ChemScale® agitation levels of 6 to 7. Elliptical or hemispherical heads of the same diameter and thickness are more rigid than ASME flanged and dished heads. Design pressures greater than atmospheric may require vessel head thickness greater than the table values. Very high ChemScale® agitation levels may require vessel head thickness greater than the table values. If the vessel head is not rigid enough, the head thickness can be increased or a reinforcement pad (Figure 2, page 13) can be added.

THIS INFORMATION IS INTENDED AS A GUIDE, AND DOES NOT RELIEVE THE USER OF COMPLETELY ANALYZING THE ENTIRE MOUNTING SYSTEM. EXTREME APPLICATIONS OR DESIGNS MAY REQUIRE SUPPORT STIFFNESS GREATER THAN THE RECOMMENDATIONS PROVIDED HEREIN. CONSULT *CHEMINEER INSIDE SALES* FOR DESIGN GUIDANCE.

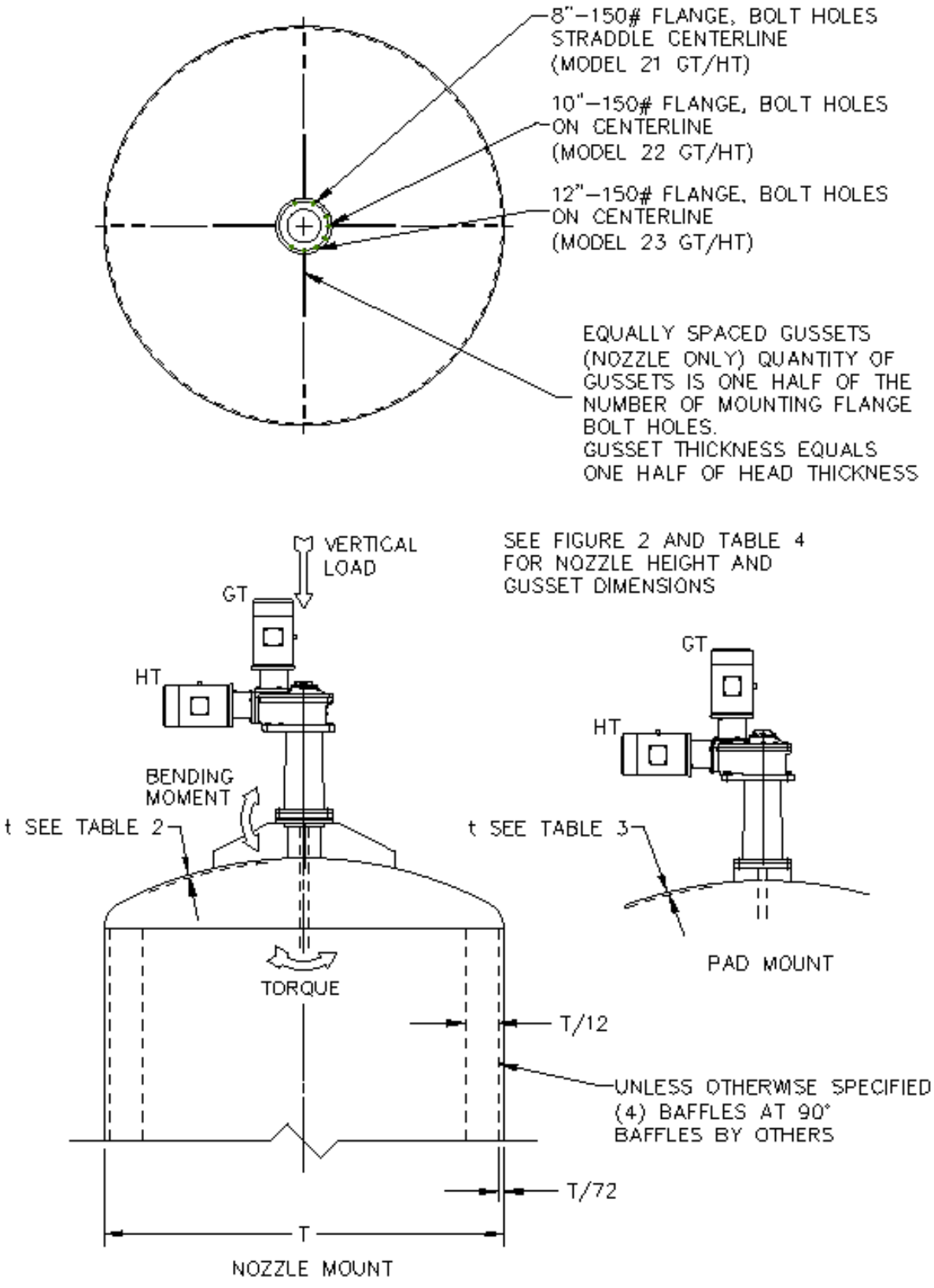


Figure 1. Vessel Mounting

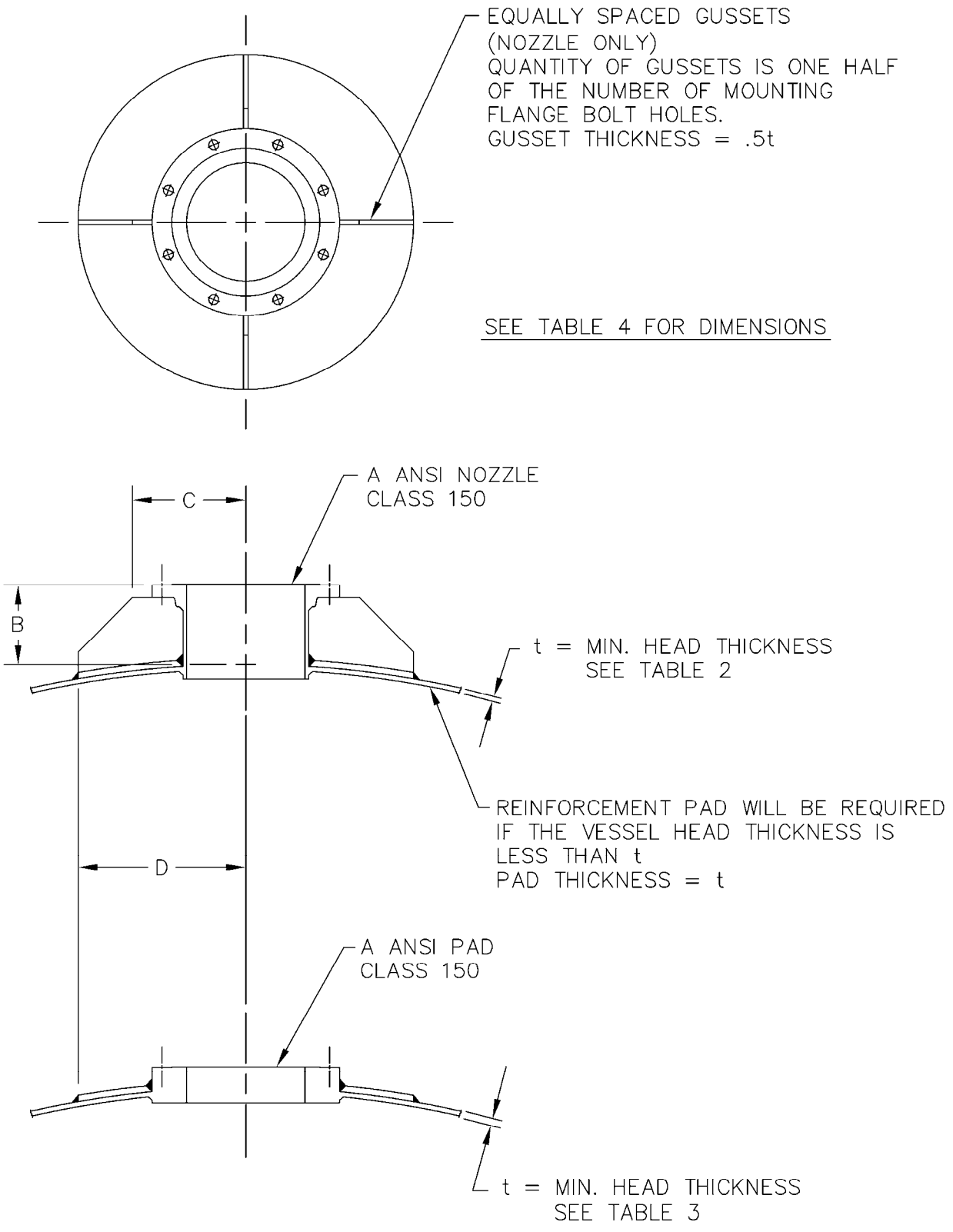


Figure 2. Vessel Mounting Nozzle/Pad

Table 2. VESSEL HEAD THICKNESS (t), NOZZLE MOUNT

VESSEL DIAMETER Ft (m)	CASE SIZE (NOZZLE SIZE)		
	Model 21 (8")	Model 22 (10")	Model 23 (12")
4 (1.22)	.188" (5.0mm)	.250" (6.0mm)	.375" (10.0mm)
5 (1.52)	.188" (5.0mm)	.313" (8.0mm)	.438" (11.0mm)
6 (1.83)	.250" (6.0mm)	.313" (8.0mm)	.500" (13.0mm)
7 (2.13)	.313" (8.0mm)	.375" (10.0mm)	.563" (14.0mm)
8 (2.44)	.313" (8.0mm)	.438" (11.0mm)	.625" (16.0mm)
9 (2.74)	.375" (10.0mm)	.500" (13.0mm)	.625" (16.0mm)
10 (3.05)	.375" (10.0mm)	.500" (13.0mm)	.750" (19.0mm)
12 (3.66)	.438" (11.0mm)	.625" (16.0mm)	.750" (19.0mm)
15 (4.57)	.563" (14.0mm)	.750" (19.0mm)	.875" (22.0mm)
20 (6.10)	.688" (18.0mm)	.938" (24.0mm)	.875" (22.0mm)

Table 3. VESSEL HEAD THICKNESS (t), PAD MOUNT

VESSEL DIAMETER Ft (m)	CASE SIZE (NOZZLE SIZE)		
	Model 21 (8")	Model 22 (10")	Model 23 (12")
4 (1.22)	.125" (3.0mm)	.188" (5.0mm)	.250" (6.0mm)
5 (1.52)	.125" (3.0mm)	.188" (5.0mm)	.250" (6.0mm)
6 (1.83)	.125" (3.0mm)	.188" (5.0mm)	.250" (6.0mm)
7 (2.13)	.125" (3.0mm)	.188" (5.0mm)	.312" (8.0mm)
8 (2.44)	.188" (5.0mm)	.250" (6.0mm)	.312" (8.0mm)
9 (2.74)	.188" (5.0mm)	.250" (6.0mm)	.375" (10.0mm)
10 (3.05)	.188" (5.0mm)	.250" (6.0mm)	.375" (10.0mm)
12 (3.66)	.188" (5.0mm)	.250" (6.0mm)	.437" (11.0mm)
15 (4.57)	.250" (6.0mm)	.313" (8.0mm)	.500" (13.0mm)
20 (6.10)	.250" (6.0mm)	.375" (10.0mm)	.625" (16.0mm)

Table 4. AGITATOR MOUNTING REINFORCEMENT DIMENSIONS

CASE SIZE	A	B	C	D
Model 21	8"	6" (152mm)	8" (203mm)	12" (305mm)
Model 22	10"	8" (203mm)	11.5" (292mm)	15.5" (394mm)
Model 23	12"	8" (203mm)	11.5" (292mm)	17" (432 mm)

G. AGITATOR INSTALLATION

Correct installation requires both the unit assembly drawing and this manual.

1. The agitator is shipped in various crates: one for the agitator gear drive **[200]**, one for the shaft and impeller **[500]** and typically one for the motor **[100]**. Optional accessories, multiple shafts, or multiple impellers may be crated separately.

2. Remove all shipping restraints. A hoist or crane system for the lifting of the agitator parts must be available. Refer to Figure 6, page 21 for lifting instructions. The approximate net weight of the unit is shown on the unit assembly drawing. Since gear drives are typically supplied with the motor un-mounted, always verify that the motor being mounted is correct for the gear drive by checking the assembly drawing.

3. Motors **[100]** that are large relative to gear drive **[200]** are shipped separately with motor bracket **[131]**, flexible motor coupling **[110]**, and coupling guard **[120]**. In this case, install the motor bracket, flexible motor coupling, motor and coupling guard prior to hoisting the agitator drive onto its mounting nozzle or pad. Check the flexible coupling alignment. If an auxiliary motor bracket support is supplied with the unit, remove the motor from the motor bracket; install the agitator drive assembly and auxiliary motor bracket support. Reinstall the motor and check the flexible coupling alignment.

4. Lift the agitator drive assembly, less extension shaft **[404]** and assemble to the vessel nozzle or pad with the proper gasket and mounting bolts (supplied by others) and torque to the value shown in APPENDIX, Page 96.

   NOTE: *Unrestrained cold flowing gasket materials must not be used to seal the agitator to the vessel.*

   a. If the drive shaft has been shipped separately, install drive shaft **[403]**, shaft collar **[2530]**, mechanical seal cartridge assembly **[2500]**, taper bore coupling half **[2363]**, spacer spool **[2367]** and coupling spacer **[2367]**. Refer to Section Q, page 82 for drive shaft replacement instructions.

      NOTE: *Extreme care should be taken in handling and installing to see that the agitator drive shaft is not jarred or bumped, causing damage to the mechanical seal parts. Do not lift the agitator drive with any attachment to the drive shaft.*

5. If the extension shaft is supplied with an optional removable extension shaft coupling half, install the coupling half. Refer to in-tank coupling installation instructions, Section L.1, page 39.

6. Lift the extension shaft and lower it into the vessel.

7. Lift and block the extension shaft so that extension shaft **[2404]** coupling half is close enough to drive shaft **[403]** coupling half to allow installation of coupling bolts, nuts and lockwashers **[405, 407, 406]** (Figure 18, page 40) The face and tenon of all rigid

couplings must be perfectly clean and free of nicks. Line up match marks and install two bolts at 180º. Tighten the bolts to engage the tenon and pull the coupling faces together.

CAUTION! Coated/rubber covered agitator parts require special handling to avoid damage to coatings/rubber coverings. Do not use chains or hooks on coated/covered surfaces. Special care is required to prevent damage to edges and outside corners. Special installation procedures are required for large one-piece impeller/extension shaft assemblies. Contact Chemineer Field Service for instructions.

8. Install the remaining coupling bolts, nuts and lockwashers. Torque bolts to the value shown in APPENDIX, Page 96. Remove the shaft blocking.

9. Check the installed extension shaft runout. Place a dial indicator on the side of the extension shaft at the bottom. Manually turn the flexible motor coupling to rotate the extension shaft one turn.

10. Total shaft runout should not exceed 0.003" per foot (0.25 mm per meter) FIM (Full Indicator Movement) of shaft length. If the shaft runout is excessive, the shaft can be re-straightened in the field. Rotate the shaft to the maximum positive indicator reading. Apply heat to the shaft at a point 180º from the indicator and just below the first in-tank shaft coupling or just below the mounting surface if there is no in-tank coupling. As heat is applied to the shaft (do not allow surface temperature of shaft to exceed 500ºF [260ºC], the shaft will move toward the indicator. After the shaft has moved .030-.060" (0.76-1.52 mm), remove the heat and the shaft will begin to move away from the indicator. The shaft will draw more than it moved initially, and as a result will be straightened. After each heating cycle, recheck the shaft until runout is within tolerance. Do not heat in the same location. Move up or down 2 or 3" (50-70 mm) to avoid reheating the same location.

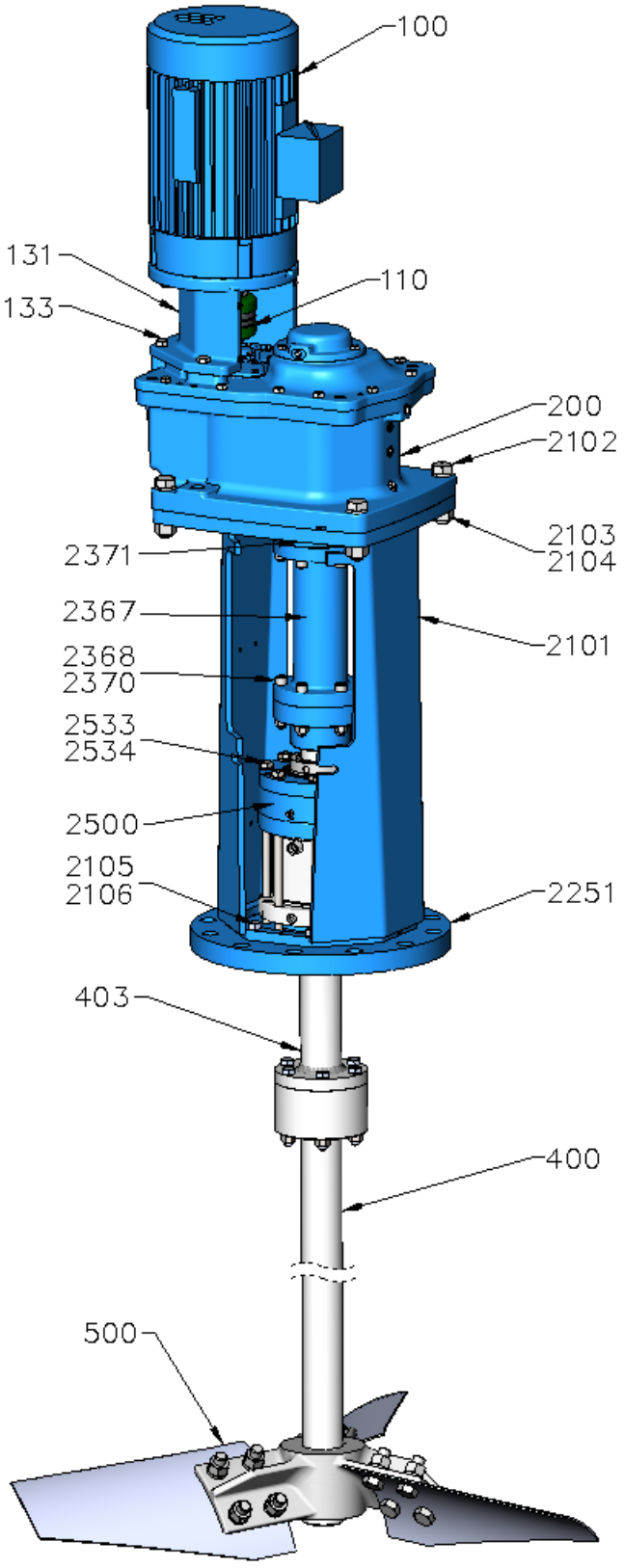


Figure 3. Model 20 GTN Agitator Assembly

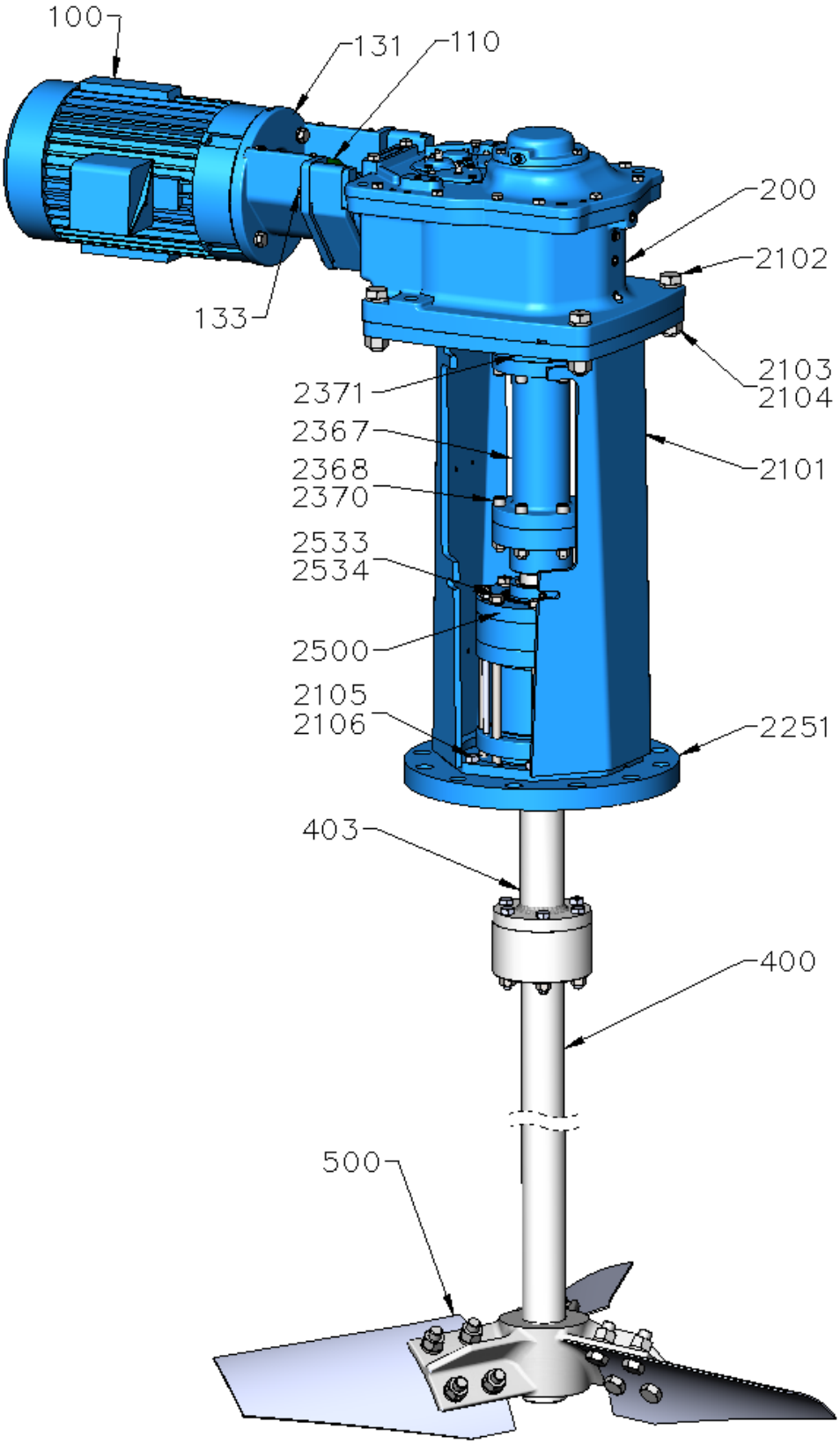


Figure 4. Model 20 HTN Agitator Assembly

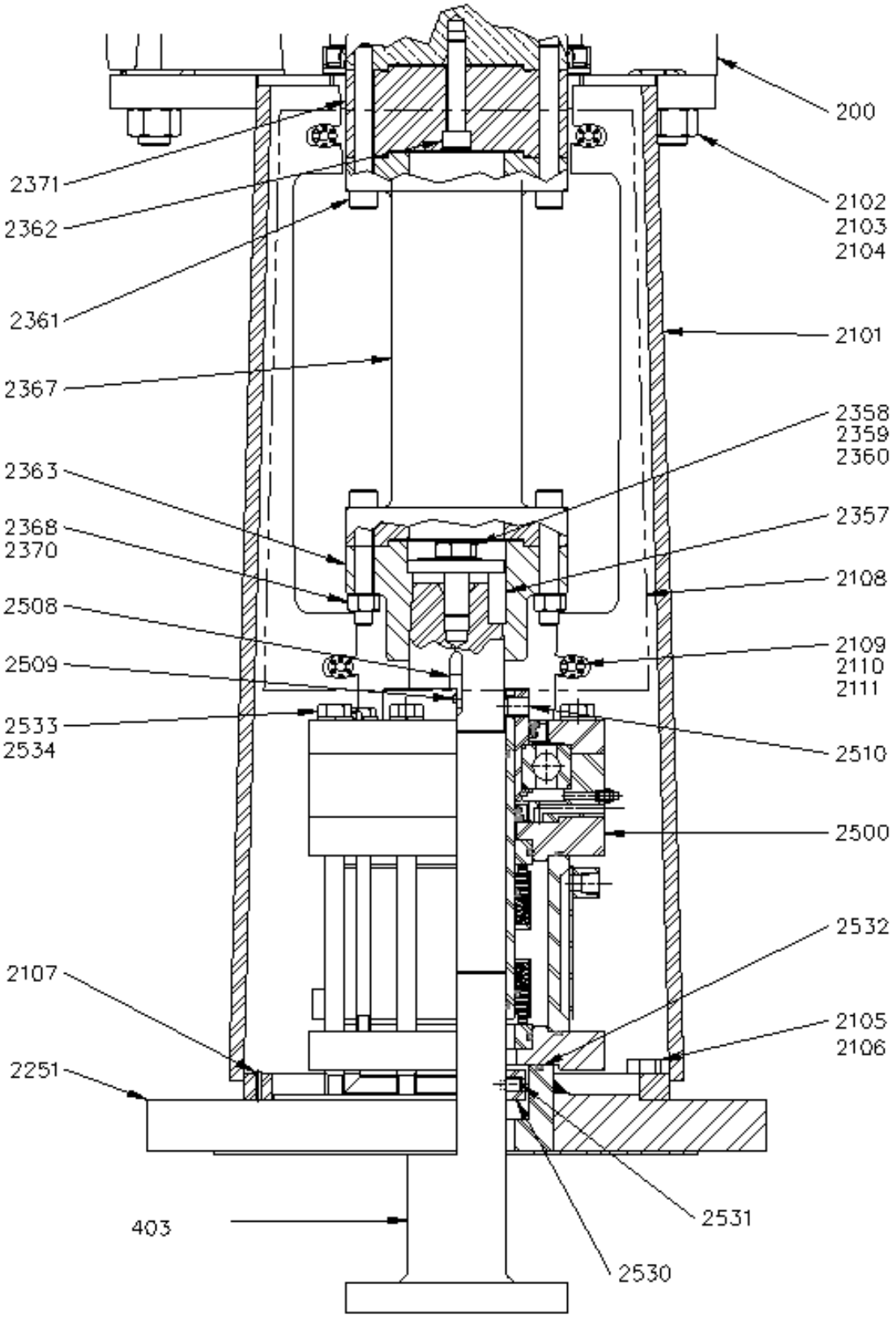


Figure 5A. N Style – Cartridge Mechanical Seal

H. LIFTING INSTRUCTIONS

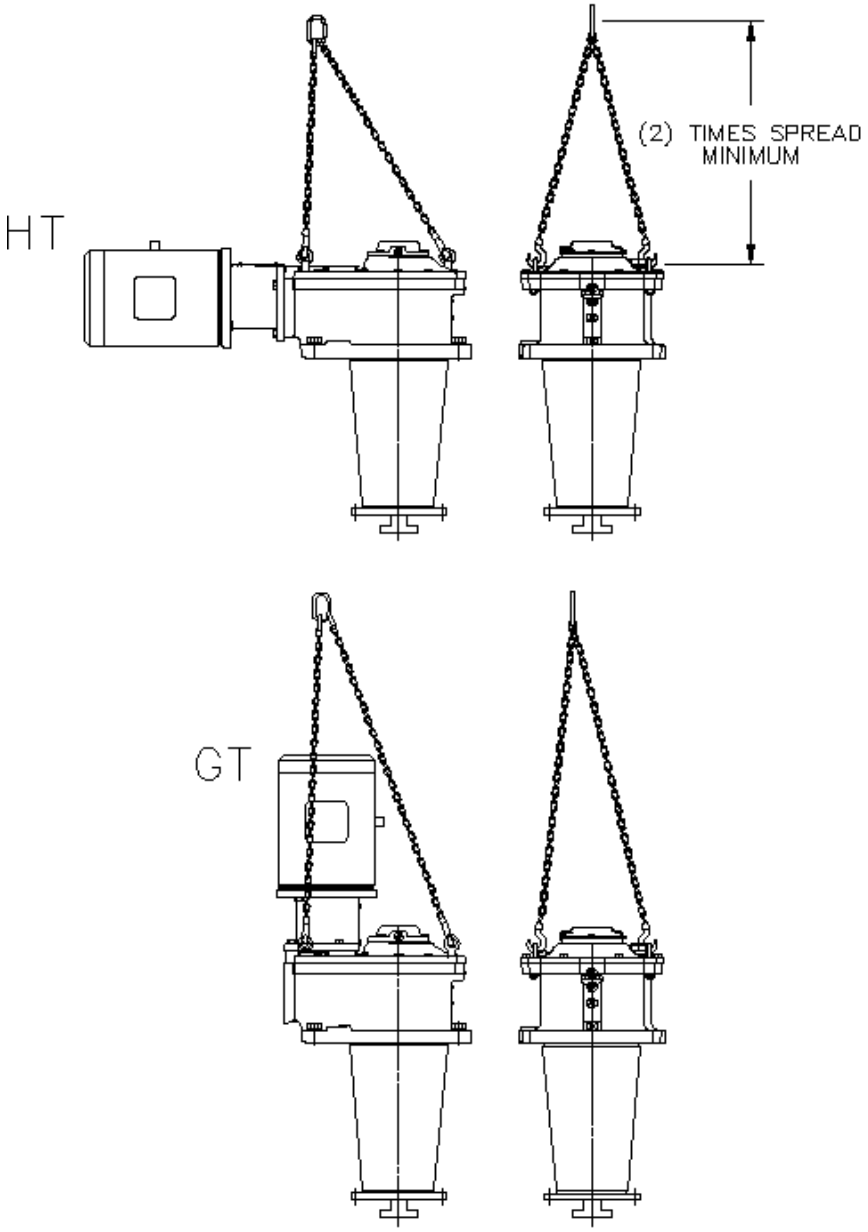


Figure 6. Agitator lifting system

1. Use a four-point chain using four eyebolts on four corners of the gear drive.
2. Do not use the lifting eye bolt supplied on the motor to lift the gearbox or agitator
3. It is recommended that the agitator lifting eyes not be used to lift the entire agitator system.

I. SHAFT RUNOUT

NOTE: *The runout values provided in this section do not apply to the runout measurements for shafts with steady bearings, but the method to straighten a shaft is the same regardless of whether there is a steady bearing or not.. Refer to the steady bearing section for maximum allowable runout value for shafts with steady bearings.*

1. Check the installed extension shaft runout. Place a dial indicator on the side of the extension shaft at the bottom. Manually turn the flexible motor coupling to rotate the extension shaft one turn.

2. Total shaft runout should not exceed .005" per foot (0.42 mm per meter) FIM (Full Indicator Movement) of shaft length. If the shaft runout is excessive, the shaft can be re-straightened in the field. Rotate the shaft to the maximum positive indicator reading. Apply heat to the shaft at a point 180º from the indicator and just below the first in-tank shaft coupling or just below the mounting surface if there is no in-tank coupling. As heat is applied to the shaft (do not allow surface temperature of shaft to exceed 500ºF [260ºC]), the shaft will move toward the indicator. After the shaft has moved .030-.060" (0.76-1.52 mm), remove the heat and the shaft will begin to move away from the indicator. The shaft will draw more than it moved initially, and as a result will be straightened. After each heating cycle, recheck the shaft until runout is within tolerance. Do not heat in the same location. Move up or down 2 or 3" (50-70 mm) to avoid reheating the same location.

J. MOTOR INSTALLATION

NOTE: Do not install the motor/motor adapter assembly **[100, 131]**, until after the gear drive **[200]** has been installed on the pedestal **[1101]** and the mechanical seal cartridge is completely installed. The procedure for the installation of the mechanical seal and any optional steady bearing assembly will require access to the gear drive input shaft.

1. Orient motor onto adapter with conduit box in an accessible position. Install motor mounting bolts **[135]** and lockwashers **[136]**. Torque bolts to the value shown in the APPENDIX, Page 96.

2. The default flexible motor coupling **[110]** used on all Chemineer Model 20 agitators is the Sure-Flex® coupling unless otherwise specified. Refer to coupling vendor's instructions supplied with coupling for exact installation instructions.

3. If using a Sure-Flex® coupling, measure and mark the setting distance on the motor shaft as per Table 5 or Table 6. Install the flexible coupling hub with motor key **[101]** on the motor shaft as per the marking (See Figure 7). Tighten the hub setscrews to the torque value shown in the APPENDIX, Page 96. Turn the motor shaft by hand to check that the shaft rotates freely.

Table 5. MOTOR (NEMA) COUPLING SETTING

CASE SIZE	MOTOR FRAME SIZE (NEMA)								
	56C	143TC 145TC	182TC 184TC	213TC 215TC	254TC 256TC	284TC 286TC	324TC 326TC	364TC 365TC	404TC 405TC
21	1.06 in (27 mm)	1.13 in (29 mm)	1.25 in. (32 mm)	1.63 in (41 mm)	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	1.13 in (29 mm)	1.63 in (41 mm)	1.94 in (49 mm)	2.25 in (59 mm)	2.44 in (62 mm)	N/A	N/A
23	N/A	N/A	1.06 in. (27 mm)	1.31 in. (33 mm)	1.69 in (43 mm)	1.88 in. (47 mm) 2.31 in.** (59 mm)**	2.50 in. (63 mm)	2.19 in (55 mm), 3.13 in.++ (79 mm)++	3.31 in. (85 mm)

** *Use this for 280 Frame, 30 Hp motor at 1755 rpm input*

++ *Use this for 360 Frame, 75 Hp motor at 1755 rpm input*

++ *Use this for 360 Frame, 50 Hp motor at 1170 rpm input*

Table 6. MOTOR (IEC) COUPLING SETTING

CASE SIZE	MOTOR FRAME SIZE (IEC)							
	IEC 80	IEC 90	IEC 100 IEC 112	IEC 132	IEC 160 IEC 180	IEC 225	IEC 250	IEC 280
21 GT/HT	22 mm (0.87 in.)	25 mm (1.0 in.)	32 mm (1.26 in.)	40 mm (1.57 in.)	N/A	N/A	N/A	N/A
22 GT/HT	N/A	N/A	26 mm (1.0 in.)	34 mm (1.34 in.)	51 mm (2.00 in.)	N/A	N/A	N/A
23 GT/HT	N/A	N/A	N/A	36 mm (1.42 in.)	52 mm (2.0 in.)	76 mm (3.0 in.)	60 mm (2.36 in.)	82 mm (3.23 in.)

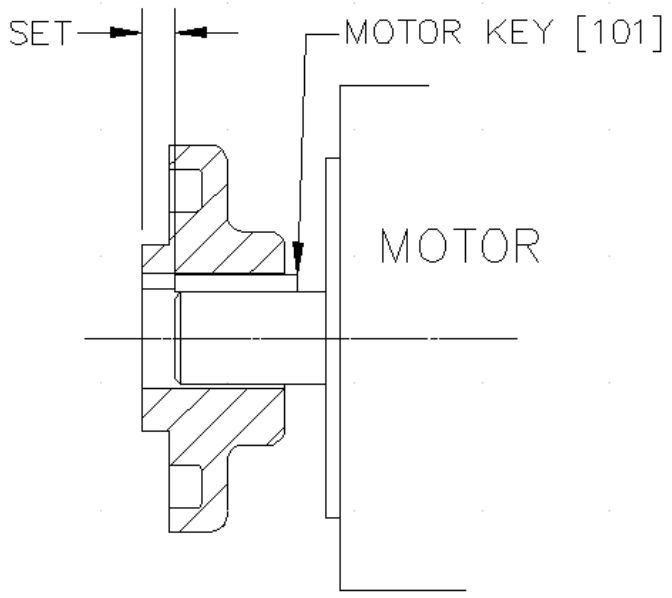


Figure 7. Motor Coupling Setting

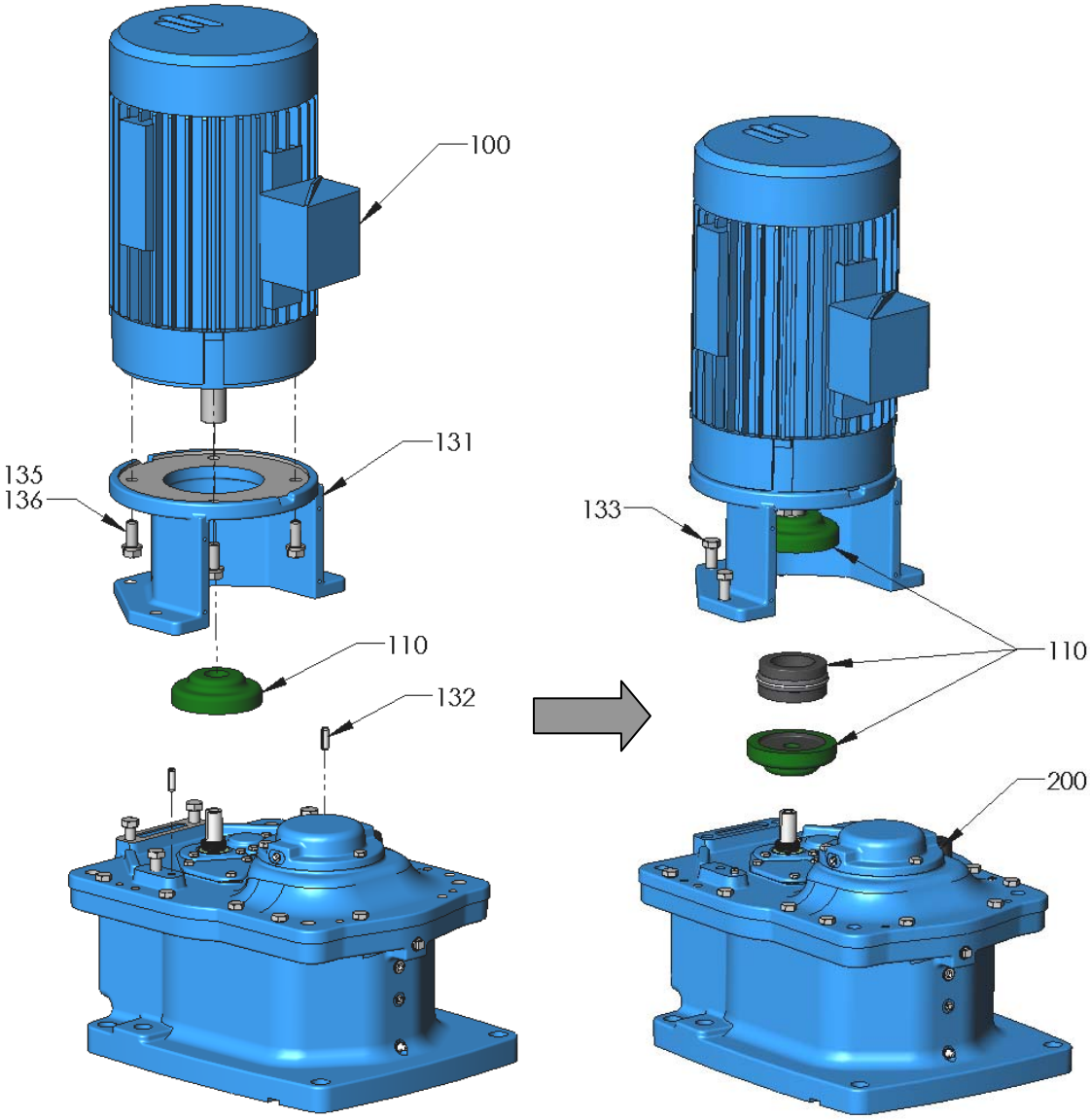


Figure 8. Model 20 GT – Motor Mounting

Note: Pedestal not shown in the above figure. However, the gear drive is already installed on the pedestal before mounting the motor

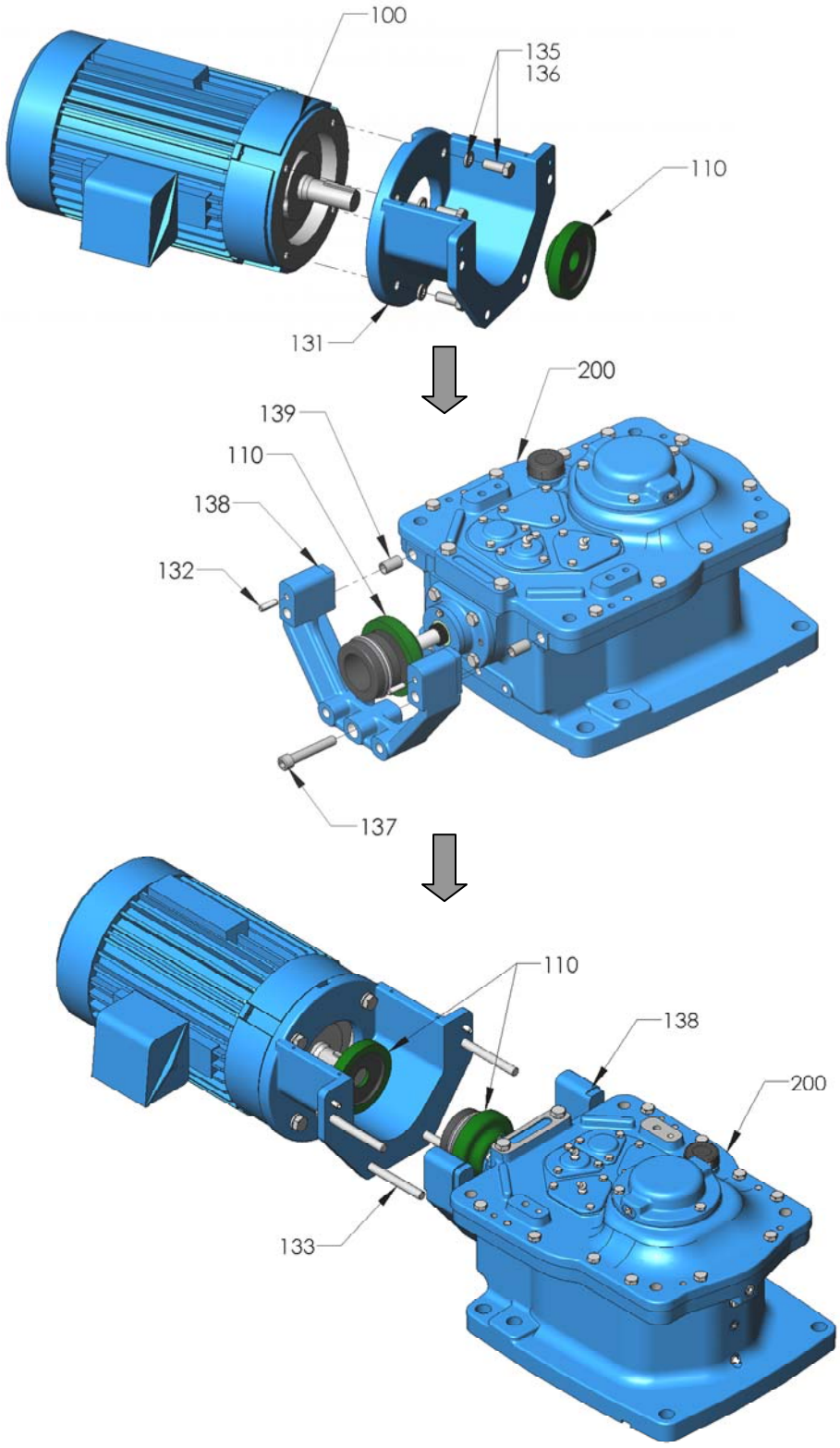


Figure 9. Model 20 HT – Motor Mounting

Note: Pedestal not shown in the above figure. However, the gear drive is already installed on the pedestal before mounting the motor

4. Install the remaining flexible coupling hub with input shaft key **[269]** onto the gear drive input shaft. Install the coupling sleeve into this hub.

5. **For GT (Parallel Drive)**, see Figure 8, page 25: If not already installed by the factory, install alignment pins **[132]** onto the gearbox lid. Using a hoist system, lift motor/adapter assembly above gear drive and lower onto the alignment pins. Install bolts **[133]** to assemble the motor adapter onto the gear drive.

   For HT (Right Angle Drive) see Figure 9, page 26: If not already installed, using the shoulder bolt **[137]**, install the spacer **[138]** with the bushings **[139]**. If not already installed, install alignment pins **[132]** on to the motor adapter. Using a hoist system, lift motor/adapter assembly in a horizontal position parallel to the gear drive. Install the motor/adapter assembly on to the spacer using bolts **[133]**.

6. Torque the bolts **[133]** to the value shown in the APPENDIX, Page 96.

7. Slide the flexible coupling hub attached to the gear drive toward the motor to the distance recommended by the coupling manufacturer. Tighten the coupling hub setscrews to the torque value provided by the coupling manufacturer. If no torque values are provided by the coupling supplier, use the values shown in the APPENDIX, Page 96.

8. The flexible coupling will not require alignment maintenance after installation. Install motor adapter cover plate, and bolts **[121, 122]**.

K. IMPELLERS

NOTE: *The instructions in this section apply to standard impeller geometry. Due to the custom nature of impeller designs for certain applications, your impeller geometry may vary from the standard configurations shown in this manual. Use discretion and consult the supplied customer specific drawings for installation specifics if your impellers do not match those shown in this manual.*

K.1 MATCH-MARKING

Unless otherwise specified on the unit assembly drawing, the impeller attaches to the shaft with a key and setscrew. Refer to Figure 10, page 29. With extended shaft keyways, the keyway is drilled at intervals for optional impeller placement.

Impeller assemblies (hub, blades, and stabilizer fins [if required]) may be match-marked. Match-marking is used on impellers that have been balanced or as an aid for locating multiple impellers on the shaft. Most agitators operating at or above 100 RPM have match-marked impellers. Check the impeller parts for match-marks before assembly.

Match-marked components are marked as a function of the agitator serial number and impeller location. Impellers are marked sequentially beginning with the bottom impeller and working up toward the agitator mounting surface. The following example assumes an order with two agitators, each having two 4-blade impellers with the lower impeller stabilized.

K.1.1 Markings for Serial Number XXXXXX-1

The lower impeller hub has stub blades marked 1-1, 1-2, 1-3, 1-4. The corresponding extension blades and stabilizer fins are marked 1-1, 1-2, 1-3, 1-4 with respect to the stub blades.

The upper impeller hub has stub blades marked 1-5, 1-6, 1-7, 1-8. The corresponding extension blades are marked 1-5, 1-6, 1-7, 1-8 with respect to the stub blades.

K.1.2 Markings for Serial Number XXXXXX-2

The lower impeller hub has stub blades marked 2-1, 2-2, 2-3, 2-4. The corresponding extension blades and stabilizer fins are marked 2-1, 2-2, 2-3, 2-4 with respect to the stub blades.

K.2 IMPELLERS - INSTALLATION

1. Slide hub **[504]** up agitator shaft **[400]** past the desired key location.

2. Install pin key **[402]** in the shaft keyway so that pin extends into the drilled hole in the keyway. Slide the hub back down agitator extension shaft, over the key, until the hub rests on the key step.

3. Tighten setscrew **[505]** firmly onto the key. Torque to the value shown in APPENDIX, Page 96. The tapped hole for the setscrew is usually a self-locking thread form. Auxiliary fastener locking is generally not necessary.

4. Bolt extension blades **[506]** to the hub **[504]** with bolts, nuts and lockwashers **[507, 509, 508]**. Refer to Figure 11 to Figure 16, page 30 to 36. Bolt split blades, if furnished, to extension blades with bolts, nuts and lockwashers **[529, 531, 530]**. Bolt stabilizer fins **[510]**, if furnished, to extension blades with bolts, nuts, and lockwashers **[511, 513, 512]**. Torque bolts to the value shown in APPENDIX, Page 96.

   NOTE: *Extreme care should be taken to see that bolts are properly tightened. It is recommended that all in-tank fasteners be checked for tightness after the first two weeks of operation.*

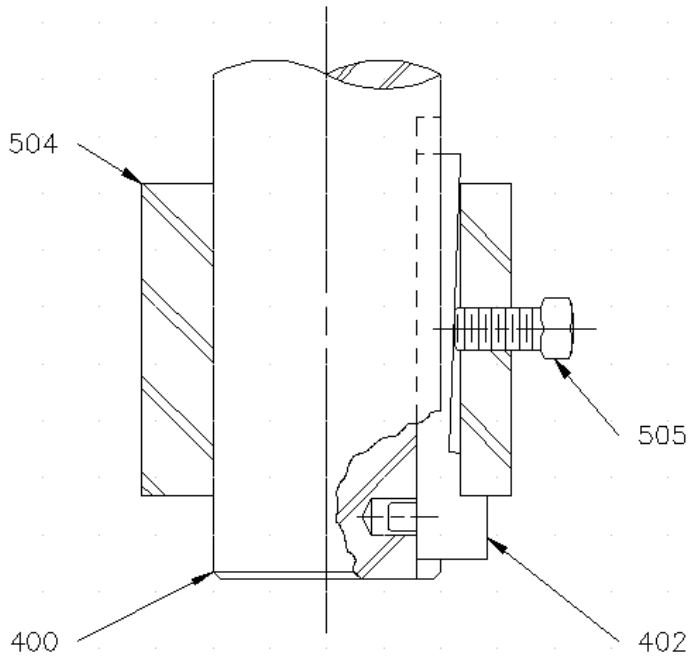


Figure 10. Hub and Pin Key Detail

K.3 IMPELLERS - STYLES

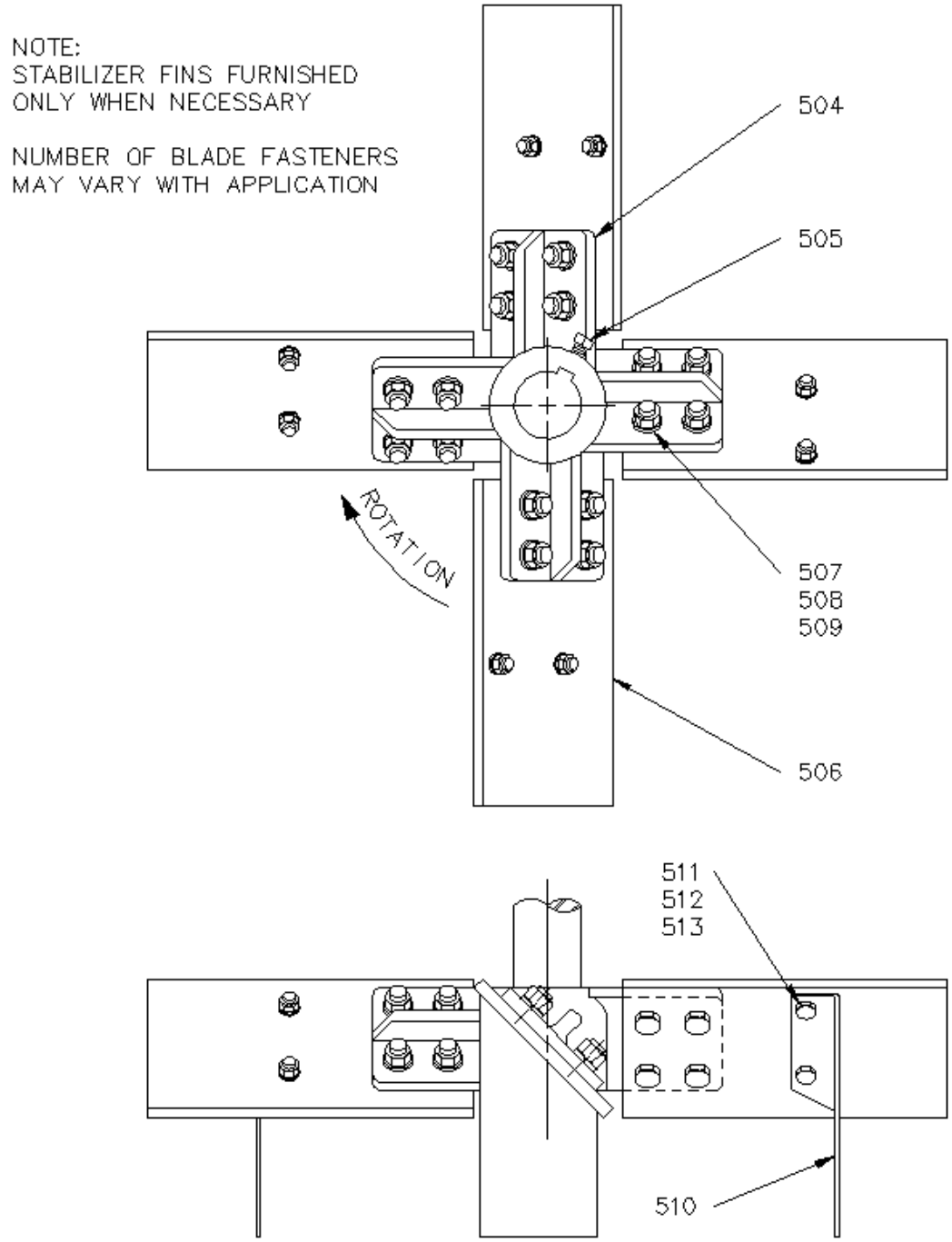


Figure 11. Style P-4 Impeller

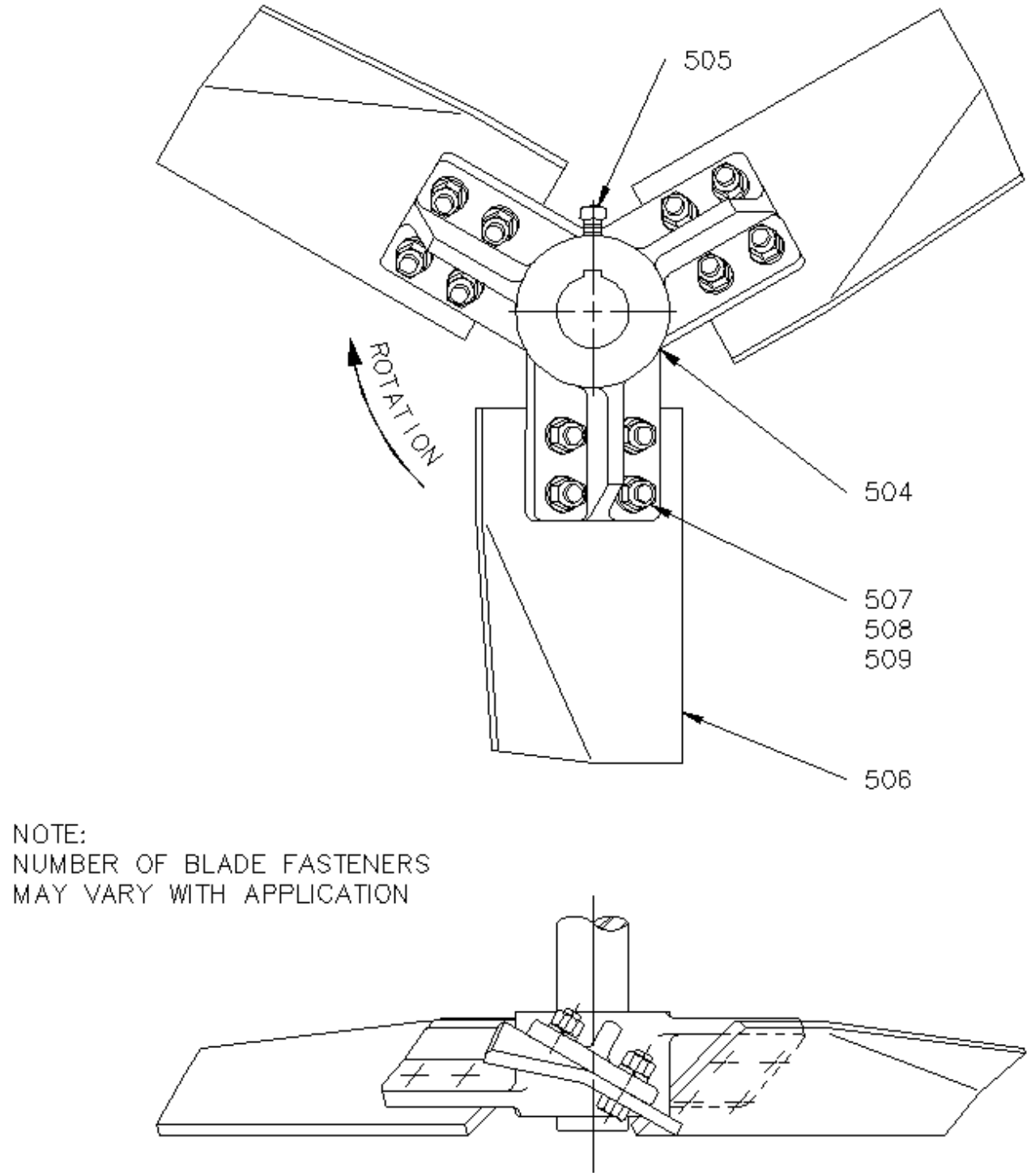


Figure 12. Style HE-3 Impeller

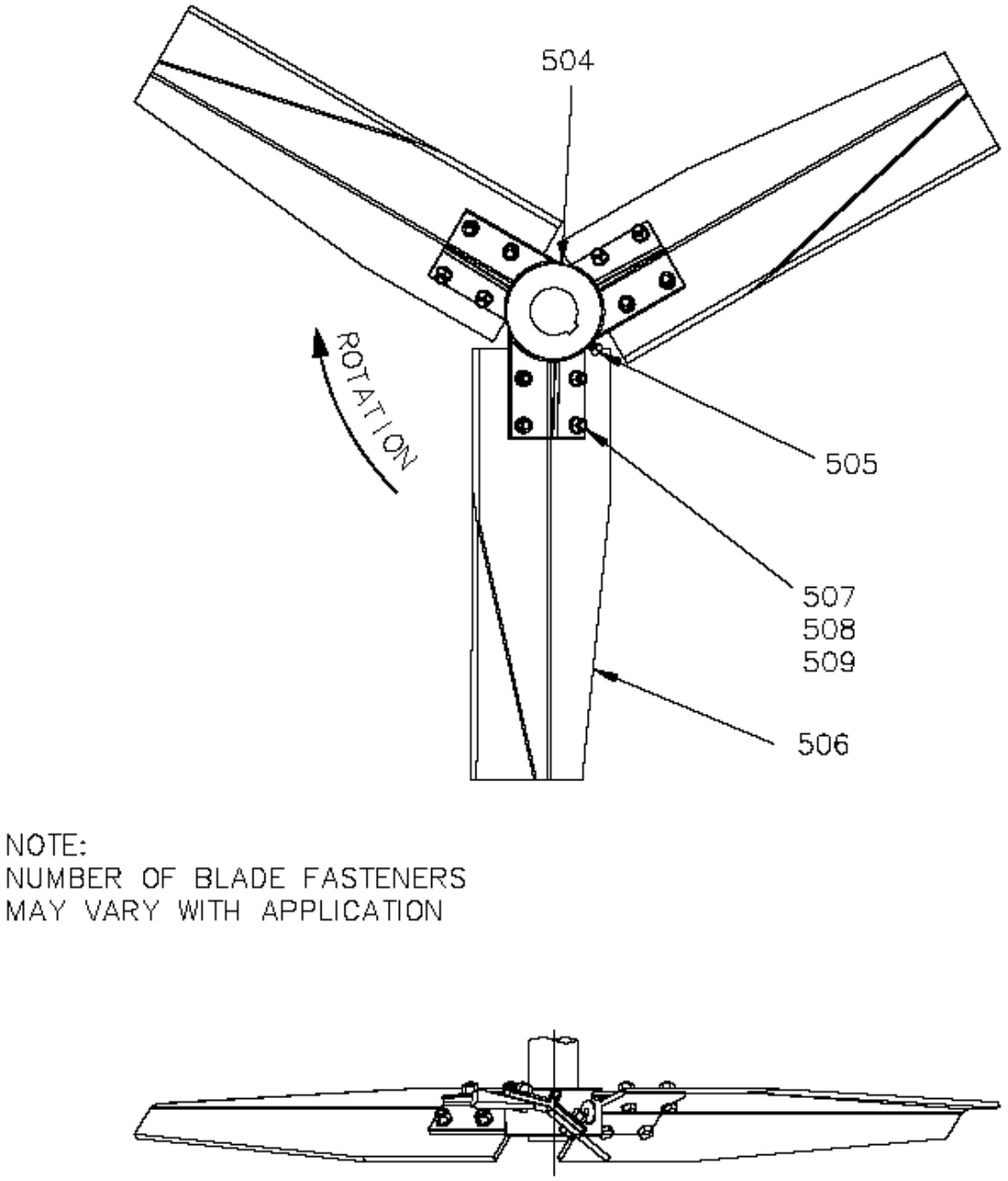


Figure 12A. Style XE-3 Impeller

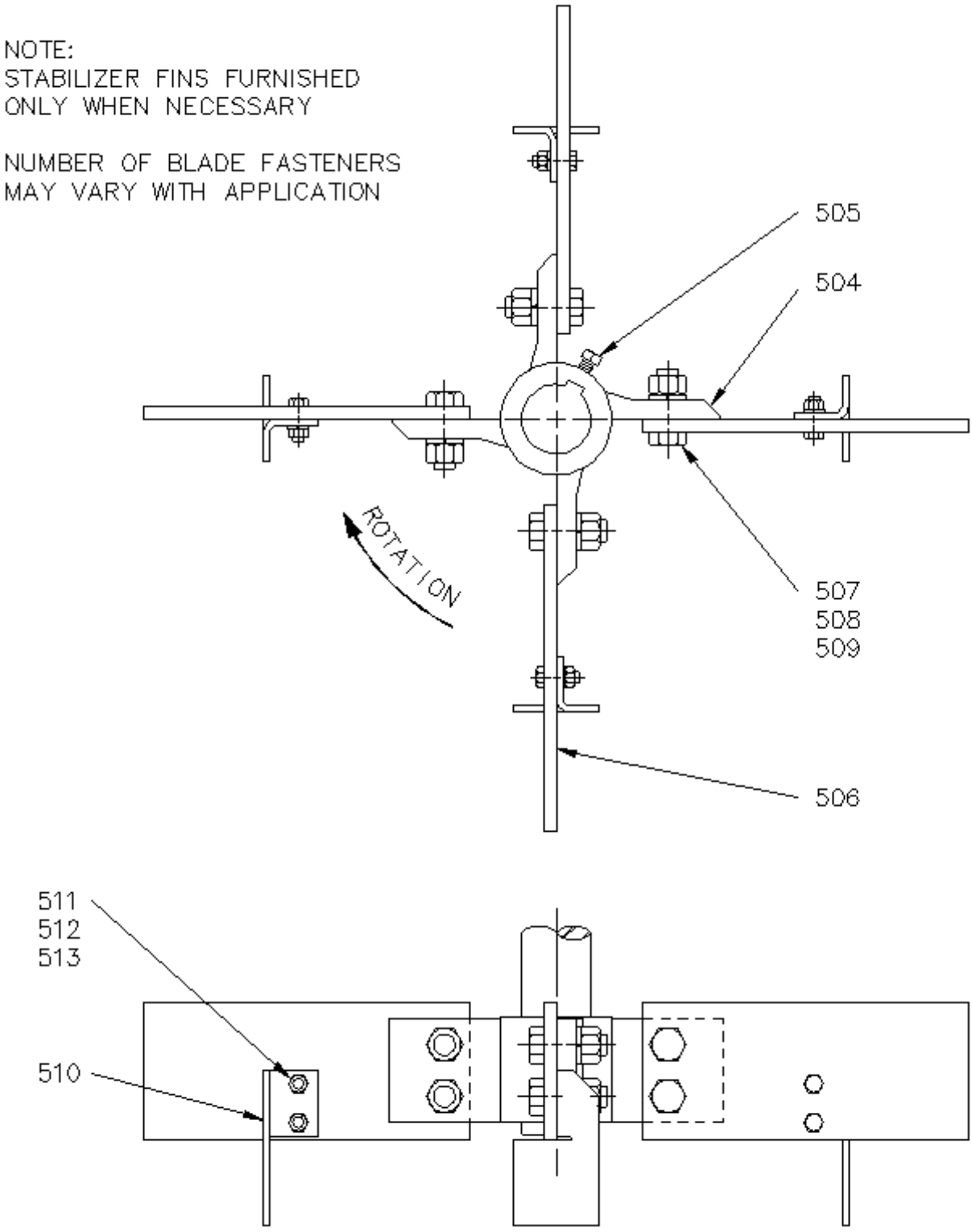


Figure 13. Style S-4 Impeller

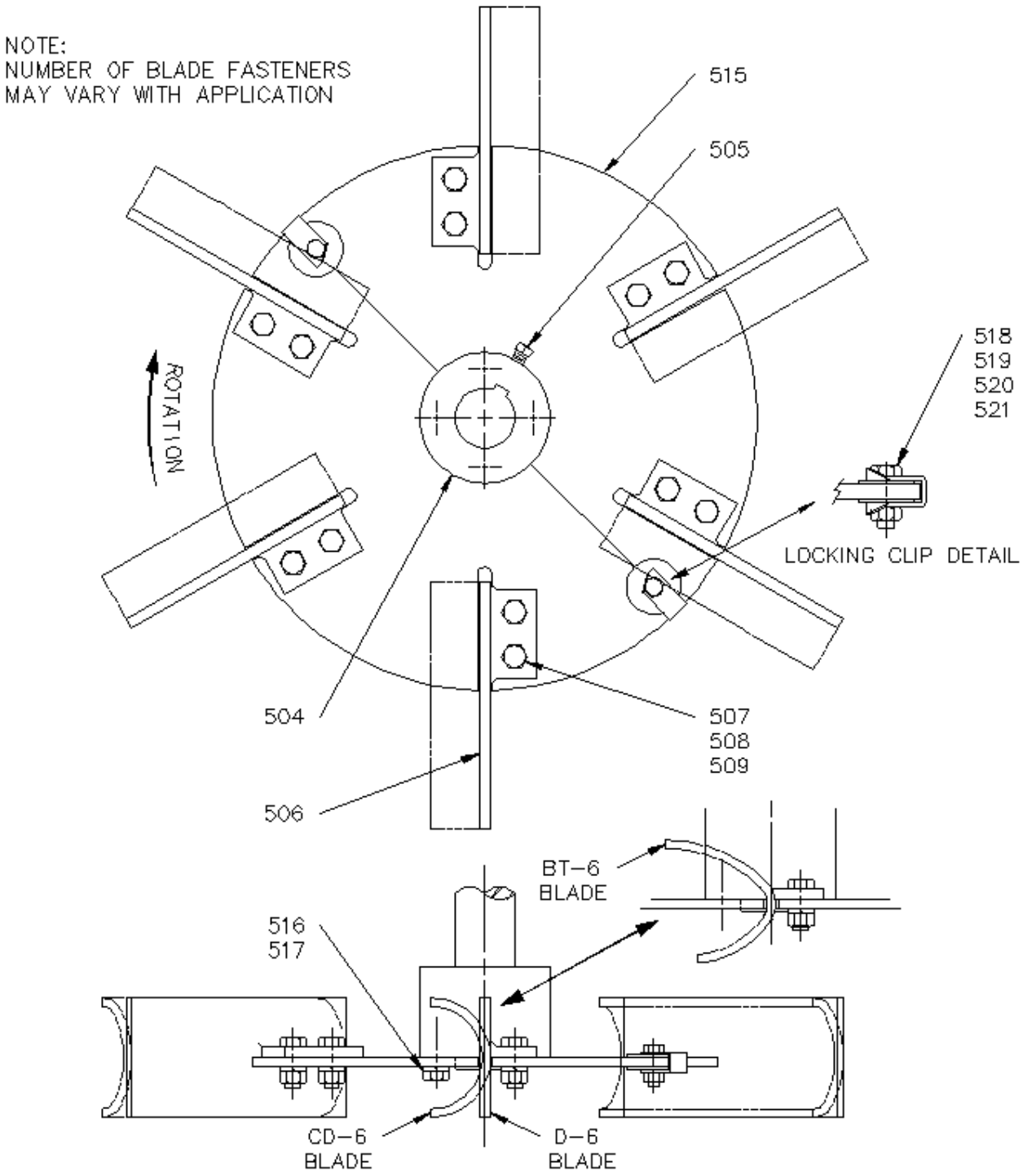


Figure 14. Style D-6, CD-6, BT-6 Impeller

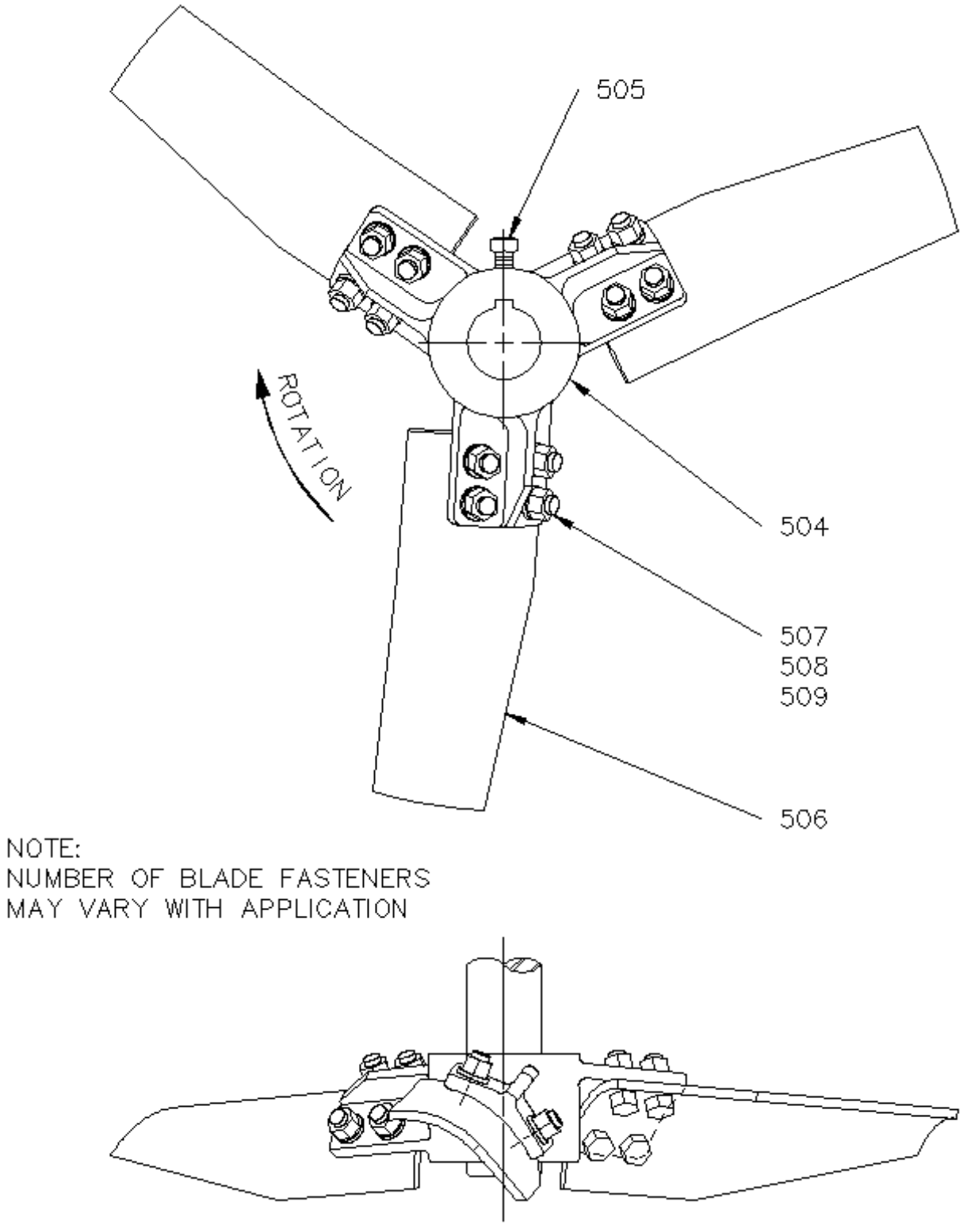


Figure 15. Style SC-3 Impeller

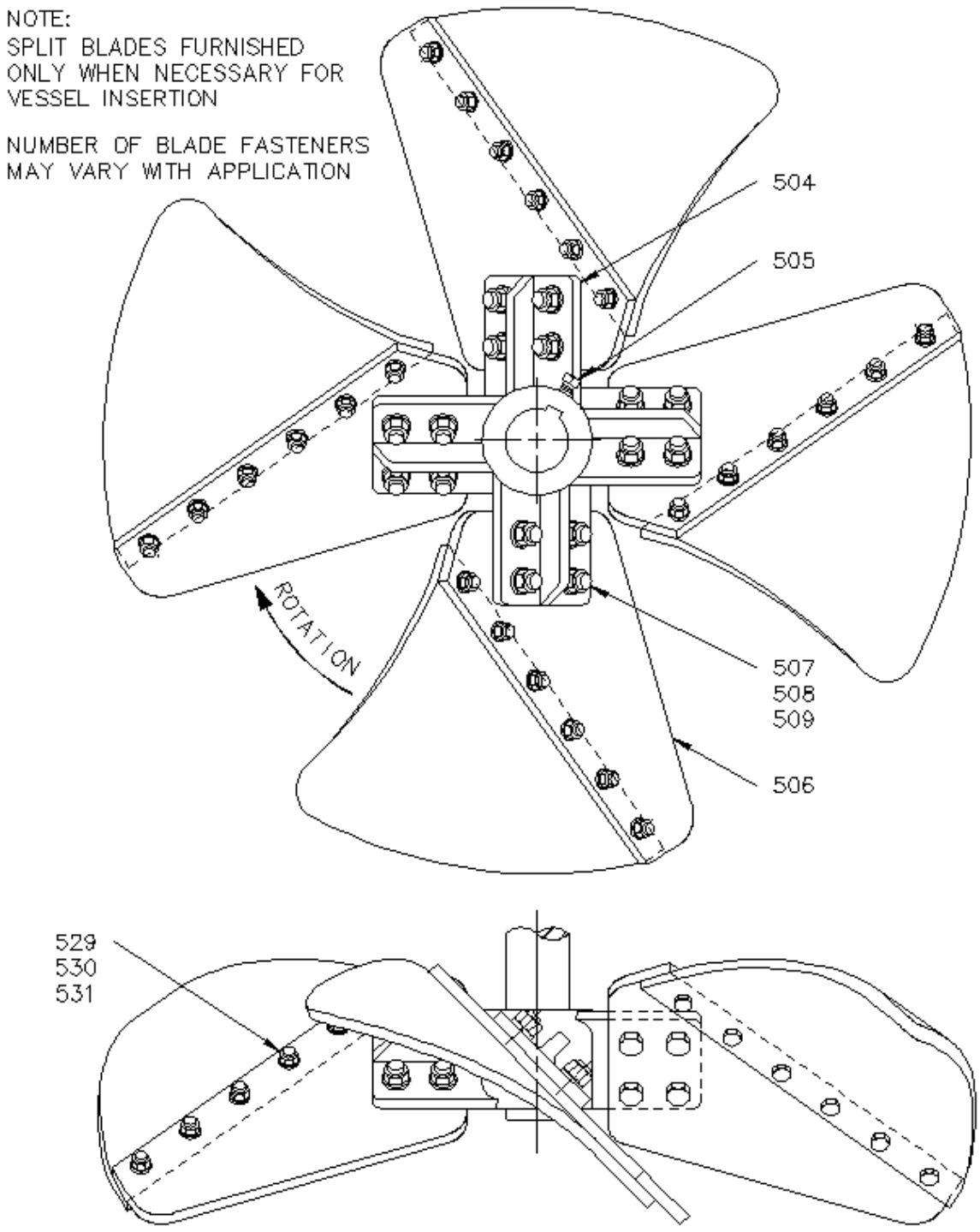


Figure 16. Style Maxflo W Impeller

K.4 IMPELLERS – COATED / RUBBER COVERED

If the unit includes a coating or rubber covering on the wetted parts, follow these instructions for installation. Refer to the unit assembly drawing.

K.4.1 One piece shaft and impeller

The shaft and impeller are usually supplied as a one-piece (welded) coated/covered assembly, and no impeller assembly is required. If your impeller was shipped separate from the shaft, follow the assembly instructions below.

K.4.2 Separate shaft and one piece impeller with thrust bolt impeller attachment

The impeller is supplied as a one-piece (welded) coated/covered assembly. For attachment to the shaft, refer to Figure 17, page 38.

1. Put gasket **[522]** on top of hub **[504]**.
2. Install key **[420]** in the shaft keyway.
3. Hoist impeller onto shaft **[400]**, being careful not to damage the coating/covering.
4. Install snap ring **[523]** in the groove at the bottom of the shaft.

CAUTION! *Do not remove the hoist until mounting bolt assembly* **[522], [524], [525]**, *and* **[526]** *are installed.*

5. Place gasket **[522]** on thrust plate **[524]**.
6. Place the thrust plate over the bottom of the shaft and install mounting bolt **[526]** with gasket **[525]**. Torque to the value shown in APPENDIX, Page 96.
7. Remove the hoist from the impeller.

K.4.3 Removable blade type

The rubber covered removable blades are provided with patch kits in order to rubber coat the uncoated surfaces after bolting the blades.

Carefully read the instructions provided with the kit before using it.

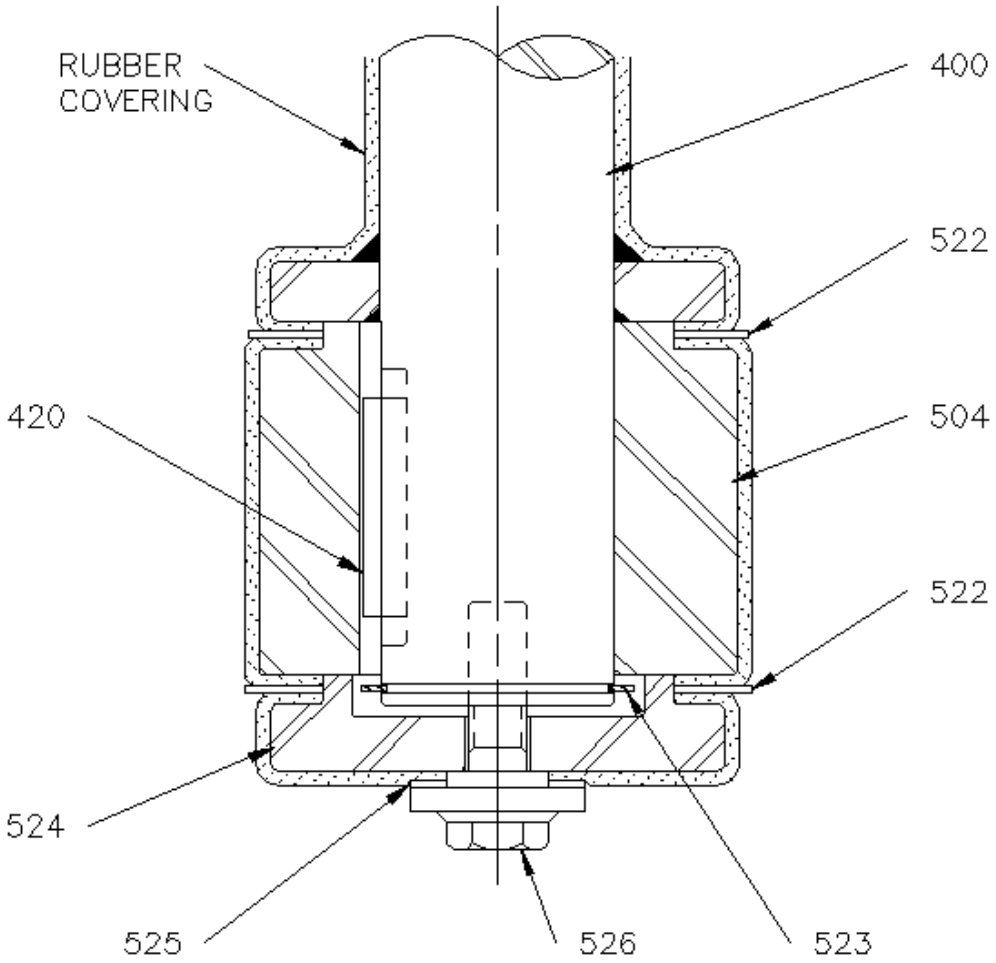


Figure 17. Thrust Bolt Impeller Attachment

L. OPTIONS

L.1 IN-TANK COUPLING

Optional in-tank couplings are available in welded (non-removable) and taper bore (removable) construction. Couplings can be supplied with one removable half and other welded on to the shaft.

NOTE: *Whenever assembly or disassembly of an agitator with an in-tank coupling is referred to in this manual, substitute flanged drive shaft* **[403]** *and/or flanged extension shaft* **[404]** Figure 18 *on page 40 or* Figure 18A *on page 41) for all references to the agitator extension shaft* **[400]**.

L.1.1 Assembly of Rigid, Removable, Taper Bore Coupling Half [408, 413]

1. Clean the shaft and coupling bore and make sure that both surfaces are free from burrs or nicks. Place key **[409, 414]** in the coupling keyway to make sure it slides freely. Place the key in the shaft keyway to make sure it is properly oriented and fully bottomed in the keyway. Install the key in the shaft keyway.
2. Slide the coupling half on the tapered shaft end until both seat firmly against each other. Make sure that the coupling half is not hung up on the key or cocked at an angle to the shaft.

   NOTE: *Do not apply lubricant or anti-seize compound to shaft or coupling taper. Shaft and coupling taper must be clean and dry prior to assembly.*
3. Shaft Bolt Installation:

   2 Bolt Design: Install coupling washer [421, 424], Install bolts and lockwashers [422, 423, 425, 426]. Torque to the value shown in the APPENDIX, Page 96.

   1 Bolt Design: Install coupling washer **[410, 415]** and locking clip **[412, 416],** Install shaft bolt **[418, 419]**. Torque to the value shown in the APPENDIX, Page 96. Bend exposed tabs of the locking clip around the shaft bolt head.
4. Assemble Coupling Halves: Connect flanged extension shaft **[404]** to flanged drive shaft **[403]** making sure the match marks are lined up and the coupling faces are clean and free from burrs or nicks. Install coupling bolts and lockwashers **[405, 406]** (and nuts **[407]** if welded construction**)**. Torque to the value shown in the APPENDIX, Page 96.
5. Ensure parts are fitted to the correct shaft.

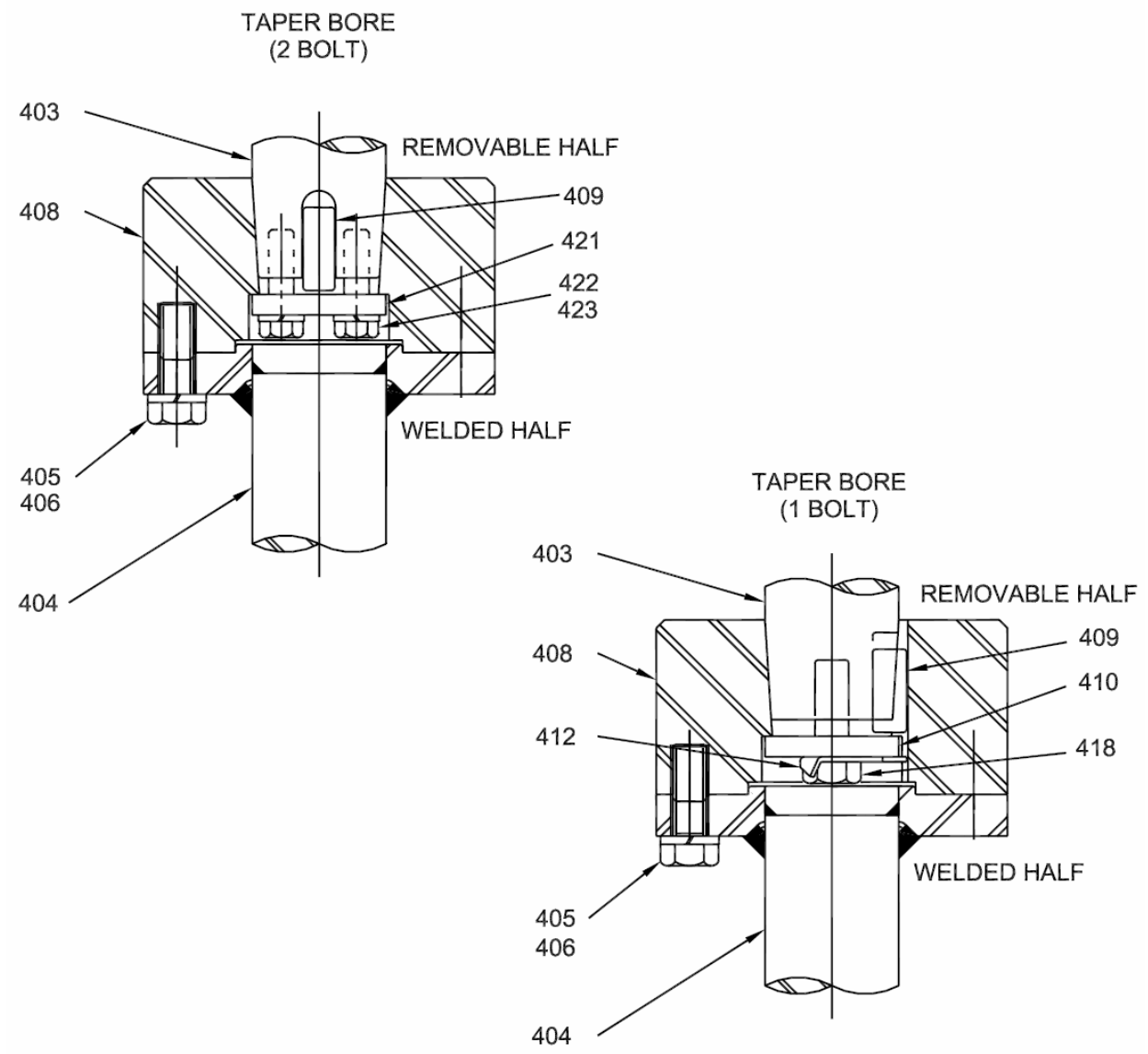


Figure 18. In-Tank Couplings

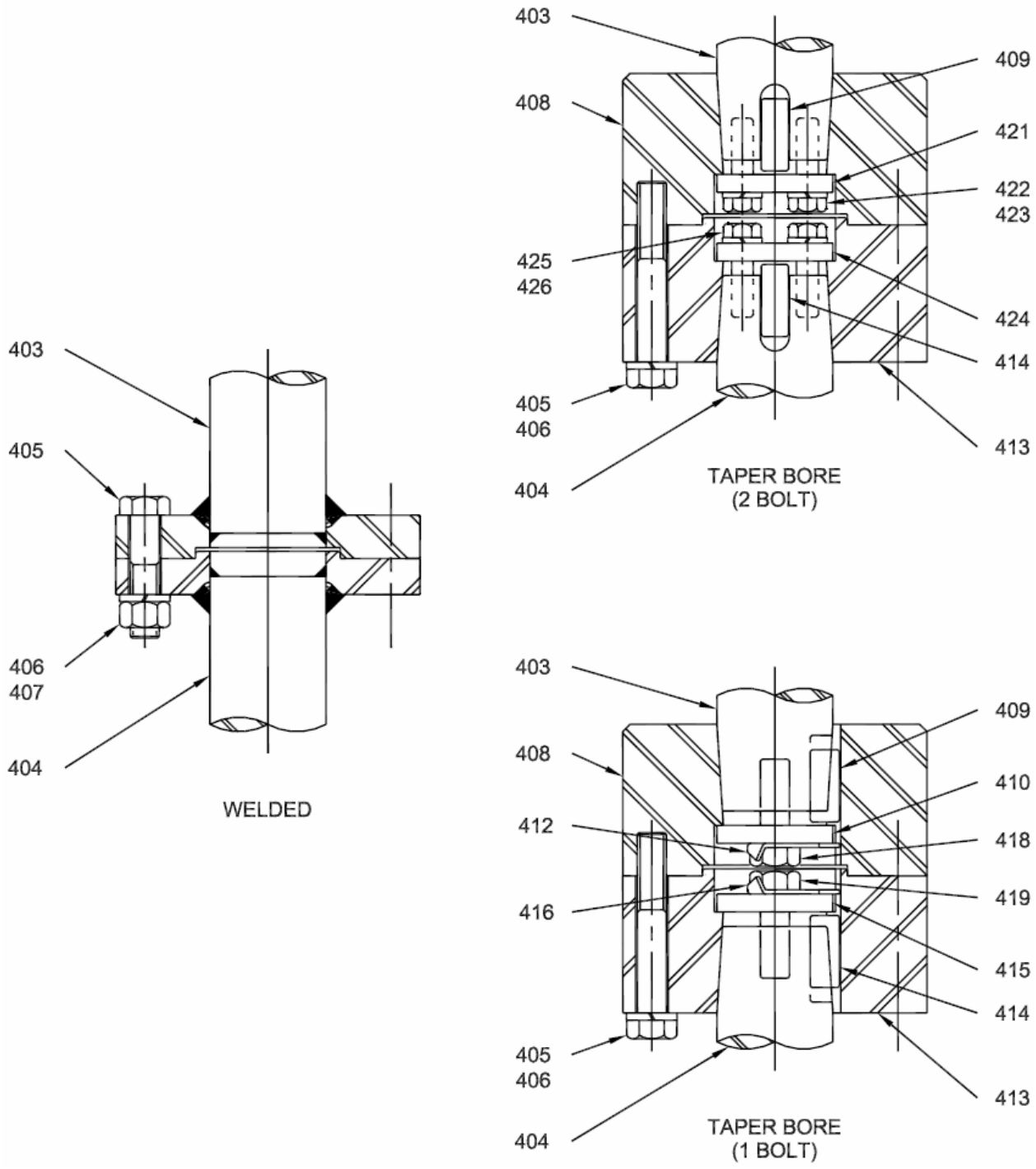


Figure 18A. In-Tank Couplings (Continued)

L.2 STEADY BEARINGS

Model 20 GT/HT agitators may include an optional in-tank steady bearing. See the unit assembly drawing for the steady bearing style, type of mounting, and vessel installation requirements.

Proper steady bearing operation requires the agitator extension shaft to be straight and the steady bearing to be centered on the shaft. Refer to the ***Shaft Runout Section***, page 22, for checking and straightening the shaft. Steady bearing mountings should be located from the installed agitator extension shaft.

L.2.1 Bracket Steady Bearing

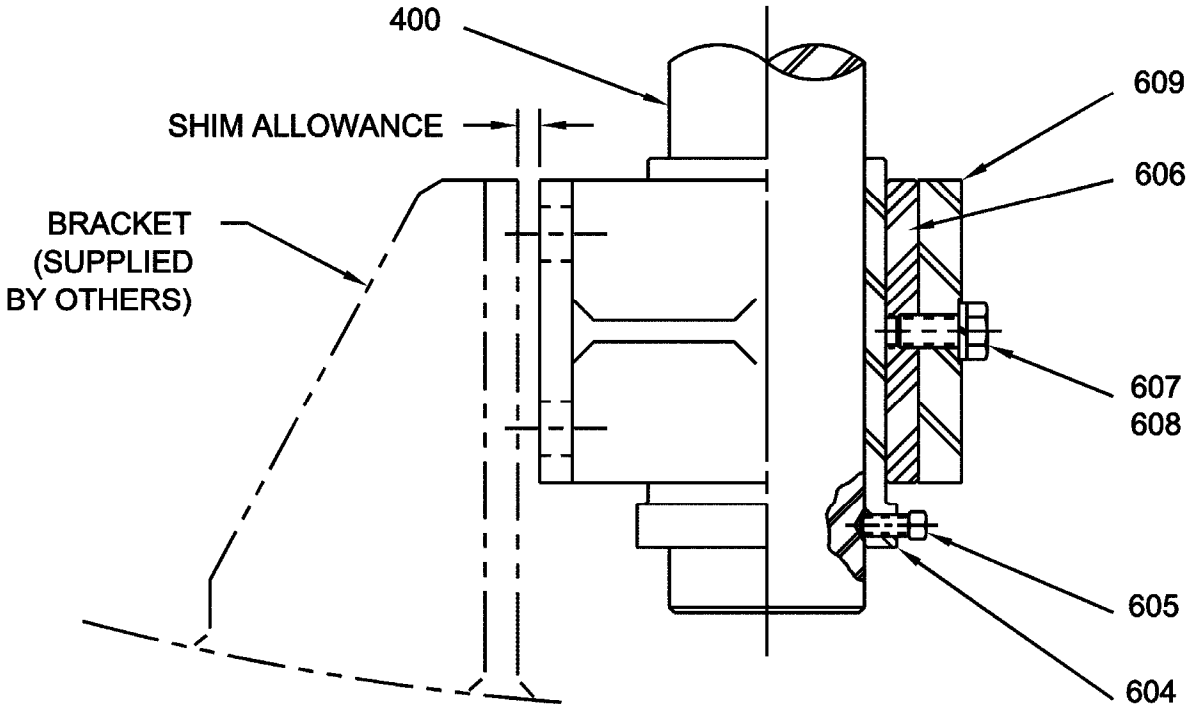


Figure 19. Bracket Steady Bearing

1. Place the steady bearing assembly on the end of the shaft and attach it to the support bracket (supplied by others). The support bracket should be located such that the steady bearing assembly is centered on the shaft. Bolt the steady bearing housing **[609]** to the support bracket. Tighten the bracket bolts (supplied by others) to 25% of specified torque per the APPENDIX, Page 96.

2. Loosen setscrews **[605]** and remove wear sleeve **[604]**. Remove bushing retaining bolt **[607]** and bushing **[606]** from steady bearing housing **[609]**.

3. Attach a dial indicator to the shaft and set it so the point of the indicator extends inside the steady bearing-housing bore.

4. Manually turn the gear drive flexible coupling half to rotate extension shaft one turn. Shim the steady bearing housing until it is located concentric to the shaft centerline within .050" (1.25 mm) FIM (Full Indicator Movement).

5. Install bushing, bushing retaining bolt, lockwasher, wear sleeve and setscrews **[606, 607, 608, 604, 605]**. See the unit assembly drawing for the position of the wear sleeve on the shaft. Tighten the bushing retaining bolt and the setscrews.

6. With a feeler gauge check the clearance between the wear sleeve and the bushing at the top and bottom in 90^{o} increments. For proper angular alignment, the gap at all locations (from top to the bottom) must be within .010" (.25 mm) of each other.

7. If the angular alignment needs correction, repeat *Steps 1 through 6.*

8. Once the final steady bearing housing location has been determined, drill the steady bearing housing and its support bracket at two locations and install roll or dowel alignment pins (supplied by others). Torque the bracket bolts to the value shown in the APPENDIX, Page 96.

9. Remove the wear sleeve setscrews one at a time and transfer punch a center into the agitator shaft. Take the wear sleeve off the shaft. Spot the shaft for the setscrews using a drill of the same diameter as the setscrews. Drill to the depth of the drill point.

10. Reinstall the wear sleeve with the setscrews over the drill spots located in Step 9. Torque the setscrews and the bushing-retaining bolt to the value shown in the APPENDIX, Page 96. The tapped holes for the setscrews are usually a self-locking thread form. When an auxiliary fastener locking is required, screws will be drilled and lock-wire will be attached..

CAUTION! *Do not operate the agitator without the steady bearing being submerged.*

L.2.2 Cup Tri-Pod Steady Bearing

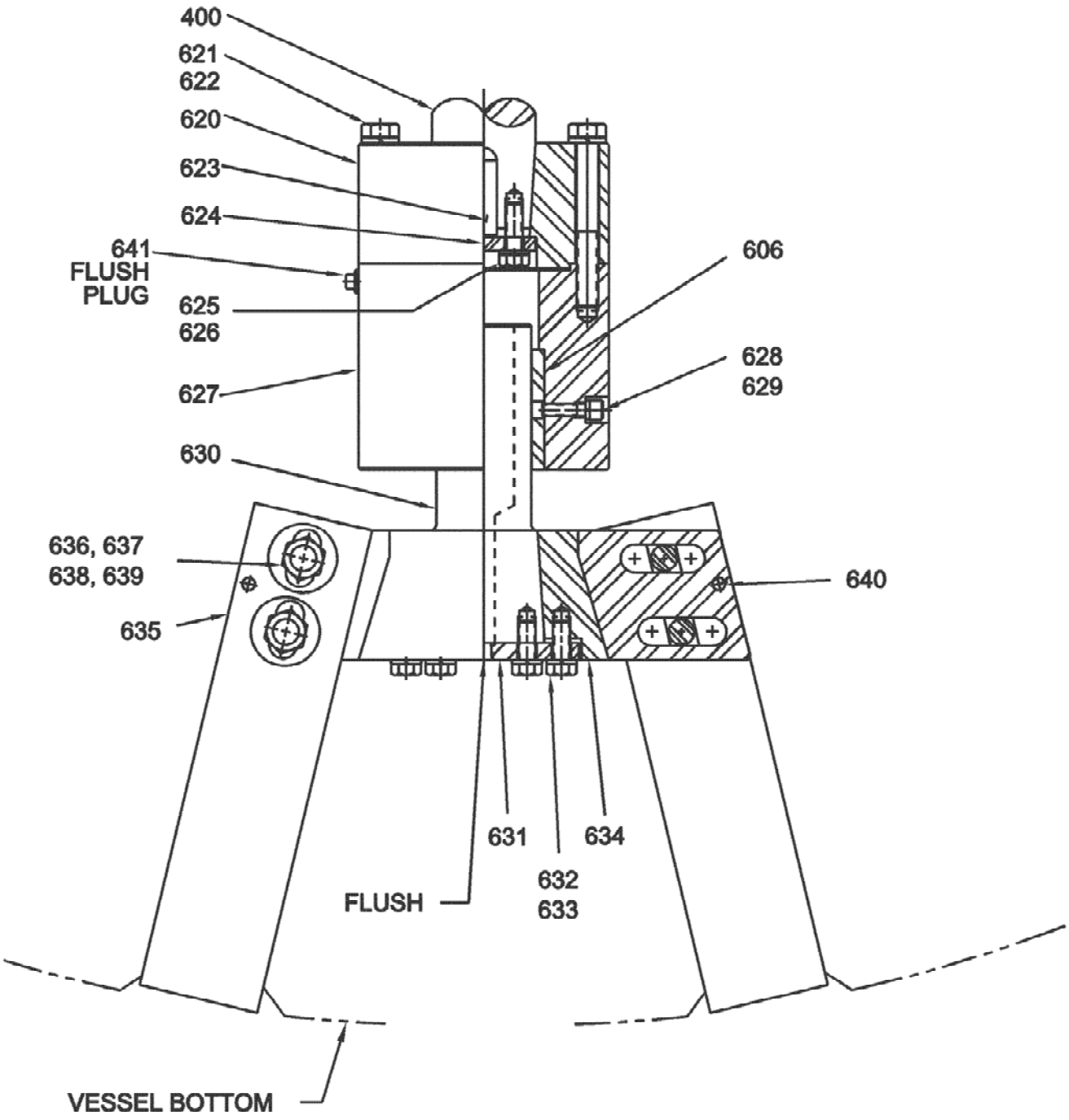


Figure 20. Cup Tripod Steady Bearing

1. Install the coupling **[620]** onto the end of the extension shaft **[400]** with key **[623]** and bolts, lockwashers, and coupling washer **[625, 626, 624]**. Refer to Installation, page 39 for in-tank coupling installation.

2. Assemble the stub shaft **[630]**, stub shaft housing **[634]**, and retainer plate **[631]** with bolts **[632]** and lockwashers **[633]**. Torque bolts to the value shown in the APPENDIX, Page 96.

   NOTE: *Be sure to assemble the stub shaft* **[630]** *to the retainer plate* **[631]** *before inserting into the stub shaft housing* **[634].** *Alignment of the stub shaft* **[630]** *to the retainer plate* **[631]** *is crucial to future maintenance.*

3. Attach legs **[635]** with bolts, nuts, lockwashers, and two flat washers **[636, 637, 638, 639]**. Do not torque the bolts at this time. Locate the steady bearing assembly so that it is centered with the extension shaft.
4. Adjust the leg angle and steady bearing assembly height. Torque the leg bolts **[636]** to value shown in the APPENDIX, Page 96. Refer to the steady bearing assembly drawing for the proper steady bearing set dimensions.

   NOTE: *Later in the procedure, the stub shaft housing will need to be adjusted for shaft concentricity and parallelism. Be sure to leave room in the leg and housing slots for future adjustment.*

5. Attach the legs **[635]** to the vessel bottom.

CAUTION! *The stub shaft* **[630]** *will need to be removed periodically for future maintenance. Be certain that there is no obstruction below the steady bearing assembly that would hinder the stub shaft removal.*

6. Attach an indicator to the coupling **[620]** and set the point of the indicator on the top of the stub shaft housing **[634]**. Manually turn the extension shaft **[400]** one full turn. Loosen the leg bolts **[636]** and nuts **[637]** and adjust the stub shaft housing **[634]** to obtain 0.010” (0.25 mm) FIM (Full Indicated Movement) maximum.

7. Place the indicator point on the outside diameter of the stub shaft **[630]** and rotate the extension shaft one turn. Loosen the leg bolts **[636]** and nuts **[637]** and move the stub shaft housing **[634]** until the stub shaft is located concentric to the shaft centerline within 0.050” (1.25 mm) FIM.

8. Torque the leg bolts **[636]** and nuts **[637]** to the value shown in the APPENDIX, Page 96.

9. Recheck the steady bearing alignment with the dial indicator. If the alignment needs correction, repeat steps 6 through 8.

10. Once the final steady bearing housing location has been determined, drill the stub shaft housing and install the dowel alignment pins **[640]**.

11. Loosen and remove bolts and lockwashers **[632, 633]** anchoring the retainer plate **[631]** to the stub shaft housing **[634]**. Re-install bolts into tapped holes at 90 degrees in the retainer plate. Progressively tighten these bolts around the bolt circle to remove the stub shaft **[630]** from stub shaft housing.

CAUTION! *Tapers can disengage with a great deal of force. On larger units, the stub shaft/retainer assembly can be very heavy. It may be advantageous to only remove half of the retainer plate to housing bolts and use those removed to break the stub shaft taper as described above. This will allow the stub shaft to still be held in position when it disengages.*

12. Install bushing **[606]** into bushing housing **[627]** and secure with bushing retaining bolt **[628]** and lockwasher **[629]**. With bushing installed, assemble bushing housing to coupling **[620]** using bolts and lockwashers **[621, 622]**. Torque the bolts to the value shown in the APPENDIX, Page 96.

13. Install the stub shaft **[630]** through the stub shaft housing **[634]** and into the bushing **[606]**. Attach the retainer plate **[631]** with bolts **[632]** and lockwashers **[633]**. Torque bolts to the value shown in the APPENDIX, Page 96. The retainer plate has been drilled and tapped for a NPT pipefitting, be sure to orient the plate so that the larger end of the tapped fitting hole is facing downward.

14. The tripod steady bearing has an optional flush feature for lubrication and cooling. If the flush is utilized, attach the flush piping to the flush hole in the retainer plate **[631]**. Keep the flush plug **[641]** in place on the bushing housing **[627]**. Note: The flush inlet pressure should be 15 to 20 psi over the vessel pressure.

15. If the flush is not utilized, remove flush plug **[641]** from the bushing housing **[627]**.

CAUTION! *Do not operate the agitator without the steady bearing flush on or the steady bearing assembly fully submerged.*

NOTE: *Later in the procedure, steady bearing housing will need to be adjusted for shaft concentricity and parallelism. Be sure to leave room in the leg and housing slots for future adjustment.*

L.2.3 Tri-Pod Steady Bearing

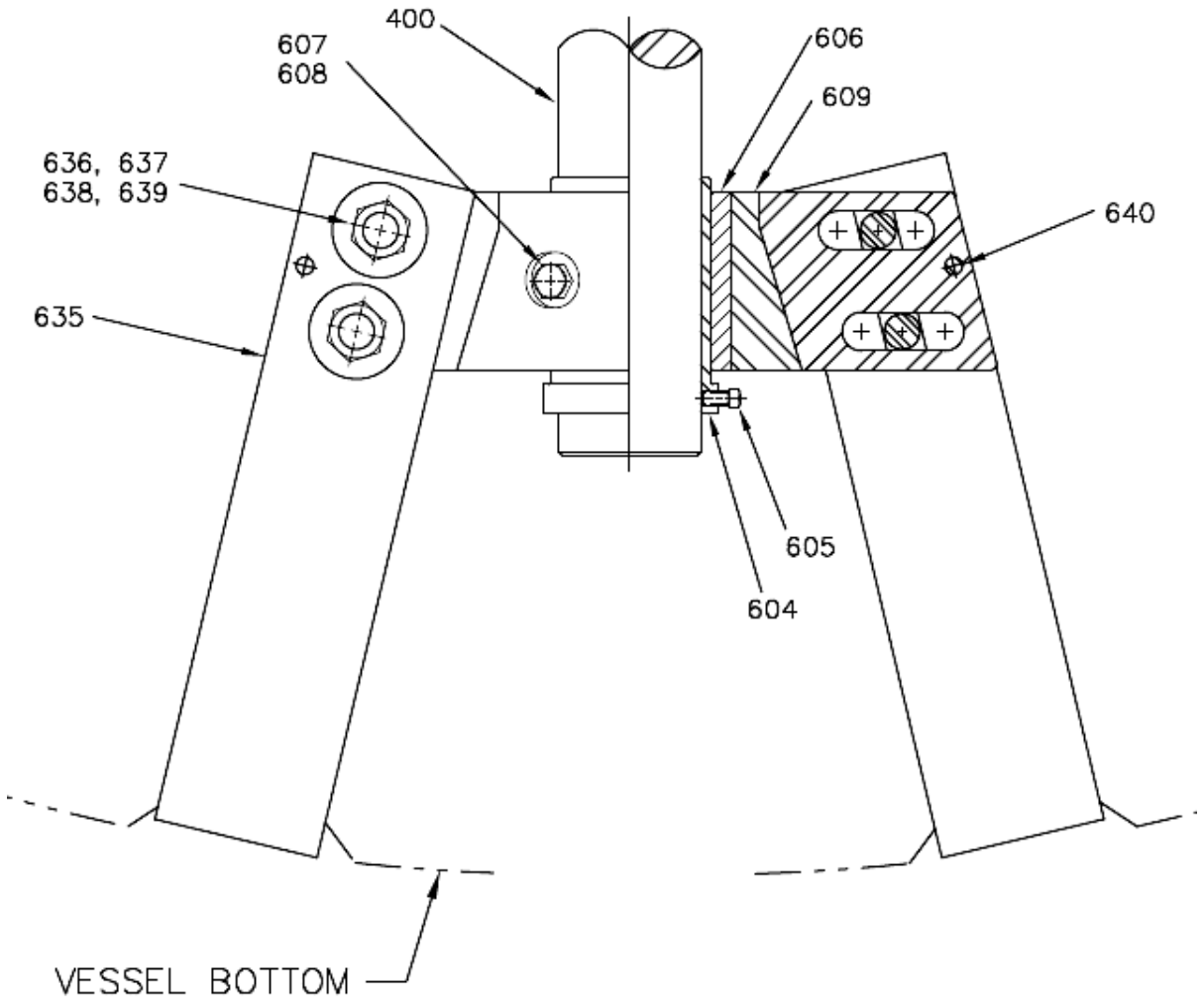


Figure 20A. Tripod Steady Bearing

1. Attach legs **[635]** with bolts, nuts, lockwashers, and two flat washers **[636, 637, 638, 639]**. Do not torque the bolts at this time. Locate the steady bearing assembly so that it is centered with the extension shaft **[400]**.

2. Adjust the leg angle and steady bearing assembly height. Torque the leg bolts **[636]** to value shown in the APPENDIX, Page 96. Refer to the steady bearing assembly drawing for the proper steady bearing set dimensions.

NOTE: *Later in the procedure, steady bearing housing will need to be adjusted for shaft concentricity and parallelism. Be sure to leave room in the leg and housing slots for future adjustment.*

3. Attach the legs **[635]** to the vessel bottom.

CAUTION! *The wear sleeve* **[604]** *and bushing* **[606]** *will need to be removed periodically for future maintenance. Be certain that there is no obstruction below the steady bearing assembly that would hinder their removal.*

4. Attach a dial indicator to the shaft **[400]** and set it so the point of the indicator extends inside the steady bearing housing bore **[609]** and rotate the extension shaft one turn. Loosen the leg bolts **[636]** and nuts **[637]** and move the housing **[609]** until the housing bore is located concentric to the shaft centerline within 0.050" (1.25 mm) FIM.

5. Install bushing, bushing retaining bolt, lockwasher, wear sleeve and setscrews **[606, 607, 608, 604, 605].** See the unit assembly drawing for the position of the wear sleeve on the shaft. Tighten the bushing retaining bolt and the setscrews.

6. With a feeler gage, check the clearance between the wear sleeve and the bushing at the top and bottom in 90° increments. For proper angular alignment, the gap at all locations (from top to the bottom) must be within 0.010" (0.25mm) of each other.

7. If the angular alignment needs correction, repeat steps 1-6.

8. Torque the leg bolts **[636]** and nuts **[637]** to the value shown in the APPENDIX, Page 96.

9. Recheck the steady bearing alignment with the dial indicator. If the alignment needs correction, repeat steps 6 through 8.

10. Once the final steady bearing housing location has been determined, drill and install the dowel alignment pins **[640]**.

11. Remove the wear sleeve setscrews **[605]** one at a time and transfer punch a center into the agitator shaft **[400]**. Take the wear sleeve **[604]** off the shaft. Spot the shaft for the setscrews using a drill of the same diameter as the setscrews. Drill to the depth of the drill point.

12. Reinstall the wear sleeve **[604]** with the setscrews **[605]** over the drill spots located in the previous step. The tapped holes for the setscrews are usually a self-locking thread form; auxiliary fastener locking is not necessary. Torque the bolts to the value shown in the APPENDIX, Page 96. When auxiliary fastener locking is required, screws will be drilled and lock-wire will be attached.

CAUTION! Do not operate the agitator without the steady bearing assembly fully submerged.

L.2.4 Pad Steady Bearing

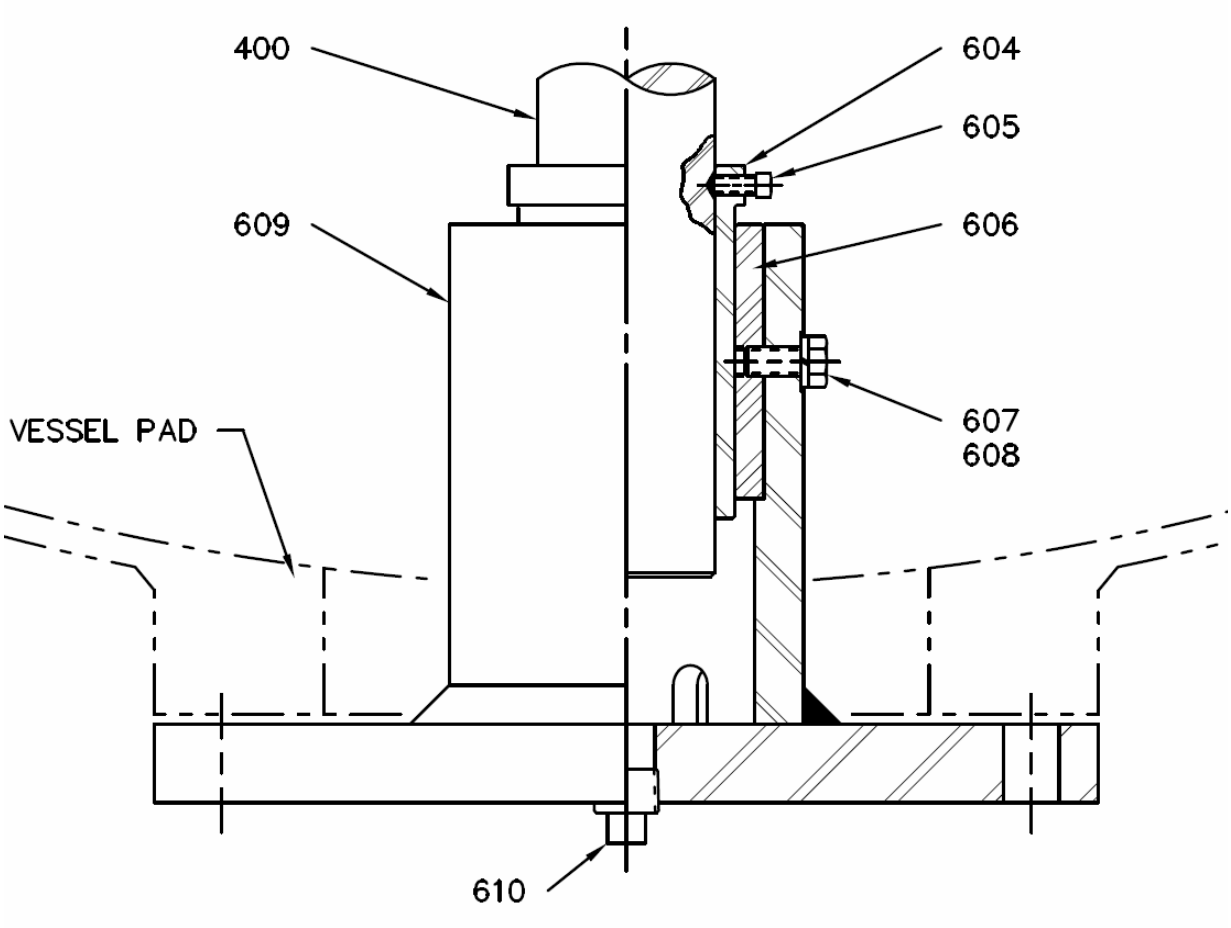


Figure 20B. Pad Steady Bearing

1. Assemble steady bearing housing **[609]** to the vessel pad with the proper gasket and flange bolts (supplied by others). Tighten the flange bolts to 25% of specified torque shown in the APPENDIX, Page 96.

2. Slide wear sleeve **[604]** up the extension shaft to disengage from bushing **[606]**.

3. Attach a dial indicator to the shaft and set the point of the indicator on the top face of housing hub **[609]**.

4. Manually turn the flexible motor coupling to rotate the extension shaft one turn. If the runout exceeds .010" (0.25 mm) FIM (Full Indicator Movement) maximum, a tapered adapter (supplied by others) should be installed between the housing mounting flange and the vessel mounting pad. Call Chemineer Field Service for assistance.

5. Place the indicator point on the outside diameter of the housing hub and rotate the extension shaft one turn. Loosen the flange bolts and move the steady bearing housing

6. until it is located concentric to the shaft centerline within .050" (1.27 mm) FIM. Torque the flange bolts to the value shown in APPENDIX, Page 96.

7. In extreme cases, the agitator drive may have to be shimmed to correct for angular misalignment. Call Chemineer Field Service for assistance.

8. If the angular alignment needs correction, repeat the previous steps.

9. Once the final steady bearing housing location has been determined, drill the steady bearing housing flange at two locations on or outside of the bolt circle and install roll or dowel alignment pins (supplied by others).

10. Slide the wear sleeve down the shaft into the bushing. See the unit assembly drawing for the position of the wear sleeve on the shaft. Tighten setscrews **[605]**.

11. Remove the wear sleeve setscrews one at a time and transfer punch a center into the agitator shaft. Slide the wear sleeve up the shaft and retain. Spot the shaft for the setscrews using a drill of the same diameter as the setscrews. Drill to the depth of the drill point.

CAUTION! *Cover the opening between the extension shaft and the bushing to prevent drill chips from getting into the housing.*

12. Reinstall the wear sleeve with the setscrews over the drill spots located in *Step 10*. Torque the setscrews to the value shown in APPENDIX, Page 96. The tapped holes for the setscrews are a self-locking thread form. Auxiliary fastener locking is not necessary.

CAUTION! Do not operate the agitator without the steady bearing assembly fully submerged.

L.3 MECHANICAL SEAL LUBRICATOR

Model 20 GTN, and HTN may include an optional mechanical seal lubricator. See the unit assembly drawing for installation requirements.

Additional information is available in sections M.3 and N.5.2, pages 65 and 68.

1. Assemble the lubricator-mounting bracket **[1702]** to the mechanical seal lubricator **[1701]**. Refer to Figure 21, page 52. Install mounting bolts, flatwashers and lockwashers **[1705, 1706, 1707]**. Torque bolts to the value shown in the APPENDIX, Page 96.
2. Install sight glass **[1709]**, drain plug **[1710]**, and pipe fittings **[1711, 1712]**.
3. Remove all plastic shipping plugs from mechanical seal barrier fluid ports.
4. Install flexible hoses **[1713]** to mechanical seal as shown.
5. Install lubricator/mounting bracket assembly using mounting bolts and lockwashers **[1703, 1704]**. Torque bolts to the value shown in the APPENDIX, Page 96.
6. Connect the flexible hose to the lubricator. Fill the mechanical seal lubricator to the center of the sight glass. The approximate capacity is 0.8 gallons U.S. (3 liters). Install the 3/8-inch NPT fill plug **[1708]**.
7. Connect a pressure line to the mechanical seal lubricator pressure inlet port, 1/4-inch NPT. Pressurize using a gas bottle, or other means. See the unit assembly drawing for the required pressure, but it is typically 25-50 psi (172-344 kPa) above the maximum vessel pressure. Check all fittings for leaks.

CAUTION! *Never pressurize the vessel without having the mechanical seal fully pressurized.*

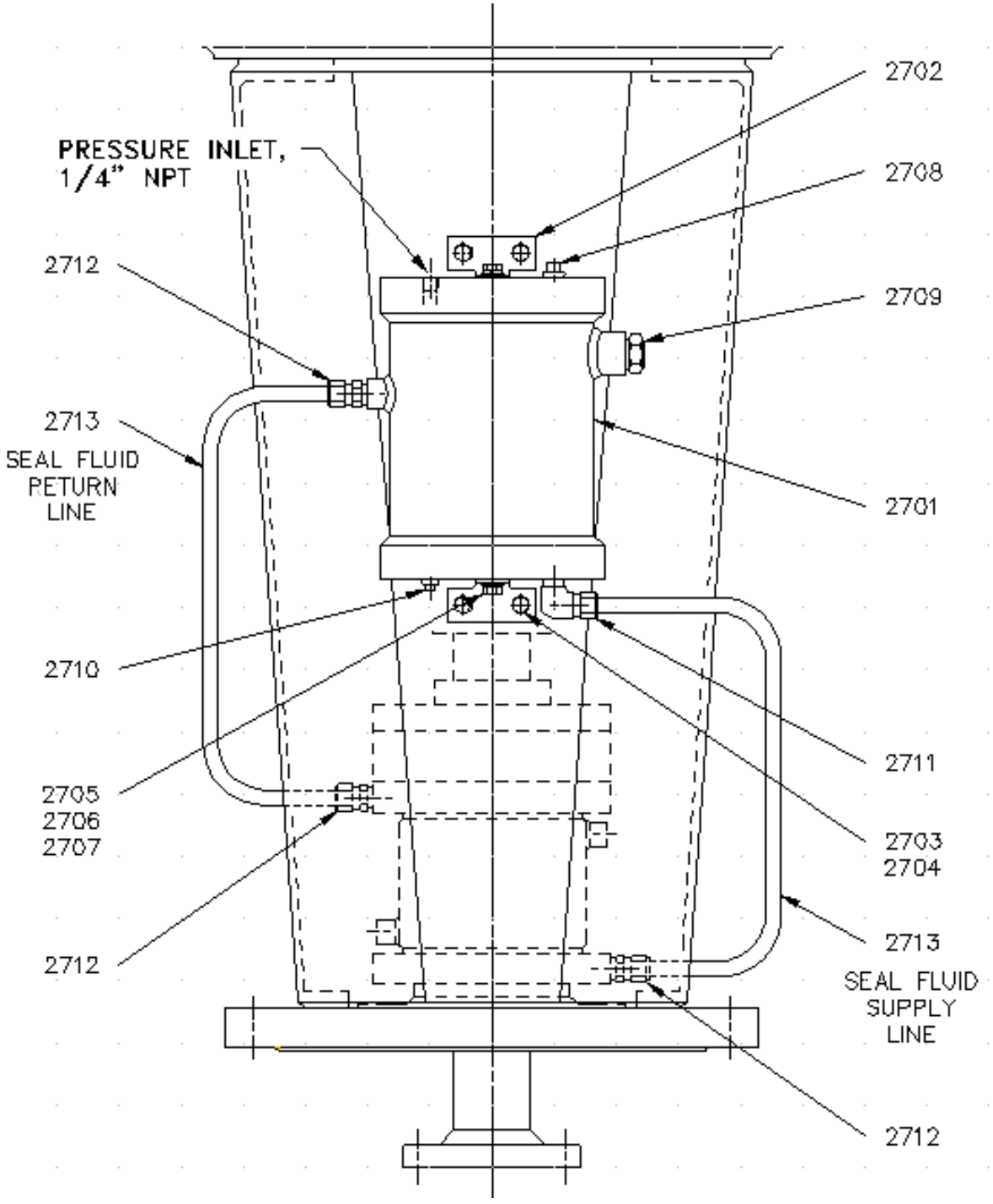


Figure 21. Mechanical Seal (Cartridge Type) Lubricator

M. LUBRICATION

This section defines the proper oils and greases that must be used with this equipment.

 ***CAUTION!*** *Check the gear drive for proper oil fill before operating.*

M.1 MOTOR - LUBRICATION

The motor bearings are properly greased by the manufacturer. Motor bearings should be re-greased at 12-month intervals when installed in clean, dry environments, or every six months for heavy duty and dusty locations. Any good quality general-purpose grease consisting of a refined base oil stock and a lithium, calcium, or polyurea (preferred) complex based soap, with an NLGI No. 2 classification, will work satisfactorily. **However, different greases are not always compatible. Hence, check for compatibility of greases before you replace one with the other.** Most major oil companies offer such products, usually with extreme pressure (EP) additives for additional protection. Table 7, page 54 lists some commonly available greases.

When re-greasing, stop the motor, remove the outlet plug and add grease according to motor supplier's recommendations with a hand lever gun only. Run the motor for about ten minutes before replacing the outlet plug. Certain TEFC motors have a spring relief outlet fitting on the fan end. If the outlet plug is not accessible at the surface of the hood, it is the spring relief type and need not be removed when re-greasing.

 ***CAUTION!*** *Over-greasing is a major cause of bearing and motor failure.*

The following actions can be taken to correct or prevent motor over-greasing and related problems[1]:

1. Review motor lubrication procedures to ensure that they identify the type and quantity of grease to use, the specific fill and drain nozzles to uncap, and the length of time motors should be run with drain plugs off after greasing the bearings.
2. To prevent foreign materials from contaminating the grease, ensure that grease containers are covered during periods of storage and that the nozzles and grease fittings are cleaned.
3. Determine the optimum quantity and correct type of grease required for each motor by examining the manufacturer's recommendations and by monitoring the behavior of grease added to motors.
4. Consider using pre-lubricated sealed bearings in applications where re-lubrication is difficult, where contaminants can adulterate the grease, or where over-greasing might damage safety systems.

[1] *US Nuclear Regulatory Commission, Information Notice No. 88-12*

Table 7. TYPICAL NLGI NO. 2 GREASES

For Ambient Temperature Range of 0º to 150º F (-18º to 66º C)		
MANUFACTURER	**GENERAL PURPOSE**	**EP**
BP oil co.		Energrease LS-EP Grade 2
Chevron U.S.A.Inc.	Chevron SRI grease Grade 2	Dura-Lith greases EP: Grade 2
Conoco Inc.		EP Conolith grease: Grade 2
Exxon Co. U.S.A.	Unirex N: Grade 2	Nebula EP: Grade 2
		Ronex MP: Grade 2
Mobil Oil Corp.	Mobilith AW Grade 2	Mobilux EP 2
Phillips 66 Co.		Philube EP grease: EP-2
Shell Oil Co.	Alvania RL grease: Grade 2	Alvania grease EP LF 2
Texaco Lubricants Co.	Polystar RB 2 grease	Multifak EP 2
Unocal 76		Unoba EP grease: Grade 2
		Multiplex Red EP: Grade 2

M.2 GEAR DRIVE - LUBRICATION

For Model 20 GT Gear Drives:

The gear drive features oil bath lubrication for all gears and all bearings except **[233, 245]**. Refer to Figure 23, page 62 for double reduction units and Figure 24, page 63 for triple reduction units.

For Model 20 HT Gear Drives:

The gear drive features oil bath lubrication for all gears and all bearings except **[233, 245, 203, 217]**. Refer to Figure 25, page 64 for spiral bevel (right angle) unit.

CAUTION! *The gear drive has been drained of oil for shipping. Fill gear drive with oil prior to operating!*

See Table 10, page 58 for operating oil capacity.

Always use new oil to avoid damage to the gearing or bearings. When checking oil level, the agitator must be shut off. Remove the breather-dipstick **[258]** and add oil until the level is between the "max" and "min" marks on the dipstick **[258]**. The Dipstick must be fully installed into the lid for a proper level reading.

CAUTION! *Do not over or under fill the gear drive.*

Do not operate before filling with oil. Re-install the breather-dipstick **[258]**.

The agitator nameplate or Table 9, page 58, should be used to select the proper viscosity oil based on ambient temperature conditions. Table 10 should be used as a guide to determine the quantity of oil required.

Use good quality straight grade, R & O petroleum base gear oil per Table 11, page 59 for most applications. If the gear drive loading is extremely heavy or if ambient temperature exceeds 100ºF (38ºC), an EP oil per , page 60 should be used. In general, EP oil will be beneficial for all operating conditions. Table 11 and Table 12 are presented for guidance and equivalent oils from other suppliers may be used.

For very heavily loaded units, or units running in very high ambient temperatures, synthetic lubricants may be necessary. The gearbox nameplate and the customer drawings will state this. Table 13 provides guidance on synthetic lubricants.

Food grade lubricants, if necessary, are to be specified by the customer. Generally, the lubricant supplier can provide FDA approved equivalents to those listed in the above mentioned tables.

Drain oil by removing drain plug **[264]** and refill the gear drive after the first week or 100 hours of operation, and then every six months or 2500 hours thereafter. If operated in adverse conditions such as an extremely dusty or humid environment, more frequent oil changes are advisable.

For GT Gear Drives:

Bearings **[233, 245]** are grease lubricated. These bearings are packed with grease prior to shipment from the factory. At 3 month intervals, bearings **[233]** and **[245]** should be re-greased. Remove pipe plug **[261]** from output cap **[254]** and pump grease into grease fitting **[260]** until new grease appears at the pipe plug hole. Re-install the pipe plug **[261]**. Remove pipe plug **[263]** and pump approximately the same amount of grease into grease fitting **[262]** that was pumped into grease fitting **[260]**. Re-install the pipe plug **[263].**

For HT Gear Drives:

Bearings **[233, 245, 203, 217]** are grease lubricated. These bearings are packed with grease prior to shipment from the factory. At 3 month intervals, bearings **[233]** and **[245]** should be re-greased. Remove pipe plug **[261]** from output cap **[254]** and pump grease into grease fitting **[260]** until new grease appears at the pipe plug hole. Re-install the pipe plug **[261]**. Remove pipe plug **[263]** and pump approximately the same amount of grease into grease fitting **[262]** that was pumped into grease fitting **[260]**. Re-install the pipe plug **[263].**

Pump grease in **[203]** and **[217]** using grease fittings **[384]** and **[385]**, as per the volume indicated in Table 8, page 56.

Table 8. MODEL 20 HT INTERMEDIATE BEARING GREASE ADDITION

GEAR DRIVE SIZE	At [203]		At [217]	
	in^3	cm^3	in^3	cm^3
21 HT	0.6	10	1.3	22
22 HT	1.2	20	2.6	44
23 HT	2.4	40	5.2	88

Other bearings in the gear drive are oil bath lubricated and do not require any greasing. Any good quality general-purpose grease consisting of a refined base oil stock and a lithium or calcium-complex based soap with a NLGI No. 2 classification will work satisfactorily. Most major oil companies offer such products usually with extreme pressure (EP) additives for additional protection. Table 7, page 54 lists some commonly available grease.

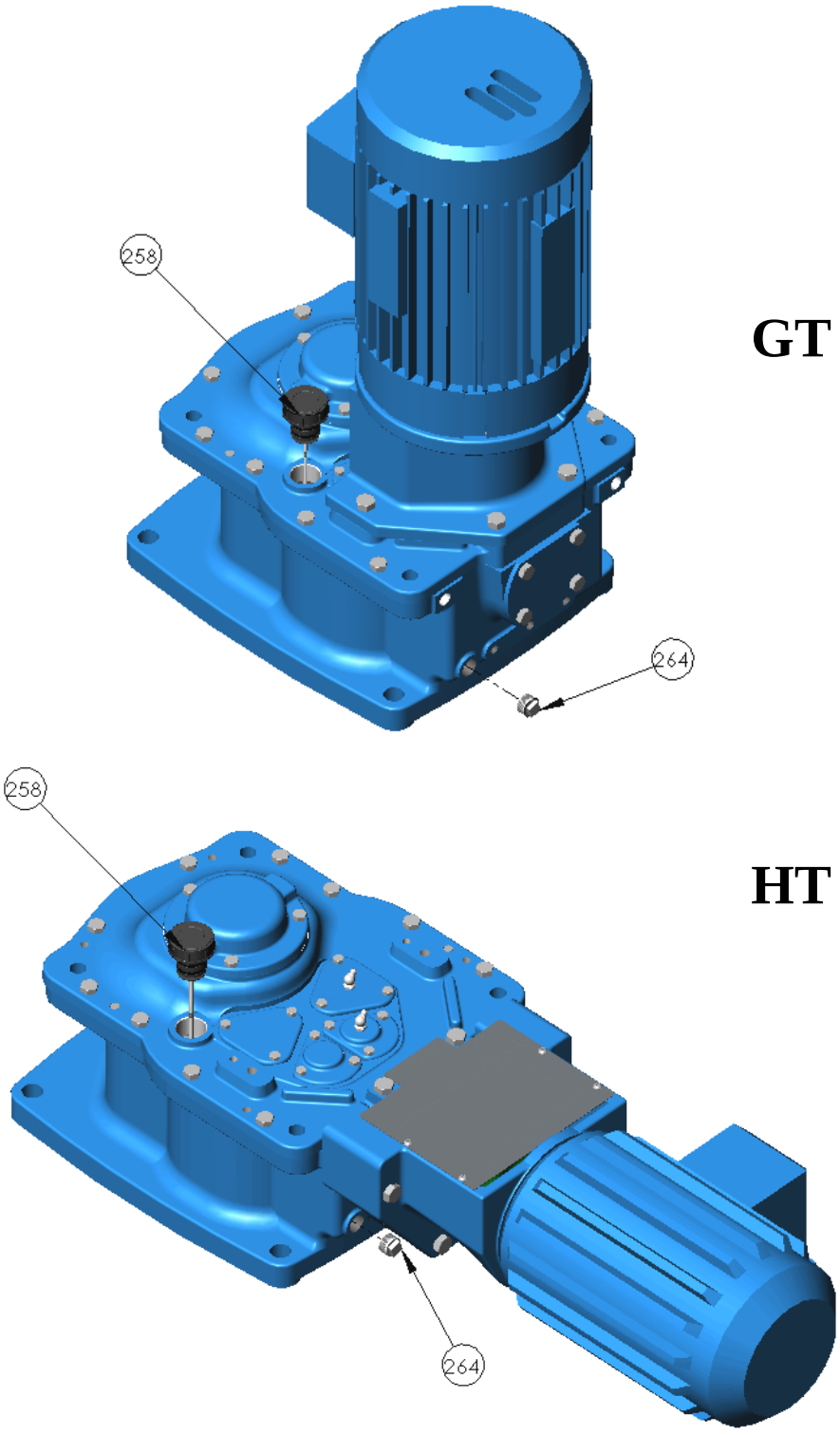


Figure 22. Model 20 GT/HT Gear Drive Oil Level Dipstick

Table 9. LUBE OIL SELECTION

Ambient Temperature	ISO Viscosity Grade	AGMA Lubricant Number
-10º to 15ºF (-24º to -10ºC)	32 to 68	Up to 2
15º to 50ºF (-10º to 10ºC)	100 to 150	3 to 4
50º to 125ºF (10º to 50ºC)	220 to 320	5 to 6

NOTE: *For low temperature operation, the oil selected should have a pour point at least 9°F or 5°C below the expected ambient temperature and a viscosity which is low enough to allow the oil to flow freely at start up temperature.*

Table 10. APPROXIMATE OPERATING OIL CAPACITY (1)

MODEL	TYPE	QUARTS	GALLONS (US)	LITRES
21	**GT**	4.4	1.1	4.2
	HT	2.4	0.6	2.3
22	**GT**	8.0	2.0	7.6
	HT	4.8	1.2	4.6
23	**GT**	20	5	19
	HT	14	3.5	13.3

NOTE: *Remove the pipe plug **[267]** while filling oil. Fill up to the mark on the dipstick and until the oil just overflows from the pipe plug **[267]** hole. (See* Figure 23*, page 62,* Figure 24*, page 63, or* Figure 25*, page 64)*

Table 11. TYPICAL RUST & OXIDATION INHIBITED (R&O) LUBE OILS

AGMA Lubricant Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**
ISO Viscosity Grade	**46**	**68**	**100**	**150**	**220**	**320**	**460**
Viscosity Range (cSt) @ 104º F (40º C)	**41.4 to 50.6**	**61.2 to 74.8**	**90 to 110**	**135 to 165**	**198 to 242**	**288 to 352**	**414 to 506**
Manufacturer	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**
BP Oil Co.	Energol HLP-HM 46	Energol HLP-HM 68	Energol HLP-HM 100	Energol HLP-HM 150	Energol HLP-HM 220	Energol HLP-HM 320	Energol HLP-HM 460
Chevron U.S.A., Inc.	Hydraulic Oil AW 46	Hydraulic Oil AW 68	Machine Oil AW 100	Machine Oil AW 150	Machine Oil AW 220	Machine Oil AW 320	…..
CITGO Petroleum Corp.	Citgo Pacemaker 46	Citgo Pacemaker 68	Citgo Pacemaker 100	Citgo Pacemaker 150	Citgo Pacemaker 220	Citgo Pacemaker 320	Citgo Pacemaker 460
Exxon Co., U.S.A.	Teresstic 46	Teresstic 68	Teresstic 100	Teresstic 150	Teresstic 220	Teresstic 320	Teresstic 460
Mobil Oil Corp	DTE Oil Medium	DTE Oil Heavy Medium	DTE Oil Heavy	DTE Oil Extra Heavy	DTE Oil BB	DTE Oil AA	…..
Phillips 66 Co.	Magnus Oil 46	Magnus Oil 68	Magnus Oil 100	Magnus Oil 150	Magnus Oil 220	Magnus Oil 320	…..
Shell Oil Co.	Turbo T 46	Turbo T 68	Morlina 100	Morlina 150	Morlina 220	Morlina 320	Morlina 460
Texaco Lubricants Co.	Regal Oil R & O 46	Regal Oil R & O 68	Regal Oil R & O 100	Regal Oil R & O 150	Regal Oil R & O 220	Regal Oil R & O 320	Regal Oil R & O 460

Table 12. TYPICAL EXTREME PRESSURE (EP) LUBE OILS

AGMA Lubricant Number	**2 EP**	**3 EP**	**4 EP**	**5 EP**	**6 EP**	**7 EP**
ISO Viscosity Grade	**68**	**100**	**150**	**220**	**320**	**460**
Viscosity Range (cSt) @ 104º F (40º C)	**61.2 to 74.8**	**90 to 110**	**135 to 165**	**198 to 242**	**288 to 352**	**288 to 352**
Manufacturer	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**
BP Oil Co.	Energol GR-XP 68	Energol GR-XP 100	Energol GR-XP 150	Energol GR-XP 220	Energol GR-XP 320	Energol GR-XP 460
Chevron U.S.A., Inc.	Gear Compounds EP 68	Gear Compounds EP 100	Gear Compounds EP 150	Gear Compounds EP 220	Gear Compounds EP 320	Gear Compounds EP 460
CITGO Petroleum Corp.	EP Compounds 68	EP Compounds 100	EP Compounds 150	EP Compounds 220	EP Compounds 320	EP Compounds 460
Exxon Co., U.S.A.	…..	…..	Spartan EP 150	Spartan EP 220	Spartan EP 320	Spartan EP 460
Mobil Oil Corp	Mobilgear 626	Mobilgear 627	Mobilgear 629	Mobilgear 630	Mobilgear 632	Mobilgear 634
Phillips 66 Co.	All Purpose Philgear 68	All Purpose Philgear 100	All Purpose Philgear 150	All Purpose Philgear 220	All Purpose Philgear 320	All Purpose Philgear 460
Shell Oil Co.	Shell Omala 68	Shell Omala 100	Shell Omala 150	Shell Omala 220	Shell Omala 320	Shell Omala 460
Texaco Lubricants Co.	Meropa 68	Meropa 100	Meropa 150	Meropa 220	Meropa 320	Meropa 460

Table 13. TYPICAL SYNTHETIC LUBE OILS

AGMA Lubricant Number	**…..**	**2**	**4**	**5**	**6**
ISO Viscosity Grade	**32**	**68**	**150**	**220**	**320**
Ambient Temperature Range ºF	**-30 to +10**	**-15 to +50**	**0 to +80**	**+10 to +125**	**+20 to +125**
Viscosity Range (cSt) @ 104º F (40º C)	**61.2 to 74.8**	**61.2 to 74.8**	**135 to 165**	**198 to 242**	**288 to 352**
Manufacturer	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**	**Lubricant**
Chevron U.S.A., Inc.	…..	…..	Tegra 150 *	Tegra 220 *	Tegra 320 *
CITGO Petroleum Corp.	Pacemake ST 32	…..	…..	…..	…..
Mobil Oil Corp	SHC 624	SHC 626	SHC 629	SHC 630	SHC 632
	…..	…..	Mobilgear SHC 150 *	Mobilgear SHC 220 *	Mobilgear SHC 220 *

* Extreme pressure EP lubricants (contains sulfur, phosphorus)

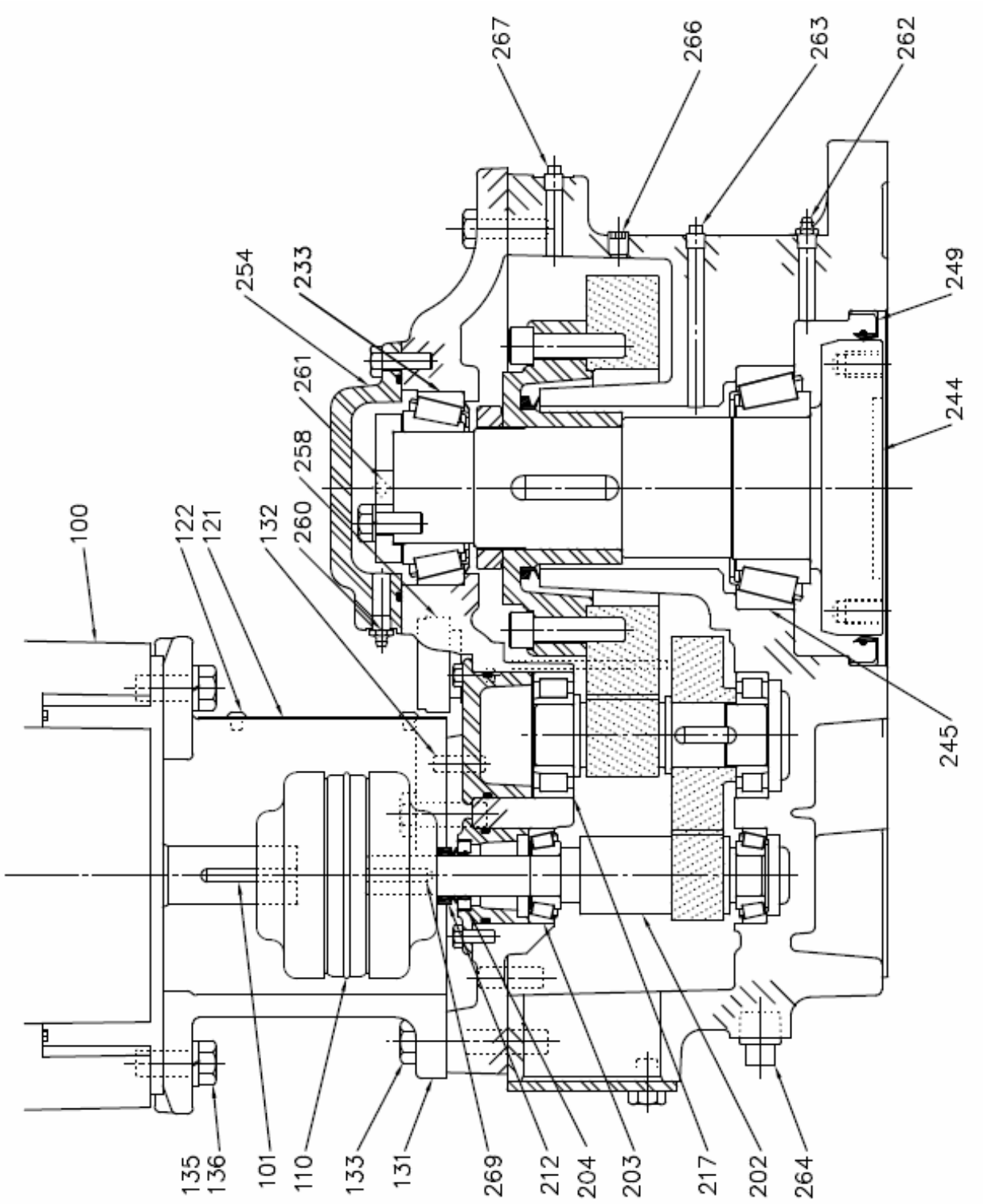


Figure 23. Model 20 GT Double Reduction Gear Drive

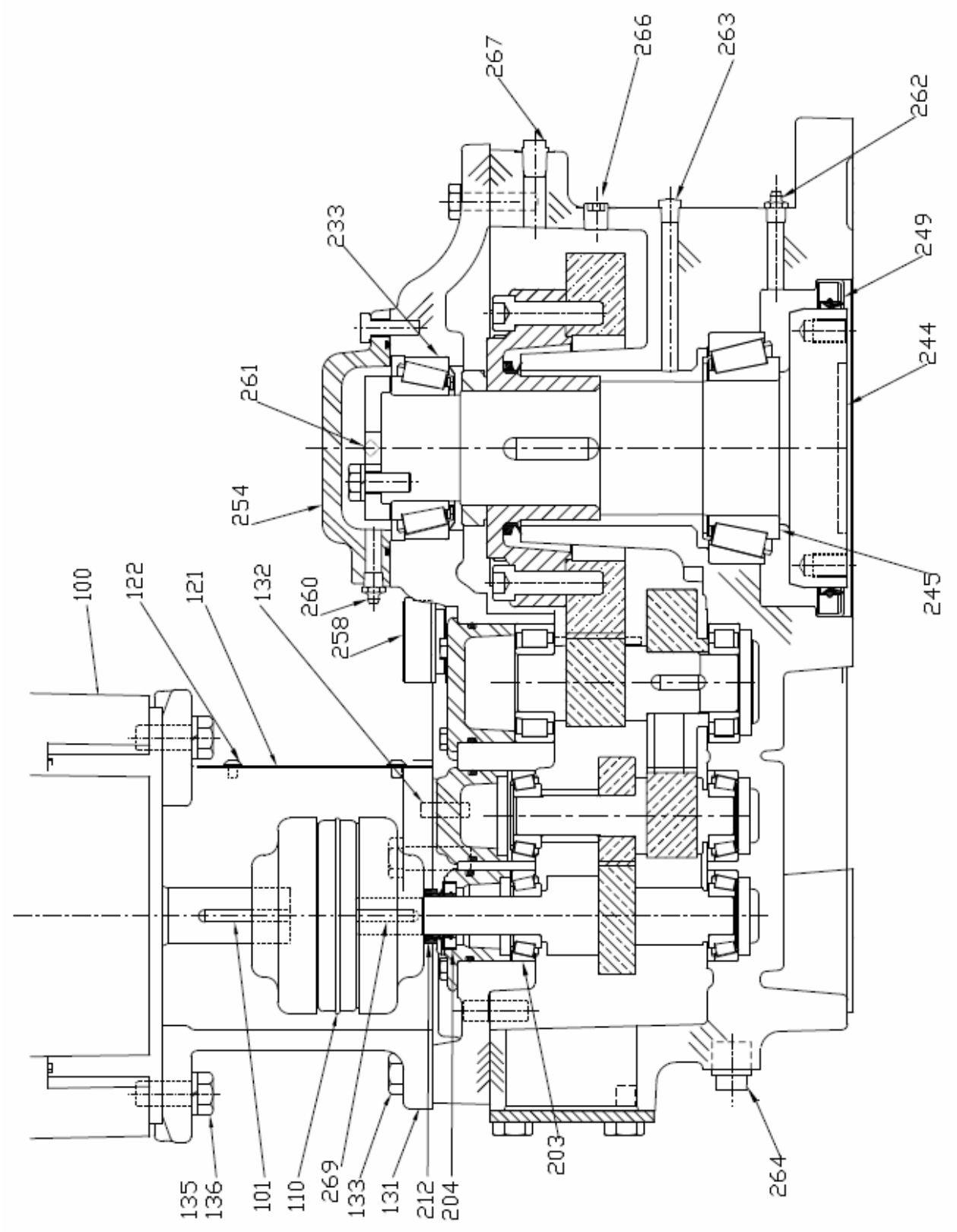


Figure 24. Model 20 GT Triple Reduction Gear Drive

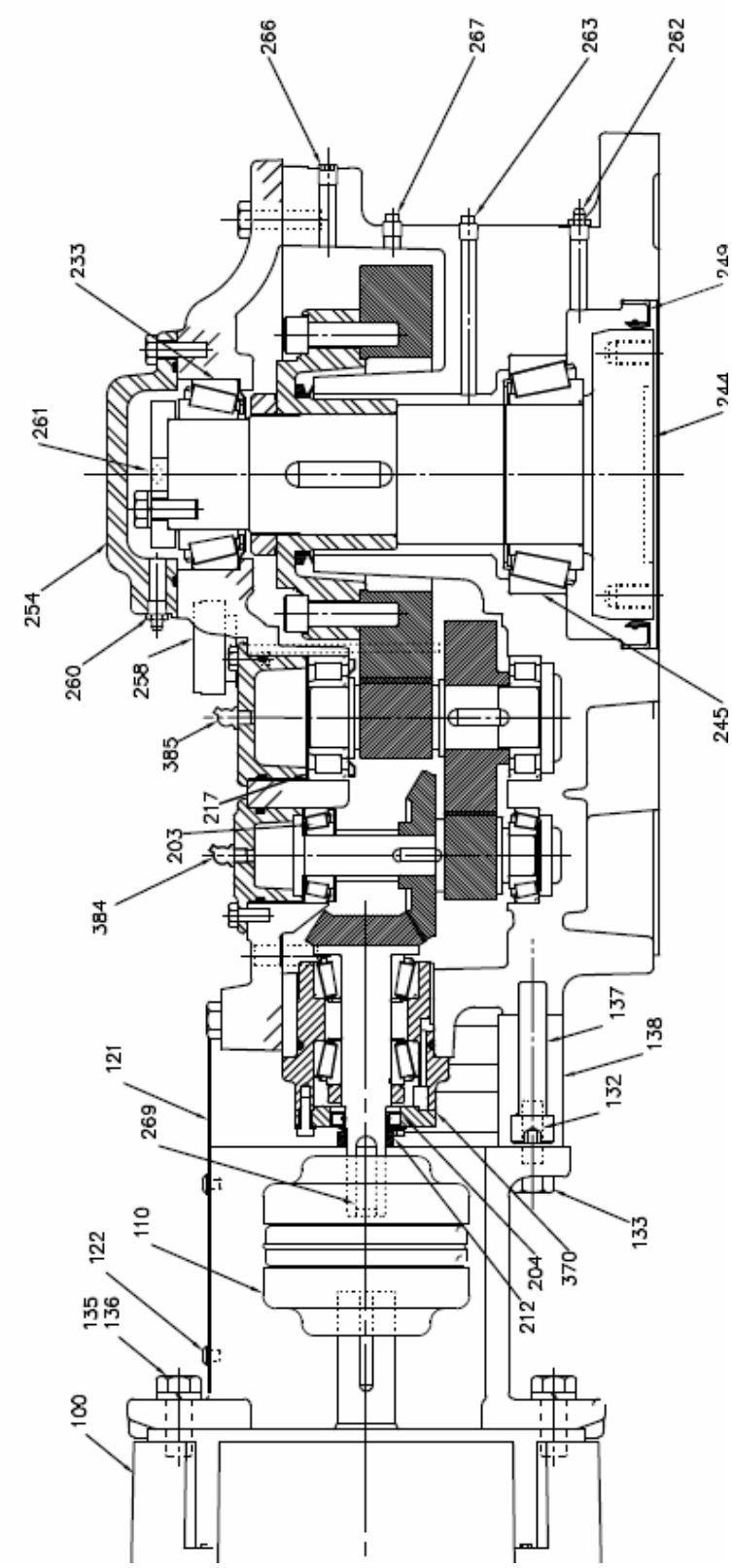


Figure 25. Model 20 HT Gear Drive

M.3 SHAFT SEALS - LUBRICATION

Mechanical seals must be supplied with adequate lubricant and coolant (if required) in order to operate properly. The lubricant can be supplied a number of ways (See Section N.5.2, page 68). The lubricant can be any low viscosity fluid with reasonable lubricity, compatible with the process fluid, and that is stable over the full range of pressures and temperatures at which the mechanical seal will be operated. Common liquid lubricants (barrier fluids) include glycerin, ethylene glycol, mineral oil and water. Operating temperature limits for the lubricants are listed below. Consult the Chemineer Factory for other lubricants.

Table 14. Mechanical Seal Lubricants

Lubricant	Temperature Limit	
	ºF	ºC
Glycerin	≤ 150	≤ 66
Ethylene Glycol	≤ 250	≤ 121
Mineral Oil	≤ 400	≤ 204
Water	≤ 160	≤ 71

Refer to unit assembly drawings for specific agitator/seal pressure and temperature operating limits.

NOTE: *The maximum temperature limits for Model 20 GT/HT N units can be increased by 100ºF (56ºC) with proper use of the standard cooling jacket on the seal cartridge.*

The specific gravity of any liquid lubricant should never be less than 0.63 at a reference temperature 50ºF (28ºC) above the maximum vessel temperature. The boiling (flash) point of a lubricant should never be less than 25ºF (14ºC) above maximum vessel operating temperature. The standard seal cavity operating pressure is 25-50 psi (172-345 kpa) above the maximum vessel operating pressure.

The mechanical seal cartridge includes an integral bearing that maintains proper seal alignment. Refer to Figure 28, and Figure 29, pages 80 to 81. This bearing **[2505]** is grease lubricated. Grease fitting **[2515]** and relief fitting **[2516]** are located in bearing housing **[2513]** and bearing cap **[2512]**. The bearing should be regreased at one-month intervals. Remove the relief fitting and add new grease slowly at the grease fitting until new grease is evident at the relief-fitting hole. Reinstall the relief fitting. Table 7, page 54 lists some commonly available greases.

M.4 STEADY BEARINGS - LUBRICATION

Steady bearings are lubricated and cooled by the process fluid. Do not operate agitator unless the steady bearing is submerged or there is a flush to the steady bearing.
If a Clean-In-Place (CIP) system is present, it will generally put enough liquid into the steady bearing to ensure that the bearing is lubricated.

N. OPERATION

N.1 AGITATOR OPERATION

Chemineer agitator has been designed for your specific application. Proper operating procedures will allow maximum performance.

The following list will aid in the safe operation of your unit.

- **Do not** operate the unit before reading and following the instructions on all tags and nameplates attached to the unit.
- **Do not** operate the unit in a fluid with a specific gravity or viscosity higher than that for which the unit was designed.
- **Do not** attempt to start a unit with the mixing impeller buried in solids or a "set up" fluid.
- **Do not** operate mechanical shaft seals at temperatures or pressures higher than those for which the unit was designed. Refer to unit assembly drawing.
- **Do not** locate large pump discharges, other agitators, down comers, coils, baffles, or other vessel internals close to the agitator impellers and extension shaft.
- **Do not** make any changes in the field (i.e. motor horsepower, agitator speed, shaft length, impeller diameter, impeller blade width, etc.) without reviewing the change with your local Chemineer office or Chemineer Field Service.

Should there be problems operating the unit; review the installation and the ***Troubleshooting Guide***, *Table 15, page 70*. If you are unable to resolve the problem, contact your local Chemineer office.

N.2 MOTOR - OPERATION

Electric motors furnished on Chemineer agitators are designed to deliver their rated output when properly installed and maintained.

Air circulation is very important to get full performance and long life from an electric motor. Do not block the suction inlets on fan-cooled motors. Life of the motor will be decreased if its temperature exceeds its thermal rating. The allowable temperature is stamped on the motor nameplate.

Prior to permanently wiring the electric motor:

- Check nameplate data on motor to assure that the available power supply agrees with the motor requirements. Protective devices should be the proper size and rating to safely carry the load and to interrupt the circuit on overloads.
- If motor has been stored in a damp location, the windings may require drying.

  NOTE: *Do not obstruct the normal flow of ventilating air through or over the motor.*

  Identify motor auxiliary devices such as space heaters or temperature sensors. Connect them in proper circuits and insulate them from motor power cables.
- Check motor leads with connection diagrams on motor nameplate and/or conduit box so that the proper connections are made. All motors should be installed in accordance with the National Electric Code and local requirements.
- Check the gear drive output shaft rotation against the proper rotation indicated on the unit nameplate. For standard three-phase electric motors, the rotation can be reversed by switching any two power leads.
- Check operating motor amperage against motor nameplate amperage.

The motor should start quickly and run smoothly. If the motor should fail to start or make abnormal noise, immediately shut motor off, disconnect it from the power supply, and investigate the cause. If the problem cannot be corrected, contact your local Chemineer office for assistance.

N.3 FLEXIBLE MOTOR COUPLING

The standard flexible motor couplings will provide years of operation with very few problems. If the motor is removed for service, the coupling should be inspected for wear. Also, inspect the coupling during every shutdown and whenever undesired noise or vibration occurs.

N.4 GEAR DRIVE - OPERATION

Gearing and most bearings are oil lubricated. Be sure the gear drive has been filled with the proper amount and type of oil before operation. Refer to the ***Lubrication*** section of this manual. Improper lubrication will result in damage to gearing and bearings in a very short time.

The gear drive should be installed in an unobstructed area with ample air circulation. The gear drive will commonly operate at temperatures of 125º to 175ºF (52º to 80ºC). Do not be alarmed if the surface of the gear drive feels extremely hot to the touch. The gear drive surface temperature should not exceed 190ºF (88ºC). If a temperature greater than 190ºF (88ºC) exists anywhere on the gear drive housing, review the installation for unusually high ambient, poor air circulation, or unusual conditions. If the conditions cannot be improved, synthetic lubrication is an option since it will typically lower the temperature of the gearbox. Consult Chemineer Field Service for advice on this matter.

N.5 SHAFT SEALS - OPERATION

N.5.1 LIP SEALS AND V-RINGS

This gearbox is sealed on the input by a lip seal **[204]**, protected by a v-ring seal **[212]**. The output shaft **[244]** is also protected by a single lip seal **[249]**. These seals are greased at the factory, so no service is necessary at start up for these seals.

The extension shaft v-ring does not come pre-greased. While it is not mandatory to grease these seals, the seal will have a lower running temperature and thus a longer life if grease is applied prior to operation. If the process conditions allow, process-compatible grease should be applied to the sealing surface.

All rotary lip seals will eventually need replacement as they are wearing components. Wear rates depend on agitator input and output speeds, frequency of service, and environmental factors. A “typical” life cannot be predicted, so periodic inspection is highly recommended.

N.5.2 MECHANICAL SEALS

Mechanical seals must be pressurized to operate properly. Before operation, the seal cavity should be pressurized to the value on the general assembly drawing, which is typically 25-50 psi (172-344 kPa) above the maximum vessel operating pressure. For operating limits of the seal, refer to appropriate assembly drawing.

CAUTION! *Never pressurize the vessel without first pressurizing the mechanical seal cavity (mechanical seal lubricator).*

If using a liquid barrier fluid, the unit may be supplied with an optional Chemineer mechanical seal lubricator (see Figure 21, page 52) or the mechanical seal lubricator system may be supplied by others. The Chemineer mechanical seal lubricator should be filled by removing fill plug **[1708]** and slowly pouring in the barrier fluid. The lubricator is self-venting while being filled. As the seal lubricator is being filled, gravity flow will fill and purge the seal cavity. After filling, replace and tighten the fill plug. Pressurize the lubricator using a constant pressure source, such as a gas bottle, to the recommended seal cavity pressure. This is a thermosiphon system for use with mechanical seals only.

During normal operation, it is common for mechanical seals to leak a few drops of fluid per minute across the seal faces. The mechanical seal lubricator lubricant level should be checked regularly and refilled as required.

Chemineer cartridge mechanical seals are supplied as standard with a water-cooling jacket on the mechanical seal housing (see Figure 28 and Figure 29, pages 80 and 81). Refer to unit assembly drawing for cooling water temperature and flow rate. If required, connect water supply, return lines, set water temperature, and flow rate before operating the agitator.

NOTE: *Cooler seal operation will usually extend seal and bearing life.*

During normal operation, it is common for mechanical seals to leak a few drops per minute across the seal faces. The seal lubricator's lubricant level should be checked regularly and refilled as required.

N.6 STEADY BEARINGS - OPERATION

If a steady bearing is supplied, do not operate agitator unless it is properly installed. Failure to install a required steady bearing will cause severe damage to the agitator assembly if operated. Do not operate agitator unless the steady bearing is submerged.

The pad and cup-tripod steady bearings have been supplied with an optional flush feature for lubrication and cooling. If the flush is utilized, the pipe plug **[641]** must remain installed on the bushing housing **[627]** and the inlet pressure should be maintained at 15 to 20 psi over the vessel pressure. If the flush is not utilized, the pipe plug **[641]** must be removed.

N.7 TROUBLE-SHOOTING

Table 15. TROUBLE-SHOOTING GUIDE

OBSERVATION	POSSIBLE CAUSE	ACTION
Noisy Operation	Worn or damaged parts	Check bearings and gears for excessive wear. Replace worn parts. Try to find cause of wear. Check for water and/or abrasives in oil, overload, incorrect rotation, excessive shock, etc.
	Overloading	Overloading can cause excessive separation of gear teeth and loud operation. Check process fluid (specific gravity and viscosity) vs. design conditions. Check agitator speed and impeller diameter against unit assembly drawing information.
	Worn or improperly installed flexible couplings	Couplings can generate noise, which seems to emanate from gear drive. Check for worn parts.
	Structural vibration and sound amplification	Steel mounting structures often amplify small amounts of normal noise into excessive noise. This can be corrected by adding stiffness or sound deadening material to the structure.
Abnormal Heating	Incorrect Oil	Review Lubrication section of manual. Replace with proper oil.
	Unusual ambient	Units installed in a hot area of a plant where airflow is restricted can overheat. Remove obstruction and if necessary force circulate air.
	Improper oil level	Add or remove oil.
	Cleanliness	Remove dirt and/or product buildup from motor/gear drive.
Leaking	Worn oil seals	Replace defective seals.
	Plugged breather	Clean or replace breather.
	Oil in Drywell	Remove relief fitting **[263]** and drain drywell. Grease the bearing and replace pipe plug.
	Worn mechanical seal.	Replace mechanical seal.

O. MAINTENANCE - MECHANICAL SEAL

The mechanical seal will require periodic replacement of wearing parts. Due to ease of replacement of the seal cartridge, it is preferable to remove the old seal cartridge and replace it with a new or rebuilt cartridge.

O.1 SEAL REMOVAL

CAUTION! *Prior to removing the agitator drive, review the agitator installation to assure that all safety issues are resolved.*

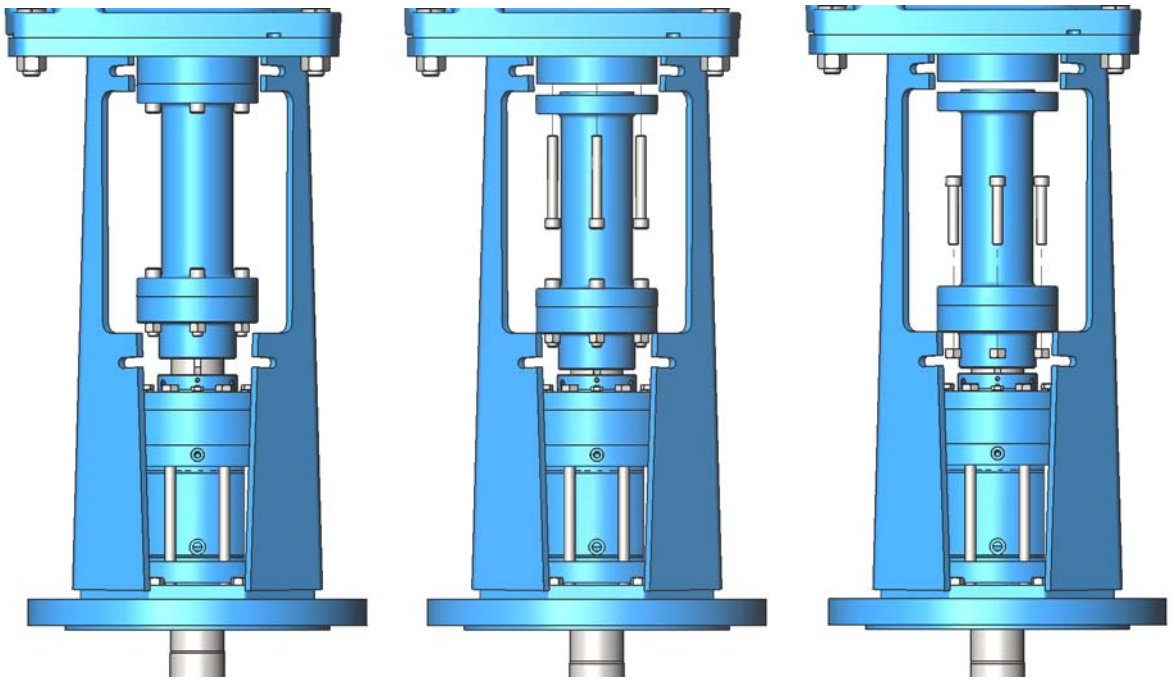
1. Lock out and disconnect all power to the gear dive motor and optional devises.

2. Depressurize and ventilate vessel.

3. Remove handhole covers and hardware **[2108, 2109, 2110, 2111]**.

4. Depressurize the mechanical seal barrier fluid lines, disconnect and plug the ports. Clean the portion of the agitator shaft **[403]** between the tapered shaft coupling **[2363]** and the mechanical seal cartridge **[2500]**. Loosen the mechanical seal sleeve cup point setscrews **[2509, 2510]** a couple of turns.

The seal/spacer spool removal procedure is illustrated in Figure 26.



1 **2** **3**

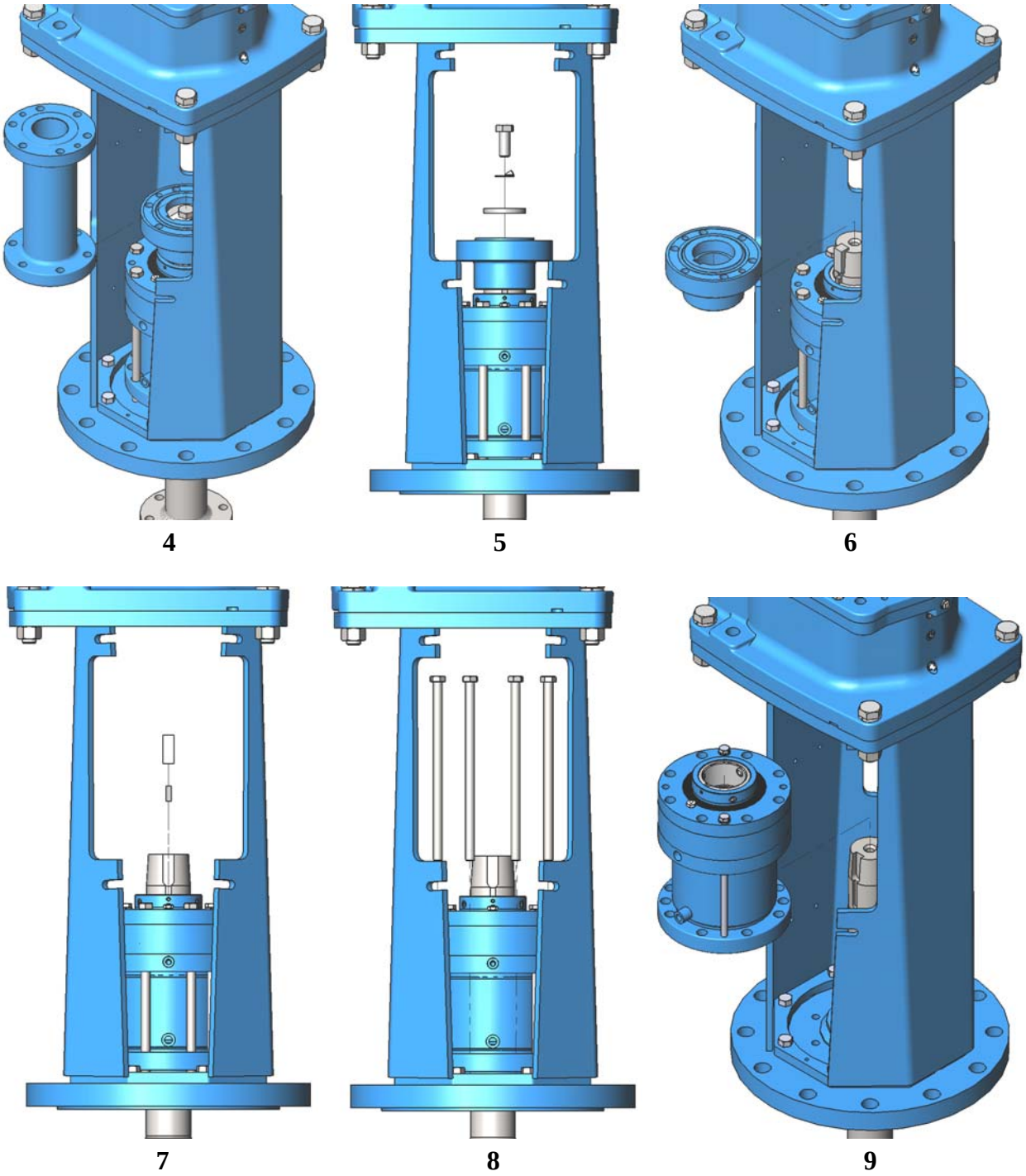


Figure 26. Vessel Mounting Nozzle/Pad Mechanical Seal Removal

5. Lower the agitator shaft by loosening the upper spacer spool bolts **[2361]**. Lower evenly until the shaft is supported by the shaft drop collar **[2530]**. The shaft should drop approximately 0.50" (13mm). Remove bolts completely once the shaft is supported.

6. Remove bolts and nuts **[2368, 2370]** on bottom of spacer spool **[2367]**.

7. Lift and remove spacer spool **[2367]** through pedestal opening.

8. Bend down the tabs on locking clip **[2359]**. Loosen shaft bolt **[2360]**. Disengage the taper by tapping with a mallet or by using a puller.

CAUTION! *Release of taper fit can cause the coupling half to jump off the shaft if not retained.*

9. Remove shaft bolt, locking clip, coupling washer and coupling half **[2358, 2359, 2360, 2363]**.

10. Remove keys **[2357, 2508]**.

11. Remove seal mounting bolts and lockwashers **[2533, 2534]**.

    NOTE: *Do not remove cartridge bolts and lockwashers* **[2517, 2518].**

12. Slide the mechanical seal cartridge up the drive shaft. Remove the mechanical seal cartridge to a suitable service area.

    NOTE: *The drive shaft is relieved under the seal sleeve such that once the shaft has dropped approximately ½" (13 mm) there is a minimum of .010" (.25 mm) clearance between the shaft and sleeve. There should be minimal resistance when raising the cartridge up the shaft.*

Refer Section O, MAINTENANCE - MECHANICAL SEAL, Page 71 for cartridge disassembly and reassembly instructions.

13. Inspect parts for wear. Replace worn or damaged parts as required.

O.2 SEAL INSTALLATION PREPERATION

NOTE: *Prior to installation of a new or rebuilt mechanical seal cartridge, inspect the drive shaft, taper bore coupling half and spacer spool for fit and finish. All mating surfaces must be clean and free from burrs and nicks.*

1. The taper bore coupling half should be checked for fit with the drive shaft. Place the taper bore coupling half on the tapered shaft end. Seat the coupling half on the shaft with coupling weight only. Do not use the shaft bolts and the coupling washer. The coupling half should slide down tight and not exhibit any tendency to rock. If it rocks on the shaft, the coupling and /or shaft will have to be machined for a more precise fit.

CAUTION! *Do not apply lubricant or anti-seize compound to shaft or coupling taper. Shaft and coupling taper must be clean and dry prior to assembly.*

2. Inspect the seal cartridge mounting area of the drive shaft for wear and/or damage. Clean the drive shaft and polish out any scratches. Coat this area of the drive shaft with a lubricant, which is compatible with the process and seal elastomers.

3. Clean and inspect the mechanical seal cartridge mounting boss on the mounting flange.

O.3 SEAL INSTALLATION

1. Place a new o-ring **[2532]** into the groove in the mounting flange **[2251]**.

2. Lift the new or rebuilt mechanical seal cartridge carefully over the drive shaft. Line up the key slot in the seal sleeve with the keyway in the drive shaft. Guide the seal cartridge down the drive shaft until the cartridge rests on the mounting boss on the mounting flange.

3. Install key **[2508]**, but do not tighten setscrew **[2509]** at this time.

4. Install bolts and lockwashers **[2533, 2534]**. Finger tight the bolts. Do not tighten any of the three setscrews **[2510]** or setscrew **[2509]** yet.

5. Install taper bore coupling half **[2363]** along with all fasteners **[2358, 2359, 2360]**. A new locking clip **[2359]** (1 bolt design only) should be used. Torque bolt per APPENDIX, Page 96, paying close attention to the fastener grade.

6. Install spacer spool **[2367]**. Align the match marks on the outside diameter of the spacer spool lower flange to the match marks on the taper coupling. Torque bolts **[2368, 2370]** to the value shown in the APPENDIX, Page 96.

   NOTE: *Pull the faces of coupling and spacer spool together evenly to avoid damage to the coupling tenon.*

7. Align the match marks on the outside diameter of the spacer spool upper flange with those on the spacer bolted to the gearbox. Install (2) bolts **[2361]** at 180° into the spacer spool upper flange. Alternately tighten these bolts, lifting the drive shaft and pulling the coupling faces together.

   NOTE: *Pull the faces coupling and spacer spool together evenly to avoid damage to the coupling tenon.*

8. Install the remaining bolts and nuts. Torque bolts to the value shown in the APPENDIX, Page 96.

9. Rotate the drive shaft two revolutions before measuring runout. Measure the drive shaft runout by placing the point of a dial indicator on the drive shaft between the mechanical seal cartridge and drive shaft coupling half. Rotate the drive shaft by turning the flexible motor coupling **[110]** by hand.

NOTE: *The key will interfere with the dial indicator probe. Rotate the drive shaft clockwise and lift the indicator probe to avoid the key.*

The maximum T.I.M. (Total Indicator Movement) is .005" (.13 mm). Measurements greater than 0.005" (13 mm) would indicate problem such as mismatched coupling/spacer spool flanges, improperly mounted taper bore coupling half or a bent drive shaft.

The drive shaft coupling half, spacer spool and coupling spacer **[2363, 2367, 2371,]** are match marked at the factory. If the match marks are aligned and the measured runout is slightly over the maximum, some runout correction can be made by rotating these components with respect to each other.

Measure the drive shaft runout after each change in orientation. If the runout cannot be reduced to 0.005" (13 mm) maximum, disassembly of the drive shaft, spacer spool, coupling spacer and drive shaft coupling half will be required to determine the cause. Corrective measures ranging from re-cleaning to machining one or more components may be required.

10. With the drive shaft runout within limits, torque seal bolts **[2533]** in sequential order (Figure 27) to 25% of the value shown in the APPENDIX, Page 96. Repeat this tightening sequence in several steps until the bolts are torqued to 100% of the value shown in the APPENDIX, Page 96. Check the drive shaft runout to be sure it is still within tolerance.

11. Locate the point of the dial indicator on the drive shaft opposite one of the three setscrews **[2510]**. Begin to tighten this setscrew. As soon as the dial indicator starts to move stop tightening and rotate the shaft until the next setscrew is opposite the indicator. Tighten this setscrew until the indicator starts to move. Repeat this procedure until all three setscrews **[2510]** are torqued to the value shown in the APPENDIX, Page 96. The drive shaft runout should be within ± 0.001" (0.025 mm) of the runout measured in step 9.

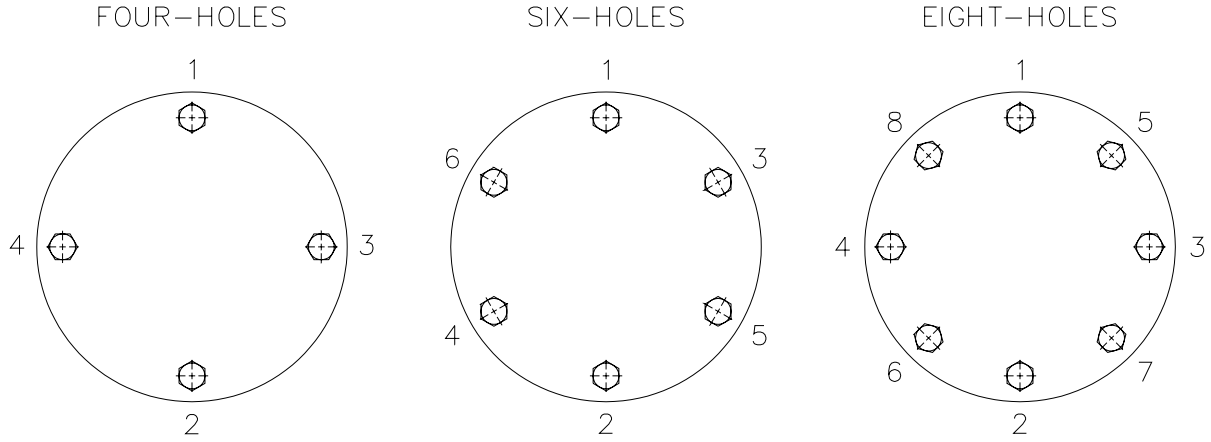


Figure 27. Sequential Tightening

12. Tighten setscrew **[2509]** against key **[2508]**. Torque to the value shown in the APPENDIX, Page 96.

13. Connect seal fluid lines and fill the seal lubricator and seal housing with seal fluid. Pressurize the seal lubricator. Refer to MECHANICAL SEAL LUBRICATOR installation, page 50.

CAUTION! *The seal housing must be pressurized to 25 to 50 psi (172-345 kpa) above the maximum vessel operating pressure prior to pressurizing the vessel.*

14. Connect the seal housing jacket water lines and turn water flow on.

15. Install pedestal handhole covers **[2108]**.

P. MECHANICAL SEAL CARTRIDGE

When the mechanical seal cartridge is disassembled, the bearing, lip seals, o-rings and packing rings should be replaced. Order replacement parts from Chemineer or obtain full manufacturer's data from Chemineer before ordering.

Prepare a clean work area prior to disassembly/assembly of the mechanical seal cartridge. Mechanical seal cartridges for shaft sizes 6" (150 mm) and larger may require the use of an overhead hoist for handling.

P.1 MECHANICAL SEAL CARTRIDGE DISASSEMBLY

1. Remove setscrews **[2509, 2510].**

2. Loosen but do not remove cartridge bolts and lockwashers **[2517, 2518].**

3. Turn the cartridge over. Set the cartridge down on bearing adapter **[2504].**

4. Completely loosen the cartridge bolts. Remove lower gland **[2525]** and o-ring **[2523].**

CAUTION! *Upper and lower glands are dimensionally identical but may be made of different materials. Refer to unit seal assembly drawing.*

5. Remove seal housing **[2524]**.

6. Push seal sleeve **[2501]** complete with seal heads **[2522, 2528]** out of the bearing adapter **[2504]**.

7. Remove upper gland **[2519]** and o-ring **[2523]**.

8. Remove bearing cap **[2512]**. Remove bearing **[2505]** and the bearing adapter from bearing housing **[2513]**.

9. Remove snap ring **[2507]** and bearing spacer **[2506]**. Press the bearing off the bearing adapter.

10. Press lip seals **[2511, 2514]** out of the bearing cap and the bearing housing.

11. Press seal seats **[2520, 2526]** out of the upper and lower glands. Slots have been provided in the gland bores to facilitate removal of the seal seats.

12. Remove the setscrews from the mechanical seal heads. Push the mechanical seal heads off the seal sleeve. Remove o-rings **[2502, 2503]** from seal sleeve.

13. The mechanical seal cartridge is now fully disassembled. Clean and inspect all parts for wear or damage. Replace all worn or damaged parts.

14. Inspect all bolts and setscrews for damage after cleaning (threads, shank and head). If replacement is required, replace with the equivalent type, material and strength grade.

15. Clean and inspect all tapped holes. If threads are damaged, chase with an appropriate tap.

P.2 MECHANICAL SEAL CARTRIDGE ASSEMBLY

1. Assemble the bearing and the bearing adapter. Thoroughly solvent clean bearing adapter **[2504]** and bearing **[2505]** bore. Apply a thin even coating of "Loctite Bearing Mount" or equal to the bearing adapter between the shoulders and snap ring groove. Slide the bearing onto the bearing adapter. Install bearing spacer **[2506]** and snap ring **[2507]**.

2. Assemble lip seals in bearing cap **[2512]** and bearing housing **[2513]**. Clean the lip seal bores and apply Permatex #2 or equal to the outside of lip seals **[2511, 2514]**. Install the lip seals in the bearing cap and bearing housing with the seal lips toward the bearing. Before installation on the seal sleeve, coat the seal lips with bearing grease.

3. Install the bearing/bearing adapter into bearing housing **[2513]**.

4. Assemble bearing cap **[2512]** to the bearing housing. Position relief fitting **[2516]** at 180^{o} from grease fitting **[2515]**.

   NOTE: *During mechanical seal cartridge assembly refer to agitator assembly drawing(s) for orientation of the seal fluid and seal housing jacket connections.*

5. Install cartridge bolts and lockwashers **[2517, 2518]** through the bearing cap/bearing housing. Turn this assembly over and set down on the bearing adapter.

6. Install seal seats and seat packing **[2520, 2526, and 2521, 2527]** into upper and lower glands **[2519, 2525]**. Install o-rings **[2523]**. Retain the o-rings in the grooves with silicone grease.

7. Assemble the upper gland to the bearing housing. Refer to unit assembly drawing for orientation of all openings.

CAUTION! *The upper gland may be carbon steel. The lower gland will be the same alloy as the wetted parts. The upper and lower glands are dimensionally identical. Refer to unit seal assembly drawing.*

NOTE: *For balanced seals only (*Figure 29*, page 81) install a new or rebuilt upper seal head* **[2522]** *on seal sleeve* **[2501]**.

8. Install the seal sleeve into the bearing adapter. The key slot in the seal sleeve must be aligned with small setscrew **[2509]** hole in the bearing adapter.

9. Install and thread setscrews **[2509, 2510]** into the clearance holes in the seal sleeve until the setscrew points are just short of projecting into the seal sleeve bore.

10. For unbalanced seals only (Figure 28, page 80) install a new or rebuilt upper seal head **[2522]** on seal sleeve **[2501]**. Tighten the setscrews over the original setscrew marks. If the setscrew marks are not visible, refer to the unit seal assembly drawing for the set dimension.

11. Measure and set the height of the upper seal head. Refer to the unit seal assembly drawing for the set dimension. Reset the set height if required. Torque the seal head setscrews to the value shown in APPENDIX, Page 96.

12. Install a new or rebuilt lower seal head **[2528]** on the seal sleeve and set to the dimension shown on the unit seal assembly drawing. Tighten the setscrews. Torque to the value shown in APPENDIX, Page 96.

13. Install o-rings **[2502, 2503]** in the seal sleeve.

14. Install seal housing **[2524]**.

15. Install lower gland **[2525]**. Refer to unit assembly drawings for orientation of all openings. Tighten cartridge bolts and lockwashers **[2517 and 2518]**. Torque to the value shown in APPENDIX, Page 96.

16. Add grease to bearing **[2505]**. Remove relief fitting **[2516]**. Fill slowly using grease fitting **[2515]** until grease appears at the relief-fitting hole. Install the relief fitting. Table 7, page 54 lists some commonly available greases.

17. To test seal cartridges at 100 psi (690 kpa) or less, install all bolts **[2533]** through the mechanical seal cartridge with flatwashers and nuts (supplied by others). Torque to 50% of the value shown in APPENDIX, Page 96. To test seal cartridges above 100 psi (690 kpa), the seal cartridge must be bolted down to a flange similar to the actual agitator mounting flange. Failure to do this may cause distortion of the lower gland, which may cause the inboard seal to leak. Pressure test the mechanical seal cartridge before use.

    Fill the seal housing with a fluid that is compatible with the process. This is normally the seal lubricant. Pressurize the mechanical seal housing to the lowest of either a.) 50 psi (345 kpa) above the maximum vessel operating pressure, or b.) 100 psi (690 kpa). Check for leaks and correct as required.

18. If the mechanical seal cartridge is to be placed into inventory, the seal housing should be completely filled with a rust preventative/lubricant, which is compatible with the sealing fluid to be used in service. Plug the seal fluid ports.

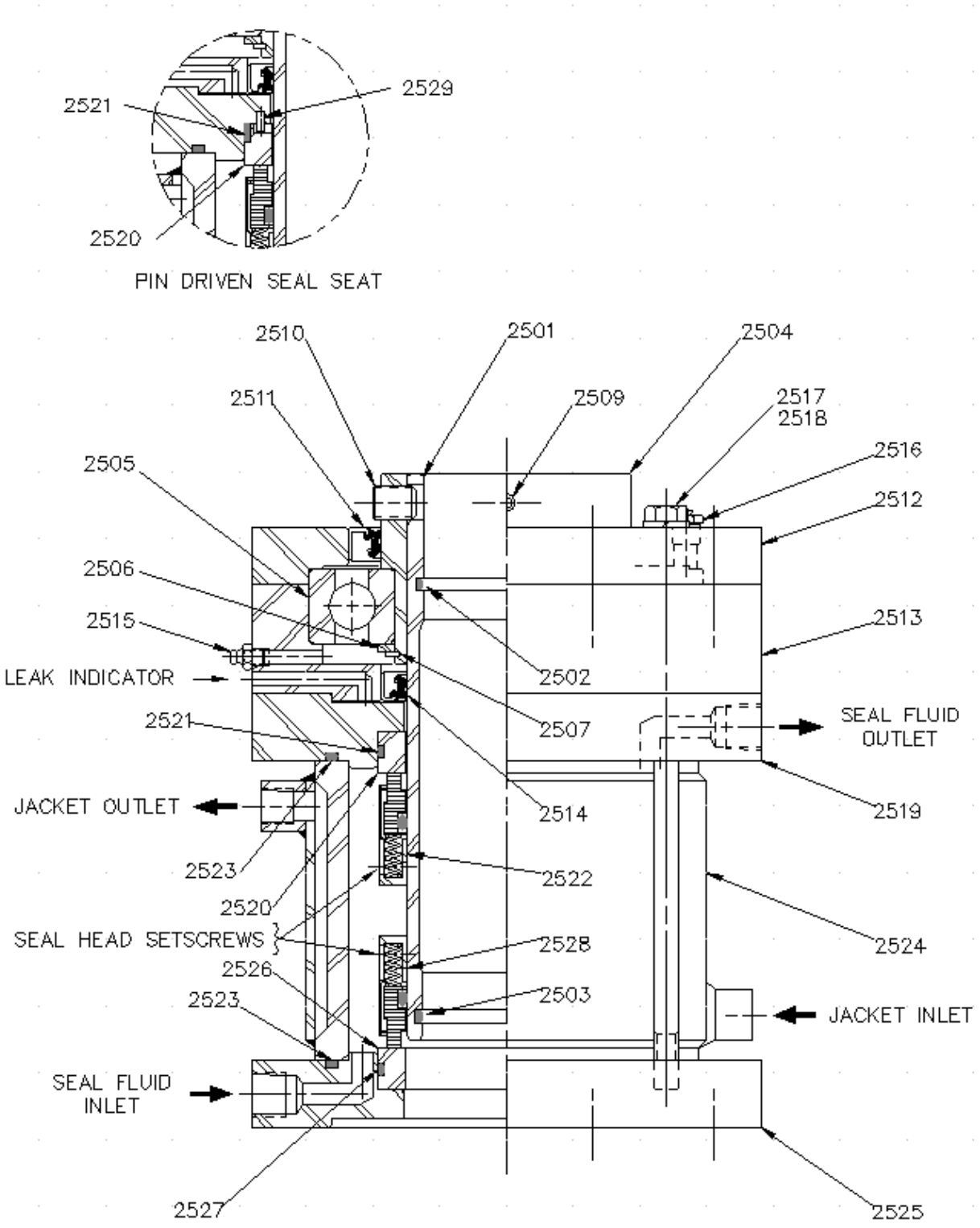


Figure 28. Mechanical Seal Cartridge (Unbalanced seals)

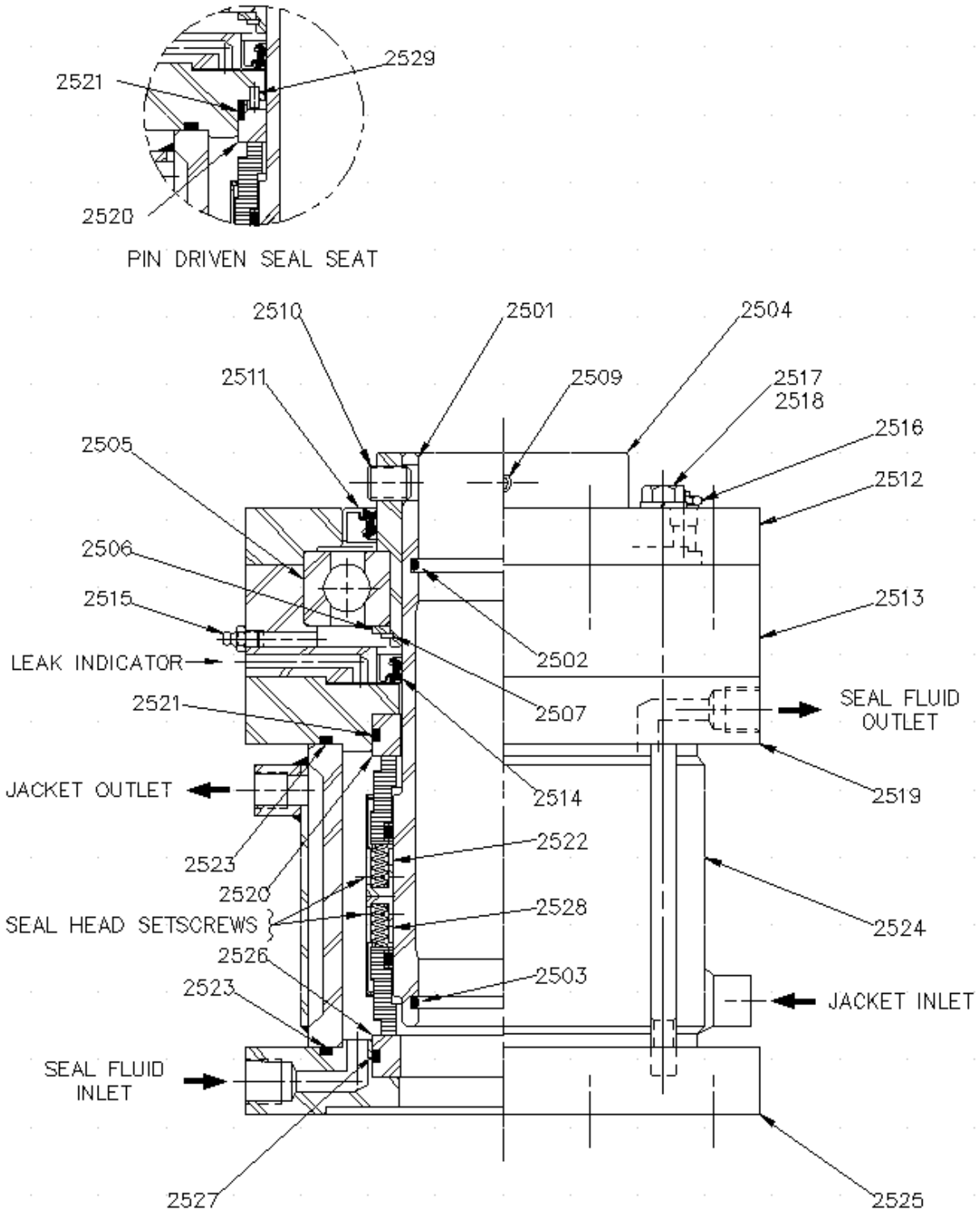


Figure 29. Mechanical Seal Cartridge (Balanced seals)

Q. DRIVE SHAFT

Q.1 DRIVE SHAFT REMOVAL

CAUTION! *Lock out and disconnect all power to the gear drive motor and any optional devices and depressurize the vessel, mechanical seal housing and mechanical seal housing jacket before servicing this equipment. Cap lines and housing ports as they are disconnected to prevent contamination.*

1. If a steady bearing is installed, remove the steady bearing to protect it from damage during shaft movement.

2. Remove handhole covers **[2108]**.

3. Loosen all three setscrews **[2510]** and setscrew **[2509]** one turn. (Figure 30A, page 85)

4. Lower drive shaft **[403]** by evenly loosening bolts **[2361]**. (Figure 30A, page 85). The drive shaft should drop approximately 1/2" (12 mm) allowing shaft collar **[2530]** to seat on mounting flange **[2251]**. If the shaft does not drop, tapped holes are provided in spacer spool **[2367]** upper flange for inserting bolts to jack the shaft down. Use these carefully, shaft will drop quickly.

CAUTION! *Do not jack the drive shaft down more than shown on the unit seal assembly drawing.*

5. Remove bolts **[2361]**.

6. Remove bolts and nuts **[2368, 2370]**. Remove the spacer spool **[2367]**.

7. Bend down the tabs on locking clip **[2359]** (1 bolt design only). Loosen shaft bolt **[2360]**. Disengage the taper by tapping with a mallet or by using a puller.

CAUTION! Release of taper fit can cause the coupling half to jump off the shaft if not retained. Do not fully remove shaft bolt **[2360]** until coupling is disengaged from shaft.

8. Remove shaft bolt, locking clip, coupling washer and coupling half **[2360, 2359, 2358, 2363]**.

9. Remove keys **[2357, 2508]**.

10. Remove bolts and lockwashers **[2533, 2534]**.

NOTE: *Do* ***NOT*** *remove cartridge bolts and lockwashers* **[2517, 2518].**

11. Slide the mechanical seal cartridge up the drive shaft and remove through pedestal opening.

12. Raise drive shaft **[403]** and extension shaft **[404]** enough to allow access to setscrews **[2531]** in shaft collar **[2530]**. Securely support the drive and extension shaft assembly.

13. Remove the setscrews and slide the shaft collar off the drive shaft.

14. While supporting the shaft assembly, disconnect the drive shaft from the extension shaft. Remove coupling bolts and lockwashers **[405, 406]** (and nuts **[407]** if welded construction) (Figure 18 or Figure 18A, page 40 or 41).

15. Lower the drive shaft into the vessel and remove through the manway.

Q.2 DRIVE SHAFT REPLACEMENT

The following procedure describes the steps required to measure and transfer the shaft collar location from the original drive shaft onto a new drive shaft. If the original drive shaft and taper bore coupling half are to be reinstalled, refer to Drive Shaft Installation.

NOTE: *Replace drive shaft* **[403]** *and taper bore coupling* **[2363]** *as a set. Do not mix old and new taper bore couplings and drive shafts.*

1. Replacement of the drive shaft will require spot drilling of the new shaft to accept the shaft collar **[2530]** setscrews **[2531].**

    a. Assemble the original shaft collar onto the original drive shaft with the original half dog point setscrews engaged into the drill spots in the drive shaft.

    b. Install original taper bore coupling half **[2363]** onto the original drive shaft. Refer to in-tank coupling installation, Section L.1, page 39.

    c. Measure and record the distance from the flange face of the taper bore coupling half to the top of the shaft collar.

    d. Remove the taper bore coupling half and shaft collar from the drive shaft.

2. Remove the half dog point setscrews from the shaft collar. Install new carbon steel cup point setscrews (supplied by others) in the shaft collar.

NOTE: *The cup point setscrews will be used to mark the new shaft for spot drilling.*

3. Slide the shaft collar down the new drive shaft. Do not tighten the setscrews.

4. Install the new taper bore coupling half onto the new drive shaft (Section L.1, page 39).

5. Measure from the flange face of the taper bore coupling half and locate the shaft collar at the dimension measured in step 1c above.

6. Tighten the cup point setscrews to mark the new drive shaft.

7. Remove the taper bore coupling half and shaft collar from the new drive shaft.

8. Remove the cup point setscrews from the shaft collar and discard them.

9. Spot drill the new drive shaft for the half dog point setscrews originally furnished in the new shaft collar. Use a drill 1/16" (1.5 mm) larger in diameter than the thread diameter of the half dog point setscrew. Drill depth (from drill point) is to be 25% of the drill diameter.

Q.3 DRIVE SHAFT INSTALLATION

1. Prior to installation of a new or refurbished drive shaft **[403]**, inspect taper bore coupling half **[2363]**, spacer spool **[2367]** and the drive shaft for fit and finish. All mating surfaces must be clean and free from burrs and nicks.

    a. The taper bore coupling half should be checked for fit with the drive shaft. Place the taper bore coupling half on the tapered shaft end. Seat the coupling half on the shaft with coupling weight only. Do not use the shaft bolts and the coupling washer. The coupling half should slide down tight and not exhibit any tendency to rock. If it rocks on the shaft, the coupling and/or shaft will have to be machined for a more precise fit.

    b. Inspect the mechanical seal mounting area of the drive shaft for damage. Clean and polish out any scratches.

2. Lower the drive shaft into the vessel through the manway and raise it through the agitator-mounting flange. Support the drive shaft such that the drill spots for shaft collar **[2530]** are accessible above the flange.

3. Slide the shaft collar down the drive shaft. Install half dog point setscrews **[2531]** through the shaft collar and into the drill spots in the drive shaft. Torque all fasteners to the value shown in APPENDIX, Page 96.

4. Lower the drive shaft until the shaft collar rests on mounting flange **[2251]**.

5. Install mechanical seal cartridge **[2500]**, taper bore coupling half **[2363]** and spacer spool **[2367]**. Refer to Mechanical Seal Cartridge Assembly, page 78 for full instructions.

6. Install extension shaft **[404]**.

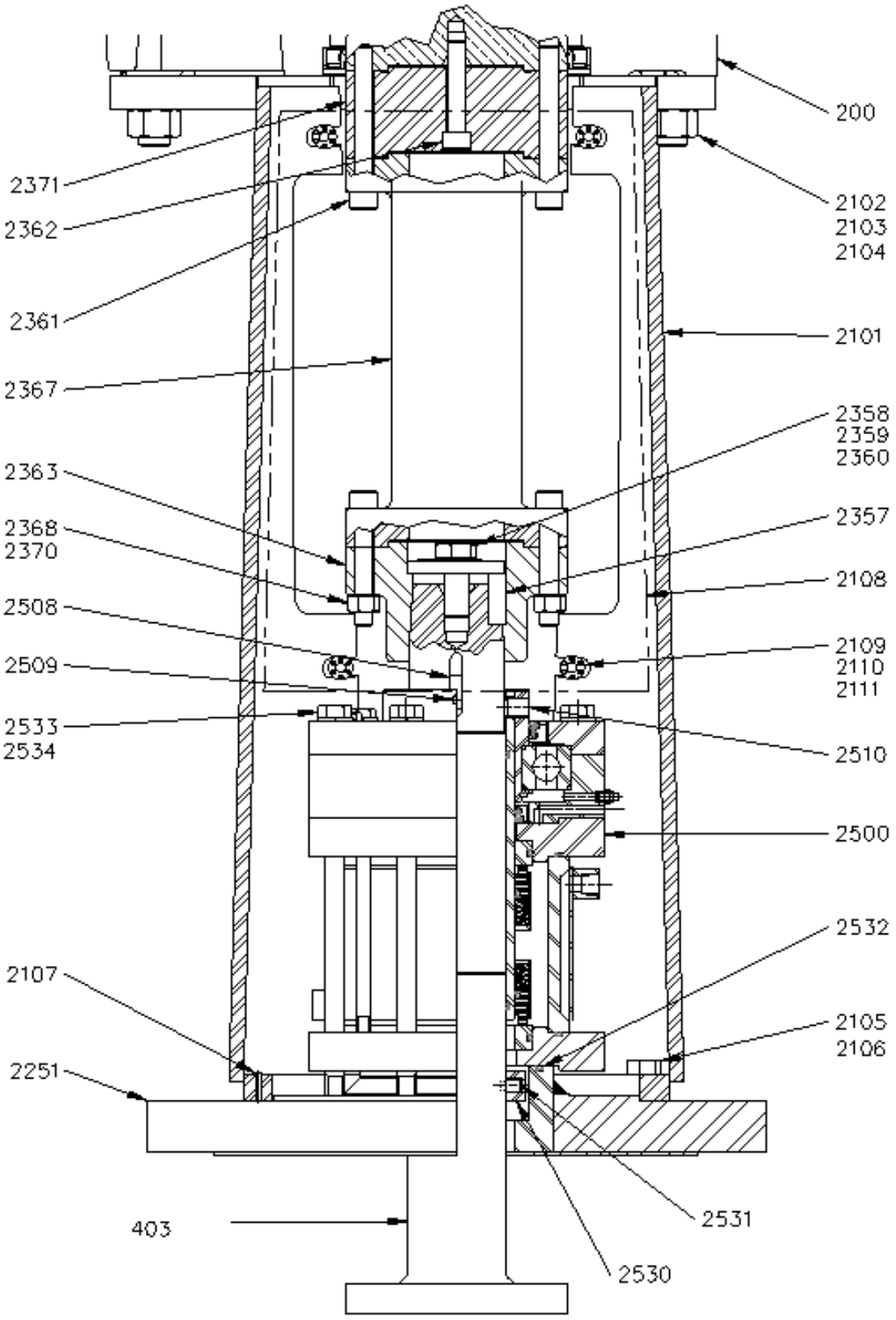


Figure 30A. N Style – Cartridge Mechanical Seal

R. MAINTENANCE - STEADY BEARING

R.1 BRACKET, TRIPOD AND PAD STEADY BEARING

In-tank steady bearings will require periodic inspection and replacement of bushing and wear sleeve **[606, 604]** (Figure 19 on page 42, Figure 20A on page 47, and Figure 20B on page 49).

It is recommended that the steady bearing fasteners be checked for tightness and the bushing and wear sleeve for wear after the first two weeks of operation.

Unless otherwise specified the recommended wear allowance is:

Table 16. BRACKET, TRIPOD, AND PAD STEADY BEARING WEAR SLEEVE AND BUSHING WEAR ALLOWANCES

SHAFT DIAMETER	UP TO 3" (76.2mm)	LARGER THAN 3" (76.2mm)
WEAR SLEEVE	.040" (1mm)	.060" (1.5 mm)
BUSHING	.120" (3mm)	.180" (4.5 mm)

The wear sleeve and bushing should be replaced in sets.

CAUTION! *Lock out and disconnect all power to the gear drive motor, any optional devices and depressurize vessel before servicing this equipment.*

1. Loosen setscrew **[605]** and slide wear sleeve **[604]** off the shaft.
2. Unbolt the housing from the bracket or tri-pod.
3. Remove bushing retaining bolt and lockwasher **[607, 608]**. Press the bushing out of the steady bearing housing.
4. Press a new bushing into the steady bearing housing. Install the bushing retaining bolt and lockwasher.

   NOTE: Line up the clearance hole in the new bushing with the tapped hole in the housing prior to pressing the bushing into the housing.

Reinstall the wear sleeve and housing/bushing assembly. Torque all fasteners to the value shown in APPENDIX, Page 96.

CAUTION! *Do not operate the agitator without the steady bearing being submerged.*

R.2 CUP TRIPOD STEADY BEARING

In-tank steady bearings will require periodic inspection and replacement of bushing and stub shaft **[606, 630]**. (Figure 20, page 44)

It is recommended that the steady bearing fasteners be checked for tightness and the bushing & stub shaft for wear after the first two weeks of operation.

Unless otherwise specified the recommended wear allowance is:

Table 17. TRIPOD STEADY BEARING WEAR SLEEVE AND BUSHING WEAR ALLOWANCES

SHAFT DIAMETER	UP TO 3" (76.2mm)	LARGER THAN 3" (76.2mm)
WEAR SLEEVE	.040" (1mm)	.060" (1.5 mm)
BUSHING	.120" (3mm)	.180" (4.5 mm)

The stub shaft and bushing should be replaced in sets.

CAUTION! *Lock out and disconnect all power to the gear drive motor, any optional devices, and depressurize vessel before servicing this equipment.*

1. Remove the retainer plate **[631]** and the stub shaft **[630]** from the stub shaft housing **[634]**. Remove the retainer to housing bolts and install them into the threaded holes on the retainer plate. Progressively tighten these bolts around the bolt circle to remove the stub shaft.

CAUTION! *Tapers can disengage with a great deal of force; also the stub shaft/retainer assembly can be very heavy on larger size agitators. In order to hold the stub shaft when it disengages use half of the supplied retainer plate bolts threaded into the stub shaft housing.*

2. Unbolt the bushing housing **[627]** from the coupling **[620]**. Remove the bushing retaining bolt **[628]** and lockwasher **[629]**. Press the bushing **[606]** out of the bushing housing **[627]**.

3. Press a new bushing into the bushing housing. Install the bushing retaining bolt and lockwasher.

   NOTE: Line up the clearance hole in the new bushing with the tapped hole in the bushing housing prior to pressing the bushing in place.

4. Reinstall the bushing housing, new stub shaft, and retainer plate as described in the ***Steady bearings installation section***. Torque fasteners to the value shown in APPENDIX, Page 96.

5. Re-attach the flush piping.

S. ITEMS LIST

Item#	Description	Qty.
100	**Motor**	**1**
101	motor key	1
110	flexible motor coupling assembly	1
120	**Gear drive cover plate assembly**	**1**
121	cover plate	1
122	bolt	4
130	**Motor adapter assembly**	**1**
131	motor adapter	1
132	alignment pin	2
133	bolt	4
135	bolt	4
136	lockwasher	4
137	shoulder Bolt (HT Only)	1
138	spacer (HT Only)	1
139	bushings (HT Only)	2
200	**Gear drive**	**1**
202	input shaft	1
203	bearing (taper roller)	1
204	lip seal	1
212	v-ring seal	1
217	bearing (cylindrical roller)	1
233	bearing (taper roller)	1
244	output shaft	1
245	bearing (taper roller)	1
249	lip seal	1
254	bearing cap	1
258	dipstick/breather	1
260	grease fitting	1
261	relief fitting	1
262	grease fitting	1
263	plut, NPT	1
264	magnetic drain plug, NPT	1
266	set screw plug, NPT	1

Item#	Description	Qty.
267	pipe plug, NPT	1
269	input shaft key	1
350	**Low speed coupling assembly**	**1**
351	Rigid, removable, taper bore coupling half	1
352	key	1
353	coupling washer (1 bolt)	1
354	coupling washer (2 bolt)	1
355	lockwasher	1
356	bolt	1
357	shaft bolt	2
358	lockwasher	2
361	bolt	
	Items used only on Model 20 HT	
370	**Spiral bevel cartridge assembly**	**1**
384	grease fitting	1
385	grease fitting	1

Note: *For detailed list of gear drive items please refer to appropriate gear drive IOM manual*

Item#	Description	Qty.
400	**Extension shaft assembly**	**1**
402	pin key	1
403-001	drive shaft (welded coupling)	1
403-002	drive shaft (removable coupling)	1
404-001	extension shaft (welded coupling)	1
404-002	extension shaft (removable coupling)	1
405	bolt	
406	lockwasher	
407	nut	
408	rigid, removable, taper bore coupling half	1
409	key	1
410	coupling washer	1
412	locking clip	1
413	rigid, removable, taper bore coupling half	1
414	key	1
415	coupling washer	1
416	locking clip	1
418	shaft bolt	1
419	shaft bolt	1
420	key	1
421	coupling washer	1
422	bolt	2
423	lockwasher	2
424	coupling washer	1
425	bolt	2
426	lockwasher	2

Item#	Description	Qty.
500	**Impeller assembly**	
501	impeller assembly P-4	
502	impeller assembly S-4	
503	impeller assembly HE-3	
504	hub	
505	setscrew	
506	extension blade	
507	bolt	
508	lockwasher	
509	nut	
510	stabilizer fin	
511	bolt	
512	lockwasher	
513	nut	
514	impeller assembly D-6, CD-6, BT-6	
515	split disc	
516	bolt	
517	flatwasher	
518	bolt	
519	flatwasher	
520	locking clip	
521	nut	
522	gasket	2
523	snap ring	1
524	thrust plate	1
525	gasket	1
526	mounting bolt	1
527	impeller assembly SC-3	
528	impeller assembly Maxflo W	
529	bolt	
530	lockwasher	
531	nut	
532	impeller assembly XE-3	

Item#	Description	Qty.
600	**Steady bearing assembly**	**1**
601	bracket steady bearing	1
602	pad steady bearing	1
603-001	cup tri-pod steady bearing	1
603-002	tri-pod steady bearing	1
604	wear sleeve	1
605	setscrew, square head	2
606	bushing	1
607	bushing retaining bolt	1
608	lockwasher	1
609	steady bearing housing	1
610	drain plug, NPT	1
620	coupling	1
621	coupling bolt	4 to 6
622	lockwasher	4 to 6
623	key	1
624	coupling washer	1
625	shaft bolt	2
626	lockwasher	2
627	bushing housing	1
628	bushing retaining bolt	1
629	lockwasher	1
630	stub shaft	1
631	retainer plate	1
632	retainer plate bolt	4 to 8
633	lockwasher	4 to 8
634	stub shaft housing	1
635	leg	3
636	leg bolt	6
637	leg nut	6
638	lockwasher	6
639	flat washer	6
640	alignment pin	3
641	pipe plug (flush)	1

Item#	Description	Qty.
2100	**Pedestal assembly**	**1**
2101	Pedestal	1
2102	bolt	4
2103	lockwasher	4
2104	nut	4
2105	bolt	4
2106	lockwasher	4
2107	roll pin	2
2108	handhole cover	2
2109	bolt	8
2110	flatwasher	8
2111	wellnut	8
2251	**flange**	**1**
2300	**Spacer Spool components**	
2357	key	1
2358	coupling washer	1
2359	locking clip	1
2360	shaft bolt	1
2361	bolt	1
2362	bolt	1
2363	removable taper bore coupling	1
2367	spacer spool	
2368	bolt	
2370	nut	
2371	coupling spacer	

Item#	Description	Qty.
2500	**HTN mechanical seal cartridge assembly**	**1**
2501	seal sleeve (unbalanced)	1
	seal sleeve (balanced)	1
2502	o-ring	1
2503	o-ring	1
2504	bearing adapter	1
2505	bearing	1
2506	bearing spacer	1
2507	snap ring	1
2508	key	1
2509	setscrew, knurled cup point	1
2510	setscrew, cup point with nylok	3
2511	lip seal	1
2512	bearing cap	1
2513	bearing housing	1
2514	lip seal	1
2515	grease fitting	1
2516	relief	1
2517	cartridge bolt	2
2518	lockwasher	2
2519	upper gland	1
2520	seal seat, upper	1
2521	seat packing	1
2522-001	seal head, upper (unbalanced)	1
-002	seal head, upper (balanced)	1
2523	o-ring	2
2524	seal housing, jacketed	1
2525	lower gland	1
2526	seal seat, lower	1
2527-001	seat packing (o-ring)	1
-002	seat packing (teflon ring)	1
2528-001	seal head, lower (unbalanced)	1
-002	seal head, lower (balanced)	1
2529	seat pin	1
2530	shaft collar	1
2531	setscrew, half dog point	3
2532	o-ring	1

Item#	Description	Qty.
2533	bolt	8
2534	lockwasher	8
2700	**mechanical seal lubricator assembly**	**1**
2701	seal lubricator	1
2702	mounting bracket	2
2703	bolt	4
2704	lockwasher	4
2705	bolt	2
2706	lockwasher	2
2707	flatwasher	2
2708	pipe plug, NPT	1
2709	sight glass, NPT	1
2710	pipe plug, NPT	1
-001	magnetic drain plug, NPT	1
2711	tube fitting	1
2712	tube fitting	3
2713	tubing	2

T. APPENDIX

Tighten all fasteners to values shown unless specifically instructed to do otherwise. Lubricate all fasteners at assembly with thread lubricant or an anti-seize material. Bolt threads and contact surfaces of bolt heads and nuts should be lubricated. Note that stainless steel and alloy fasteners can gall while being tightened. The risk of galling or thread seizing is reduced by using lubrication, by tightening fasteners with low rpm's and without interruptions, and applying only light pressure. Dry fasteners, components with dirt or dust, bolting faces with rough finish, or even some environmental factors such as heat or moisture can effect the torque readings, and require values different than those listed in the table below.

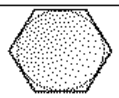
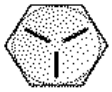
Table 18. BOLT TIGHTENING TORQUE

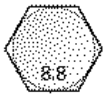
BOLT SIZE	SAE J429 CARBON STEEL						STAINLESS STEEL	
	GRADE 2 METRIC GRADE 4.6		GRADE 5 METRIC GRADE 8.8		METRIC GRADE 12.9		300 Series Stainless Steel (e.g. 304, 316)	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
1/4 - 20	-	-	6	8.1	-	-	4.1	5.6
5/16 -18	-	-	13	18	-	-	8	11
3/8 - 16	-	-	23	31	-	-	15	20
1/2 - 13	38.0	52	55	75	-	-	38	52
9/16 -12	50.0	68	79	107	-	-	50	68
5/8 - 11	68.0	92	110	149	-	-	68	92
3/4 - 10	120.0	163	195	264	-	-	95	129
7/8 - 9	122.0	165	314	426	-	-	153	207
1 - 8	184.0	250	470	637	-	-	230	312
1-1/8 - 7	260.0	353	587	796	-	-	326	442
1-1/4 - 7	368.0	499	828	1123	-	-	460	624
1-3/8 - 6	482.0	654	1085	1471	-	-	602	816
1-1/2 - 6	640.0	868	1440	1953	-	-	800	1085
M6 x 1.00	3.8	5.1	6.9	9.4	9.7	13	4.3	5.8
M8 x 1.25	8	10	17	23	24	32	10	14
M10 x 1.50	15	20	34	45	47	63	21	28
M12 x 1.75	26	35	58	79	81	110	36	49
M16 x 2.00	64	87	145	196	202	274	89	121
M20 x 2.50	126	170	282	383	394	534	174	236
M24 x 3.00	217	295	489	663	537	728	300	407

Table 19. BOLT TIGHTENING TORQUE (CONTD)

BOLT SIZE	ALLOY 600 (UNS#N06600), ALLOY C4 (UNS#N06455), ALLOY G30 (UNS#N06030), ALLOY 2205 (UNS#S32205)		ALLOY C276 (UNS#N10276), ALLOY C2000 (UNS#N06200)		ALLOY 20 (UNS#N08020), ALLOY 400 (UNS#N04400), ALLOY 825 (UNS#N08825)	
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
1/4 - 20	4	5.4	5	6.8	3.4	4.6
5/16 -18	8	11	10	14	7	9
3/8 - 16	15	20	18	25	12	17
1/2 - 13	36	49	45	61	30	41
9/16 -12	52	70	65	88	43	59
5/8 - 11	72	97	89	121	60	81
3/4 - 10	127	172	159	215	106	143
7/8 - 9	205	277	256	347	170	231
1 - 8	307	416	383	520	256	346
1-1/8 - 7	435	589	543	737	362	491
1-1/4 - 7	613	832	767	1040	511	693
1-3/8 - 6	804	1090	1005	1363	670	908
1-1/2 - 6	1067	1447	1334	1809	889	1206
M6 x 1.00	3.7	5.0	4.9	6.6	3.1	4.2
M8 x 1.25	9	12	12	16	7	10
M10 x 1.50	18	24	24	32	15	20
M12 x 1.75	31	42	41	56	26	35
M16 x 2.00	77	104	102	139	64	87
M20 x 2.50	150	203	200	271	125	169
M24 x 3.00	276	374	345	468	216	292

Table 20. Bolt grades and mechanical properties

Head Marking	Grade and Material	Nominal Size Range (inches)	Mechanical Properties		
			Proof Load (psi)	Min. Yield Strength (psi)	Min. Tensile Strength (psi)
US Bolts					
 No Markings	**Grade 2** Low or medium carbon steel	1/4 thru 3/4	55,000	57,000	74,000
		Over 3/4 thru 1-1/2	33,000	36,000	60,000
 3 Radial Lines	**Grade 5** Medium Carbon Steel, Quenched and Tempered	1/4 thru 1	85,000	92,000	120,000
		Over 1 thru 1-1/2	74,000	81,000	105,000
 6 Radial Lines	**Grade 8** Medium Carbon Alloy Steel, Quenched and Tempered	1/4 thru 1-1/2	120,000	130,000	150,000
Stainless markings vary. Most stainless is non-magnetic	**18-8 Stainless** Steel alloy with 17-19% Chromium and 8-13% Nickel	1/4 thru 5/8		40,000 Min. 80,000 – 90,000 Typical	100,000 – 125,000 Typical
		3/4 thru 1		40,000 Min. 45,000 – 70,000 Typical	100,000 Typical
		Above 1			80,000 – 90,000 Typical

Head Marking	Class and Material	Nominal Size Range (mm)	Mechanical Properties		
			Proof Load (MPa)	Min. Yield Strength (MPa)	Min. Tensile Strength (MPa)
Metric bolts					
 8.8	**Class 8.8** Medium Carbon Steel, Quenched and Tempered	All Sizes below 16mm	580	640	800
		16mm - 72mm	600	660	830
 10.9	**Class 10.9** Alloy Steel, Quenched and Tempered	5mm - 100mm	830	940	1040
12.9	**Class 12.9** Alloy Steel, Quenched and Tempered	1.6mm - 100mm	970	1100	1220
Stainless markings vary. Most stainless is non-magnetic. Usualy stamped A-2	**A-2 Stainless** Steel alloy with 17- 19% Chromium and 8-13% Nickel	All Sizes thru 20mm		210 Min. 450 Typical	500 Min. 700 Typical

Tensile Strength: The maximum load in tension (pulling apart) which a material can withstand before breaking or fracturing.

Yield Strength: The maximum load at which a material exhibits a specific permanent deformation

Proof Load: An axial tensile load which the product must withstand without evidence of any permanent set.

1MPa = 1N/mm^2 = 0.2248 pounds/mm^2

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