

Installation and Operating Instructions

with Parts List for Cleveland HGD/HGDS Mixer Series

HGD AGITATOR MANUAL



Customer	_____
TAG No.	_____ P.O. No.
CLEVELAND MIXER MODEL	_____
Serial No.	_____
DRAWING NO.	_____
Date:	_____



A brand of Subiaco, Inc.

CAUTION: Units are shipped without oil.

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INTRODUCTION

HOW TO USE THIS MANUAL

This Owners Manual provides information and instructions on the installation, operation, and maintenance of Cleveland Model HGD parallel-shaft mixer reducers, Sizes 6 through 9. The Table of Contents will help you find any information you might need. To obtain maximum performance and trouble free service from this Cleveland equipment, follow all instructions carefully. The Cleveland Mixer Division of EMI offers installation service, maintenance seminars and aids in planning spare parts programs. Contact EMI for details.

UNIT RATINGS & APPLICATIONS — Operate mixer reducers only at the horsepower and speed indicated on the nameplate. Do not operate HGD units with the output shaft in horizontal position. Consult EMI before making any changes in operating conditions of HGD units, differing from "as built".

WARRANTY — EMI warrants that, for a period of one year from the date of shipment, the product described herein will deliver successfully its rated output as indicated in the quotation, provided it is properly installed and maintained, correctly lubricated, and operated in the environment and within the limits of speed, torque or other load conditions for which it was sold.

SECTION I — INSTALLATION

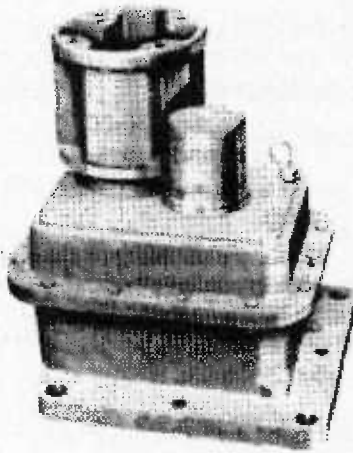


Figure 1 — Typical HGD reducer

GENERAL INFORMATION

Description & identification

The HGD reducer is designed with a hollow output shaft secured to the mixer shaft by a tapered bushing and keeper plate at the input-end.

EQUIPMENT OPTION: As an option to a hollow shaft connection, HGD units may be connected to the in-tank shaft by a flanged coupling. Coupling connection requires installation of a "stub-shaft" in the hollow shaft bore of the reducer. Stub-shaft installation procedures are discussed later in this manual.

HGD Units are powered by NEMA C-Face motors mounted to an adapter, which is bolted to a plate on the upper housing (see Fig. 2).

NOTE: Maximum input (motor) speed is 1750 rpm.

MOUNTING OPTIONS: HGD models including those fitted for stub-shaft connection, may be rail, pedestal or tank flanged mounted. The mounting-bolt foot-print in the housing base is square to permit 90° variations in positioning; the underside of the base has also been drilled and tapped for mounting to a standard ASA flange* (see Fig. 3).

* Case Size 6 and 8 — 8"150#
9 — 10"150#

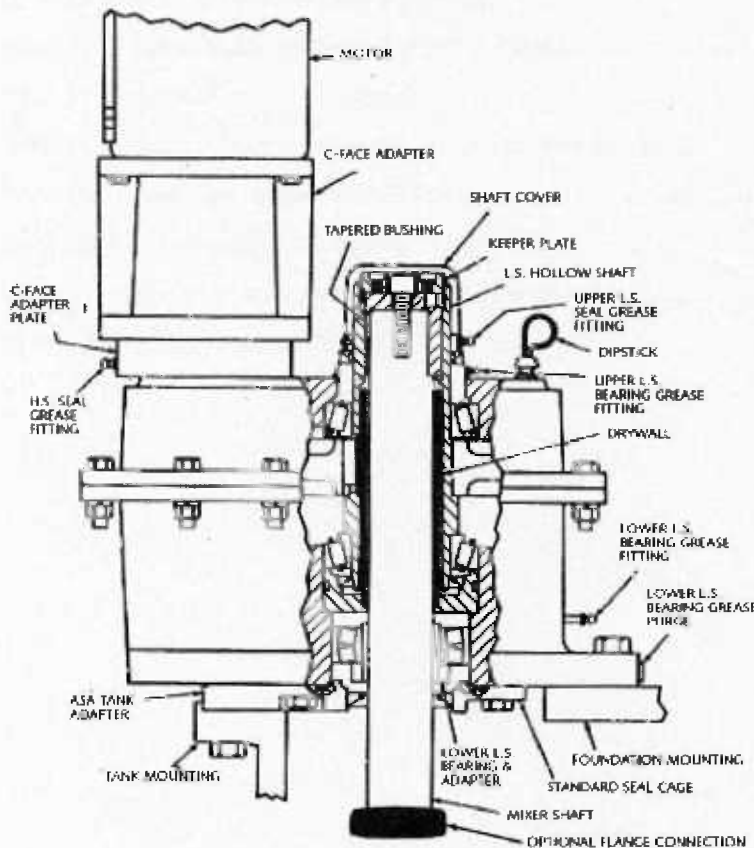


Figure 2 — Equipment features

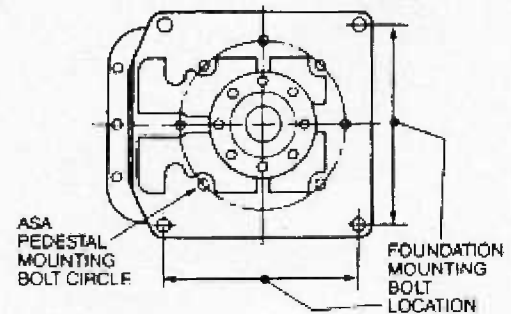


Figure 3 — Mounting features

Uncrating & Inspection

Be sure to use care when uncrating and handling the mixer. Certain parts such as turbine hubs, turbine blades, couplings, steady bearing, seals and hardware may be packed individually inside the crate.

Be sure all components are accounted for before discarding packing materials.

The mixer should be carefully checked for possible shipping damage. Any damage should be reported immediately to the TRANSPORTATION COMPANY AND EMI, INC.

Improper handling may cause damage to the mixer and seriously reduce the service life. The shaft has been straightened to within .003". Extra care should be taken to see that it is not damaged in the process of uncrating.

NOTE: DO NOT LIFT OR SUPPORT THE MIXER BY THE BOTTOM END OF THE SHAFT.

Shaft and Impellers

Shaft and Impeller Storage: During storage, be sure that the shaft is fully supported along its entire length and that heavy items are not placed on top of the shaft. Similar cautions should be taken for storage of impellers.

1. Mixer shafts should be removed from crates and coated with Cosmoline or a suitable preservative. (NOTE: Even stainless steel shafts should be coated where they come into contact with steel banding or hold-down straps). Then recrate the shaft and provide support so that no bending or set takes place. Crate supports supplied by the factory, should be adequate.

When storing carbon steel shafts and impellers out of doors, apply a suitable grease or rust preventive to all parts.

2. Turbine parts should also be coated with a preservative, especially the bore of the turbine hub.
3. Motors should be stored in a cool, dry environment; and the motor shafts rotated 360° at least once each month.
4. Reducers which have been stored for an extended

period with no preventive maintenance, the top cover should be removed and a preservative thoroughly sprayed into the housing, bearings and gears. Once this is done, monthly spraying as outlined above should be followed.

Lifting & Moving

WARNING: Without oil or motor, a Size 6 HGD Unit weighs 230 lbs.* Do not attempt to lift or move an HGD reducer without a crane, hoist, or other mechanical assistance.

*Size 8 weighs 390 lbs.; size 9 weighs 485 lbs.

MOVING HGD REDUCERS — Refer to Fig. 4. Replace three reducer housing flange fasteners with shouldered eyebolts as shown. Use a three-leg sling to lift and position the reducer.

NOTE: If the unit is being positioned for pre-installation preparation or for service, the eyebolts may be left in place. If the reducer is being positioned for final installation, the eyebolts must be removed after final placement and the housing flange fasteners reinstalled and tightened to the torque indicated in Table 1.

Table 1 — Housing Flange Fastener Torques

Unit Size	Torque — Lb.-in.
6	330
8-9	825

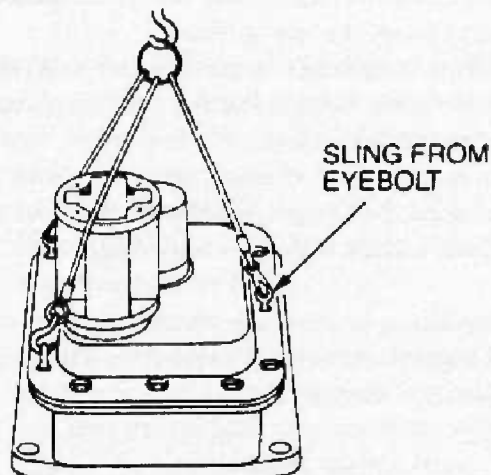


Figure 4 — Lifting a HGD (vertical shaft) reducer

Items Furnished With Reducer

Required parts furnished with a standard HGD or HGD reducer include the following items:

- Tapered Bushing and Fastener
- Shaft key, Output
- Keeper plate (with setscrews)
- Shaft key, Input
- Lower L.S. Bearing & Adapter
- Low-speed seal cage-tank flange adapter with O-Ring & Fasteners
- Air vent
- Street-Elbow
- Dipstick bushing and dipstick
- C-Flange Motor adapter and hardware including H.S. Coupling
- Magnetic Drain Plug

INSTALLATION

Preface

Most mixer operational problems can be avoided by following proper installation and operation instructions. The following is a list of suggestions to help insure proper installation and therefore satisfactory mixer service.

- Before permanently wiring the motor, check for the correct rotation of the low speed shaft.
- Read and follow the instructions of all tags and nameplates before operating.
- Check the operating full load motor amperage and voltage before operating the mixer.
- Always operate the mixer in a fluid which has a specific gravity and viscosity less than or equal to the design specific gravity and viscosity.
- When starting the mixer, make sure the impeller is not buried in solids or a "set-up" fluid.
- Operate stuffing boxes or mechanical seals only at or below the design temperatures and pressures specified on the assembly drawing.
- When making field changes of motor horsepower, mixer speed, shaft length, impeller diameter, width, etc., be sure to consult with Cleveland Mixer.

Before beginning work on any installation, make sure you have all required parts. Keep all parts for a single installation together at all times.

Mixer Assembly

As previously mentioned there are two styles of agitators that this manual addresses; Open and Closed tank.

Open tank models are typically mounted to a pair of beams or bridge work that traverses the tank. This super structure can be either independent from the vessel or an integral part of the tank itself.

Closed or sealed tank units are typically mounted on ASA schedule nozzles and incorporate some style of sealing mechanism to contain pressure or rogue emissions.

Please refer to your equipment drawing for the specific detail of your particular design.

In either case it is critical that the mounting afford a solid foundation for the installation and not allow excessive deflection of the equipment.

NOTE: Level the drive as closely as possible. This assures that the shaft will turn in a true vertical position, as in figure 5.

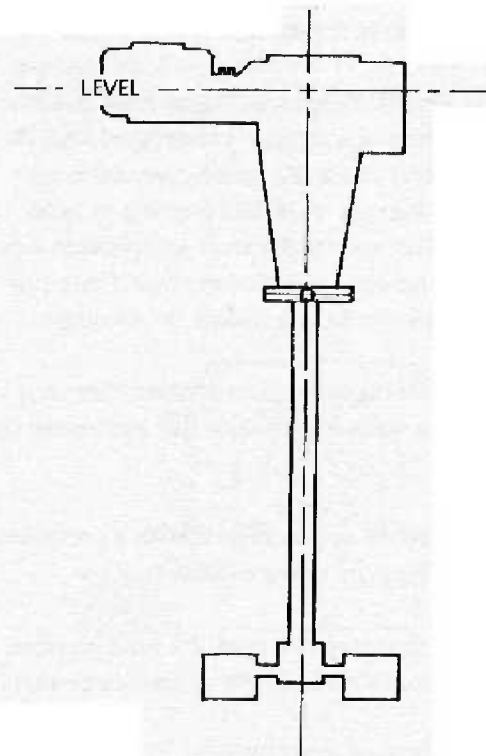


Figure 5

Mounting

Incorrect mounting is often a cause of mechanical difficulty with a mixer. Unless specified on the mixer assembly drawing, the mixer extension shaft is designed to run in a true vertical position.

NOTE: Never angle or side mount. Never mount on a nozzle or pad which is skewed away from horizontal.

- While operating, there's random fluid motion in the vessel that exerts great forces on the extension shaft of the mixer. The mixer accommodates these forces since they are transmitted directly to the support mountings. Therefore, the mounting system must be rigid. It must support dead mixer weight as well as live mixer reactions that result from Torque and Bending Moment (see Figure 3). It is not enough to design the support system for acceptable levels of stress. It must be rigid enough to take care of start-up torque load and preclude large deflections which may result in mixer vibration.
- Check the mixer assembly drawing, it includes the mixer weight, as well as the maximum values of torque and bending moment. When designing the structure to accommodate bending moments, be sure the structure is sufficiently rigid so that the mixer extension shaft will not move more than 1/32" per foot of shaft length due to deflection of the structure. Where vessel internals require very close proximity to turbines or shaft special shaft deflection limits may be defined on the assembly drawing.

Preparing the Equipment

Before installation of a HGD mixer reducer to a mixer shaft, it is necessary to:

1. Check the Mixer Drive-shaft Dimensions.
 - a. Check the Mixer shaft diameter. Refer to Fig. 6. Mixer shaft diameters which can be accommodated by the tapered bushings are shown in Table 2.

Table 2 — Mixer Shaft Diameters

Unit Size	Shaft Diameter
6	1.50 or 2.00"
8	2.00, 2.25 and 2.50"
9	2.75 and 3.00"

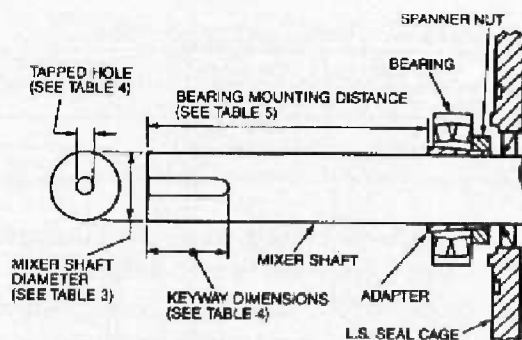


Figure 6 — Mixer shaft dimensions

- b. Check the Dimensions of the Mixer shaft tapped hole and keyway. Refer to Fig. 6. Dimensions shown in Table 3 for the depth of the tapped hole.

Table 3 — Mixer Shaft Tapped Hole & Keyway Dimensions¹

Unit Size	Center Tapped Hole	Keyway Size
6	0.625-11UNC x 1.50	0.500 x 0.250 x 3.00"
8	0.625-11UNC x 1.50	0.500 x 0.250 x 3.00"
9	0.675-9UNC x 1.75	0.625 x 0.312 x 3.31"

¹The depth given for the tapped hole is a minimum, and the keyway must be open ended.

2. Install the Seal Cage and Mixer Drive-Shaft Bearing & Adapter. To install the Mixer-Shaft bearing:
 - a. Refer to Fig. 6. Protect the seal in the seal cage (tank adapter flange) from the sharp edges of the keyway by taping over the keyway with common transparent tape and applying a light coat of oil to the shaft.
 - b. Slide the seal cage/tank adapter flange onto the shaft.

NOTE: If the shaft is in the horizontal position, support both the shaft and the seal cage tank adapter flange to prevent the weight of the adapter from pinching the seal.

- c. Install the O-Ring in the groove in the seal cage/tank adapter flange.
- d. Loosely assemble the bearing, tapered bearing adapter, bearing Lockwasher and bearing locknut, and slide the assembly onto the shaft with the nut toward the seal-cage/tank adapter flange.

Table 4 — Mixer Shaft Bearing Location

Unit Size	Distance from Shaft End
6	$9.63 \pm 1/16"$
8	$10.83 \pm 1/16"$
9	$12.83 \pm 1/16"$

e. Position the bearing on the shaft as required by Table 4 above and tighten the nut as follows: To tighten the bearing nut on the adapter, two procedures are available. The first procedure is most accurate and should be used whenever practical:

(1) Proper tightening of the adapter is measured as a reduction in internal clearance in the bearing. The more the nut is tightened, the less internal clearance will exist in the bearing. Measure the internal clearance of the bearing prior to installation by using feeler gages between the bearing rollers and the outer race (Figure 7). The bearing outer race must be centered and the shims must pass over both sets of rollers to properly measure the internal clearance. Once the bearing is on the shaft and in the proper position, the adapter may be tightened until the internal clearance is reduced by .001" to .0015."

(2) The proper tightening of the adapter may also be measured by assuming that a specific amount of axial movement of the adapter relative to the bearing inner race will provide a specific amount of reduction of internal clearance and hence a certain fit on the shaft. The ratio of axial movement to radial clearance reduction is approximately 15:1. Once the bearing is on the shaft and in the proper position, the adapter may be tightened on the shaft and becomes difficult to slide axially on the shaft. This is considered the starting point. Continue to tighten the nut until the bearing moves 0.020" to 0.025". The minimum bearing internal clearance after mounting is 0.0012" to 0.0014".

Bend one of the bearing lock-washer tangs into interference position to prevent loosening.

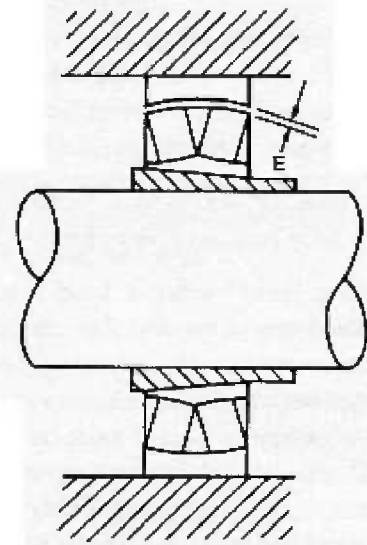


Figure 7 — Internal clearance using feeler gages

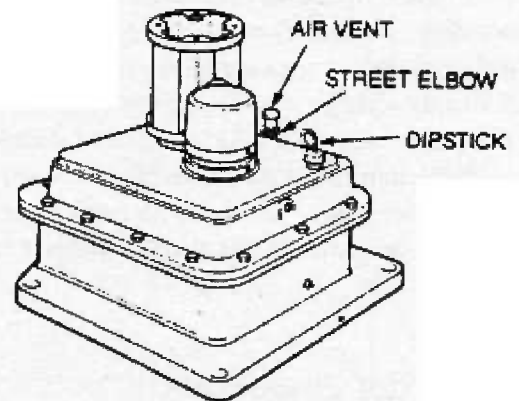


Figure 8 — HGD reducer preparation

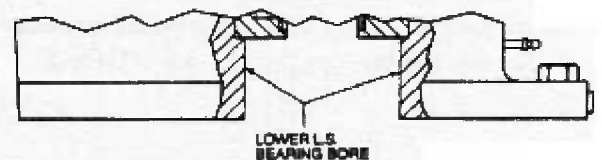


Figure 9 — Lower L.S. bearing bore

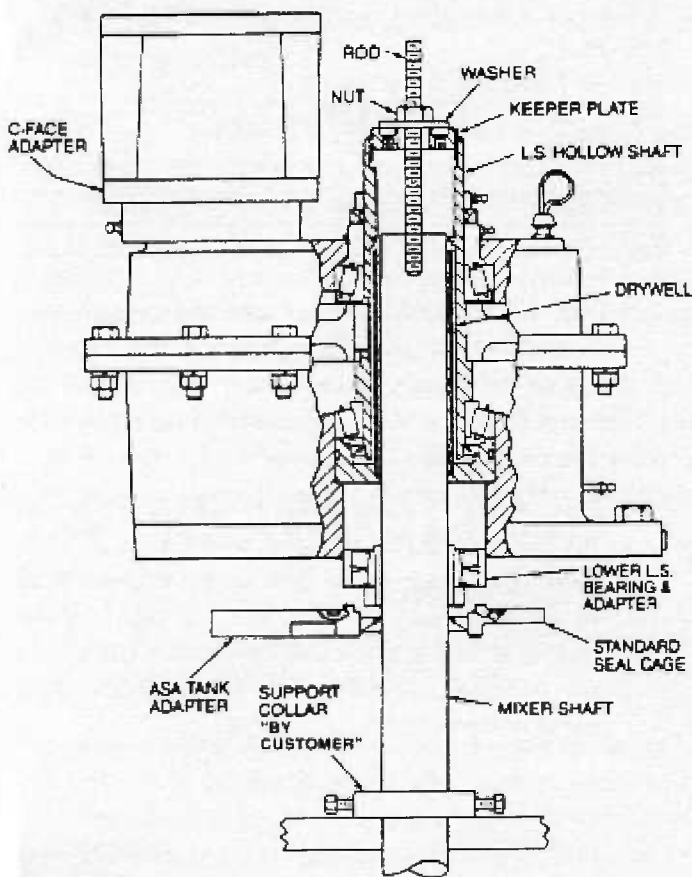


Figure 10 — HGD reducer installation

3. Prepare the reducer for installation.

- a. Refer to Fig. 8. Remove the pipe plug from the input-housing half and replace it with the street-elbow and air-vent assembly as shown. Seal the threads with pipe compound or teflon tape. Make sure the vent is in the vertical position.
- b. Refer to Fig. 8. Remove the pipe plug from the dipstick opening and replace it with the dipstick bushing.
- c. Refer to Fig. 9. Make sure the lower L.S. bearing and the bearing bore in the lower housing are clean and free of burrs or dirt. Coat these surfaces with light oil.
- d. Make sure oil fill, inspection and drain ports, and all grease fittings will be accessible after installation. If necessary, reposition the unit or install pipe extensions.

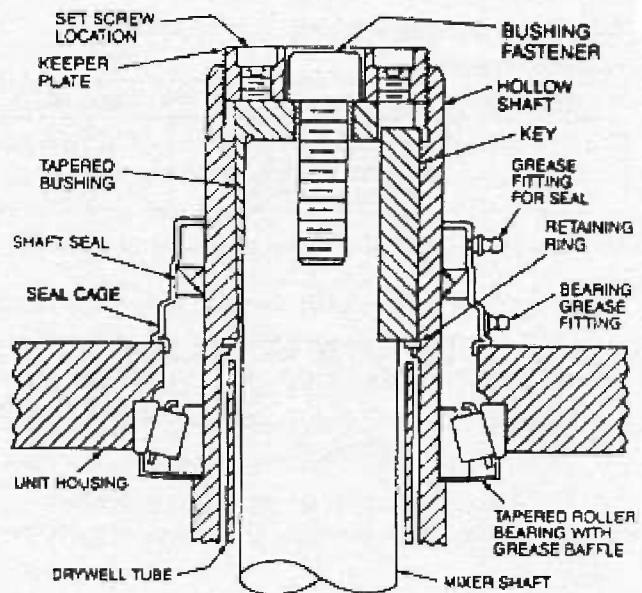


Figure 11 — Tapered bushing installation

Installing Vertical Shaft Reducers

1. Refer to Fig. 10. Support the mixer shaft to allow working room beneath the seal cage or tank-flange adapter.
 2. Lift the reducer as described in "Lifting & Moving" on Page 5 and position the unit above the mixer shaft. Do not install the key at this time.
 3. Slide the reducer down over the mixer shaft and seat the outer race of the bearing mounted on the mixer shaft in the bore in the reducer housing. Tap the bearing race softly to make certain it is not cocked in the bore.
- NOTE:** Do not force the mixer shaft into the reducer; it should slide in smoothly.
4. Refer to Fig. 10. Thread the keeper plate all the way into the hollow shaft. Insert a threaded rod (See Table 3 for size) through the plate and into the mixer shaft. Tighten a nut on the threaded rod to draw the mixer shaft into the unit until it contacts the keeper plate. When the mixer shaft is in place (support it in this position), remove the threaded rod and keeper plate.
 5. Refer to Fig. 11. Rotate the mixer shaft to line up the keyways. Insert the key in the keyway from the top and tap it into place against the internal retaining ring in the hollow shaft.
 6. Refer to Fig. 11. Slide the tapered bushing over the top of the mixer shaft. Install the bushing fastener and tighten to the torque shown in Table 5.

Table 5 — Tapered Bushing Fastener Torques

Unit Size	Fastener Size (Inches)	Torque (lb.-in.)
6	0.625-11UNC x 1.75"	2190
8	0.625-11UNC x 1.75"	2190
9	0.875-9UNC x 2.00"	6400

- Thread the keeper plate into the top of the hollow shaft. Use a face spanner wrench or a piece of steel stock bolted to the keeper plate to position it against the upper surface of the bushing. Tighten it to the torque shown in Table 6.
- Install and tighten the keeper plate set-screws.

TABLE 6 — Keeper Plate Torques

Unit Size	Spanner Holes 7	Torque (lb.-in.)
6	.500 Dia. x .250 Deep, 1,750 B.C.	1000
8	.500 Dia. x .250 Deep, 1,750 B.C.	1500
9	.500 Dia. x .250 Deep, 2,500 B.C.	2000

- Refer to Fig. 13. Check to be sure the lower bearing assembly is recessed into the housing. Pack the bearing cavity with NLGI #2 bearing grease.
- Slide the lower seal cage or tank-flange adapter into position against the housing. Install the fasteners and tighten to 330 lb-in torque.
- Remove the mixer shaft support and lower the unit into position on the pedestal or foundation. Refer to Table 7. Secure the unit with appropriate fasteners tightened to the torques specified.

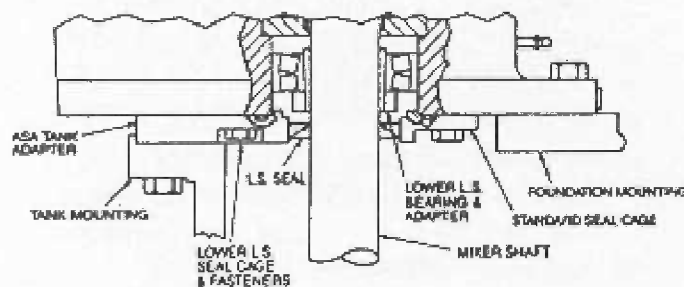


Figure 12 — Low-speed shaft output-end seal cage installation

Table 7 — Foundation Fastener Tightening Torque (Lb.-In.)

Do Not Lubricate Fasteners

Thread Size	Metal to Metal	Metal to Concrete
0.625-11UNC	1640	1290
0.750-10UNC	2940	2290
0.875-9UNC	4560	3750
1.000-8UNC	6800	5600

NOTE: Both the standard seal-cage and the ASA Tank-Flange adapter allow for the use of the four foundation holes or the tapped holes on the underside of the housing base. Both fastening methods provide a male register for positive location.

- Refer to Fig. 13. Pump NLGI #2 bearing grease into the upper fitting on the low-speed seal cage while rotating the high speed shaft until a uniform bead of grease appears between the seal cage and the hollow shaft. Place the low speed shaft cover over the seal-cage and secure it with the three sheet-metal screws provided.

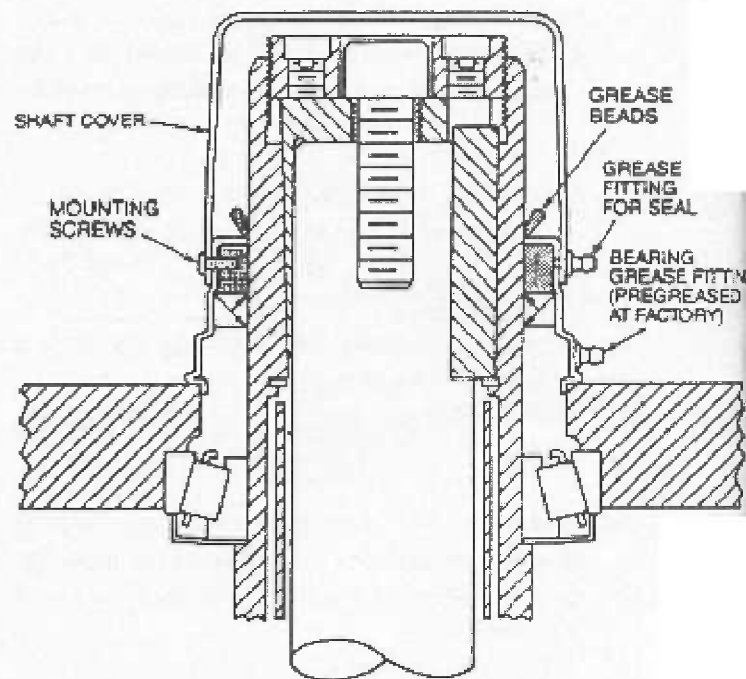


Figure 13 — Installing the low-speed shaft cover

Shafts and Impellers

The lower mixer shaft extension consists of one or more ridged shaft sections and will accommodate one or more impeller assemblies.

This shaft will either mount directly to the gear reducer as a one piece shaft or it will be assembled from sections of shaft that are joined by bolted flanged connections, refer to fig. 14. These flanged connections are machined mated faces and care should be taken in their assembly. Both coupling faces should be wiped clean and checked for burrs before joining them together.

In the case of units have balanced wetted ends or close tolerances assemblies (such as units with mechanical seals), take special care to locate and align all match marks on the coupling edges to ensure proper fit.

NOTE: When shipped, the extension shaft was straight to within several thousandths of an inch. Handle the shaft carefully to be sure that it is not damaged.

1. After the shaft has been installed, check it for straightness. Storage and handling may have resulted in a bend. To check it, an indicator is placed at the end of the shaft and the high speed shaft is then rotated by hand. Runout of the total shaft should not be in excess of .003" per foot of shaft length. If the runout is greater, the shaft can be restraigtened in the field. To restraigten the shaft, follow this procedure:

a. Where the maximum, positive readout is found, place the indicator on the side of the shaft.

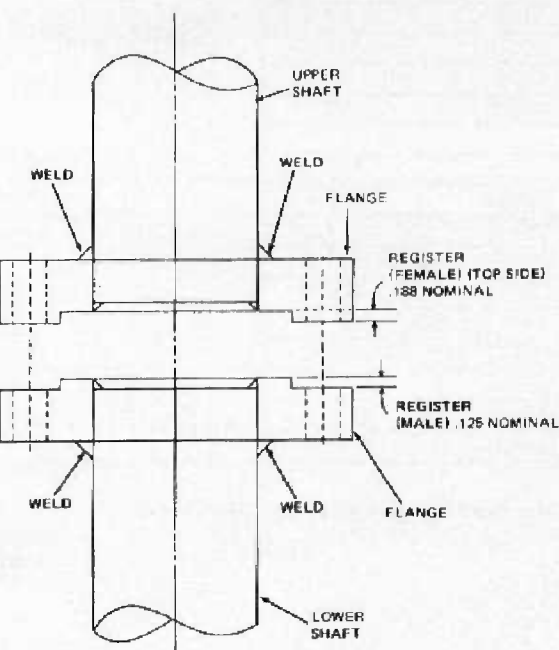


Figure 14

b. Now, heat the shaft at a point of 180 degrees from the indicator and just below the first in-tank coupling, apply heat just below the mounting nozzle.

c. The shaft will grow toward the indicator as heat is applied to it. However, do not permit the surface temperature of the shaft to go over 500°F.

d. The shaft will straighten since it will draw more than it grows.

e. After each heating process, recheck the shaft until the straightness is within tolerance.

2. To install any impeller, simply slide the impeller hub onto the extension shaft above the shaft keyway.

NOTE: Keys have drill points on one side for set screw alignment.

Slide the hub back down the shaft and over the key until the hub is positioned over the drill point. Firmly tighten the hub set screw into the key. Now that the impeller hub is on the shaft, firmly bolt the impeller hardware (blades, discs, stabilizers) into place.

NOTE: Where static or dynamic balancing is specified on high speed mixers, impeller parts are match marked. Install according to the match marks.

All in-tank fastenings involving the couplings and turbine hubs do not use lockwashers. All in-tank fastenings should be rechecked for tightness after 1500 hours of operation. It is also recommended to check at scheduled

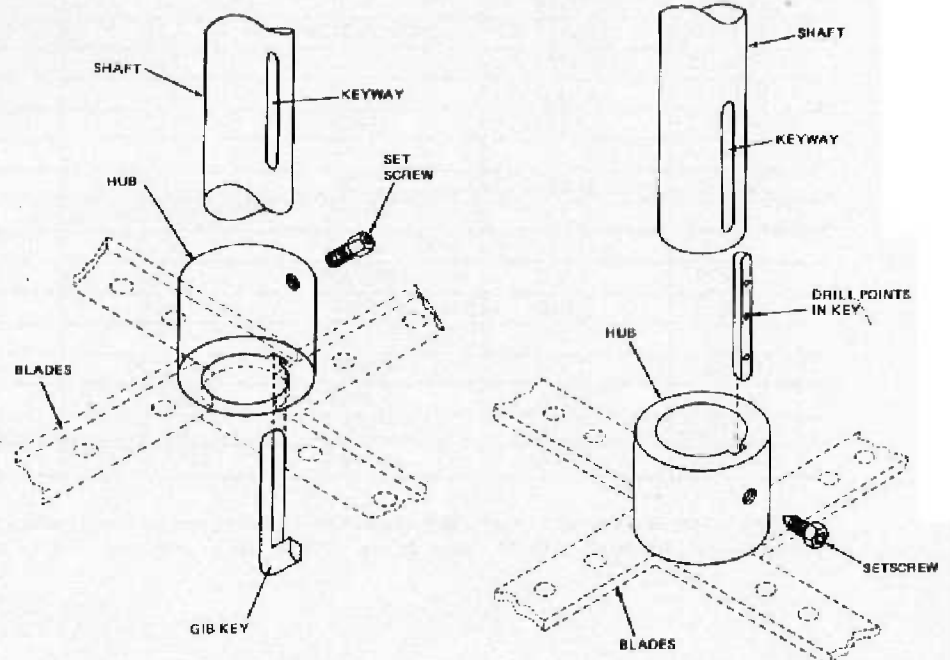


Figure 15 — Installing the Impeller

shut-down periods. All shaft and impeller bolts should be torqued to the values shown in the Torque Value Tables (see Table 8 or 9). This is important for proper bolt performance.

Where split hub turbines are supplied, the hubs should be fit around the shaft and loosely assembled before positioning the hub on the key. The split hub bolts may then be tightened and torqued following a crossing pattern to insure uniform tightening of the bolts.

Bolt Torque

NOTE: The bolt torque shown here will develop a fastener preload of 80% of the fastener's minimum yield.

COUPLING BOLTS — LOW SPEED SHAFT

Assume these bolts to be at least Grade 5. The torque required may be found by using the Grade 5 chart and reading across from the bolt diameter to be used. If stainless bolts are used, proceed with the proper stainless steel chart.

Any looseness in these bolts causes the coupling to apply a shear load on the bolt and a high impact tensile load or shock load.

This shock load and shear load causes either the bolts to snap, the holes to elongate or the coupling to fail and/or a combination of all three conditions.

NOTE: In cases where welded upper flanges are combined with removable lower flanges, this gets very expensive to repair and the entire reducer must be dismantled to repair the flange.

TABLE 8

**CLAMP LOADS & RECOMMENDED TORQUES FOR DRY ASSEMBLY OF PLAIN FINISH BOLTS
FOR LUBRICATED ASSEMBLY; REDUCE VALUES SHOWN BY 20%**

Bolt size And Thread	Tensile stress area (in. ²)	GRADE 2		GRADE 5		GRADE 8	
		Preload (Lbs.)	Ft/lbs. Torque	Lbs. Preload	Ft/lbs. Torque	Lbs. Preload	Ft/lbs. Torque
1/4-20	0.0318	1450	6.0	2035	8.5	CALL FACTORY	
5/16-18	0.0524	2389	12.5	3353	17.5		
3/8-16	0.0775	3534	22.1	4960	31.0		
7/16-14	0.1063	4847	35.3	6803	49.5		
1/2-13	0.1419	6448	53.9	9081	75.7		
9/16-12	0.182	8299	77.	11648	109.2		
5/8-11	0.226	10305	107.4	14464	150.7		
3/4-10	0.334	15230	190.4	21376	267.2		
7/8-9	0.462	*13305	194.0	29568	431.2		
1.0-8	0.606	17452	290.9	38784	646.4		
1-1/8-7	0.763	21974	412.0	48832	915.6		
1-1/4-7	0.969	27907	581.4	62016	1292.0		
1-3/8-6	1.155	33264	762.3	73920	1694.0		
1-1/2-6	1.405	40464	1011.6	89920	2248.0		

NOTE: Torques shown are set to develop 80% of minimum yield in fasteners. For torque and preload @ 50% of minimum yield, multiply values shown by 62.5%.
*Minimum yield drops from 57 x 103 @ .750 dia. to 36 x 103 @ .875 dia.

TABLE 9

**CLAMP LOADS & RECOMMENDED TORQUES FOR DRY ASSEMBLY OF PLAIN FINISH BOLTS
FOR LUBRICATED ASSEMBLY; REDUCE VALUES SHOWN BY 20%**

Bolt size And Thread	Tensile stress area (in. ²)	Stainless Steel Rolled Thread 304, 316, 317		Carpenter 20 Lbs. Preload	Mach. Thread Ft./lbs. Torque	Hastalloy "C" Lbs. preload Ft.	Mach. Thread Lbs. Torque
		Preload (Lbs.)	Ft./lbs. Torque				
1/4-20	0.0318	1272	5.3	1017	4.3	1170	4.9
5/16-18	0.0524	2096	10.9	1676	8.7	1928	10.0
3/8-16	0.0775	3100	19.4	2480	15.5	2852	17.8
7/16-14	0.1063	4252	31.0	3401	24.8	3912	28.5
1/2-13	0.1419	6025	55.7	4540	37.8	5222	13.5
9/16-12	0.182	7280	68.3	5824	54.6	6697	62.8
5/8-11	0.226	9040	94.2	7232	75.3	8317	86.6
3/4-10	0.334	13360	167.0	10688	133.6	12291	153.6
7/8-	0.462	18480	269.5	14784	215.6	17002	247.9
1.0-8	0.606	24240	404.0	19392	323.2	22301	371.7
1-1/8-7	0.763	30520	572.3	24416	457.8	28078	526.5
1-1/4-7	0.969	38760	807.5	31008	646.0	35659	742.9
1-3/8-6	1.155	46200	1058.8	36960	847.0	42504	974.0
1-1/2-6	1.405	56200	1405.0	44960	1124.0	51704	1292.6

NOTE: Torques shown are set to develop 80% of minimum yield in fasteners.
For torque and preload @ 50% of minimum yield, multiply values shown by 62.5%.

REDUCER AND MOUNTING PLATE BOLTS

These bolts are also subject to high loads and should be properly torqued to prevent bolt stretch and/or reducer wobble. For situations of large reducer or long shafts with large turbines, use additional care to make sure these bolts are installed and torqued properly.

If torque wrenches are not available in the field, use turn of the nut method.

This "Turn of the nut Method" can be summed up in one sentence: "Turn the Nut 1/2 to 2/3 turn beyond the snug tight position." This applies to any bolt of any size. However, fasteners should be clean, rust free and lightly oiled.

In cases where the nut is not accessible, the bolt may be turned 1/2 to 3/4 turn beyond the snug tight position. Use lever arm system shown below.

TABLE 10

LEVER ARM SYSTEM	
Bolt Size	Lever Arm
1/4 - 3/8	6 inch handle
7/16 - 5/8	12 inch handle
3/4 - 1-1/8	24 inch handle
1-1/4 and over	36 inch handle

This lever arm system can be used with or without lockwasher. If lockwasher shows signs of splitting or fatigue, it must be replaced.

Installing the C-Faced Motor

Preface

These mixers are supplied with the finest electric motors available. They are manufactured by nationally known sources. Under normal operating conditions, within specified temperatures, given proper installation and maintenance, these motors are guaranteed to deliver rated output.

- To get top performance and long life from any electric motor, be sure there is plenty of air circulation and a minimum of obstructions. On fan cooled motors, be sure not to choke off the suction inlets, also be sure to check the allowable temperature that's indicated on the motor plate. Do not decrease the service life of a motor by operating it at excess ambient temperature.
- To avoid damage to the motor during temporary overloads, jams, etc., be sure overload protection is provided, per local codes. Starter overload heater elements can be sized, from the full load current of the motor, as shown on the motor nameplate. It is advisable to consult a supplier of motor control equipment when selecting heaters.

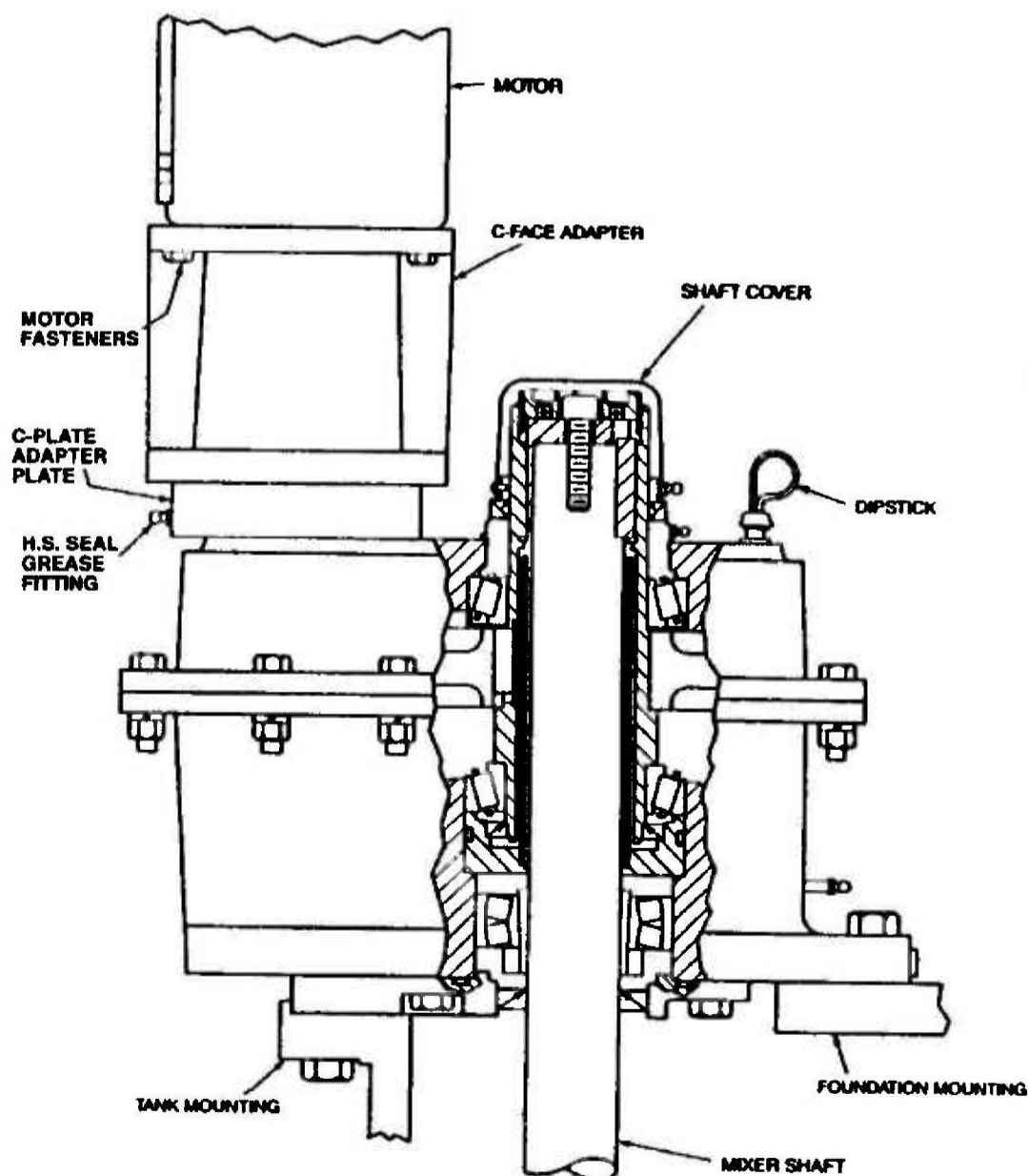


Figure 16 — Installing the C-faced motor

Before the electric motor is permanently wired, check the gear drive nameplate to be sure the output shaft rotation is correct.

Caution: Be sure to check rotation of the mixer before it is operated. To reverse the rotation of standard 3 phase electric motors, simply switch any two power leads. Check the manufacturers literature for other drives.

Your mixer motor is manufactured by a reputable manufacturer with service facilities located throughout the United States. In the event of difficulties, contact the nearest service representative. The manufacturer's name appears on the motor nameplate. The local service facility will honor the motor warranty.

Motors and variable speed drives that are large in relation to the gear case are mounted on the motor bracket when shipped. However, to avoid shipping damage the motor bracket is removed. When installing the motor bracket, realign it to the gear case, reinstall the flexible coupling and bolt the bracket into position.

Installing the C-faced Motor

1. Refer to Fig. 16. Pump NLGI #2 bearing grease into the grease fitting on the adapter plate while rotating the high-speed shaft until a uniform bead of grease appears at the base of the high speed shaft.
2. Position the motor adapter on the adapter plate with the inspection window oriented for easy access.

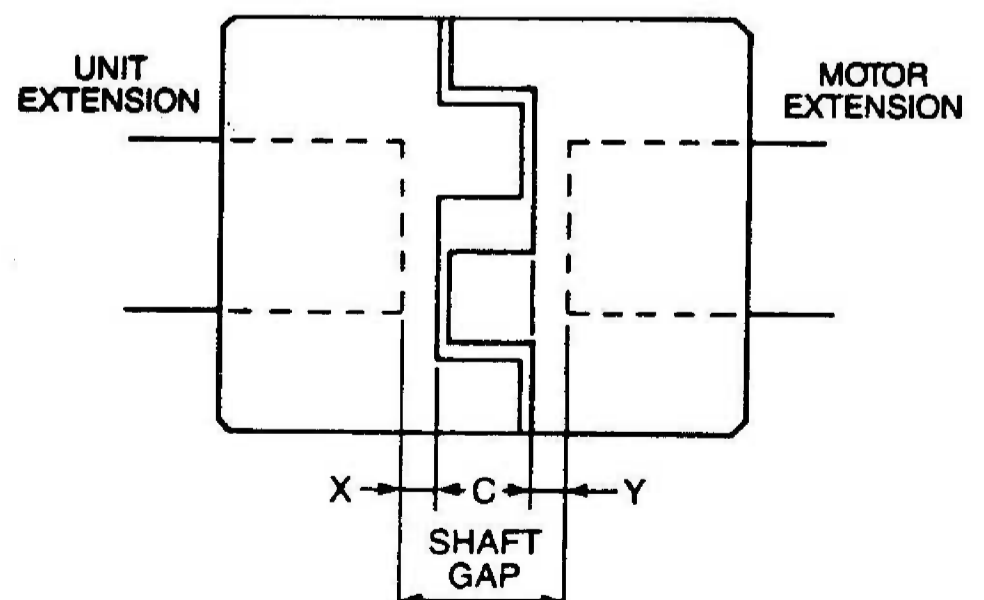


Figure 17 — Positioning the motor coupling

NOTE: Size 6 units require that the circular relief in the adapter be located over the low-speed shaft.

3. Install the adapter fasteners and tighten to 330 lb-in. torque.
4. Refer to Fig. 17 and to Table 11. Place the coupling halves on the unit input (high-speed) shaft and motor shaft and set the coupling overhang distances as shown in Table 11. Tighten the set screws. The reducer hub set screw can be tightened through the access hole in the C-faced adapter.

TABLE 11 — C-Faced Motor Coupling Settings

Unit Size	Motor Frame Size	Coupling Size	Nominal Shaft Gap	C Face Gap	Coupling Overhang	
					Unit X	Motor Y
6	56	L-110	1.375	0.875	0.25	0.25
	143-145	L-110	1.310	0.875	0.38	0.06
	182-184	L-190	1.935	1.000	0.44	0.50
	213-215	L-190	1.435	1.000	0.00	0.44
	254-256	L-190	1.310	1.000	0.00	0.32
	284286	L-190	1.435	1.000	0.00	0.44
	284286	L-190	1.185	1.000	0.18	0.00
8	56	L-110	1.123	0.875	0.12	0.12
	143-145	L-110	1.060	0.875	0.18	0.00
	182-184	L-190	1.685	1.000	0.58	0.12
	213-215	L-190	1.185	1.000	0.18	0.00
	284256	L-190	1.060	1.000	0.06	0.00
	284286	L-190	1.185	1.000	0.18	0.00
9	56	L-110	1.073	0.875	0.18	0.00
	143-145	L-110	1.010	0.875	0.12	0.00
	182-184	L-190	1.635	1.000	0.50	0.12
	213-215	L-190	1.135	1.000	0.12	0.00
	284256	L-190	1.010	1.000	0.00	0.00
	284286	L-190	1.135	1.000	0.12	0.00

5. Install the coupling spider to the unit hub and install the motor to the adapter. If necessary, reach in through the access window on the adapter to align the coupling spider. Orient the motor for convenient electrical connection and tighten the motor fasteners to the manufacturer's recommendations or to Table 8.

Lubrication

Lubricant Recommendations

Lubricants listed in this manual are typical products **ONLY** and should not be construed as exclusive recommendations. Industrial type petroleum based rust and oxidation inhibited (R & O) gear lubricants or industrial type sulphur-phosphorus extreme pressure (EP) gear lubricants are the recommended lubricants for ambient temperatures of 15°F to 125°F (-9°C to 52°C).

For units operating outside the above temperature range refer to the synthetic lubricants paragraph.

Table 12 — Gear Oil Viscosity Recommendations

Ambient Temperature	AGMA No.	Viscosity at 104°F (40°C)	
		SSU	cSt
Output RPM 80 and Above			
+15°to+60°F (-9°to +16°C)	4	625-765	135-165
+50°to+125°F(+10°to +51°C)	5	918-1122	196-242
Output RPM Below 80			
+15°to+60°F(-9°to+16°C)	4	626-765	135-165
+50°to+125°F(+10°to+52°C)	6	1135-1632	288-352

Viscosity (Important)

The proper viscosity grade for R & O and EP lubricants is found in Table 13 and 14. For cold climate conditions refer to Table 15, Page 17, and the "Synthetic Lubricant" paragraphs. Select a lubricant which has a pour point at least 10°F (5.5°C) below the expected minimum ambient starting temperature.

Useable temperature ranges can sometimes be widened if specific application conditions are known.

Table 13 — Petroleum Based R & O Gear Oils

(Maximum operating temperature of lubricants 200°F(93°C)

AGMA Viscosity Grade	4	5	6
ISO Viscosity Grade	150	220	320
Viscosity at 55U 104°F (40°C) cSt	626-765 135-165	918-1122 198-242	1335-1632 288-352
Manufacturer	Lubricant	Lubricant	Lubricant
Aramco Oil Co. Ashland Oil, Inc. BP Oil Co. Chevron U.S.A., Inc. Citgo Petroleum Corp	Amer. Ind. Oil 150 100H ISO 150 Turbinol T-150 Machine Oil AW150 Citgo Pacemaker 150	Amer. Ind. Oil 220 100H ISO 220 Energol HL 220 Machine Oil AW220 Citgo Pacemaker 220	Amer. Ind. Oil 320 100H ISO 320 Energol HL320 Machine Oil AW320 Citgo Pacemaker 320
Conoco Inc. Exxon Company, U.S.A. E.F. Houghton & Co. Imperial Oil Ltd.	Dectol R&O Oil 150 Teresstic 150 Hydro-Drive HP 750 Teresso 150	Dectol R&O Oil 220 Teresstic 220 Hydro-Drive HP 1000 Teresso 220	Dectol R&O Oil 320 Teresstic 320 — Teresso 320
Kendall Refining Co. Keystone Div. Pennwalt Corp. Lyondell Petrochemical (ARCO) Mobil Oil Corp. Petro-Canada Products	Four Seasons AW 150 KLC-40 Duro 150 DTE Oil Extra Heavy Harmony 150 or 150D	— — Duro 220 DTE Oil BB Harmony 220	— — Duro 320 DTE Oil AA Harmony 320
Philips 66 Co. Shell Oil Co. Shell Canada Limited Sun Oil Co. Texaco Lubricants	Magnus Oil 150 Morlina 150 Tellus 150 Sun R&O L150 Regal Oil R&O 150	Magnus Oil 220 Morlina 220 Tellus 220 — Regal Oil R&O 220	Magnus Oil 320 Morlina 320 Tellus 320 — Regal Oil R&O 320
Unocal 76 (East) Unocal 76 (West)	Unax RX 150 Turbine Oil 150	Unax RX 220 Turbine Oil 220	Unax AW 320 Turbine Oil 320

Petroleum Based Lubricants

R & O GEAR LUBRICANTS (TABLE 13) — Industrial type petroleum based rust and oxidation inhibited (R & O) gear lubricants are the most common and readily available general purpose gear lubricants.

EXTREME PRESSURE (EP) LUBRICANTS (TABLE 14) —

For highly loaded units or for units loaded in excess of original estimates, industrial-type petroleum extreme pressure lubricants are preferred. The EP lubricants currently recommended are of the sulphur-phosphorus type.

CAUTION: EP LUBRICANTS IN FOOD PROCESSING INDUSTRY — EP lubricants may contain toxic substances and should not be used in the food processing industry without the lubricant manufacturer's approval.

Synthetic Lubricants

Synthetic lubricants of the polyalphaolefin type are recommended for cold climate operation, high temperature applications, extended temperature range (all season) operation and/or extended lubricant change intervals.

CAUTION: SYNTHETIC LUBRICANTS IN FOOD PROCESSING INDUSTRY — Synthetic lubricants may contain toxic substances such as sulphur phosphorus, chlorine, lead derivatives, graphite or molybdenum disulfides and should not be used in the food processing industry without the lubricant manufacturer's approval.

Lubricant Changes

PETROLEUM LUBRICANTS — For normal operating conditions, change lubricant every six months or 2500 hours, whichever occurs first. If the unit is operated in an area where temperatures vary with the season, change the oil viscosity to suit the temperature, refer to Table 13. Lubricant suppliers can test oil from the unit periodically and recommend economical lubricant change schedules.

SYNTHETIC LUBRICANTS — Synthetic lube change intervals can be extended to 8,000-10,000 hours based on operating temperatures and lubricant contamination. Laboratory analysis is recommended for optimum lubricant life and gear drive performance. Change lubricant with change in ambient temperature, if required. Refer to Table 15.

Bearing & Seal Greases

Some units have one or more grease lubricated bearings and grease purged seals. Whenever changing oil in the unit, grease the bearings and purge the seals with one of the NLGI #2 greases listed in Table 16.

Some of these products are of the EP type and may contain toxic substances not allowed in the food processing industry. A grease that meets the USDA "H1" classification is suitable for food processing applications.

TABLE 14 — Extreme Pressure Lubricants
Maximum Operating Temperature
200°F(93°C)

Manufacturer	Lubricant
Amoco Oil Co. Ashland Oil, Inc. BP Oil Co. Chevron U.S.A. Inc. Citgo Petroleum Corp.	Pemagear/Amogear EP AGMA/EGC ISO Energear EP Gear Compounds EP Citgo EP Compound
Conoco Inc. Exxon Co. U.S.A. E.F. Houghton & Co. Imperial Oil Ltd.	Gear Oil Spartan EP MP Gear Oil Spartan EP
Kendall Refining Co. Keystone Div. Pennwalt Corp. Lyondell Petrochemical (ARCO) Mobil Oil Corp. Petro-Canada Products	Kendall NS-MP Keygear Pennant NL Mobilgear Ultima EP
Phillips 66 Co. Shell Oil Co. Shell Canada Limited Sun Oil Co. Texaco Lubricants	Philgear Omala Oil Omala Oil Sunep Meropa
Unocal 76 (East & West)	Extra Duty NL Gear Lube

TABLE 15 — Polyalphaolefin Type Synthetic Lubricants¹

AGMA Viscosity Grade	4	5	6
ISO Viscosity Grade	150	220	320
Viscosity at 104°F (40°C)	SSU 626-765 cSt 135-165	918-1122 198-242	1335-1632 288-352
Ambient Temp. Range °F	0 to +80	+10 to +125	+20 to +125
MANUFACTURER			
Chevron U.S.A., Inc.	—	Synthetic Gear Lube Tegra 220 ²	—
Conoco, Inc.	—	—	—
CPI Engineering Service, Inc.	CP-4620 -150 CP-4620 -150 ³	CP-4620 -220 CP-4620 -220 ³	—
Exxon Co. U.S.A.	Spartan Synthetic EP 150 ³	Spartan Synthetic EP 220 ³	Spartan Synthetic EP 320 ³
Mobil Oil Corp.	—	Mobilgear SHC 220 ³	Mobilgear SHC 220 ³

¹Minimum viscosity index of 130. Max. operating temperature 225°F(107°C).

²With complete application information, temperature range can sometimes be extended, consult Factory.

³200°F (93°C) maximum operating temperature (contains sulphur phosphorus EP).

TABLE 16 — Greases for Bearings & Grease Purged Seals

0° to 200°F(-18° to 93°C)

Manufacturer	Lubricant
Amoco Oil Co. Ashland Oil Co., Inc. BP Oil Co. Chevron U.S.A., Inc. Citgo Petroleum Corp.	Amolith Grease No. 2 Multilube Lithium ER Grease Energrease LS-EP2 Industrial Grease Medium Premium Lithium Grease No.2
Conoco Inc. Exxon Company, U.S.A. E.F. Houghton & Co. Imperial Oil Ltd.	EP Conolith Grease No.2 Unirex N2 Cosmolube 2 Unirax N2L
Kendall Refining Co. Keystone Div. Pennwalt Corp. Lyondell Petrochemical (ARCO) Mobil Oil Corp. Mobil Oil Corp. Petro-Canada Products	Multi-Purpose Lithium Grease L-421 Zeniplex-2 Litholine H EP 2 Grease Moblith 22 Moblith SHC 460 ¹ Multipurpose EP2
Phillips 66 Co. Shell Oil Co. Shell Canada Limited Sun Oil Co. Texaco Lubricants	Philube Blue EP Alvania Grease 2 Alvania Grease 2 Ultra Prestige EP2 Premium RB Grease
Unocal 76 (East & West)	Unoba EP2

¹High performance synthetic alternate.

Grease — Lubricated Bearings & Seals

All HGD units are equipped with four grease fittings: One at the C-Face Motor adapter plate, one on the lower housing for the low-speed bearing, and two at the input end of the low-speed shaft. Both the upper low-speed shaft bearing and the lower low-speed shaft bearing are grease-lubricated. The upper low-speed bearing is pregreased at the factory.

To regrease the upper bearing, remove the plastic button plug from the input side L.S. seal cage. Pump NLGI #2 bearing grease into the seal cage through the fitting opposite the plastic button until grease appears at the button plug hole.

Reinstall the button plug before operating the unit.

To grease the lower bearing, remove the small pipe plug located on the lower housing just beneath the output side grease fitting (Fig. 19). Pump NLGI #2 bearing grease into the bearing cavity until grease appears at the plug hole.

GREASE — LUBRICATED SEALS—The high-speed shaft and the input end of the low-speed shaft are equipped with grease-purge seals which minimize entry of contaminants into the unit. The purge seal at the high speed shaft should be greased during installation (see Figure 19) and at regular maintenance intervals. The purge seal cavity at the low-speed shaft cover may be left empty if extruded grease could contaminate the product.

Oil Levels

Before adding oil, make sure the dipstick bushing and all housing plugs or vents are undamaged, correctly positioned and tightly fastened.

Remove the air vent and fill the unit through the street elbow. Fill to the level indicated on the dipstick. Approximate oil quantities are shown in Table 17. Do not overfill the unit or leakage may result.

TABLE 17 — Approximate Oil Capacity — Quarts¹

HGD	Unit Size
6	3
8	6
9	8

¹Quantities are approximate. Always fill unit to specified level.

Figure 18 — Oil fill access locations

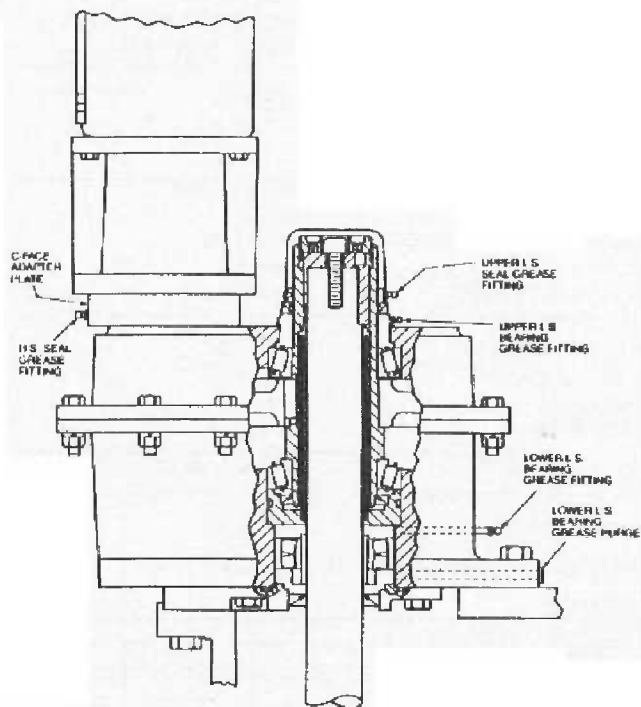
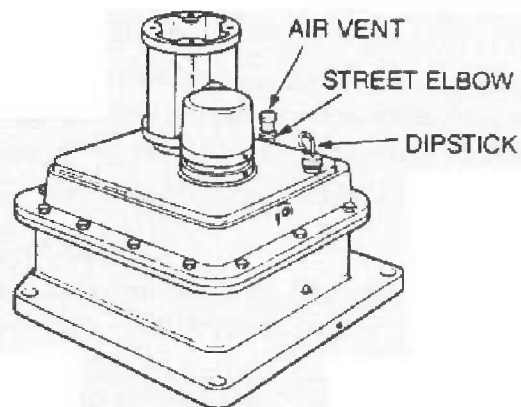


Figure 19 — Grease fitting locations

SECTION II — OPERATION & MAINTENANCE

General Information

Refer to the unit nameplate. Operate the unit only within the horsepower and output speed range for which it was selected and specified. Failure to observe limits of speed, torque, or other load conditions may void the warranty.

WARNING: Consult all applicable local and national safety codes for proper guarding of rotating elements.

Start-up

Before start-up, check all fasteners, fittings, vents, plugs and connections that may have been loosened during preparation and installation. Check oil and grease levels and make sure all foundation or mounting bolts are securely tightened.

Preventive Maintenance

AFTER THE FIRST WEEK

Check all external fasteners and plugs for tightness.

NOTE: Gears and internal bearings have been factory set and require no adjustments. Driven shaft bearings require no maintenance other than periodic regreasing.

AFTER THE FIRST MONTH

1. Start the unit. When the sump oil reaches normal operating temperature, shut the drive down and immediately drain the oil. The magnetic plug should be cleaned at this time.
2. Flush the unit immediately with warm (100° F) oil of the same type and viscosity used in the original fill. Pour or pump oil equivalent in volume to 25% of the original fill through the unit. If necessary, repeat the procedure until clean oil appears at the drain.
3. Close the drain and refill the unit to the correct level with fresh oil.

NOTE: If declared to be in good condition by the supplier, reclaimed oil filtered through a 10 micron or finer filter may be used to refill the unit.

PERIODICALLY — Check oil level and oil condition with unit stopped and oil at normal operating temperature. Add oil if required (DO NOT OVERFILL)

NOTE: If the oil level has risen since the previous check, have the oil analyzed for water content. Moisture in the oil may indicate seal leakage or condensation. Drain the oil, correct the defect and refill the unit with fresh oil.

EVERY 2500 OPERATING HOURS OR NOT LESS THAN ONCE EVERY SIX MONTHS

1. Drain and replace R & O or Extreme Pressure oil.

NOTE: The change interval for Synthetic lubricants can be extended to 8,000-10,000 operating hours. Ask the lubricant supplier to test oil from the unit and to recommend an economical change schedule.

NOTE: Seasonal temperature variations or changes in operating conditions may require more frequent oil changes or changes in oil viscosity. The magnetic plug should also be cleaned at this time.

2. Regrease purged seals.

NOTE: Purged seals should be regreased whenever the grease shows signs of contamination. Pump fresh grease into the seal cavity while rotating the shaft until fresh grease can be wiped away from around the seal face. The low-speed shaft can be reached by removing the shaft cover at the input side. (See Figure 13, page 10.) The high speed shaft can be reached through the panel (window) in the C-Face motor adapter.

3. Regrease Bearings.

a. Low-speed Shaft — Input side: Prior to each oil change, remove the button plug on the side of the seal cage. Pump 6 ounces of an NLGI #2 grease into the input-side low-speed shaft bearing cavity through the fitting on the seal cage nearest the housing. **DO NOT APPLY EXCESSIVE PUMPING PRESSURE:** overfilling the cavity may pop the seal cage out of the housing. Replace the button plug when greasing is complete.

NOTE: Some old or excess, grease may enter the unit and will be drained away with the oil change.

b. Low-speed Shaft — Output side: Remove the small pipe-plug below the grease fitting on the housing base. Pump an NLGI #2 grease into the bearing cavity through the fitting just above the plug until clean grease appears at the plug hole. Replace the plug when greasing is complete.

4. Inspect Couplings.

The C-Face motor coupling is of the elastomeric-jaw type. It requires no maintenance but should be replaced when the elastomeric element is no longer intact.

EMI-supplied couplings connecting low-speed stub-shaft equipped units to the In-tank Shaft are the rigid-hub type and require no maintenance.

Deactivation & Storage

Deactivation of Operating Units

SHORT TERM SHUTDOWN — Units may be deactivated and left on line for up to four months without special precautions.

CAUTION: *If the unit is to be removed from installation for storage, follow the removal procedures described in "Off-Line Service & Repair" on Page 23.*

EXTENDED TERM SHUTDOWN — If a unit is to be deactivated or stored for more than 4 months after any period of operation:

1. Refer to Table 18 below, add the recommended amount of "Motorstor"[®] to the oil sump and rotate the shaft several times.

TABLE 18 — Recommended Quantity (Fl. Oz.) Motorstor[®] Rust Inhibitor

Unit Size	HGD
6	5
8	12
9	18

[®]Product of Daubert Chemical Company, Chicago, IL (Formerly known as "Nucle Oil")

2. Remove the dipstick and the air-vent and seal the opening with a pipe plug.

NOTE: Tape or wire the removed dipstick and air vent to the unit to prevent loss and to keep them available when start-up is required.

NOTE: Indoor dry storage is recommended for all inactive units. Deactivated units stored outdoors should be protected from the weather.

Reactivation After Shutdown & Storage

Inspect all fasteners and re-tighten to recommended torques as required. If the unit has been stored in excess of 6 months and "Motorstor"[®] rust inhibitor has been added to the oil, check the oil condition and drain if necessary. Refill all units to the proper level. Remove pipe plugs installed for storage and replace with the dipstick and air vent as required.

New Unit Storage

HGD units may be ordered for extended storage before operation. Such units are factory treated with special preservative and sealed to rustproof internal parts. Indoor dry-storage is recommended for all new units.

Periodic inspection of Stored Units

Inspect stored or inactive units at 90 day intervals. Re-spray with rust preventive or add rust inhibitor at least once every six months as required.

SECTION III — SERVICE & REPAIR

GENERAL INFORMATION

The service and repair procedures detailed on the following pages generally apply to all standard HGD Ram Mixer reducers. In some instances, instructions may apply only to a specific model type. Before servicing a reducer, check the nameplate for identification detail and note the ratio and shaft-orientation information. Check for specific model or type instructions and follow all directions carefully.

WARNING: *Lock out the power source and remove all external loads before servicing the unit or accessories.*

Refer to Fig. 20 and to the lifting and moving instructions in "Lifting & Moving" on Page 5 before removing an installed unit.

CAUTION: *when removing an installed or mounted unit, position the lifting sling and take up all slack in the sling and hoisting equipment before releasing fasteners securing the unit to its foundation or pedestal.*

EQUIPMENT REQUIRED — In addition to a hoist sling, and standard mechanics tools, the following service equipment may be required:

- Arbor press
- Wheel puller
- Torque wrench
- Feeler gauges
- Dial indicator
- Face spanner wrench — for Unit Size 6 and 8, Armstrong Tools No. 34-110 or equivalent; for unit Size 9, Armstrong Tools No.34-119 or equivalent

SPECIAL TOOLS — A special cylindrical tool helpful in re-installing the stamped low-speed input-side seal-cage may be fabricated by referring to Fig. 21, and to the dimensions shown in Table 19 below.

TABLE 19 — Seal Cage Installation Tool Dimensions

Unit Size	Tool Bore (In)	Minimum Length (In)
6	4.060	4.00
8	4.440	4.00
9	5.290	4.63

General Service Notes & Recommendations

PINION REPLACEMENT — When replacing a pinion, replace the entire assembly (pinion, shaft, bearings, spacers, etc.). Also replace the mating gear.

GASKETS AND SHIMS — When reassembling a gasketed joint, discard the old gaskets and replace them with new gaskets of identical thickness. NOTE: Use only Cleveland shims and gaskets.

NOTE: Shim gaskets of minimum compressibility are available from the factory in thicknesses of 0.007", 0.009", 0.015" and 0.031". Compressed thicknesses are, respectively, 0.006", 0.008", 0.013", and 0.028". The compressed thickness should be used when determining total shim thickness required for proper bearing settings.

SEALS AND BEARINGS — The seals at the high-speed (motor) shaft and input end of the low-speed shaft may be replaced while the unit is in the installed (on-line) position. Replacement of all other seals and all bearings require that the unit be dismantled for service. Replace all bearings and seals before reassembling any unit that has been disassembled after any period of operation.

FASTENERS — Do not lubricate fasteners before re-installation after service. Always tighten fasteners to the torque values specified in this manual.

Vertical Shaft Lifting

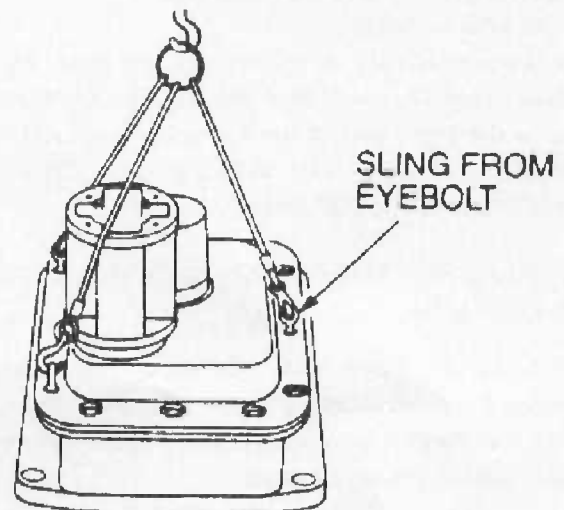


Figure 20 — Lifting and moving reducer units

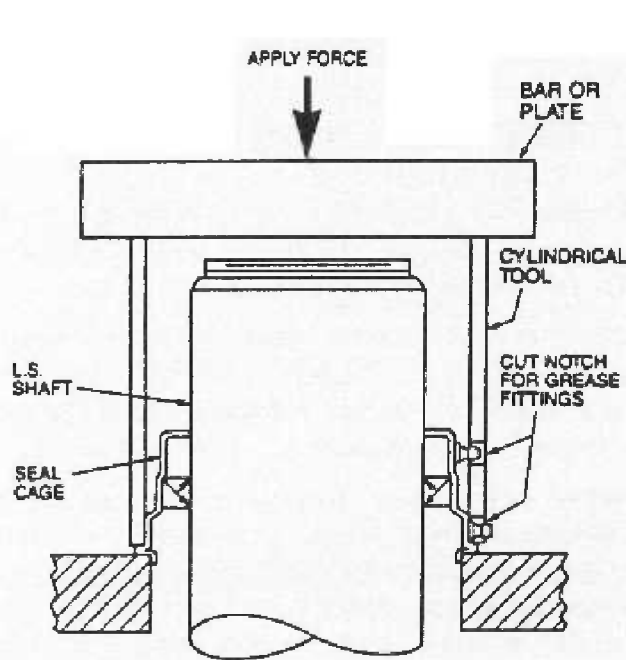


Figure 21 — Low-speed input-side seal cage installation tool

Replacement Parts

Always use genuine Cleveland parts when worn or damaged parts must be replaced. Part numbers and a complete diagram for ordering repair parts or service may be found on pages 31 and 32. Call 1-800-243-1188 for assistance.

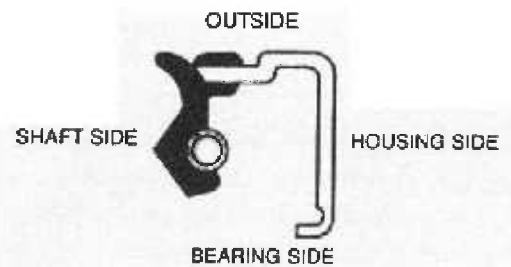
Service Procedures

On-line Service

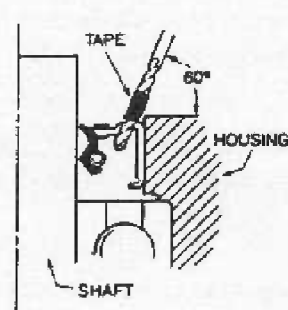
It is not necessary to remove the unit from the mixer-shaft to replace the seals at the high speed (motor) shaft or at the input end of the low-speed-shaft. **ALL OTHER SERVICE PROCEDURES REQUIRE THE UNIT TO BE REMOVED FROM THE INSTALLATION.**

REPLACING THE HIGH-SPEED (MOTOR) SHAFT SEAL

WARNING: Lock out the power source and relieve all mechanical system loads before working on the motor or electrical power system connections or components.



CORRECT WAY



WRONG WAY

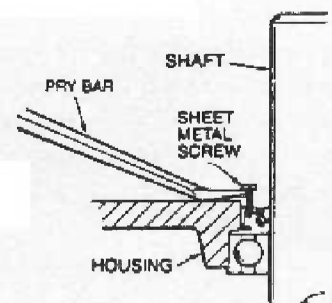
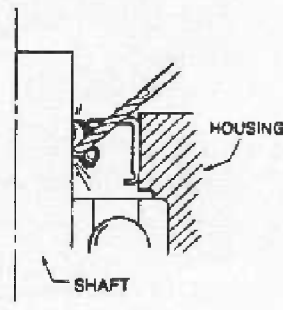


Figure 22 — Replacing the high-speed (motor) shaft oil seals

To replace the high-speed (motor) shaft seal:

1. Clean all exterior surfaces. Disconnect and lockout all power source wiring at the motor.
2. Remove motor fasteners and remove the motor.
3. Remove the inspection cover in the motor adapter, loosen the setscrew in the coupling hub and remove the coupling hub and extension key.
4. Remove the adapter and adapter plate.

NOTE: Refer to Fig. 22. Note the position of the seal in the housing bore. Seals in housing bores are not axially retained and disassembly of the unit may be required if the seal has been driven too deep into the bore. If the unit must be disassembled to remove the seal, the unit must be dismantled before work can proceed. See "Off Line Service & Repair" on Page 23 for Dismounting and Disassembly procedures.

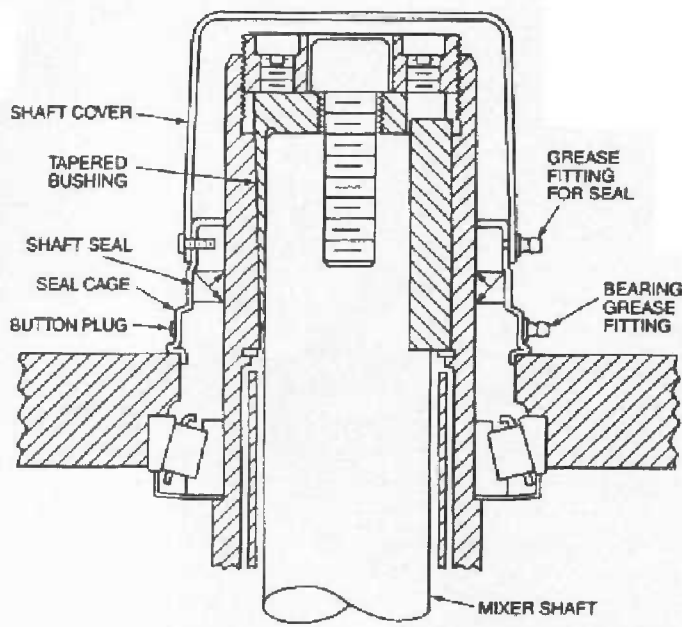


Figure 23 — HGD low-speed shaft input-end seal replacement

5. Refer to Fig. 22. Wrap several turns of tape around an 0.125" drill approximately 0.250" from the end. Grease or magnetize the drill to retain chips.
6. Note the angle shown in Fig. 22 and drill two holes (180° apart) in the seal-case. Position the drill carefully and DO NOT drill so deep as to damage the reducer shaft.
7. Insert #10-0.750" sheet metal screws into the seal-case holes. Turn the screws in until firmly seated, but DO NOT drive them in more than 0.250".
8. Refer to Fig. 22. Use a claw-type pry bar to work the seal free of the housing bore. Use a magnet to remove any chips that may remain in the bore after the seal is removed.
9. Clean the housing bore of all traces of Permatex. Coat the O.D. of the new seal with Permatex #3 or equivalent and position it squarely in the housing bore.
10. Place a square ended cylindrical tool against the seal and press or tap lightly until the seal is properly seated.

NOTE: The seal will be correctly positioned when it is evenly recessed 0.150" below the housing surface and seal face runout is <.010".
11. Replace the adapter plate. See page 14 for instructions on reinstallation of the motor adapter, coupling and motor. Observe all instructions on torques and lubrication before reconnecting and restarting the unit

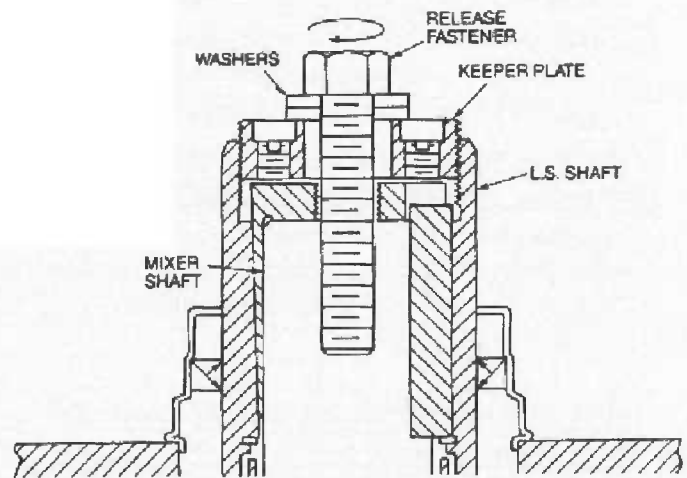


Figure 24 — Removing the unit from installation

Off-line Service & Repair

Dismounting the Unit

WARNING: Lock out the power source and relieve all mechanical system loads before attempting to dismount the unit.

1. REMOVE THE MOTOR

- a. Drain the oil from the unit and clean all exterior surfaces. The drain location for HGD units is on the side of the housing below the air vent. Disconnect all power source wiring at the motor.
- b. Remove motor fasteners and remove the motor
- c. Remove the inspection cover in the motor adapter, loosen the setscrew in the coupling hub and remove the coupling hub and extension key.
- d. Remove the adapter and adapter plate.

2. RELEASE THE HOLLOW SHAFT CONNECTION

- Install a retaining collar below the reducer to support the mixer shaft during the removal procedure.
- a. Loosen the sheet-metal screws securing the shaft cover to the low-speed input-end seal cage and remove the shaft cover.
 - b. Apply a hook-type spanner wrench to the high-speed shaft to keep it from turning. Remove the fastener, securing the mixer-shaft to the bushing.

c. Remove the set-screws in the keeper plate and use a face spanner wrench to loosen the keeper plate two turns. See "Equipment Required" on Page 21 for face-spanner wrench size requirements.

d. Refer to Fig. 24. Thread a hex-head fastener with a flat washer through the keeper plate hole into the tapped hole in the mixer shaft. (See Table 20 below for fastener size recommendations.) Tighten the fastener until the tapered bushing breaks free from the hollow shaft.

TABLE 20 Bushing Release Fastener Dimensions

Unit Size	Fastener Size
6-8	0.625" — 11 UNC
9	0.875" — 9UNC

e. Remove the hex-head fastener (shaft must be supported) and remove the keeper plate. Thread a larger fastener into the threaded hole in the tapered bushing and use it as a handle to pull the bushing from the unit. (See Table 21 below for fastener size recommendations.) Remove the shaft key.

NOTE: If the bushing adheres to the mixer shaft, a pry bar may be inserted into the slot in the bushing to spread it for release.

TABLE 21 — Bushing Withdrawal Fastener Dimensions

Unit Size	Fastener Size
6-8	0.750" — 10UNC
9	1.000" — 8UNC

3. REMOVE THE UNIT FROM INSTALLATION

a. Position hoisting equipment and attach lifting slings or chains. See "Lifting & Moving" on Page 4 for detailed lifting and moving instructions for HGD units before proceeding.

b. Remove the foundation bolts or pedestal fasteners and carefully lift or slide the unit off the mixer shaft.

NOTE: The lower low-speed shaft bearing and seal cage or tank-adapter will remain on the mixer shaft.

Removing the Mixer Shaft Bearing & Output End Seal Cage

1. Bend the bearing lockplate tang out of the slot in the lock-nut and loosen the locknut with a spanner wrench.
2. Carefully tap the inner race of the bearing toward the lock-nut to free it from the taper. Slide the bearing off the shaft.

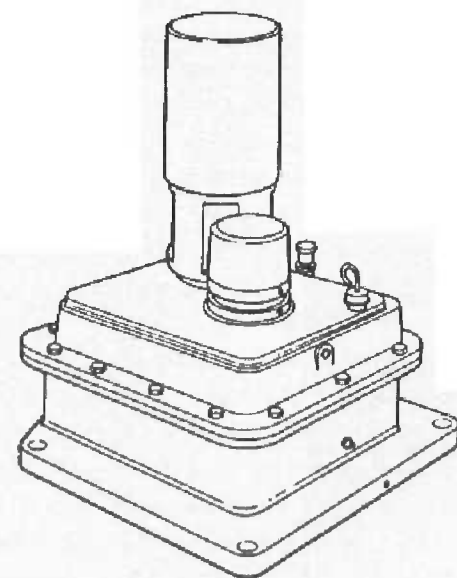


Figure 25 — Reducer ready for disassembly

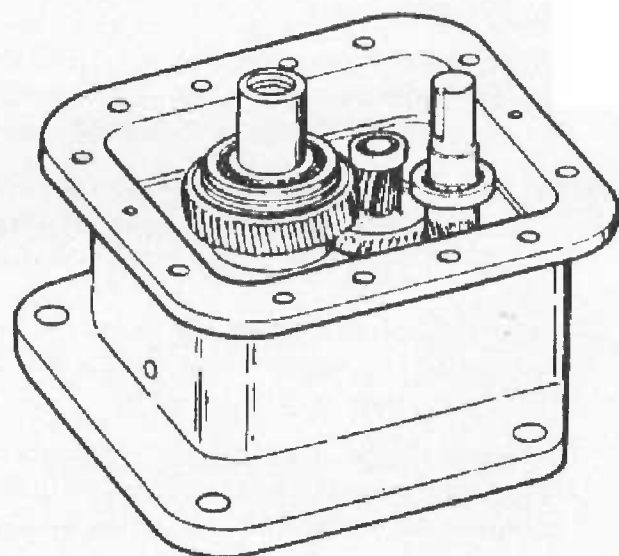


Figure 26 — Reducer with upper housing removed

3. Slide the seal cage or tank-adapter flange off the shaft.

Disassembly of the Reducer

To disassemble the reducer:

1. With a 1/4" or 5/16" punch, tap both the spring pin and dowel pin down and out of the housing halves.
2. Coat both the high-speed and low-speed shafts with grease and remove the housing flange fasteners.
3. Lift the input-side housing straight-up off the output housing.
4. Lift out all shaft assemblies simultaneously. Be careful not to strike the low-speed-shaft against the drywell tube.

Cleaning, Inspection & Repair of Parts & Assemblies

Upper (Input) Housing

Unless it has been damaged, the upper (input) housing will require no service other than routine cleaning and inspection.

Lower Housing

Disassembly:

1. Remove all plugs and pipe fittings.
2. Bearing Cups — If bearings are to be replaced, or the drywell is to be removed, use a bearing puller to remove the tapered roller bearing cups.
3. High-speed Bearing Adapter — Unless it is damaged, or unless the ratio is to be changed to one that does not require the adapter, the high-speed bearing adapter installed in the lower housing of some double-reduction units need not be removed. If it is necessary, to remove the adapter:
 - a. Use a tip grinder to remove deformed metal where the adapter has been staked to the housing.
 - b. Use a wheel-puller to remove the adapter from the housing.
4. Drywell Assembly — Unless leakage between the drywell base and the tube is apparent, or unless the drywell tube is damaged, the drywell need not be removed from the housing. To remove the drywell:
 - a. Use a chain or pipe wrench to unscrew the drywell tube from the base.
 - b. If the base must also be removed, use a tip grinder to remove deformed metal where the tube base has been staked to the housing, turn the housing over and drive the base from the housing.

Lower Housing Cleaning and Inspection:

1. Remove all burrs in bores and on the adapter O.D..
2. Clean and remove all sealing compound, grease, and gasket material from housing bores and flanges.

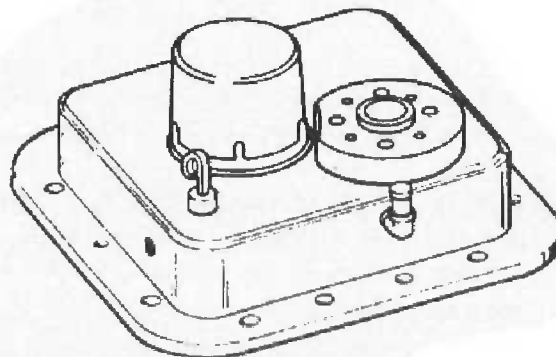


Figure 27 — Upper (input) housing

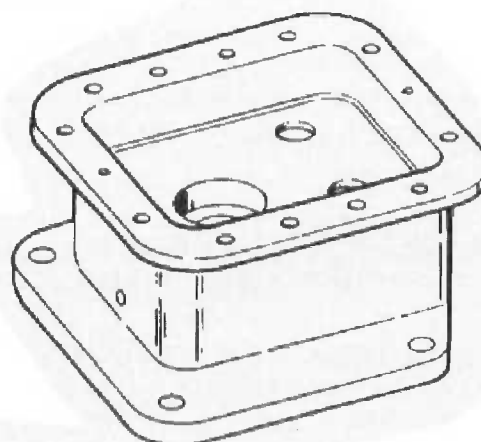


Figure 28 — Lower (output) housing

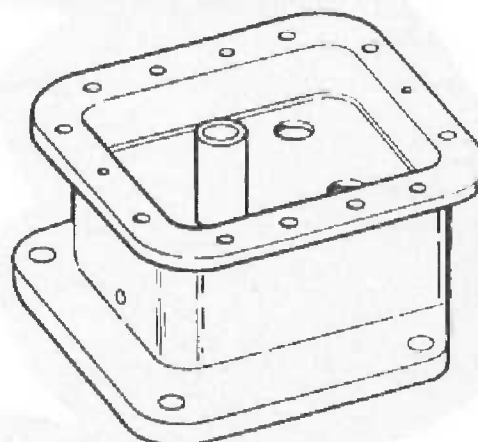


Figure 29 — Drywell assembly

3. Clean oil chambers with solvent. Inspect the passage between the high-speed and intermediate bores. Make sure it is open.
4. Clean and inspect all plug holes. Clean and chase all straight tapped holes.

Reassembly:

1. Refer to Fig. 29 on Page 25. Reinstall the drywell tube.

- a. Inspect the outer diameter of the tube base and housing bore. Use a file to remove all burrs.
- b. Chill the base to no less than -90°F , oil the O-ring and install the O-ring in the groove in the base. Position the base in the housing immediately and use a square ended cylindrical tool to drive it to the bottom of the bore. Be sure the O-ring is not sheared or rolled out of the groove.
- c. Stake the base to the housing.
- d. Coat the O.D. of the inner low-speed seal with Permatex #3 or equivalent and install the seal with the garter spring facing the driver. Use a seal driver to seat the seal.
- e. Drive the low-speed bearing cup into the housing bore until it contacts the drywell base.
- f. Coat the threads of the new drywell tube with Locktite 242 thread sealant or equivalent. Be sure to coat the entire O.D. for at least the first five threads.
- g. Screw the tube into the base. Tighten with a chain wrench. Be sure the tube has contacted the bottom of the base.

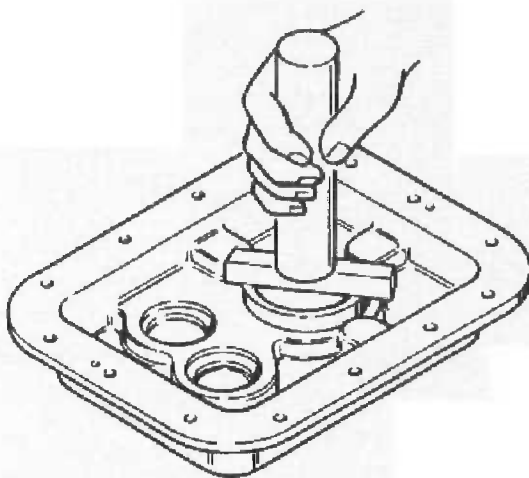


Figure 30 — Seating bearing cups on housing

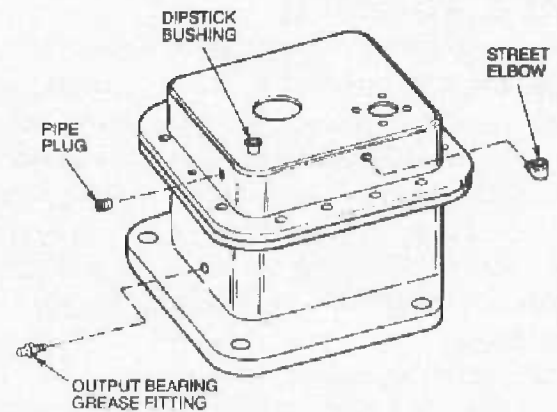


Figure 31 — Pipe plug and pipe fitting locations

2. Refer to Fig. 27. Reinstall adapter and bearing cups.

- a. If the adapter has been removed, oil the adapter and drive it into the high-speed bore of the lower housing.
- b. Coat tapered bearing cup with an SAE 20 (or heavier) oil and drive or press cup squarely into the housing bore until fully seated. Use a press or steel bar as shown in Fig. 30, below left.

3. Coat all pipe-plugs and pipe-fittings with Permatex #3 or equivalent, and install as shown in Fig. 31 above.

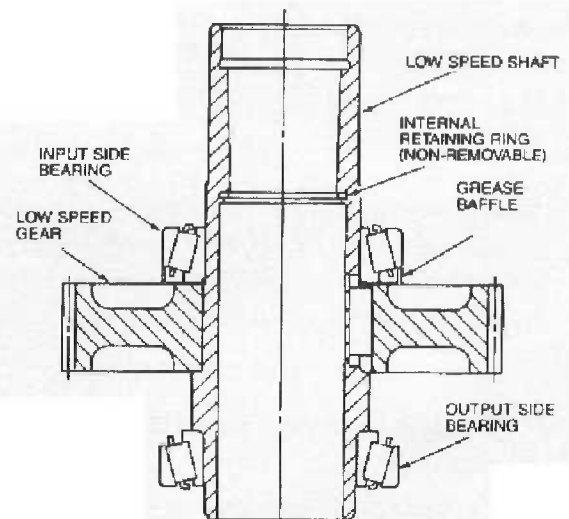


Figure 32 — Low-speed shaft assembly

SHAFT ASSEMBLIES

Inspect gear teeth for wear. Inspect bearing condition. Unless replacement is necessary, bearings and gears need not be removed from shaft assemblies.

Wash open bearings with solvent and dry thoroughly. To prevent scoring because of lack of lubricant, avoid spinning dry bearings. DO NOT submerge sealed bearings in solvent.

LOW-SPEED SHAFT ASSEMBLY, REPAIR & REASSEMBLY

To disassemble the low-speed shaft assembly:

1. Use a wheel puller or press to remove the bearing cones. Apply force to the inner race only. If bearings are removed, replacement is recommended.

NOTE: The bearing cone on the gear side of the shaft can be removed by removing the gear, or by carefully cutting and removing the roller cage and heating the inner race until it slides off the shaft.

2. Use a wheel puller or press to remove the gear from the shaft.

Reassembly:

NOTE: Replace bearing cups & cones when bearings are replaced and replace the low-speed pinion when replacing the gear.

1. Assemble the gear key to the shaft.
2. Heat the gear to 275°F maximum and assemble the gear to the shaft with the large chamfer on the gear bore toward the shaft shoulder. Seat with a press.
3. Place the grease baffle over the low speed shaft at the gear end so that the edge of the baffle faces away from the gear.
4. Heat the tapered roller bearing cones to 275°F maximum and assemble to the shaft. Seat with a bearing cone driver. Be sure that the grease baffle remains centered and is not free to rotate on the shaft.

5. Lubricate the bearings and coat the reassembled components with oil.

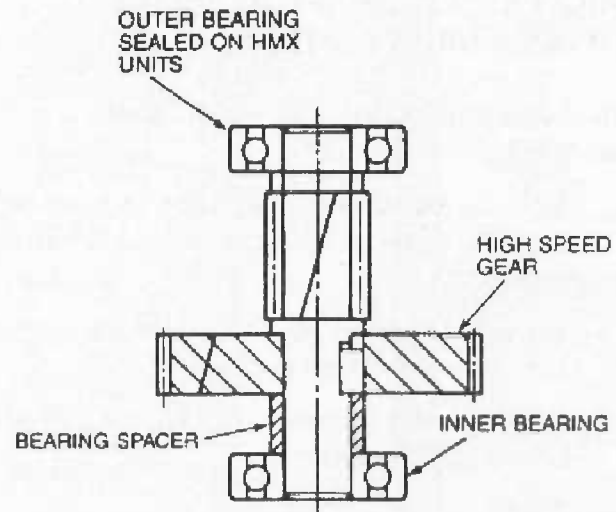


Figure 33 — Intermediate speed shaft assembly

INTERMEDIATE SPEED SHAFT ASSEMBLY, DISASSEMBLY & REPAIR

To disassemble the intermediate speed shaft assembly:

1. Use a wheel puller or press to remove the bearings. Apply force to the inner race only.
2. Use a wheel puller or press to remove the gear from the shaft.

Reassembly:

NOTE: Replace the high-speed shaft pinion when replacing the intermediate shaft assembly gear.

1. Assemble the gear key to the shaft.
2. Heat the gear to 275°F maximum. Assemble the gear to the shaft with the large chamfer on the gear bore toward the shaft shoulder. Seat with a press.
3. Assemble bearings to the shaft and seat by pressing or driving against the inner race only.

NOTE: These units use sealed bearings on the pinion end of the intermediate shaft. DO NOT heat sealed bearings. Replacement is recommended. Be careful not to damage seals or sealing surfaces during installation.

4. Lubricate the bearings and coat the reassembled components with oil.

HIGH SPEED SHAFT ASSEMBLY, DISASSEMBLY & REPAIR

To disassemble the high speed shaft assembly:

NOTE: On Size 6 Units, with ratios 25:1 and 31:1, remove the retaining ring from the shaft before proceeding.

1. Use a wheel puller or press to remove the bearings. Apply force to the inner race only.
2. Remove the shaft extension retaining ring. (See note above on Size 6 exceptions.)

Reassembly:

NOTE: Replace the high speed gear on the intermediate shaft assembly whenever replacing the high speed pinion.

1. On Size 6 units, with ratios 25:1 and 31:1 assemble the input bearing to the shaft from the output end and then install the retaining ring. On all other units, assemble the shaft extension end retaining ring before positioning the bearing.

NOTE: Bearings with retaining rings in the outer race should be assembled with the groove toward the pinion side of the bearing.

2. Seat bearings with a press. Apply force to the inner race only.

NOTE: These units use sealed bearings at the input (extension) end of the shaft. DO NOT heat sealed bearings. Replacement is recommended.

3. Lubricate the bearings and coat the reassembled components with oil.

Unit Reassembly

PRELIMINARY INSPECTION OF PARTS & SUB-ASSEMBLIES

Make sure all parts are clean. Inspect all housing bores, threaded openings, and bearing surfaces. Check the condition and configuration of all repaired parts and assemblies: make sure all bearing and gear positions are correct. Verify the accessibility of required replacement parts.

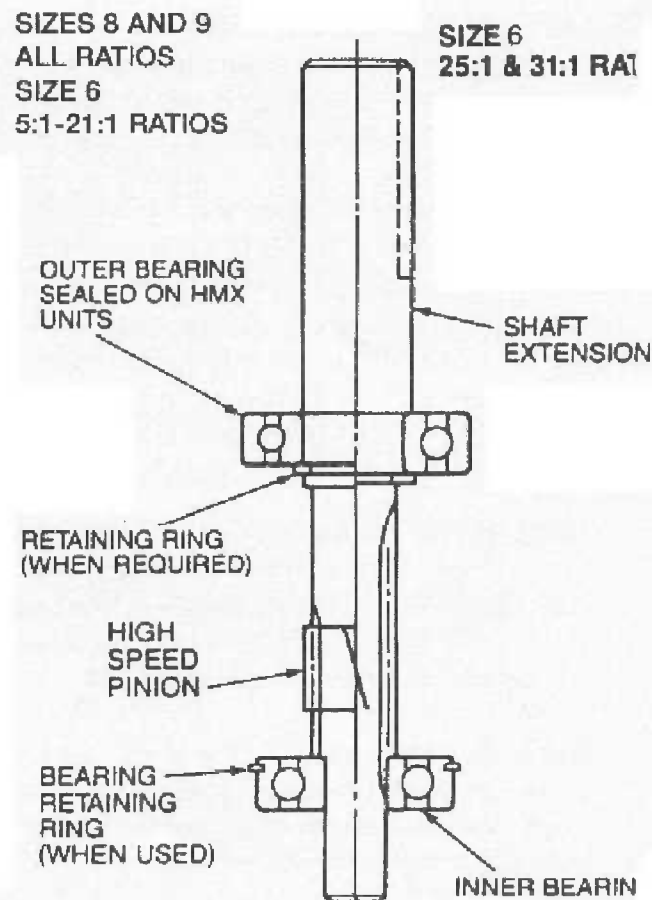


Figure 34 — High Speed shaft assembly

TRIAL ASSEMBLY TO CHECK LOW-SPEED BEARING ADJUSTMENT

1. Position the reducer output (lower) housing on its foundation feet on a bench. Oil the radius end of the low speed shaft to aid in installation into the internal seal.
2. Position the low-speed shaft assembly over the drywell tube and lower it into the output housing. Be careful not to strike the low-speed shaft assembly against the drywell tube and be careful not to roll the lip of the seal at the lower bearing adapter.
3. Position a .060" thick shim pack on the housing flange. Use only one .015" gasket.
4. Install the solid dowel pin and hollow spring pin halfway into the housing flange as shown in Fig. 35. DO NOT place the High Shaft or Intermediate shaft assemblies into the housing at this time.
5. Position the input (upper) housing over the dowel and spring pins and lower it onto the output housing.
6. Install flange fasteners on opposite sides of the housing, next to the low speed shaft as shown in Fig. 36 and cross tighten to the torques specified in Table 22.

TABLE 22 — Flange Fastener Torques

Unit Size	Assembly Torques
6	330 lb-in
8-9	825 lb-in

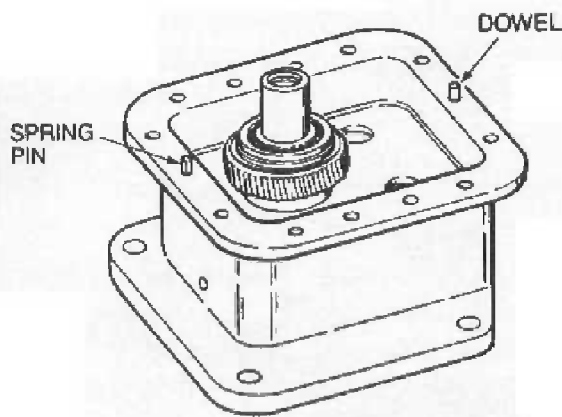


Figure 35 — Reducer assembly

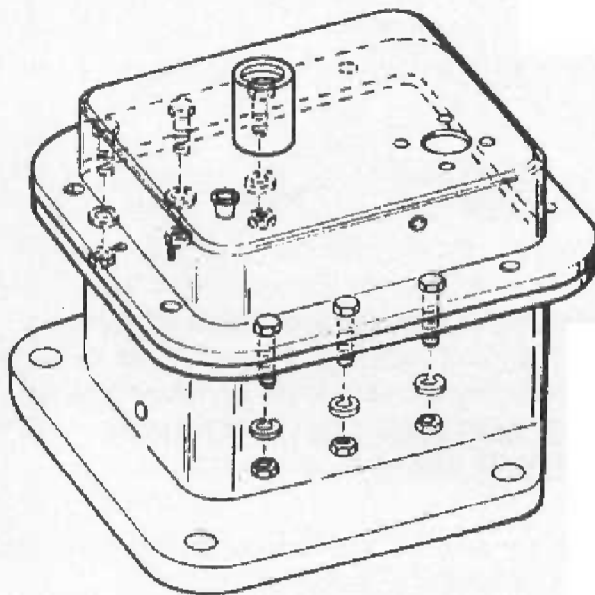


Figure 36 — Flange fastener positions

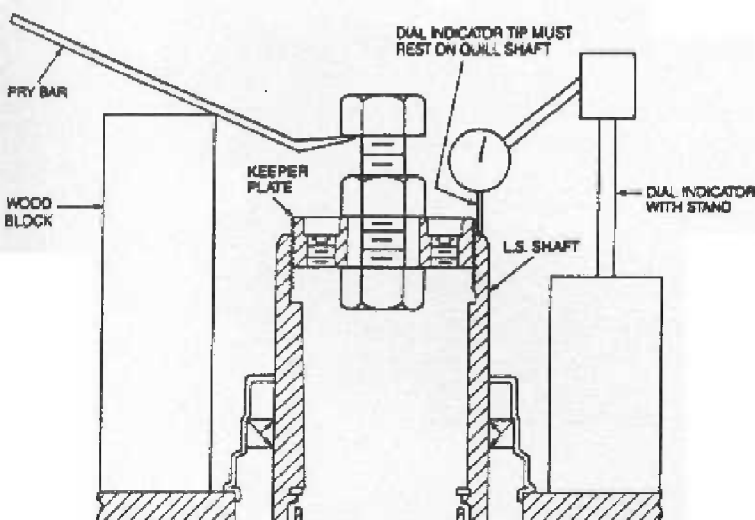


Figure 37 — Checking axial bearing float

7. Refer to Fig. 38. Check the Low-Speed bearing axial float with a dial indicator by pushing and pulling on the low-speed shaft while alternately rotating it in opposite directions.
8. Remove the input-side housing and remove shim gaskets to obtain a low-speed shaft axial preload of 0.003" — 0.007".

EXAMPLE: If the preload is .003 to .005 inches and the axial movement is .007 inches, removal of shims with a total thickness of .010 to .012 inches will produce the desired preload.

NOTE: Retain the shim gasket set developed to obtain the required pre-load for final assembly.

FINAL REASSEMBLY

1. Simultaneously lower all revolving elements into the output-side (lower) housing. Be careful not to strike the low-speed shaft assembly against the drywell tube and be careful not to roll the lip of the seal at the lower low-speed shaft bearing adapter.
2. Refer to Fig. 35. Install dowel and spring pins halfway into the output housing flange.
3. Pack the upper low-speed shaft bearing with NLGI #2 grease.
4. Assemble the input (upper) housing to the output (lower) housing. Tap the input housing to ensure that it is seated against the gaskets and rotate the gear train by hand. Check for binding.

NOTE: Some resistance to rotation, provided by the pre-loaded low-speed bearings, may be expected.

5. Install all housing flange fasteners with nuts and lock-washers and tighten to the torques shown in Table 22.
6. Install the input (motor) shaft seal:
 - a. Coat the O.D. of the seal with Pennatex #3 or equivalent.
 - b. Wrap thin strong paper around the shaft to protect the seal lips from the sharp edges of the shaft chamfer and keyway.

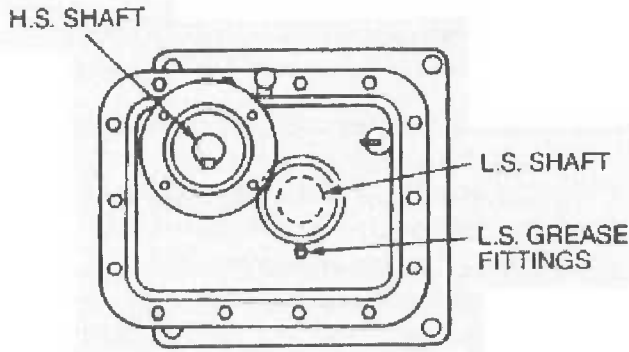


Figure 38 — L.S. grease fitting location

- c. Coat the seal lips with NLGI #2 bearing grease and slide the seal down over the shaft. Work carefully, do not expand the seal lip I.D. by more than .030".
- d. Seat the seal with a square-ended cylindrical tube. In final position the seal should be recessed .140" into the housing bore. Seal face runout should be <.010".

7. Install the input-side low-speed shaft seals.

- a. Coat the seal bore in the stamped seal cage with Permatex #3 or equivalent.
- b. Refer to Fig. 39. Install the seal into the cage with the garter spring facing the driver. Use a square-ended cylindrical tool to prevent the seal from cocking. Work carefully, so not damage the seal or seal cage.
- c. Apply a thin layer of grease to the low-speed shaft and slide the seal cage down over the shaft. Orient the seal cage so that the grease fittings on the seal cage are in the position shown in Figure 21 and drive the cage into position with the cylindrical driving tool shown in Fig. 21.

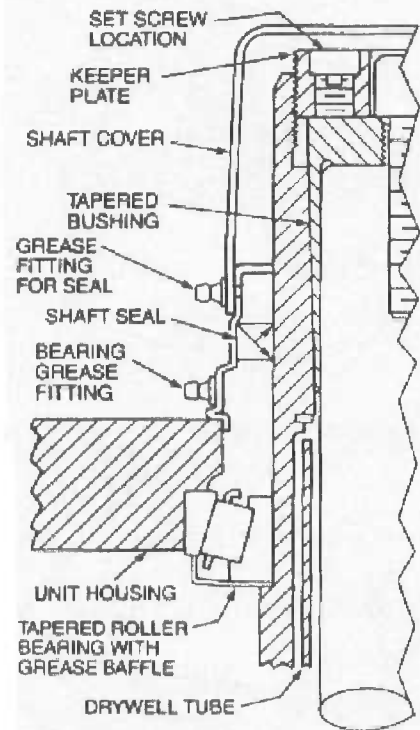


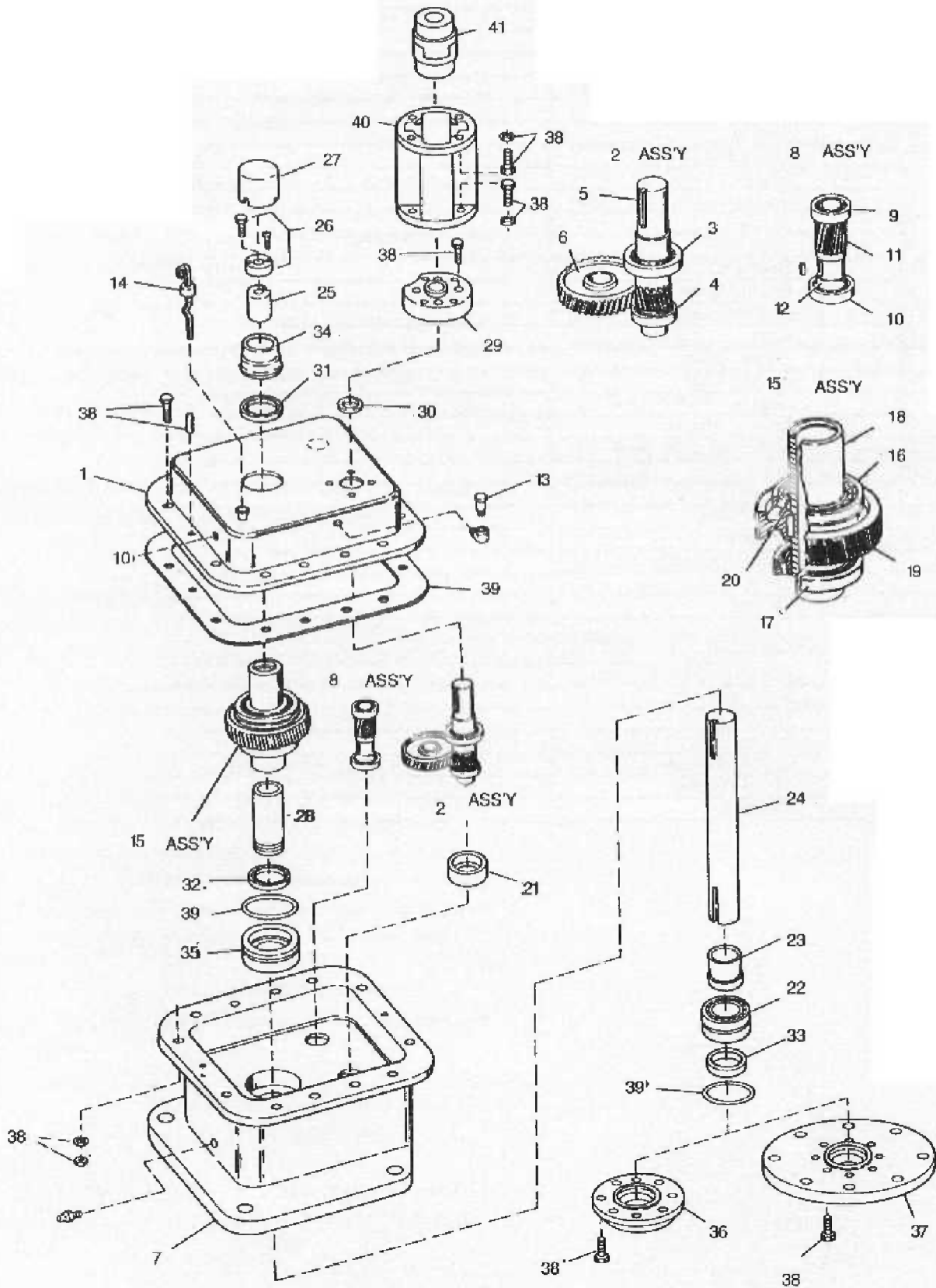
Figure 39 — Low speed shaft seal installation

FINAL ASSEMBLY CHECK BEFORE REINSTALLATION

Rotate the gear train by turning the high-speed shaft. Check for binding or irregular action.

Follow the installation instructions provided in Section 1 of this manual when reinstalling the unit.

CUTAWAY PARTS BREAKDOWN FOR HGD-6,8,9



ADDENDUM 1

Ref. #	Description	Qty.	Note
1	Housing Cover	1	
2	Shaft Assy.	1	**
3	Bearing	1	**
4	Bearing	1	**
5	Pinion & Shaft	1	
6	Gear,	1	**
8	Shaft Assy	1	**
9	Bearing	1	**
10	Bearing	1	
11	Pinion and Shaft	1	**
12	Spacer	1	
13	Air Vent	1	
14	Dipslick	1	
15	Shaft Assy.	1	
16	Bearing Cup	2	
16	Bearing Cone	2	**
18	Hollow Shaft	1	
19	Gear	1	
20	Grease Baffle	1	
21	Bearing Cage	1	
22	Bearing	1	**
23	Bearing Adapter	1	
24	Stub Shaft, 2.0" Shaft	1	
25	Bushing	1	
26	Thrust Plate	1	
27	Shaft Cover	1	
28	DryWell	1	
29	Mounting Plate	1	
30	Oil Seal	1	**
31,32	Oil Seal	1	
33	Oil Seal		
34	Seal Cage	1	
35	Seal Cage	1	
36	Seal Cage	1	
37	Seal Cage	1	
38	Fastener Kit	1	
39	Gasket/Shim Set	1	*
40	Motor Adapter	1	
41	Coupling	1	

*recommended spare

** major overhaul

ADDENDUM 2

Part Installation instructions for Cleveland, HGD-6 output shaft.

See page 36 for figures.

1. Locate upper end of mixer output shaft this end will have a key way and tapped hole on the end of the shaft. (fig. 1.)
2. Measure 9.631 from the end of the shaft and scribe a line. (fig.1.)
3. Slide the low speed seal cage (adapter flange) down the shaft with the O-ring groove facing the tapped end. (fig. 1.)
4. Slide the low speed bearing assembly onto the shaft (threaded end facing the seal cage) until the inner race of the unthreaded side lines up with the scribe mark done in step #2.
5. Tighten the spanner nut on the bearing assembly until the bearing is snug to the shaft and will not spin, install a .020" feeler gauge between the bearing rollers and race, continue tightening the spanner nut until the gap has been reduced to .020". bend one of the lock nut tangs into the nut to prevent loosening.
6. Support the output shaft in the vertical plane with the upper end protruding through the mounting base. (fig.2.)
7. Lift the reducer and slide it down over the output shaft until the bearing assembly starts itself in bore of the housing Note: Do not force the bearing and shaft into the reducer, they should slide in smoothly, tap on the outer race of the bearing if required to assure that it is not cocked in the bore. (fig.2.)
8. Thread the Keeper plate into the top of the reducer hollow quill until it bottoms. (fig.2.)
9. Insert a one foot piece of .625" threaded rod through the center hole in the keeper and thread it into the end of the output shaft, install a fiat washer and nut onto the threaded rod and tighten until the shaft and bearing are drawn up and touch the keeper plate. (fig.2.)
10. Adjust the shaft support to hold the shaft in this position and remove the threaded rod and keeper plate.
11. Rotate the output shaft until the keyways are aligned and insert the key from the top and tap it into place until it seats against the retaining ring. (fig. 3.)
12. Slide the tapered bushing down over the end of the shaft and install the fastener (.625 x 11 WNC X 1.75" socket head cap screw), torque to 2,190 lb-in. (fig.3.)
13. Reinstall the keeper plate into the hollow quill until it bottoms against the taper bushing and torque to 1,500 lb-in, install the set screws. (fig.3.)
14. Check to be sure that the bearing assembly is recessed into the housing bore and pack it with NLGI#2 grease.
15. Slide the seal cage into place on the housing and install the fasteners and torque to 330 lb-in.
16. Remove the supports from the shaft and lower the shaft and reducer into place and secure the unit to its mounting foundation.
17. Lubricate upper grease fitting with NLGI#2 grease until you observe grease all the way around the shaft between the seal cage and hollow shaft. Install sheet metal cover over shaft end and fasten with the three sheet-metal screws.

ADDENDUM 3

Part Installation instructions for Cleveland, HGD-8 output shaft.

See page 36 for figures.

1. Locate upper end of mixer output shaft, this end will have a key way and tapped hole on the end of the shaft. (fig.1.)
2. Measure $10.83" + .0625"$ from the end of the shaft and scribe a line. (fig.1.)
3. Slide the low speed seal cage (adapter flange) down the shaft with the 0-ring groove facing the tapped end. (fig.1.)
4. Slide the low speed bearing assembly onto the shaft (threaded end facing the seal cage) until the inner race of the unthreaded side lines up with the scribe mark done in step #2. (fig.1.)
5. Tighten the spanner nut on the bearing assembly until the bearing is snug to the shaft and will not spin, install a .020" feeler gauge between the bearing rollers and race, continue tightening the spanner nut until the gap has been reduced to .020". bend one of the lock nut tangs into the nut to prevent loosening.
6. Support the output shaft in the vertical plane with the upper end protruding through the mounting base. (fig.2.)
7. Lift the reducer and slide it down over the output shaft until the bearing assembly starts itself in bore of the housing Note: Do not force the bearing and shaft into the reducer, they should slide in smoothly, tap on the outer race of the bearing if required to assure that it is not cocked in the bore. (fig.2.)
8. Thread the Keeper plate into the top of the reducer hollow quill until it bottoms. (fig.2.)
9. Insert a one foot piece of .625" threaded rod through the center hole in the keeper and thread it into the end of the output shaft, install a flat washer and nut onto the threaded rod and tighten until the shaft and bearing are drawn up and touch the keeper plate. (fig.2.)
10. Adjust the shaft support to hold the shaft in this position and remove the threaded rod and keeper plate.
11. Rotate the output shaft until the keyways are aligned and insert the key from the top and tap it into place until it seats against the retaining ring. (fig.3.)
12. Slide the tapered bushing down over the end of the shaft and install the fastener (.625 x 11 UNC X 1.75" socket head cap screw), torque to 2,190 lb-in. (fig.3.)
13. Reinstall the keeper plate into the hollow quill until it bottoms against the taper bushing and torque to 1,500 lb-in, install the set screws. (fig.3.)
14. Check to be sure that the bearing assembly is recessed into the housing bore and pack it with NLGI#2 grease.
15. Slide the seal cage into place on the housing and install the fasteners and torque to 330 lb-in.
16. Remove the supports from the shaft and lower the shaft and reducer into place and secure the unit to its mounting foundation.
17. Lubricate upper grease fitting with NLGI#2 grease until you observe grease all the way around the shaft between the seal cage and hollow shaft. Install sheet metal cover over shaft end and fasten with the three sheet-metal screws.

ADDENDUM 4

Part Installation instructions for Cleveland, HGD-9 output shaft.

See page 36 for figures.

1. Locate upper end of mixer output shaft, this end will have a key way and tapped hole on the end of the shaft. (fig.1.)
2. Measure $12.83" + .0625"$ from the end of the shaft and scribe a line. (fig.1.)
3. Slide the low speed seal cage (adapter flange) down the shaft with the O-ring groove facing the tapped end. (fig. 1.)
4. Slide the low speed bearing assembly onto the shaft (threaded end facing the seal cage) until the inner race of the unthreaded side lines up with the scribe mark done in step #2. (fig.1.)
5. Tighten the spanner nut on the bearing assembly until the bearing is snug to the shaft and will not spin, install a .020" feeler gauge between the bearing rollers and race, continue tightening the spanner nut until the gap has been reduced to .020". bend one of the lock nut tangs into the nut to prevent loosening.
6. Support the output shaft in the vertical plane with the upper end protruding through the mounting base. (fig.2.)
7. Lift the reducer and slide it down over the output shaft until the bearing assembly starts itself in bore of the housing Note: Do not force the bearing and shaft into the reducer, they should slide in smoothly, tap on the outer race of the bearing if required to assure that it is not cocked in the bore. (fig.2.)
8. Thread the Keeper plate into the top of the reducer hollow quill until it bottoms. (fig.2.)
9. Insert a one foot piece of .875" threaded rod through the center hole in the keeper and thread it into the end of the output shaft, install a flat washer and nut onto the threaded rod and tighten until the shaft and bearing are drawn up and touch the keeper plate. (fig.2.)
10. Adjust the shaft support to hold the shaft in this position and remove the threaded rod and keeper plate.
11. Rotate the output shaft until the keyways are aligned and insert the key from the top and tap it into place until it seats against the retaining ring. (fig.3.)
12. Slide the tapered bushing down over the end of the shaft and install the fastener (.625 x 11 UNC X 1.75" socket head cap screw), torque to 2,190 lb-in. (fig.3.)
13. Reinstall the keeper plate into the hollow quill until it bottoms against the taper bushing and torque to 1,500 lb-in, install the set screws. (fig.3.)
14. Check to be sure that the bearing assembly is recessed into the housing bore and pack it with NLGI#2 grease.
15. Slide the seal cage into place on the housing and install the fasteners and torque to 330 lb-in.
16. Remove the supports from the shaft and lower the shaft and reducer into place and secure the unit to its mounting foundation.
17. Lubricate upper grease fitting with NLGI#2 grease until you observe grease all the way around the shaft between the seal cage and hollow shaft. Install sheet metal cover over shaft end and fasten with the three sheet-metal screws.

ADDENDUM 5 — PART INSTALLATION DIAGRAM

Figure 1 — Mixer Shaft Dimensions

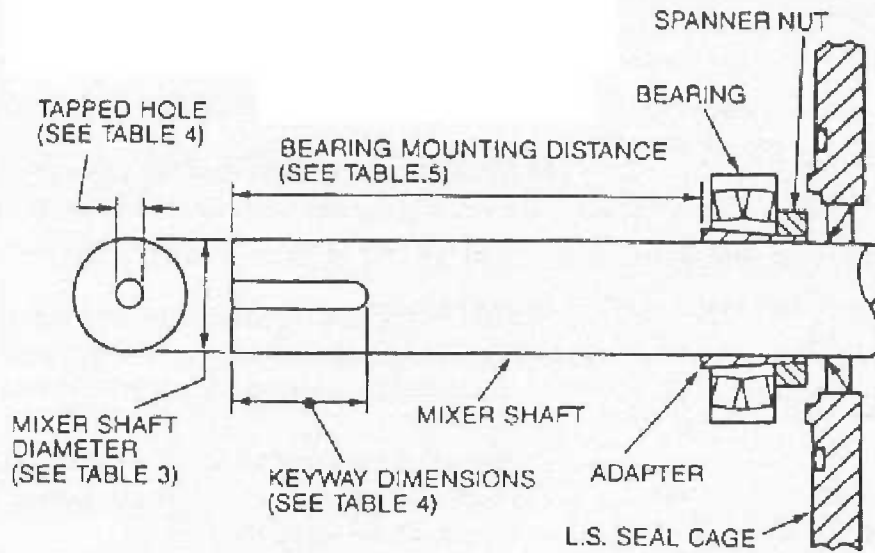


Figure 2 — Tapered Bushing Installation

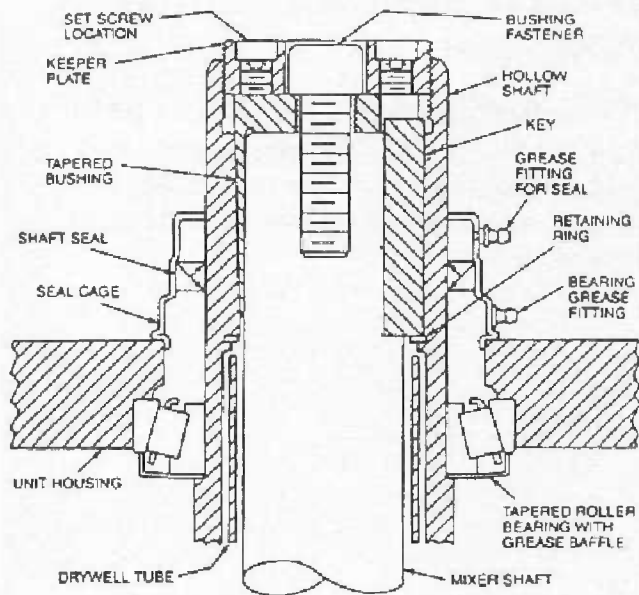


Figure 3 — Shaft Installation Procedures

