

Installation, Operation and Maintenance Manual

Model 20 GTN, GTNC, GTNS Agitators

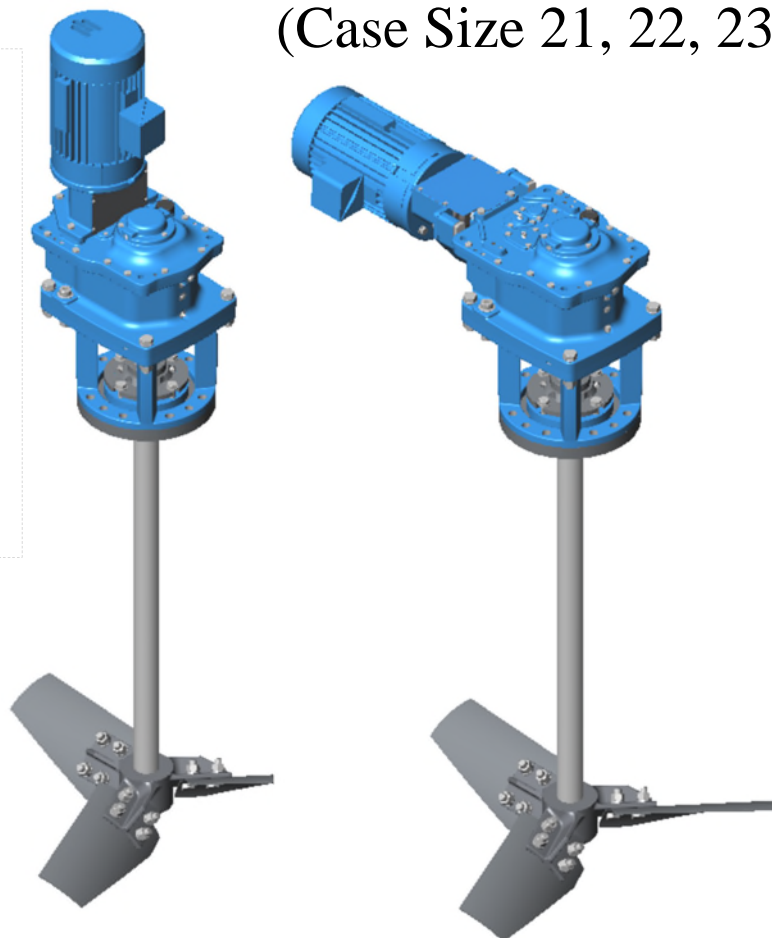
Model 20 HTN, HTNC, HTNS Agitators

(Case Size 21, 22, 23)

Equipment Reference:

MODELS:	EQUIPMENT TAG'S:
23GTN-7.5,	603.1-A 19-A-754
22GTN-3,	622.1-A, 622.2-A
	19-A-757, 19-A-857
22GTN-5,	W503B.1-A, W503B.2-A
	19-A-751, 19-A-851
22GTN-5	W503W.1-A, W503W.2-A
	19-A-755, 19-A-855

UNIT SERIAL #:
4572878-01-01,
4572878-03-01
4572878-07-01
4572878-09-01



For service and information contact:

Chemineer, Inc.
5870 Poe Ave,
Dayton, OH 45414

Carl Eric Johnson Co., Inc.
1725Q MacLeod Drive
Lawrenceville, GA 30043

Chemineer
7 Cranmer Road
West Meadows
Derby, UK
DE21 6XT

Toll Free: 1 (800) 643-0641
Phone: 1 (937) 454 3200
Fax: 1 (937) 454 3379

Phone: (678) 377-3100

Phone: +44 (0) 1332 363175
Fax: +44 (0) 1332 290323

E-mail: sales.chemineerus@robn.com
parts.chemineerus@robn.com

E-mail: keisert@cejco.net

E-mail: sales.chemineeruk@robn.co.uk
spares.chemineeruk@robn.co.uk

Web: www.chemineer.com

Web: www.chemineer.com

TABLE OF CONTENTS

A.	PRODUCT NOMENCLATURE.....	1
B.	INITIAL INSPECTION.....	2
C.	CHEMINEER ASSISTANCE.....	3
D.	SAFETY	4
D.1	VESSELS	4
D.2	FASTENERS	4
D.3	CE MARKING (WHERE APPLICABLE).....	4
D.4	SAFETY CHECKLIST	5
E.	STORAGE	6
E.1	SHORT-TERM INDOOR STORAGE.....	6
E.2	OUTDOOR OR LONG-TERM INDOOR STORAGE.....	6
E.3	CUSTOMER RESPONSIBILITY	8
F.	VESSEL MOUNTING	10
F.1	DESCRIPTION OF AGITATOR LOADS	10
G.	AGITATOR INSTALLATION	16
H.	SEAL INSTALLATION - MECHANICAL CARTRIDGE SEAL	20
H.1	Safety Notes	20
H.2	ChemSeal Mechanical Seal Options	20
H.3	Installation	22
I.	SEAL INSTALLATION - SINGLE MECHANICAL SEAL	27
J.	TAPER BORE COUPLING AND GEAR DRIVE INSTALLATION	29
K.	SHAFT RUNOUT	32
L.	HANDHOLE COVER INSTALLATION.....	33
M.	MOTOR INSTALLATION	34
N.	IMPELLERS.....	39
N.1	MATCH-MARKING	39
N.2	IMPELLERS - INSTALLATION.....	39
N.3	IMPELLERS – STYLES.....	41
N.4	IMPELLERS – COATED / RUBBER COVERED	48
O.	OPTIONS.....	50
O.1	IN-TANK COUPLING	50
O.2	STEADY BEARINGS	53
P.	LUBRICATION	62

P.1	MOTOR - LUBRICATION	62
P.2	MECHANICAL SEAL LUBRICATOR	64
P.3	GEAR DRIVE - LUBRICATION	66
P.4	STEADY BEARINGS - LUBRICATION	76
P.5	SHAFT SEALS - LUBRICATION	76
Q.	OPERATION	77
Q.1	AGITATOR OPERATION	77
Q.2	MOTOR - OPERATION	78
Q.3	FLEXIBLE MOTOR COUPLING	79
Q.4	GEAR DRIVE - OPERATION	79
Q.5	SHAFT SEALS - OPERATION	79
Q.6	STEADY BEARINGS - OPERATION	80
Q.7	TROUBLE-SHOOTING	81
R.	MAINTENANCE - MECHANICAL CARTRIDGE SEAL	82
R.1	SEAL REMOVAL	82
R.2	REPLACEMENT SEAL CARTRIDGE INSTALLATION	88
S.	MAINTENANCE - SINGLE MECHANICAL SEAL	90
S.1	SEAL REMOVAL	90
S.2	SEAL INSTALLATION	91
T.	MAINTENANCE - GEAR DRIVE	92
T.1	AGITATOR DRIVE REMOVAL	92
T.2	PREPARATION FOR DISASSEMBLY	92
U.	MAINTENANCE - STEADY BEARING	93
U.1	BRACKET, TRIPOD AND PAD STEADY BEARING	93
U.2	CUP TRIPOD STEADY BEARING	94
V.	ITEMS LIST	95
W.	APPENDIX	105

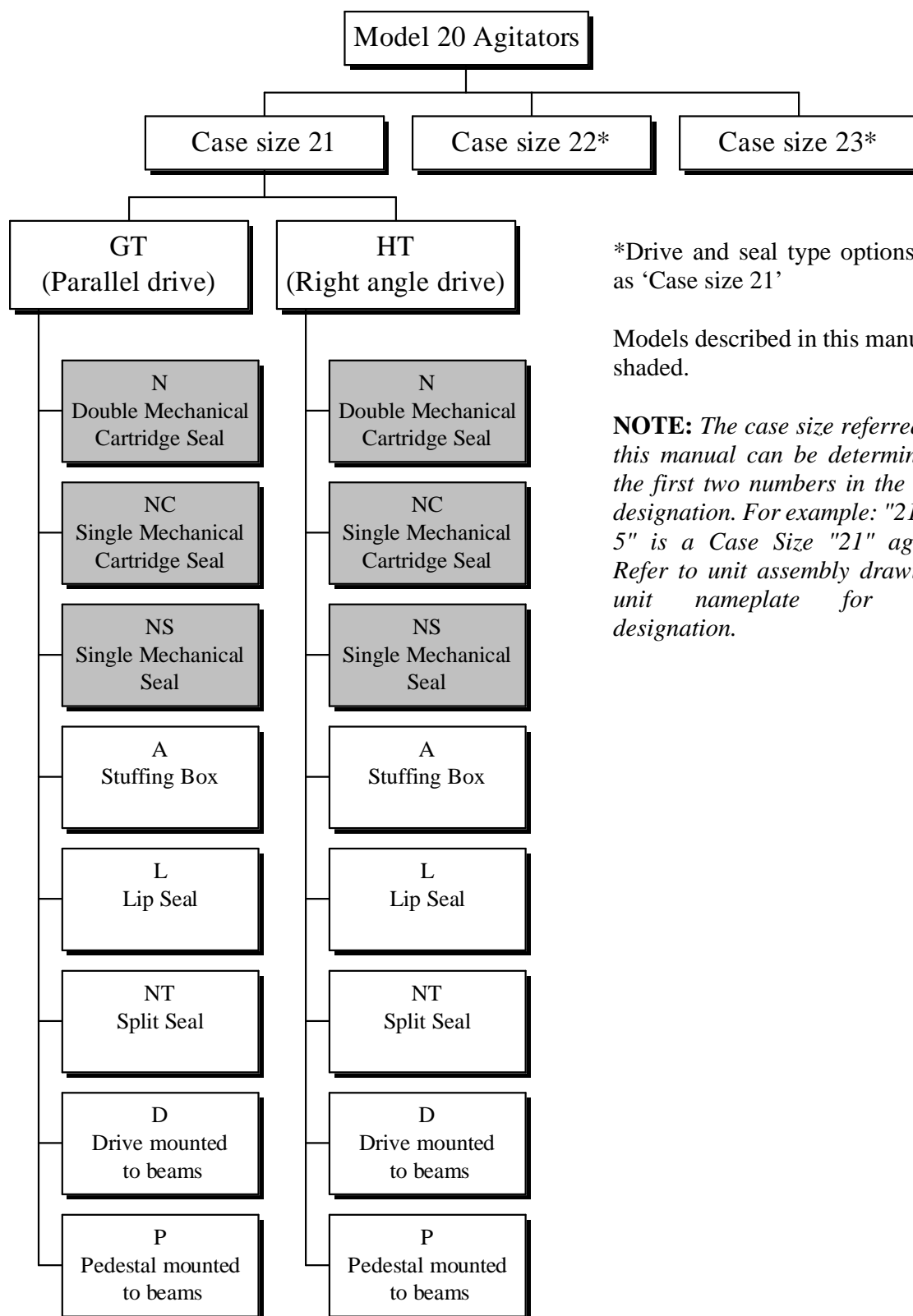
LIST OF FIGURES

FIGURE 1.	VESSEL MOUNTING	12
FIGURE 2.	VESSEL MOUNTING NOZZLE/PAD	13
FIGURE 4.	MODEL 20 GTN, GTNC, GTNS AGITATOR ASSEMBLY	18
FIGURE 5.	MODEL 20 HTN, HTNC, HTNS AGITATOR ASSEMBLY	19
FIGURE 5A.	CHEMSEAL WITH THROTTLE BUSH AND FLUSHING SYSTEM OPTION.....	21
FIGURE 5B.	CHEMSEAL WITH DEBRIS WELL OPTION.....	21
FIGURE 6.	N STYLE – DOUBLE MECHANICAL SEAL WITH ADAPTER PLATE	24
FIGURE 7.	N STYLE – DOUBLE MECHANICAL SEAL WITHOUT ADAPTER PLATE	24
FIGURE 8.	NC STYLE – SINGLE MECHANICAL SEAL WITH ADAPTER PLATE.....	25
FIGURE 9.	NC STYLE – SINGLE MECHANICAL SEAL WITHOUT ADAPTER PLATE	25
FIGURE 10.	IDENTIFYING PRESENCE OF PUMPING RING FOR BARRIER FLUID	26
FIGURE 11.	NS STYLE – MECHANICAL SEAL	27
FIGURE 12.	SHAFT COUPLING INSTALLATION.....	29
FIGURE 13.	AGITATOR LIFTING SYSTEM.....	30
FIGURE 14.	HANDHOLE COVER INSTALLATION (CASE SIZES 21 AND 22).....	33
FIGURE 15.	HANDHOLE COVER INSTALLATION (CASE SIZE 23)	33
FIGURE 16.	MOTOR COUPLING SETTING	35
FIGURE 17.	MODEL 20 GT – MOTOR MOUNTING.....	36
FIGURE 18.	MODEL 20 HT – MOTOR MOUNTING.....	37
FIGURE 19.	HUB AND PIN KEY DETAIL	40
FIGURE 20.	STYLE P-4 IMPELLER.....	41
FIGURE 21.	STYLE HE-3 IMPELLER.....	42
FIGURE 21A.	STYLE XE-3 IMPELLER.....	43
FIGURE 22.	STYLE S-4 IMPELLER.....	44
FIGURE 23.	STYLE D-6, CD-6, BT-6 IMPELLER.....	45
FIGURE 24.	STYLE SC-3 IMPELLER	46
FIGURE 25.	STYLE MAXFLO W IMPELLER.....	47
FIGURE 26.	THRUST BOLT IMPELLER ATTACHMENT	49
FIGURE 27.	IN-TANK COUPLINGS	51
FIGURE 27A.	IN-TANK COUPLINGS (CONTINUED)	52
FIGURE 28.	BRACKET STEADY BEARING	53
FIGURE 29.	CUP TRIPOD STEADY BEARING.....	55
FIGURE 29A.	TRIPOD STEADY BEARING.....	58
FIGURE 29B.	PAD STEADY BEARING	60
FIGURE 30.	MECHANICAL SEAL (CARTRIDGE TYPE) LUBRICATOR	65
FIGURE 31.	MODEL 20 GT/HT GEAR DRIVE OIL LEVEL DIPSTICK	68
FIGURE 32.	MODEL 20 GT DOUBLE REDUCTION GEAR DRIVE.....	73
FIGURE 33.	MODEL 20 GT TRIPLE REDUCTION GEAR DRIVE	74
FIGURE 34.	MODEL 20 HT GEAR DRIVE.....	75
FIGURE 35.	MODEL 21 AND MODEL 22 GEAR DRIVE PIVOT FEATURE.....	83
FIGURE 36.	21 AND 22 GT/HT PIVOT SEAL CHANGE PROCEDURE	84
FIGURE 37.	23 GEAR DRIVE SWIVEL ARRANGEMENT.....	85
FIGURE 38.	23 GT/HT PIVOT SEAL CHANGE PROCEDURE.....	86
FIGURE 39.	23 GT/HT PIVOT SEAL CHANGE PROCEDURE (CONTD.)	87
FIGURE 40.	DOUBLE MECHANICAL SEAL WITH ADAPTER PLATE	88
FIGURE 41.	SINGLE MECHANICAL SEAL WITH ADAPTER PLATE	89
FIGURE 42.	MODEL GTNS, SINGLE MECHANICAL SEAL	91

LIST OF TABLES

TABLE 1.	APPROXIMATE STORAGE OIL CAPACITY	9
TABLE 2.	VESSEL HEAD THICKNESS (T), NOZZLE MOUNT.....	14
TABLE 3.	VESSEL HEAD THICKNESS (T), PAD MOUNT	14
TABLE 4.	AGITATOR MOUNTING REINFORCEMENT DIMENSIONS	15
TABLE 5.	MOTOR (NEMA) COUPLING SETTING.....	34
TABLE 6.	MOTOR (IEC) COUPLING SETTING	35
TABLE 7.	TYPICAL NLGI NO. 2 GREASES.....	63
TABLE 8.	MODEL 20 HT INTERMEDIATE BEARING GREASE ADDITION.....	67
TABLE 9.	LUBE OIL SELECTION.....	69
TABLE 10.	APPROXIMATE OPERATING OIL CAPACITY	69
TABLE 11.	TYPICAL RUST & OXIDATION INHIBITED (R&O) LUBE OILS	70
TABLE 12.	TYPICAL EXTREME PRESSURE (EP) LUBE OILS	71
TABLE 13.	TYPICAL SYNTHETIC LUBE OILS	72
TABLE 14.	TROUBLE-SHOOTING GUIDE.....	81
TABLE 15.	BRACKET, TRIPOD, AND PAD STEADY BEARING WEAR SLEEVE AND BUSHING WEAR ALLOWANCES	93
TABLE 16.	TRIPOD STEADY BEARING WEAR SLEEVE AND BUSHING WEAR ALLOWANCES	94
TABLE 17.	BOLT TIGHTENING TORQUE	105
TABLE 18.	BOLT TIGHTENING TORQUE (CONTD)	106
TABLE 19.	BOLT GRADES AND MECHANICAL PROPERTIES	107

A. PRODUCT NOMENCLATURE



*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 designation.

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:

USA

Chemineer, Inc.
5870 Poe Ave,
Dayton, OH 45414

Phone: +1 (937) 454 3200
Toll Free: 1 800 643-0641
Fax: +1 (937) 454 3379

UK

Chemineer
7 Cranmer Road
West Meadows
Derby, UK
DE21 6XT

Phone: +44 (0) 1332 363175
Fax: +44 (0) 1332 290323

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.

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, NC, and NS 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° 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.

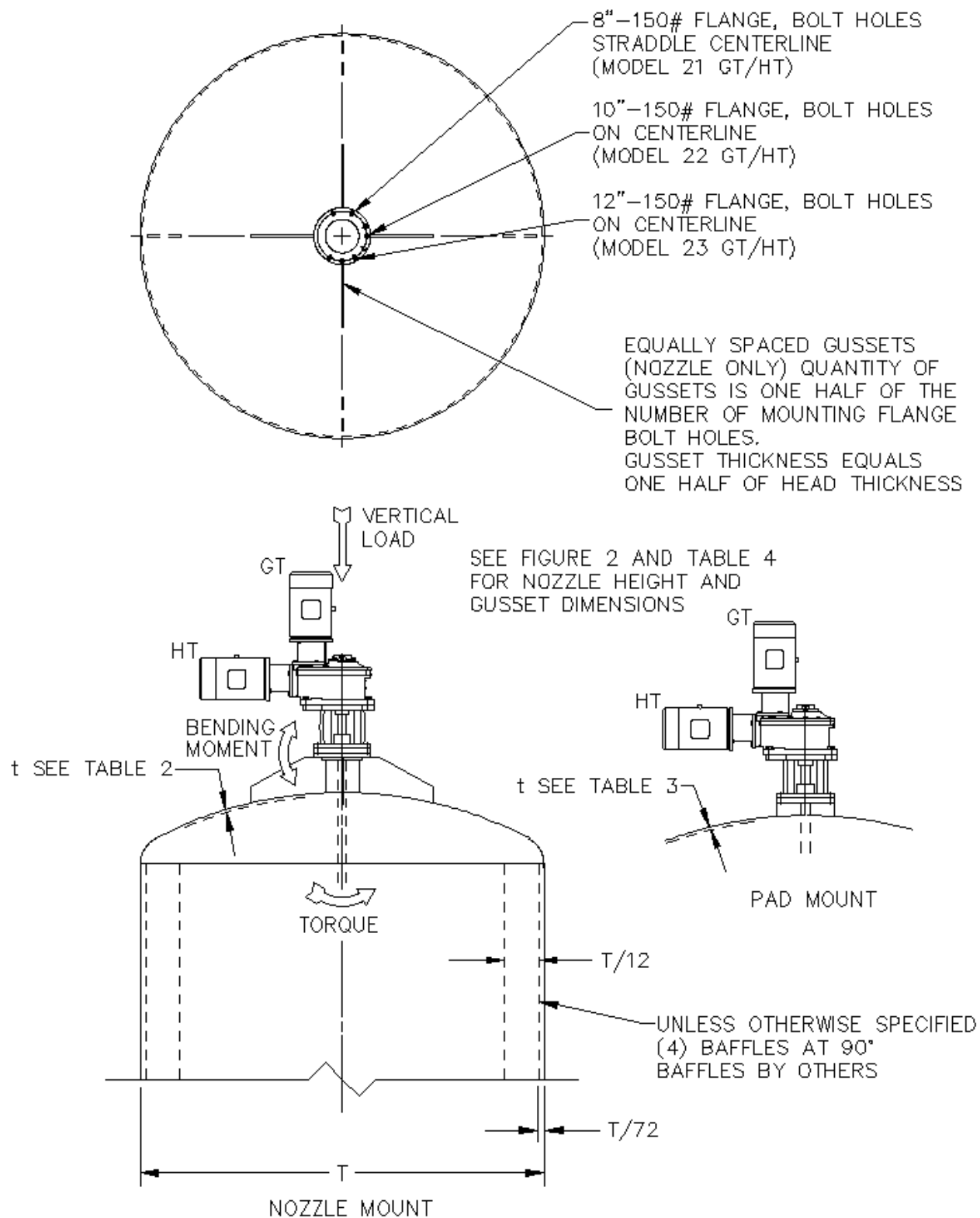


Figure 1. Vessel Mounting

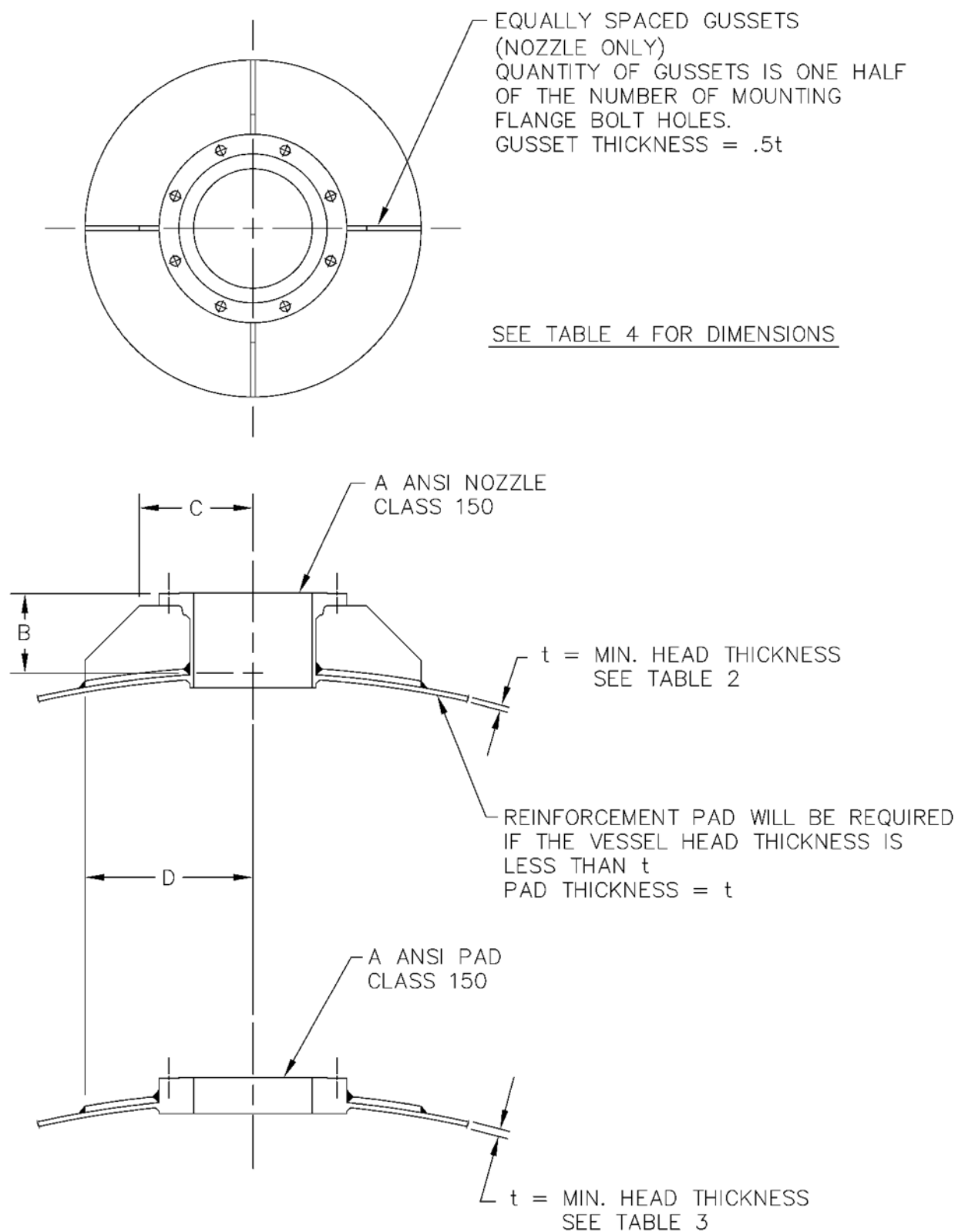


Figure 2. Vessel Mounting Nozzle/Pad

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
21 GT/HT	8"	6" (152mm)	8" (203mm)	12" (305mm)
22 GT/HT	10"	8" (203mm)	11.5" (292mm)	15.5" (394mm)
23 GT/HT	12"	8" (203mm)	11.5" (292mm)	17" (432 mm)

G. AGITATOR INSTALLATION

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

Note: These instructions deal with the highest level of details required to assemble the entire unit. However, the specific unit supplied to you may have some assembly steps completed. Use discretion and omit these steps

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.



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.

2. Remove all shipping restraints. A hoist or crane system for the lifting of the agitator parts must be available. Refer to Figure 13, page 30 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. Install handhole cover bolts, lockwashers [1106, 1107] into the pedestal [1101]. Refer to Figure 14 and Figure 15, page 33. Assemble the pedestal to mounting flange [1251] using bolts and lockwashers [1116, 1117] (see Figure 4 or Figure 5). Torque bolts to value shown in the APPENDIX, Page 105. Install gear drive support pedestal/mounting flange assembly to vessel nozzle, along with the gasket and fastener set furnished by customer (on stud mounted units, studs [1258] are supplied by Chemineer).

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

4. Install drop collar [1253], with the flanged side up if applicable (refer Figure 3, page 17), onto the tapered end of the agitator extension shaft [400]. Slide the collar down until the collar covers the setscrew relief area machined in the extension shaft. Rotate the collar until one of the tapped holes in the collar lines up with the spot on the shaft. Install half dog point setscrew [1254] into the spot on the shaft. Install the remaining cup point setscrews [1255] in the collar. Torque the setscrews to the value shown in the APPENDIX, Page 105.
5. Lift the agitator extension shaft and lower it through the mounting flange until the shaft drop collar is seated in the mounting flange counter bore. If the headroom will not allow the agitator shaft to be lowered through the mounting flange, or if the extension shaft is furnished with an optional in-tank coupling (Figure 27, page 51), lift the extension shaft and lower it into the vessel. Lift the shaft up through the mounting flange from inside the vessel. Assemble the drop collar to the shaft.

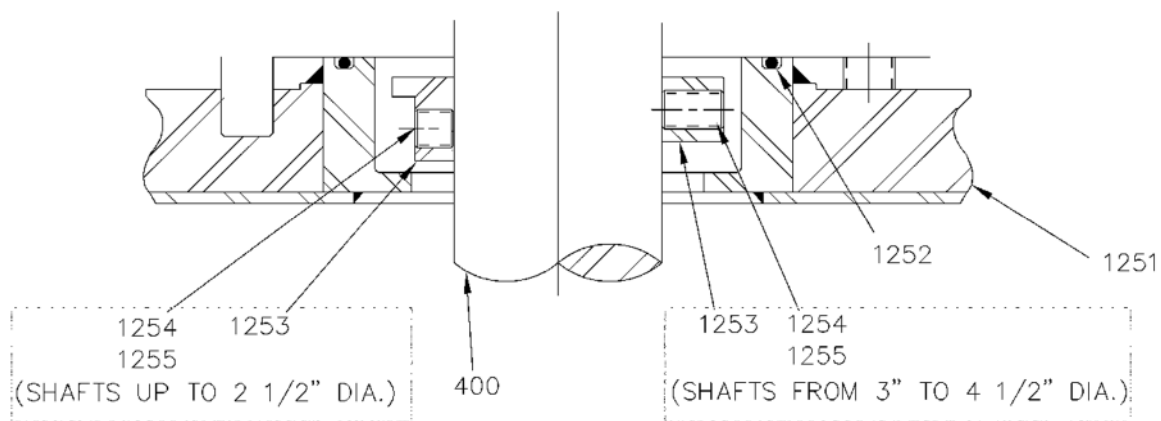


Figure 3. Types of Drop Collars

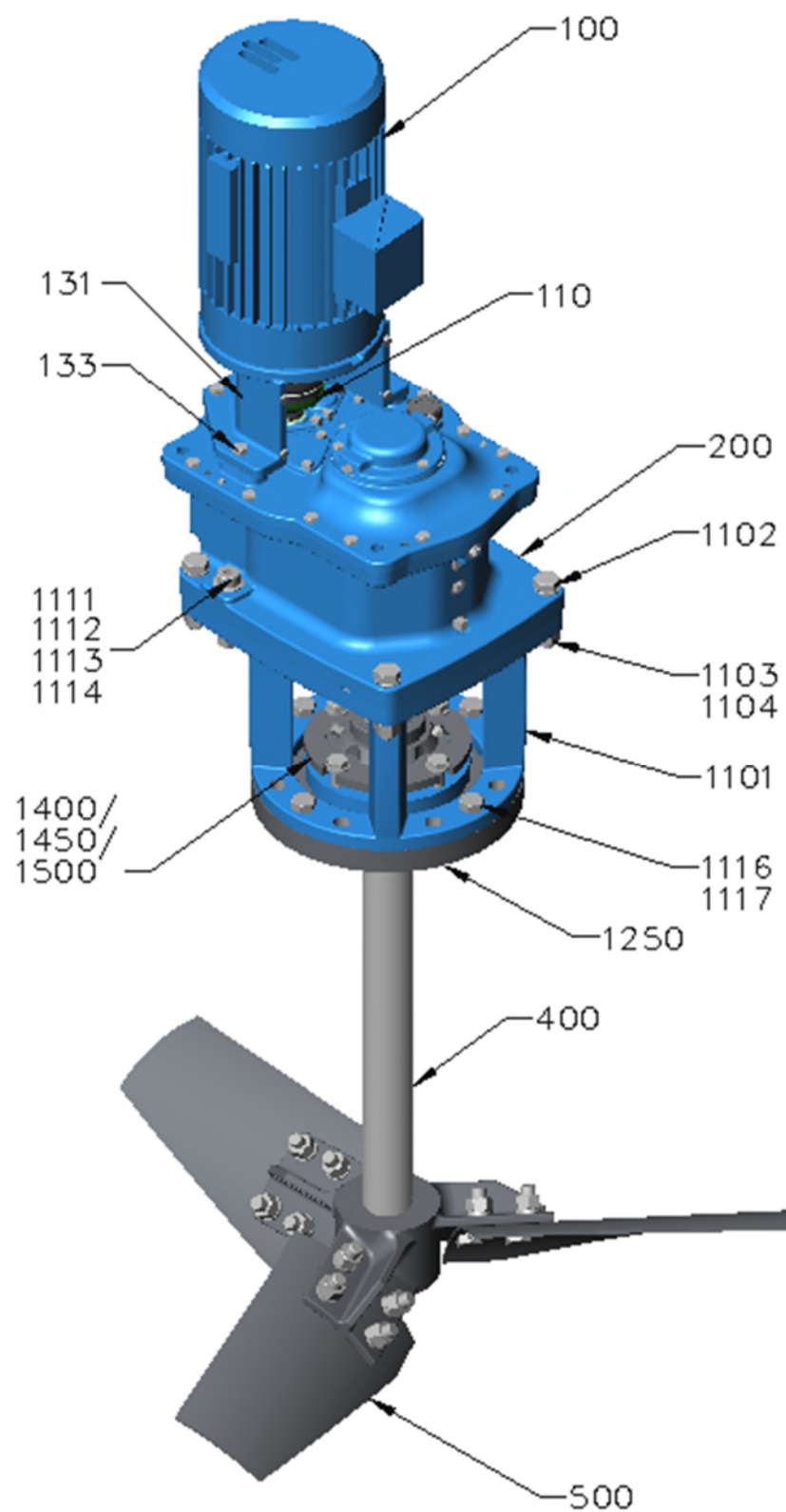


Figure 4. Model 20 GTN, GTNC, GTNS Agitator Assembly

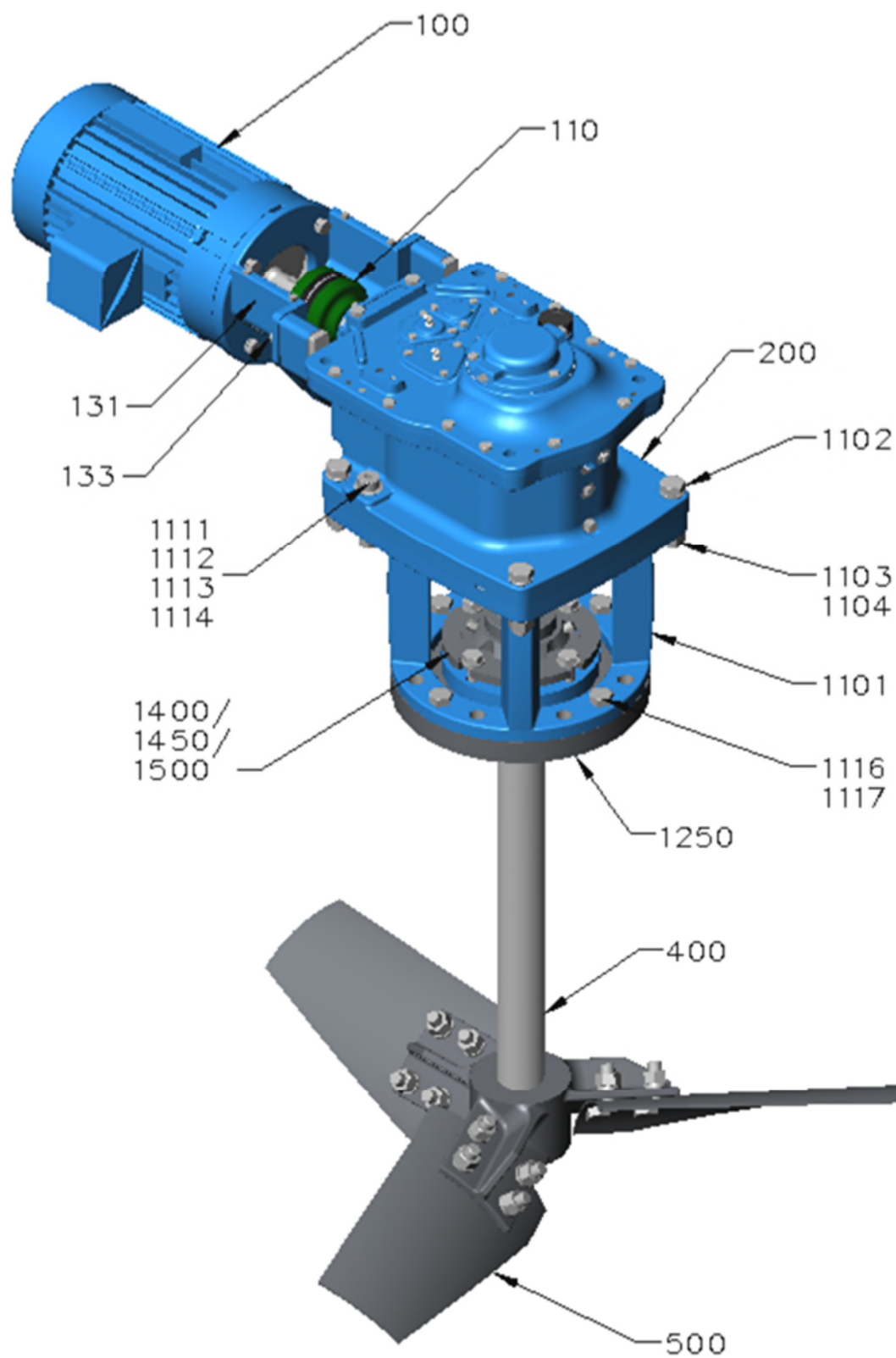


Figure 5. Model 20 HTN, HTNC, HTNS Agitator Assembly

H. SEAL INSTALLATION - MECHANICAL CARTRIDGE SEAL

H.1 Safety Notes

These instructions cannot provide for every possible contingency to be met regarding installation, operation, or maintenance. This manual should be read in conjunction with your general arrangement drawing and any supplementary (specific) information supplied. Should further information be desired, or problems arise that are not covered by this manual, do not hesitate to contact Chemineer.



SAFETY NOTES – *Read the following carefully before proceeding!*

1. Do not exceed the operating pressures, temperatures, and other conditions for which the seal has been designed. This information can be found on the general arrangement drawing for your unit.
2. The seal can become hot in service. Where this applies, take appropriate precautions to protect personnel.
3. This machine may be designed for use in hazardous areas; specific precautions have been taken during the design process. **Do not modify or change any components without consulting Chemineer.**

H.2 ChemSeal Mechanical Seal Options

H.2.1 Design Options

Both the ChemSeal Single (CSS) and ChemSeal Double (CSD) provide design options to meet a broad range of sealing requirements. Fitted in the bottom of the seal housing between the seal and the flange, an optional throttle bush or debris well provide an extra barrier between the process fluids and seal components.

H.2.1.1 Throttle Bush and Flushing System

The seal can be supplied with a dry running or flushable throttle bush system for use with process fluids that may be detrimental to the seal components.

In a dry running throttle bush configuration, a glass-filled PTFE bushing [1582] and stainless retaining ring [1583] are installed below the seal. The bushing [1582] provides another sealing barrier, reducing the amount of process fluids and size of process particles that can come in contact with the sealing faces.

A flushing system works in the same way as the dry running throttle bush, except that a liquid (or gas) is introduced through the flush port. The flushing pressure is set so that the flushing fluid is flowing through the throttle bush and into the vessel. This ensures that the seal is effectively sealing against a relatively neutral flushing fluid, and not the process fluids. This can be achieved with a reasonably low flow rate (typically a minimum rate of 0.5 gal/min [1.9 L/min] is sufficient) through the flushing system.

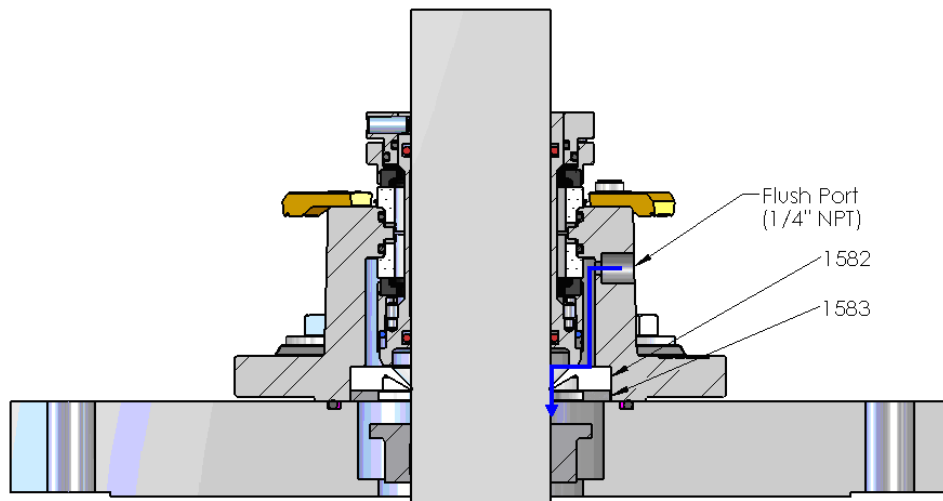


Figure 5A. ChemSeal with Throttle Bush and Flushing System Option

H.2.2 Debris Well

Dry-running seals, by their nature, shed particles from the sealing faces as they wear. A debris well [1584] option is available for applications where no carbon contamination is permissible. Chemineer recommends that debris wells, if fitted, should be periodically checked and cleaned. Optionally, the debris well can be periodically flushed between batches via the flush port on the seal gland. The debris well [1584] is also sealed by an external debris well o-ring [1585].

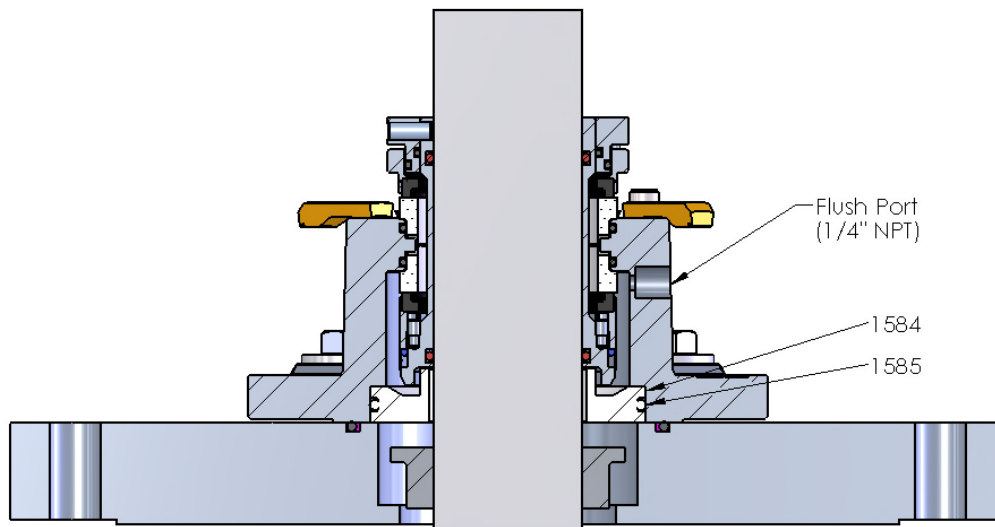


Figure 5B. ChemSeal with Debris Well Option

H.3 Installation

Applicable to: Model 20 GTN, GTNC, HTN, and HTNC

Either the “N” or “NC” seals may be supplied with or without adapter plates depending on the type of seal supplied. The ChemSeal is supplied without an adapter plate.

1. Place o-ring [1252] into the groove in mounting flange [1251].
2. **If an adapter plate is present**, install studs [1262] into mechanical seal adapter plate [1261]. Install the adapter plate, bolts and lockwashers [1266, 1267]. Do not tighten bolts at this time.

If no adapter plate is present, ignore step 2 and continue.

3. Remove the ready-to-install mechanical seal cartridge [1400/1470/1500/1570] from the shipping carton. Be sure to read and understand all manufacturers' installation instructions prior to installation. Check that the mechanical seal sleeve cup point setscrews [1402/1472/1502/1572] do not protrude into the bore of the sleeve and that the centering strap/clips [1403/1473/1503/1573] are in place.

NOTE: *Silicone lubricant is packaged with the cartridge mechanical seal. If this lubricant is not compatible with your process, do not use. Select a more suitable lubricant.*

4. Apply a light coat of suitable lubricant to the agitator extension shaft [400] and slide the cartridge mechanical seal down the shaft to rest on the adapter plate or directly on the mounting flange if there is no adapter plate.



CAUTION! *Do not bolt the seal down tight at this stage. Do not secure it to the shaft.*

5. **If this is the first time the gearbox is being installed**
 - a. Follow the instructions in Section J, page 29 in order to install the gearbox and taper bore coupling.

If the gearbox was swiveled 90° to service the seal:

- a. Install the taper bore coupling half [351]. Refer to steps 1 to 3 in Section J, page 29.

NOTE: *Do not apply lubricant or anti-seize compound to coupling taper. Shaft and coupling tapers must be clean and dry.*

- b. Remove bolt and nut [1102, 1104]. Rotate the gear drive 90° clockwise until the gearbox contacts the stop pin [1128]. For size 23 only, lower the gearbox down until the gearbox fully contacts the pedestal. Install four bolts [1102], lockwashers and nuts [1103, 1104]. Torque the bolts to the values shown in APPENDIX, page 105.
 - c. Install two bolts and lockwashers [359, 360] at 180° into the flange of the taper bore coupling half [351]. Engage the bolt threads into gear drive output shaft [244]. Tighten the bolts evenly to engage the tenon and pull the faces together. Install the remaining bolts and lockwashers [359, 360]. Torque the bolts to the values shown in the APPENDIX, Page 105.
6. Follow instructions in Section K, page 32 in order to check for shaft runout before continuing to install the seal.

7. **If an adapter plate is present**, slide the mechanical seal cartridge up the extension shaft. Center the seal adapter plate [1261] on the extension shaft. Slowly and evenly tighten the bolts [1266] in a star pattern to the value shown in the APPENDIX, Page 105. This must be done very carefully to ensure that the adapter does not bend, and that it is seated completely flat on the flange. Slide the mechanical seal cartridge down the shaft.

If no adapter plate is present, ignore step 7 and continue.

8. Orient the barrier fluid ports as shown in Figure 6, page 24, with the ‘Quench’ and ‘Drain’ ports in line with the openings in the pedestal handhole covers.
9. Install flatwashers [1265/1480/1580], lockwashers [1264/1479/1579], and nuts/bolts [1263/1478/1578]. Taking care not to push the shaft sideways, progressively tighten the seal retention bolts/nuts [1263/1478/1578] in a diametrically opposing pattern. Ensure that the seal gland is down square to the flange or adapter. Torque the fasteners to the value shown in the APPENDIX, Page 105.
10. Evenly tighten all collar setscrews [1402/1472/1502/1572, 1420/1521]. Finger tighten all the screws, and then progressively tighten in stages. Torque to the values shown in the APPENDIX, Page 105.
11. **For Seals with Centering Clips:** Remove centering clip socket head cap screws [1477/1507/1577] and centering clips [1473/1503/1573]. Retain the clips and manufacturer's installation instructions for later use.

For Seals with a Centering Strap: Remove centering strap [1403]. Retain the strap and the manufacturer's installation instructions for later use.

12. It is important to make sure that the mechanical seal is centered on the shaft. The installation procedure described ensures that the seal is centered on the shaft. If there is any doubt, or if the gearbox has been moved in any way, follow the instructions below to center the mechanical seal cartridge on the shaft:

Seals with Centering Clips: Replace the centering clips finger tight, loosen nuts [1263] or bolts [1478/1578], tighten centering clip socket head cap screws [1507], re-tighten nuts/bolts [1263/1478/1578] and then remove the centering clips.

Seals with a Centering Strap: Start the centering strap through the slot in the hub gland, loosen nuts [1263], push the strap in until it completely surrounds the seal sleeve, install centering strap [1403], retighten nuts [1263] and then remove the centering strap.

13. Install handhole covers.

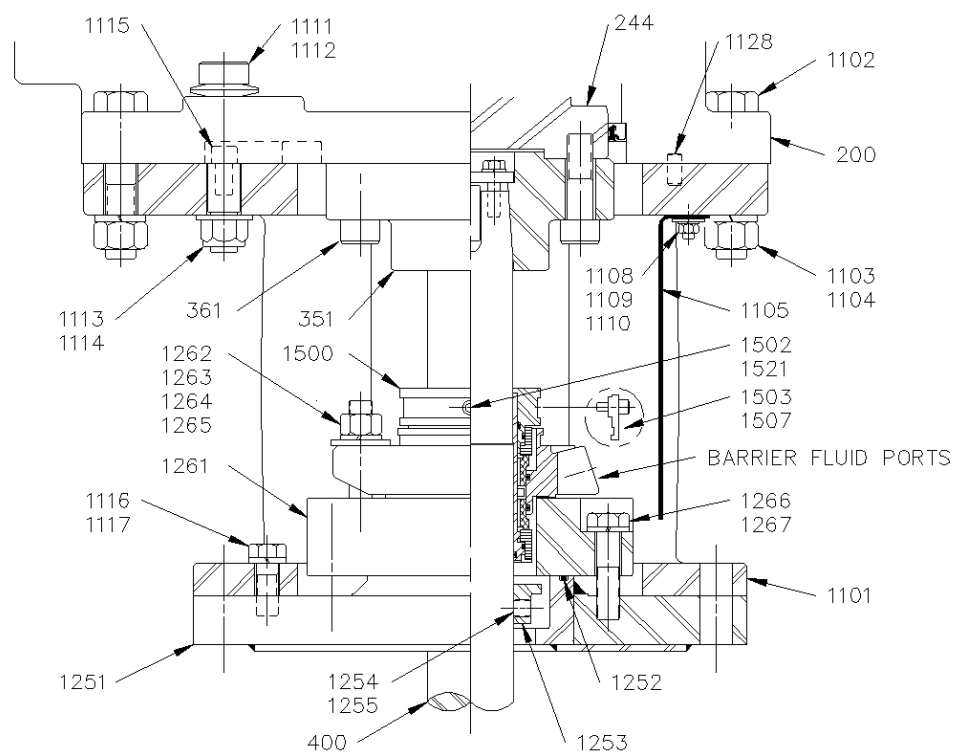


Figure 6. N Style – Double Mechanical Seal with Adapter Plate

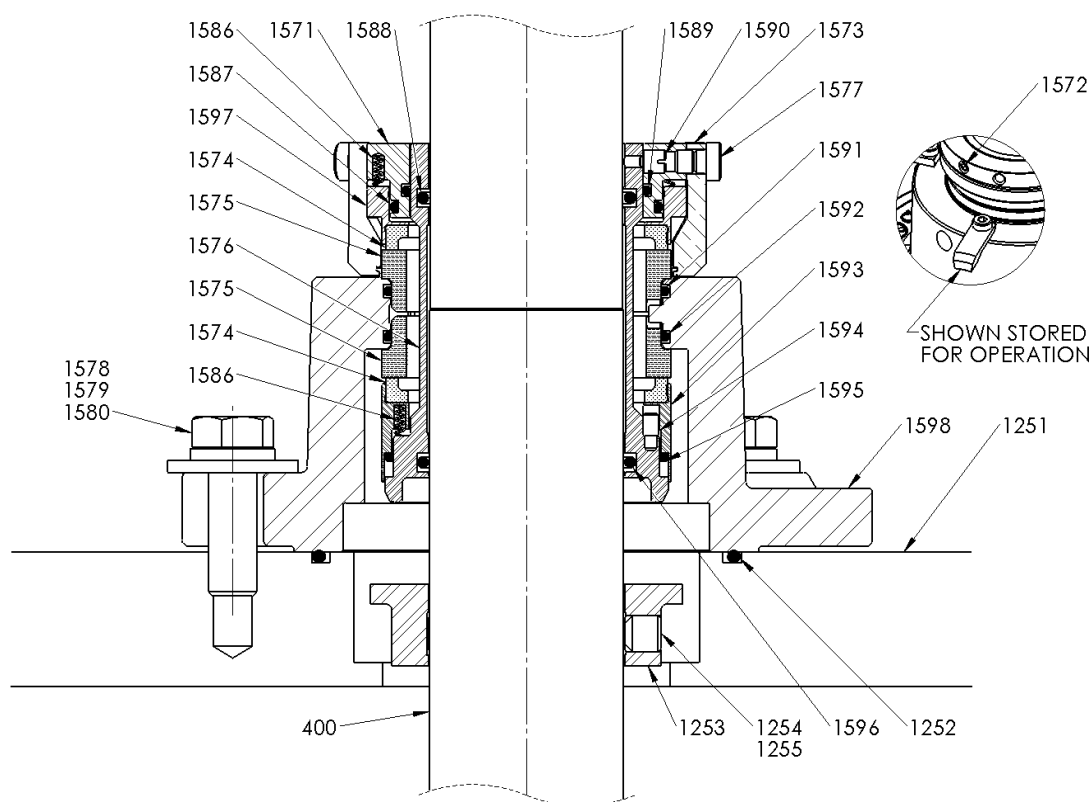


Figure 7. N Style – Double Mechanical Seal without Adapter Plate

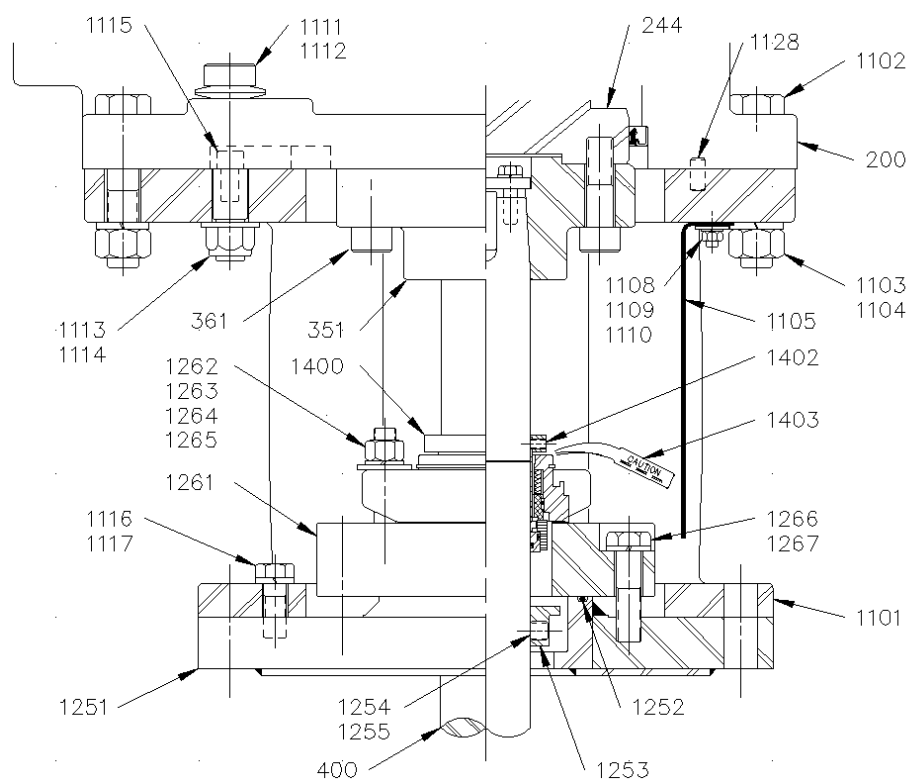


Figure 8. NC Style – Single Mechanical Seal with Adapter Plate

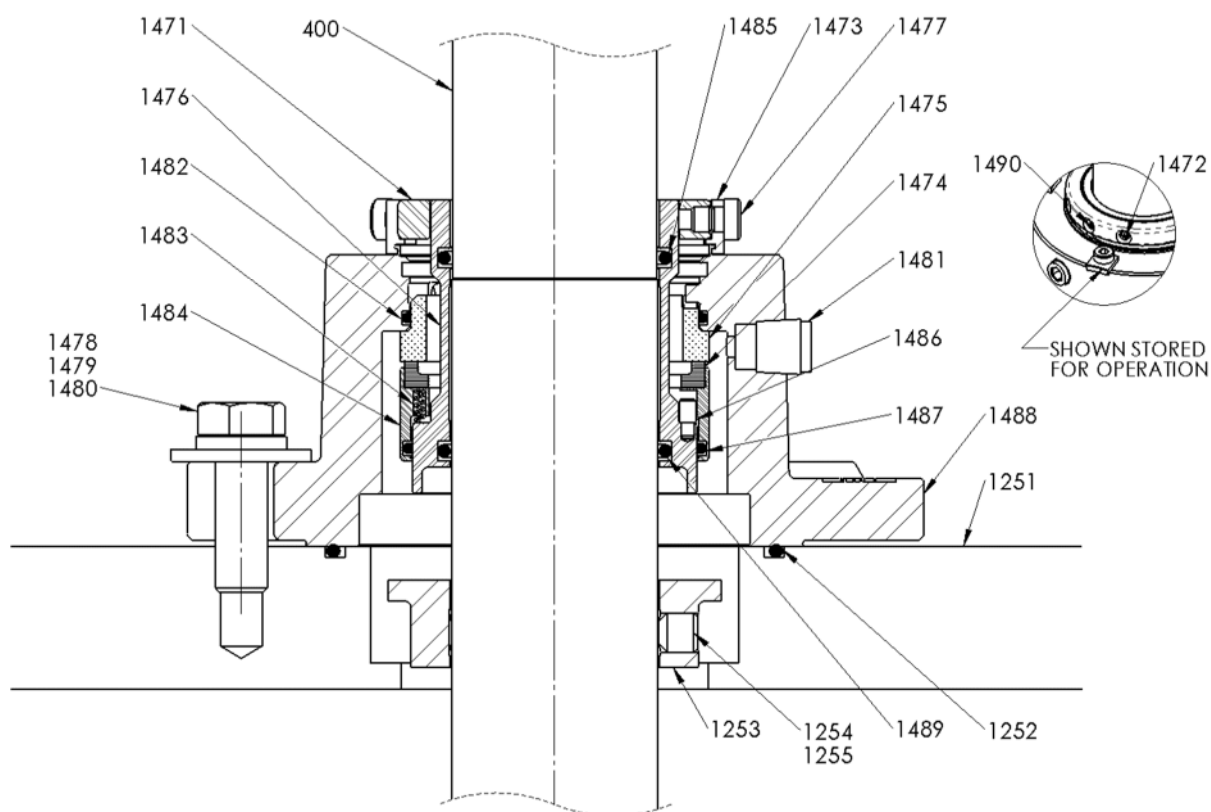


Figure 9. NC Style – Single Mechanical Seal without Adapter Plate

14. The **GTN/HTN** seal may be equipped with a pumping device to circulate the barrier fluid (refer Figure 10). Whenever such a pumping device (usually a pumping ring) is present:
- For clockwise shaft rotation, the barrier fluid supply enters through the left port. The barrier fluid return exits through the right port.
 - For counter-clockwise shaft rotation (as viewed from above), the barrier fluid supply enters through the right port. The barrier fluid return exits through the left port.

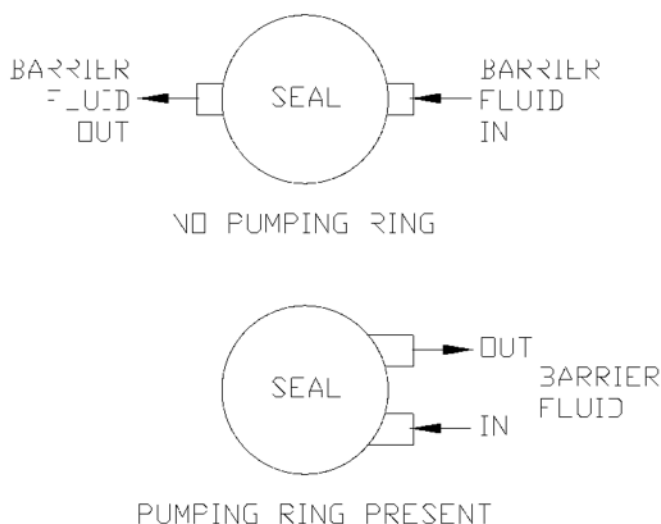


Figure 10. Identifying presence of pumping ring for barrier fluid

NOTE: The barrier fluid port connections are dependant upon the agitator extension shaft rotation.

- Connect the barrier fluid lines. Charge the system with barrier fluid and pressure test.
- If your agitator drive is furnished with an optional mechanical seal lubricator, see Section P.2, **MECHANICAL SEAL LUBRICATOR** for installation instructions.

I. SEAL INSTALLATION - SINGLE MECHANICAL SEAL

Applicable to: Model 20 GTNS, and Model 20 HTNS

1. Place o-ring [1252] into the groove in the mounting flange [1251].
2. If not already installed, press anti-rotation pin [1451] (refer Figure 42, page 91 for seal assembly details) into the mechanical seal gland plate [1272].
3. Install the mechanical seal gland plate [1272]. Do not install bolts [1266] at this time.
4. Install stationary seal insert and o-ring [1458, 1457] into the mechanical seal gland plate [1272].
5. Remove o-ring [1452] from rotary seal ring [1453]. Slide rotary seal ring down the shaft to rest on the stationary seal insert.
6. Lubricate o-ring [1452]. Install the o-ring into the rotary seal ring.



CAUTION! Do not get lubricant on the sealing faces.

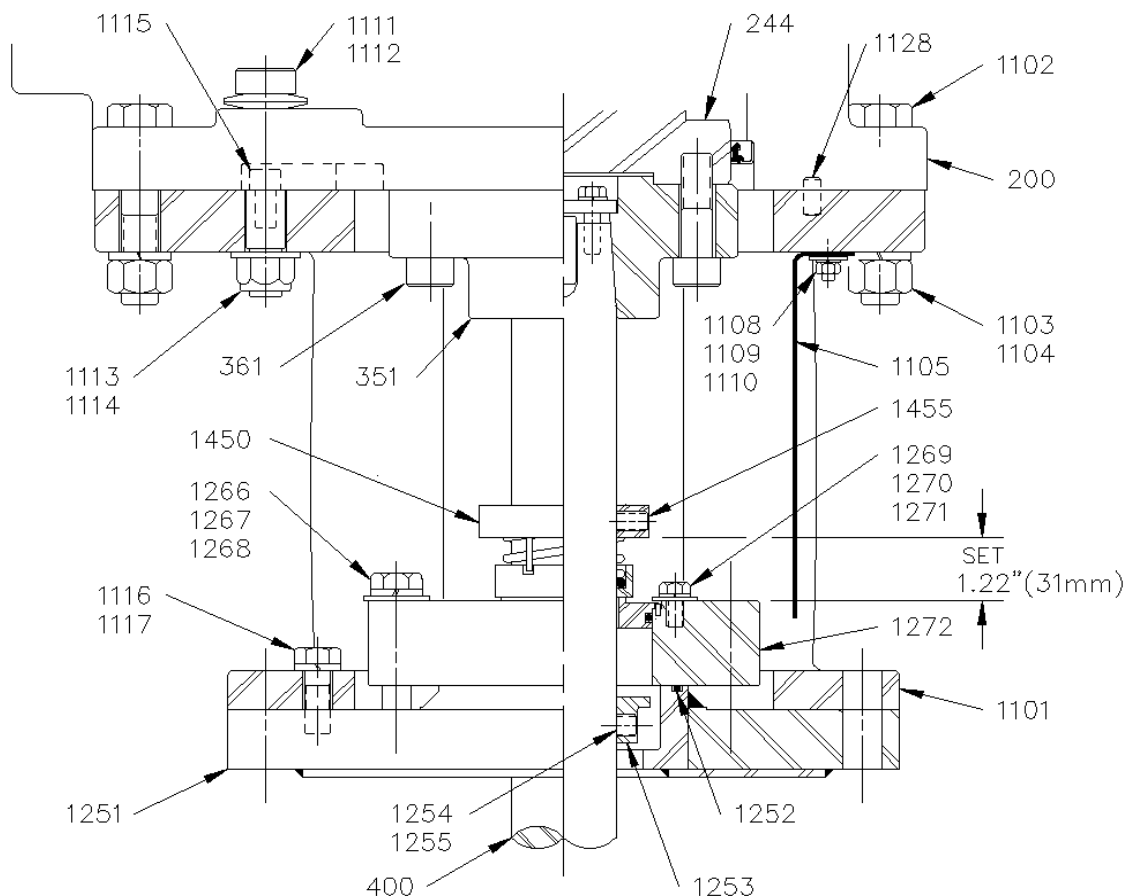


Figure 11. NS Style – Mechanical Seal

7. Install spring [1454] and collar [1456] with setscrews [1455].
8. **If this is the first time the gearbox is being installed**
 - a. Follow the instructions in Section J, page 29 in order to install the gearbox and taper bore coupling.

If the gearbox was swiveled 90° to service the seal:

- a. Install the taper bore coupling half [351]. Refer to steps 1 to 3 in Section J, page 29.

NOTE: Do not apply lubricant or anti-seize compound to coupling taper. Shaft and coupling tapers must be clean and dry.

- b. Remove bolt and nut [1102, 1104]. Rotate the gear drive 90° clockwise until the gearbox contacts the stop pin [1128]. For size 23 only, lower the gearbox down until the gearbox fully contacts the pedestal. Install four bolts [1102], lockwashers and nuts [1103, 1104]. Torque the bolts to the values shown in the APPENDIX, page 105.
 - c. Install two bolts and lockwashers [359, 360] at 180° into the flange of the taper bore coupling half [351]. Engage the bolt threads into gear drive output shaft [244]. Tighten the bolts evenly to engage the tenon and pull the faces together. Install the remaining bolts and lockwashers [359, 360]. Torque the bolts to the values shown in the APPENDIX, Page 105.
9. Follow instructions in Section K, page 32 in order to check for shaft runout before continuing to install the seal.
10. Slide the rotary seal ring up the extension shaft. Center mechanical seal gland plate/stationary seal insert [1272/1458] on the extension shaft. Install bolts, lockwashers and flatwashers [1266, 1267, 1268]. Torque the bolts to the value shown in the APPENDIX, Page 105.
11. Install bolts, lockwashers, and flatwashers [1269, 1270, 1271]. Torque to the value shown in the APPENDIX, Page 105
12. Set collar [1456] at 1.22" (31 mm). Evenly tighten all cup point setscrews [1455]. Torque the setscrews to the value shown in the APPENDIX, Page 105.
13. Install the handhole covers.

J. TAPER BORE COUPLING AND GEAR DRIVE INSTALLATION

1. Clean the extension shaft [400] and coupling half [351] bore and make sure that both surfaces are free from burrs or nicks. Place key [352] in the coupling keyway to make sure it slides freely. Install the key in the shaft keyway making sure it is properly oriented and fully bottomed in the keyway.

NOTE: Do not apply lubricant or anti-seize compound to coupling taper. Shaft and coupling tapers must be clean, dry and free of nicks.

2. Slide the coupling half onto 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: Avoid surface damage and bending of the shaft. Protect the tenon and the face of the coupling. These surfaces must be perfectly clean and free of nicks.

3. Install shaft bolts:

2 Bolt Design: Install coupling washer [354]. Install bolts [357] and lockwashers [358]. Torque bolts to the value shown in the APPENDIX, Page 105.

1 Bolt Design: Install coupling washer [353]. Install bolt [355] and lockwasher [356]. Torque bolts to the value shown in the APPENDIX, Page 105.

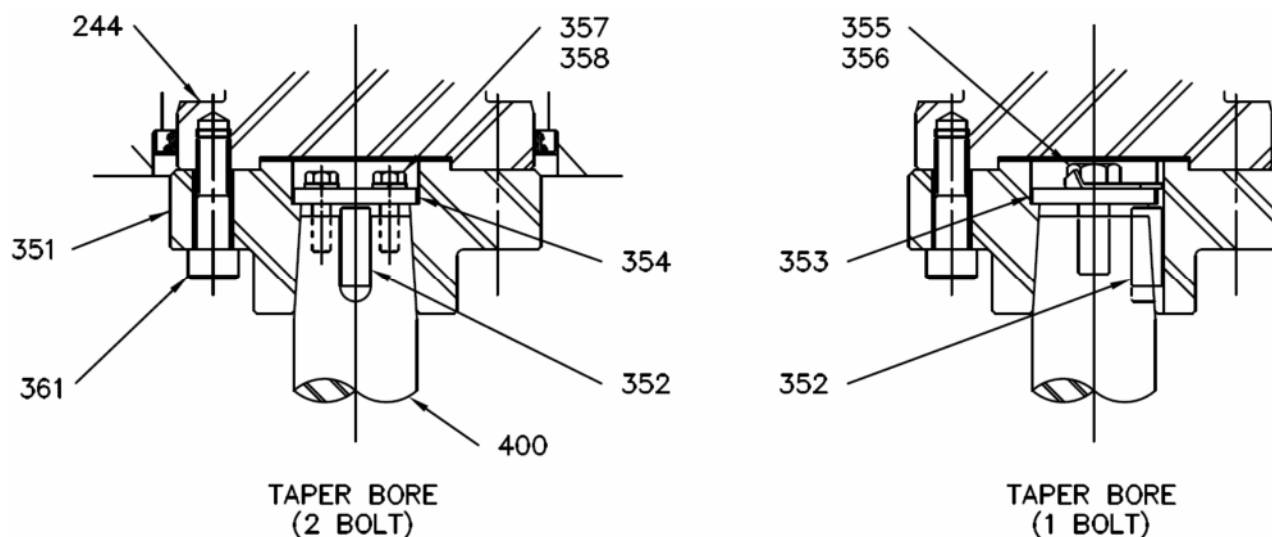


Figure 12. Shaft Coupling Installation

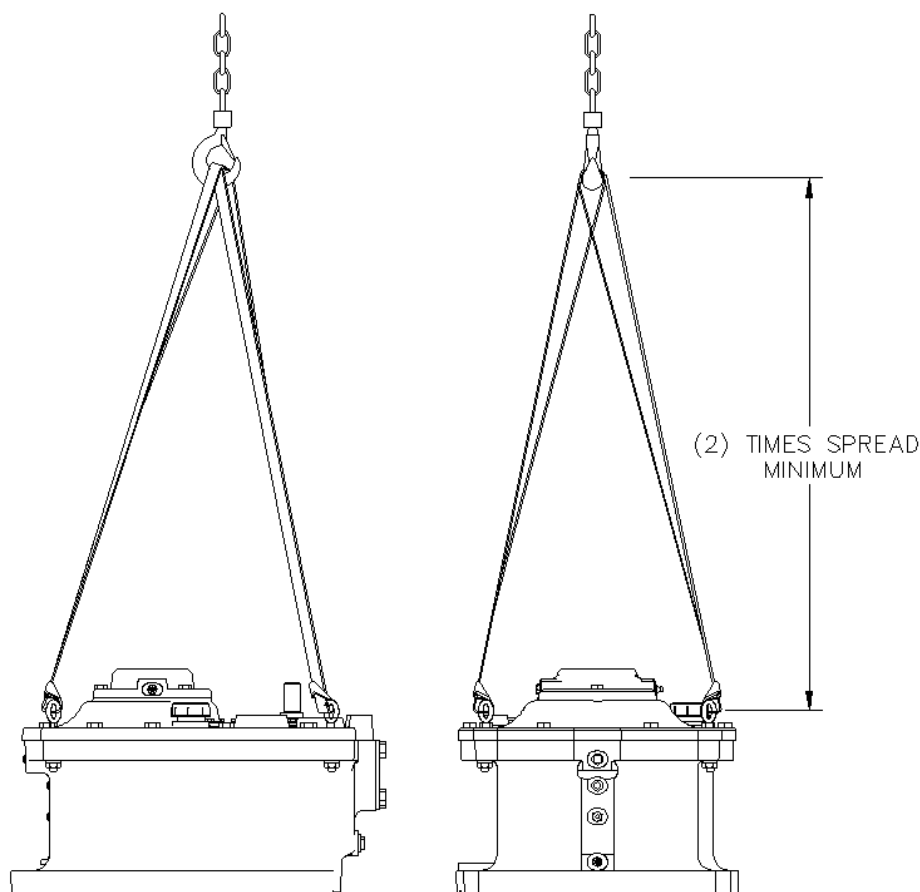


Figure 13. Agitator Lifting System

4. **For case size 21 and 22 (Figure 35, page 83):**
 - A. Install the handhole cover bolts and lockwashers [1106, 1107] into the pedestal [1101]. Insert socket bolt [1115] and dowel pin [1128].
 - B. Lift the agitator drive assembly using a four-point nylon sling anchored using four eyebolts on four corners of the gear drive, and lower it onto the pedestal [1101].
 - C. Install pivot shoulder bolt [1111] with Belleville washers [1112] into the gear drive housing. Install flatwasher [1113] and locknut [1114]. Tighten the locknut until the Belleville washers are compressed 1/16" (1.5 mm).
5. **For case size 23 (Figure 37, page 85):**
 - A. Install the lower swivel bracket [1125] using bolts [1126].
 - B. Insert the swivel rod [1127] into the bracket, along with the bearing ball [1122]. The bearing ball should snap in the hole provided on the top of the swivel rod. If it does not snap in easily, use a mallet and tap it in.
 - C. Install the upper swivel bracket [1123] on to the gearbox using bolts [1124].

- D. Install the handhole cover bolts and lockwashers **[1136, 1137]** into the pedestal **[1101]**. Insert dowel pin **[1128]**.
 - E. Lift the agitator drive assembly using a four-point nylon sling anchored using four eyebolts on four corners of the gear drive, and lower it onto the pedestal **[1101]** so the upper swivel bracket fits on to the swivel rod.
 - F. Install the swivel bolt **[1121]**.
- 6. Install bolts, lockwashers and nuts **[1102, 1103, 1104]**. Torque bolts to the value shown in the APPENDIX, page 105.
 - 7. Install two bolts **[359]** at 180° into the flange of the taper bore coupling half **[351]**. Engage the bolt threads into the gear drive output shaft **[244]**. Tighten the bolts evenly to engage the tenon and pull the faces together.

Install the remaining bolts **[359]**. Torque the bolts to the value shown in the APPENDIX

- 8. APPENDIX, Page 105.

K. 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 180° 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 500°F [260°C]), 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.

L. HANDHOLE COVER INSTALLATION

For case sizes 21 and 22: Install handhole covers [1105] onto pedestal. Attach flatwasher, lockwasher and nut [1108, 1109, 1110] to previously installed bolt and lockwasher [1106, 1107] and tighten.

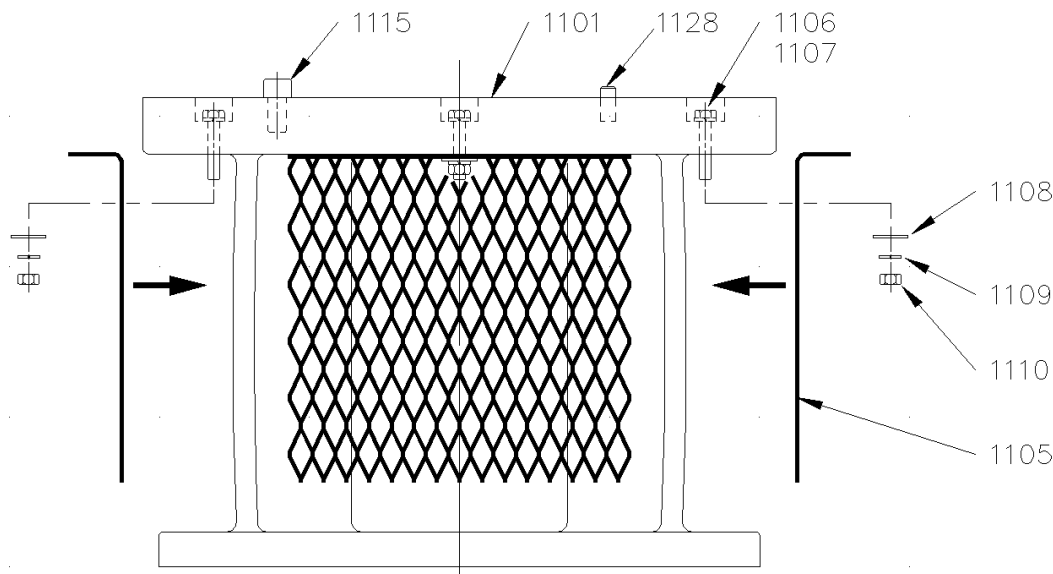


Figure 14. Handhole Cover Installation (case sizes 21 and 22)

For case sizes 23: Install three of the four handhole covers [1135] using flatwasher, lockwasher and nut [1138, 1139, 1130] to previously installed bolt and lockwasher [1136, 1137] and tighten. Install the fourth cover using bolt [1141], lockwasher [1142] and flatwasher [1143].

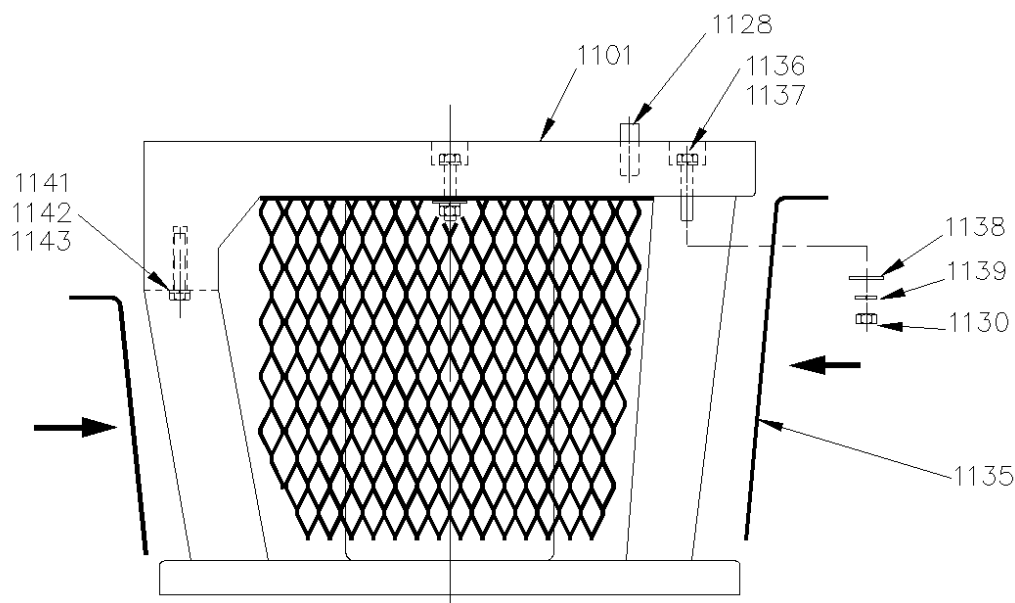


Figure 15. Handhole Cover Installation (case size 23)

M. 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 105.
2. The default flexible motor coupling [110] used on all Chemineer Model 20 agitators is the “Sure-Flex” coupling or equivalent. Refer to coupling vendor’s instructions supplied with coupling for exact installation instructions.
3. 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 16). Tighten the hub setscrews to the torque value shown in the APPENDIX, Page 105. 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)

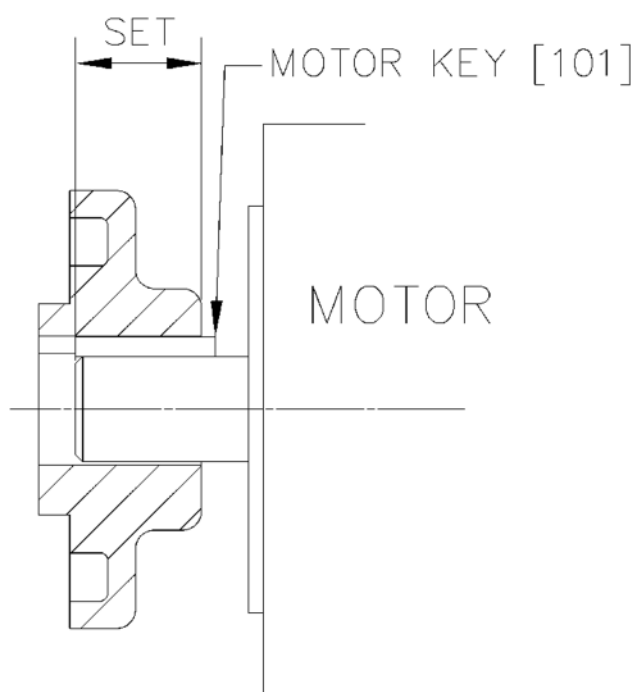
** Use this for 280 Frame, 30 Hp motor at 1755 rpm input

++ 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 16. Motor Coupling Setting**

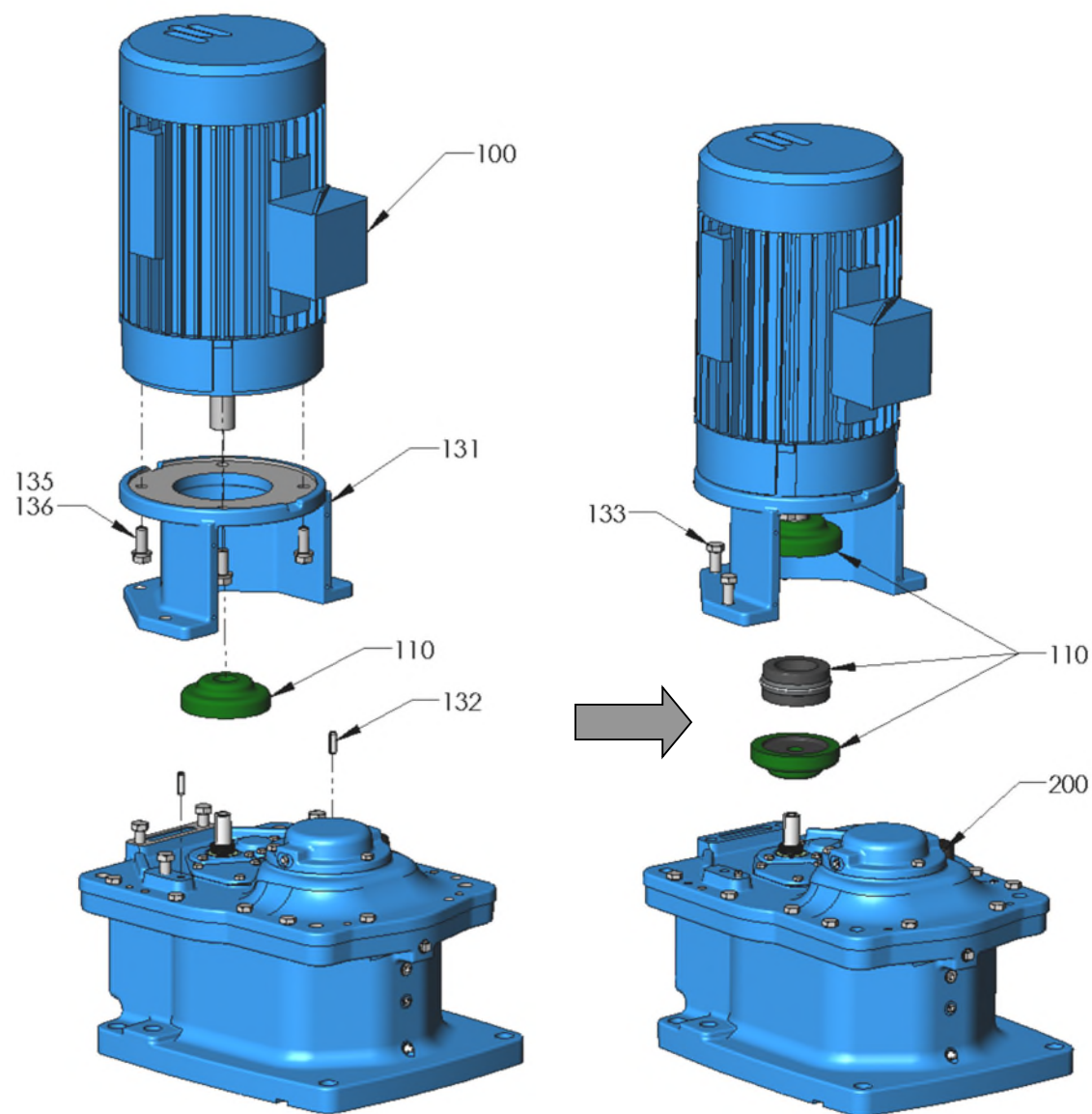


Figure 17. Model 20 GT – Motor Mounting

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

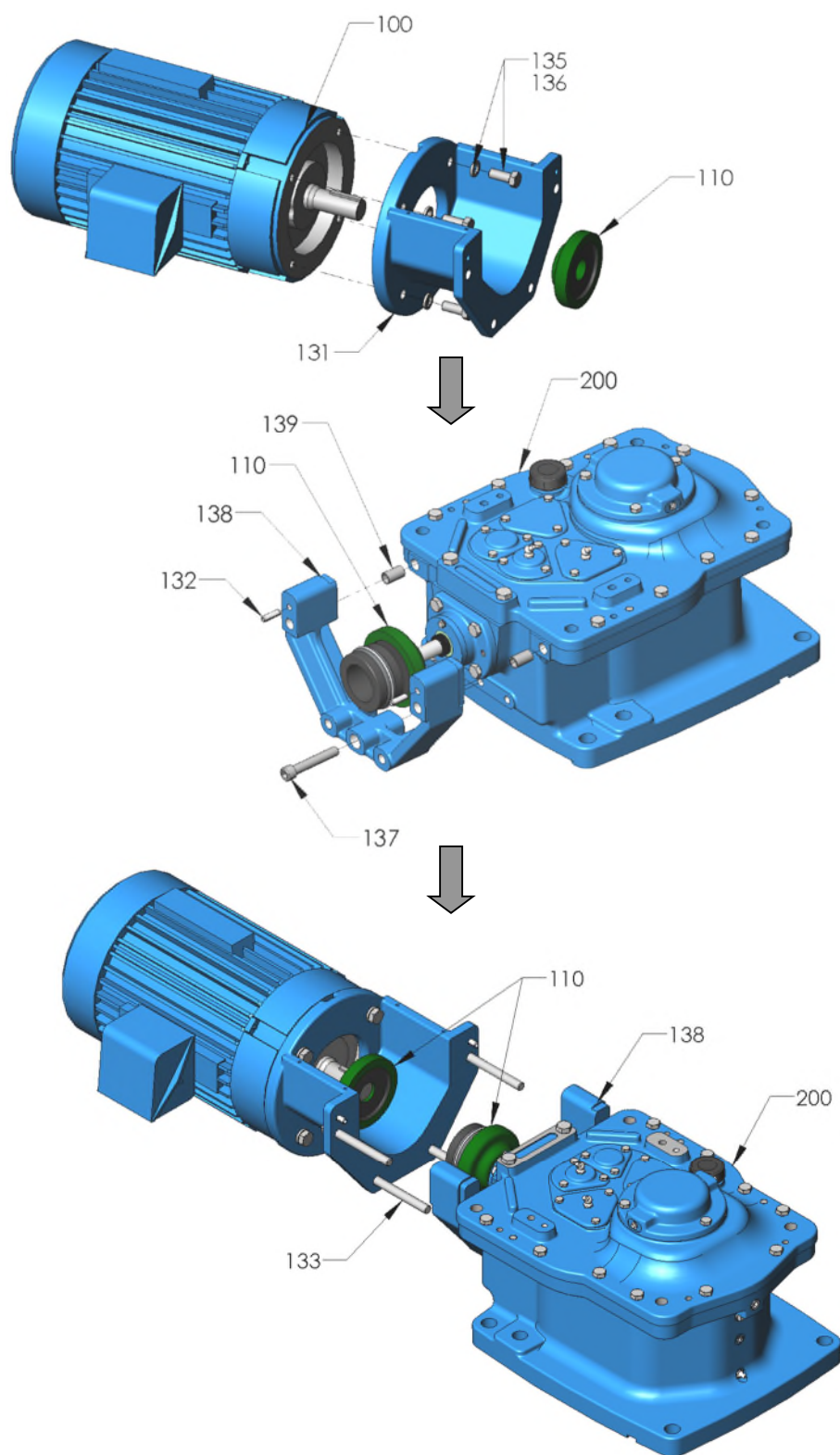


Figure 18. Model 20 HT – Motor Mounting

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 17, page 36: If not already installed by the factory, install alignment pins [132] onto the gearbox lid. Using a hoist system, lift motor/adaptor assembly above gear drive and lower onto the alignment pins. Install bolts [133] to assemble the motor adaptor onto the gear drive.

For HT (Right Angle Drive) see Figure 18, page 37): 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 adaptor. Using a hoist system, lift motor/adaptor assembly in a horizontal position parallel to the gear drive. Install the motor/adaptor assembly on to the spacer using bolts [133].
6. Torque the bolts [133] to the value shown in the APPENDIX, Page 105.
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 105.
8. The flexible coupling will not require alignment maintenance after installation. Install motor adaptor cover plate, and bolts [121, 122].

N. 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.*

N.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 19, page 40. 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.

N.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.

N.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.

The upper impeller hub has stub blades marked 2-5, 2-6, 2-7, 2-8. The corresponding extension blades are marked 2-5, 2-6, 2-7, 2-8 with respect to the stub blades.

N.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 105. 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 20 to Figure 25, page 41 to 47. 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 105.

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.

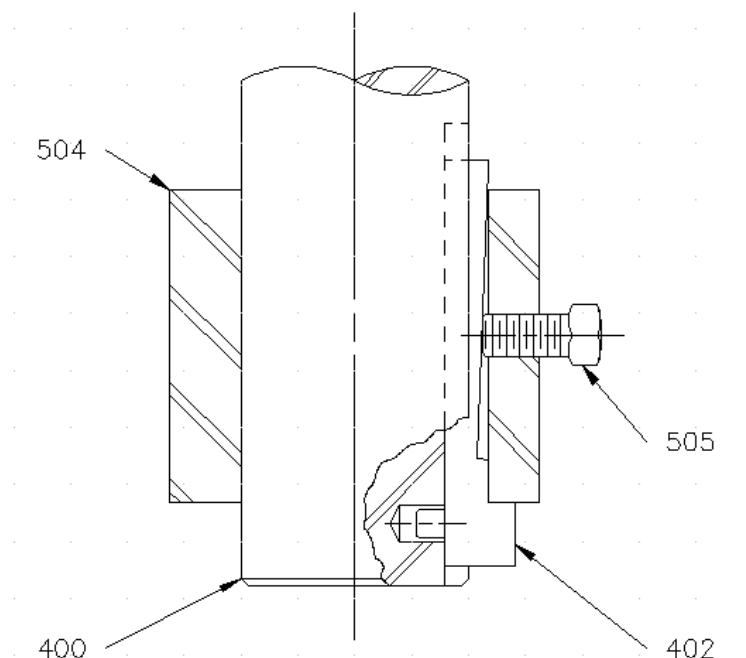


Figure 19. Hub and Pin Key Detail

N.3 IMPELLERS – STYLES

NOTE:
STABILIZER FINS FURNISHED
ONLY WHEN NECESSARY

NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

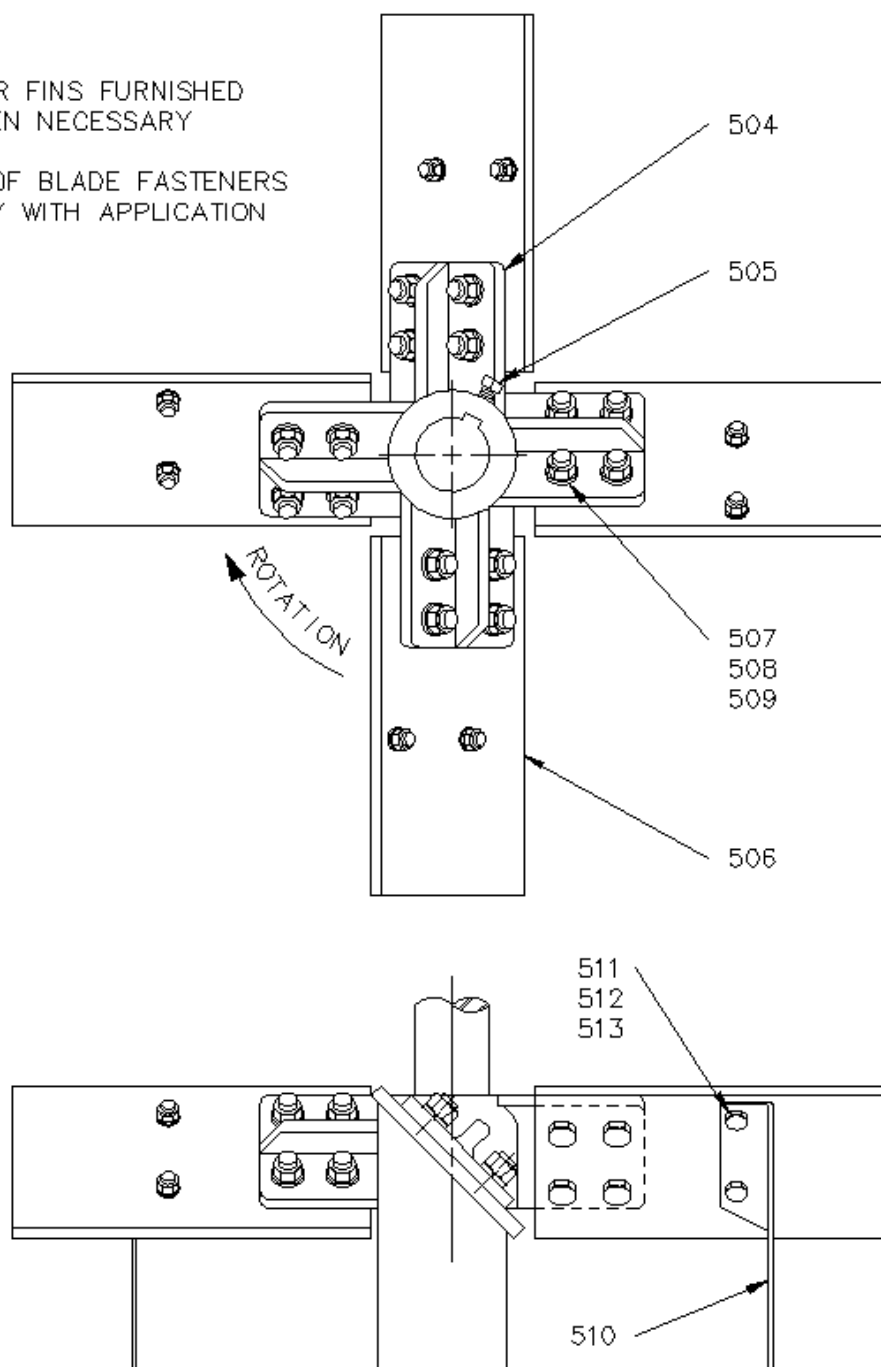
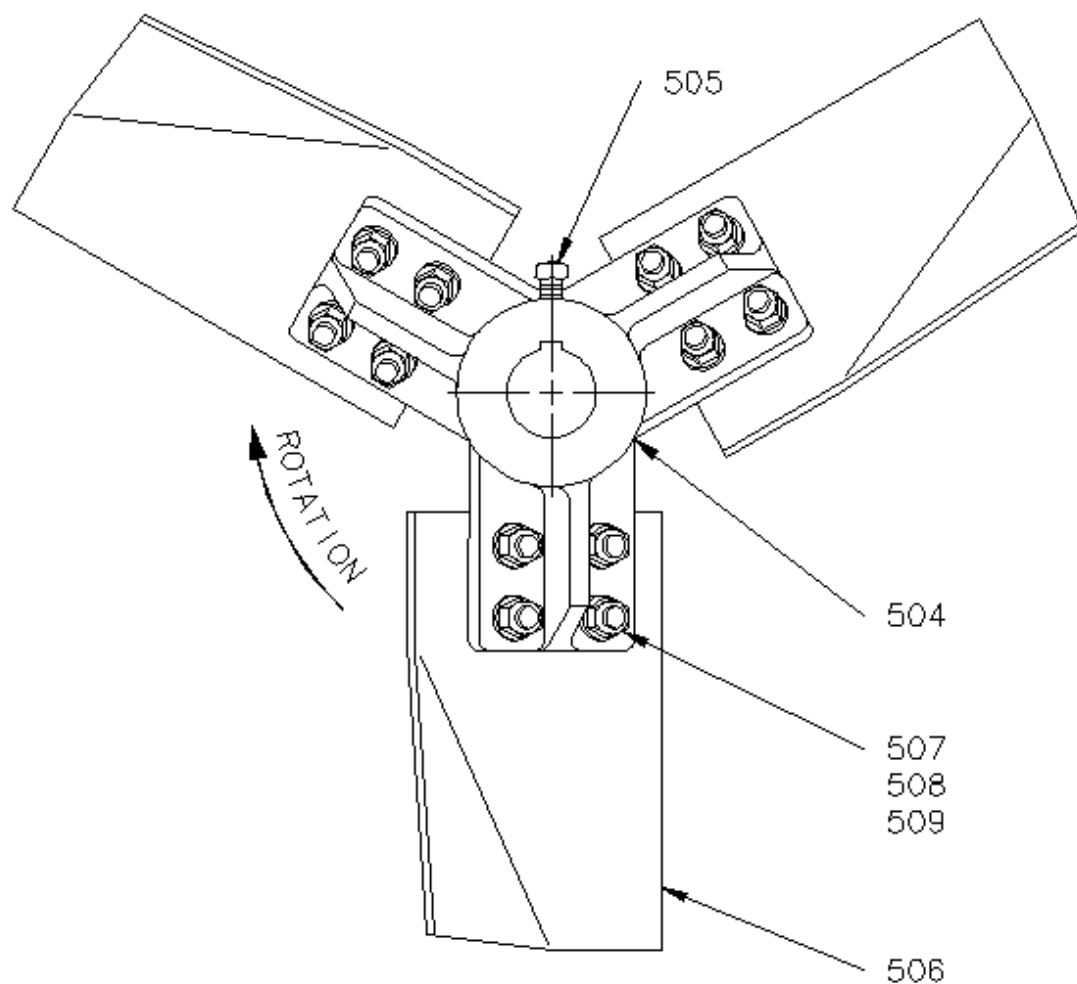


Figure 20. Style P-4 Impeller



NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

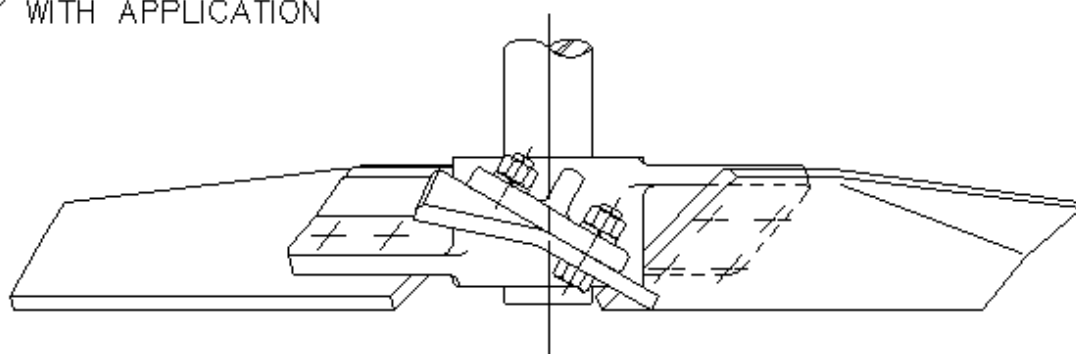
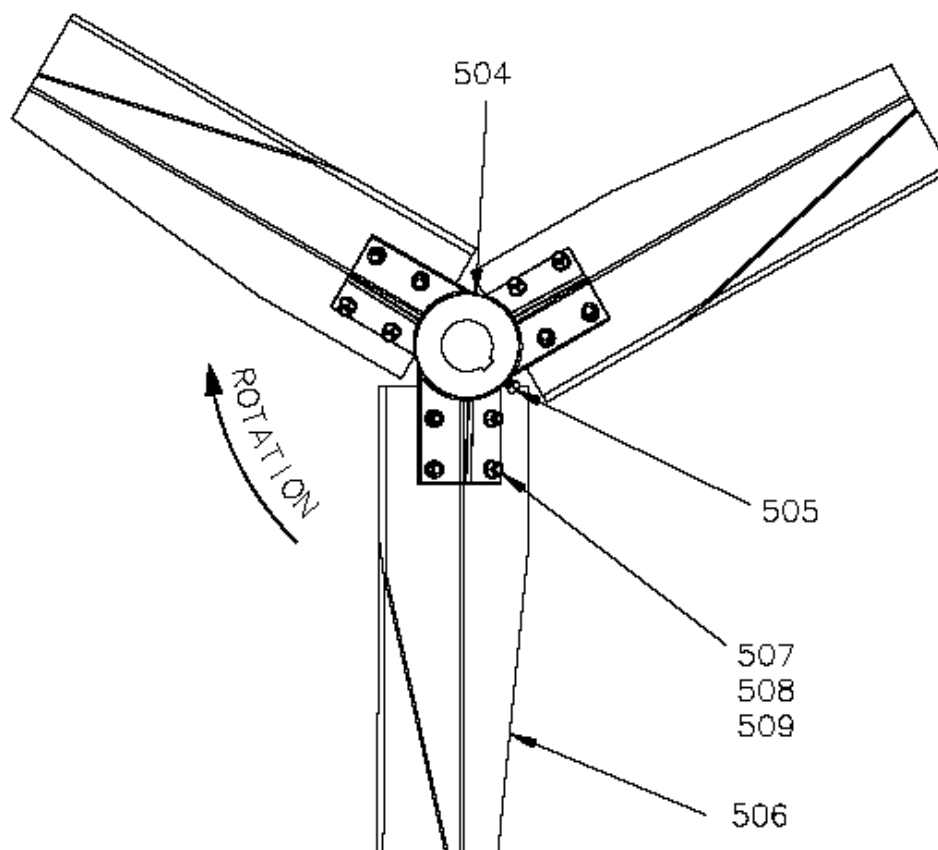


Figure 21. Style HE-3 Impeller



NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

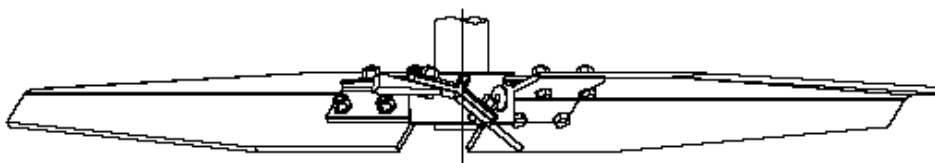


Figure 21A. Style XE-3 Impeller

NOTE:
STABILIZER FINS FURNISHED
ONLY WHEN NECESSARY

NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

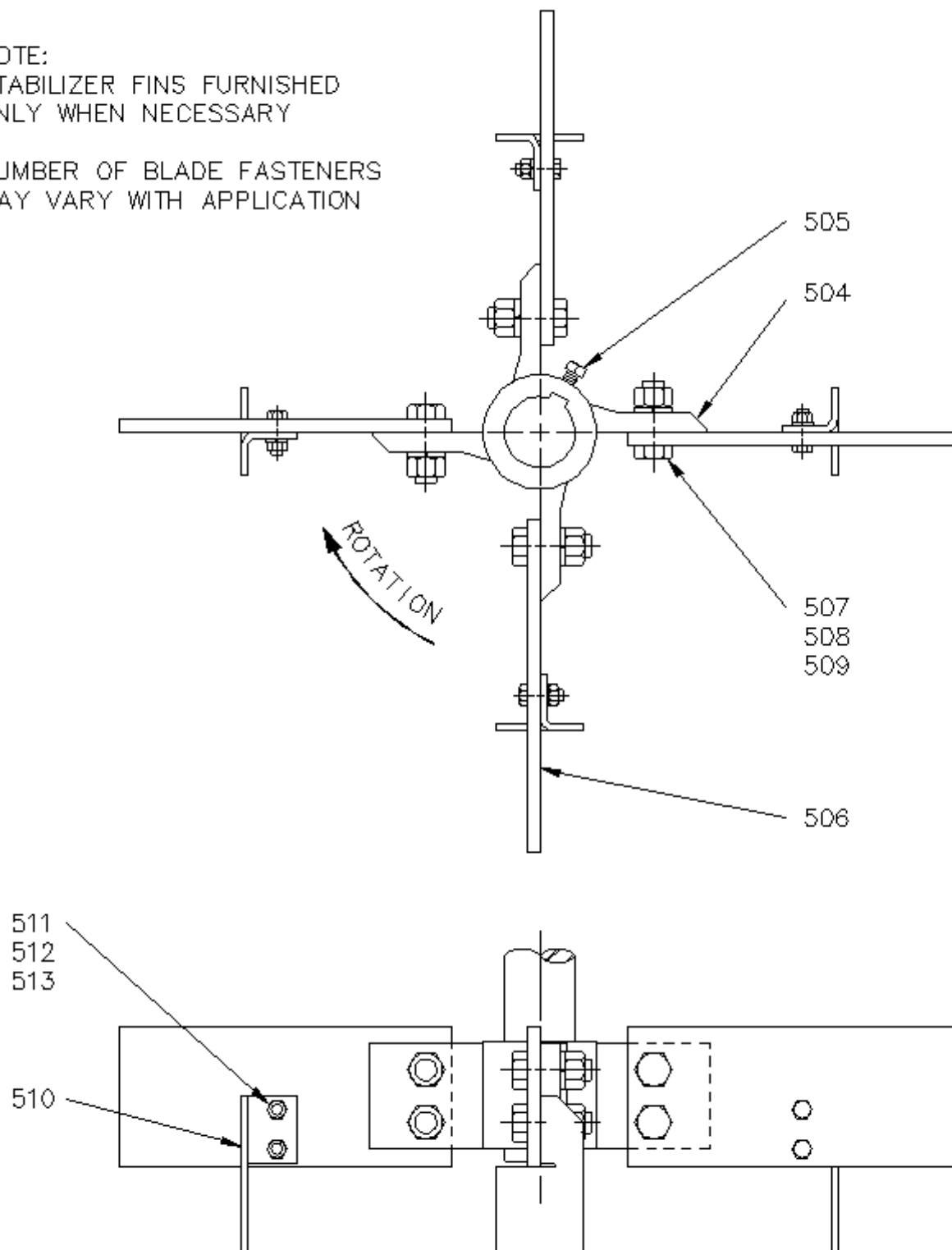


Figure 22. Style S-4 Impeller

NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

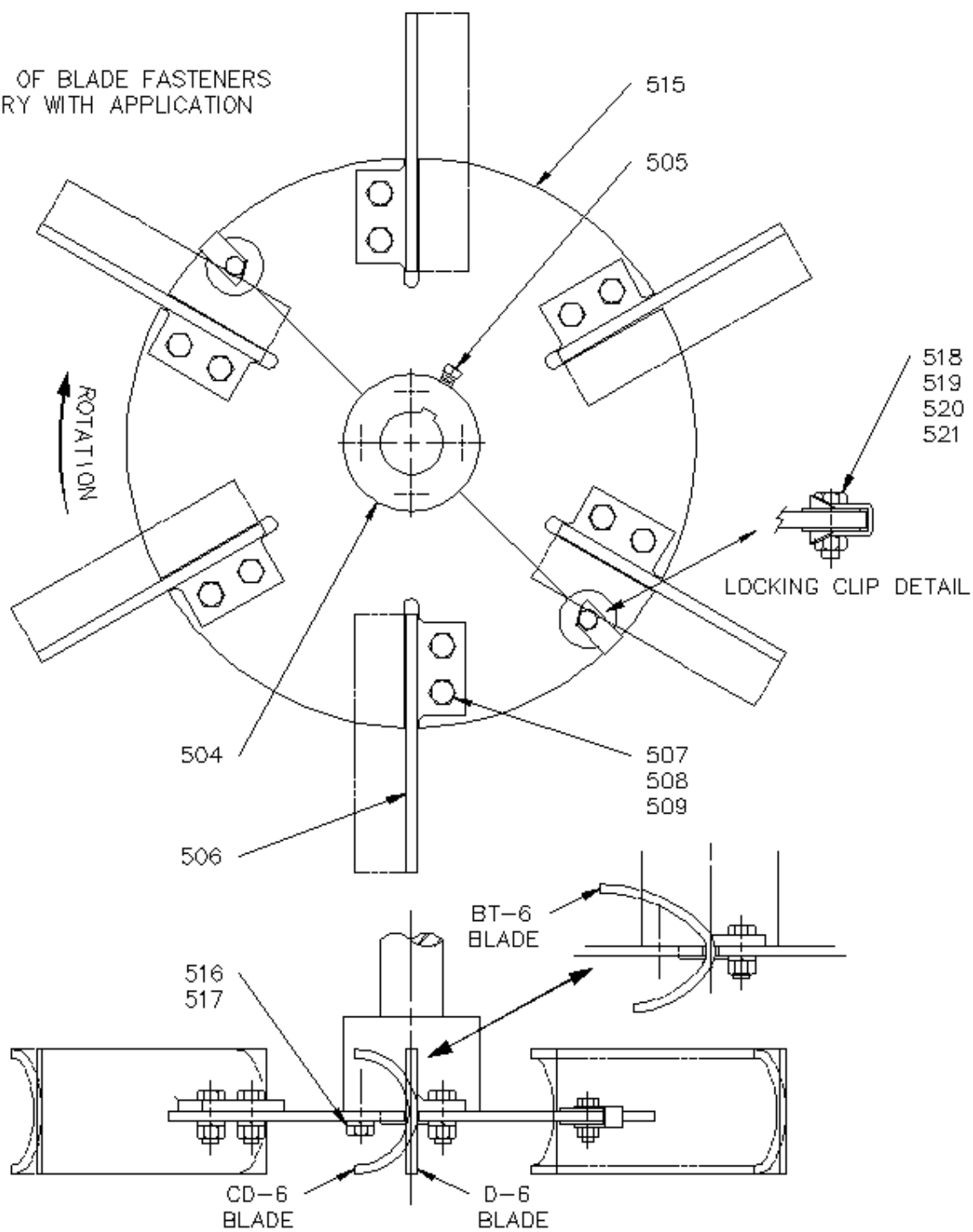
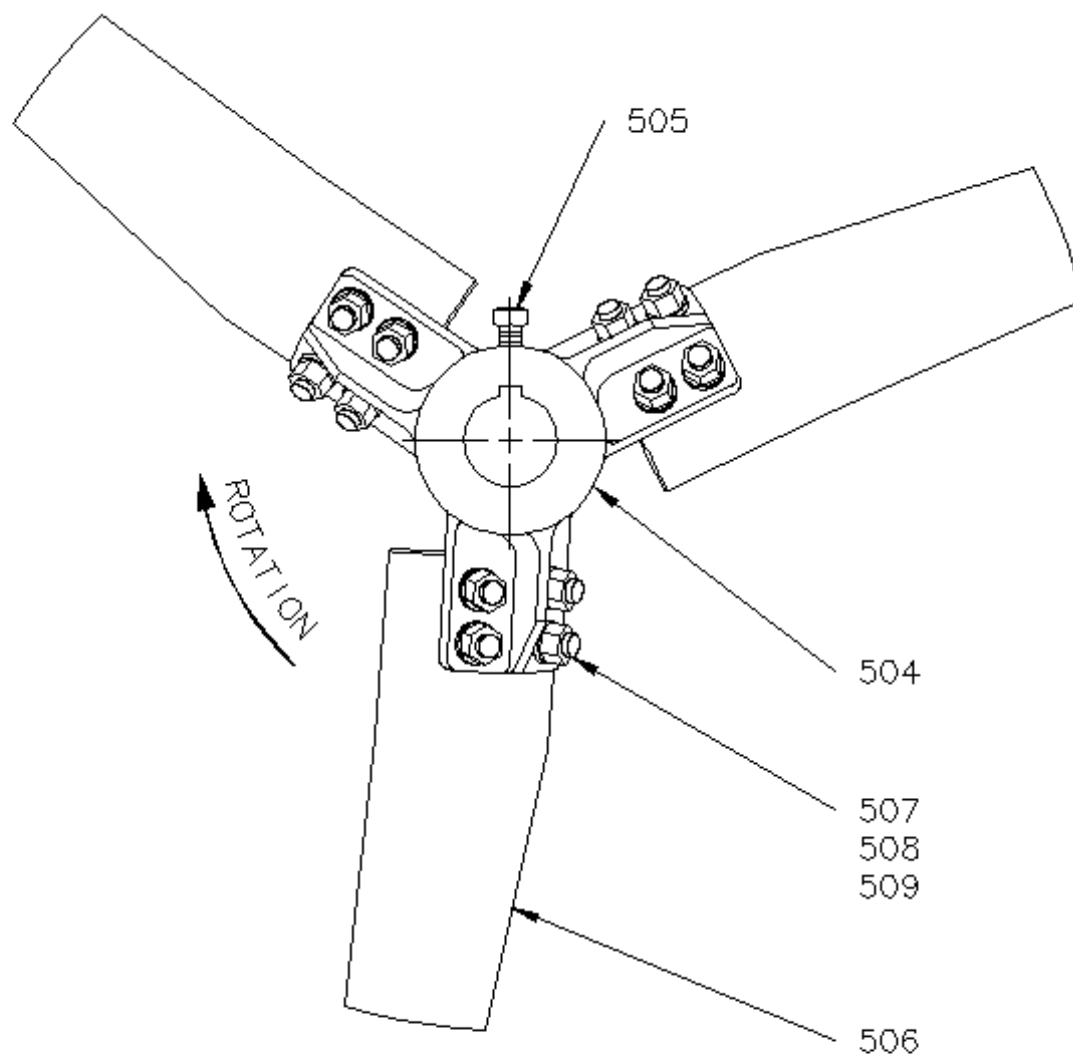


Figure 23. Style D-6, CD-6, BT-6 Impeller



NOTE:
NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

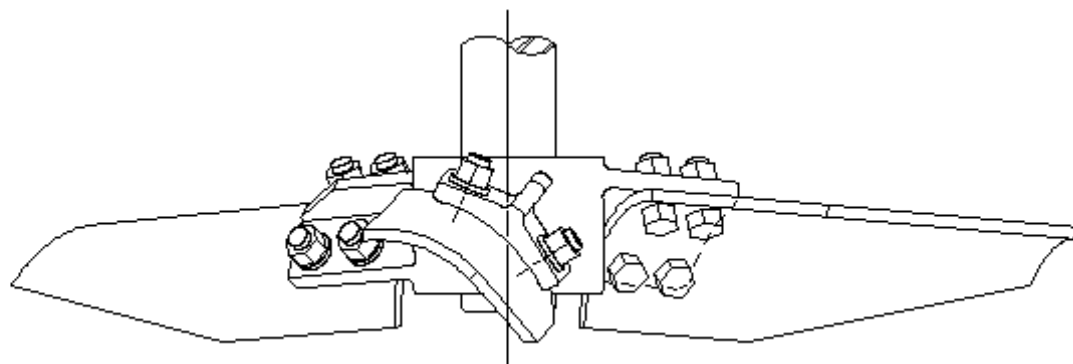


Figure 24. Style SC-3 Impeller

NOTE:

SPLIT BLADES FURNISHED
ONLY WHEN NECESSARY FOR
VESSEL INSERTION

NUMBER OF BLADE FASTENERS
MAY VARY WITH APPLICATION

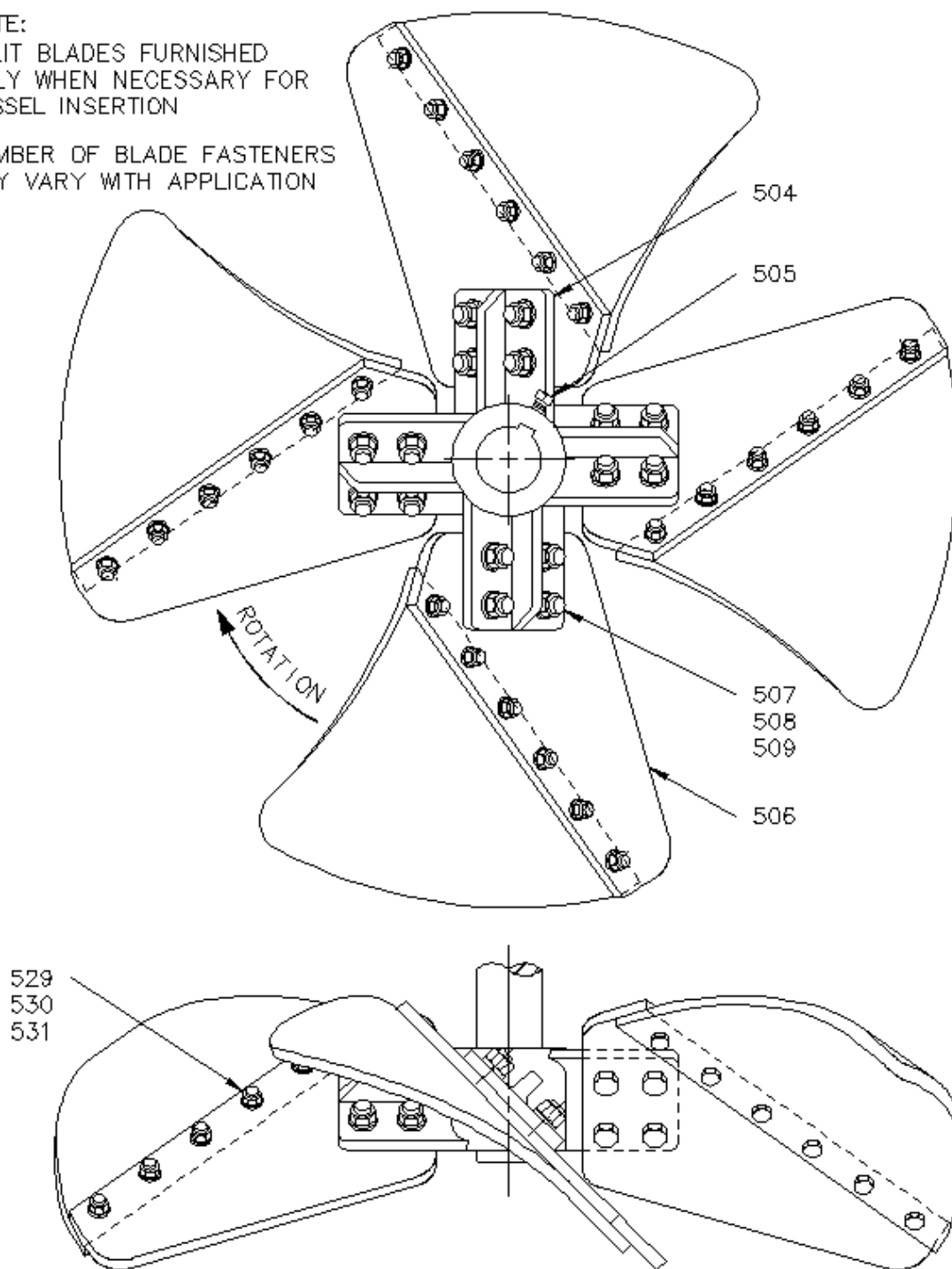


Figure 25. Style Maxflo W Impeller

N.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.

N.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.

N.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 26, page 49.

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 the APPENDIX, Page 105.
7. Remove the hoist from the impeller.

N.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.

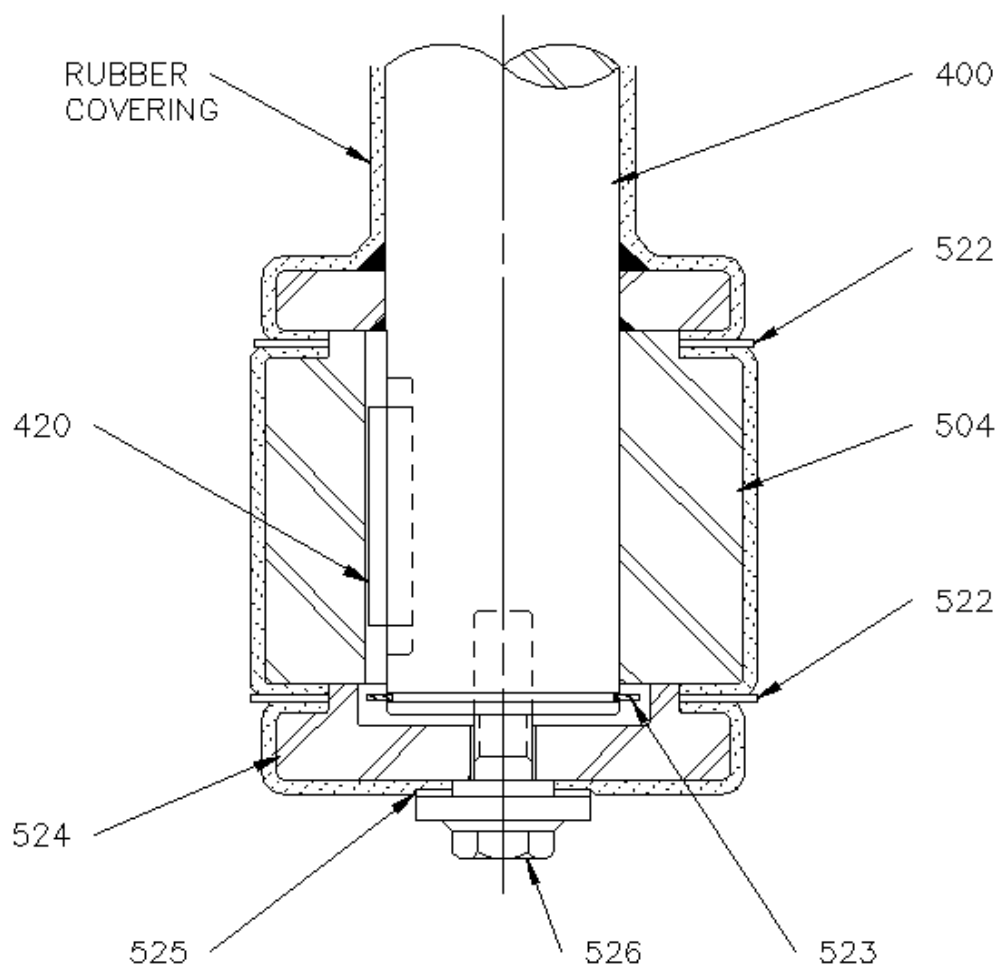


Figure 26. Thrust Bolt Impeller Attachment

O. OPTIONS

O.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 27 on page 51 or Figure 27A on page 52) for all references to the agitator extension shaft [400].*

O.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 105.

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 105. 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 105.
5. Ensure parts are fitted to the correct shaft.

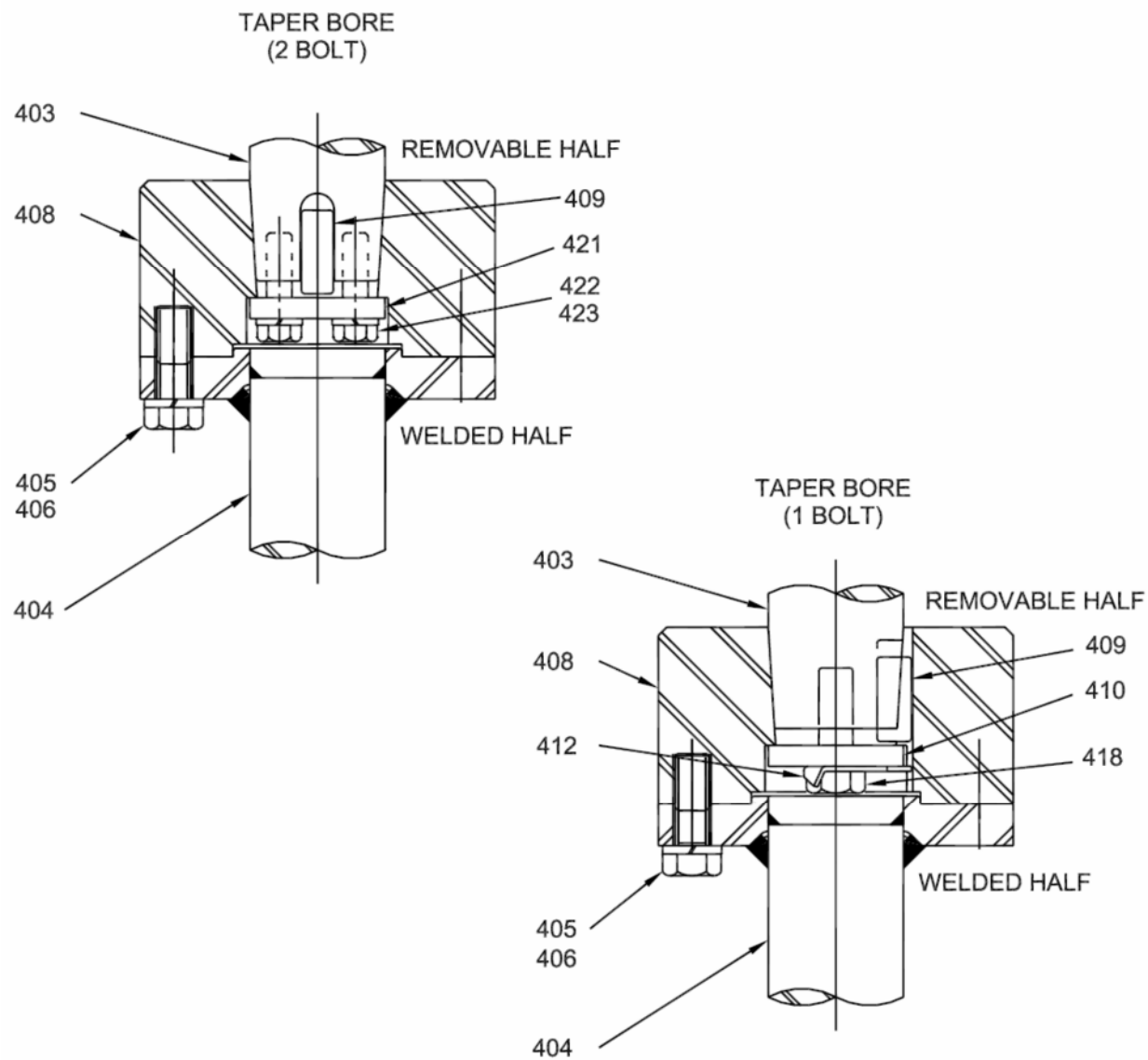


Figure 27. In-Tank Couplings

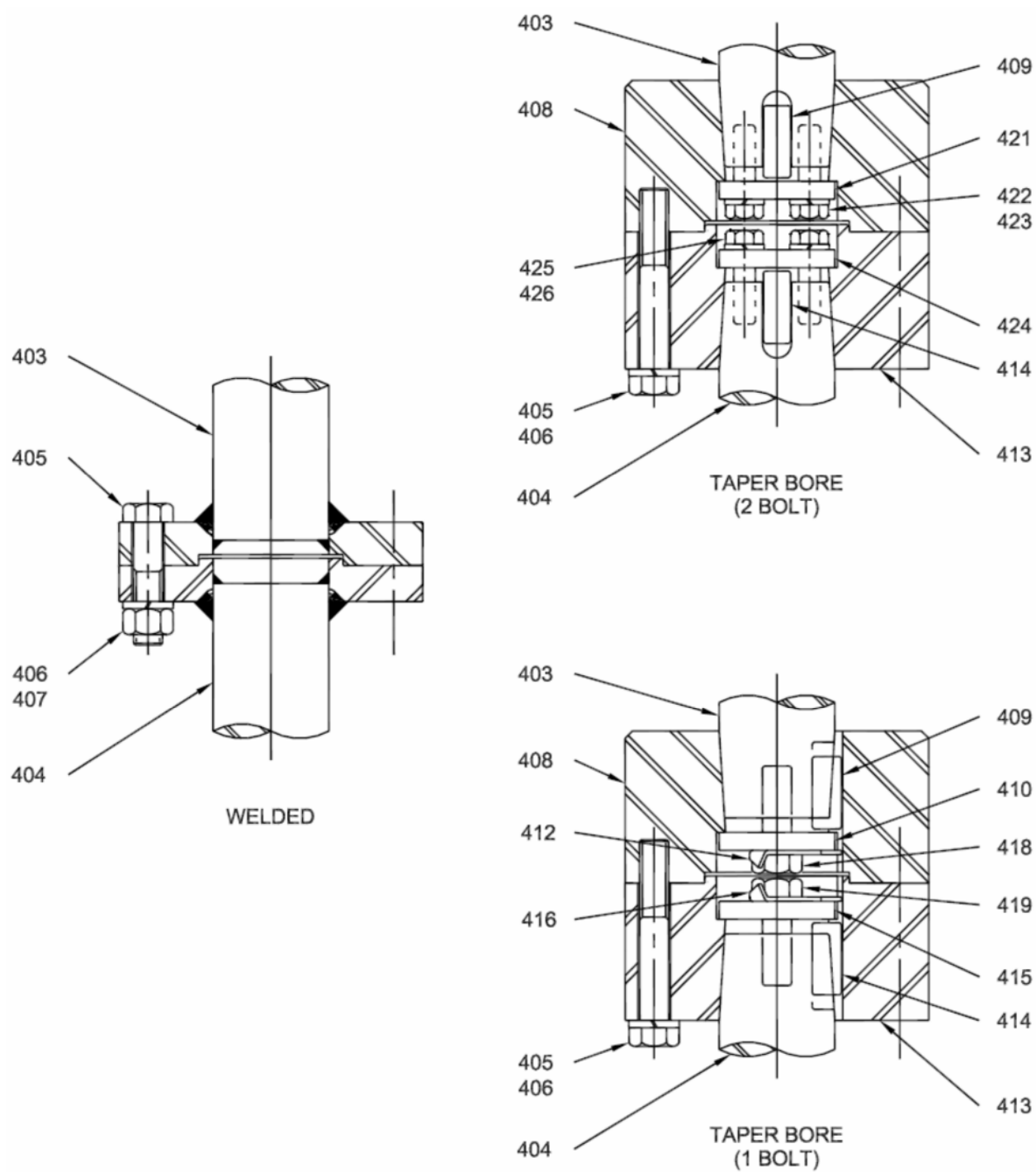


Figure 27A. In-Tank Couplings (Continued)

O.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 32, for checking and straightening the shaft. Steady bearing mountings should be located from the installed agitator extension shaft.

O.2.1 Bracket Steady Bearing

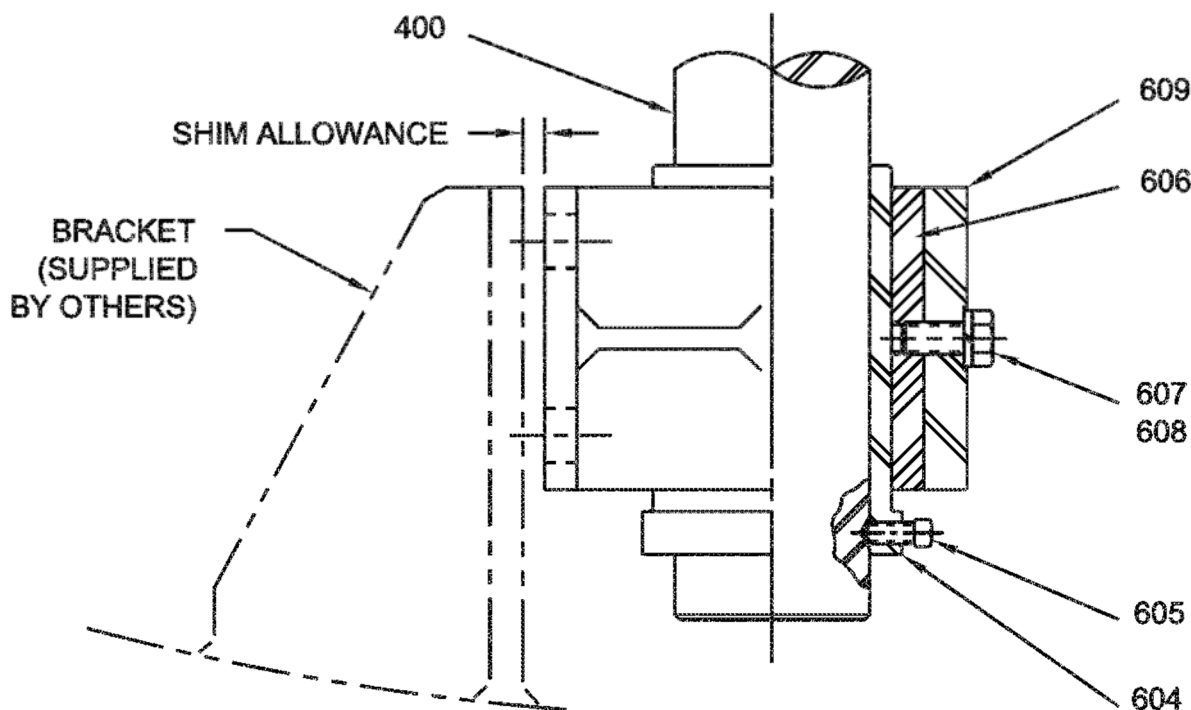


Figure 28. Bracket Steady Bearing

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 105.
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° 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 105.
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 105. 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.*

O.2.2 Cup Tri-Pod Steady Bearing

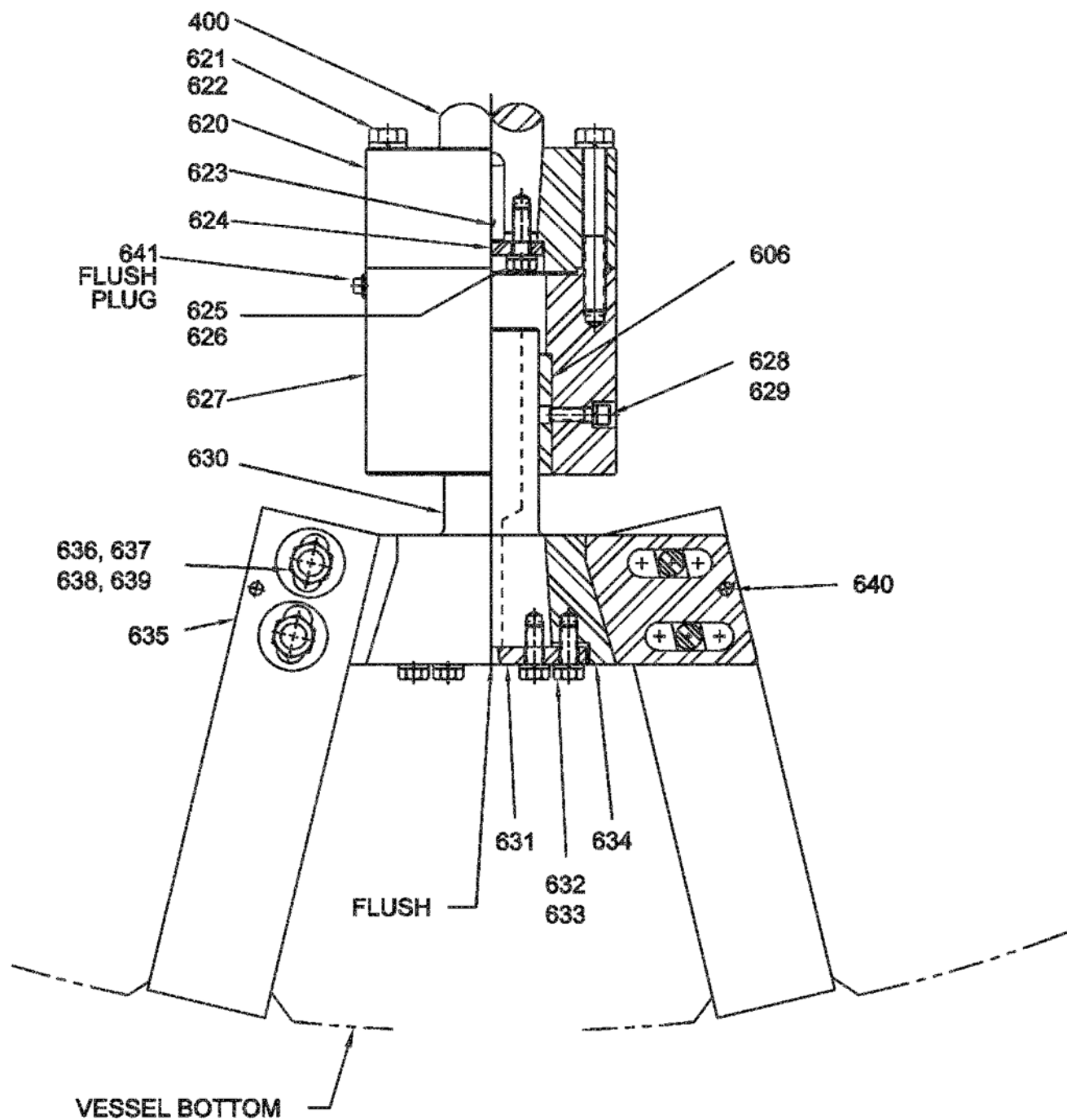


Figure 29. Cup Tripod Steady Bearing

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 50 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 105.

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 105. 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 105.
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° 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 105.
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 105. 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.*

O.2.3 Tri-Pod Steady Bearing

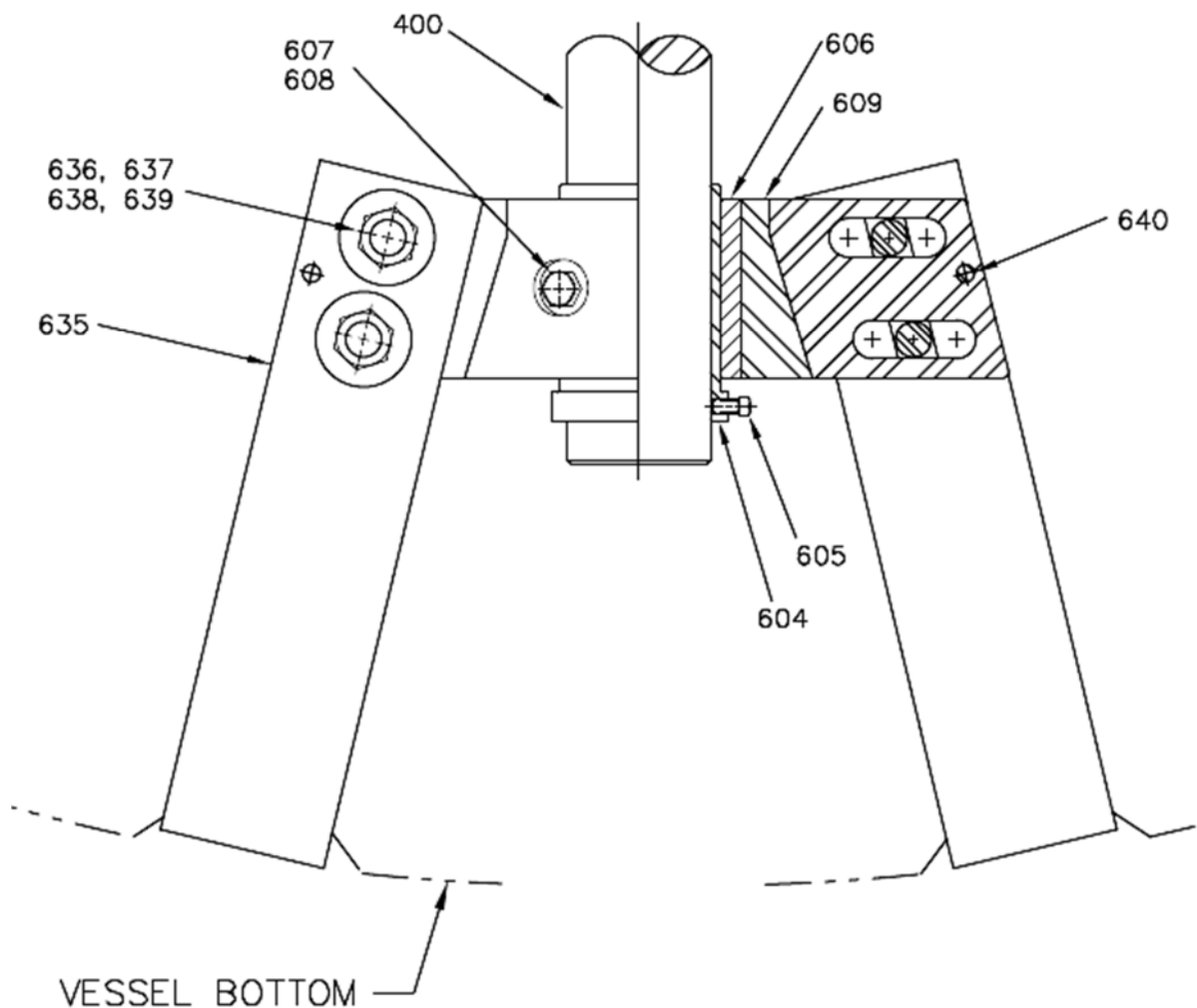


Figure 29A. Tripod Steady Bearing

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 105. 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 105.
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 105. 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.

O.2.4 Pad Steady Bearing

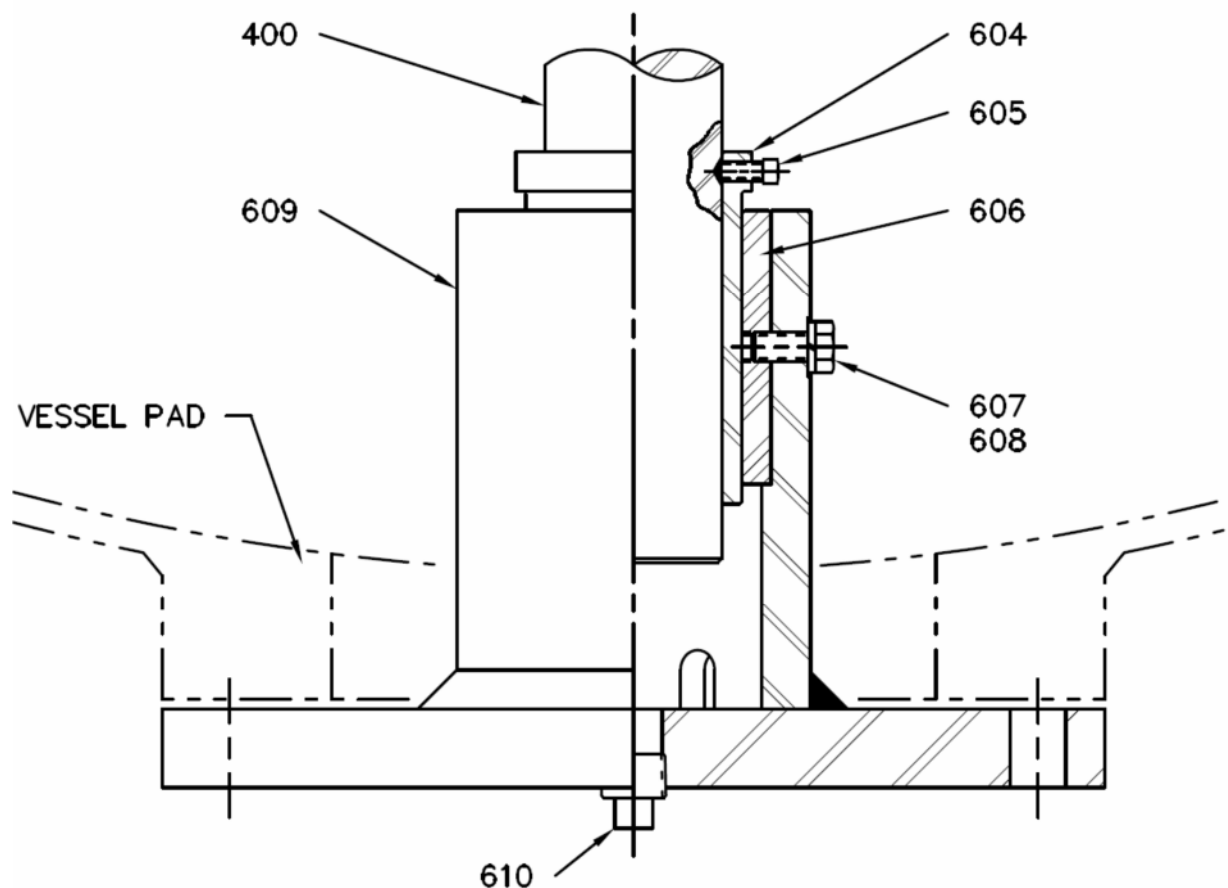


Figure 29B. Pad Steady Bearing

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 105.
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 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 105.

6. In extreme cases, the agitator drive may have to be shimmed to correct for angular misalignment. Call Chemineer Field Service for assistance.
7. If the angular alignment needs correction, repeat the previous steps.
8. 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).
9. 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].
10. 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.

11. 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 105. 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.

P. 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.

P.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 63 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 problems¹:

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.

¹US Nuclear Regulatory Commission, Information Notice No. [88-12](#)

Table 7. TYPICAL NLGI NO. 2 GREASES

<i>For Ambient Temperature Range of 0° to 150° F (-18° to 66° C)</i>		
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

P.2 MECHANICAL SEAL LUBRICATOR

Note: *The instructions below pertain to the Chemineer seal lubricator option. If your lubricator is not the Chemineer lubricator, read, understand and follow the manufacturer's instructions provided with the lubricator.*

Applicable to: Some Model 20 GTN, and HTN (*See assembly drawing for more information*)

1. Assemble the lubricator-mounting bracket [1710] to the mechanical seal lubricator [1701]. Refer to Figure 30, page 65. Install mounting bolts, flatwashers and lockwashers [1711, 1712, 1713]. Torque bolts to the value shown in the APPENDIX, Page 105.
2. Remove all plastic shipping plugs from mechanical seal barrier fluid ports. Install sight glass [1704], drain plug [1705], and pipe nipples [1706, 1708].
3. Install flexible hoses [1707, 1709], NPT male end into the cartridge mechanical seal barrier fluid ports. Install NPT female union ends onto pipe nipples [1706, 1708].
4. Remove two gear drive mounting bolts, lockwashers, and nuts, [1102, 1103, 1104]. Install lubricator/mounting bracket assembly. Re-install the gear drive mounting bolts, lockwashers, and nuts. Torque bolts to the value shown in the APPENDIX, Page 105.
5. Connect the flexible metal hose, union ends. 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 [1703].
6. Connect a pressure line to the mechanical seal lubricator pressure inlet port, 1/4-inch NPT. Pressurize using a gas bottle, or other means, to 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.*

7. Install handhole covers [1105, 1714].

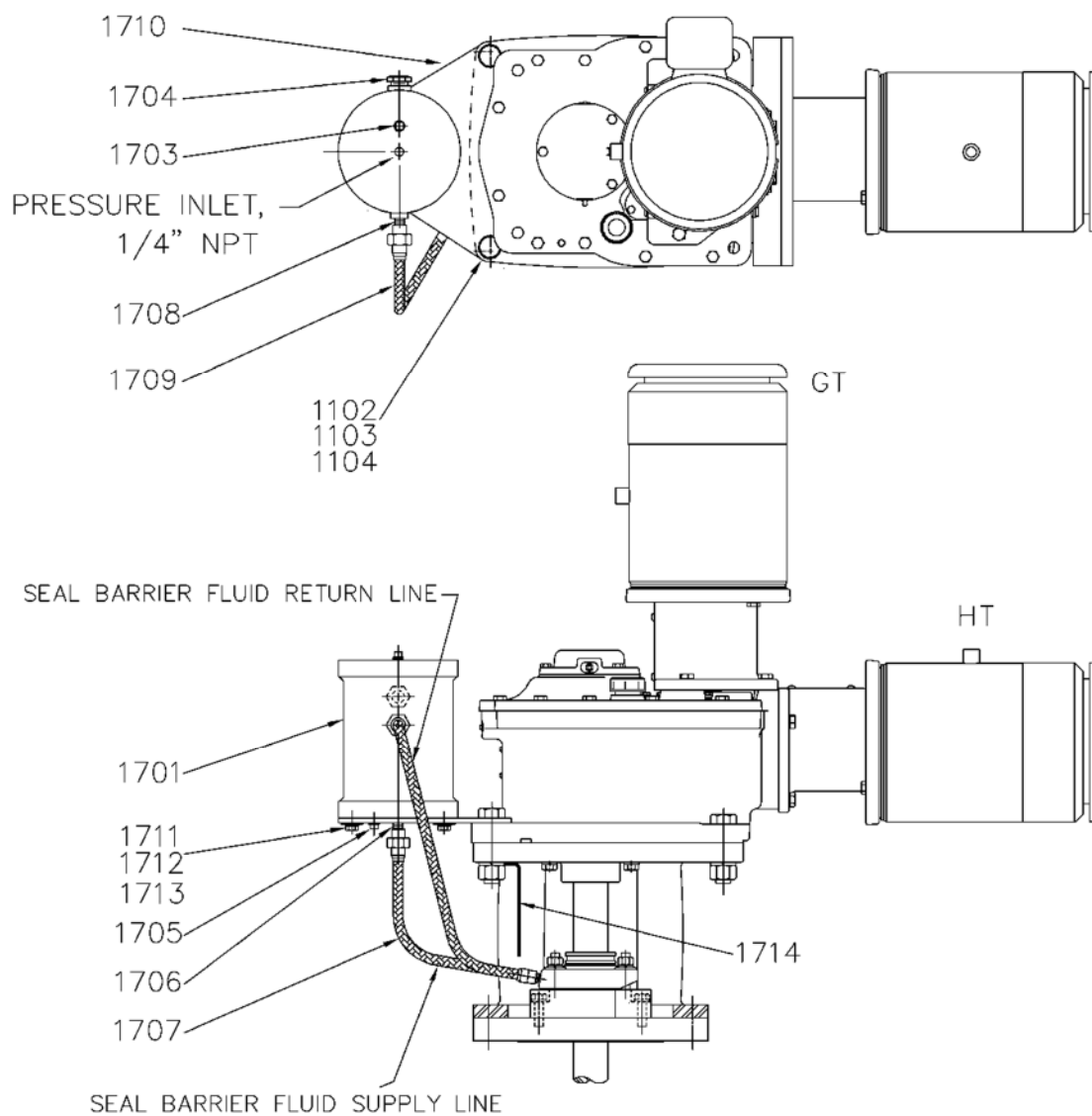


Figure 30. Mechanical Seal (Cartridge Type) Lubricator

P.3 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 32, page 73 for double reduction units and Figure 33, page 74 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 34, page 75 for spiral bevel unit.



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

See Table 10, page 69 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 69, 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 70 for most applications. If the gear drive loading is extremely heavy or if ambient temperature exceeds 100°F (38°C), an EP oil per Table 12, page 71 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 67.

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 63 lists some commonly available grease.

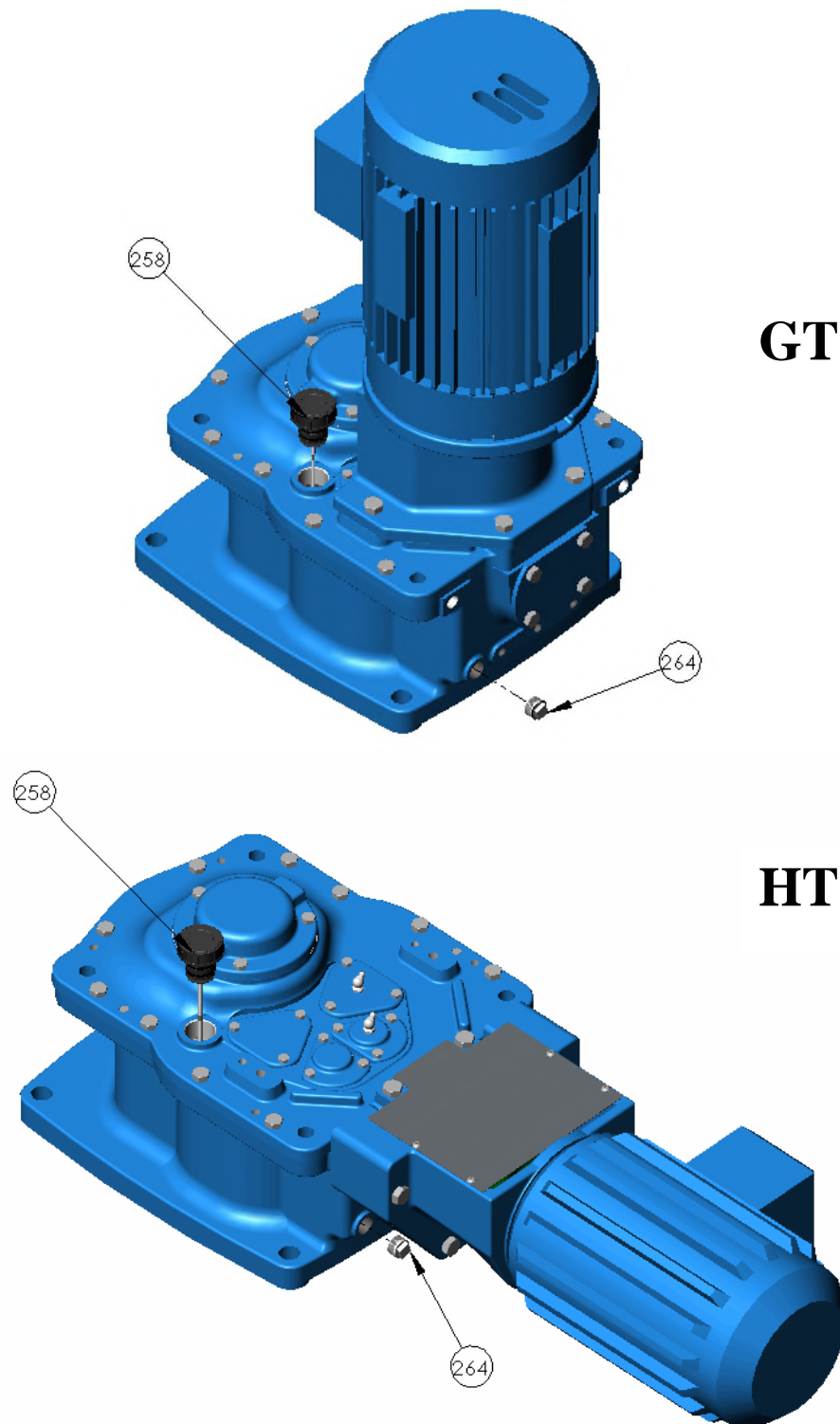


Figure 31. Model 20 GT/HT Gear Drive Oil Level Dipstick

Table 9. LUBE OIL SELECTION

Ambient Temperature	ISO Viscosity Grade	AGMA Lubricant Number
-10° to 15°F (-24° to -10°C)	32 to 68	Up to 2
15° to 50°F (-10° to 10°C)	100 to 150	3 to 4
50° to 125°F (10° to 50°C)	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

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 knurled mark on the dipstick and until the oil just overflows from the pipe plug [267] hole. (See Figure 32, page 73, Figure 33, page 74, or Figure 34 on page 75)

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) @ 104° F (40° 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) @ 104° F (40° 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 °F	-30 to +10	-15 to +50	0 to +80	+10 to +125	+20 to +125
Viscosity Range (cSt) @ 104° F (40° 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)

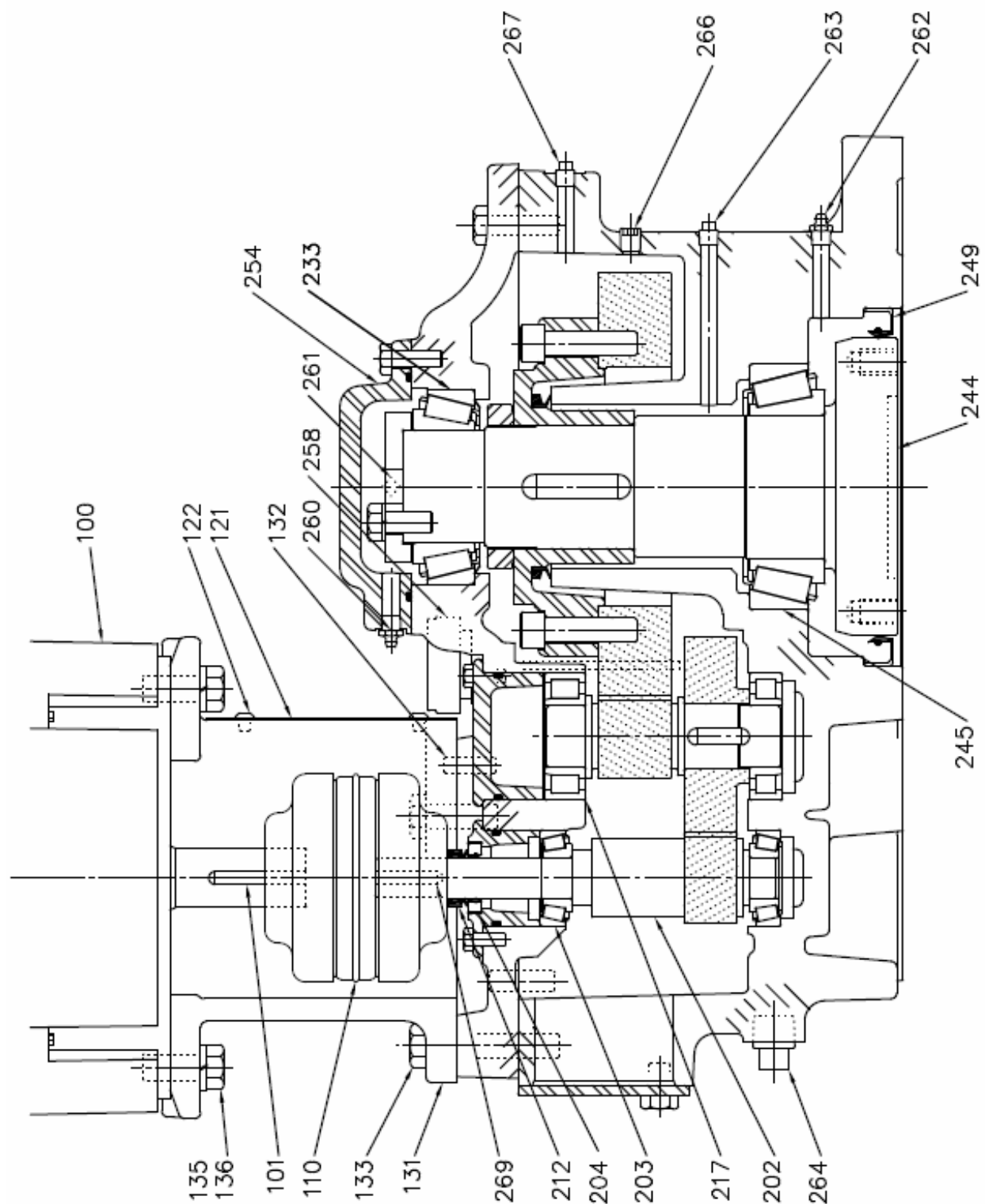


Figure 32. Model 20 GT Double Reduction Gear Drive

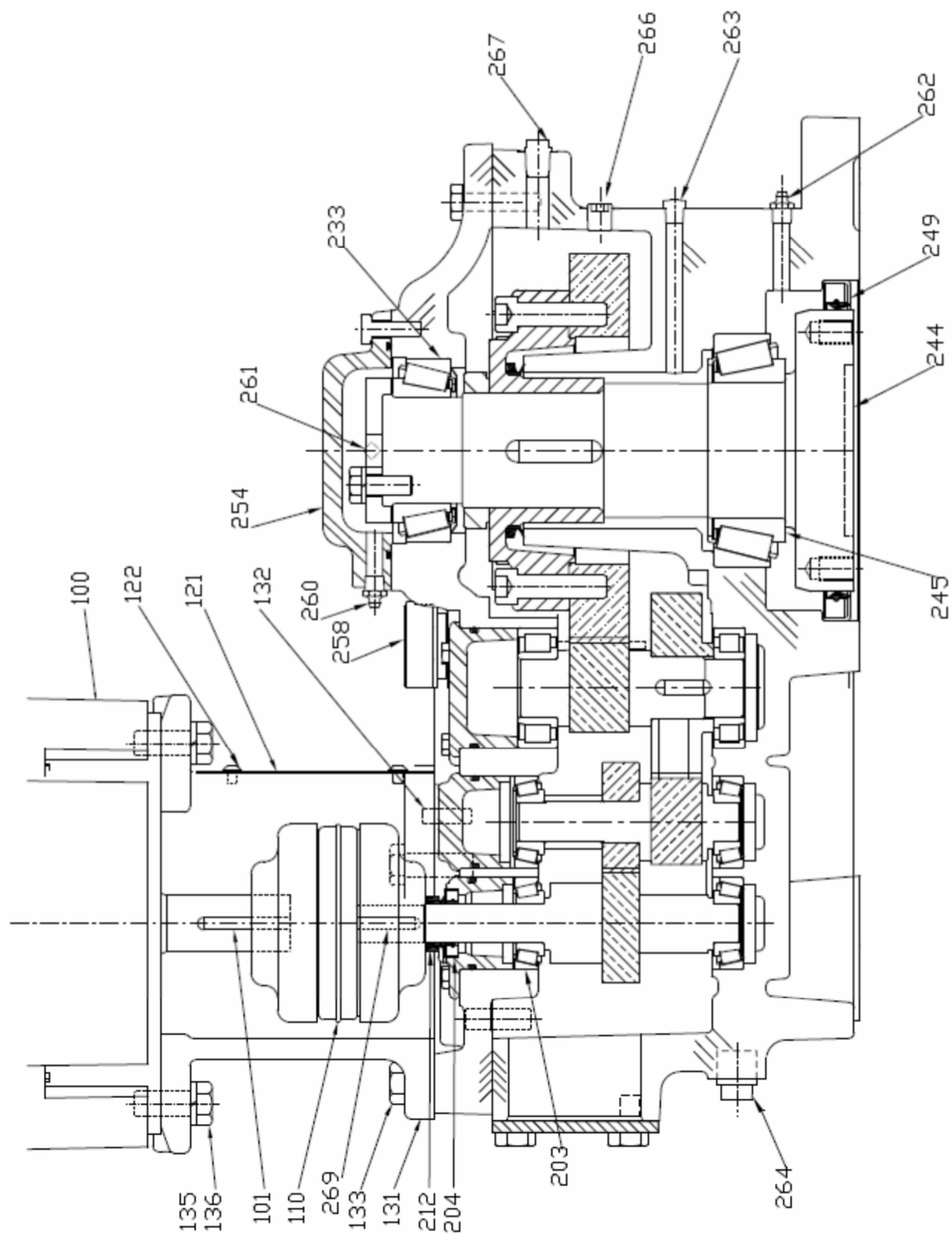


Figure 33. Model 20 GT Triple Reduction Gear Drive

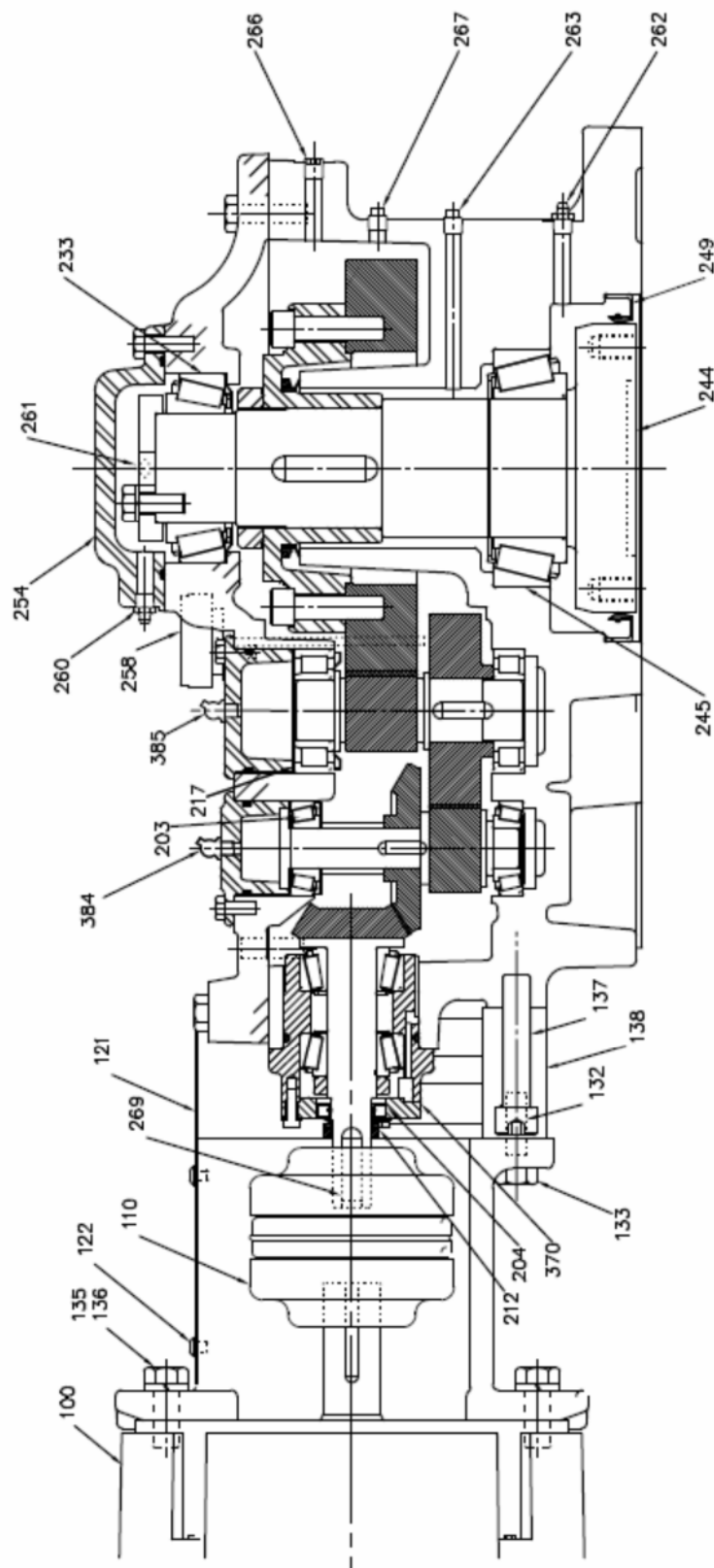


Figure 34. Model 20 HT Gear Drive

P.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.

P.5 SHAFT SEALS - LUBRICATION

Model 20 GTN and HTN mechanical seals can be designed to operate “dry” with a gas barrier fluid or “wet” with a liquid barrier fluid. The barrier fluid can be supplied a number of different ways (*see, [Shaft Seals Operation Section](#), page 79*). The barrier fluid can be a gas or a low viscosity liquid with reasonable lubricity, compatible with the process fluid, and stable over the full range of operating pressures and temperatures. Common liquid barrier fluids include glycerine, ethylene glycol, mineral oil and water. The most common gas barrier fluid is dry nitrogen. Seal supplied to you will have been selected for the barrier fluid you specified.

The seal barrier fluid is to be pressurized 25-50 psi (172 – 344 kPa) above the maximum vessel pressure. The seal should always be pressurized before pressurizing the vessel and operating the agitator.

Units supplied with an optional Chemineer mechanical seal lubricator or other customer-supplied lubrication system should be checked regularly for proper lubricant level.

Models 20 GTNC, GTNS, HTNC and HTNS are furnished with single mechanical seals. The seals are designed to run dry. Do not lubricate sealing faces.

Q. OPERATION

Q.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. Minor changes could upset the dynamics and result in dramatic and potentially dangerous failures.

Should there be problems operating the unit, review the installation and the [Troubleshooting Guide](#), 0 on page 81. If you are unable to resolve the problem, contact your [local Chemineer office](#).

Q.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.

Q.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.

Q.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 125° to 175°F (52° to 80°C). 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 190°F (88°C). If a temperature greater than 190°F (88°C) 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.

Q.5 SHAFT SEALS - OPERATION

Q.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.

Q.5.2 Model 20 GTN and HTN

Mechanical seals must be pressurized to operate properly. Before operation, the seal cavity should be pressurized to 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 30, page 65) or the mechanical seal lubricator system may be supplied by others. The Chemineer mechanical seal lubricator should be filled by removing fill plug [1703] 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.

Some leakage of the barrier fluid should be expected under normal operating conditions, and is inherent with the design of mechanical seals. Leakage should be relatively low, around 1 or 2 drips per minute. Barrier fluid should always be chosen to be compatible with the process for this reason. Be sure to regularly inspect the fluid levels within the reservoir and top off as needed.

Excessive reduction in barrier fluid level indicates a problem with the seal and / or lubrication system. Check all seal and reservoir connections and tighten / replace as necessary. If fluid levels continue to drop at an above average rate, then your seal may need replacing. Contact your Chemineer representative for further information.

The condition of the barrier fluid should be inspected periodically. Failure to do so will have a negative impact on the lifespan of the seal.

When maintaining or changing the seal, it is recommended to clean the lubrication system and replace the barrier fluid.

Q.5.3 Models 20 GTNC, GTNS, HTNC and HTNS:

For operating limits of the seal, refer to appropriate assembly drawing.

Q.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.

Q.7 TROUBLE-SHOOTING

TROUBLE-SHOOTING GUIDE Z01000-261LCERT Material Certification Newman Sanit 223962-00

Table 14.

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.

R. MAINTENANCE - MECHANICAL CARTRIDGE SEAL

Applicable to: Model 20 GTN, GTNC, HTN, and HTNC

The mechanical seal (cartridge type) 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. (Refer to Figure 40, page 88, Figure 41, page 89)

R.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 drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove handhole covers [1105, 1714].
4. **For Seals with Locking Clips:** Depressurize the mechanical seal barrier fluid lines, disconnect and plug the ports. Clean the portion of the agitator shaft [400] between the tapered shaft coupling [351] and the mechanical seal cartridge [1500]. Install centering clips [1473/1503/1573]. If these do not fit then it is advised to investigate why. Loosen the mechanical seal sleeve cup point setscrews [1472/1502/1572] one turn.

For Seals with a Centering Strap: Clean the portion of the agitator shaft [400] between the tapered shaft coupling [351] and the mechanical seal cartridge [1400]. Install the centering strap [1403]. A standard wire wrap 0.054" thick x 0.187" wide [1.37 mm x 4.75 mm] can be used for 1-1/2" (38.1 mm) to 2-1/2" (63.5 mm) shaft diameters; 0.068" thick x 0.300" wide [1.73 mm x 7.6 mm] can be used for 3" (76.2 mm) to 4-1/2" (114.3 mm) shaft diameters. Loosen the mechanical seal sleeve cup point setscrews [1402] one turn. Do not loosen flat head socket screws.

5. Take note of match marking on the shaft coupling and gearbox shaft face, or add your own marking, to aid refitting in the correct orientation. Lower the agitator shaft by loosening the coupling bolts [359]. Lower evenly until the shaft is supported by the shaft drop collar [1253]. The shaft should drop approximately 1/2" (13 mm). Remove bolts [359].
6. Prepare the motor electrical conduit for pivoting the gear drive. Remove all electrical conduits connected to the motor or loosen the union installed in a section of the conduit along the pivot shoulder bolt [1111] axis.
7. **For Model 21 and Model 22 GT/HT with N or NC:**
 - a. Remove gear drive mounting bolts, nuts and lockwashers [1102, 1103, 1104]. Rotate the gear drive 90° counter-clockwise. See Figure 35, page 83.



CAUTION! Do not remove pivot shoulder bolt [1111].

- b. Install one bolt [1102] through the gear drive-housing flange and pedestal flange. Install nut [1104].
- c. Remove bolts [357], coupling washer and lockwashers [354, 358]. Disengage the taper by tapping the coupling half [351] with a mallet or apply a puller. Remove coupling half.



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

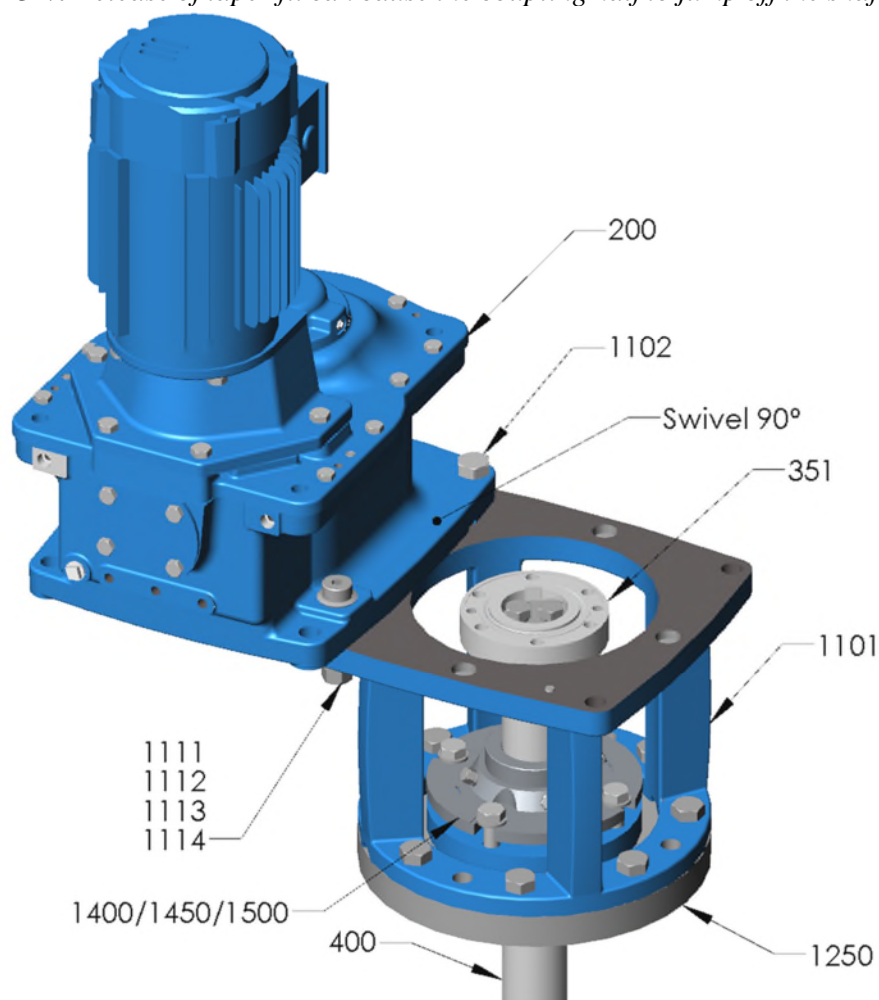


Figure 35. Model 21 and Model 22 Gear Drive Pivot Feature

Note: Only the GT configuration is shown in the above figure. The same arrangement is available on the 21 and 22 HT.

- d. Remove nuts [1263] or bolts [1478/1578], lockwashers and flatwashers [1264, 1265/1479, 1480/1579, 1580]. Remove the cartridge mechanical seal.
- e. If present on your seal, remove bolts [1266] and lockwashers [1267]. Remove mechanical seal adapter plate [1261] and o-ring [1252].

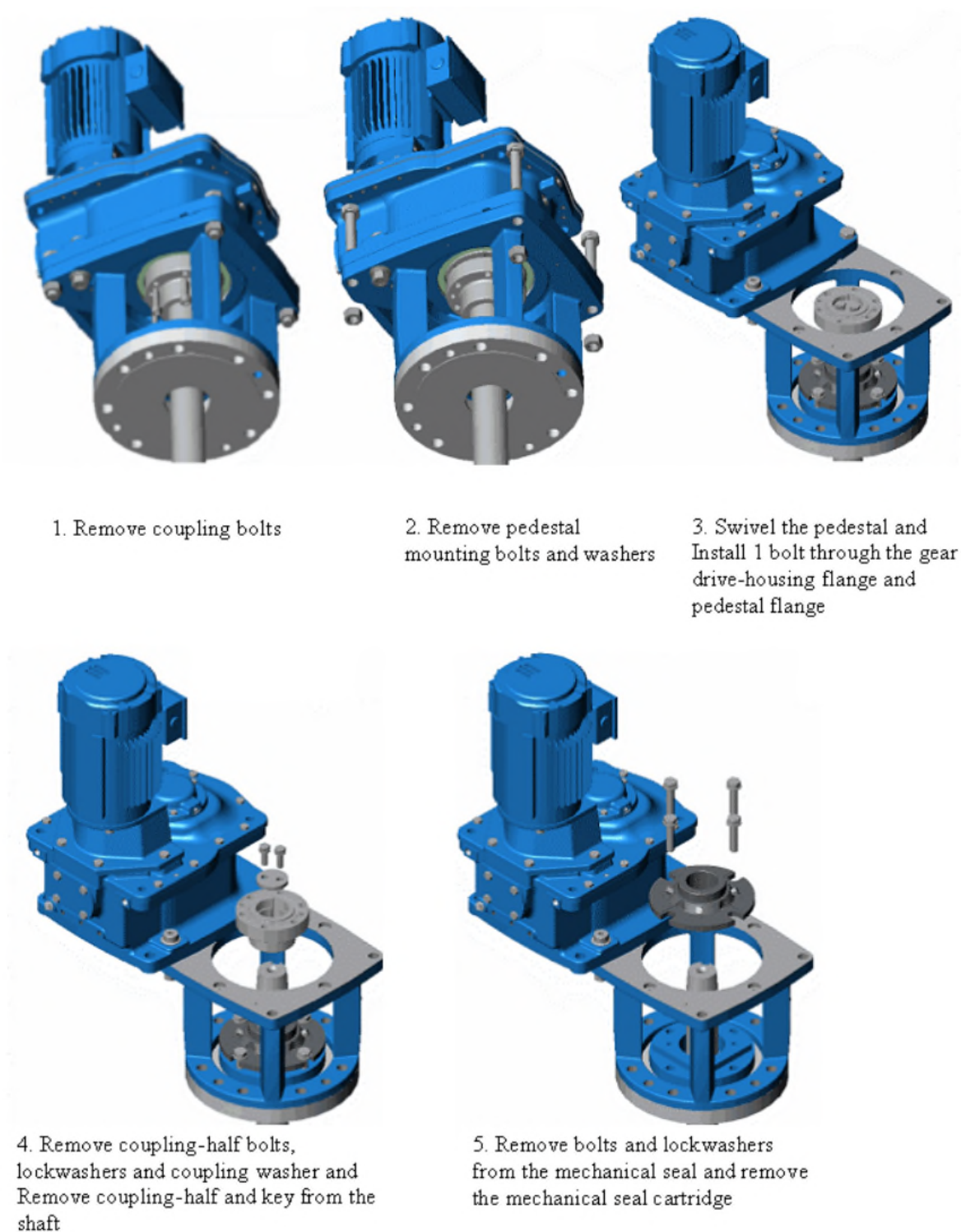


Figure 36. 21 and 22 GT/HT pivot seal change procedure

Note: Only GT configuration is shown in the above figure. Use same procedure for 21 and 22 HT.

For Model 23 GT/HT with N or NC:

- a. Remove gear drive mounting bolts [1102] and lockwashers. Slightly tighten the swivel arrangement bolt [1121] in order to lift the gearbox by approx 2 mm.
- b. Rotate the gear drive 90° counter-clockwise. See Figure 37, page 85.
- c. Remove bolts [357], coupling washer and lockwashers [354, 358]. Disengage the taper by tapping the coupling half [351] with a mallet or apply a puller. Remove coupling half.
- d. Remove nuts [1263], lockwashers and flatwashers [1264, 1265]. Remove the cartridge mechanical seal.
- e. Remove bolts [1266] and lockwashers [1267]. Remove mechanical seal adapter plate [1261] and o-ring [1252].

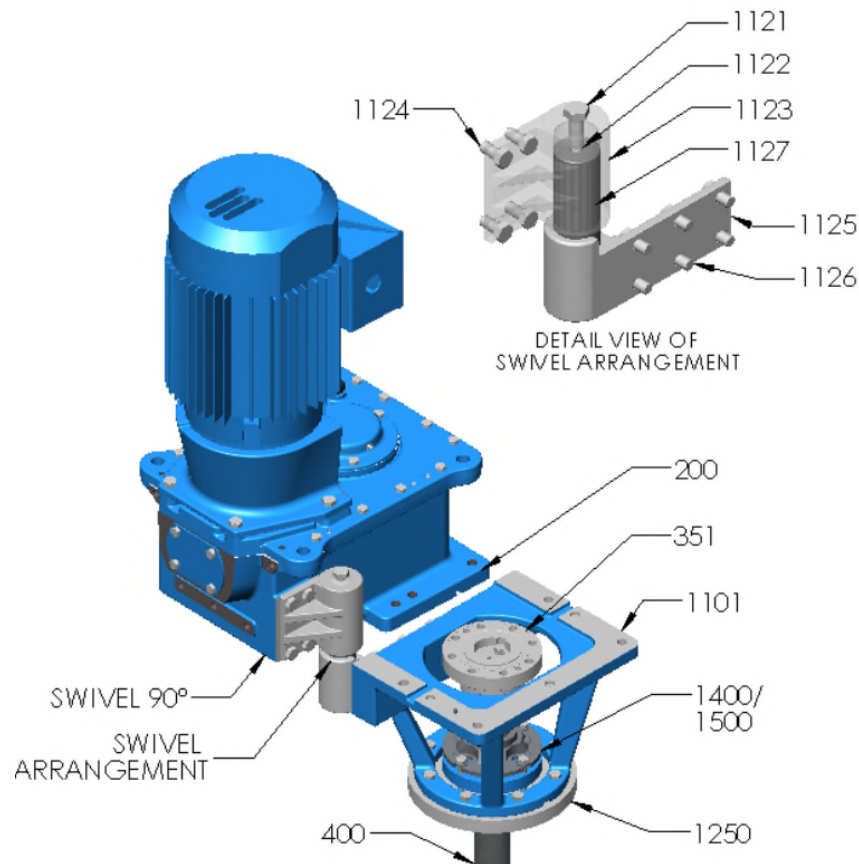


Figure 37. 23 Gear Drive Swivel Arrangement

Note: Only GT configuration is shown in the above figure. Use same procedure for 23 HT.

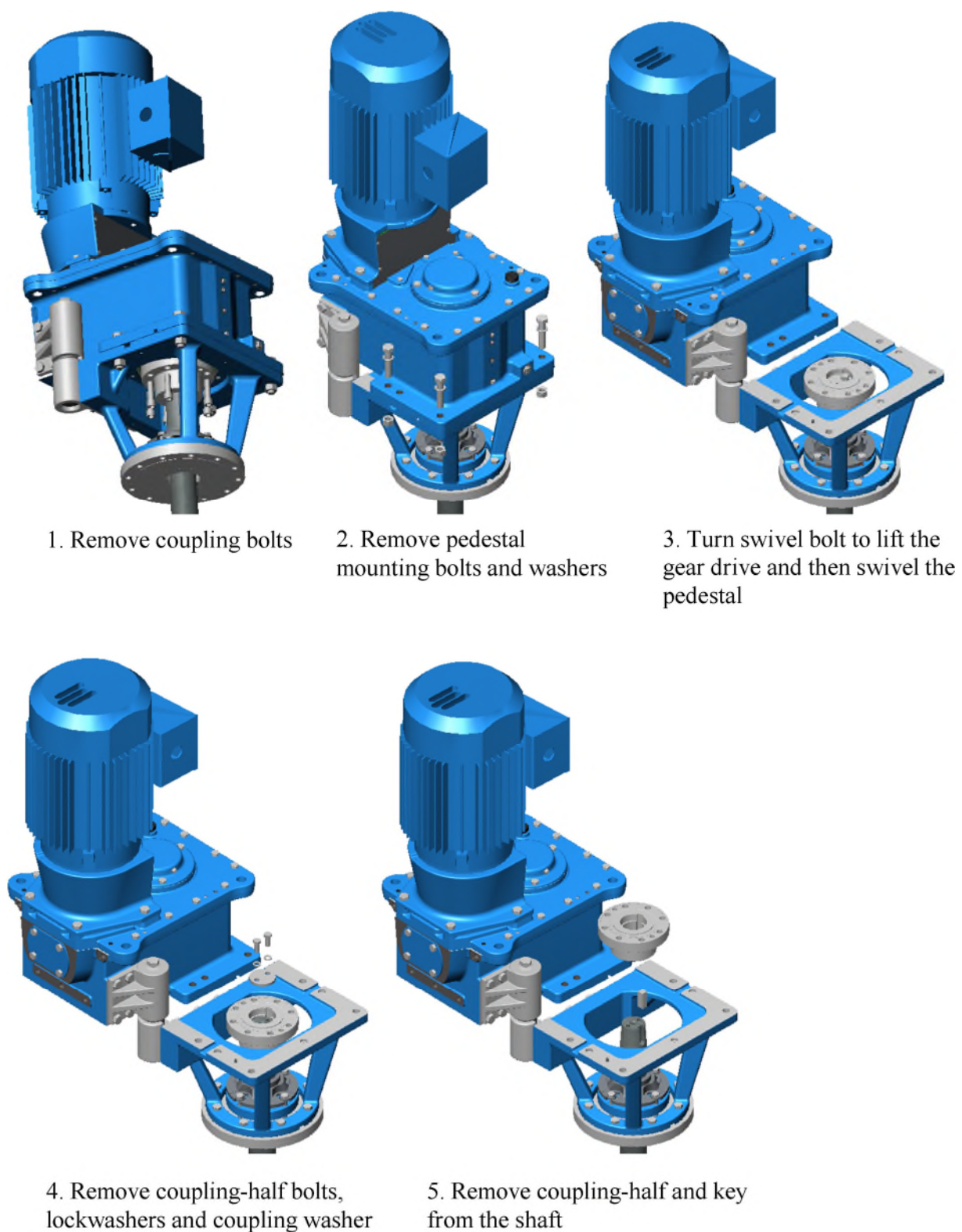
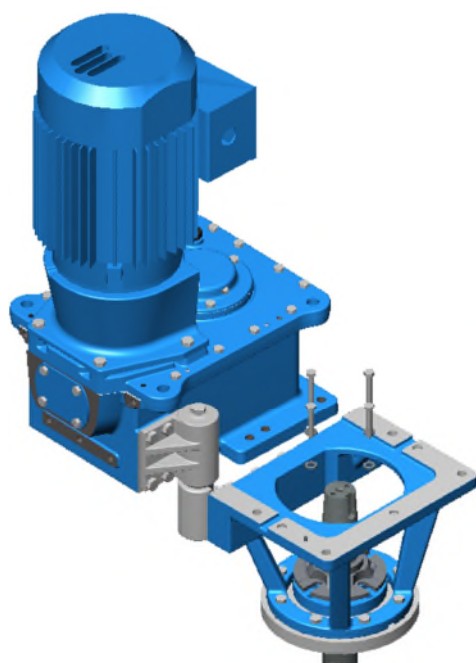
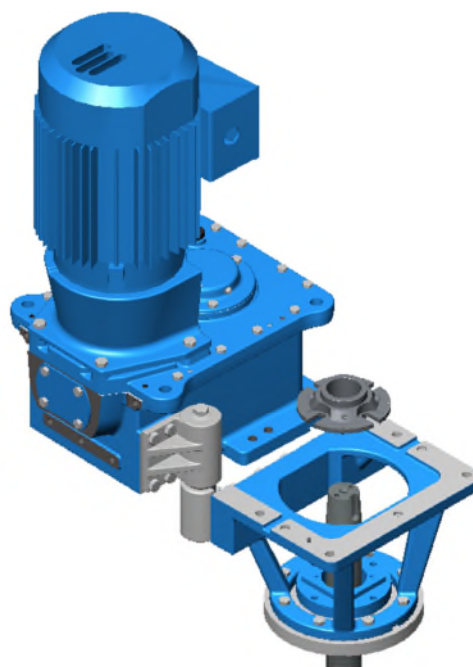


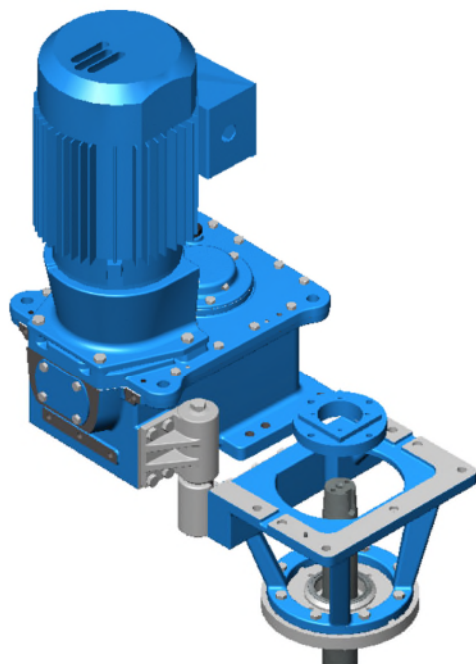
Figure 38. 23 GT/HT pivot seal change procedure



6. Remove bolts and lockwashers from the mechanical seal



7. Remove the mechanical seal cartridge



8. Remove the adapter plate *(if supplied with the unit)*

Figure 39. 23 GT/HT pivot seal change procedure (Contd.)

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

R.2 REPLACEMENT SEAL CARTRIDGE INSTALLATION

Note: It is recommended that, at a minimum, new o-rings and new fasteners be installed whenever the seal is serviced.

1. Clean the agitator shaft in the seal area. Be sure to remove any burrs left by the seal set screws on the shaft, otherwise they may damage the o-rings as the seal is re-installed.
2. Install the new or rebuilt seal per the seal installation instruction in Section H, page 20.

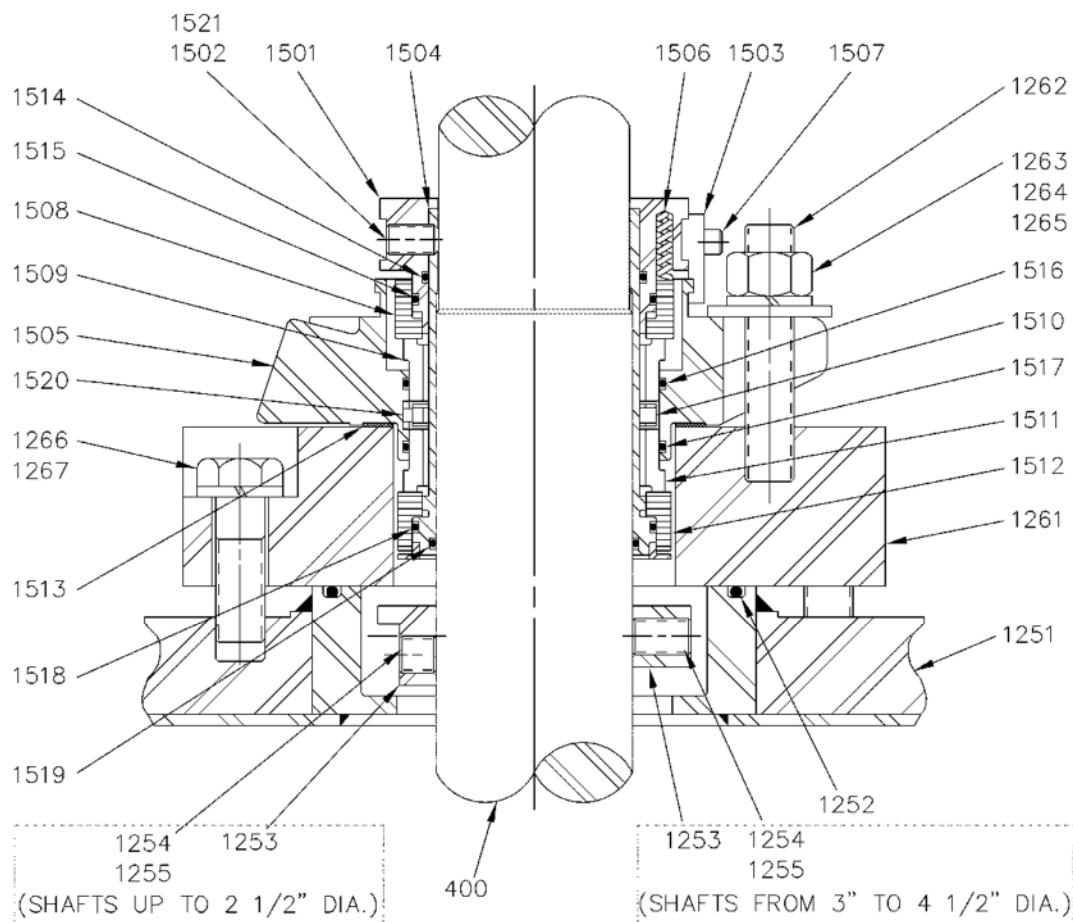


Figure 40. Double Mechanical Seal with Adapter Plate

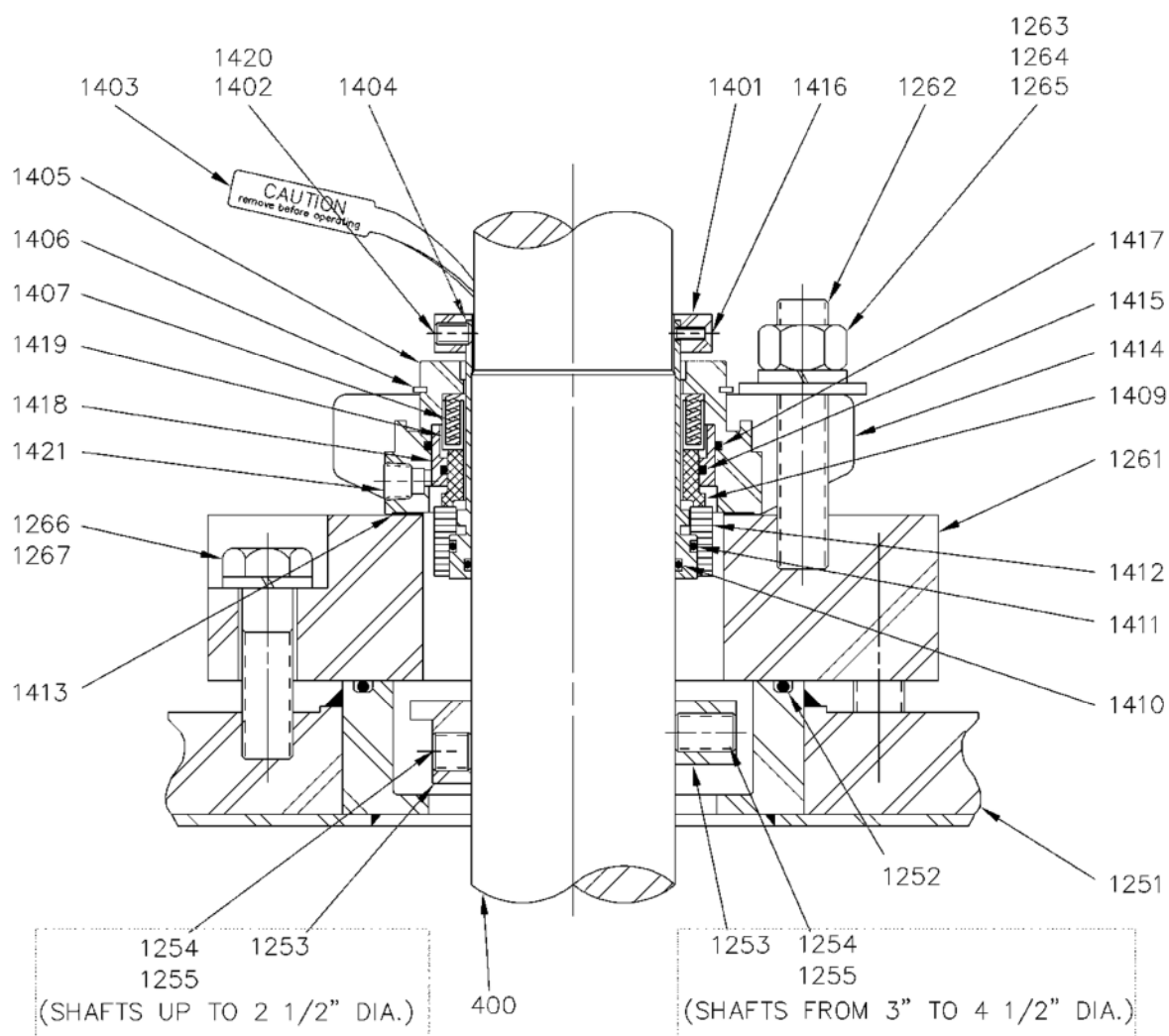


Figure 41. Single Mechanical Seal with Adapter Plate

S. MAINTENANCE - SINGLE MECHANICAL SEAL

Applicable to: Model 20 GTNS and HTNS

The single 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 (*Refer to Figure 11, page 27, and Figure 42, page 91*)

S.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 drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove handhole covers [1105].
4. Clean the portion of the agitator shaft [400] between the tapered shaft coupling [351] and the mechanical seal [1450]. Loosen cup point setscrews [1455] one turn. Slide the collar [1456] up the shaft.
5. Lower the agitator shaft by loosening the coupling bolts [359]. Lower evenly until the shaft is supported by the shaft drop collar [1253]. The shaft should drop approximately 3/4" (19mm). Remove bolts and lockwashers [359, 360].
6. Prepare the motor electrical conduit for pivoting the gear drive. Remove all electrical conduits connected to the motor or loosen the union installed in a section of the conduit along the pivot shoulder bolt [1111] axis.
7. Remove gear drive mounting bolts [1102]. Rotate the gear drive 90° counter-clockwise. Refer to Figure 35, page 83 or Figure 37, page 85.



CAUTION! Do not remove pivot shoulder bolt [1111].

8. Install one bolt [1102] through the gear drive housing flange and pedestal flange. Install nut [1104], and torque to the value shown in APPENDIX, Page 105.
9. Remove bolts [357], coupling washer and lockwashers [354, 358]. Disengage the taper by tapping the coupling half [351] with a mallet or apply a puller. Remove the coupling half.



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

10. Remove collar, spring, rotary seal ring and o-ring [1456, 1454, 1453, 1452].

11. Remove bolts, lockwashers and flatwashers [1269, 1270, 1271]. Remove stationary seal insert [1458] and o-ring [1457].
12. Remove bolts [1266] and lockwashers and flatwashers [1267, 1268]. Remove mechanical seal gland plate [1272] and o-ring [1252].
13. Inspect parts for wear. Replace worn or damaged parts as required.

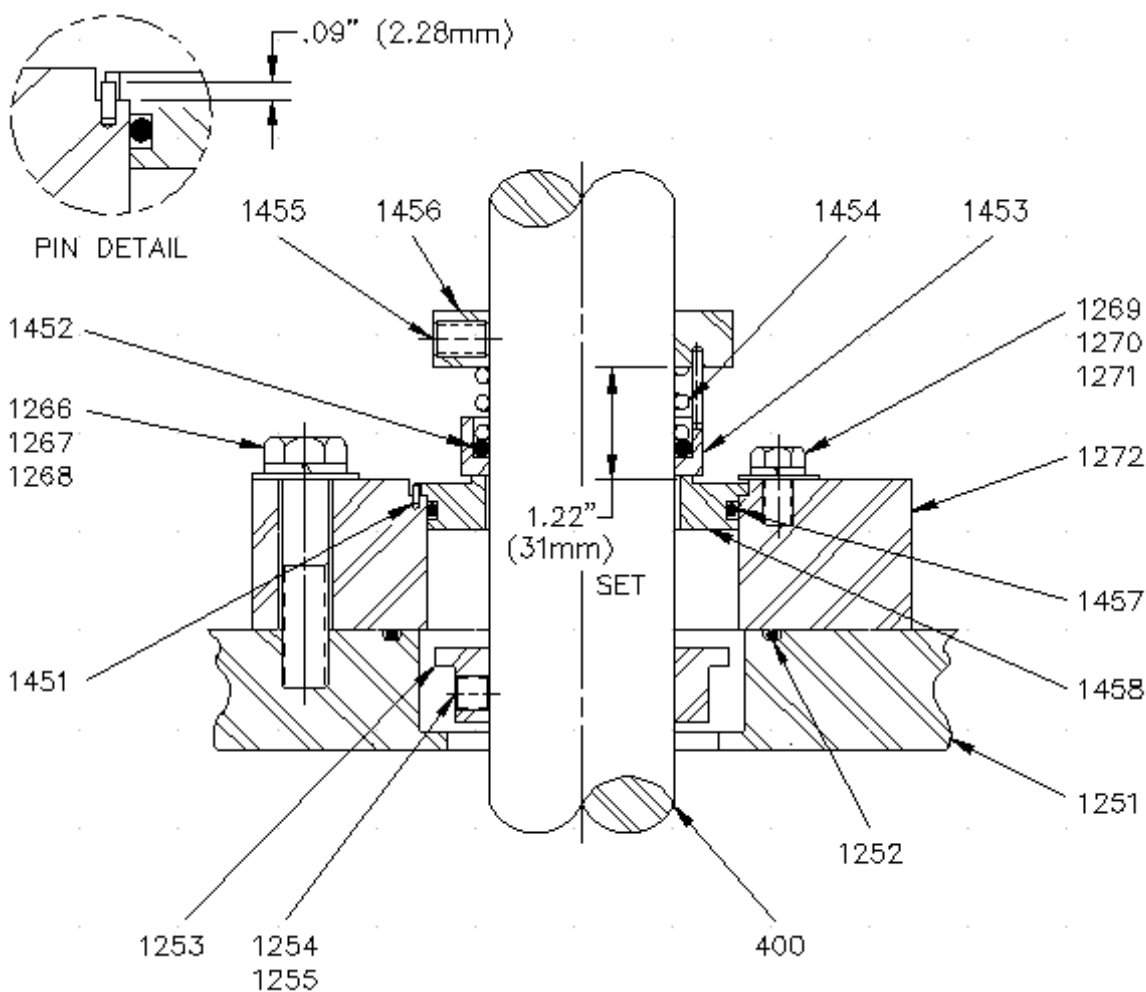


Figure 42. Model GTNS, Single Mechanical Seal

S.2 SEAL INSTALLATION

Note: It is recommended that, at a minimum, new o-rings [1252, 1457, 1452], new fasteners [1266, 1267, 1268, 1269, 1270, 1271], and a new spring [1454] be installed whenever the seal is serviced.

1. Clean the agitator shaft in the seal area. Be sure to remove any burrs left by the seal set screws on the shaft, otherwise they may damage the o-rings as the seal is re-installed.
2. Install the new or rebuilt seal per the seal installation instruction in Section I, page 27.

T. MAINTENANCE - GEAR DRIVE

T.1 AGITATOR DRIVE REMOVAL

1. Lock out and disconnect all power to the gear drive motor and optional devices.
2. Depressurize and ventilate vessel.
3. Remove handhole covers.
4. **For Seals with Centering Clips:** Depressurize the mechanical seal barrier fluid lines, disconnect and plug the ports. Clean the portion of the agitator shaft [400] between the tapered shaft coupling [351] and the mechanical seal cartridge [1470/1500/1570]. Install centering clips [1473/1503/1573]. Loosen the mechanical seal sleeve cup point setscrews [1472/1502/1572] one turn.

For Seals with a Centering Strap: Clean the portion of the agitator shaft [400] between the tapered shaft coupling [351] and the mechanical seal cartridge [1400]. Install the centering strap [1403]. A standard wire wrap 0.054" thick x 0.187" wide [1.37 mm x 4.75 mm] can be used for 1-1/2" (38.1 mm) to 2-1/2" (63.5 mm) shaft diameters; 0.068" thick x 0.300" wide [1.73 mm x 7.6mm] can be used for 3" (76.2 mm) to 4-1/2" (114.3 mm) shaft diameters. Loosen the mechanical seal sleeve cup point setscrews [1402] one turn. Do not loosen flat head socket screws.

For GTNS/HTNS: Clean the portion of the agitator shaft [400] between the tapered shaft coupling [351] and the mechanical seal [1450]. Loosen cup point setscrews [1455] one turn. Slide the collar [1456] up the shaft.

5. Lower the agitator shaft by loosening the coupling bolts [359]. Lower evenly until the shaft is supported by the shaft drop collar [1253]. The shaft should drop approximately 1/2" (13mm). Remove bolts and lockwashers [359, 360].
6. Remove the agitator drive to a suitable service area.

T.2 PREPARATION FOR DISASSEMBLY

1. Clean external surfaces and drain the oil.
2. Remove motor adapter mounting bolts [133]. Remove motor [100] and the motor adapter [131].
3. Refer to the *Gear drive Maintenance Manual* for gear drive disassembly and assembly instructions.

U. MAINTENANCE - STEADY BEARING

U.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 28 on page 53, Figure 29A on page 58, and Figure 29B on page 60).

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 15. 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.

5. Reinstall the wear sleeve and housing/bushing assembly. Torque all fasteners to the value shown in APPENDIX, Page 105.



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

U.2 CUP TRIPOD STEADY BEARING

In-tank steady bearings will require periodic inspection and replacement of bushing and stub shaft [606, 630]. (Figure 29, page 55)

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 16. 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 the APPENDIX, Page 105.
5. Re-attach the flush piping.

V. 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	plug, NPT	1
264	magnetic drain plug, NPT	1
266	set screw plug, NPT	1
267	pipe plug, NPT	1
269	input shaft key	1

Item#	Description	Qty.
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 detail 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.
1100	Pedestal assembly	1
1101	pedestal	1
	<i>For case size 21 and 22</i>	
1102	bolt	4
1103	lockwasher	4
1104	nut	4
1105	handhole cover	4
1106	bolt	4
1107	lockwasher	4
1108	flatwasher	4
1109	lockwasher	4
1110	nut	4
1111	pivot shoulder bolt	1
1112	belleville washer	2
1113	flatwasher	1
1114	Locknut	1
1115	socket bolt	1
1116-001	bolt	4
1116-002	bolt	8
1117-001	lockwasher	4
1117-002	lockwasher	8
	<i>For case size 23</i>	
1121	bolt	1
1122	steel ball	1
1123	top swivel bracket	1
1124	bolt	4
1125	bottom swivel bracket	1
1126	bolt	6
1127	swivel rod	1
1128	dowel pin	1
1130	nut	3
1135	handhole cover	4
1136	bolt	3
1137	lockwasher	3
1138	flatwasher	3
1139	lockwasher	3
1141	bolt	1
1142	lockwasher	1
1143	flatwasher	1

Item#	Description	Qty.
1250	Mounting flange assembly	1
1251	mounting flange	1
1252	o-ring	1
1253	drop collar	1
1254	setscrew, half dog point	1
1255-001	setscrew, cup point	2
1255-002	setscrew, cup point	3
1258-001	stud	8
1258-002	stud	12
1260	Mechanical seal adapter plate assembly	1
1261	adapter plate	1
1262	stud	4
1263	nut	4
1264	lockwasher	4
1265	flatwasher	4
1266	bolt	4
1267	lockwasher	4
1268	flatwasher	4
1269	bolt	4
1270	lockwasher	4
1271	flatwasher	4
1272	gland plate	1

Item#	Description	Qty.
1400	Single cartridge seal assembly	1
1401	lock ring	1
1402	setscrew, cup point	6
1403	centering strap	1
1404	sleeve	1
1405	hub gland	1
1406	snap ring	1
1407	spring	6 to 7
1409	stationary seal ring	1
1410	o-ring	1
1411	o-ring	1
1412	rotary seal ring	1
1413	gasket	1
1414	bolt tab (w/ springs)	8
1415	o-ring	1
1416	flat head socket screw	3
1417	o-ring	1
1418	adapter	1
1419	stationary drive	1
1420	setscrew, quarter dog point	3
1421	pipe plug, NPT	1
1450	Single seal assembly	1
1451	anti-rotation pin	1
1452	o-ring	1
1453	rotary seal ring	1
1454	spring	1
1455	setscrew, cup point	4
1456	collar (w/ drive pins)	1
1457	o-ring	1
1458	stationary seal insert	1
1470	ChemSeal Single Seal (CSS)	1
1471	collar	1
1472	set screw, cup point	
1473	centering clip	
1474	rotating seal ring	1
1475	stationary seal ring	1
1476	sleeve	1
1477	centering clip socket head cap screw	
1478	screw	4
1479	lockwasher	4
1480	flat washer	4

Item#	Description	Qty.
1481	plug	
1482	o-ring	1
1483	spring	
1484	sleeve	1
1485	o-ring	1
1486	pin	2
1487	o-ring	1
1488	housing, cast	1
1489	o-ring	1
1490	screw, flat head	2
1500	Double seal assembly	1
1501	lock ring	1
1502	setscrew, cup point	3 to 6
1503	centering clip	3
1504	sleeve	1
1505	gland	1
1506	spring	6 to 7
1507	centering clip socket head cap screw	3
1508	rotary seal ring, outboard	1
1509	stationary seal ring, outboard	1
1510	flow channel (w/ drive clips)	1
1509	stationary seal ring, outboard	1
1510	flow channel (w/ drive clips)	1
1511	stationary seal ring, inboard	1
1512	rotary seal ring, inboard	1
1513	gasket	1
1514	o-ring	1
1515	o-ring	1
1516	o-ring	1
1517	o-ring	1
1518	o-ring	1
1519	o-ring	1
1520	drive lug	1
1521	setscrew, quarter dog point	3
1570	ChemSeal Double Seal (CSD)	1
1571	collar	1
1572	set screw, cup point	
1573	centering clip	
1574	rotating seal ring	1
1575	stationary seal ring	1
1576	sleeve	1

Item#	Description	Qty.
1577	centering clip socket head cap screw	
1578	bolt	4
1579	lockwasher	4
1580	flat washer	4
1582	throttle bushing	1
1583	retaining ring	1
1584	debris well	1
1585	o-ring	1
1586	spring	
1587	o-ring	1
1588	o-ring	1
1589	o-ring	1
1590	screw, flat head	2
1591	o-ring	1
1592	o-ring	1
1593	sleeve, lower	1
1594	pin	4
1595	o-ring	1
1596	o-ring	1
1597	sleeve, upper	1
1598	housing, cast	1
1700	Mechanical seal lubricator assembly	1
1701	mechanical seal lubricator	1
1703	fill plug, NPT	1
1704	sight glass, NPT	1
1705	drain plug, NPT	1
1706	pipe nipple, NPT	1
1707	flexible metal hose	1
1708	pipe nipple, NPT	1
1709	flexible metal hose	1
1708	pipe nipple, NPT	1
1709	flexible metal hose	1
1710	mounting bracket	1
1711	bolt	2
1712	flatwasher	2
1713	lockwasher	2
1714	lubricator handhole cover	1

W. 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.

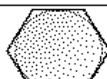


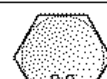

Table 17. BOLT TIGHTENING TORQUE

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 18. 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 19. 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. Usually 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					

(Source: www.boltdepot.com)



P.O. Box 1123
Dayton, Ohio 45401
Phone: (937) 454-3200
Fax: (937) 454-3379

<http://www.chemineer.com>