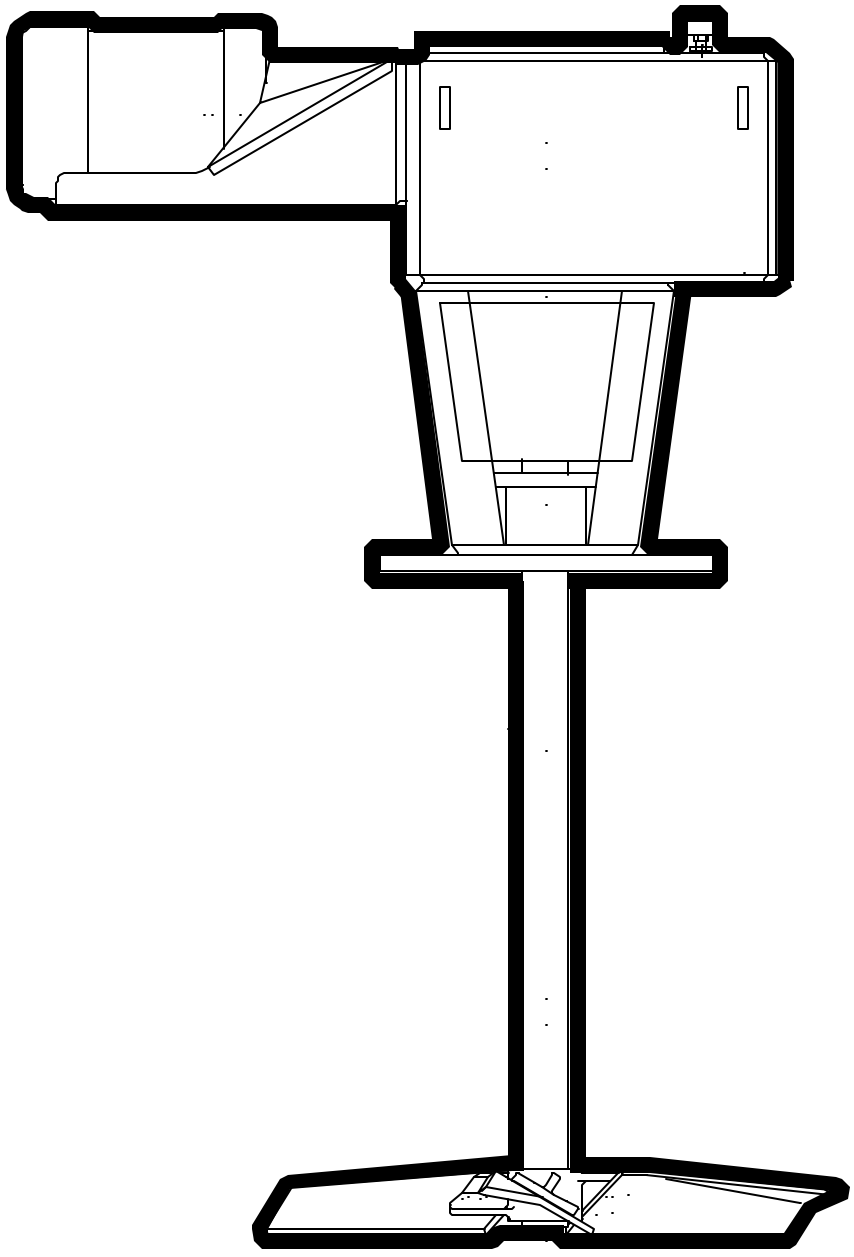
Chemineer

Manual 310

HTA/HTAL/HTL Turbine Agitators Installation, Operation Maintenance Manual



Equipment Reference:

For Service and
Information Contact

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Page

Tables

TABLE OF CONTENTS

Page

Figures

INITIAL INSPECTION

Step 1: Inspect crates. Upon receipt, inspect all crates and equipment for shipping damage. Report shipping damage to your local Chemineer office or to the factory in Dayton, Ohio. A claim should be filed immediately with the carrier involved.

Step 2: Uncrate. Check the contents. Do not uncrate the unit until you have read the *Installation* section of this manual and looked at the assembly drawing shipped with the unit. Be careful in uncrating and handling. Do not discard the crating without carefully making 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.

CHEMINEER ASSISTANCE

Chemineer maintains a fully staffed Parts and Field Service Department ready to help you with any service requirement. Simply contact *your local Chemineer office*, or you can contact Parts/Field Service at the Chemineer Factory in Dayton, Ohio:

Chemineer, Inc.
P.O. Box 1123
Dayton, OH 45401
Phone: (937) 454-3200
FAX: (937) 454-3375

Services available are as follows:

Installation and maintenance training seminars,
Installation and start-up supervision,
Preventive maintenance planning,
Parts order service,
Special instructions.

STORAGE

Do not remove protective coatings until the agitator is to be put into service. If the shipment 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.

At six-month intervals, inspect for external rust. Apply rust preventative as required. If the unit has been in storage for more than six months or subjected to adverse moisture conditions, the motor windings may have to be dried prior to operation.

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 Long-Term Indoor Storage section.

Outdoor or Long-Term Indoor Storage

Storage of agitators and motors outdoors is not recommended. If a unit is stored for an extended period indoors, stored outdoors or decommissioned, the following recommendations apply.

1. Fill the gear drive completely with oil. Refer to *Table 1, page 3*.

   NOTE: The case size referred to in this manual can be determined by the first number in the model designation; for example, "1HTA-5" is a Case Size "1" agitator. Refer to unit assembly drawing or unit nameplate for model number.

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

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

4. Apply a rust preventative to unpainted carbon steel surfaces such as the gear drive output shaft coupling, the gear drive input shaft, the motor output shaft, and the agitator wetted parts (carbon steel) to prevent corrosion during storage.

TABLE 1: STORAGE OIL CAPACITY

CASE SIZE	COMPLETE FILL	
	GALLONS	LITERS
1	3	11
2	6	23
3	9	34
4	15	57
5	21	80
6	27	102
7	58	220
8	86	326
9	120	454
10	175	662
11	225	852
12	344	1302
13	600	2271

5. The unit should be covered to prevent damage by the elements but still allow free air circulation.

CAUTION! Before placing an agitator in 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 "dry well" around the output shaft and could result in leakage at the output shaft seal. The gear drive should be filled with new oil and regreased as indicated in the Lubrication section of this manual.

MOUNTING

HTA, HTAL and HTL style units are designed to mount on an ANSI flange, nozzle or pad located on the vessel top head. See *Figure 1, page 6.*

Unless otherwise specified on the agitator assembly drawing, the agitator extension shaft is designed to run in a true vertical position. The agitator drive assembly must be **level within 1/4 degree.** The angular misalignment may be corrected by machining the nozzle or pad level and flat. In extreme cases, a tapered adapter will be required (supplied by others). Call *Chemineer Field Service* for assistance. *Do not angle or side mount.*

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 and turbine hydraulic (side) force. Torque implies an unchanging load, but the actual operating torque will show plus or minus 10 to 20 percent variability due to turbulent conditions within the agitated fluid. Start up of the agitator with the turbine impacted in solids is beyond the scope of these recommendations. 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 normally pumps downward and generates and upward thrust. The thrust force is generally less than the weight of the unit. Upward pumping turbine thrust force will add to the unit weight. The net effect of the turbine thrust force is to offset or add to the unit weight, contributing to the variability of the support structure loading. The agitator has been designed to accommodate these forces, and as a result, the forces are transmitted directly to the agitator mounting nozzle or pad. The nozzle or pad and vessel top head must be rigid enough support the agitator weight and limit the angular displacement of the agitator drive to .05 degrees as a result of the torque and bending moment. Refer to the agitator assembly drawing for the nozzle or pad design loads.

See *Tables 3 and 4, pages 9 and 10,* 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 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 required vessel head thicknesses greater than the table values.

MOUNTING

Very high ChemScale agitation levels may require vessel head thicknesses 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 7)* can be added.

This information is intended as a guide and does not relieve the user of completely analyzing the entire mounting system.

CAUTION! Optional pad type steady bearing (see Figure 21, page 42) may require the agitator mounting nozzle or pad to be precisely level and concentric with the steady bearing nozzle or pad. Call Chemineer Field Service for assistance.

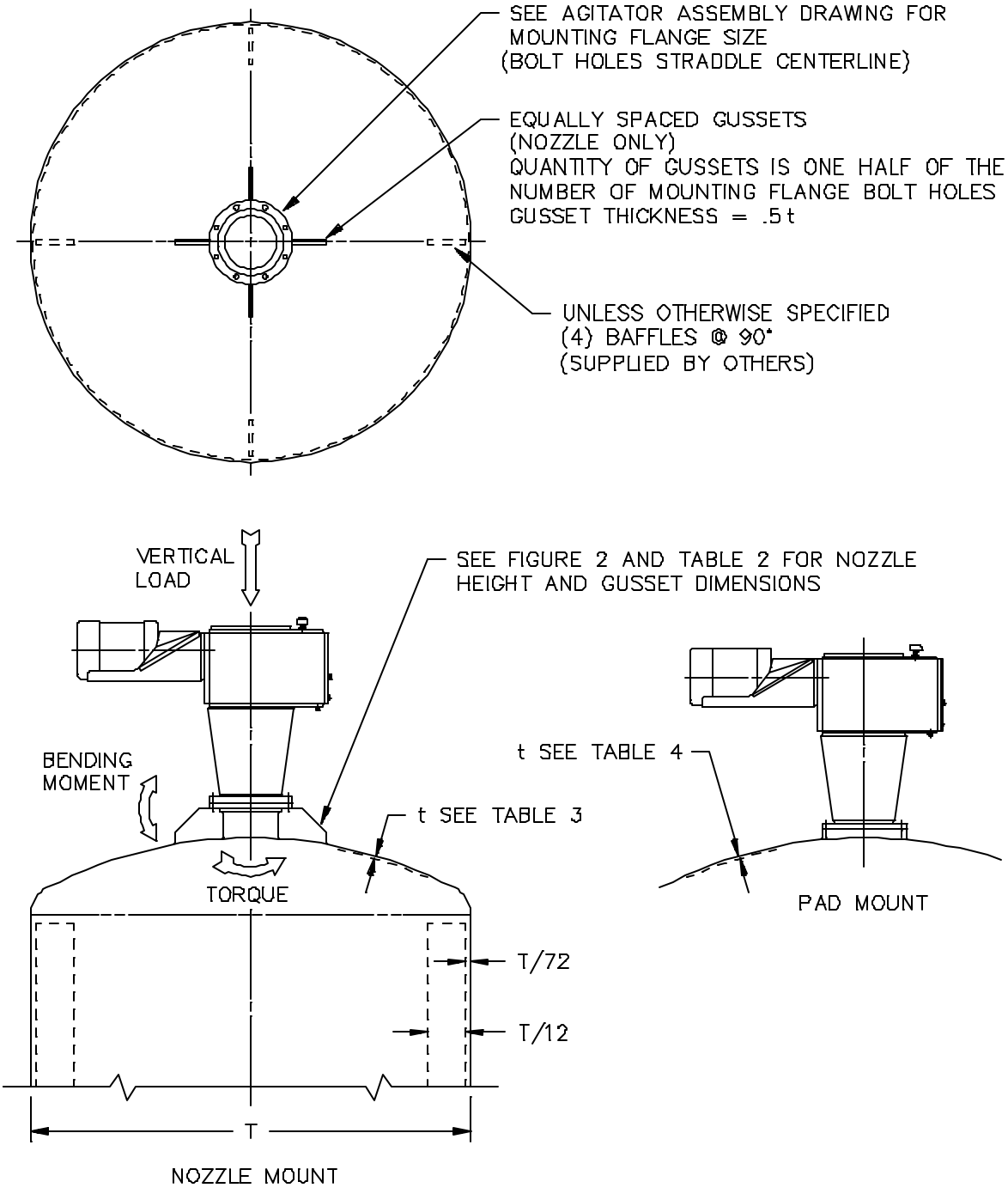


Figure 1: Agitator Mounting

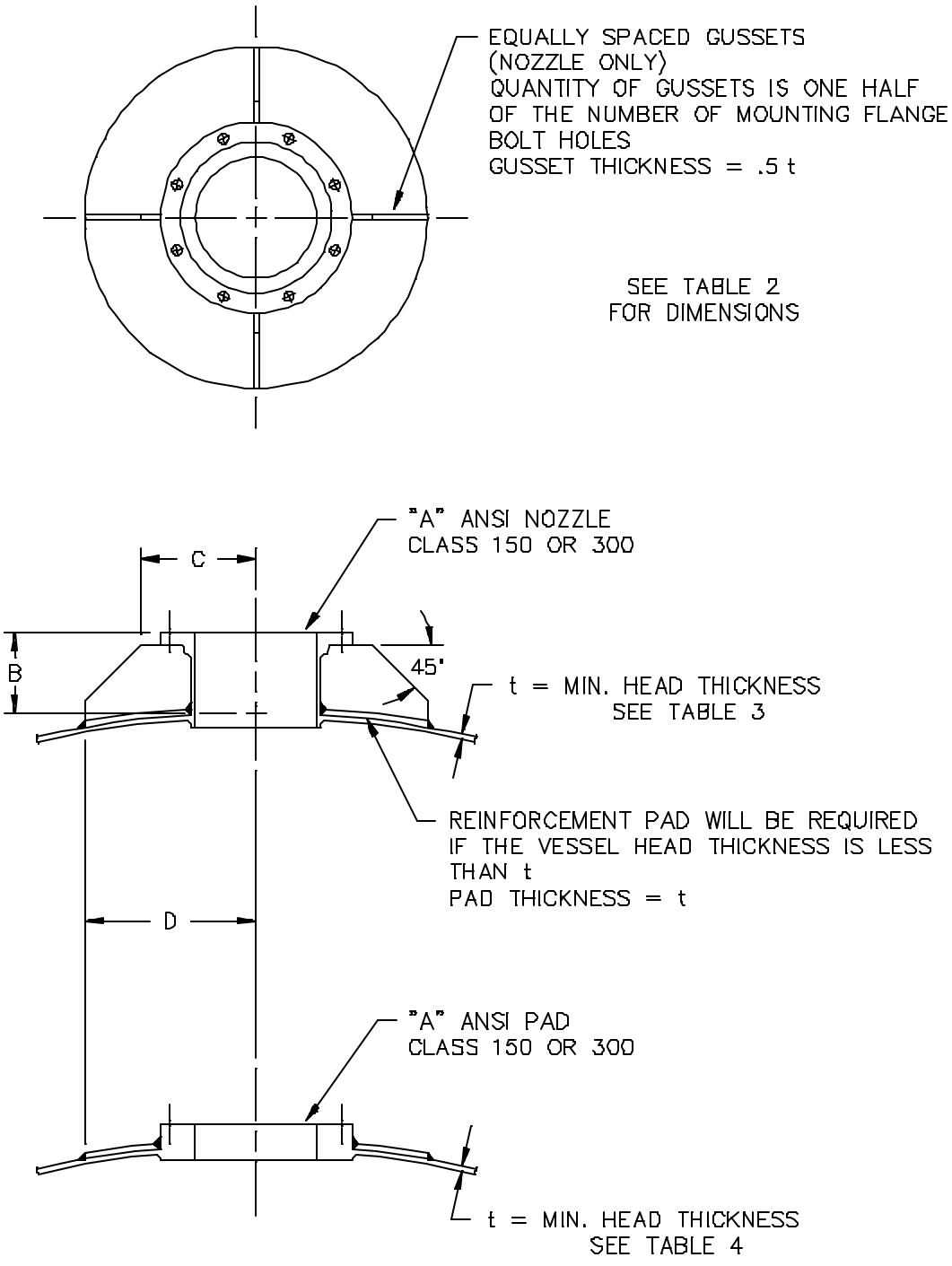


Figure 2: Agitator Mounting Nozzle/Pad

TABLE 2: AGITATOR MOUNTING NOZZLE/PAD REINFORCEMENT DIMENSIONS

Case Size	A	B	C	D
1, 2 & 3	8"	6" (152 mm)	8" (203 mm)	12" (305 mm)
4, 5 & 6	12"	8" (203 mm)	11.5" (292 mm)	17" (432 mm)
7 & 8	16"	8" (203 mm)	13.5" (343 mm)	19" (483 mm)
9	20"	12" (305 mm)	17.5" (445 mm)	26" (660 mm)
10 & 11	24"	12" (305 mm)	19.5" (495 mm)	28" (711 mm)
12 & 13	30"	12" (305 mm)	24" (610 mm)	31" (787 mm)

TABLE 3: VESSEL HEAD THICKNESS (t), NOZZLE MOUNT

Case Size	Nozzle Size [1]	Vessel Diameter, Feet (Meters)				
		4 (1.22)	5 (1.52)	6 (1.83)	7 (2.13)	8 (2.44)
1	8"/10"	.125"(3.18mm)	.187"(4.76mm)	.187"(4.76mm)	.187"(4.76mm)	.250" (6.35 mm)
2	8"/10"	.187" (4.76mm)	.250"(6.35mm)	.250"(6.35mm)	.312"(7.92mm)	.312" (7.92 mm)
3	8"/10"	.312" (7.92mm)	.312"(7.92mm)	.375"(9.53mm)	.437"(9.53mm)	.437" (11.1 mm)
4	12"	.187" (4.76mm)	.250"(6.35mm)	.312"(7.92mm)	.312"(7.92mm)	.375" (9.53 mm)
5	12"	.250" (6.35mm)	.312"(7.92mm)	.375"(9.53mm)	.437"(11.1mm)	.500" (12.7 mm)
6	12"	.375" (9.53mm)	.437"(11.1mm)	.500"(12.7mm)	.562"(14.3mm)	.625" (15.9 mm)
7	16"	---	---	.375"(9.53mm)	.437"(11.1mm)	.500" (12.7 mm)
8	16"	---	---	.500"(12.7mm)	.562"(14.3mm)	.562" (14.3 mm)
9	20"	---	---	---	.437"(11.1mm)	.500" (12.7 mm)
10	24"	---	---	---	---	.500" (12.7 mm)
11	24"	---	---	---	---	.500" (12.7 mm)
12	30"	---	---	---	---	---
13	30"	---	---	---	---	---

Case Size	Nozzle Size[1]	Vessel Diameter, Feet (Meters)				
		9 (2.74)	10 (3.05)	12 (3.66)	15 (4.57)	20 (6.10)
1	8"/10"	.250"(6.35mm)	.250"(6.35mm)	.312"(7.92mm)	.312"(7.92mm)	.375" (9.53 mm)
2	8"/10"	.375"(9.53mm)	.375"(9.53mm)	.375"(9.53mm)	.437"(11.1mm)	.437" (11.1 mm)
3	8"/10"	.500"(12.7mm)	.500"(12.7mm)	.500"(12.7mm)	.562"(14.3mm)	.562" (14.3 mm)
4	12"	.437" (11.1mm)	.437"(11.1mm)	.500"(12.7mm)	.562"(14.3mm)	.625" (15.9 mm)
5	12"	.500" (12.7mm)	.562"(14.3mm)	.625"(15.9mm)	.75" (19.1 mm)	.75" (19.1 mm)
6	12"	.625" (15.9mm)	.75" (19.1 mm)	.75" (19.1 mm)	.875"(22.2mm)	.875" (22.2 mm)
7	16"	.562" (14.3mm)	.562"(14.3mm)	.625"(15.9mm)	.75" (19.1 mm)	.875" (22.2 mm)
8	16"	.625" (15.9mm)	.687"(17.5mm)	.75" (19.1 mm)	.875"(22.2mm)	1.00" (25.4 mm)
9	20"	.562" (14.3mm)	.625"(15.9mm)	.687"(17.5)	.875"(22.2mm)	1.00" (25.4 mm)
10	24"	.562" (14.3mm)	.625"(15.9mm)	.75" (19.1 mm)	.875"(22.2mm)	1.00" (25.4 mm)
11	24"	.562" (14.3mm)	.625"(15.9mm)	.75" (19.1 mm)	.875"(22.2mm)	1.00" (25.4 mm)
12	30"	---	.625"(15.9mm)	.75" (19.1 mm)	.875"(22.2mm)	1.25" (31.7 mm)
13	30"	---	---	1.00"(25.4mm)	1.25"(31.7mm)	1.50" (38.1 mm)

[1] Vessel head thickness (t), may be reduced if the nozzle pressure class is greater than 150. Consult factory for recommendations. Refer to Assembly Drawing for actual nozzle size.

TABLE 4: VESSEL HEAD THICKNESS (t), PAD MOUNT

Case Size	Pad[1] Size 150#	Vessel Diameter, Feet (Meters)				
		4 (1.22)	5 (1.52)	6 (1.83)	7 (2.13)	8 (2.44)
1	8"/10"	.125"(3.18mm)	.125"(3.18mm)	.125"(3.18mm)	.125"(3.18mm)	.125" (3.18 mm)
2	8"/10"	.125" (3.18mm)	.125"(3.18mm)	.125"(3.18mm)	.187"(4.76mm)	.187" (4.76 mm)
3	8"/10"	.187" (4.76mm)	.187"(4.76mm)	.187"(4.76mm)	.250"(6.35mm)	.250" (6.35 mm)
4	12"	.187" (4.76mm)	.187"(4.76m)	.187"(4.76m)	.187"(4.76m)	.187" (4.76 mm)
5	12"	.250" (6.35mm)	.250"(6.35mm)	.250"(6.35mm)	.250"(6.35mm)	.250" (6.35 mm)
6	12"	.250" (6.35mm)	.250"(6.35mm)	.250"(6.35mm)	.312"(7.92mm)	.312" (7.92 mm)
7	16"	---	---	.250"(6.35m)	.250"(6.35mm)	.250" (6.35 mm)
8	16"	---	---	.312"(7.92mm)	.312"(7.92mm)	.312" (7.92 mm)
9	20"	---	---	---	.312"(7.92mm)	.312" (7.92 mm)
10	24"	---	---	---	---	.375" (9.53 mm)
11	24"	---	---	---	---	.375" (9.53 mm)
12	30"	---	---	---	---	---
13	30"	---	---	---	---	---

Case Size	Pad[1] Size 150#	Vessel Diameter, Feet (Meters)				
		9 (2.74)	10 (3.05)	12 (3.66)	15 (4.57)	20 (6.10)
1	8"/10"	.125"(3.18mm)	.125"(3.18mm)	.125"(3.18mm)	.187"(4.76mm)	.250" (6.35 mm)
2	8"/10"	.187" (4.76mm)	.187"(4.76mm)	.250"(6.35mm)	.312"(7.92mm)	.375" (9.53 mm)
3	8"/10"	.250" (6.35m)	.312"(7.92mm)	.312"(7.92mm)	.375"(9.53mm)	.437" (11.1 mm)
4	12"	.250" (6.35mm)	.250"(6.35mm)	.250"(6.35mm)	.375"(9.53mm)	.500" (12.7 mm)
5	12"	.312" (7.92mm)	.312"(7.92mm)	.375"(9.53mm)	.437"(11.1mm)	.500" (12.7 mm)
6	12"	.375" (9.53mm)	.375"(9.53mm)	.437"(11.1mm)	.500"(12.7mm)	.625" (15.9 mm)
7	16"	.312" (7.92mm)	.312"(7.92mm)	.375"(9.53mm)	.437"(11.1mm)	.562" (14.3 mm)
8	16"	.375" (9.53mm)	.375"(9.53mm)	.437"(11.1mm)	.500"(12.7mm)	.625" (15.9 mm)
9	20"	.375" (9.53mm)	.375"(9.53mm)	.437"(11.1mm)	.500"(12.7mm)	.625" (15.9 mm)
10	24"	.437" (11.1mm)	.437"(11.1mm)	.437"(11.1mm)	.562"(14.3mm)	.687" (17.5 mm)
11	24"	.375" (9.53mm)	.437"(11.1mm)	.437"(11.1mm)	.562"(14.3mm)	.687" (17.5 mm)
12	30"	---	.500"(12.7mm)	.500"(12.7mm)	.625"(15.9mm)	.75" (19.1 mm)
13	30"	---	---	.625"(15.9mm)	.75" (19.1 mm)	1.00" (25.4 mm)

[1] Vessel head thickness (t), may be reduced if the pad pressure class is greater than 150#. Consult factory for recommendations. Refer to Assembly Drawing for actual pad size.

INSTALLATION

AGITATOR

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

1. The HT agitator is shipped in two or more crates: one for extension shaft **[400]** and impeller **[500]** and one for the agitator drive *(Figure 3, page 13)*. Optional accessories, multiple impellers and large motors may be crated separately.

2. Remove all shipping restraints. A hoist or crane system for the lifting of the agitator parts must be available. Refer to *Figure 4, page 15* for lifting. The approximate net weight of the unit is shown on the unit assembly drawing.

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

4. HTA Units *(Figure 5, page 18)*

   4a. Lift the agitator drive assembly, less extension shaft **[400]** and assemble to the vessel nozzle or pad with the proper gasket and mounting bolts (supplied by others) and torque to the value shown in *Table 5, page 14.*

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

   4b. Remove gland plate **[1305]**, split gland **[1306]**, packing **[1307]** and lantern ring **[1308]** (six-ring stuffing box only).

   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.

AGITATOR

4c. Remove removable taper bore coupling half **[363]** from the extension shaft. Lift the extension shaft and lower it into the vessel. Lift the shaft up through stuffing box **[1301]** from inside of the vessel. Block the shaft from inside the vessel such that the shaft extends above the stuffing box housing. Install packing, lantern ring, split gland and gland plate over the shaft.

4d. Install the extension shaft coupling half. Refer to *INSTALLATION, Rigid Shaft Couplings* for instructions.

4e. Lift and block the extension shaft so that the extension shaft coupling half is close enough to gear drive coupling half **[351]** to allow installation of coupling bolts and lockwashers **[361, 362]**. The face and tenon of all rigid couplings must be perfectly clean and free of nicks. Line up match marks and install two bolts at 180°. Tighten the bolts to engage the tenon and pull the coupling faces together.

4f. Install the remaining coupling bolts and lockwashers. Torque to the value shown in *Table 5, page 14*. Remove the shaft blocking.

5. HTAL Units *(Figure 6, page 19)*, HTL Units *(Figure 7, page 20)*

5a. Unbolt gear drive **[200]** and remove from pedestal **[1101]**. Install the pedestal assembly on the vessel nozzle or pad with the proper gasket and mounting bolts (supplied by others) and torque to the value shown in *Table 5*.

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

5b. Model HTAL: Remove gland plate **[1305]**, split gland **[1306]** and packing **[1307]**.

5c. Model HTL: Remove snap ring **[1802]** and lip seal **[1803]** from flange **[1801]**.

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 turbine/extension shaft assemblies. Contact Chemineer Field Service for instructions.

5d. Refer to *INSTALLATION, Rigid Shaft Couplings,* if the extension shaft is supplied without the coupling half installed.

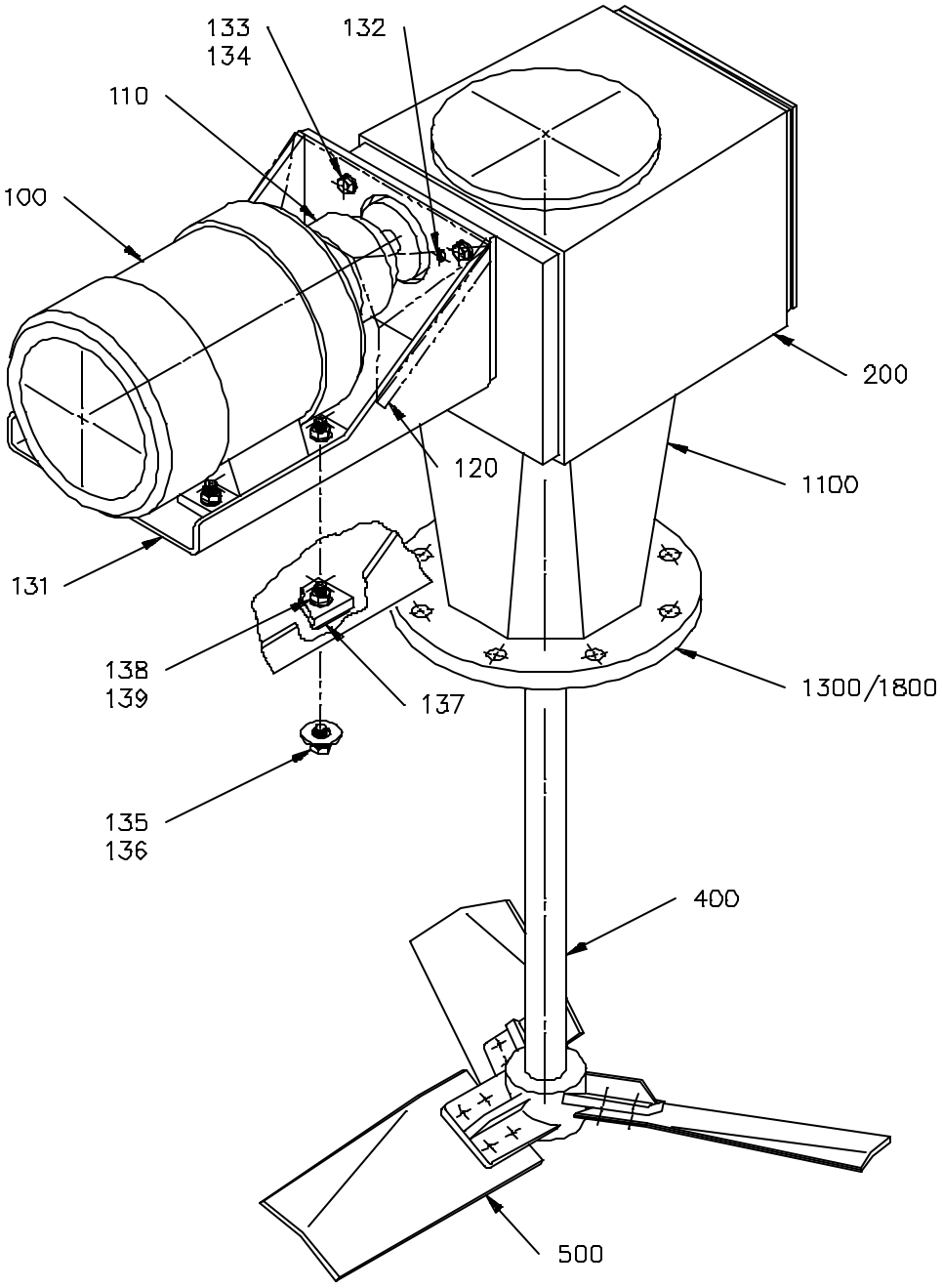


Figure 3: Model HTA, HTAL, HTL Agitator Assembly

AGITATOR

TABLE 5: BOLT TIGHTENING TORQUE[1],[2]

Bolt Size	CARBON STEEL[3]				300 Series Stainless Steel, Alloy 20, Monels, Inconels & Hastelloys B & C[4]	
	Grade 2		Grade 5			
	ft-lb	Nm	ft-lb	Nm	ft-lb	Nm
8 - 32	1.2	1.6	1.9	2.5	1.2	1.6
10 - 24	1.7	2.3	2.7	3.6	1.7	2.3
10 - 32	1.9	2.6	3.1	4.1	1.9	2.6
1/4 - 20	4.1	5.6	6	8.1	4.1	5.6
5/16 -18	8.3	11	13	17	8.3	11
5/16 -24	9	12	14	19	9	12
3/8 - 16	15	20	23	31	15	20
1/2 - 13	38	51	56	76	38	51
9/16 -12	50	68	83	113	50	68
5/8 - 11	68	92	113	153	68	92
3/4 - 10	120	163	200	271	120	163
7/8 - 9	105	143	296	401	182	247
1 - 8	165	224	443	601	273	370
1 ! 1/8-7	225	305	596	808	386	523
1 ! 1/4-7	315	428	840	1139	545	739
1 ! 3/8-6	417	566	1103	1495	715	969
1 ! 1/2-6	555	752	1463	1983	948	1286

[1] Tighten all fasteners to values shown unless specifically instructed to do otherwise.
[2] Lubricate all fasteners at assembly with grease, oil or an anti-seize material. Bolt threads and contact surfaces of bolt heads and nuts should be lubricated.
[3] If fasteners cannot be lubricated, multiply table values by 1.33.
[4] If fasteners cannot be lubricated, multiply table values by 1.25.

AGITATOR

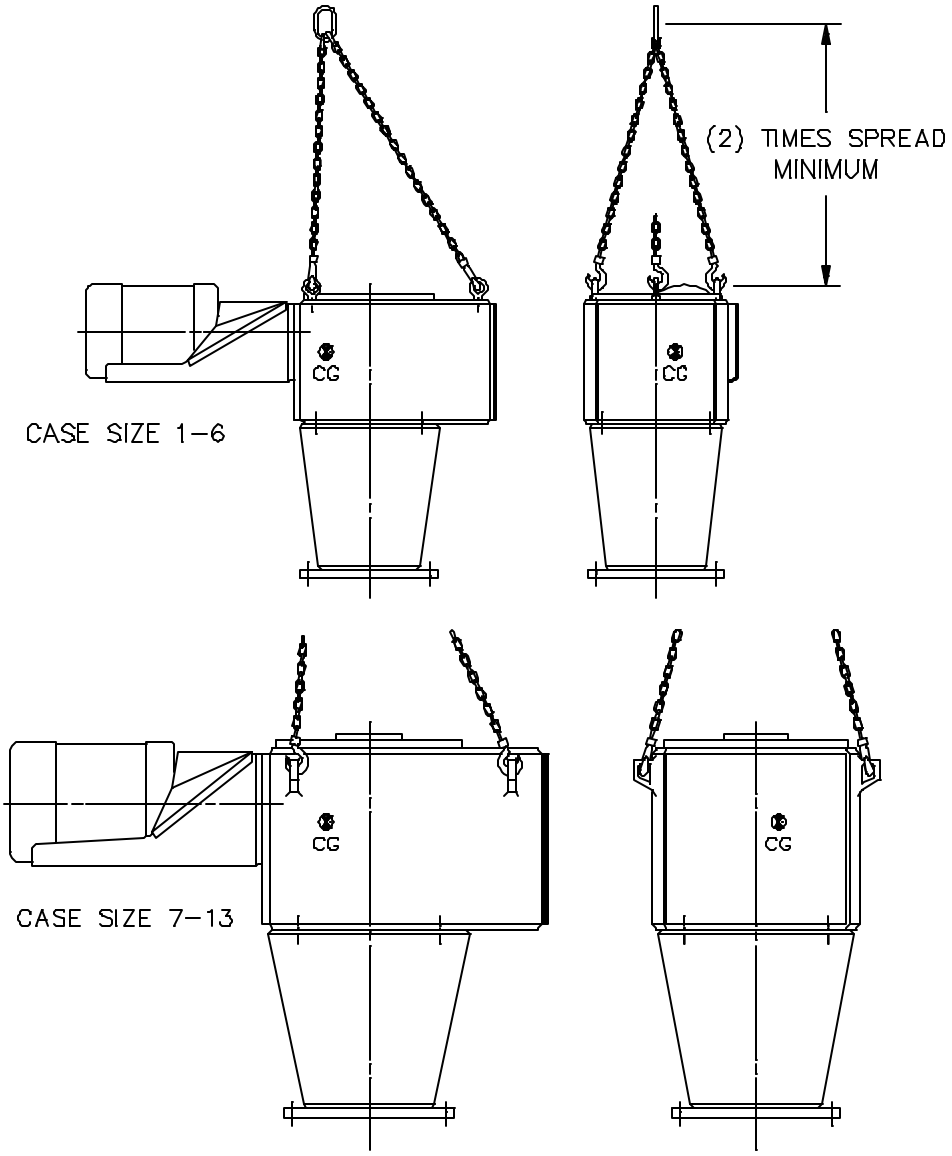


Figure 4: Agitator Lifting System

For case sizes 1-6, use a three point chain fall utilizing the three eyebolts installed in the top of the gear drive.

For case sizes 7-13, use a four point chain fall utilizing the lifting lugs located on the sides of the gear drive.

CAUTION: Do not lift the agitator drive with any lifting lugs attached to the motor.

AGITATOR

5e. Model HTAL: Lift the extension shaft from the coupling end. Place the packing and the gland plate over the extension shaft and lower the extension shaft into the vessel through the pedestal assembly.

5f. Model HTL: Lift the extension shaft from the coupling end. Place the lip seal and snap ring over the extension shaft and lower the extension shaft into the vessel through the pedestal assembly.

5g. Block the shaft in place with the extension shaft coupling half extending above the pedestal assembly.

5h. Lift and suspend the gear drive assembly over the extension shaft coupling half close enough to allow installation of coupling bolts and lockwashers **[361, 362]**. The face and tenon of all rigid couplings must be perfectly clean and free of nicks. Line up match marks and install two bolts at 180°. Tighten the bolts to engage the tenon and pull the coupling faces together.

5i. Lift the agitator drive assembly and the extension shaft. Remove the shaft blocking.

5j. Lower the agitator drive assembly onto the pedestal assembly. Rebolt the gear drive to the pedestal. Install shoulder bolts **[1102]** first to ensure alignment, then install bolts and lockwashers **[1103, 1104]**. Torque to the value shown in *Table 5, page 14*.

5k. Install the remaining coupling bolts and lockwashers. Torque to the value shown in *Table 5*.

6. Model HTA: Install packing, lantern ring, split gland (holes at top) and gland plate.

7. Model HTAL: Install packing, split gland (holes at top) and gland plate.

8. Model HTL: Assemble the lip seal and snap ring to the lip seal flange.

9. Stuffing box shaft seals will require adjustment at start up. See the *Lubrication* and *Maintenance* sections of this manual.

10. 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.

AGITATOR

11. Total shaft runout should not exceed .003" per foot (.25 mm per meter) FIM (Full Indicator Movement) of shaft length. If the shaft runout is excessive, the shaft can be restraightened 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 flange 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" (.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 to 3" (50 to 70 mm) to avoid reheating in the same location.

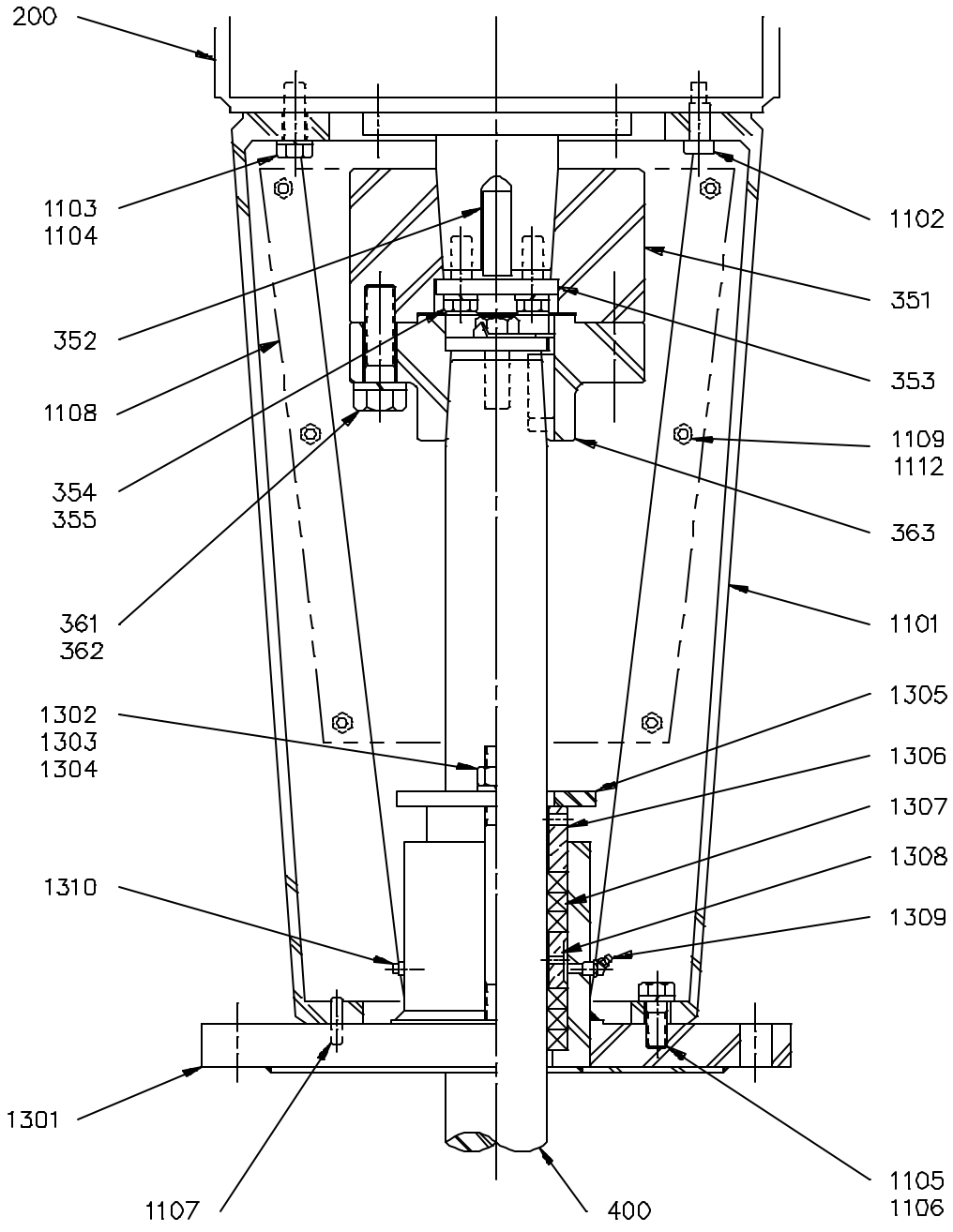


Figure 5: Model HTA

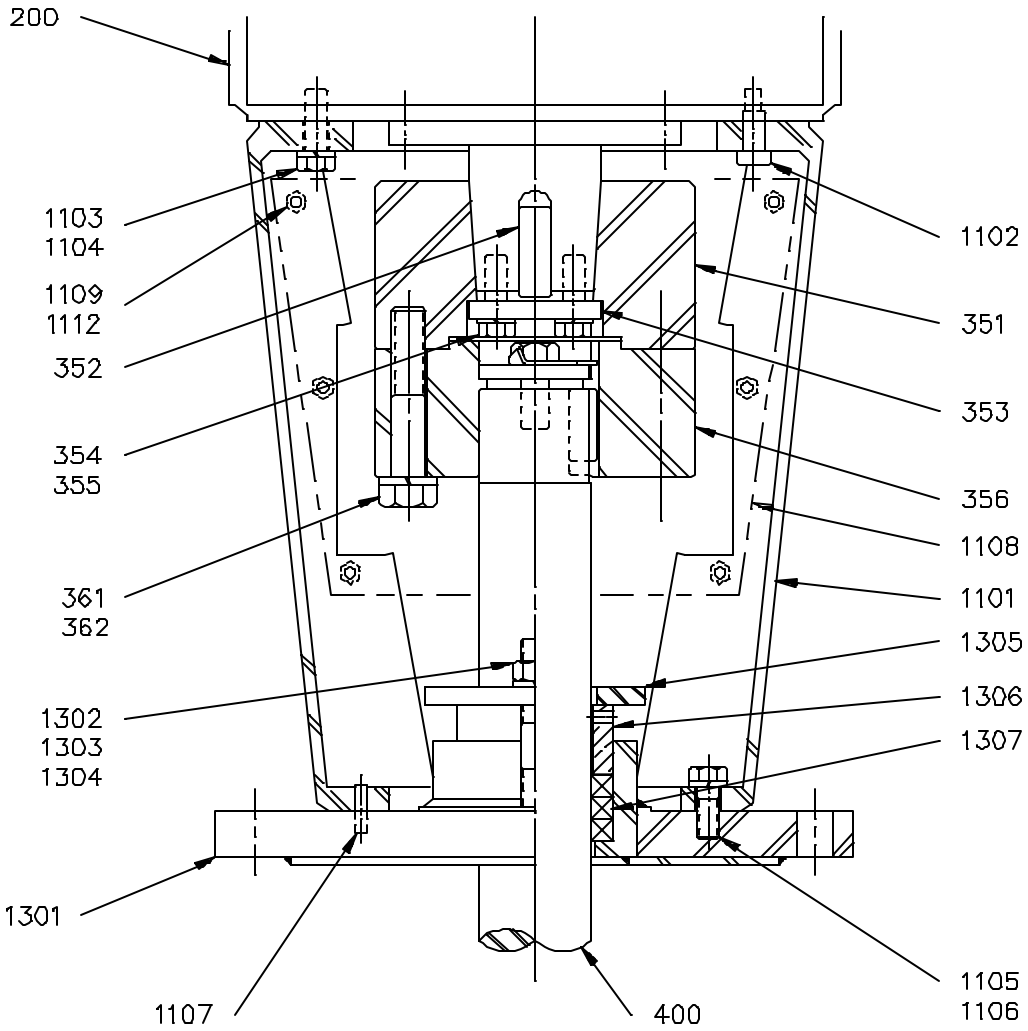


Figure 6: Model HTAL

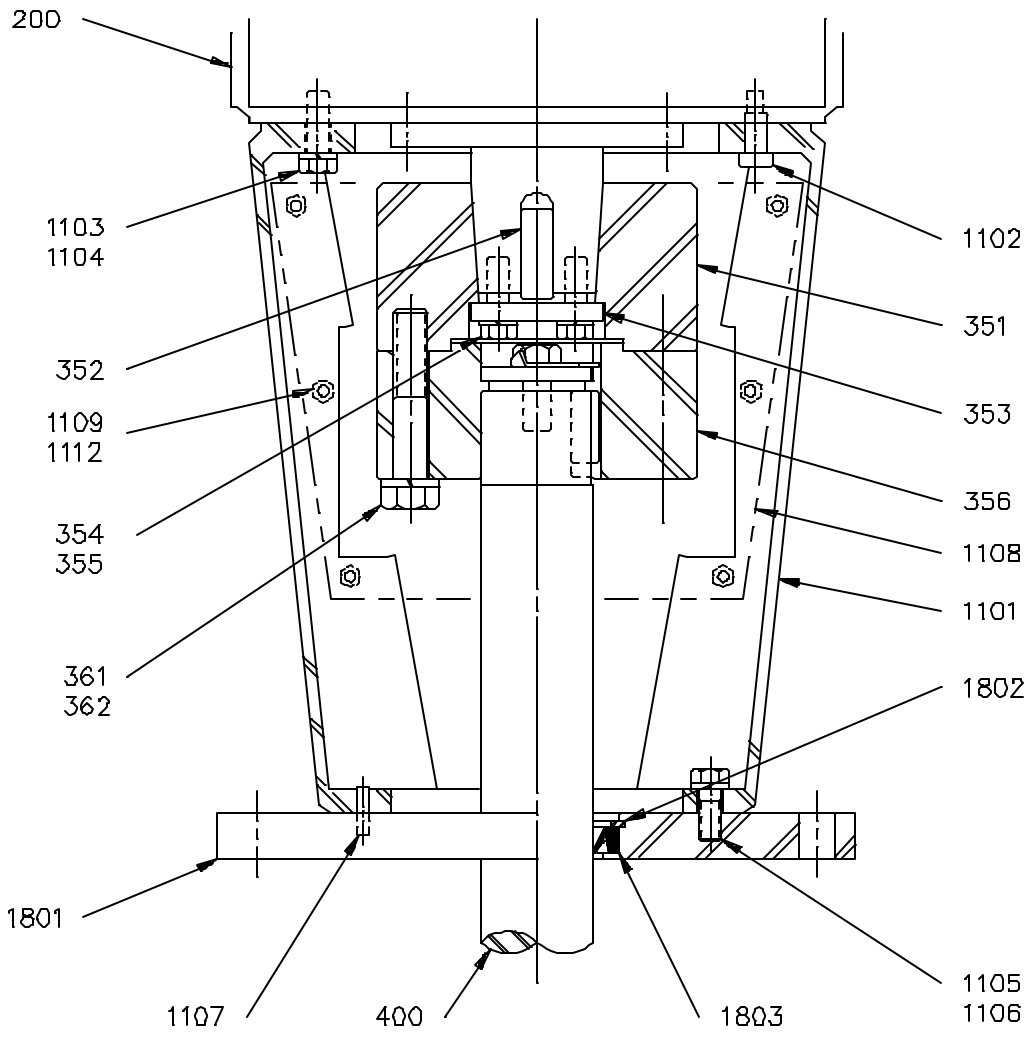


Figure 7: Model HTL

IMPELLERS

Unless otherwise specified on the unit assembly drawing, the impeller attaches to the shaft with a key and setscrew. Refer to *Figure 8, page 22*. 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. All 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.

Markings for Serial Number 1-XXXXX-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.

Markings for Serial Number 1-XXXXX-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.

IMPELLERS

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

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

3. Tighten square head setscrew **[505]** firmly onto the key. Torque to the value shown in *Table 5, page 14*. The tapped hole for the setscrew is a self-locking thread form. Auxiliary fastener locking is not necessary.

4. Bolt extension blades **[506]** to the hub with bolts, nuts and lockwashers **[507, 508, 509]**. *Refer to Figures 9-14, pages 23-28*. 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 to the values shown in *Table 5*.

   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.

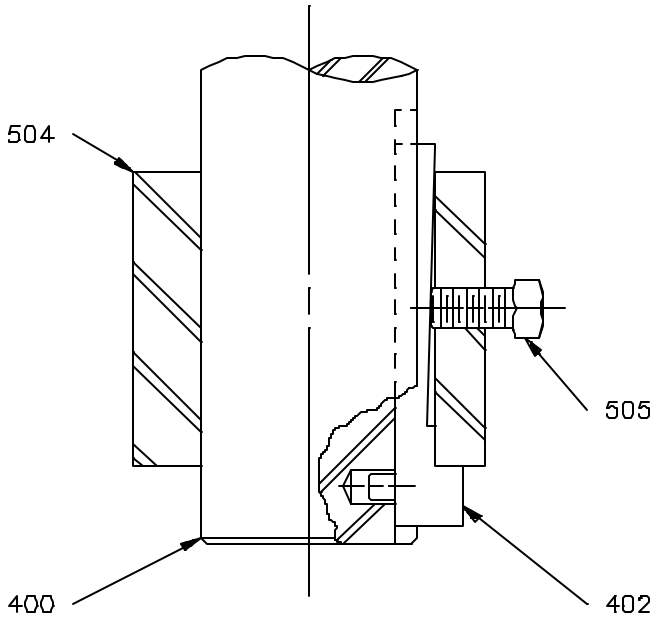


Figure 8: Hub and Pin Key Detail

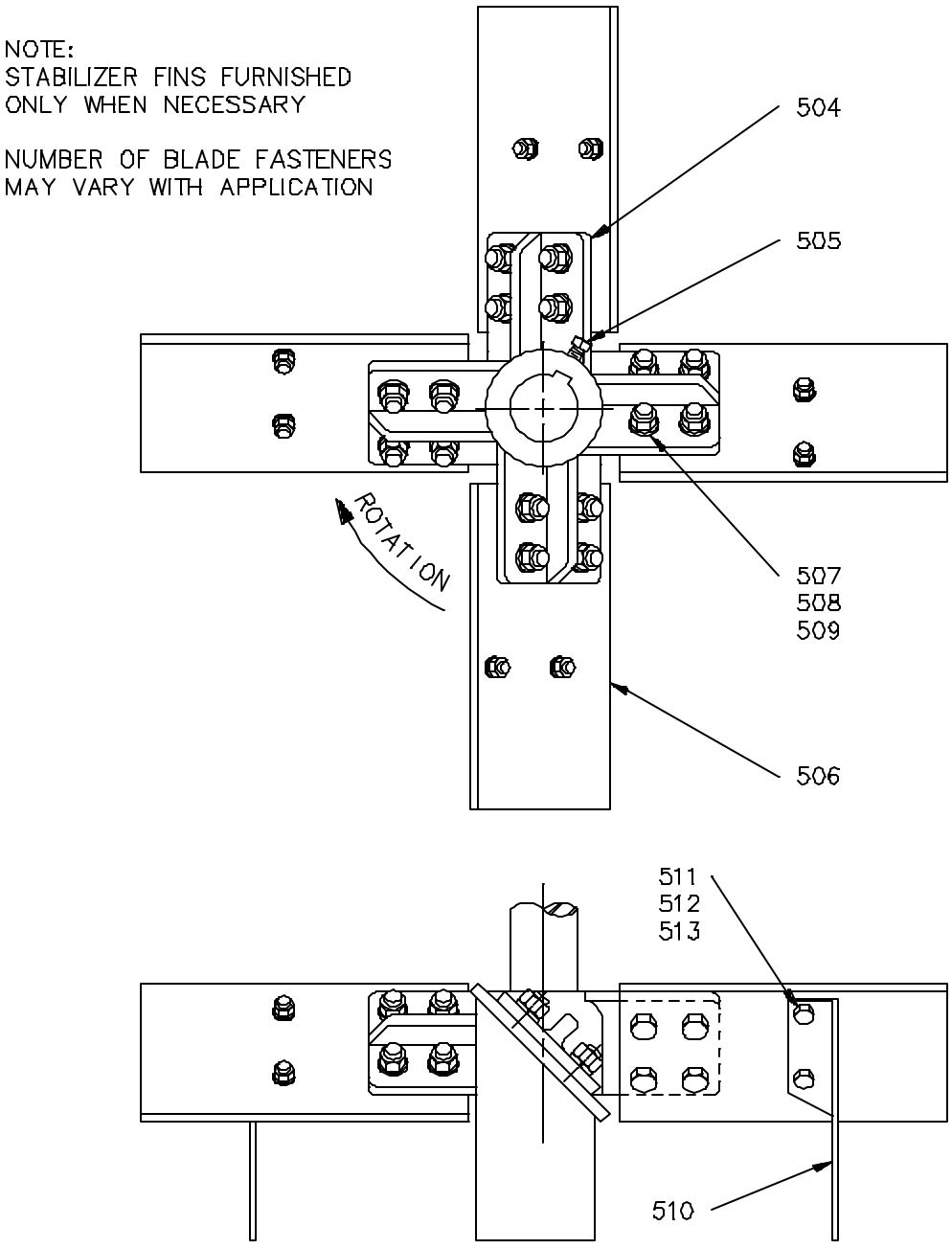


Figure 9: Style P-4 Impeller

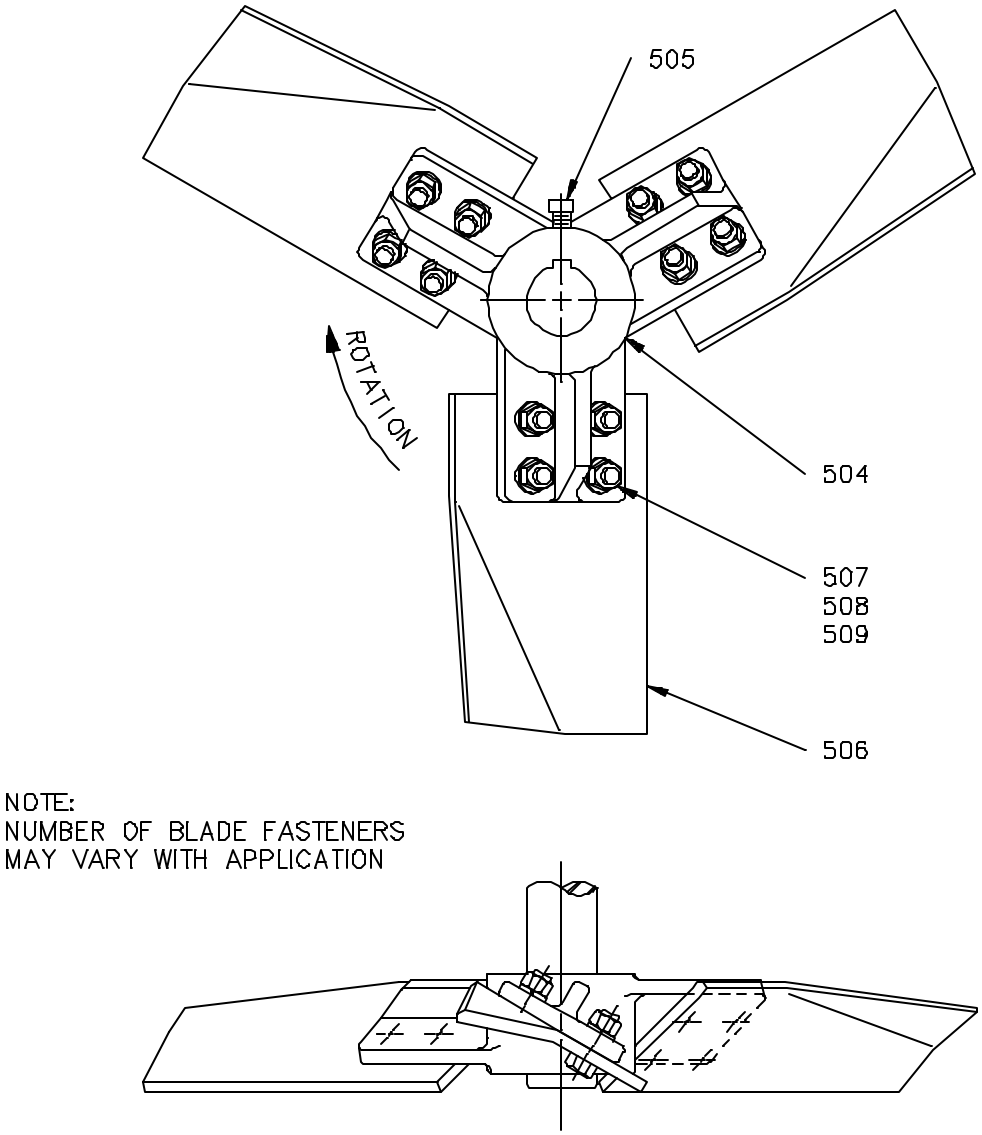


Figure 10: Style HE-3 Impeller

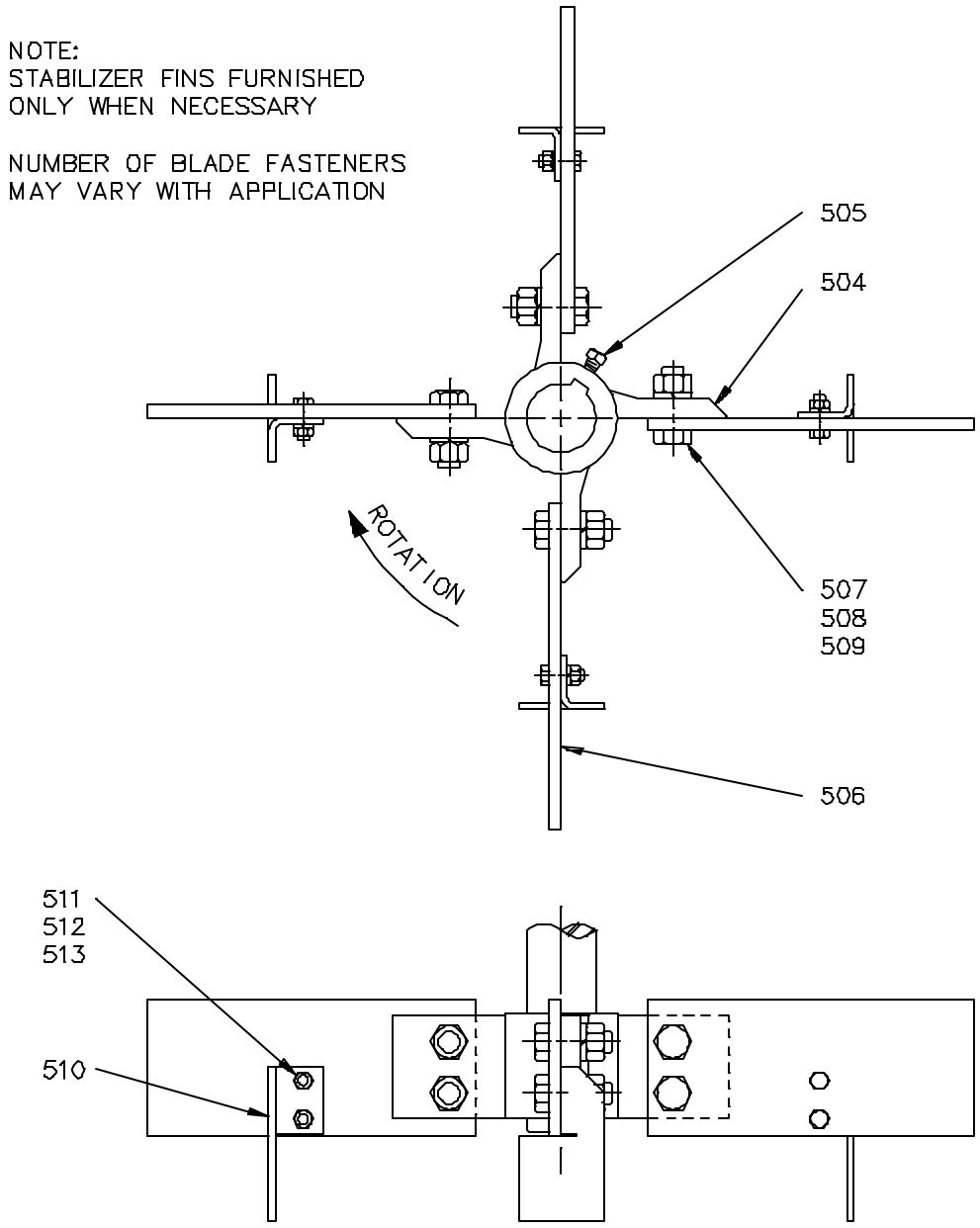


Figure 11: Style S-4 Impeller

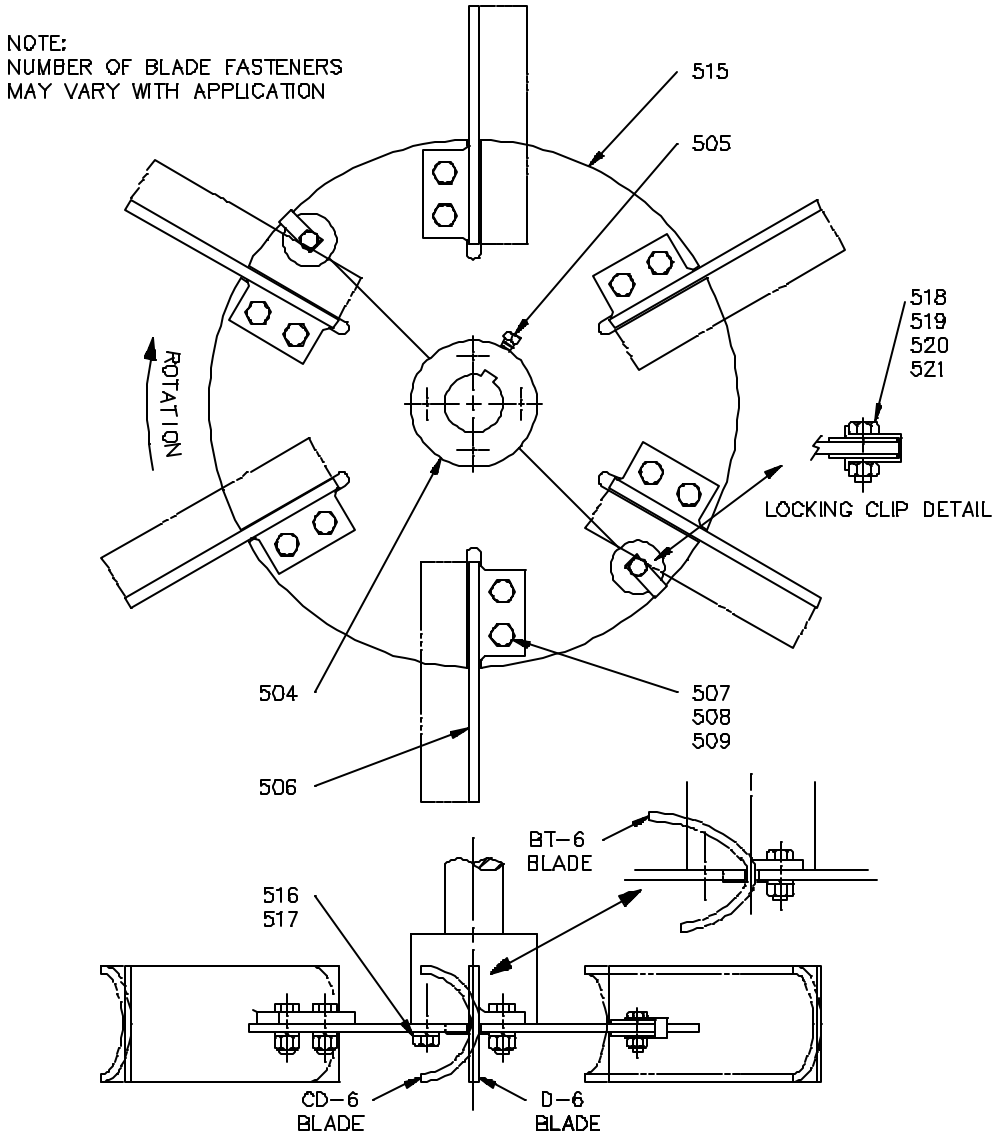


Figure 12: Style D-6 Impeller

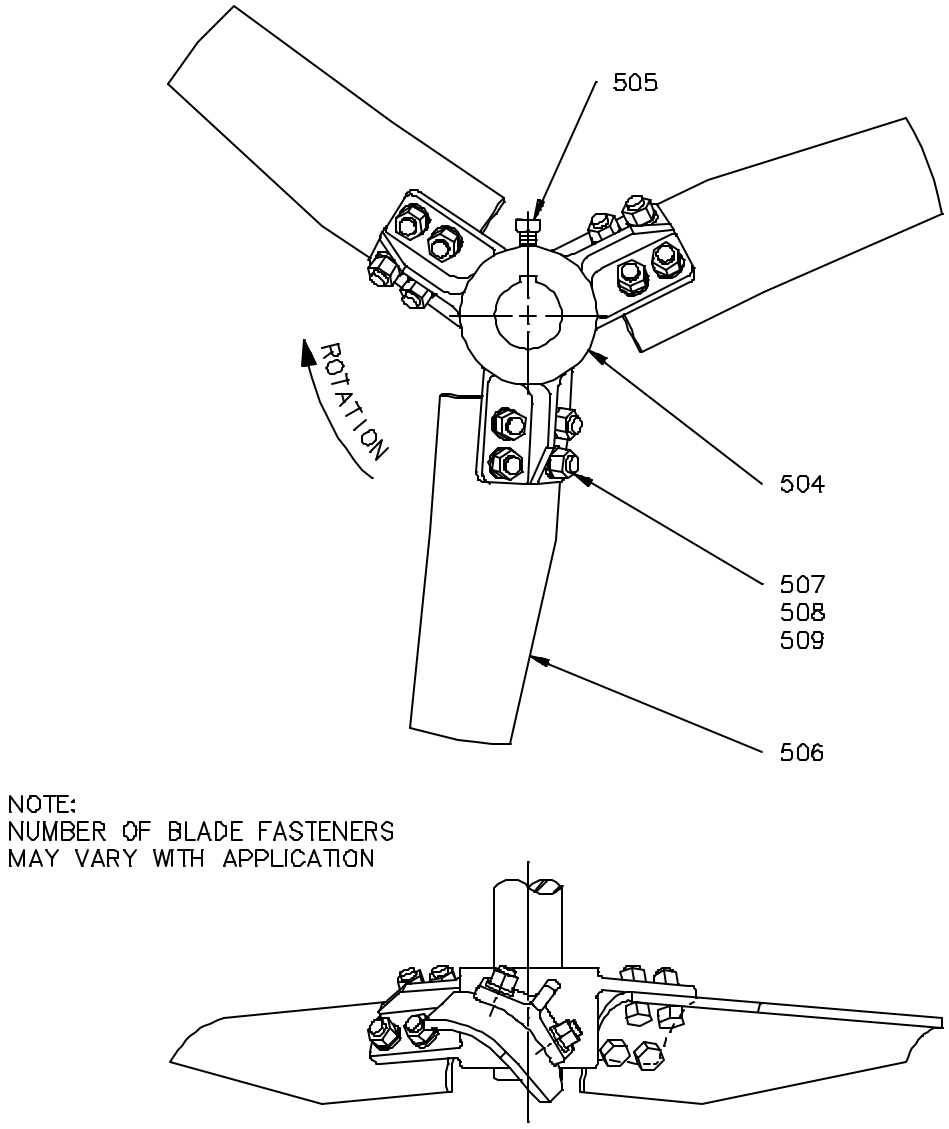


Figure 13: Style SC-3 Impeller

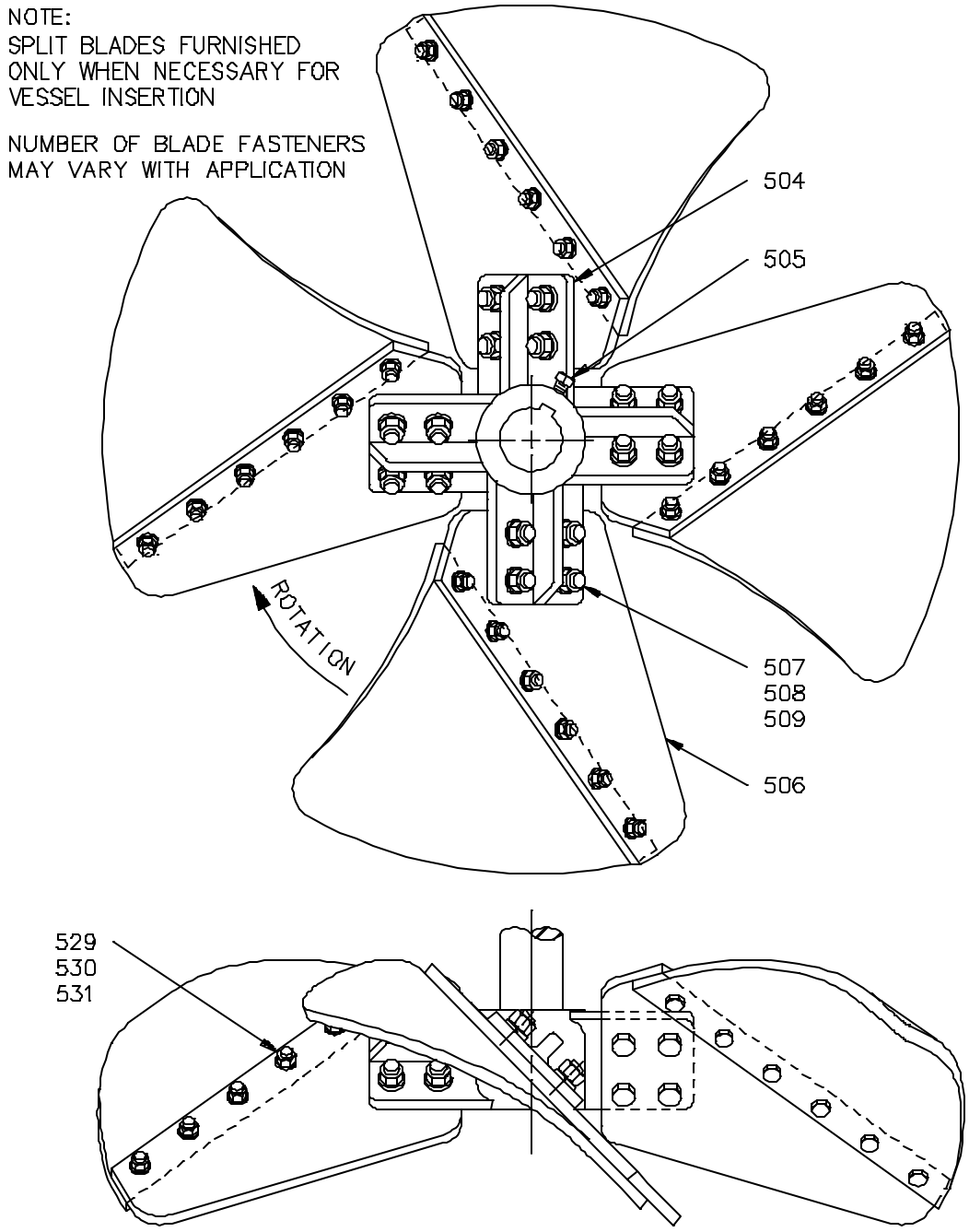


Figure 14: Style Maxflo W Impeller

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.

Impeller diameter # 84" (2133 mm) :
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 for impeller diameters > 84".

Impeller diameter > 84" (2133 mm) :
The impeller is supplied as a one-piece (welded) coated/covered assembly. For attachment to the shaft, refer to *Figure 15, page 30.*

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]** *is 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 *Table 5, page 14*.

7. Remove the hoist from the impeller.

IMPELLERS

(Coated/Rubber Covered)

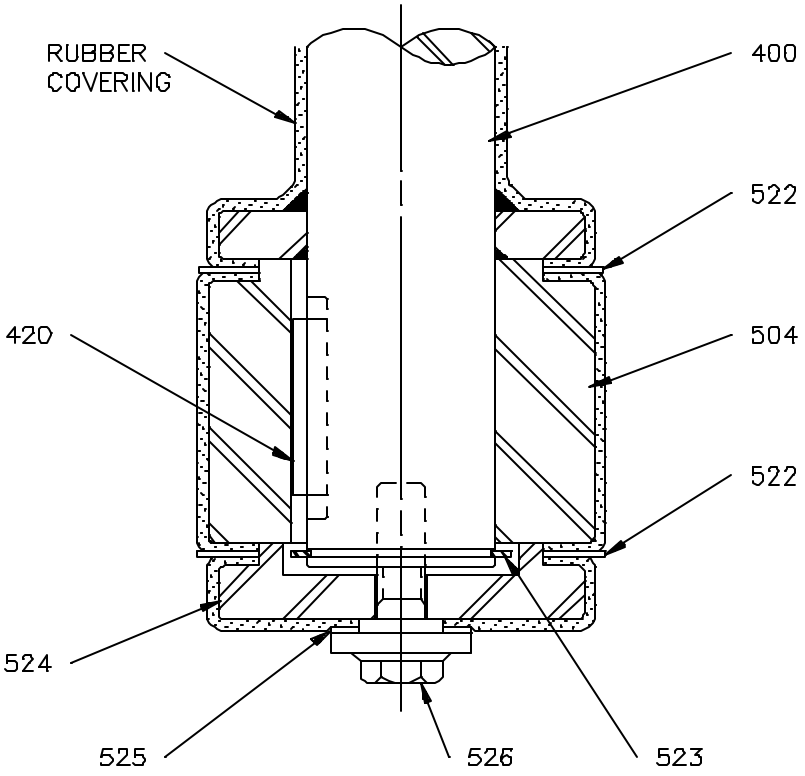


Figure 15: Thrust Bolt Impeller Attachment

GEAR DRIVE

CAUTION! The gear drive has been drained of oil for shipping. Add oil to the gear drive according to the *Lubrication* section.

MOTOR

1. Check the nameplate data on the motor to assure that the available power supply agrees with the motor requirements. Protective devices should be of the proper size and rating to safely carry the load and interrupt the circuit on overloads.

2. Turn the shaft by hand to check that it turns freely.

3. If the 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.

4. Connect the motor in accordance with the National Electric Code and local requirements, but do not make the connections permanent until the motor rotation has been checked.

   Identify motor auxiliary devices such as space heaters or temperature sensors. Connect them in proper circuits and insulate them from motor power cables.

5. Jog the motor to check for correct rotation prior to securing wiring.

FLEXIBLE MOTOR COUPLING

The standard flexible motor couplings **[110]** *(Figure 3, page 13)* used on Chemineer HT agitators are as follows:

T.B. Woods "Sure-Flex" couplings are supplied for motor frames up to and including Series 320T.

Falk "T-10" couplings are supplied for motor frame Series 360T and larger.

Check the unit assembly drawing for the manufacturer, type and size coupling. Refer to *Vendor Data, Flexible Motor Couplings* for Installation, Alignment, Lubrication, Operation, and Maintenance instructions.

Verify coupling alignment and correct if necessary.

RIGID SHAFT COUPLINGS

All HT gear drive coupling halves **[351]** are rigid, removable taper bore 2 bolt design, and are installed at the factory.

The extension shaft for HTA style units normally has a rigid, removable taper bore coupling half. See *Figure 17, page 34* for assembly.

The extension shaft for HTAL and HTL style units normally has a rigid, non-removable, shrink (interference) fit, straight bore coupling half installed by customer at assembly. Units supplied with (1) a shaft covering or coating, (2) a non-removable, in-tank shaft coupling or (3) an impeller hub which would be "trapped" on the shaft, are all supplied without the extension shaft coupling half installed.

If the unit requires assembly of the shaft coupling half, see *page 33*. *NOTE: Be sure to install any impeller hub, etc. which may be "trapped" on the shaft prior to installing a non-removable, shrink fit, straight bore coupling half.*

If the unit's extension shaft has a rigid, removable taper bore coupling half that was not installed at the factory, see *page 34*.

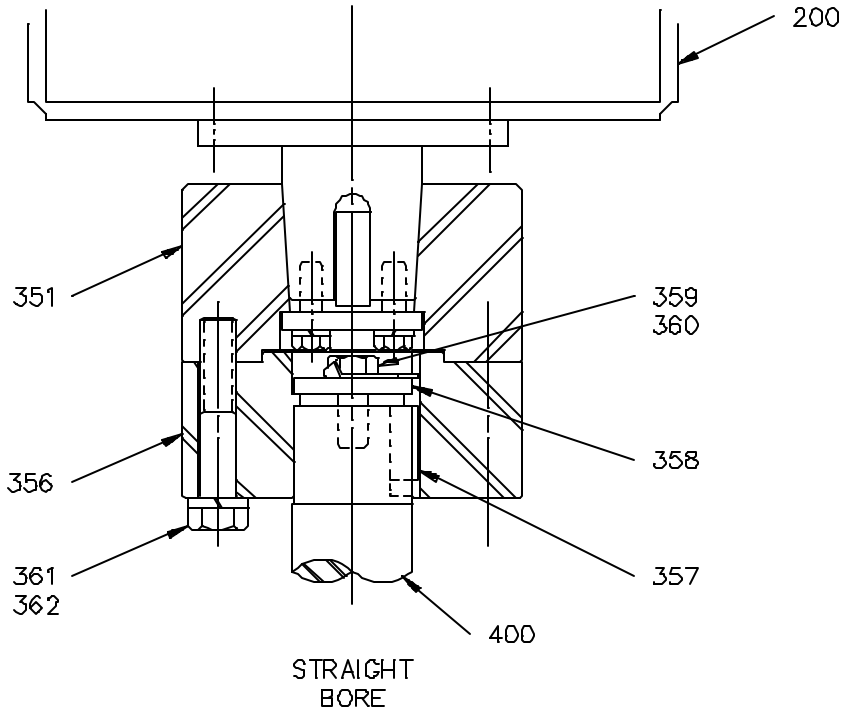


Figure 16: Shrink Fit Coupling Half [356]

RIGID SHAFT COUPLINGS

Assembly of Rigid, Non-removable, Shrink Fit, Straight Bore Coupling Half *(Figure 16, page 32)*

1. Clean the shaft and coupling bore and make sure that both surfaces are free from burrs or nicks. Place key **[357]** 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. Heat the coupling half per *Table 6* and install on the shaft.

TABLE 6: COUPLING HALF SHRINK FIT TEMPERATURE

Coupling Bore (Nominal) inches (mm)	Temperature °F (°C)*
1.5 - 3.0" (38.1 - 76.2 mm)	650°F (343°C)
3.5 - 4.5" (88.9 - 114.3 mm)	500°F (260°C)
5.0 - 8.0" (127 - 203.2 mm)	400°F (204°C)
8.5 - 10.0" (215.9 - 254 mm)	300°F (149°C)

* At 100°F (38°C) ambient.

NOTE: Install coupling half quickly. Be sure it is not cocked on the shaft and is seated properly.

3. Install coupling washer **[358]** and locking clip **[359];** lubricate and install shaft bolt **[360]**. Torque to the value shown in *Table 7, page 35*. Bend exposed tabs of the locking clip around the shaft bolt head.

4. Assemble Coupling Halves:

   Connect extension shaft coupling half **[356]** to gear drive coupling half **[351]** 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 **[361, 362]**. Torque to the value shown in *Table 5, page 14*.

RIGID SHAFT COUPLINGS

Assembly of Rigid, Removable, Taper Bore Coupling Half

1. Clean the shaft and coupling bore and make sure that both surfaces are free from burrs or nicks. Place key **[357]** 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. Be sure the coupling half is not hung up on the key or cocked at an angle to the shaft.

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

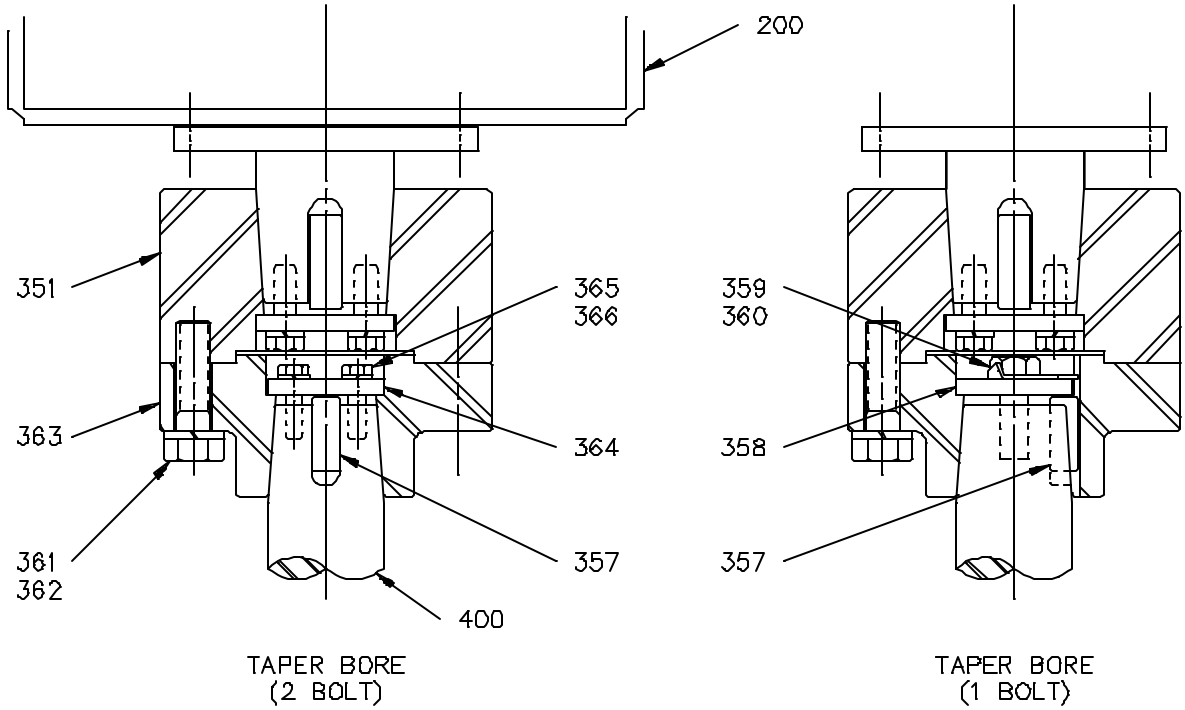


Figure 17: Removable Coupling Half [363]

RIGID SHAFT COUPLINGS

3. Shaft Bolt Installation:

2 Bolt Design:
Install coupling washer **[364]**; lubricate and install bolts and lockwashers **[365, 366]**. Torque to the value shown in *Table 5, page 14*.

1 Bolt Design:
Install coupling washer **[358]** and locking clip **[359];** lubricate and install shaft bolt **[360]**. Torque to the value shown in *Table 7*. Bend exposed tabs of the locking clip around the shaft bolt head.

TABLE 7: SHAFT BOLT TIGHTENING TORQUE(1),(2),(3)

Bolt Size	ALL MATERIALS	
	ft-lb	Nm
1/2 - 13	38	51
5/8 - 11	68	92
3/4 - 10	120	163
7/8 - 9	105	143
1 - 8	165	224
1 1/8 - 7	225	305
1 1/4 - 7	315	428
1 3/8 - 6	417	566
1 1/2 - 6	555	752
1 3/4 - 5	825	1119
2 - 4 1/2	1125	1525
2 1/4 - 4 1/2	1725	2339
2 1/2 - 4	2325	3153

(1) Regardless of material or head markings, tighten all 1 bolt design shaft bolts to the value shown.
(2) Lubricate all fasteners at assembly with grease, oil or an anti-seize material. Bolt threads and contact surfaces of bolt heads and nuts should be lubricated.
(3) If fasteners cannot be lubricated, multiply table values by 1.33.

4. Assemble Coupling Halves:
Connect extension shaft coupling half [363] to gear drive coupling half [51] making sure the coupling faces are clean and free from burrs or nicks. Install coupling bolts and lockwashers [51, 362]. Torque to the value shown in *Table 5.*

OPTIONS: IN-TANK COUPLINGS

Optional in-tank couplings are available in welded (non-removable) and taper bore (removable) construction.

NOTE: Whenever assembly or disassembly of an agitator with an in-tank coupling is referred to in this manual, substitute flanged drive shaft **[403]** *and/or flanged extension shaft* **[404]** *(Figure 18, page 37) for all references to the agitator extension shaft* **[400]** *(Figure 3, page 13).*

Assembly of Rigid, Removable, Taper Bore Coupling Half [408, 413] *(Figure 18)*

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. Be sure the coupling half is not hung up on the key or cocked at an angle to the shaft.

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

3. Shaft Bolt Installation:

   2 Bolt Design:
   Install coupling washer **[421, 424]**; lubricate and install bolts and lockwashers **[422, 423, 425, 426]**. Torque to the value shown in *Table 5, page 14*.

   1 Bolt Design:
   Install coupling washer **[410, 415]** and locking clip **[412, 416];** lubricate and install shaft bolt **[418, 419]**. Torque to the value shown in *Table 7, page 35*. 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 *Table 5*.

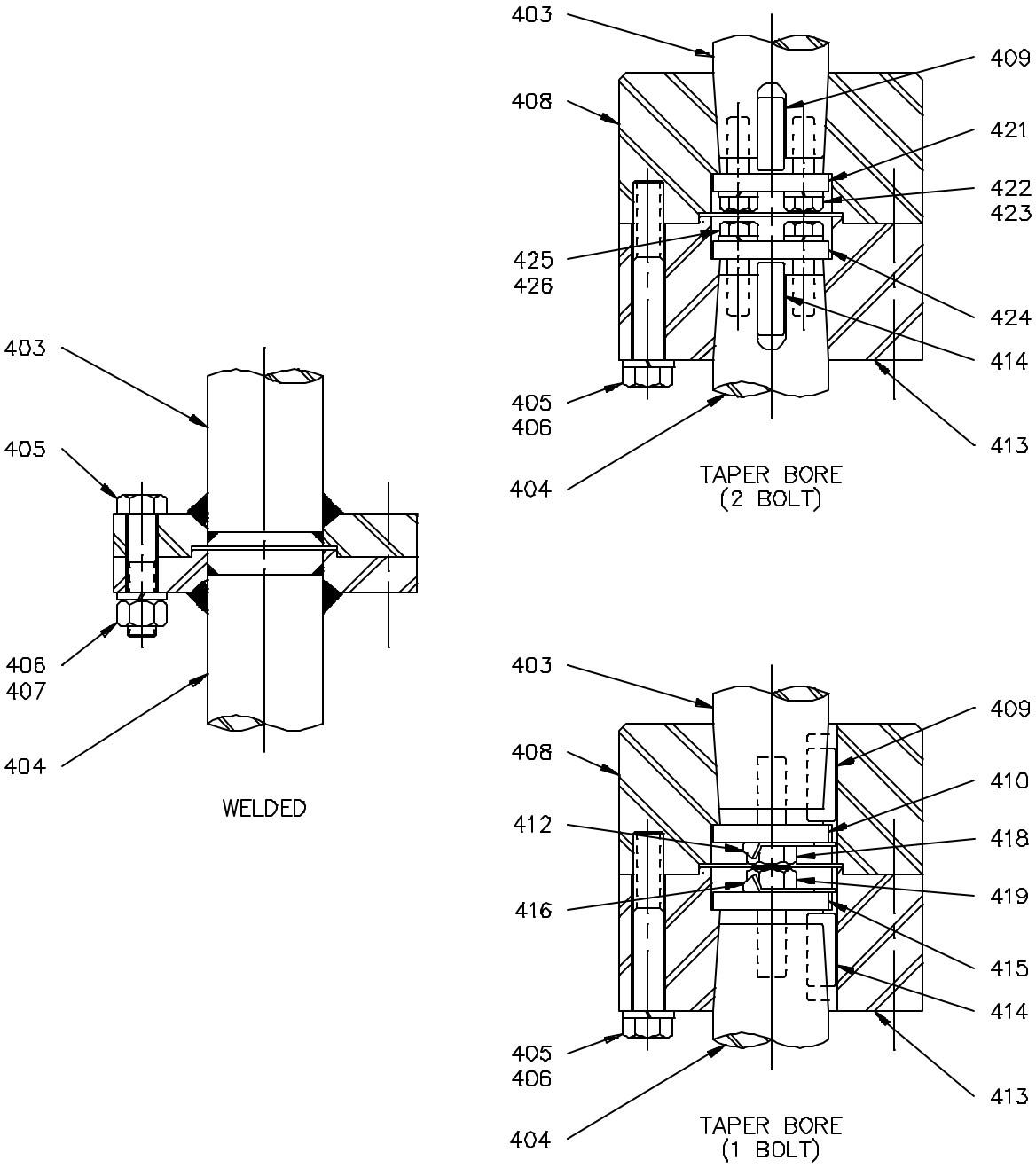


Figure 18: In-Tank Couplings

OPTIONS: STEADY BEARINGS

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. *See INSTALLATION, pages 16 and 17* for checking and straightening the shaft. Steady bearing mountings should be located from the installed agitator extension shaft.

Bracket Steady Bearing

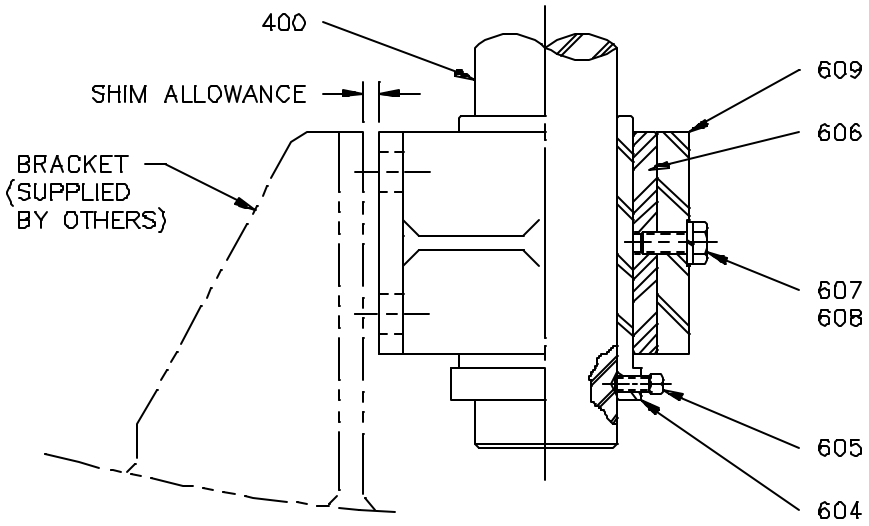


Figure 19: Bracket Steady Bearing [601]

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 steady bearing housing **[609]** to the support bracket. Tighten the bracket bolts (supplied by others) to 25% of specified torque per *Table 5, page 14*.

OPTIONS: STEADY BEARINGS

Bracket Steady Bearing (Cont'd)

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 flexible motor coupling to rotate the extension shaft one turn. Shim the steady bearing housing until it is located concentric to the shaft centerline within .050" (1.27 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 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 should 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 *Table 5, page 14*.

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 *Table 5*. 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 being submerged.

OPTIONS: STEADY BEARINGS

Tri-Pod Steady Bearing

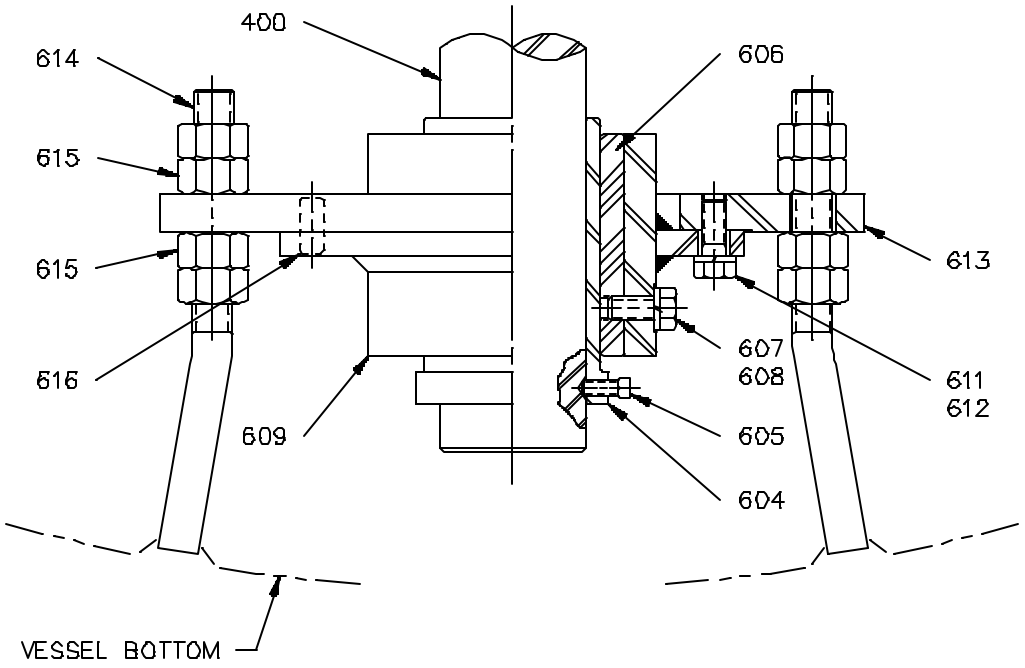


Figure 20: Tri-Pod Steady Bearing [603]

1. Locate the steady bearing assembly so that it is centered on the shaft. Attach support legs **[614]** to the vessel bottom.

2. Loosen setscrews **[605]** and remove wear sleeve **[604]**.

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. Adjust nuts **[615]** to obtain .010" (.25 mm) FIM (Full Indicator Movement) maximum.

OPTIONS: STEADY BEARINGS

Tri-Pod Steady Bearing (Cont'd)

5. Place the indicator point on the outside diameter of housing hub **[609]** and rotate the extension shaft one turn. Loosen bolts **[611]** and move steady bearing housing **[609]** until it is located concentric to the shaft centerline within .050" (1.27 mm) FIM. Adjust nuts **[615]** to obtain .010" (.25 mm) FIM maximum.

6. Tighten the bolts and nuts to the values shown in *Table 5, page 14* and recheck alignment with the dial indicator.

7. If the angular alignment needs correction, repeat *Steps 2 through 6*.

8. Once the final steady bearing housing location has been determined, drill the steady bearing housing and mounting plate **[613]** at two locations and install dowel alignment pins **[616]**.

9. Install the wear sleeve. 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. 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.

11. Reinstall the wear sleeve with the setscrews over the drill spots located in Step 10. Torque the setscrews to the value shown in *Table 5*. 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 being submerged.

OPTIONS: STEADY BEARINGS

Pad Steady Bearing

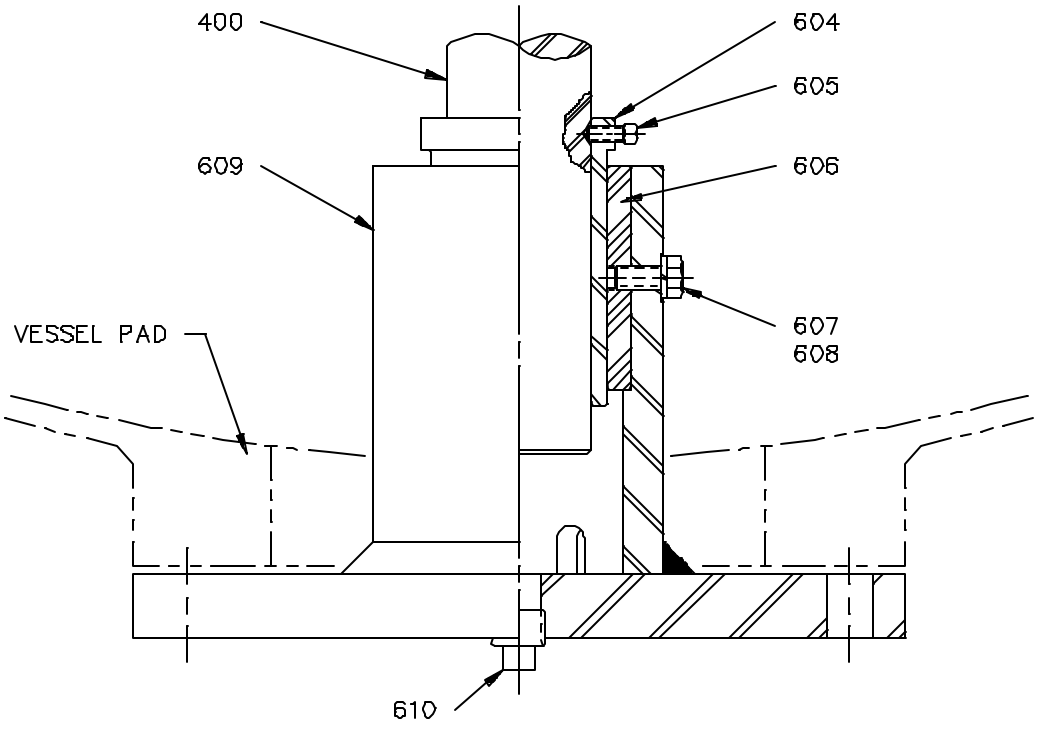


Figure 21: Pad Steady Bearing [602]

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 per *Table 5, page 14*.

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]**.

OPTIONS: STEADY BEARINGS

Pad Steady Bearing (Cont'd)

4. Manually turn the flexible motor coupling to rotate the extension shaft one turn. If the runout exceeds .010" (.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 *Table 5, page 14*.

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 *Steps 1 through 5*.

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 *Table 5*. 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 being submerged.

OPTIONS: EXTERNAL MOTOR-DRIVEN OIL PUMP

HT gear drives may include an optional external motor-driven oil pump *(Figures 22 and 23; pages 45 and 46)*. See the unit assembly drawing for the power requirements.

The pump motor is marked with an arrow indicating the proper rotation. Do not operate the agitator without checking the pump motor rotation.

The pump motor and the agitator drive motor must be interconnected so the agitator drive motor cannot be energized without energizing the pump motor.

All external motor-driven oil pump systems are furnished with an oil flow alarm switch. If the oil flow is interrupted, this switch is to be used to activate an alarm and stop the agitator drive motor. See the unit assembly drawing for the switch current rating.

CAUTION! For all case sizes the oil flow alarm switch must be used to stop the agitator drive motor.

If the gear drive requires cooling, the external motor-driven oil pump will include a water-to-oil heat exchanger and temperature actuated regulating valve. Cooling water will have to be provided to the heat exchanger. See the unit assembly drawing for the required flow rates.

All cooling systems are provided with a temperature alarm switch. The factory temperature setting is 180°F (83°C). This switch is to be used to activate an alarm. See the unit assembly drawing for the switch current rating.

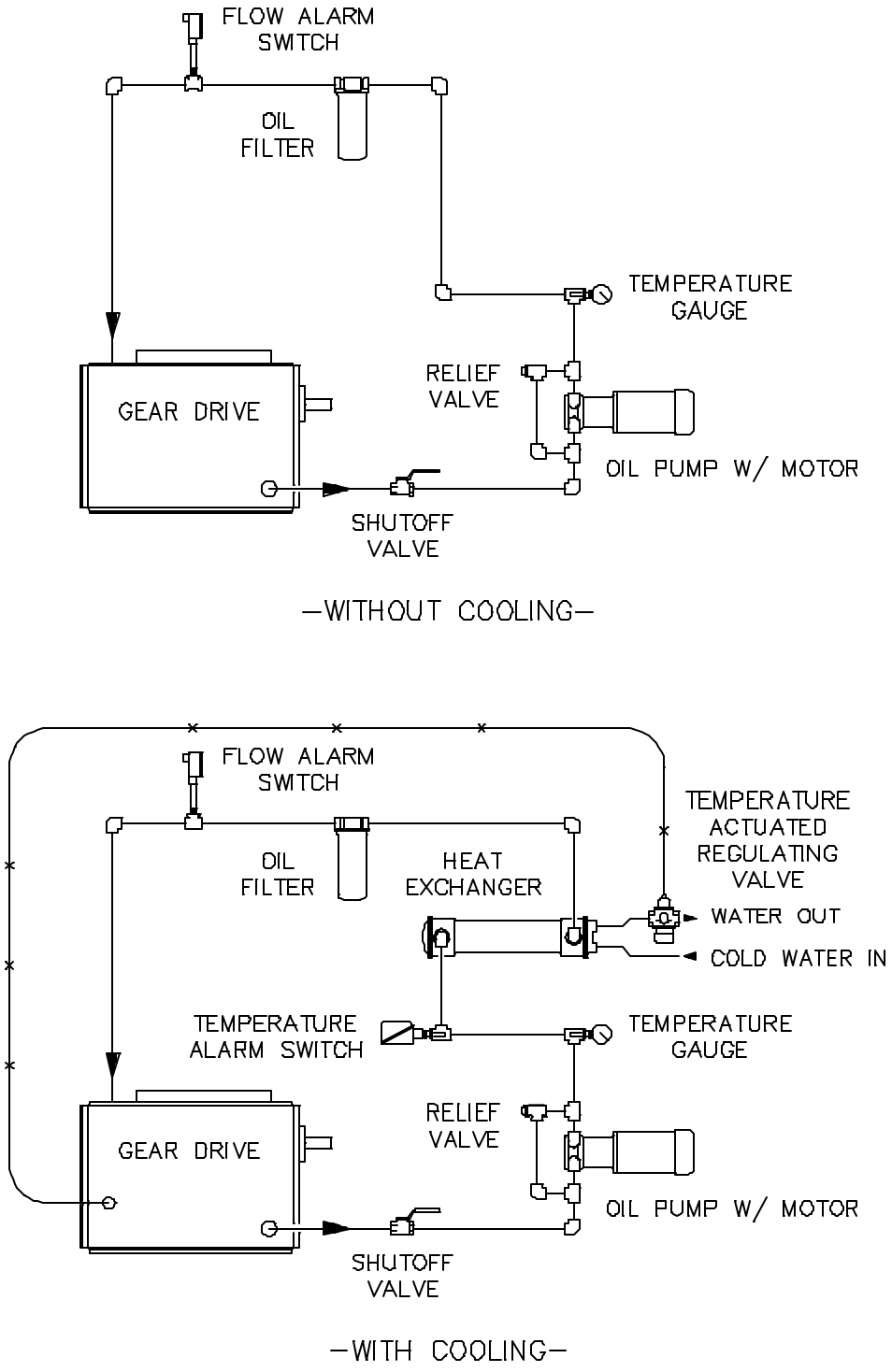


Figure 22: External Motor-Driven Oil Pump

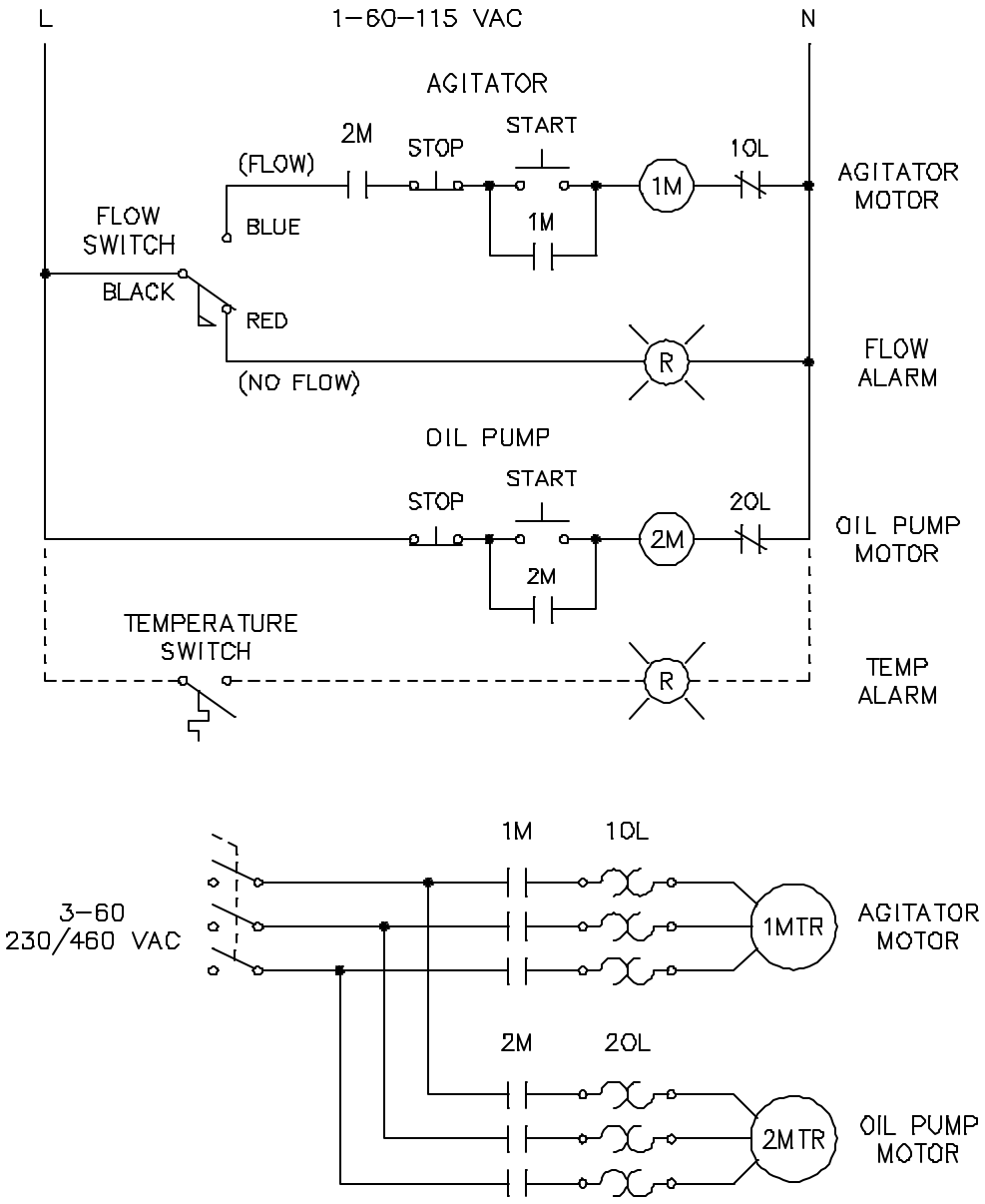


Figure 23: Wiring Diagram

OPTIONS: TACHOMETER

HT gear drives may include an optional magnetic signal tachometer.

The tachometer assembly is shipped in a separate box and requires assembly to the gear drive. Tachometer is mounted on the top of the gear drive and is driven by the gear drive output shaft.

Magnetic Signal Tachometer

1. Remove bolts, lockwashers and tachometer cover **[2021, 2022 and 2018].**

2. Install speed sensor **[2004]** to bracket **[2011]** using U-bolts **[2014]**. Assemble the speed sensor/bracket assembly to the gear drive with bolts, lockwashers, and flatwashers **[2015, 2016, 2017]**.

3. Adjust the speed sensor to obtain a 1/8 to 1/4" (3 to 6 mm) air gap and tighten bolts **[2015]** securely.

4. Assemble the tachometer cover to the bracket assembly with screws, lockwashers and flatwashers **[2023, 2024 and 2025]**. Install bolts and lockwashers **[2021, 2022]**. Tighten all fasteners securely.

5. The speed sensor is mounted in an enclosure with a 1/2" NPT conduit connection. A 3-wire shielded cable 10 ft (30.48 m) long is provided for connection to the digital panel meter. If required, longer cables (supplied by others) are commercially available.

6. The digital meter **[2003]** is housed in a plastic case and designed for installation in a control panel designated suitable for non-hazardous areas. Ambient operating temperature range is 32° to 158°F (0° to 70°C). The input power required is single phase, 50/60 Hz, 115 VAC.
   See *Figure 25, page 49* for the wiring diagram and panel cut-out dimensions.

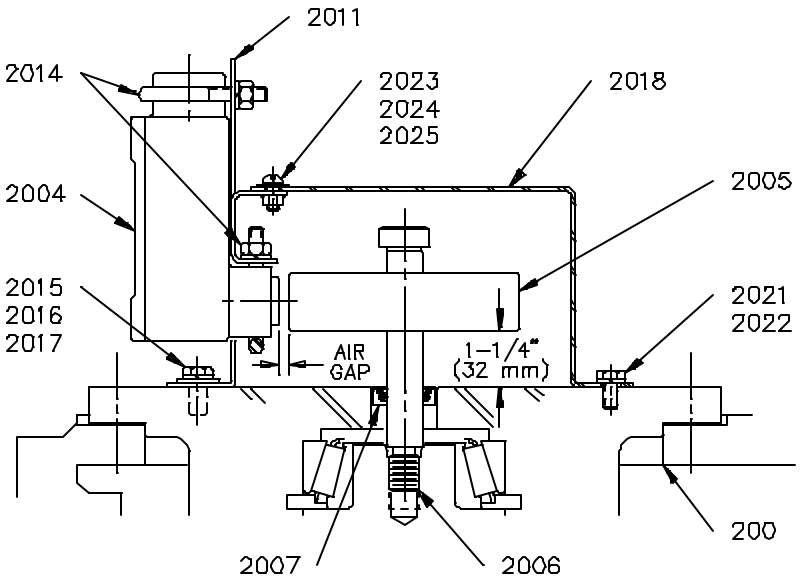


Figure 24: Magnetic Signal Tachometer

The meter is factory set and no adjustment or maintenance is required.

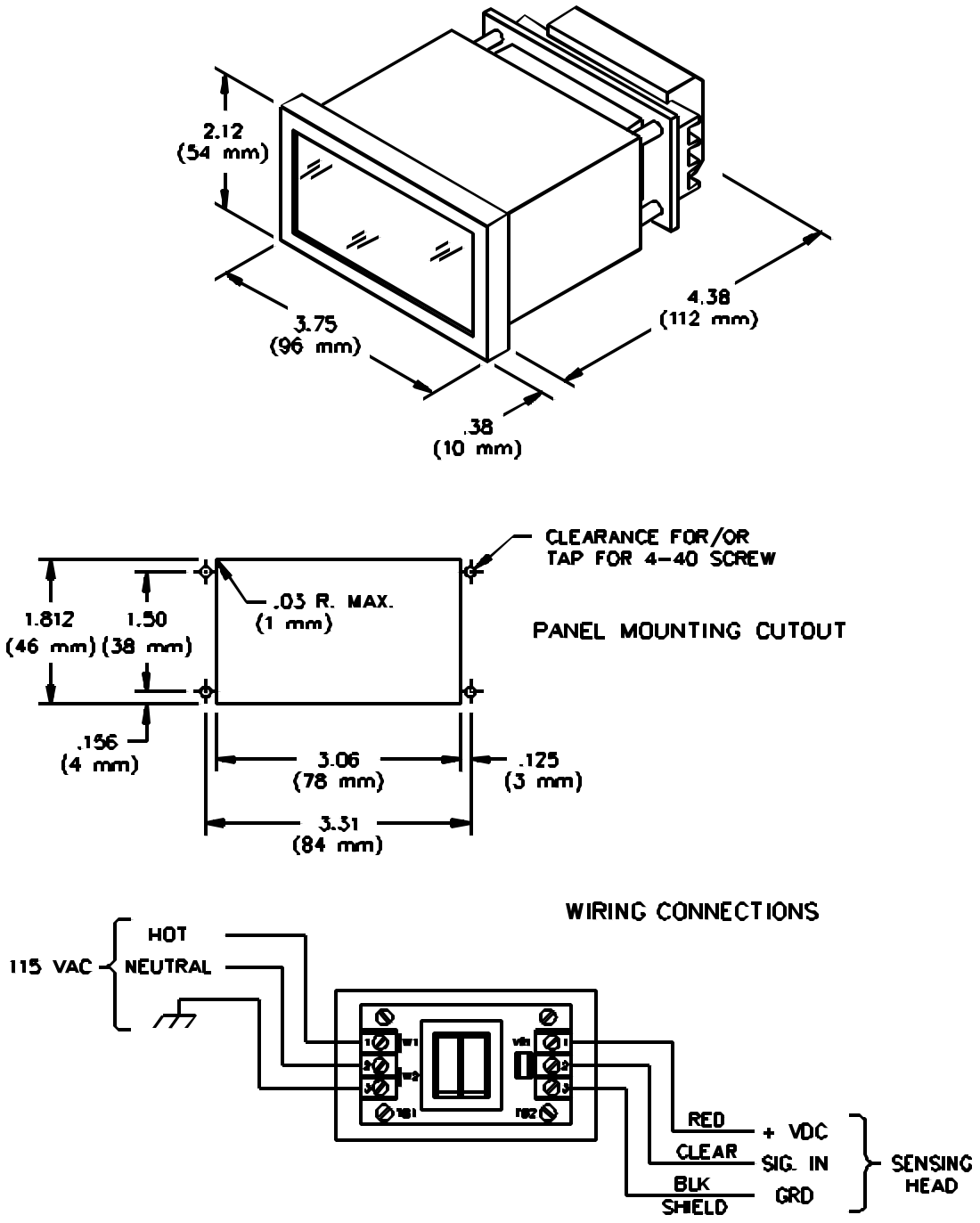


Figure 25: Tachometer Panel Meter

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.

MOTOR

The motor bearings have been properly greased by the manufacturer. Motor bearings should be regreased 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 or calcium-complex based soap, with an NLGI No. 2 classification, will work satisfactorily. Most major oil companies offer such products, usually with extreme pressure (EP) additives for additional protection. *Table 8, page 51* lists some commonly available greases.

When regreasing, stop the motor, remove the outlet plug and add grease according to *Table 9, page 52* 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 regreasing.

CAUTION! Overgreasing is a major cause of bearing and motor failure.

MOTOR

TABLE 8: TYPICAL NLGI NO. 2 GREASES

For Ambient Temperature Range of 0º to 150º F (-18º to 66º C)		
MANUFACTURER	**GENERAL PURPOSE**	**EP**
Amoco Oil Co.	Amolith grease: Grade 2	Amolith grease: Grade 2EP
Ashland Oil Co.		Multi-lube Lithium EP grease: Grade 2
		EP Lithium #2
Chevron U.S.A.Inc.	Industrial grease: Grade medium	Dura-Lith greases EP: Grade 2
CITGO Petroleum Corp.		Premium Lithium EP grease: 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.		Mobilux EP 2
Pennzoil Products Co.		Pennlith EP grease 712
Phillips 66 Co.	Philube L Multi-purpose grease L-2	Philube EP grease: EP-2
Shell Oil Co.	Alvania grease 2	Alvania grease EP 2
		Alvania grease EP LF 2
Texaco Lubricants Co.	Premium RB grease	Multifak EP 2
Unocal 76		Unoba EP grease: Grade 2
		Multiplex EP: Grade 2

MOTOR

TABLE 9: MOTOR BEARING GREASE ADDITION

Motor Frame Size	RELIANCE		SIEMENS		BALDOR	
	in^3	cm^3	in^3	cm^3	in^3	cm^3
140T	sealed for life		0.4	6.6	0.6	9.8
180T	0.5	8.2	0.6	9.8	0.6	9.8
210T	0.5	8.2	3.1	50.8	0.6	9.8
250T	1.0	16.4	4.4	72.1	1.2	19.7
280T	1.0	16.4	5.0	82.0	1.2	19.7
320T	1.5	24.6	10.6	173.7	1.5	24.6
360T	1.5	24.6	14.4	236.0	1.5	24.6
400T	2.5	41.0	14.4	236.0	4.1	67.2
440T	2.5	41.0	14.4	236.0	4.1	67.2
Other	(consult motor manufacturer's data)					

GEAR DRIVE

In HT gear drives, all gearing and all bearings except **[241]**, **[255]** (and **[322]** on case sizes 11, 12 and 13) *(Figures 27-31, pages 59-63)* are normally splash lubricated. Bearings **[241]** and **[322]** may be oil lubricated if the gear drive is supplied with an external motor-driven oil pump. *CAUTION! The gear drive has been drained of oil for shipping.*

Always use new oil to avoid damage to the gearing or bearings. When checking oil level the agitator must be shut off.

For all case sizes, except case size 10, remove the shipping plug from the top of the gear drive. Add oil until the level is at the center of sight glass **[285]** located on change gear cover **[276]**. Install breather **[280]** in place of the shipping plug. If the gear drive is supplied with an optional oil level dipstick **[298]** *(Figure 26)*, it can be used to check oil level by removing the dipstick and resting it on top of the gear drive (do not engage threads) so it hangs vertically. Oil level should be at the full mark.

For case size 10, remove shipping plug and install breather-dipstick **[280]**. Remove oil fill plug **[281]** and add oil until the level is at the center of sight glass **[285]** located on change gear cover **[276]**. Replace oil fill plug. When checking oil level with the breather-dipstick, rest the dipstick on top of hex bushing **[282]** (do not engage threads) so it hangs vertically. Oil level should be at the full mark.

Case sizes 11, 12 and 13 require the following additional lubrication step. Remove oil fill plug **[281]** and add one (1) quart of oil. Replace oil fill plug.

Caution! Do not over or under fill the gear drive. Do not operate before filling with oil.

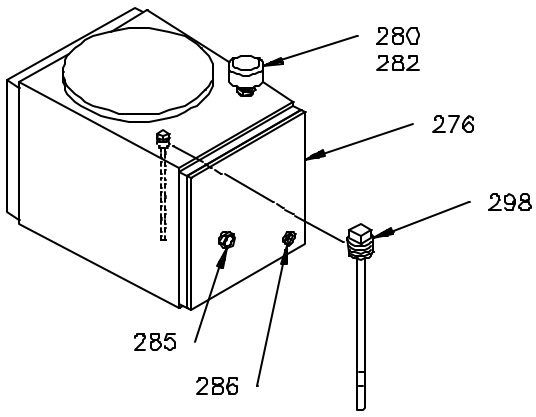


Figure 26: Optional Oil Level Dipstick

GEAR DRIVE

The agitator nameplate or *Table 10, page 55*, should be used to select the proper viscosity oil based on ambient temperature conditions.

Table 11, page 56 should be used as a guide to determine the quantity of oil required. Units equipped with an external motor-driven oil pump will require more oil.

Use a good quality straight grade, R & O petroleum base gear oil per *Table 12, page 57* for most applications. If the gear drive loading is extremely heavy or if the ambient temperature exceeds 100° F (38° C), an EP oil per *Table 13, page 58* should be used. In general an EP oil will be beneficial for all operating conditions. *Tables 12 and 13* are presented for guidance and equivalent oils from other suppliers may be used.

Drain oil by removing drain plug **[284, 286 or 287]** 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.

Bearings **[241]** and **[255]** on all case sizes and bearing **[322]** on case sizes 11, 12 and 13 are grease lubricated. These bearings are packed with grease prior to shipment from the factory. At 3 to 4 month intervals, bearings **[241]** and **[322]** should be regreased by pumping grease into the grease fitting **[288]** until new grease appears at the relief fitting **[289]**. Bearing **[255]** should be regreased by adding approximately twice the volume of grease to fitting **[288]** as required at bearing **[241]**. Any good quality general purpose grease consisting of a refined base oil stock and a lithium or calcium-complex based soap with an NLGI No. 2 classification will work satisfactorily. Most major oil companies offer such products usually with extreme pressure (EP) additives for additional protection. *Table 8, page 51* lists some commonly available greases.

GEAR DRIVE

TABLE 10: LUBE OIL SELECTION

LUBE OIL SELECTION FOR CASE SIZES 1-6		
Ambient Temperature	Lube Oil Selection	
	ISO Viscosity Grade	AGMA Lubricant Number
-10º to 15º F (-24º to -10º C)	32 to 46	- to 1
15º to 50º F (-10º to 10º C)	68 to 100	2 to 3
50º to 125º F (10º to 50º C)	100 to 150	3 to 4
LUBE OIL SELECTION FOR CASE SIZES 7-11		
Ambient Temperature	Lube Oil Selection	
	ISO Viscosity Grade	AGMA Lubricant Number
-10º to 15º F (-24º to -10º C)	46 to 68	1 to 2
15º to 50º F (-10º to 10º C)	100 to 150	3 to 4
50º to 125º F (10º to 50º C)	150 to 220	4 to 5
LUBE OIL SELECTION FOR CASE SIZES 12-13		
Ambient Temperature	Lube Oil Selection	
	ISO Viscosity Grade	AGMA Lubricant Number
-10º to 15º F (-24º to -10º C)	Consult factory for recommendations	
15º to 50º F (-10º to 10º C)	150 to 220	4EP to 5EP
50º to 125º F (10º to 50º C)	220 to 320	5EP to 6EP

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

GEAR DRIVE

TABLE 11: APPROXIMATE OPERATING OIL CAPACITY

	Volume	
CASE SIZE	**GALLONS**	**LITERS**
1	1	4
2	2	8
3	3	11
4	5	19
5	6.5	25
6	9	34
7	18	68
8	28	106
9	39	148
10	53	201
11	77	291
12	125	473
13	203	768

GEAR DRIVE

TABLE 12: TYPICAL R&O LUBE OILS

ISO Viscosity Grade	**32**	**46**	**68**	**100**	**150**	**220**
AGMA Lubricant Number	---	1	2	3	4	5
Viscosity Range (cSt) @ 104º F (40º C)	28.8 to 35.2	41.4 to 50.6	61.2 to 74.8	90 to 110	135 to 165	198 to 242
MANUFACTURER/ Product Line						
Amoco Oil Co./American Industrial Oils	32	46	68	100	150	220
Ashland Oil Inc. (Valvoline Oil Co.)/ Ashland ETC R&O Oils	R&O 15	R&O 20	R&O 30	R&O 45	R&O 70	R&O 100
Chevron U.S.A. Inc./ Chevron AW Machine Oils	----	----	----	100	150	220
CITGO Petroleum Corp./ Citgo Pacemaker Oils	32	46	68	100	150	220
Conoco Inc./ Dectol R&O Oil	32	46	68	100	150	220
Exxon Co. U.S.A./ Teresstic Oil	32	46	68	100	150	220
Mobil Oil Corp./ Mobil DTE Oil	Light	Medium	Heavy Medium	Heavy	Extra Heavy	BB
Pennzoil Products Co./ Pennzbell R&O Oils	32	46	68	100	150	220
Phillips 66 Co./ Magnus Oils	150	215	315	465	700	1000
Shell Oil Co./ Shell Turbo T Oils	32	46	68	100	150	220
Texaco Lubricants Co./ Regal Oil R&O	32	46	68	100	150	220
Unocal 76/ Unocal Turbine Oil	32	46	68	100	150	220

GEAR DRIVE

TABLE 13: TYPICAL EP LUBE OILS

ISO Viscosity Grade	**68**	**100**	**150**	**220**	**320**
AGMA Lubricant Number	2 EP	3 EP	4 EP	5 EP	6 EP
Viscosity Range (cSt) @ 104º F (40º C)	61.2 to 74.8	90to	135 to 165	198 to 242	288 to 352
MANUFACTURER/ Product Line					
Amoco Oil Co./Permagear EP Lubricants	68	100	150	220	320
Ashland Oil Inc. (Valvoline Oil Co.)/AGMA Enclosed EP Gear Lubricants	#2 EP	#3 EP	#4 EP	#5 EP	#6 EP
Chevron U.S.A. Inc./ Chevron NL Gear Compounds	68	100	150	220	320
CITGO Petroleum Corp./ Citgo EP Compounds	68	100	150	220	320
Conoco Inc./Gear Oil	68	100	150	220	320
Exxon Co. U.S.A./ Spartan EP	68	100	150	220	320
Mobil Oil Corp./ Mobilgear 600 Series	626	627	629	630	632
Pennzoil Products Co./ Maxol EP Gear Oils	68	100	150	220	320
Phillips 66 Co./Philube All Purpose or Superior Multi Purpose Gear Oils	APGO 80W	---	SMP 80W-90	APGO 85W-90	---
Shell Oil Co./Omala Oils	68	---	150	220	320
Texaco Lubricants Co./ Meropa Gear Lubricants	68	100	150	220	320
Unocal 76/Unocal Extra Duty NL Gear Lube	2EP	3EP	4EP	5EP	6EP

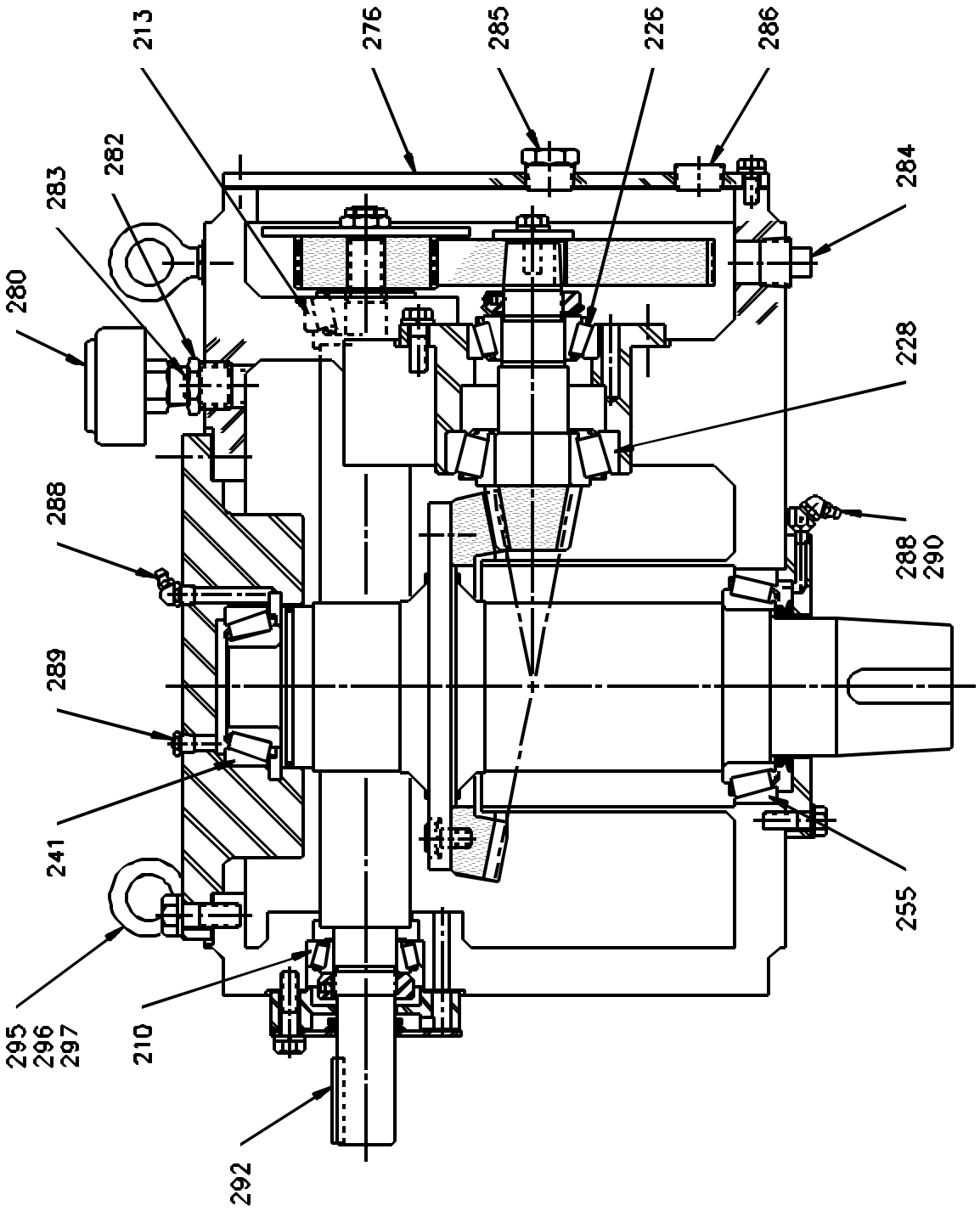


Figure 27: Gear Drive: Sizes 1,2,3

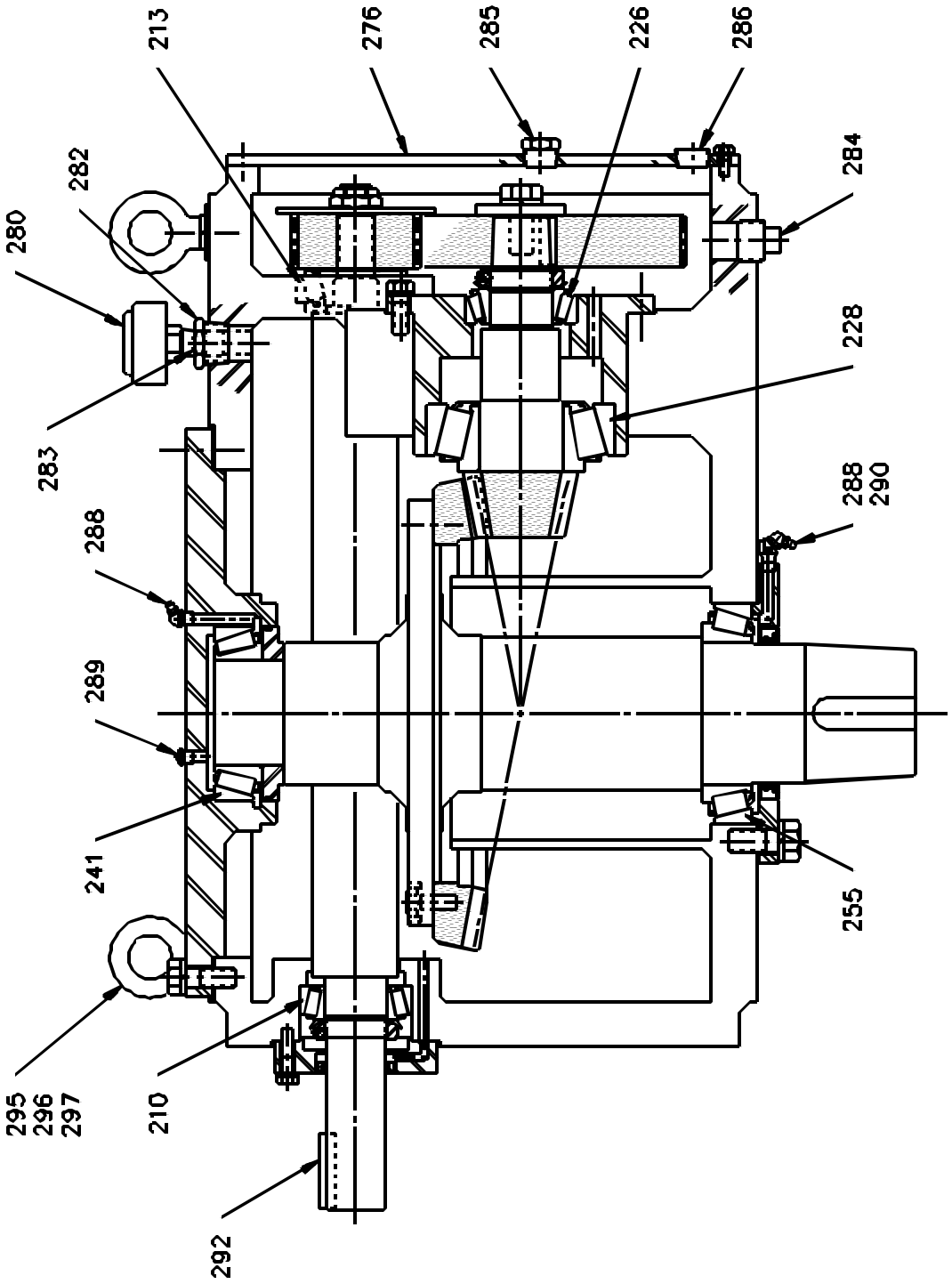


Figure 28: Gear Drive: Sizes 4,5,6

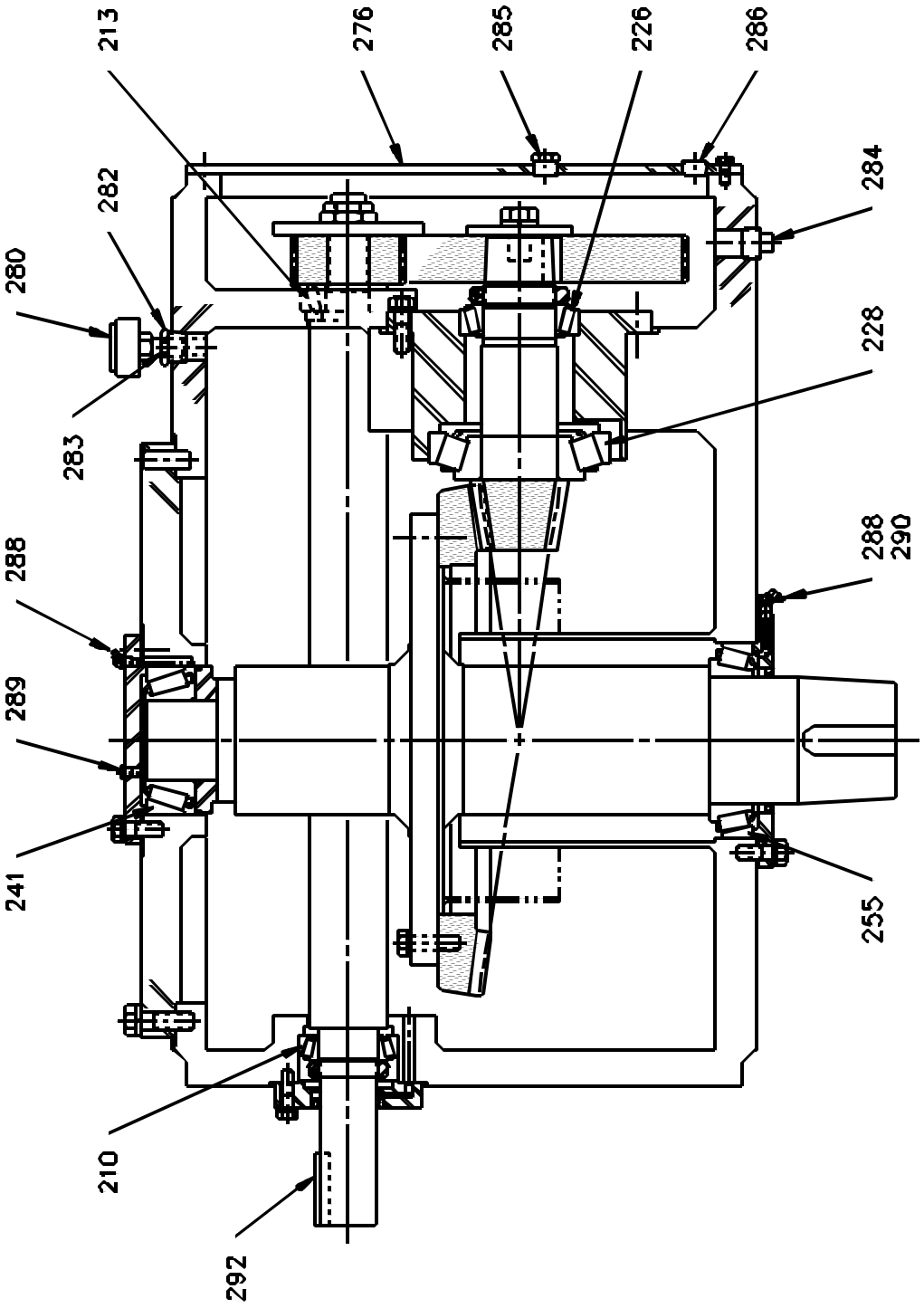


Figure 29: Gear Drive: Sizes 7,8,9

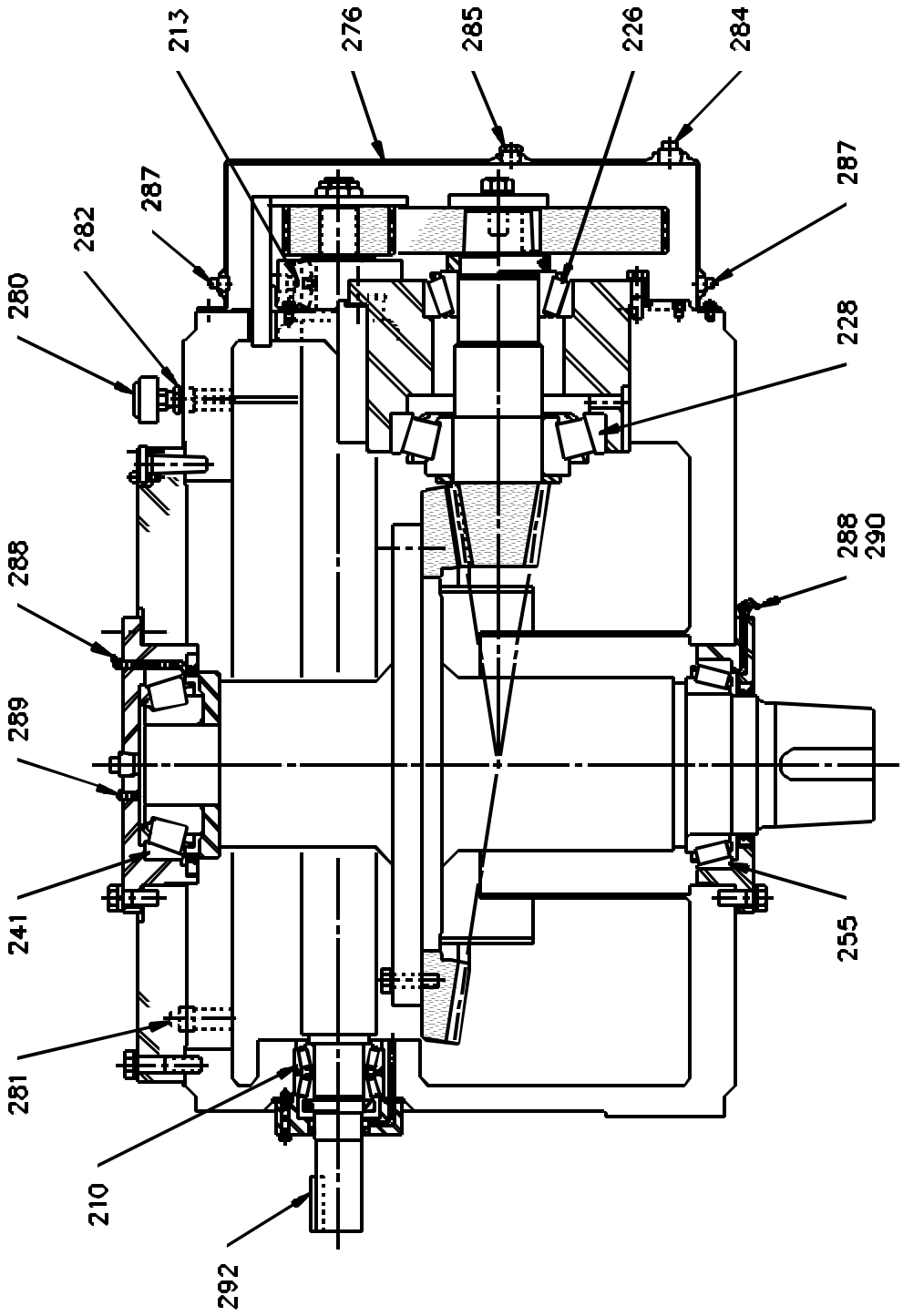


Figure 30: Gear Drive: Size 10

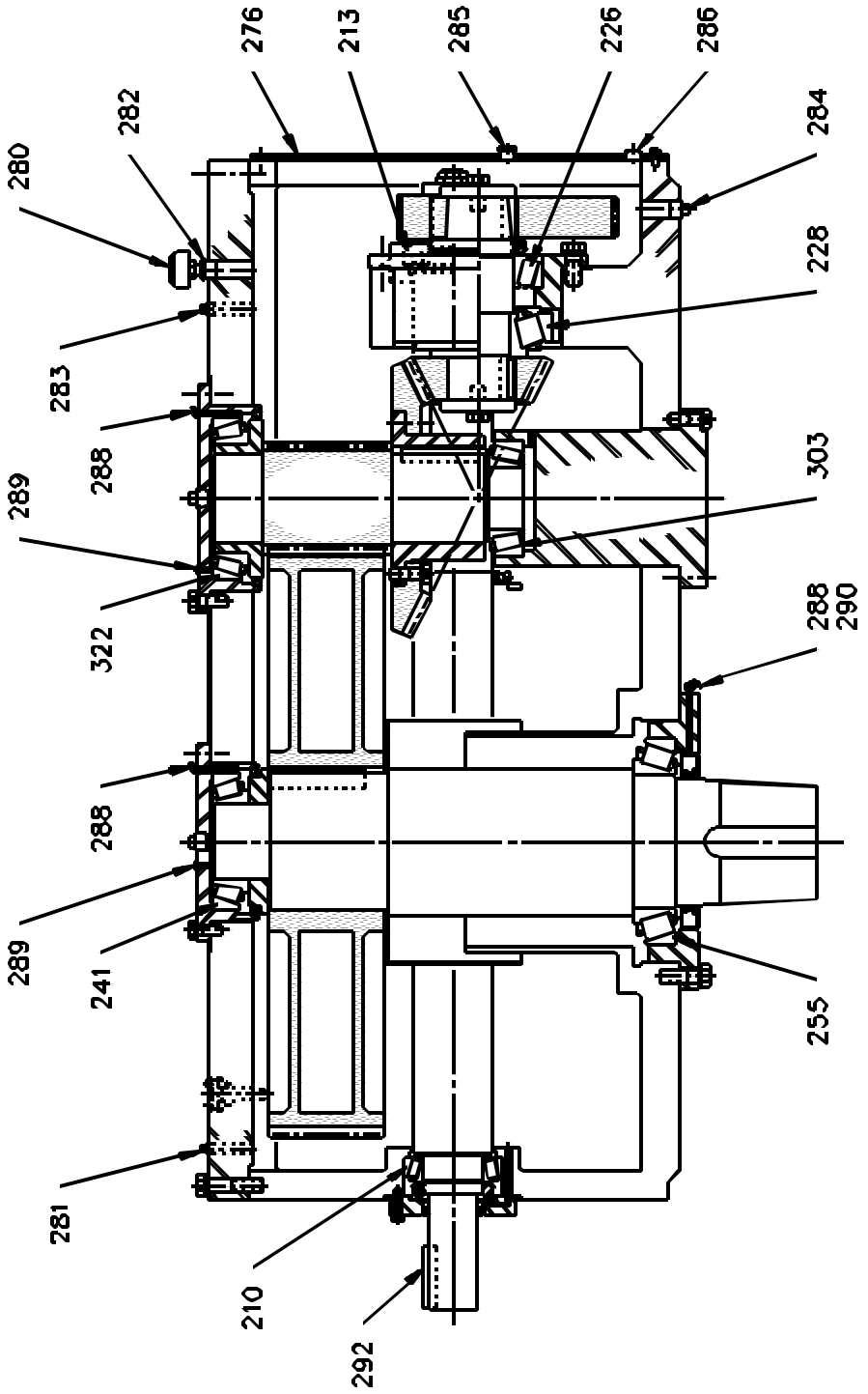


Figure 31: Gear Drive: Sizes 11,12,13

SHAFT SEALS

Only 6-ring stuffing box seals may require lubrication. Refer to the agitator assembly drawings for seal style and packing type. The 6-ring stuffing box *(Figure 5 and 33, pages 18 and 73)* is supplied with six rings of packing and a lantern ring. Packing shown as 1065 or 1625 does not require external lubrication.

If other packing has been supplied, grease lubrication may be required. The lubricant selected should be compatible with the process fluid. To lubricate the stuffing box, remove pipe plug **[1310]** and pump grease into grease fitting **[1309]** until grease comes out of the pipe plug hole. Replace the pipe plug. Relubricate as required, approximately every 24 hours.

STEADY BEARINGS

Steady bearings are lubricated and cooled by the process fluid. Do not operate the agitator unless the steady bearing is submerged.

OPERATION

AGITATOR

Your Chemineer HT 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 shaft seals at temperatures or pressures higher than those for which the unit was designed. Refer to unit assembly drawing.

! **Do not** locate large pump discharges, other agitators, down comers, coils, baffles, or other vessel internals close to the agitator impellers and extension shaft.

! **Do not** make any changes in the field (i.e. motor horsepower, agitator speed, shaft length, impeller diameter, impeller blade width, etc.) without reviewing the change with *your local Chemineer office* or Chemineer Field Service.

Should there be problems operating the unit, review the installation and the *Troubleshooting Guide, Table 14, page 69*. If you are unable to resolve the problem, contact *your local Chemineer office*.

MOTOR

Electric motors furnished on Chemineer HT 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.

- 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 is 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.

FLEXIBLE MOTOR COUPLING

Most flexible motor couplings provide years of operation with very few problems, provided they operate in a clean environment and are lubricated as required. If the motor is removed for service, the coupling alignment should be rechecked before restarting the unit. Refer to the *Motor Coupling* supplement with this manual.

GEAR DRIVE

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.

When required, the gear drive will include an optional external motor-driven oil pump *(Figure 22, page 45)*. Do not operate the unit without checking pump motor rotation. The pump motor coupling guard is marked with an arrow indicating proper rotation. The pump motor and agitator drive motor must be interconnected so the agitator drive motor cannot be energized without energizing the pump motor.

The pump system includes an oil flow alarm switch which should be hooked up before operation. 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 other unusual conditions.

If gear drive cooling is required, the external motor-driven oil pump will include a water-to-oil heat exchanger and temperature actuated regulating valve. This system will include both an oil flow alarm switch and a temperature alarm switch which should be hooked up before operation. Plumb water to the heat exchanger before operation. With the agitator operating at full load, adjust the temperature actuated regulating valve to obtain a temperature gauge reading of 140° to 150°F (60° to 66°C). Several valve adjustments may be required to obtain a stabilized temperature reading.

SHAFT SEALS

Stuffing box shaft seals require extreme care during initial installation and operation if proper packing life is to be realized. Six (6) ring stuffing boxes are equipped with a lantern ring. Lubricate packing if required before operation. Refer to the *Lubrication* section of this manual. In order to obtain proper sealing from a stuffing box the packing must be allowed to "run in". Prior to operation, the gland nuts should be tightened finger tight. As the unit is started up, the packing should be allowed to "run in" by tightening the gland nuts gradually (no more than one flat on the nuts every 15 minutes) until the desired level of sealing is obtained. Once the packing has been "run in", the gland nuts should be retightened on a regular basis. This can vary from weekly to monthly depending upon the desired level of sealing.

STEADY BEARINGS

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 the agitator unless the steady bearing is submerged.

TROUBLESHOOTING

TABLE 14: TROUBLESHOOTING

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 or maintained couplings	Couplings can generate noise which seems to emanate from gear drive. Check for proper lubrication, alignment, or 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 air flow 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 grease fitting from lower bearing cap and drain drywell. Replace grease fitting and grease the bearing.
	Worn Packing	Replace packing.

MAINTENANCE

GEAR DRIVE

Agitator Drive 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. Disconnect any water lines to oil coolers.

3. Models HTA, HTAL: Depressurize vessel and loosen gland nuts **[1303]**.

4. Remove handhole covers [1108].

5. If a bracket or tripod steady bearing is installed, remove the wear sleeve.

6. Attach lifting system to the agitator drive *(Figure 4, page 15)*. Unbolt the gear drive from pedestal **[1101]**. *(Figures 5, 6 and 7; pages 18, 19 and 20.)*

7. Lift the gear drive/extension shaft assembly sufficiently to allow the shaft to be blocked in place. Block shaft and remove coupling bolts and lockwashers **[361, 362]**.

8. Remove the agitator drive to a suitable service area.

MAINTENANCE

GEAR DRIVE

Preparation for Gear Drive Disassembly

1. Clean external surfaces and drain the oil.

2. Remove the setscrews securing flexible motor coupling hub **[110]** to the gear drive input shaft. This hub must be free to slide off the input shaft as the motor and motor bracket assembly are removed from the gear drive. See *Figure 3, page 13*.

   NOTE: Larger units may be furnished with shrink fit flexible motor coupling hubs. Remove the motor from the motor bracket and remove the hub with a puller.

3. Remove bolts **[133]** securing motor bracket **[131]** to gear drive **[200]**. Remove the motor and motor bracket as an assembly.

4. Remove gear drive coupling half **[351],** *(Figures 5, 6 and 7; pages 18, 19 and 20)*. Remove bolts, lockwashers, and coupling washer **[354, 355, 353]**. Remove the coupling half with a gear puller.

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

5. Refer to the *HT Gear Drive Maintenance Manual* for gear drive disassembly and assembly instructions and parts listings.

MAINTENANCE

STUFFING BOX

Repacking is required when satisfactory control over leakage is not attainable or when the holes in the split gland meet the outboard end of the stuffing box housing.

Repack Procedure *(see Figures 32 and 33, page 73)*

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

1. Remove handhole covers [1108].

2. Model HTA: Remove gland nuts **[1303]** and lockwashers **[1304]**. Slide gland plate **[1305]** towards the gear drive. Remove split gland **[1306]**. With packing tools remove three rings of packing **[1307]**, lantern ring **[1308]** and the remaining three rings of packing. The lantern ring is provided with two #8-32 tapped holes to aid in removal.

3. Model HTAL: Remove gland nuts **[1303]** and lockwashers **[1304]**. Slide gland plate **[1305]** towards the gear drive. Remove split gland **[1306]**. With packing tools remove three rings of packing.

   NOTE: Never add new packing on top of the old packing, as this will cause accelerated wear and scoring of the shaft.

   Refer to the unit assembly drawing for the number and composition of the packing rings supplied originally with your agitator.

4. Model HTA: Install three packing rings, lantern ring, three more packing rings, split gland (holes at top), gland plate, lockwashers and gland nuts.

5. Model HTAL: Install three packing rings, split gland (holes at top), gland plate, lockwashers and gland nuts.

6. Tighten the gland nuts until the lockwashers are compressed.

7. Install pedestal handhole covers [1108].

After repacking, relubricate the stuffing box (if required) according to the *Lubrication* section of this manual.

The stuffing box will require adjustment at start-up. Do not overtighten gland nuts. Always strive for satisfactory sealing with the least gland force possible. Tighten the gland nuts uniformally and gradually (no more than one flat on the nuts every 15 minutes) until the leakage rate is acceptable. Do not overtighten the gland nuts. Make sure the gland plate remains square with the shaft.

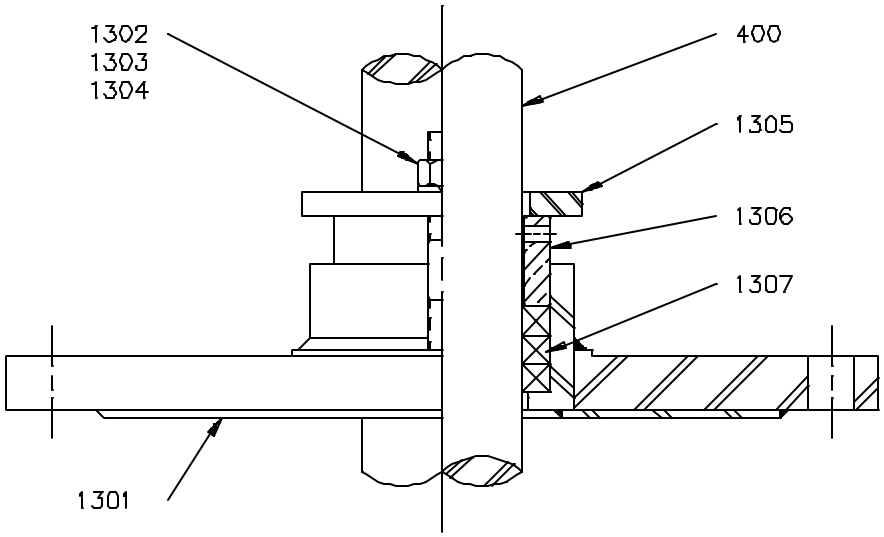


Figure 32: 3-Ring Stuffing Box

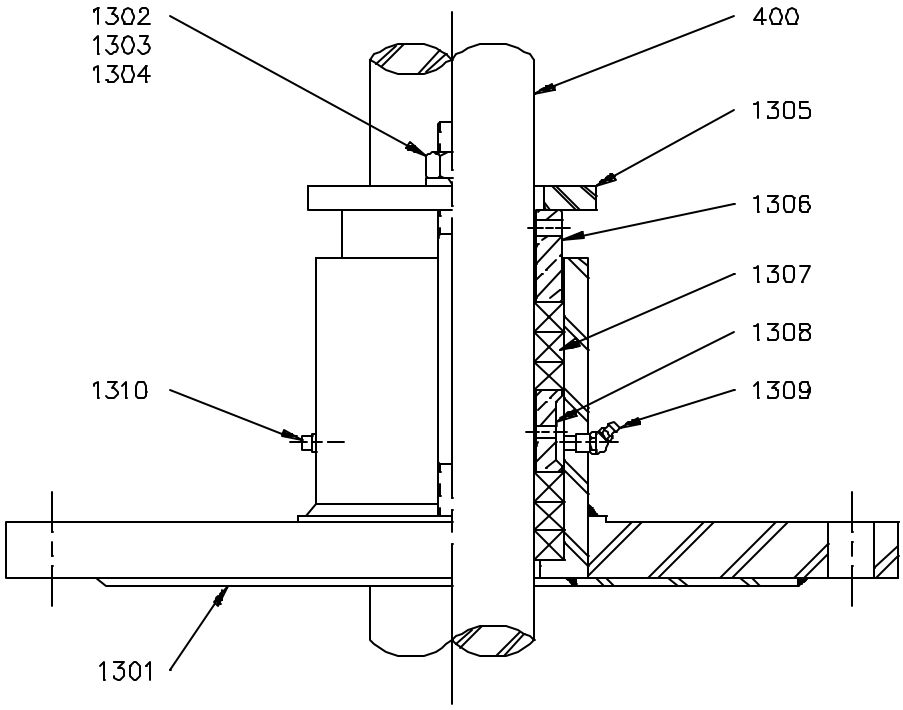


Figure 33: 6-Ring Stuffing Box

MAINTENANCE

STEADY BEARINGS

In-tank steady bearings will require periodic inspection and replacement of bushing and wear sleeve **[606, 604]**. *(Figures 19, 20 and 21; pages 38, 40 and 42).*

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: STEADY BEARING WEAR SLEEVE AND BUSHING WEAR ALLOWANCES

Shaft Diameter	Up to 3" Size (76.2 mm)	Larger than 3" (76.2 mm)
Wear Sleeve	.040" (1 mm)	.060" (1.5 mm)
Bushing	.120" (3 mm)	.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. Pad type steady bearings *(Figure 21)* will require removal of steady bearing housing **[609]** prior to removal of the wear sleeve.

2. Unbolt the housing from the bracket or tripod.

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. Tighten all fasteners to the values shown in *Table 5, page 14.*

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

HTA, HTAL, HTL AGITATOR ITEM LIST

Item #	Description	Qty.
100	**motor**	**1**
101	motor key	1
110	**flexible motor coupling assembly**	**1**
120	**coupling guard assembly**	**1**
121	coupling guard	1
122	bolt	
123	flatwasher	
124	wellnut	
130	**motor bracket assembly**	**1**
131	motor bracket	1
132	dowel pin	2
133	bolt	
134	lockwasher	
135	bolt	4
136	large flatwasher	4
137	shim set	4
138	lockwasher	4
139	nut	4
200	**gear drive assembly**	**1**
210-001	bearing	1
-002	bearing assembly with spacer	1
213-001	bearing	1
-002	bearing assembly with spacer	1
226	bearing	1
228	bearing	1
241	bearing	1
255	bearing	1
276	change gear cover	1
280-001	breather	1
-002	breather-dipstick	1
281	pipe plug, NPT	1
282	hex bushing	1
283	pipe plug, NPT	1
284	magnetic drain plug, NPT	1
285	oil level sight glass	1
286	pipe plug, NPT	1
287	pipe plug, NPT	2

HTA, HTAL, HTL AGITATOR ITEM LIST

Item #	Description	Qty.
288	grease fitting	
289	relief fitting	
290	elbow fitting	1
292	input shaft key	1
295	lifting eye bolt	3
296	lockwasher	3
297	flatwasher	
298	dipstick (optional)	1
303	bearing	1
322	bearing	1
350	**low speed coupling assembly**	**1**
351	gear drive coupling half	1
352	key	1
353	coupling washer	1
354	shaft bolt	
355	lockwasher	
356	rigid, non-removable, shrink fit, straight bore coupling half	1
357	key	1
358	coupling washer	1
359	locking clip	1
360	shaft bolt	1
361	bolt	
362	lockwasher	
363	rigid, removable, taper bore coupling half	1
364	coupling washer	1
365	bolt	2
366	lockwasher	2
400	**extension shaft assembly**	**1**
401	extension shaft	1
402	pin key	1
403-001	drive shaft (welded coupling)	1
-002	drive shaft (removable coupling)	1
404-001	extension shaft (welded coupling)	1
-002	extension shaft (removable coupling)	1
405	bolt	
406	lockwasher	
407	nut	

HTA, HTAL, HTL AGITATOR ITEM LIST

Item #	Description	Qty.
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
500	**impeller assembly**	
501	impeller assembly P-4	
502	impeller assembly S-4	
503	impeller assembly HE-3	
504	hub	
505	setscrew, square head	
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	lockwasher	
518	bolt	
519	flatwasher	
520	locking clip	
521	nut	

HTA, HTAL, HTL AGITATOR ITEM LIST

Item #	Description	Qty.
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	
600	**steady bearing assembly**	**1**
601	bracket steady bearing	1
602	pad steady bearing	1
603	tri-pod steady bearing	1
604	wear sleeve	1
605	setscrew, square head	2
606-001	bushing	1
-002	bushing	1
607	bushing retaining bolt	1
608	lockwasher	1
609	steady bearing housing	1
610	pipe plug, NPT	1
611	bolt	
612	lockwasher	
613	mounting plate	1
614	support leg	3
615	nut	12
616	dowel pin	2
1100	**pedestal assembly**	**1**
1101	pedestal	1
1102	shoulder bolt	2
1103	bolt	
1104	lockwasher	
1105	bolt	
1106	lockwasher	
1107	roll pin	2
1108	handhole cover	2
1109	bolt	
1112	lockwasher	

HTA, HTAL, HTL AGITATOR ITEM LIST

Item #	Description	Qty.
1300	**stuffing box assembly**	**1**
1301-001	flanged stuffing box (6 ring)	1
-002	flanged stuffing box (3 ring)	1
1302	stud	2
1303	gland nut	2
1304	lockwasher	2
1305	gland plate	1
1306	split gland	1
1307-001	packing (2 sets of 3 rings)	6
-002	packing (1 set of 3 rings)	3
1308	lantern ring	1
1309	grease fitting	1
1310	pipe plug, NPT	1
1800	**lip seal assembly**	**1**
1801	lip seal flange	1
1802	snap ring	1
1803	lip seal	1
1900	**external motor-driven oil pump assembly**	**1**
2000	**tachometer assembly**	**1**
2003	digital panel meter	1
2004	speed sensor	1
2005	magnetic pulsar wrap	1
2006	drive spindle	1
2007	lip seal	1
2011	bracket	1
2014	U-bolt with nut, lockwasher	2
2015	bolt	2
2016	lockwasher	2
2017	flatwasher	2
2018	cover	1
2021	bolt	
2022	lockwasher	
2023	screw, round head	2
2024	lockwasher	2
2025	flatwasher	2