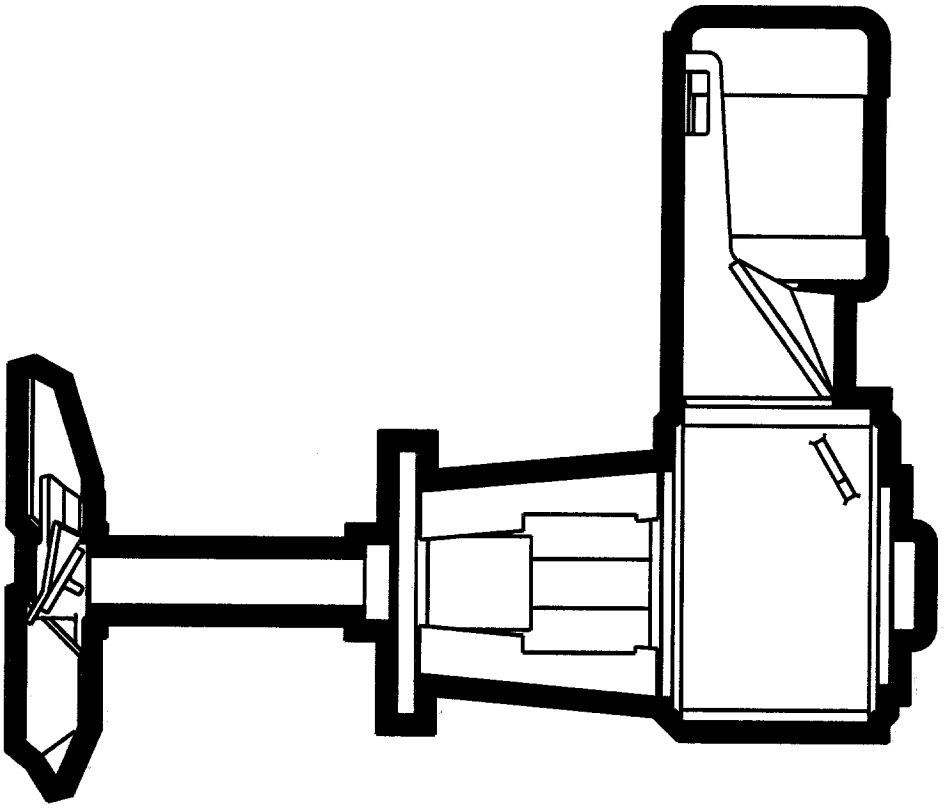
Chemineer

Manual 34

HSN/HSNS Side-Entering Agitators Installation, Operation, Maintenance Manual

Equipment Reference:



For service and information contact:

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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 crate 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 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.

Storage (Cont'd.)

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.

TABLE 1: STORAGE OIL CAPACITY

CASE SIZE	COMPLETE FILL	
	GALLONS	LITERS
1	2.6	9.8
2	2.6	9.8
3	6.6	25.0
4	14.0	53.0

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

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.

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

4. Apply a rust preventive to unpainted steel surfaces to prevent corrosion during storage.

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. The gear drive should be filled with new oil as indicated in the Lubrication section of this manual.

MOUNTING

A final check should be made of the mounting nozzle for orientation, strength and rigidity. Inadequate strength and/or rigidity may allow excessive movement of the agitator and deflection of the vessel.

NOZZLES

Unless otherwise specified, the agitator nozzle should be oriented as shown in *Figure 1*. The shaft centerline should be located one (1) impeller diameter from the tank bottom. The agitator nozzle should be level or corrected to within ±1° before proceeding.

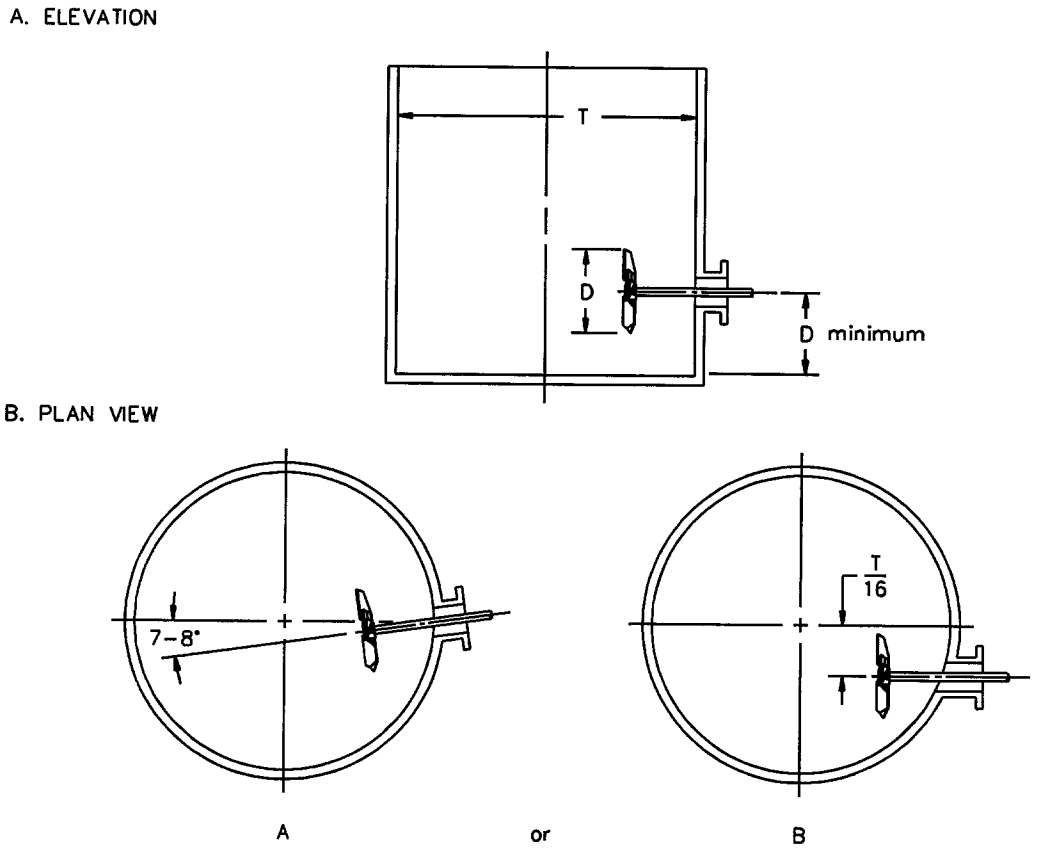

Figure 1: Nozzle Orientation

Nozzle Loads

The nozzle and vessel combination should be rechecked for strength and rigidity. The nozzle strength should be such that the maximum operating stresses will not exceed the fatigue limit of the material used. The nozzle rigidity should be designed so that the dynamic deflection is less than 1/64 inch (.4 mm) per foot of nozzle extension.

Side-Entering Agitators impose four types of loads on the supporting structure: torque, thrust, bending moment and a vertical downward load. *Figure 2* shows these four loads pictorially. See *Table 2 (page 6)* for design load values.

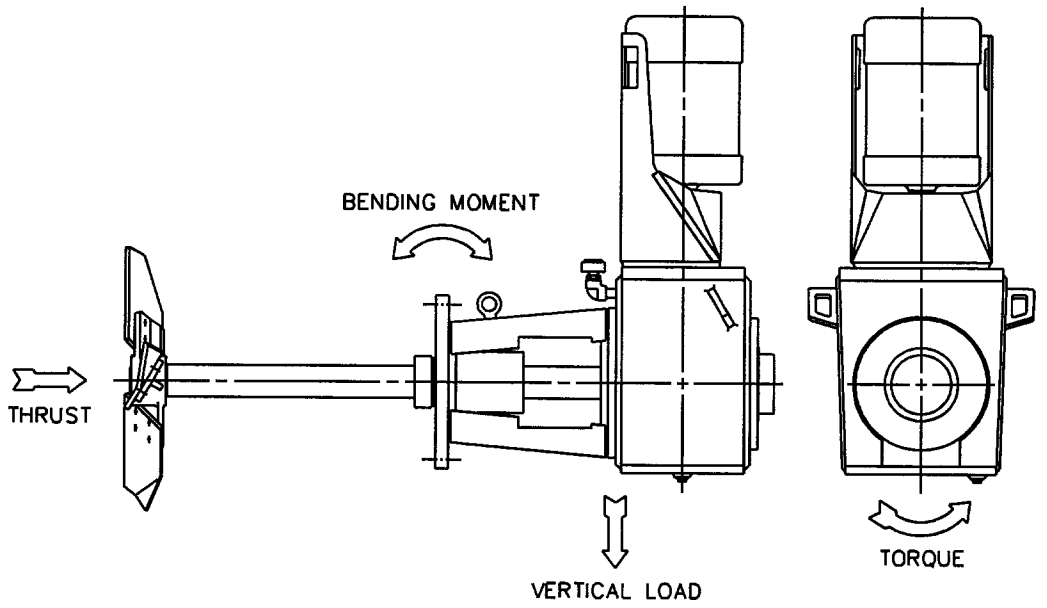

Figure 2: Agitator Mounting Nozzle Loads

Nozzle Loads (Cont'd)

TABLE 2: NOZZLE DESIGN LOAD VALUES

DESIGN LOAD ENGLISH UNITS	CASE SIZE			
	1	2	3	4
Torque, in-lb	1,080	5,400	16,450	27,000
Bending Moment, in-lb	6,240	7,000	16,750	33,700
Vertical Load, lbs	994	1,294	2,120	4,400
Thrust, lbs	275	1,000	2,200	3,650

DESIGN LOAD METRIC UNITS	CASE SIZE			
	1	2	3	4
Torque, Nm	122	610	1,859	3,051
Bending Moment, Nm	705	791	1,893	3,808
Vertical Load, kg	451	587	963	1,998
Thrust, kg	125	454	999	1,657

REINFORCING PADS & GUSSETING

Unless otherwise specified, use reinforcing pads and gussets to reduce the stress in the nozzle area and provide rigidity.

Figure 3 shows a typical design recommendation. Refer to *Table 3 (page 8)* for pad and gusset design. Trim the reinforcing plate near the tank floor as required. Gusset plate thickness is t/2 minimum.

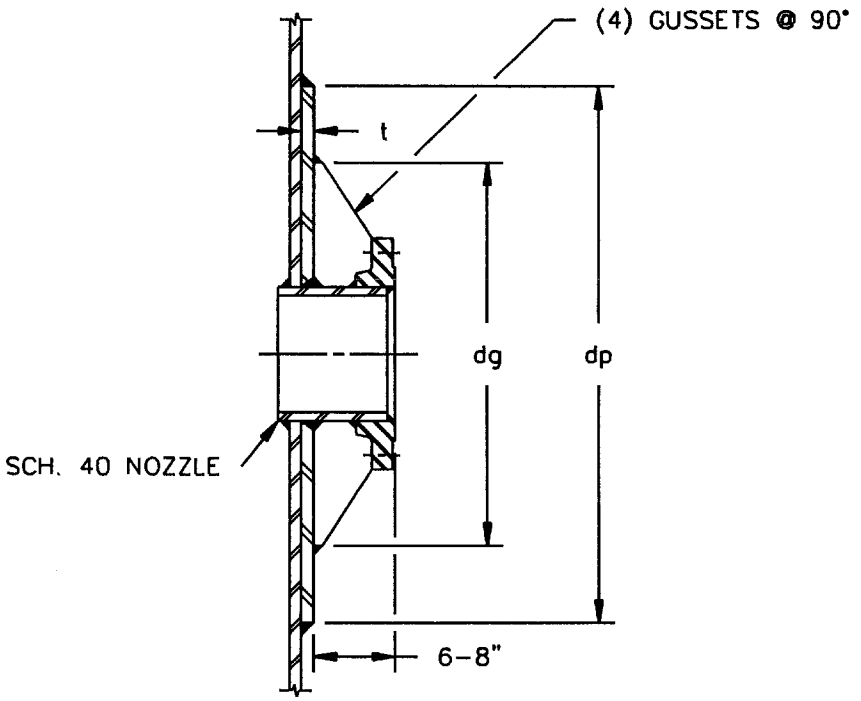

Figure 3: Reinforcing Pad & Gussets

REINFORCING PADS & GUSSETING

TABLE 3: REINFORCING PAD WITH GUSSET DESIGN

TANK DIA., FT.	8" ANSI						12" ANSI					
	CASE 1			CASE 2			CASE 3			CASE 4		
	t in	dg in	dp in	t in	dg in	dp in	t in	dg in	dp in	t in	dg in	dp in
12	5/16	27	27	1/2	27	30	7/8	27	52	3/4	41	45
18	3/8	27	27	5/8	27	38	1	27	60	1	41	60
24	7/16	27	27	5/8	27	38	1	27	60	1-1/8	41	68
30	7/16	27	27	3/4	27	45	1-1/4	27	75	1-1/4	41	75
36	7/16	27	27	3/4	27	45	1-1/4	27	75	1-1/4	41	75
42	7/16	27	27	3/4	27	45	1-1/4	27	75	1-1/4	41	75
48	7/16	27	27	3/4	27	45	1-1/4	27	75	1-3/8	41	82
54	7/16	27	27	3/4	27	45	1-1/4	27	75	1-3/8	41	82
>60	1/2	27	30	3/4	27	45	1-1/4	27	75	1-3/8	41	82

TANK DIA., METERS	8" ANSI						12" ANSI					
	CASE 1			CASE 2			CASE 3			CASE 4		
	t mm	dg mm	dp mm	t mm	dg mm	dp mm	t mm	dg mm	dp mm	t mm	dg mm	dp mm
3.66	7.94	686	686	12.7	686	762	22.23	686	1321	19.05	1041	1143
5.40	9.53	686	686	15.88	686	965	25.40	686	1524	25.40	1041	1524
7.32	11.11	686	686	15.88	686	965	25.40	686	1524	28.56	1041	1727
9.14	11.11	686	686	19.05	686	1143	31.75	686	1905	31.75	1041	1905
10.97	11.11	686	686	19.05	686	1143	31.75	686	1905	31.75	1041	1905
12.80	11.11	686	686	19.05	686	1143	31.75	686	1905	31.75	1041	2083
14.63	11.11	686	686	19.05	686	1143	31.75	686	1905	31.75	1041	2083
16.46	11.11	686	686	19.05	686	1143	31.75	686	1905	31.75	1041	2083
>18.29	12.7	686	762	19.05	686	1143	31.75	686	1905	31.75	1041	2083

INSTALLATION

AGITATOR

The HS Agitator is shipped fully assembled and ready to install. Review assembly drawings. Special instructions may be included for options not covered by this manual. Read all tags and instructions before installation and start-up.

Exercise caution in handling the agitator to avoid damage to the shaft or shaft seal components. Do not lift or support the unit by the end of the shaft or by the motor. The agitator nozzle should be level or corrected to within ±1° before proceeding.

Remove all shipping restraints from the agitator (crate, straps, bolts, etc.). Remove the impeller from the end of the shaft, if required. A hoist or crane system for lifting the agitator must be available. The approximate lifting weights are shown in *Table 4*.

TABLE 4: HS AGITATOR LIFTING WEIGHTS

CASE SIZE	APPROXIMATE WEIGHT	
	POUNDS	KILOGRAMS
1	1000	454
2	1300	590
3	2200	998
4	4400	1996

NOTE: The case sizes referred to in this manual can be determined by the first number in the model designation; for example, "1HSN-5" is a Case Size "1" Agitator.

AGITATOR

1. Lift the agitator with a three-point system utilizing the cutouts on the sides of the motor bracket and the eyebolt on the pedestal near the mounting flange. The eyebolt may also be used with a come-a-long to align the shaft for mounting. Refer to *Figure 4.*

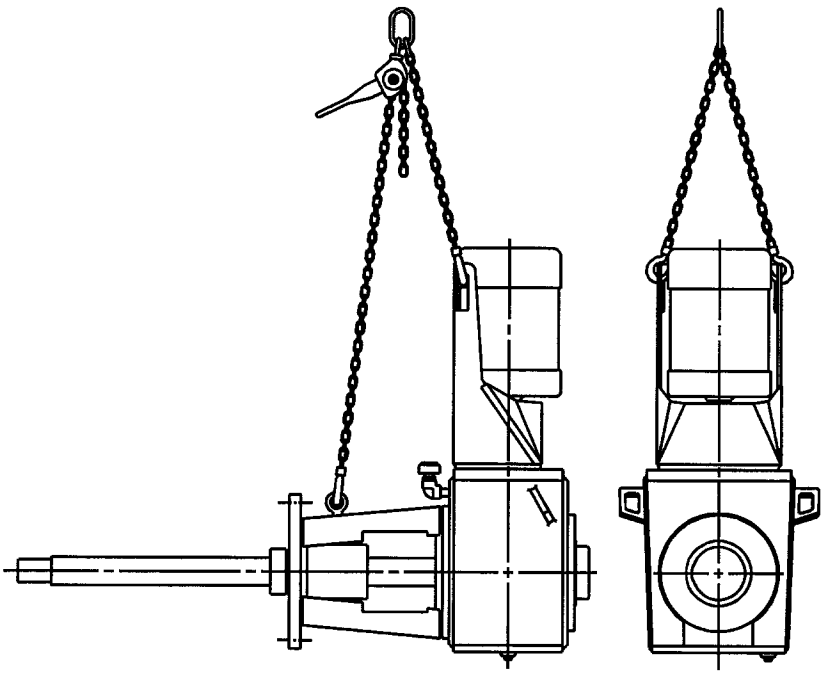

Figure 4: Agitator Lifting System

Be sure that the mating surfaces of the agitator mounting flange and the vessel nozzle are clean, free of nicks and scratches, and a mounting flange gasket (furnished by others) is properly located.

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

AGITATOR

2. While fully supporting the agitator, insert the shaft into the nozzle opening and carefully position the flanges. Install all flange bolting. Torque the bolts according to the values shown in *Table 5*.

3. The agitator has been provided with a floor support or an optional set of tie rods to be field located. The floor support should be bolted to a concrete pad and shimmed to insure proper fit. The required dimensions for the support are shown on the unit assembly drawing. (Do not raise or lower the unit with the support.)

4. Torque the floor support bolts to the value shown in *Table 5*.

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
48 - 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.

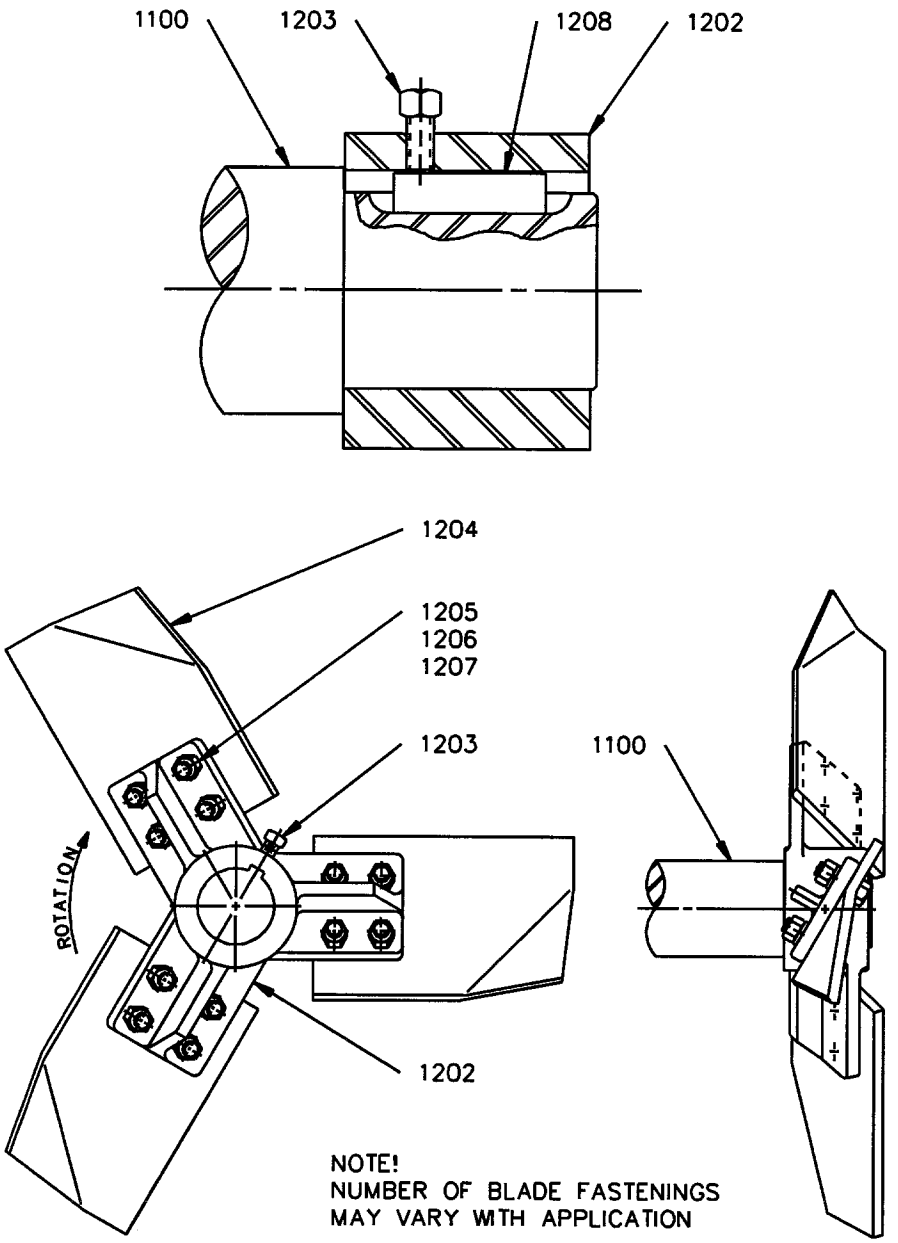

Figure 5: HS Impeller Hub

IMPELLER

1. Bolt extension blades **[1204]** to hub **[1202]** with bolts **[1205, 1206, 1207]**. Torque the bolts to the value shown in *Table 5 (page 11)*.

   NOTE: Impeller parts are match marked. Install parts as marked so the impeller will be properly balanced.

2. Install the impeller as shown in *Figure 5, page 12* with the concave side of its blades away from the wall of the vessel. Unless otherwise specified on the unit assembly drawing, the impeller attaches to the shaft with a key and setscrew. The tapped hole in the impeller hub is a self-locking thread form. Torque the setscrew to the value shown in *Table 5*.

GEAR DRIVE

The gear drive has been drained of oil for shipping; add lubricant to the gear drive according to the *Lubrication* section.

MOTOR

Chemineer side-entering agitators are normally shipped with the motor installed on the motor bracket. Before connecting the motor to the power supply:

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.

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 for correct rotation prior to securing wiring. Unless specified otherwise, rotation of the motor should be *counterclockwise* when viewed from the fan end of the motor.

MOTOR COUPLING

The standard flexible couplings used on the Chemineer side-entering agitator are as follows:

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

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 the supplemental Motor Coupling section for installation, alignment, lubrication, operation, and maintenance instructions.

Verify motor coupling alignment and correct if necessary.

MECHANICAL SEAL

The mechanical seal cartridge has been properly set and tested at the factory. It is assembled, adjusted and ready to operate when received. Model HSNS has a single seal which is lubricated by the process liquid. Model HSN has a double seal which must be externally lubricated/pressurized.

If supplied by Chemineer, the pressure lubricator (HSN only) is mounted, plumbed and ready for operation (see *Lubrication* section). A customer-supplied, regulated, gas pressure source is required. It must be capable of maintaining a pressure of 25 psig (172 kpa) above the maximum pressure on the vessel side of the seal cartridge. This vessel side pressure includes the maximum combination of vessel operating pressure, liquid head pressure, and throttle bushing inlet pressure. A customer supplied system may also be used provided it meets all of the requirements of the application.

If the unit has been supplied with a throttle bushing **[1401]** *(Figure 14, page 36)*, it will be necessary to connect a flush fluid line to flush connection **[1402]**. Flow of fluid through the throttle bushing is controlled by the clearance between the throttle bushing and the shaft and the pressure of the flush fluid. For the throttle bushing to work properly, the pressure of the flush fluid must be 10 to 15 psi above the vessel pressure plus liquid head pressure.

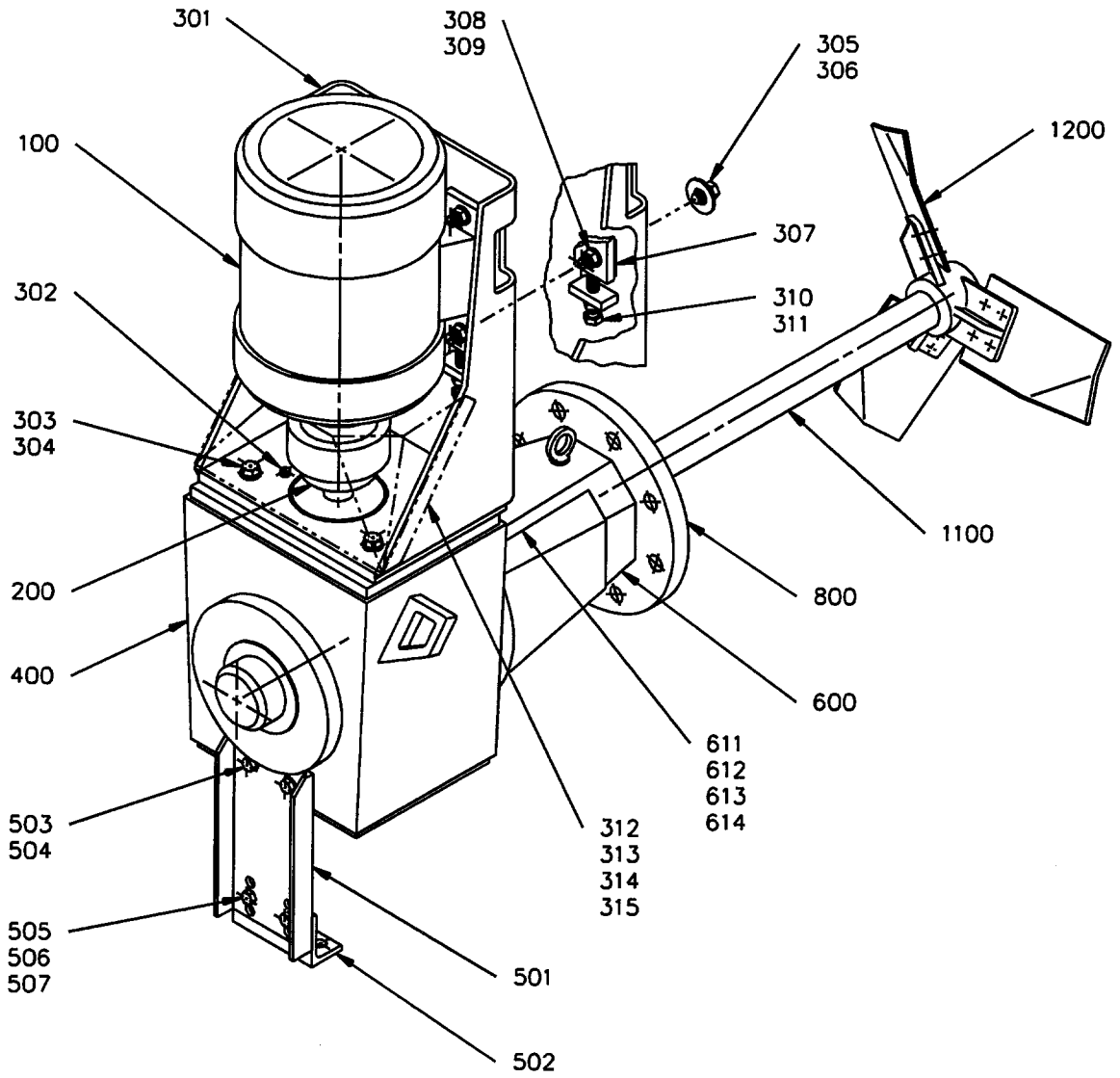

Figure 6: Model HS Agitator Assembly

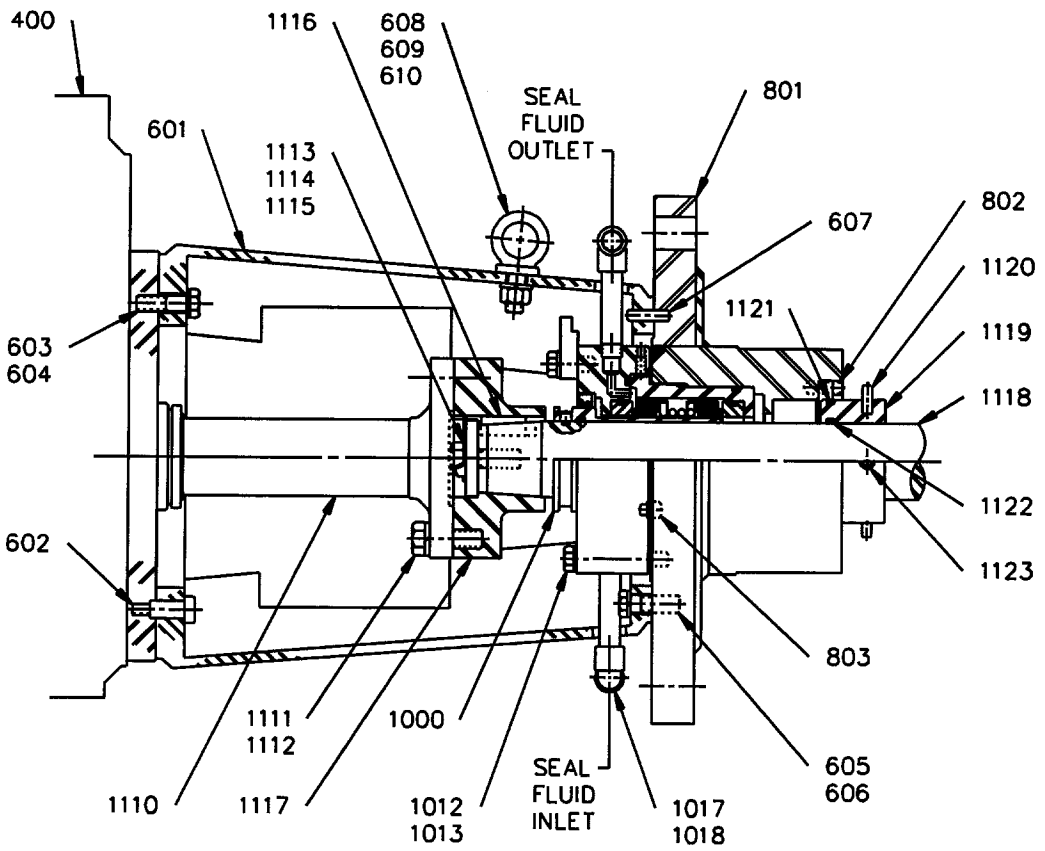

Figure 7: Model HSN Mechanical Seal

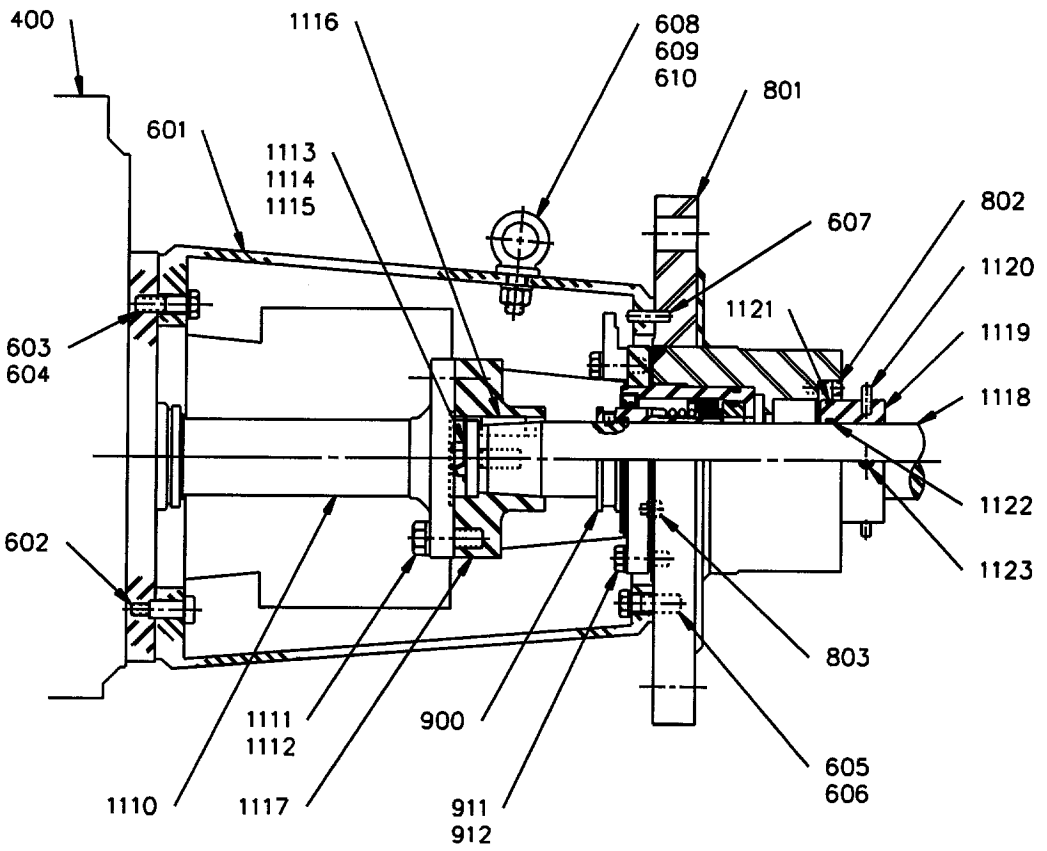

Figure 8: Model HSNS Mechanical Seal

LUBRICATION

This section defines the proper oils and greases that must be added to the unit for proper operation.

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 7 (page 20)* lists some commonly available greases.

When regreasing, stop the motor, remove the outlet plug and add grease according to *Table 6* with 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.

TABLE 6: MOTOR BEARING GREASE ADDITION

Frame Size	Amount to Add
140T, 180T	0.4 oz. (11 gram)
210T, 250T	0.6 oz. (17 gram)
280T, 320T	1.0 oz. (28 gram)
360T	1.4 oz. (39 gram)

MOTOR

TABLE 7: TYPICAL NLGI NO. 2 GREASES

For Ambient Temperature Range of 0° to 150° F (-18° to 66° 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

GEAR DRIVE

All bearings and gears are splash oil lubricated.

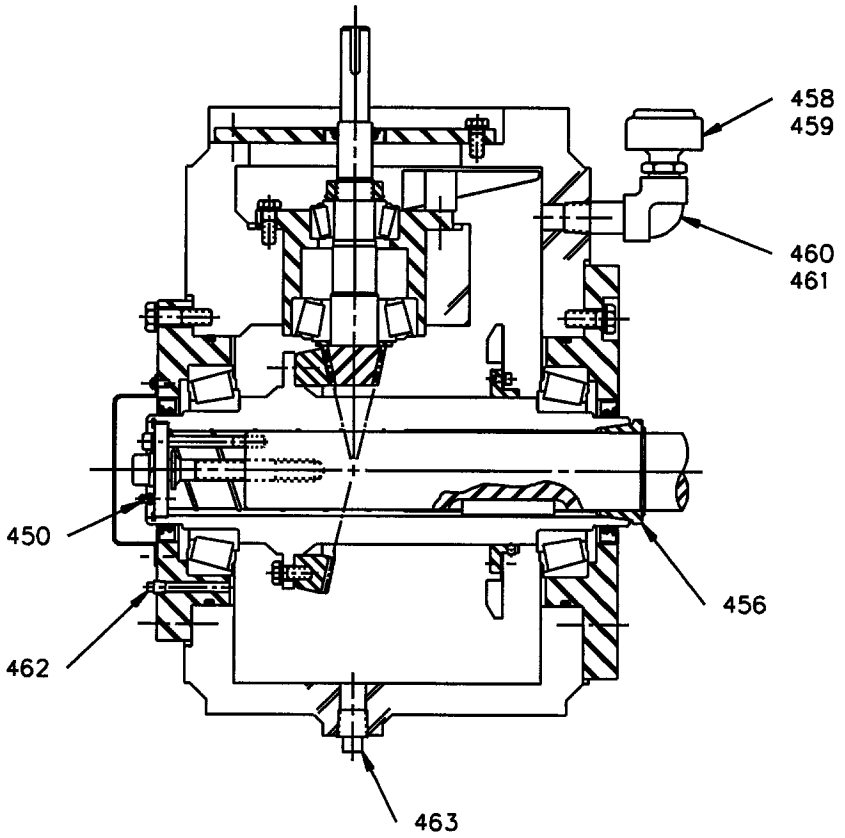

Figure 9: HS Gear Drive

The gear drive has been drained of oil for shipping. Remove oil level plug **[462]**. Remove breather **[458]** and bushing **[459]** from elbow **[460]**. Add oil through pipe elbow **[460]** until oil flows from the oil level plug hole. Always use new oil. Reinstall oil level plug **[462]**, bushing **[459]** and breather **[458]**.

GEAR DRIVE

The following table provides an oil selection guideline based upon ambient temperature according to AGMA 250.3.

TABLE 8: OIL SELECTION

Ambient Temperature	Lube Oil Selection	
	ISO Viscosity Grade	AGMA Lubricant Number
-10° to 15°F (-24° to -10°C)	32 to 46	- to 1
15° to 50°F (-10° to 10°C)	68 to 100	2 to 3
50° to 125°F (10° to 50°C)	150 to 220	4 to 5

NOTE: For low temperature operation the oil selected should have a pour point at least 9° F (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.

Approximate operating oil capacities of the HS agitators are as listed in *Table 9.*

TABLE 9: GEAR DRIVE OPERATING OIL CAPACITY

OIL CAPACITY			
Case	Qts.	Gal.	Liters
1	4	1	3.8
2	4	1	3.8
3	10	2.5	9.5
4	20	5	18.9

Drain and refill the gear drive after the first week or 100 hours of operation and then every six months or 2500 hours thereafter. Use a good quality, straight grade, R&O petroleum base gear oil *(Table 10)*. When the loading is extremely heavy or when the gear drive temperature exceeds 160° F (71° C), an EP oil *(Table 11, page 24)* should be used . In general, an EP oil will be beneficial.

GEAR DRIVE

TABLE 10: 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) @ 104° F (40° 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 11: 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) @ 104° F (40° C)	61.2 to 74.8	90 to 110	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

Periodically check the oil level and add oil, if necessary. The agitator must be shutoff when checking and adding oil.

GEAR DRIVE

The cavity between the drive shaft and the hollow reducer shaft is grease filled to prevent fretting and chemical corrosion and to provide for ease of retraction when a seal change is required. After a seal change, grease (*Table 7, page 20*) must be added through grease fitting **[450]** *(Figure 9, page 21)* until the shaft cavity is filled.

MECHANICAL SEAL

The Model HSNS *(Figure 8, page 18)* mechanical seal cartridge is equipped with a single mechanical seal which is lubricated by the vessel contents. The Model HSN *(Figure 7, page 17)* mechanical seal cartridge is equipped with a double mechanical seal which is lubricated by an external lubrication system.

The HSN mechanical seal is normally designed to be lubricated with a light weight, straight grade, ISO viscosity grade 32, mineral oil without additives. Contact Chemineer's Field Service group if other fluids are to be used as the lubricant.

To fill a Chemineer supplied lubricator, remove the plug from the pressure inlet *(Figure 10, page 26)* and fill through port **[1317]** until the fluid is at the sight glass level. *Do not fill the lubricator above the sight glass.* There must be an air space in the top of the lubricator to allow for expansion of the lubricant as it heats up during operation.

The seal must be depressurized to refill the lubricator. Before removing the pressure from the seal, turn off the agitator.

CAUTION! If the pressure inboard of the seal cartridge is in excess of 15 psi (vessel pressure plus head pressure or flush pressure), the pressure must be reduced to below 15 psi prior to depressurizing the seal cartridge.

If the unit is equipped with a flush, do not interrupt the flush flow unless the pressure exceeds 15 psi. If the pressure in the flush chamber exceeds 15 psi, throttle the flow until it is less than 15 psi during the refill of the lubricator.

WARNING! Failure to reduce the vessel/flush pressure below 15 psi could result in seal failure.

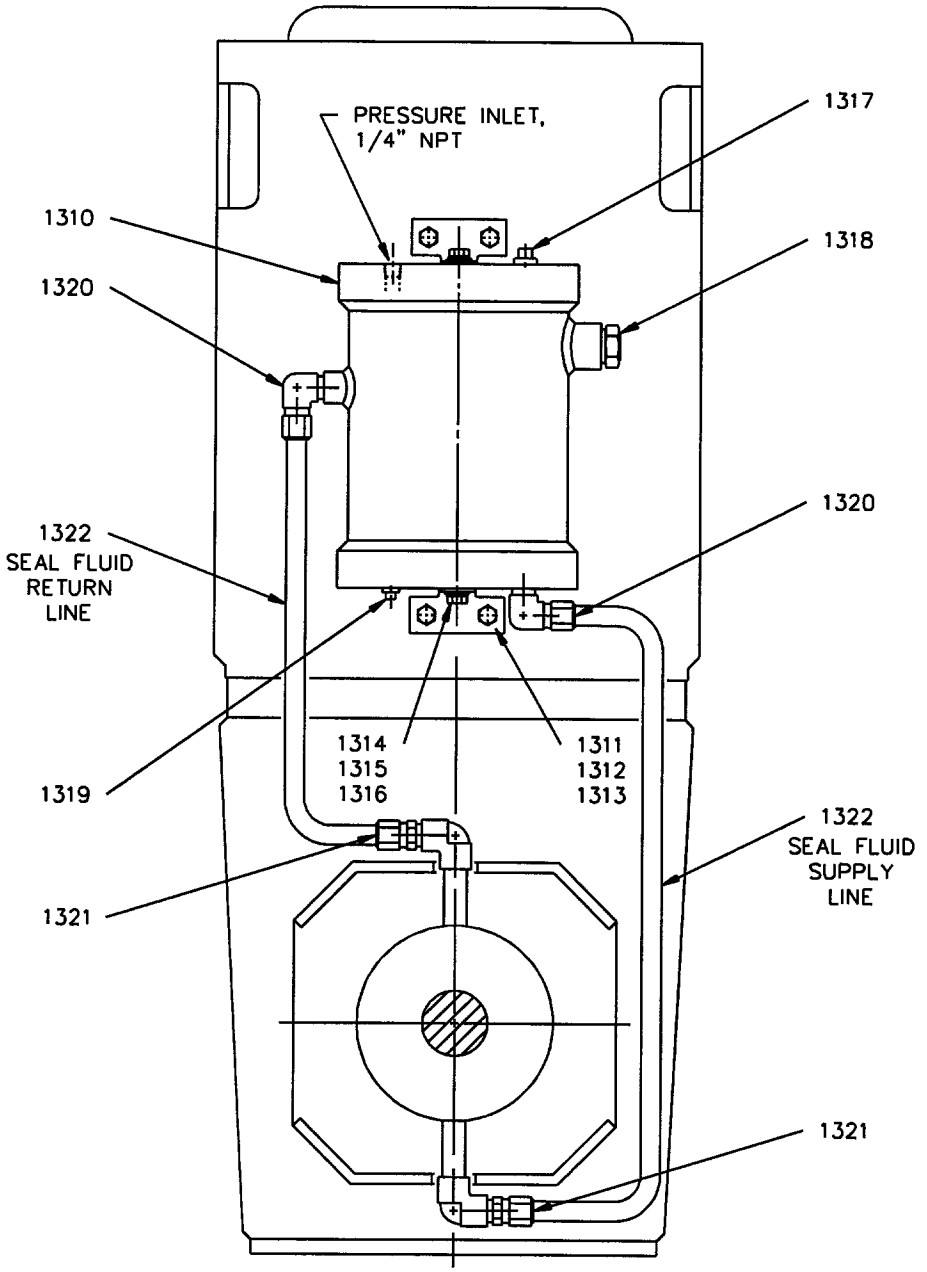

Figure 10: Model HSN Seal Lubricator

OPERATION

AGITATOR

Review the following procedure prior to start-up:

Make sure the gear drive is filled with the correct oil and to the proper level. If a seal lubricator is used, make sure it is filled with the proper type and amount of lubricant and is correctly pressurized. See the *Lubrication* section of this manual.

Make sure all electrical connections are made according to local codes and regulations.

Check for proper motor rotation according to the arrow on the drive. See *Installation* and *Lubrication* sections of this manual.

Recheck all fasteners for proper tightening.

Rotate the high speed coupling by hand to be sure that the shaft turns freely.

Be sure that all coupling guards and safety covers are in place.

Do not operate the agitator without at least one impeller diameter of liquid depth over the shaft. Damage could result from dry operation. Operating the agitator as the tank liquid level approaches and passes through the impeller will severely reduce unit life. Liquid level switches may be used to shutoff the agitator when the liquid level approaches the impeller. Never try to start the agitator with the impeller buried in settled solids.

Should there be problems operating the unit, review the Installation procedures and troubleshooting guide *(Table 12, page 30)*. If you are unable to resolve the problem , contact your local Chemineer office.

MOTOR

Upon initial start-up it is recommended that the motor current be measured and compared to nameplate current. The motor on your unit should be kept free of dirt to allow proper cooling. Noise, vibration, or an increase in temperature may indicate increases in load, an electrical imbalance, or the need to replace the bearings.

MOTOR COUPLING

Most motor couplings provide years of operation with very few problems, provided they operate in a clean environment and are lubricated periodically, if required. Any time 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

The gear drive on this agitator is entirely oil lubricated. Failure to fill the gear drive with the proper amount and type of oil will result in damage to the gearing and bearings in a very short time. Overfilling the gear drive will result in elevated operating temperatures and premature oil breakdown. Surface temperature of the gear drive should not exceed 190° F (172° C). Normal operating temperature is 140-150° F (122-
132° C.)

MECHANICAL SEAL

The Model HSNS has a mechanical seal cartridge with a single mechanical seal which is lubricated by the process materials. The Model HSN has a mechanical seal cartridge with a double mechanical seal which must be externally lubricated. The mechanical seal cartridge has been properly set and tested at the factory. However, the following comments are important for proper seal operation.

A mechanical seal may leak a drop or more per minute and still be functioning normally. No adjustment is necessary or even possible. When seal leakage increases to a level which is unacceptable, the seal must be changed (*Maintenance* section).

Even a small rate of leakage will result in a drop in fluid level in a unit lubricator. The fluid level should be checked frequently and adjusted as needed.

To refill the standard Chemineer unit lubricator *(Figure 10, page 26)*, the agitator must be turned off and the seal cartridge must be completely depressurized.

CAUTION! The pressure on the vessel side of the seal cartridge must not exceed 15 psi (104 kpa) at any time that the seal cartridge is depressurized. This may require reducing the vessel pressure, flush pressure, and/or even the vessel liquid head.

Shut off the pressure supply and slowly depressurize the lubricator. Remove fill port plug **[1317]**.

Add the proper lubricant at the fill port until the liquid is at the sight glass level. *Do not fill the lubricator above the sight glass.* There must be an air space in the top of the lubricator to allow for expansion of the lubricant as it heats up during operation.

Replace the fill port plug and slowly repressurize the lubricator. Check for and correct any leaks. Restore vessel pressure, flush pressure/flow, and vessel liquid head as required.

TROUBLESHOOTING

TABLE 12: 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 reducer.
Leaking	Worn oil seals	Replace defective seals.
	Plugged breather	Clean or replace breather.
	Worn mechanical seal	Replace mechanical seal.

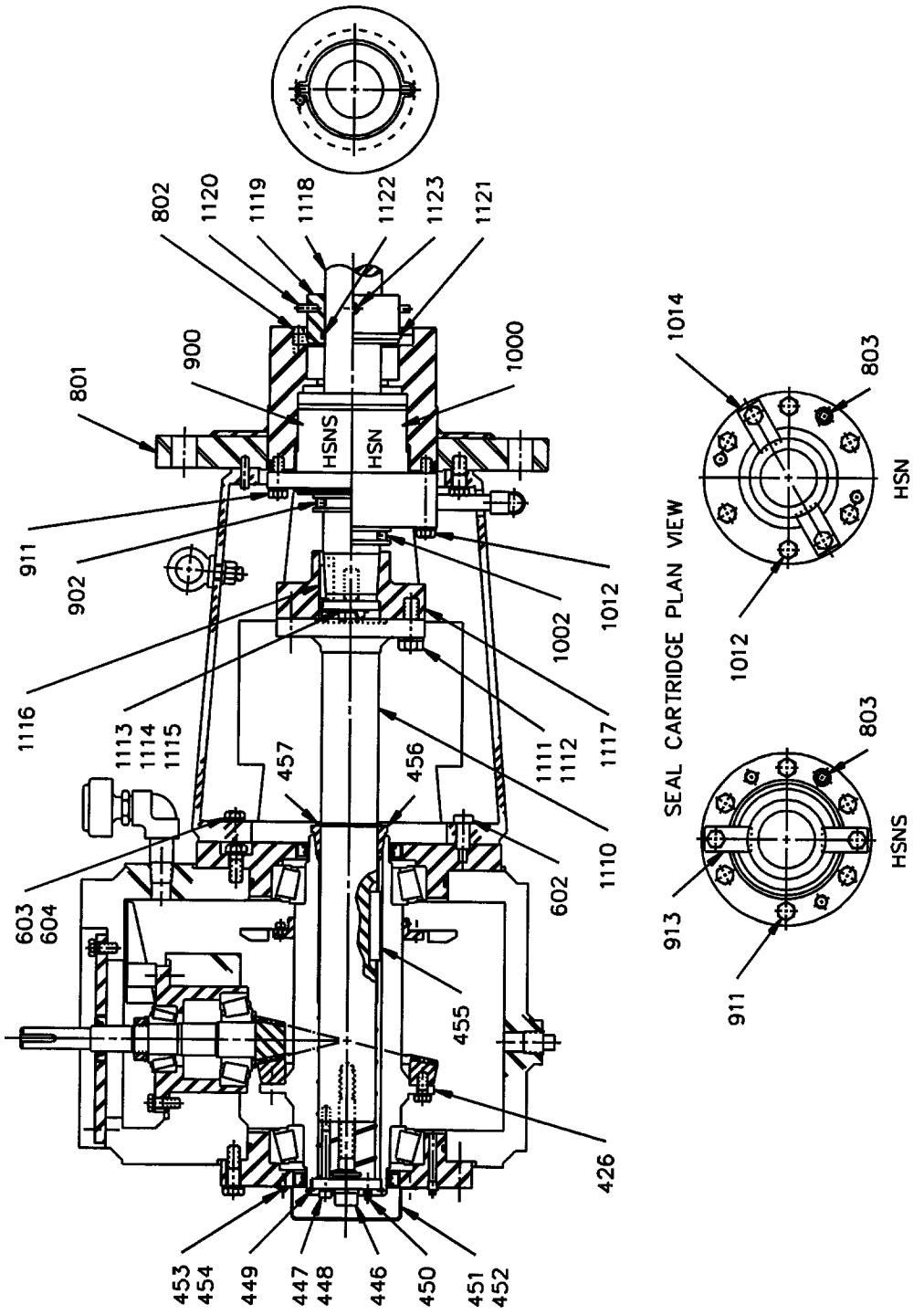

Figure 11: Model HSN/HSNS Mechanical Seal

SEAL CARTRIDGE MAINTENANCE

Excessive external leakage of lubricator fluid or process material from the mechanical seal cartridge indicates the seal elements need to be replaced. The following procedure should be used when changing the mechanical seal:

1. Turn off the agitator. Lock out all electrical power for safety. Depressurize the vessel.

2. Remove dust cap **[451]**, coupling guard **[312]** and hand hole covers **[611]**.

3. Engage sleeve locating clips **[913 or 1014]** and loosen sleeve setscrews **[902 or 1002]**.

4. Loosen three small cap screws **[447]** approximately 1/4 inch (6 mm). Rotate center retract bolt **[446]** *counterclockwise* moving the shaft toward the tank 1/8 inch (3 mm) thus removing the load on snap ring **[457]** and split tapered collar **[456]**.

   NOTE: Hold the flexible coupling to prevent the drive shaft from rotating when the center retract bolt is turned.

5. Unseat the snap ring and slide it to the shaft flange. Remove the split tapered collar.

SEAL CARTRIDGE MAINTENANCE

6. Turn flexible coupling **[200]** (*Figure 6, page 16*) to rotate the shaft and align the punched "match marks". Marks are located on the end of hollow reducer shaft **[426]** and outer bearing cap **[418]**, shown in *Figure 12*.

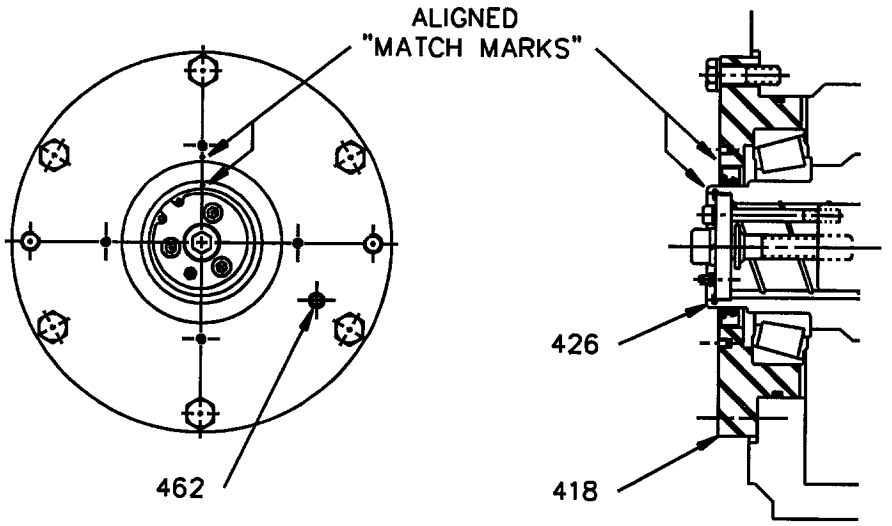

Figure 12: Retract Alignment Markings

7. Carefully bleed the pressure from the seal cartridge (Model HSN only).

8. Remove lubricator **[1017, 1018]** *(Figure 7, page 17)* and flush port **[1402, 1403]** *(Figure 14, page 36)* piping if supplied.

   NOTE: Some leakage will occur. Place a bucket under the drain hole in the pedestal to catch leakage.

SEAL CARTRIDGE MAINTENANCE

9. Remove bolts **[911 or 1012]** securing the seal cartridge to mounting flange **[801]**.

10. Retract the shaft assembly by turning center retract bolt **[446]** *clockwise* until collar locking pins **[1120]** seat against the groove in the mounting flange hub. See assembly drawing for approximate retract distance. When the pins contact the shoulder in the mounting flange, resistance to turning the retract bolt will increase. Turn the retract bolt about one revolution *counterclockwise* to relieve the pressure on the locking pins. Hold flexible coupling **[200]** if necessary, to prevent the shaft from rotating.

    NOTE: The seal cartridge will be drawn partially out of the mounting flange as the shaft is retracted.

11. Rotate the extension shaft *counterclockwise* by hand, turning the flexible coupling until collar locking pins **[1120]** "lock" against stop pin **[802]**. Increased resistance to turning the flexible coupling will signal contact.

    NOTE: The extension shaft is restrained and the vessel is completely shut off during the remaining seal removal steps.

12. Remove snap ring **[449]** from reducer hollow shaft **[426]**.

13. Remove coupling bolts and lockwashers **[1111, 1112]** from tapered coupling half **[1117]**.

    CAUTION! Keep the shaft from turning while loosening the bolts that secure the coupling halves together or damage may occur to the pins on the shutoff collar. The tapered coupling half **[1117]** *has been drilled radially at two (2) locations. A 1/2" (12.7mm) diameter bar positioned in one of these holes and held firmly will eliminate the possibility of unlocking the shaft or damaging the pins.*

14. Disengage the coupling tenons by turning retract bolt **[446]** *clockwise*. (Tapped "jacking bolt" holes in the tapered coupling half may be used if needed.)

SEAL CARTRIDGE MAINTENANCE

15. Manually pull drive shaft **[1110]** away from tapered coupling half **[1117]** as far as possible.

16. Bend down the tabs on locking clip **[1115]**. Remove bolt, locking clip and thrust washer **[1113, 1114, 1115]** from the tapered coupling half.

17. Remove tapered coupling half **[1117]** and key **[1116]**.

NOTE: Inspect extension shaft **[1118]** *for burrs, nicks, etc., and "dress", if necessary, by lightly filing.*

18. Remove three sleeve setscrews **[902 or 1002]**.

19. Remove the seal cartridge using tapped "jacking bolt" holes provided.

CAUTION! If the seal cartridge does not move freely, it may be frozen to the shaft. A puller should be used from the end of the shaft to the seal cartridge. Excessive pushing against the mounting flange from the jacking holes in the seal cartridge could damage the locking pins on the shutoff collar.

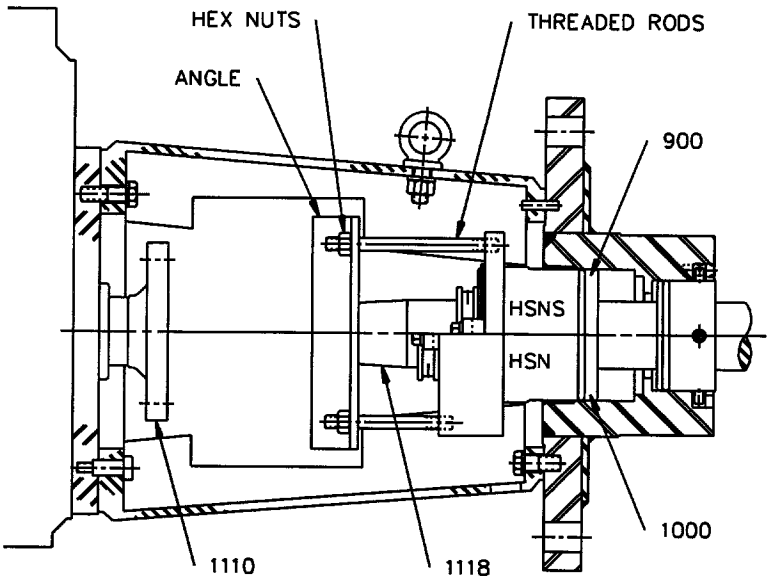

Figure 13: Seal Cartridge Removal

SEAL CARTRIDGE MAINTENANCE

Seal Flush

If the unit is equipped with a seal flush **[1400]**, throttle bushing **[1401]** should be removed and replaced whenever the seal cartridge is removed. To remove the standard Teflon® throttle bushing, use a packing puller. The new throttle bushing slides into the bore in the flange and seats against the bottom of the flange.

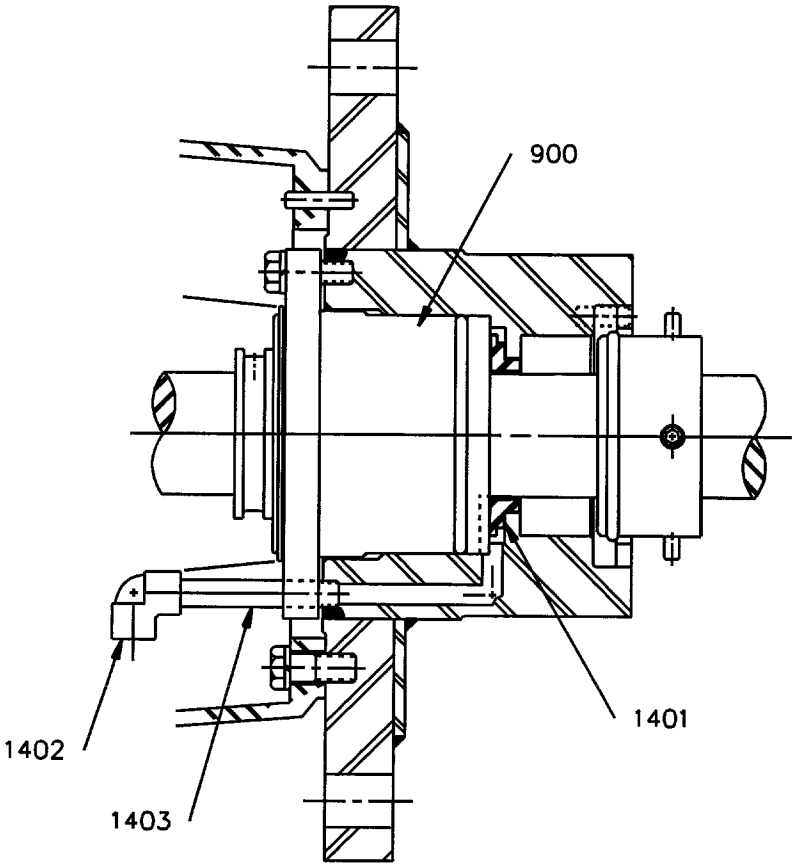

Figure 14: Seal Flush

SEAL CARTRIDGE REBUILD (Model HSN)

Rebuild the seal cartridge as required. Always replace all o-rings and setscrews during the cartridge rebuild. The locking clip in the tapered bore coupling should be replaced each time the coupling is removed. Inspect all mating parts for burrs, nicks, etc., and "dress", if necessary, by lightly filing.

Disassembly (Model HSN)

The following procedure applies to Chemineer standard Model HSN seal cartridges:

1. Set the seal cartridge on a clean, flat surface with the inboard side of the cartridge down.

2. Press down on seal gland **[1004]** to contain the seal spring pressure and carefully remove three setscrews **[1006]**.

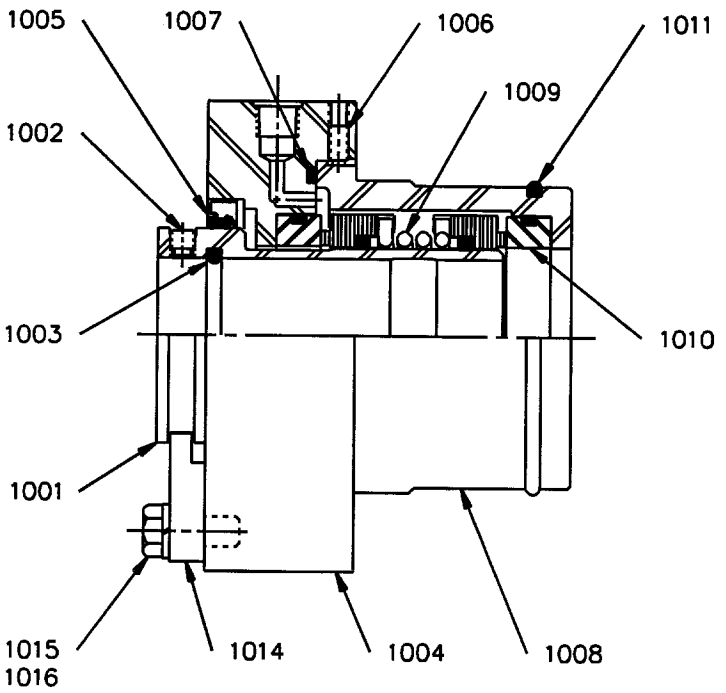

Figure 15: Model HSN Seal Cartridge

SEAL CARTRIDGE REBUILD (Model HSN)

Disassembly (Model HSN) (Cont'd)

3. Slowly release the spring pressure on the seal gland allowing seal housing **[1008]** to separate from seal gland **[1004]**.

4. Lift seal gland **[1004]** with seal sleeve **[1001]** out of the seal housing.

   NOTE: The standard Crane 8TD seal will slide off of the sleeve at this point. Some optional setscrew driven seal styles require loosening seal head setscrews before the seal head can be removed.

5. Once the seal heads are removed from the sleeve and the locating clips are disengaged, sleeve **[1001]** can be removed from seal gland **[1004]**.

6. Remove one seal seat **[1010]** from seal housing **[1008]** and the other from seal gland **[1004]**.

7. Remove lip seal **[1005]** from seal gland **[1004]**.

The seal cartridge is now completely disassembled.

Assembly (Model HSN)

If there is any damage to the seal sleeve, the sleeve should be replaced.
Assemble the cartridge in a clean environment. Clean all of the parts prior to assembly. Replace all o-rings and setscrews with new parts. Inspect mating parts for burrs, nicks, etc. and "dress", if necessary, by lightly filing.

1. Install lip seal **[1005]** in seal gland **[1004]**.

2. Using a lubricant compatible with the process fluids and the elastomers, lightly coat the seal seat elastomers. Press the seal seats **[1010]** into seal gland **[1004]** and seal housing **[1008]**.

3. Slide seal sleeve **[1001]** through seal gland **[1004]**.

SEAL CARTRIDGE REBUILD (Model HSN)

Assembly (Model HSN) (Cont'd)

4. Engage locating clips **[1014]** to hold sleeve **[1004]** in position during the remainder of the assembly.

5. For the Crane 8TD seal, slide the outboard seal head with lubricated o-ring over the sleeve until the head is against the outboard seal seat.

   NOTE: Some optional seal styles require locating a seal head retainer at a "set height" and tightening setscrews in the retainer. Refer to the unit seal drawing to determine seal type and specific set dimensions.

6. Engage the seal spring into the seal head with the drive tang engaging the slot in the seal head.

7. Install the inboard seal head and the o-ring.

8. Install three setscrews **[1006]** into seal gland **[1004]**.

9. Place housing o-ring **[1007]** in seal gland **[1004]**.

10. Carefully place seal housing **[1008]** over the sleeve.

11. Press seal housing **[1008]** down until it fully engages seal gland **[1004]**.

12. Evenly and securely tighten three setscrews **[1006]** which hold the cartridge together.

13. Install new seal sleeve o-ring **[1003]** and seal housing o-ring **[1011]**.

14. Install three seal sleeve setscrews **[1002]**.

SEAL CARTRIDGE REBUILD (Model HSN)

Seal Cartridge Bench Test (Model HSN)

The double mechanical seal cartridge may be pressure tested before it is installed in the unit.

CAUTION! Setscrews **[1006]** *are designed to hold the assembly together, not to withstand test pressure. During the bench test, clamp the seal housing and the seal gland together.*

1. Fill the cartridge with the barrier fluid to be used in operation.

2. Vent all air from the cartridge.

3. Use a hydraulic pump to pressurize the seal cartridge to the normal operating pressure.

NOTE: Since the seal sleeve is not centered by the extension shaft during the bench test, slight leakage is not uncommon. Seals with a Teflon wedge under the head require approximately 125 psig to seat the Teflon. After completing the bench test, slowly bleed the pressure out of the seal cartridge.

SEAL CARTRIDGE REBUILD (Model HSNS)

Rebuild the seal cartridge as required. Always replace all o-rings and setscrews during the cartridge rebuild. The locking clip in the tapered bore coupling should be replaced each time the coupling is removed. Inspect all mating parts for burrs, nicks, etc., and "dress", if necessary, by lightly filing.

Disassembly (Model HSNS)

The following procedure applies to Chemineer standard Model HSNS seal cartridges:

1. Set the seal cartridge on a clean, flat surface with the inboard side of the cartridge down.

2. Press down on seal sleeve **[901]** and disengage locating clips **[913]**.

3. Slowly release the seal spring pressure on seal sleeve.

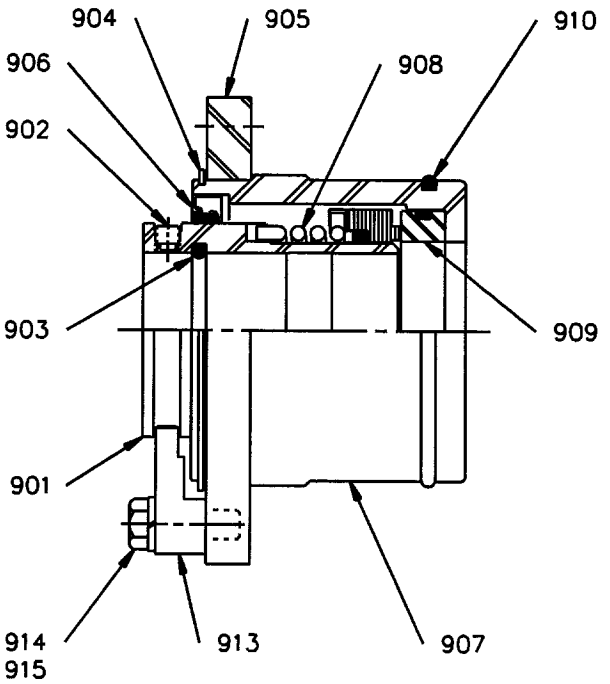

Figure 16: Model HSNS Seal Cartridge

SEAL CARTRIDGE REBUILD (Model HSNS)

Disassembly (Model HSNS) (Cont'd)

NOTE: If the seal cartridge is equipped with the standard Crane 8TD seal, the sleeve can be removed at this point. If equipped with an optional setscrew driven seal style, the lip seal must be removed before the sleeve. Loosen the seal head setscrews to remove the seal head from the sleeve.

4. Remove lip seal **[906]** from seal housing **[907]**.

5. Remove snap ring **[904]** from the seal housing.

6. Remove housing flange **[905]** from the seal housing.

7. Remove seal seat **[909]** from the seal housing.

The seal cartridge is now completely disassembled.

Assembly (Model HSNS)

If there is any damage to the seal sleeve, the sleeve should be replaced.

Assemble the cartridge in a clean environment. Clean all of the parts prior to assembly. Replace all o-rings and setscrews with new parts. Inspect mating parts for burrs, nicks, etc. and "dress", if necessary by lightly filing.

1. Use a lubricant compatible with the process fluids and o-rings and lightly coat the seal seat elastomer. Press seal seat **[909]** into seal housing **[907]**.

2. Slide housing flange **[905]** over seal housing **[907]**.

3. Install snap ring **[904]** on the seal housing.

4. For the Crane 8TD seal, place the seal head with lubricated o-ring against the seal seat.

SEAL CARTRIDGE REBUILD (Model HSNS)

Assembly (Model HSNS) (Cont'd)

5. Set the seal spring into the seal head with the drive tang engaging the slot in the seal head.

6. Slide seal sleeve **[901]** through the spring and seal head and engage the outer drive tang in the slot in the seal sleeve.

NOTE: Some optional seal styles are setscrew driven and the seal head should be installed on the sleeve (refer to the unit assembly drawing) prior to installing the sleeve in the seal housing. Refer to the unit seal drawing to determine seal type and specific set dimension.

7. Install lip seal **[901]** in seal housing **[907]**.

8. Push down on seal sleeve **[901]** and engage locating clips **[913]**.

9. Install new seal sleeve o-ring **[903]** and seal housing o-ring **[910]**.

10. Install three seal sleeve setscrews **[902]**.

SEAL CARTRIDGE REBUILD (Model HSN/HSNS)

Installation

NOTE: Clean all components thoroughly before reassembly. Lightly lubricate all components during reassembly to prevent galling and for ease of assembly. The seal lubrication system should be flushed to make sure it is free of contaminants prior to filling the system for operation.

1. Remove one seal sleeve setscrew **[902 or 1002]** and make sure the other two setscrews do not extend into the inside of the sleeve.

2. Draw a line with a marker from the center of one of the seal sleeve setscrew spots in the extension shaft straight back to the tapered end of the shaft.

3. Line up the setscrew holes in the seal sleeve with the spots in the shaft. Using the marker line as a guide, slide the seal cartridge over the shaft until the setscrew hole lines up with the spot in the shaft.

SEAL CARTRIDGE REBUILD (Model HSN/HSNS)

Installation (Cont'd)

CAUTION! If a Teflon or Kalrez o-ring is installed in the sleeve, the seal cartridge may be difficult to install. Use the tapped hole in the end of the shaft to push the cartridge on the shaft. Do not hammer on the seal cartridge as this may damage the seal components. Do not put bolts or threaded rods in the flange as this may damage the pins in the shutoff collar.

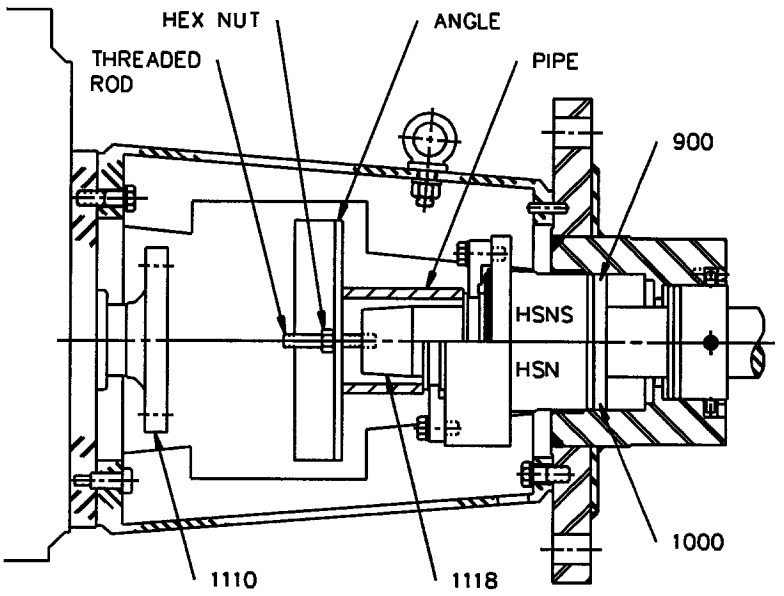

Figure 17: Seal Cartridge Installation

4. Install and tighten the seal sleeve setscrews.

5. Clean any lubricant off of the taper on the extension shaft.

6. Slide tapered coupling half **[1117]**, dry and without the key, onto the extension shaft.

7. Install key **[1116]**. The key should slide in easily. If the key does not slide in easily, remove the coupling from the shaft and check the tapered surfaces, keyways and key for burrs or dirt.

SEAL CARTRIDGE REBUILD (Model HSN/HSNS)

Installation (Cont'd)

8. Install thrust washer **[1115]**, locking clip **[1114]**, and bolt **[1113]**.

9. Torque the thrust washer bolt **[1113]** to the value shown in *Table 13.*

TABLE 13: SHAFT BOLT TIGHTENING TORQUE[1],[2],[3]

Bolt Size	ALL MATERIALS	
	ft-lb	Nm
1/2- 13	50	68
5/8- 11	90	122
3/4- 10	160	217

(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.

10. Bend up at least one of the tabs on locking clip **[1114]** against one flat on the bolt head to keep the bolt from loosening during operation.

11. Remove shaft retract bolt assembly **[446]**. Manually push drive shaft **[1110]** forward to bring the coupling halves together.

12. Turn the flexible coupling to align the flange match mark on drive shaft **[1110]** with the mark on tapered coupling half **[1117]**.

13. It may be necessary to push down on the extension shaft coupling to install the coupling bolts and lockwashers **[1111, 1112]**. Tighten the coupling bolts to engage the tenon. There should not be a gap between the coupling flanges if the tenons are properly engaged.

SEAL CARTRIDGE REBUILD (Model HSN/HSNS)

Installation (Cont'd)

14. Torque the coupling bolts to the value shown in *Table 5 (page 11)*.

CAUTION! Keep the shaft from turning while tightening the bolts that secure the coupling halves together or damage may occur to the pins on the shutoff collar. Tapered coupling half **[1117]** *has been drilled radially at two (2) locations. A 1/2 inch (12 mm) diameter bar positioned in one of these holes and held firmly will eliminate the possibility of unlocking the shaft or damaging the pins.*

15. Insert retract bolt assembly **[446]** and snap ring **[449]** into hollow output shaft **[426]**.

16. Turn flexible coupling **[200]** to rotate the extension shaft clockwise until it stops (almost 1/2 turn) to unlock the shutoff collar. Increased resistance to turning the flexible coupling will signal contact.

17. Turn the seal cartridge flange and line up the bolt holes with those in the mounting flange (lube and flush line holes must be properly oriented.)

18. Engage three small cap screws and lockwashers **[447, 448]** only one or two turns into drive shaft **[1110]**.

    NOTE: The small cap screws will extend well away from the center retract bolt washer.

19. Hold flexible coupling **[200]** and rotate center retract bolt **[446]** *counterclockwise* to move the shaft toward the tank just far enough to allow the split tapered collar and snap ring to be installed. Do not loosen the retract bolt excessively because the seal could be damaged.

    NOTE: If the shaft has been properly unlocked, (see Step 16) the center retract bolt should turn easily. Do not force operation of the retract bolt. The three small cap screws **[447]** *must not contact the retract bolt washer during this operation.*

20. Position split taper collar halves **[456]** and install snap ring **[457]** in the snap ring groove on drive shaft **[1110]**.

SEAL CARTRIDGE REBUILD (Model HSN/HSNS)

Installation (Cont'd)

21. Install bolts and lockwashers **[911, 912 or 1012, 1013]** and disengage locating clips **[913 or 1014]**.

22. Rotate center retract bolt **[446]** clockwise until the drive shaft, snap ring, and split tapered collar draw up tight. Torque the retract bolts to the values shown in *Table 14*. Do not rotate the shaft.

TABLE 14: RETRACT BOLT TIGHTENING TORQUE

CASE SIZE	CENTER BOLT		SMALL CAP SCREW	
1 & 2	27 ft. lbs.	37 Nm	6 ft. lbs.	8 Nm
3	101 ft. lbs.	137 Nm	17 ft. lbs.	23 Nm
4	152 ft. lbs.	206 Nm	30 ft. lbs.	41 Nm

23. Torque the seal cartridge bolts to the value shown in *Table 5 (page 11*.

24. Install all plumbing.

25. Model HSN only: Fill the lubrication system per the instructions in the *LUBRICATION* section of this manual and pressurize the system to operating pressure.

26. If the unit is equipped with a seal flush, start the flow.

CAUTION! On HSNS units, pressure at the flush must not exceed 30 psi (206 kpa).

27. Pump grease into fitting **[450]** to fill the cavity.

28. Install dust cap and gasket **[451, 452]** using screws and lockwashers **[453, 454]**.

29. Rotate the extension mixer shaft through one complete revolution turning the flexible coupling by hand to make sure it is free before starting the unit.

30. Install coupling guard **[312]** and handhole covers **[611]**.

AGITATOR SHAFT

Extension Shaft Removal

Any time the extension shaft is removed from the unit, the shutoff collar o-rings should be replaced. To provide support for the shaft prior to removal, the shaft should be retracted and locked and the seal cartridge removed as outlined in the *MAINTENANCE - Seal Cartridge* section of this manual.

1. Drain and clean the vessel for entry.

2. Remove impeller **[1200]** (see *Figure 6, page 16*).

(Refer to *Figure 11, page 31.*)

3. Support the extension shaft inside the vessel. Rotate the shaft *counterclockwise* (viewed from the end inside the vessel) until the collar locking pins appear behind the notches unlocking the shutoff collar. Pull the shaft into the vessel.

4. Match mark the collar locking pin/shaft relationship with a marker.

5. Remove two setscrews **[1123]** to remove shutoff collar **[1119]** from the shaft.

   NOTE: The shutoff collar must be removed from the tapered end of the shaft.

AGITATOR SHAFT

Installing Original Extension Shaft

NOTE: Clean all components throughly before assembly. Lightly lubricate all components during assembly to prevent galling and for ease of assembly.

The following procedure assumes the original extension shaft will be reinstalled. Prior to reinstalling the original extension shaft in a unit, repair nicks, scoring and scratches, as required.

1. Install new shutoff collar o-rings **[1121, 1122]**. *(Refer to the unit assembly drawing for the o-ring material.)*

2. Set shutoff collar **[1119]** in place with the match marks aligned and seat setscrews **[1123]**. Make sure the dog points on the setscrews are engaged in the spots in the shaft. Tighten the setscrews to the value shown in *Table 5 (page 11).*

   NOTE: The shutoff collar must be installed from the tapered end of the shaft.

3. Insert the shaft through the mounting flange from inside the vessel. Line up collar locking pins **[1120]** with the notches in the mounting flange.

4. Push the shaft through the mounting flange until travel stops. (The collar locking pins will be behind the notches and in contact with the shoulder in the mounting flange.)

5. Rotate the shaft clockwise (viewed from the end inside the vessel), until collar locking pin **[1120]** rotation is stopped by stop pin **[802]**.

6. Install the seal cartridge and complete the assembly of the unit per the *Seal Cartridge Installation* instructions.

7. Install the impeller as shown in *Figure 5, page 12,* with the concave side of its blades away from the wall of the vessel. Unless otherwise specified on the unit assembly drawing, the impeller attaches to the shaft with a key and setscrew. The tapped hole in the impeller hub is a self-locking thread form. Torque the setscrew to the value shown in *Table 5.*

AGITATOR SHAFT

Installing New Extension Shaft

NOTE: Clean all components thoroughly before assembly. Lightly lubricate all components during assembly to prevent galling and for ease of assembly.

1. Place shutoff collar **[1119]**, without setscrews or o-rings, in the mounting flange and rotate the collar clockwise to the locked position. Make sure the collar is facing in the proper direction.

2. Insert new extension shaft **[1118]** through the shutoff collar and mounting flange from inside the vessel. Support the shaft from inside the vessel.

3. Install the mechanical seal cartridge, with the sleeve locating clips in place, but without the sleeve setscrews, sleeve o-ring, or seal housing o-ring.

4. Install and tighten the seal cartridge mounting bolts.

5. Install tapered coupling half **[1117]**. Use only the key, bolt, and thrust washer (no locking clip) to hold the coupling on the shaft.

6. Push the drive shaft forward and engage the coupling tenons, taking care to align the flange match marks.

7. Install and tighten the coupling flange bolts.

8. Rotate center retract bolt **[446]** *counterclockwise* to move the shaft just far enough to allow the split tapered collar and snap ring to be installed.

9. Position split tapered collar halves **[456]** and install snap ring **[457]** in the snap ring groove.

10. Rotate center retract bolt **[456]** *clockwise* until the drive shaft, snap ring, and split tapered collar draw up tight. Tighten the retract bolt.

11. Align the punched "match marks" *(Figure 12, page 33)* on gear drive outer bearing cap **[418]** and the end of hollow reducer shaft **[426]**.

AGITATOR SHAFT

Installing New Extension Shaft (Cont'd)

12. Inside the vessel, use a square to accurately scribe an axial mark about 6" long along the extension shaft centerline directly in line with the center of the notch that the collar locking pin enters.

13. Scribe a radial mark on the extension shaft at the set distance *(Table 15)* inboard from the face of the mounting flange.

14. Scribe a radial mark on the extension shaft at the outboard end of the mechanical seal sleeve.

TABLE 15: COLLAR SET DIMENSIONS

Case Size	Shaft Diameter	Set Distance
1	2" (50.8 mm)	1-1/8" (28.6 mm)
2	2" (50.8 mm)	1-1/8" (28.6 mm)
3	3" (76.2 mm)	1-5/8" (41.3 mm)
4	3-1/2" (88.9 mm)	1-7/8" (47.6 mm)

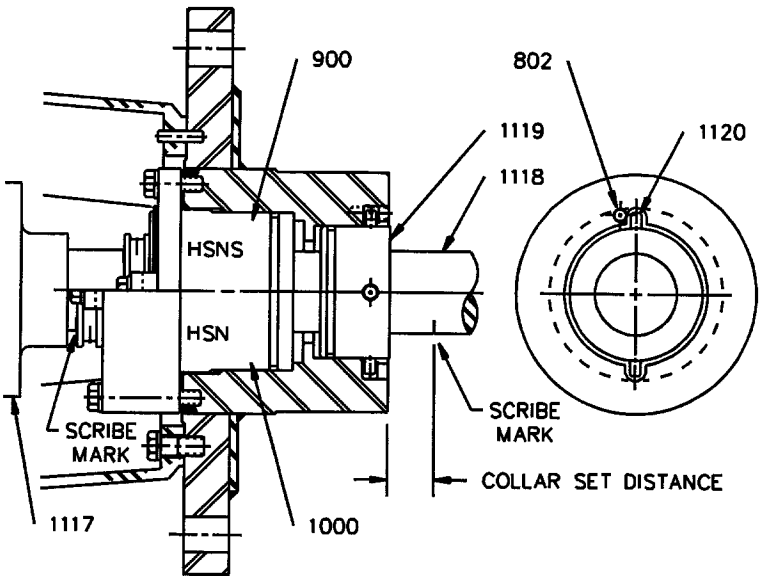

Figure 18: New Extension Shaft Marking

AGITATOR SHAFT

Installing New Extension Shaft (Cont'd)

15. Rotate center retract bolt **[446]** *counterclockwise* to remove the load on snap ring **[457]** and split tapered collar **[456]**.

16. Unseat the snap ring and slide it to the shaft flange. Remove the split tapered collar.

17. Remove snap ring **[449]** from reducer hollow shaft **[426]**.

CAUTION! Support the shaft from inside the vessel while removing the tapered coupling and the mechanical seal cartridge.

18. Remove the coupling flange bolts from the tapered coupling half.

19. Manually pull drive shaft **[1110]** away from tapered coupling half **[1117]** as far as possible.

20. Remove bolt and thrust washer **[1113, 1115]** from the tapered coupling half.

21. Remove tapered coupling half **[1117]** and key **[1116]**.

22. Remove the seal cartridge mounting bolts.

23. Remove the seal cartridge from the extension shaft.

24. Carefully remove extension shaft **[1118]** into the vessel.

25. Unlock and remove shutoff collar **[1119]** from the mounting flange.

26. Slide the shutoff collar onto the extension shaft and position it by aligning the inboard end of the shutoff collar with the scribe mark made in *Step 13*. Angular position is established by aligning the centerline of a collar locking pin with the axial scribe line on the shaft made in *Step 12*.

    NOTE: The shutoff collar must be installed from the tapered end of the shaft.

AGITATOR SHAFT

Installing New Extension Shaft (Cont'd)

27. Mark the collar setscrew locations on the extension shaft.

28. Remove the shutoff collar and spot-drill the extension shaft to accept the setscrew's dog point. See *Table 16*. Remove burrs.

TABLE 16: SHAFTING SPOT-DRILL DIMENSIONS

Setscrew Size	Drill Diameter	Drill Depth [1]
5/16- 18	15/64" (6.0 mm)	1/8" (3.2 mm)
3/18- 16	9/32" (7.2 mm)	5/32" (4.0 mm)
1/2- 13	3/8" (9.5 mm)	7/32"(5.5 mm)

[1] Drill depth is to drill point.

29. Slide the seal cartridge onto the extension shaft and position it by aligning the outboard end of the seal sleeve with the scribe mark made in *Step 14*.

30. Mark the sleeve setscrew locations on the extension shaft.

31. Remove the seal cartridge, and spot-drill the extension shaft to accept the setscrew's dog point. See *Table 16*. Remove burrs.

32. Install new shutoff collar o-rings **[1121, 1122]**.

33. Set shutoff collar **[1119]** in place with the match marks aligned and seat setscrews **[1123]**. Make sure the dog points on the setscrews are engaged in the spots in the shaft. Torque the setscrews to the value shown in *Table 5 (page 11)*.

34. Insert the shaft through the mounting flange from inside the vessel. Line up collar locking pins **[1120]** with the notches in the mounting flange.

AGITATOR SHAFT

Installing New Extension Shaft (Cont'd)

35. Push the shaft through the mounting flange until travel stops. (The collar locking pins will be behind the notches and in contact with the shoulder in the mounting flange.)

36. Rotate the shaft *clockwise* (view from the end inside the vessel), until collar locking pin **[1120]** rotation is stopped by stop pin **[802]**.

37. Install the seal cartridge and complete the assembly of the unit per the *Seal Cartridge Installation* instructions.

38. Install the impeller as shown in *Figure 5, page 12* with the concave side of its blades away from the wall of the vessel. Unless otherwise specified on the unit assembly drawing, the impeller attaches to the shaft with a key and setscrew. The tapped hole in the impeller hub is a self-locking thread form. Torque the setscrew to the value shown in *Table 5 (page 11)*.

GEAR DRIVE

This section covers the removal, disassembly, assembly and installation of the HS Agitator gear drive.

CAUTION! The shaft must be fully retracted and locked (see Seal Maintenance section) before removing the gear drive from the pedestal. When the gear drive is fully disassembled, all bearings, lip seals, o-rings, shims and gaskets should be replaced with new parts. When replacing bearings, always replace both cup and cone. Spiral bevel gears must always be replaced in matched sets.

Removal

Retract and lock extension shaft **[1118]** in place per the *MAINTENANCE, Seal Cartridge* section. Drive shaft **[1110]** will be removed with the gear drive.

1. With a hoist or crane system, hook up to the cutouts on the sides of the motor bracket and apply just enough tension to relieve the gear drive and motor weight from the drive support.

2. Remove channel support **[501]** (*Figure 6, page 16*) or the tie-rods.

3. Remove shoulder bolts **[602]** and bolts **[603]** *(Figure 11, page 31)* securing the gear drive to the pedestal.

4. Remove the gear drive and motor assembly.

GEAR DRIVE

Preparation for Disassembly

1. Clean all external surfaces and drain the oil.

2. Remove the setscrews securing the flexible coupling hub to the input pinion shaft. This coupling hub must be free to slide off the shaft as the motor and motor bracket assembly are removed from the gear drive.

3. Remove bolts **[303]** securing motor bracket **[301]** to gear drive **[400]** (*Figure 6, page 16*). Remove the motor and motor bracket as an assembly.

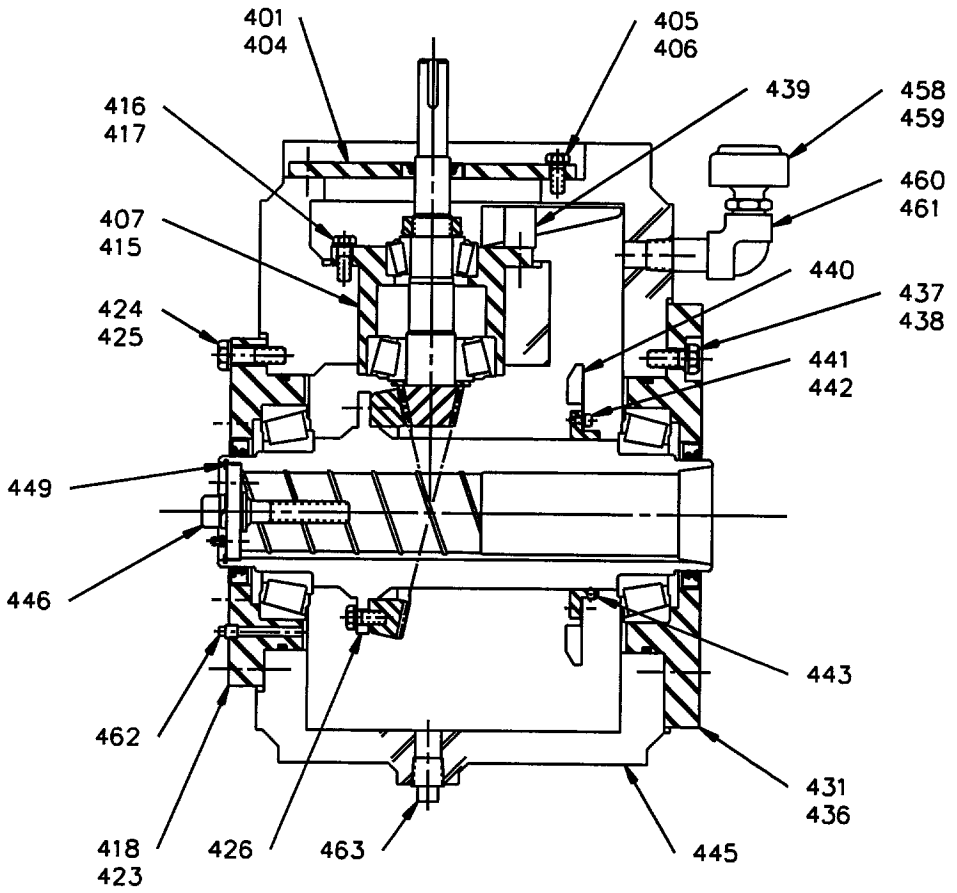

Figure 19: HS Gear Drive

GEAR DRIVE

Disassembly

1. Remove snap ring **[449]** and retract bolt assembly **[446]** *(Figure 19, page 58).*

2. Remove drive shaft **[1110]** and key **[455]** from the hollow output shaft. *(Figure 11, page 31).*

3. Remove breather **[458]** and fittings **[459, 460, 461].**

4. Set the gear drive on a clean work surface with the hollow shaft vertical, outer bearing cap **[418]** down.

5. Remove bolts **[437]**, inner bearing cap assembly **[431]** and shim set **[436]**. Keep the shim set intact for reference at assembly.

6. Remove cap screws **[441]** and slingers **[440]**.

7. Remove bolts **[405]**, input cap assembly **[401]** and gasket **[404]**.

8. Remove bolts **[416]** securing the spiral bevel pinion cartridge to the housing. Remove lube trough **[439]**, cartridge assembly **[407]** and shim set **[415]**. Keep the shim set intact for reference at assembly.

9. Remove hollow shaft assembly **[426]**.

10. Tip the gear drive housing up, remove bolts **[424]**, outer bearing cap assembly **[418]** and shim set **[423]**. Keep the shim set intact for reference at assembly.

The gear drive is now disassembled into major subassemblies; spiral bevel pinion cartridge, hollow shaft assembly and bearing caps.

Bearing cups mounted in caps are interference fit and can be difficult to remove with a commercial bearing puller. Removal can be made easier by welding a 1/8" bead completely around the cup in the center of the roller race. Upon cooling the cup will shrink allowing removal. Be sure to protect adjacent surfaces from weld spatter.

GEAR DRIVE

Disassembly (Cont'd)

Spiral Bevel Pinion Cartridge

1. Remove the setscrew from locknut **[409]**. Remove locknut and lockwasher **[409, 410]** from the pinion shaft.

2. Press spiral bevel pinion shaft **[408]** out of bearing **[411]** cone. Press bearing **[413]** cone (and pinion washer **[414]**, Case 4 only) off the pinion shaft.

3. Pull bearing **[411, 413]** cups out of the cartridge.

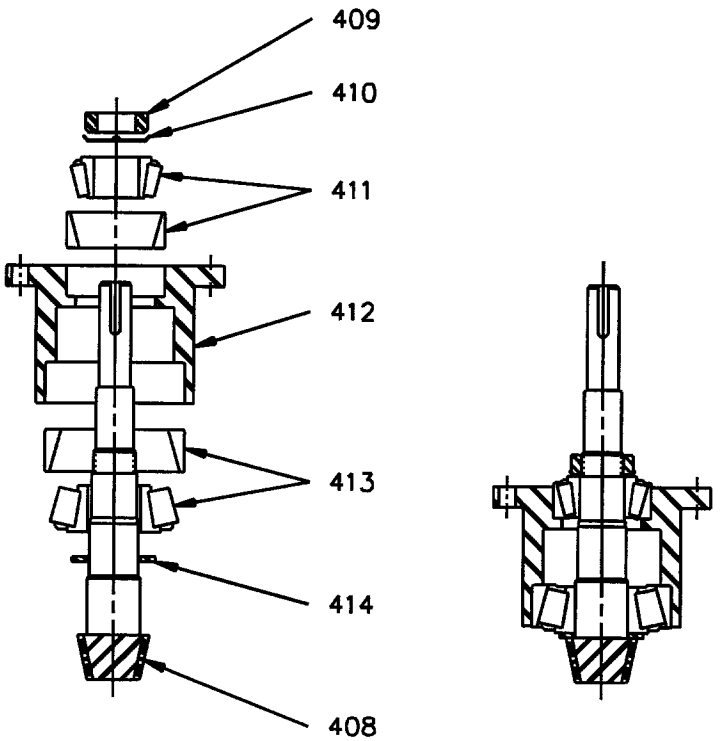

Figure 20: Spiral Bevel Pinion Cartridge [407]

GEAR DRIVE

Disassembly (Cont'd)

Hollow Shaft

1. Press bearing **[420, 433]** cones off the shaft.

2. Loosen setscrews **[444]** and remove slinger collar **[443]**.

3. Remove gear mounting bolts **[429]** and spiral bevel gear **[428]**.

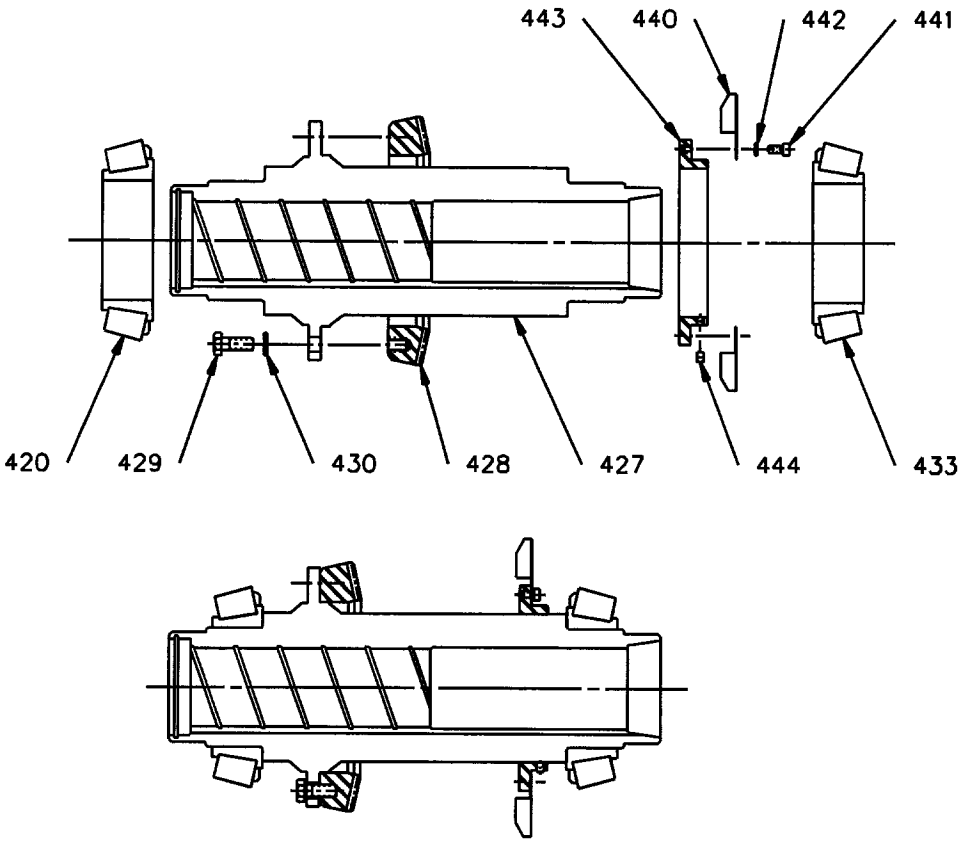

Figure 21: Hollow Shaft [426]

GEAR DRIVE

Disassembly (Cont'd)

Bearing Caps

1. Remove each bearing **[420, 433]** cup from its respective cap.
2. Press lip seals **[421, 434]** out of the caps.
3. Remove o-rings **[422, 435]**.

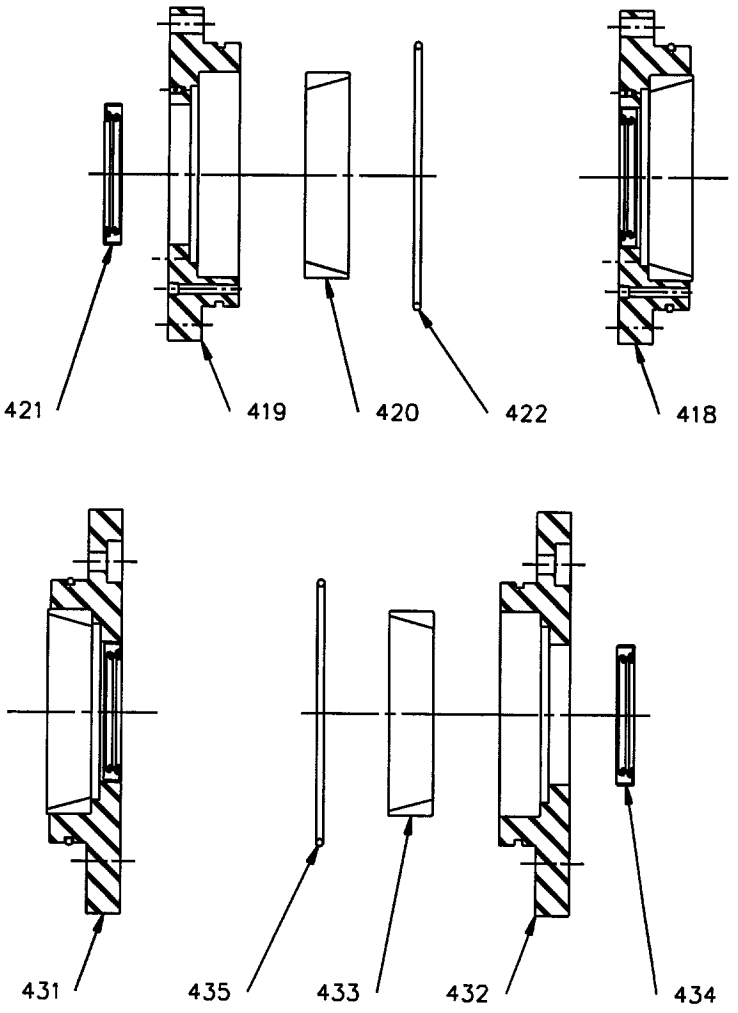

Figure 22: Outer [418] and Inner [431] Bearing Cap

GEAR DRIVE

Disassembly (Cont'd)

Input Cap

1. Press lip seal **[403]** out of cap **[402]**.

2. Remove gasket **[404]**.

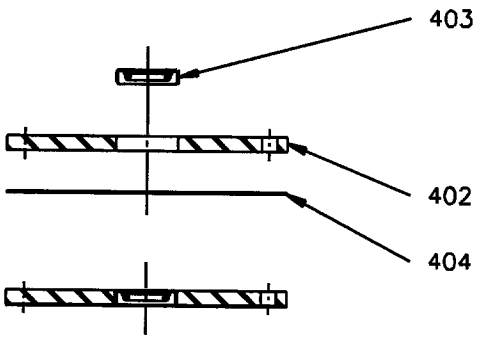

Figure 23: Input Cap [401]

The gear drive is now fully disassembled. Clean all parts and inspect for wear. Replace worn parts as required.

GEAR DRIVE

Assembly

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

CAUTION! The tapped holes in the slinger collar are a self-locking thread form. Do not chase threads with a standard tap. Thread damage will require replacement of the slinger collar.

Inspect and clean all tapped holes. If threads are damaged, chase with an appropriate tap.

CAUTION! The recommended assembly procedure requires the use of a torque wrench. The values listed in Table 17 (page 65) are proper tightening torques as a function of thread size.

All bearing cones are mounted with interference fits. Heat the cones and press them onto the shaft. Heat bearings in an oven or oil bath.

NOTE: Do not heat parts in excess of 275° F (135° C). Do not apply direct flame. Do not allow parts to touch the bottom or sides of the oven or oil bath.

All bearing cups are mounted with interference fits. Press the bearing cups into their housings cold. *Placing the cups in dry ice will cause them to shrink and ease installation.*

Before installing lip seals clean the cap bore and apply Permatex #2 or equivalent to the outside of the lip seal. Install the lip seal with the spring facing the bearing. Before installation on a shaft, coat the shaft and lip seal with bearing grease.

GEAR DRIVE

Assembly (Cont'd)

TABLE 17: BOLT TIGHTENING TORQUE[1],[2]

Bolt Size	CARBON STEEL[3]			
	Grade 2		Grade 5	
	ft lb	Nm	ft lb	Nm
8-32	1.2	1.6	1.9	2.5
10-24	1.7	2.3	2.7	3.6
10-32	1.9	2.6	3.1	4.1
1/4-20	4.1	5.6	6	8.1
5/16-18	8.3	11	13	17
5/16-24	-	-	14	19
3/8-16	15	20	23	31
3/8-24	-	-	26	36
1/2-13	38	51	56	76
1/2-20	-	-	68	92
5/8-11	68	92	113	153
5/8-18	-	-	135	161
3/4-10	120	163	200	271
3/4-16	-	-	225	305
7/8-9	105	143	296	401
1-8	165	224	443	601
1-1/8-7	225	305	596	808
1-1/4-7	315	428	840	1139
1-3/8-6	417	566	1103	1495
1-1/2-6	555	752	1463	1983

[1] Tighten all fasteners to values shown in the table 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.

GEAR DRIVE

Assembly (Cont'd)

Most gear drive bolt patterns are circular with six- or eight-hole spacings. Install all bolts finger-tight, then tighten in sequential order (see below) to 50% of the prescribed torque values. Repeat the sequence, tightening the bolts to full torque values.

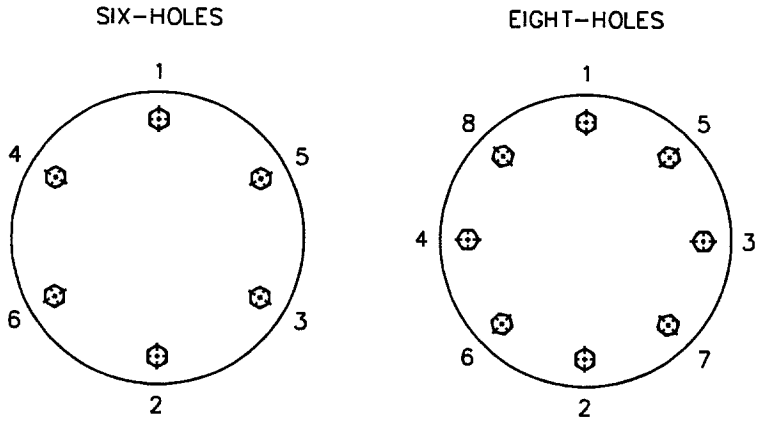

Figure 24: Sequential Bolt Tightening

When tightening two or more setscrews which retain a collar, flange, or sleeve to a shaft, tighten alternately, working back and forth or around the shaft. Tighten in steps to final torque values.

GEAR DRIVE

Assembly (Cont'd)

Spiral Bevel Pinion Cartridge

1. Press bearing **[411, 413]** cups into housing **[412]**. The cup must be firmly seated against the shoulder. Check with a feeler gauge.

2. Install pinion washer **[414]** (Case 4 only) onto pinion shaft **[408]**. Heat and press bearing **[413]** cone onto the pinion shaft. Allow the bearing to cool. The cone must be firmly seated against the shoulder. Check with a feeler gauge.

3. Insert the pinion shaft into cartridge housing **[412]**.

4. Heat bearing **[411]** cone and press it onto the pinion shaft until the cartridge housing shows slight resistance to turning by hand.

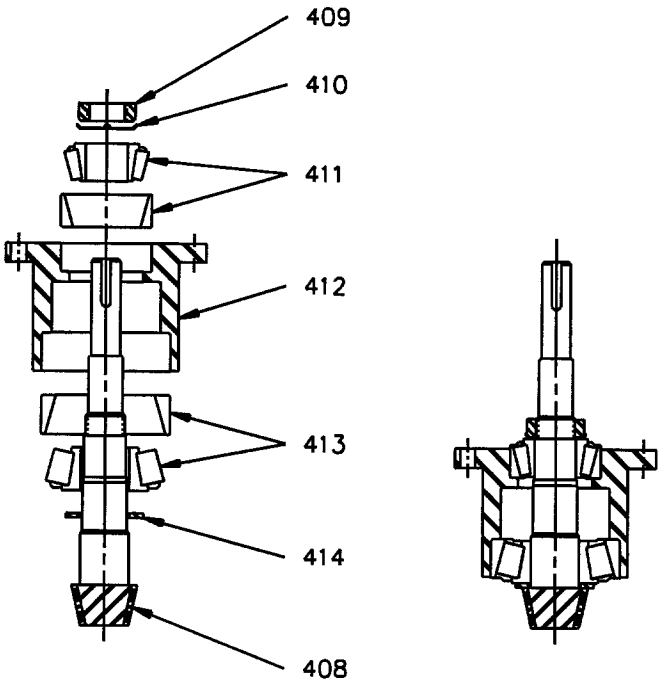

Figure 25: Spiral Bevel Pinion Cartridge [407]

GEAR DRIVE

Assembly (Cont'd)

Spiral Bevel Pinion Cartridge

5. Clamp the housing flange of the cartridge assembly in a soft jawed bench vise.

6. Spray bearings **[411, 413]** and shaft threads with a light machine oil and install locknut and lockwasher **[409, 410]** finger tight.

7. Wrap the keyed end of the pinion shaft with tape and force a 12-point socket over the taped end.

   NOTE: Case Sizes 1 and 2 will require a 3/4" socket. Case Size 3 requires a 1-1/8" socket. Case Size 4 requires a 1-7/16" socket.

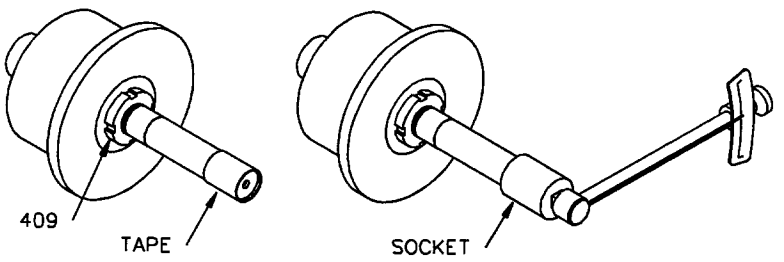

Figure 26: Pinion Cartridge Torque Reading

8. Apply a torque wrench and measure the shaft turning torque. The torque reading is to be taken while rotating the pinion shaft at about 3 rpm. Increase turning torque by tightening locknut **[409]**. Turn the shaft one complete revolution between adjustments. Adjust to:

   Case Size 1 and 2 -- 2 to 4 in-lb (0.3 to 0.5 Nm)
   Case Size 3 and 4 -- 4.5 to 8.5 in-lb (0.5 to 1 Nm)

GEAR DRIVE

Assembly (Cont'd)

Spiral Bevel Pinion Cartridge

9. Engage lockwasher **[410]** and tighten the setscrew to 23 in-lb (2.6 Nm). Precision measure and record the assembled height "A" of the spiral bevel pinion cartridge. This measurement will be required to set the mounting distance of the spiral bevel pinion. Delete the original dimension stamped on the housing.

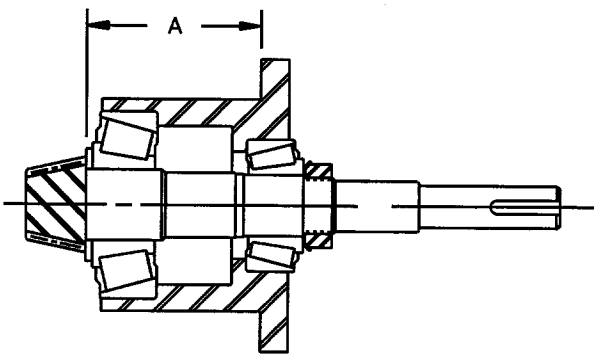

Figure 27: Pinion Cartridge Measurement

GEAR DRIVE

Assembly (Cont'd)

Hollow Shaft

1. Install spiral bevel gear **[428]**.

2. Install bolts and lockwashers **[429, 430]** and torque the bolts according to the values shown in *Table 17 (page 65)*.

3. Install slinger collar **[443]**, set at the shaft scribe mark. Tighten setscrews **[444]** to 8.3 ft-lb (11.3 Nm).

4. Heat bearing **[420, 433]** cones and press onto the hollow shaft. Cones must be firmly seated against the shaft shoulders. Check with a feeler gauge.

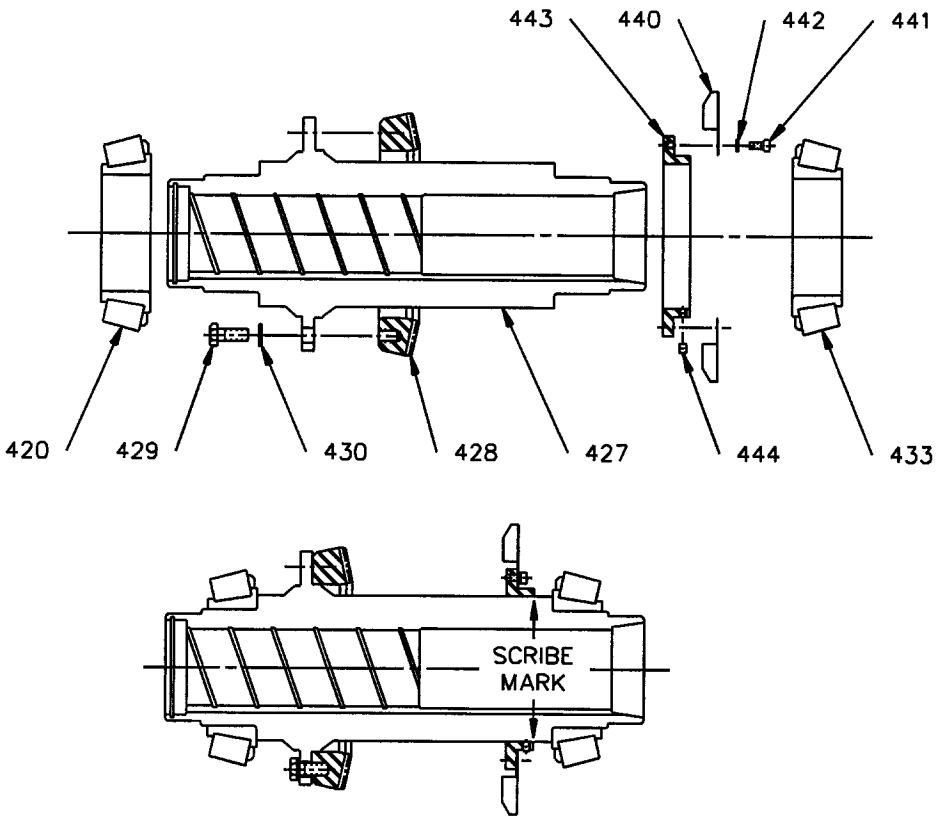

Figure 28: Hollow Shaft [426]

GEAR DRIVE

Assembly (Cont'd)

Hollow Shaft

5. Install slingers **[440]** onto the slinger collar using cap screws and lockwashers **[441, 442]**. Position the slingers in the retracted position (see below) and tighten the cap screws finger tight.

6. Spray the inside diameter of the hollow shaft with light oil.

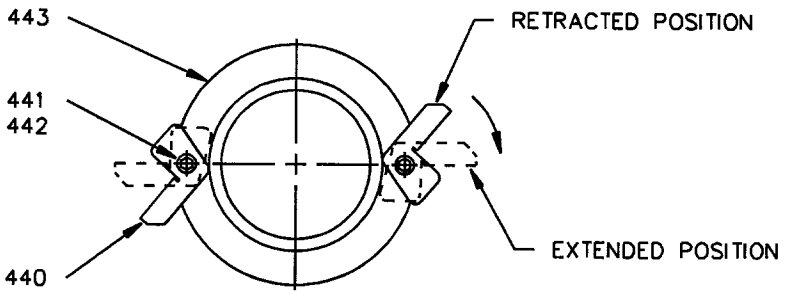

Figure 29: Slinger

GEAR DRIVE

Assembly (Cont'd)

Bearing Caps

1. Install each bearing **[420, 433]** cup in its respective cap. *Do not install the lip seals or o-rings at this time.*

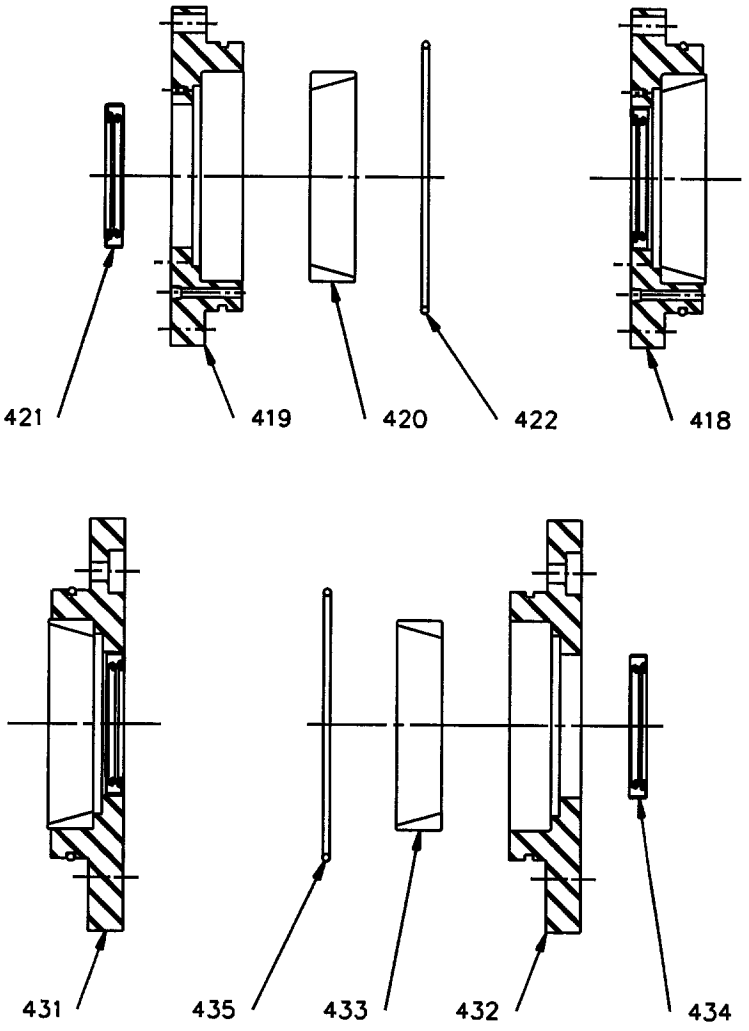

Figure 30: Outer [418] and Inner [431] Bearing Cap

GEAR DRIVE

Assembly (Cont'd)

Gear Drive *(Figure 19, page 58)*

1. Mike the thickness of original shim set **[436]** for the inner bearing cap and duplicate the thickness with new shims.

   Example:

   If the thickness of the old shim set was 0.062", use (12) blue shims and (1) red shim to equal 0.062" when compressed.

   Red = 0.002" (0.051 mm) thick
   Blue = 0.005" (0.127 mm) thick

2. Install inner bearing cap **[431]** and new shim set **[436]** into gear drive housing **[445]** using only four bolts **[437]**, equally spaced. Torque the bolts to the value shown in *Table 17 (page 65)*.

3. Calculate the required pinion cartridge shim set **[415]** thickness as follows:

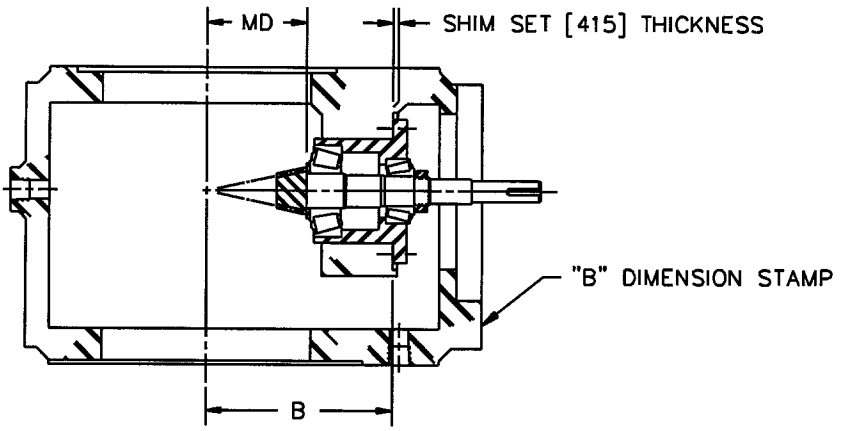

Figure 31: Shim Calculation

GEAR DRIVE

Assembly (Cont'd)

Gear Drive

A+MD-B = Shim Set **[415]** thickness

MD = Pinion mounting distance (MD X.XXX) etched on the small end of the pinion.

B = Dimensional value marked on the motor end of the gear housing (*Figures 31 and 33, pages 73 and 76*)

A = Assembled cartridge height measurement (*Figures 27 and 33, pages 69 and 76*)

Duplicate the calculated thickness with new shims.

4. Using a paint stick, highlight the top edge of the tooth marked with an "X" on pinion shaft **[408]**.

5. Install spiral bevel pinion cartridge assembly **[407]** and shim set **[415]** into the housing.

6. Install lube trough **[439]** *(Figure 32, page 75)*. Install bolts and lockwashers **[416, 417]** and torque bolts according to the values shown in *Table 17 (page 65)*.

   NOTE: Make sure there is no interference between the lube trough and the rotating portion of the bearing. If there is an interference, bend the lube trough just enough to provide clearance.

7. Position the gear drive housing so the inner cap assembly **[431]** is down. Rotate the pinion shaft until the tooth marked "X" is at top center.

8. Using a paint stick, highlight the "X" match marks on the outside of spiral bevel gear **[428]** *(Figure 28, page 70)*.

9. Spray bearings **[420, 433]** with light machine oil and lower hollow shaft assembly **[426]** into the housing.

   CAUTION: Make sure the spiral bevel gear teeth marked "X" straddle the pinion shaft tooth marked "X."

GEAR DRIVE

Assembly (Cont'd)

Gear Drive

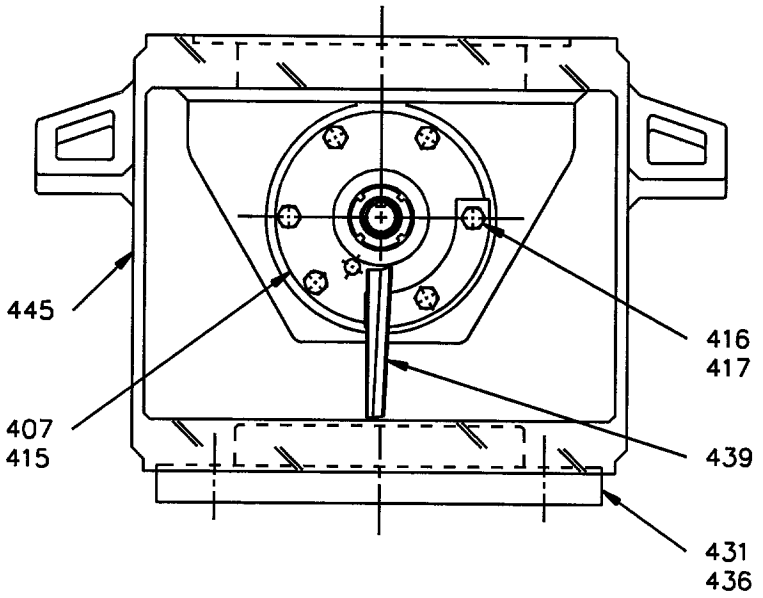

Figure 32: Lube Trough Installation

10. Install outer bearing cap **[418]**. Bolt it in place using three equally spaced bolts **[424]**. Alternately tighten the bolts until the cap is seated on the bearing. *Do not torque the bolts; finger tighten only.*

11. Install the key in the pinion shaft, tape the key in place, and measure the backlash by placing a dial indicator against the key at a right angle to the rotation. Restrain the hollow output shaft from turning and rotate the pinion shaft back and forth measuring the free movement. *(Figure 33, page 76)*

    Backlash Setting (Dial Indicator Movement)

    Case 1 and 2 = 0.002 to 0.0025" (0.05 to 0.06 mm)
    Case 3 and 4 = 0.003 to 0.004" (0.08 to 0.1 mm)

GEAR DRIVE

Assembly (Cont'd)

Gear Drive

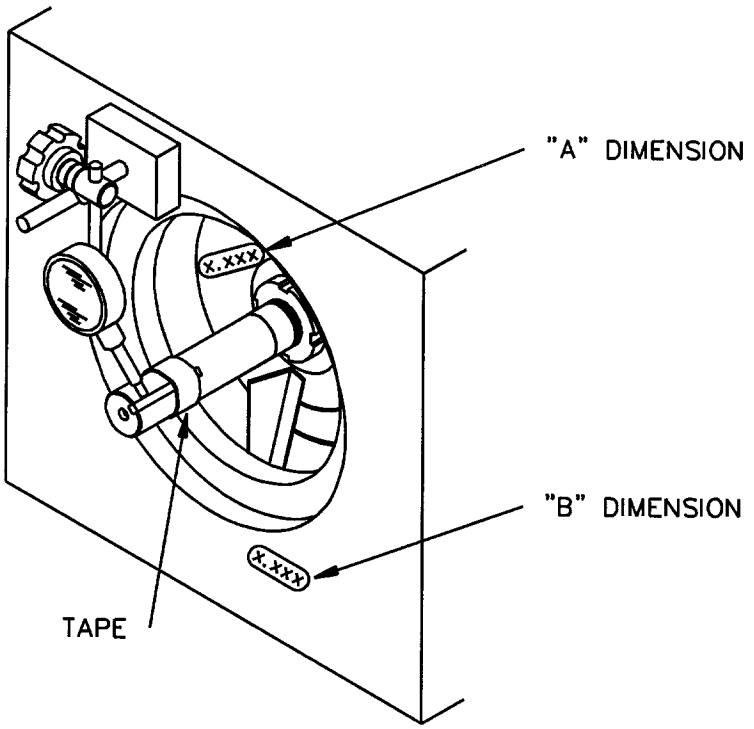

Figure 33: Backlash Setting

12. Take four consecutive backlash readings. Rotate the pinion shaft one revolution counterclockwise after each reading. If there is any variation in the backlash readings, turn the pinion shaft backwards to the position of the lowest backlash reading.

13. Add shims **[436]** to inner bearing cap **[431]** to decrease backlash; remove shims to increase backlash.

    NOTE: Before each shim change, the bolts on the outer bearing cap should be loosened. After changing the shims, the bolts on the inner bearing cap should be torqued to the value shown in Table 17 (page 65) and then the bolts on the outer bearing cap should be finger tightened.

GEAR DRIVE

Assembly (Cont'd)

Gear Drive

14. Measure the gap between outer bearing cap **[418]** and the gear drive housing. Count out new shims equal to the gap minus 0.002". This should provide a bearing setting of 0.000" end play to 0.002" (0.051 mm) preload.

15. Remove outer bearing cap **[418]**. Install lip seal **[421]** and o-ring **[422]**.

16. Spray the o-ring and housing bore with light machine oil. Install outer bearing cap assembly **[418]** with new shim set **[423]** *(see Step 14)*. Install bolts and lockwashers **[424, 425]** and torque the bolts to the value shown in *Table 17 (page 65)*.

17. Remove inner bearing cap **[431]**.

18. Loosen slinger cap screws **[441]** and extend the blades. Torque the cap screws to the value shown in *Table 17*.

19. Install lip seal **[434]** and o-ring **[435]** on inner bearing cap **[431]**. Spray the o-ring and housing bore with light machine oil.

20. Install inner bearing cap assembly **[431]** with new shim set **[436]**. Install bolts and lockwashers **[437, 438]** and torque the bolts to the value shown in *Table 17*.

21. Check the spiral bevel gear backlash; adjust if required *(see Steps 11, 12, 13)*. Check the hollow drive shaft end play; adjust if required *(see Step 14)*. Turn the pinion shaft by hand until the hollow shaft makes one revolution. The shaft should turn easily with no binding.

GEAR DRIVE

Assembly (Cont'd)

Input Cap

1. Install lip seal **[403]** into input cap **[402]**.

2. Coat the gasket surfaces on the cap and gear drive housing with Permatex #2 or equivalent.

3. Install gasket **[404]** and the input cap on the housing. Install bolts and lockwashers **[405, 406]** and torque the bolts to the value shown in *Table 17 (page 65)*.

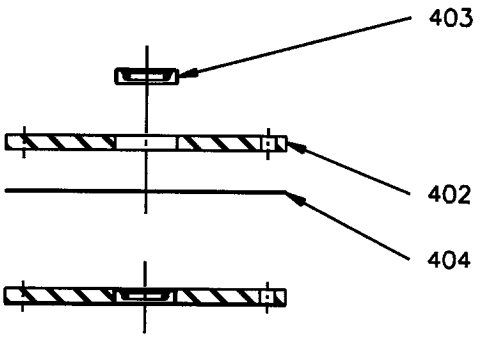

Figure 34: Input Cap [401]

GEAR DRIVE

Assembly (Cont'd)

Motor Bracket *(Figure 6, page 16)*

1. Install the motor bracket assembly, the pinion shaft key, and the flexible coupling hub. Install bolts and lockwashers **[303, 304]** and dowel pins **[302]** and torque the bolts to the value shown in *Table 5 (page 11)*.

2. Assemble the flexible coupling and make sure the motor alignment is correct (see *Maintenance* - Motor Couplings).

3. Install oil drain plug **[463]**.

4. With the gear drive in the operating position, fill with oil to the operating level (see *Lubrication*). Plug the gear drive breather connection so that the oil does not spill during handling. Apply a light coating of bearing grease to the inside diameter of the hollow shaft.

5. Install oil level plug **[462]** *(Figure 19, page 58)*.

Drive Shaft *(Figure 11, page 31)*

1. Position key **[455]** in drive shaft **[1110]**.

2. Insert the drive shaft and key into hollow output shaft **[426]** of the gear drive.

   NOTE: Snap ring **[457]** *must be positioned next to the shaft flange.*

3. Insert retract bolt assembly **[446]** into the end of the hollow output shaft. Thread the bolt into the drive shaft.

The gear drive is now ready to be assembled to the drive support.

GEAR DRIVE

Installation

NOTE: Clean all components thoroughly before reassembly. Lightly lubricate all parts during reassembly to prevent galling and for ease of assembly.

1. Use the cutouts on the sides of motor bracket **[301]** *(Figure 6, page 16)* and hoist the gear drive into position.

2. Attach the gear drive to the pedestal using shoulder bolts **[602]** *(Figure 11, page 31)*. These bolts insure the alignment of the gear drive with the pedestal. Torque these bolts to:

   Case 1, 2, and 3 -- 15 ft-lb (20.3 Nm)
   Case 4 -- 38 ft-lb (51.5 Nm)

3. Install pedestal bolts and lockwashers **[603, 604]**. Torque the bolts to the value shown in *Table 5 (page 11)*.

4. Remove the plug from the gear drive breather connection and install fittings **[459, 460, 461]** and breather **[458]** *(Figure 19, page 58)*.

5. Complete the assembly per the instructions in the *Maintenance, Seal Cartridge Installation* section.

HSN/HSNS AGITATOR ITEM LIST

Item #	Description	Qty.
100	**motor**	1
101	motor key	1
200	**flexible coupling assembly**	1
300	**motor bracket assembly**	1
301	motor bracket	1
302	dowel pin	2
303	hex bolt	4
304	spring lockwasher	4
305	hex bolt	4
306	large flatwasher	4
307	shim set	4
308	spring lockwasher	4
309	hex nut	4
310	hex bolt	2
311	hex nut	2
312	coupling guard	1
313	hex bolt	4
314	flatwasher	4
315	wellnut	4
400	**gear drive assembly**	1
401	input cap assembly	1
402	input cap	1
403	lip seal	1
404	gasket	1
405	hex bolt	6
406	spring lockwasher	6
407	pinion shaft assembly	1
408	spiral bevel pinion shaft	1
409	locknut w/setscrew	1
410	keyed lockwasher	1

HSN/HSNS AGITATOR ITEM LIST

Item #		Description	Qty.
411		bearing	1
412		cartridge housing	1
413		bearing	1
414		pinion washer (Case 4 only)	1
415		shim set	1
416		hex bolts	6
417		spring lockwasher	6
418		outer bearing cap assembly	1
419		outer bearing cap	1
420		bearing	1
421		lip seal	1
422		o-ring	1
423		shim set	1
424		hex bolt	6
425		spring lockwasher	6
426		hollow shaft assembly	1
427		hollow shaft	1
428		spiral bevel gear	1
429	-001	hex bolt	6
	-002	hex bolt	8
	-003	hex bolt	10
430	-001	spring lockwasher	6
	-002	spring lockwasher	8
	-003	spring lockwasher	10
431		inner bearing cap asssembly	1
432		inner bearing cap	1
433		bearing	1
434		lip seal	1
435		o-ring	1
436		shim set	1
437		hex bolt	8
438		spring lockwasher	8
439		lube trough	1

HSN/HSNS AGITATOR ITEM LIST

Item #		Description	Qty.
440		slinger	2
441		cap screw	2
442		spring lockwasher	2
443		slinger collar	1
444		setscrew, cup point	2
445		gear drive housing	1
446		retract bolt assembly	1
447		cap screw	3
448		spring lockwasher	3
449		snap ring	1
450		grease fitting	1
451		dust cap	1
452		gasket	1
453	-001	screw, round head	4
	-002	screw, round head	6
454	-001	lockwasher	4
	-002	lockwasher	6
455		key	1
456		split tapered collar	1
457		snap ring	1
458		breather	1
459		hex bushing	1
460		pipe elbow	1
461		pipe nipple	1
462		oil level plug, NPT	1
463		magnetic drain plug, NPT	1
464		pinion shaft key	1
500		**drive support assembly**	1
501		channel support	1
502		angle bracket	1
503		hex bolt	2
504		spring lockwasher	2
505		hex bolt	2
506		spring lockwasher	2
507		hex nut	2
550		**tie rod support assembly**	1

HSN/HSNS AGITATOR ITEM LIST

Item #	Description	Qty.
600	**pedestal assembly**	1
601	pedestal	1
602	shoulder bolt	2
603	hex bolt	6
604	spring lockwasher	6
605	hex bolt	8
606	spring lockwasher	8
607	roll pin	2
608	eye bolt	1
609	spring lockwasher	1
610	hex nut	1
611	hand hole cover	2
612	hex bolt	8
613	flatwasher	8
614	wellnut	8
800	**mounting flange mechanical seal assy.**	1
801	mounting flange mechanical seal	1
802	stop pin	1
803	plug, NPT	1
900	**HSNS mechanical seal cartridge assy.**	1
901	seal sleeve	1
902	setscrew, dog point	3
903	o-ring	1
904	snap ring	1
905	housing flange	1
906	lip seal	1
907	seal housing	1
908	seal head (single)	1
909	seal seat and seat ring	1
910	o-ring	1
911	hex bolt	6
912	spring lockwasher	6
913	sleeve locating clips	2
914	hex bolt	2
915	spring lockwasher	2

HSN/HSNS AGITATOR ITEM LIST

Item #	Description	Qty.
1000	**HSN mechanical seal cartridge assembly**	1
1001	seal sleeve	1
1002	setscrew, dog point	3
1003	o-ring	1
1004	seal gland	1
1005	lip seal	1
1006	setscrew, dog point	3
1007	o-ring	1
1008	seal housing	1
1009	seal head (double)	1
1010	seal seat and seat ring	2
1011	o-ring	1
1012	hex bolt	6
1013	spring lockwasher	6
1014	sleeve locating clips	2
1015	hex bolt	2
1016	spring lockwasher	2
1017	pipe elbow	2
1018	pipe nipple	2
1100	**shaft assembly**	1
1110	drive shaft	1
1111	hex bolt	6
1112	spring lockwasher	6
1113	hex bolt	1
1114	locking clip	1
1115	thrust washer	1
1116	key	1
1117	tapered coupling half	1
1118	extension shaft	1
1119	shutoff collar	1
1120	locking pin	2
1121	o-ring	1
1122	o-ring	1
1123	setscrew, dog point	2

HSN/HSNS AGITATOR ITEM LIST

Item #	Description	Qty.
1200	**impeller assembly**	1
1201	impeller assembly HE-3S	1
1202	impeller hub	1
1203	setscrew, square head	1
1204	extension blades	3
1205	hex bolts	12
1206	spring lockwasher	12
1207	hex nut	12
1208	key	1
1300	**HSN seal lubricator assembly**	1
1310	seal lubricator	1
1311	mounting bracket	2
1312	hex bolt	4
1313	spring lockwasher	4
1314	hex bolt	2
1315	flat washer	2
1316	spring lockwasher	2
1317	fill plug, NPT	1
1318	sight glass, NPT	1
1319	magnetic drain plug, NPT	1
1320	tube fitting, elbow	2
1321	tube fitting	2
1322	metal tubing	2
1400	**mechanical seal flush assembly**	1
1401	throttle bushing	1
1402	pipe elbow	1
1403	pipe nipple	1

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