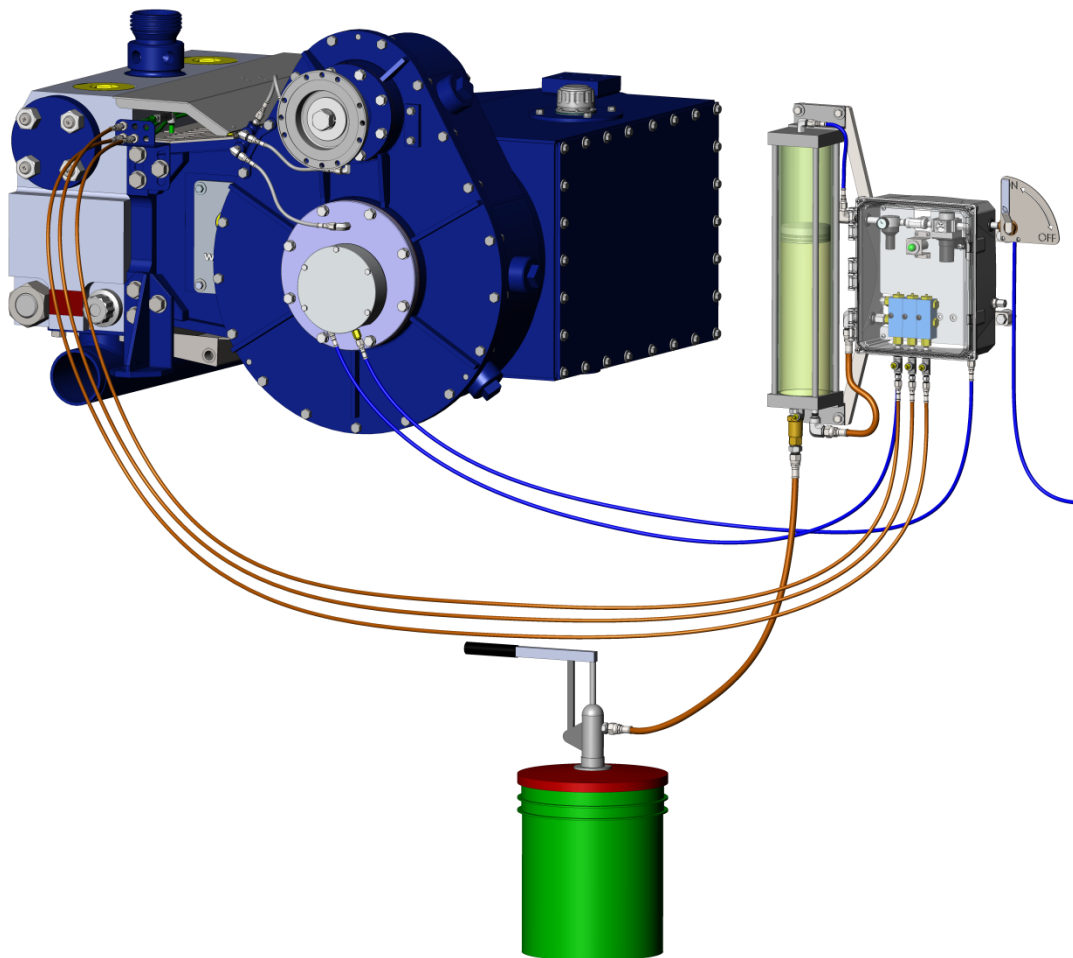




Technical Manual

MSI Auto-Lube™ System



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Revision A

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SECTION 1 WARNINGS

The MSI Auto-Lube™ System has hoses and fittings that are under high pressure. High pressure equipment, if not used and maintained properly, can cause serious injury and damage to equipment. Not taking proper precautions and failing to perform routine maintenance and inspections can also contribute to loss of plunger lubrication, and such loss could cause damage to equipment.

The Auto-Lube™ System is designed to lubricate plungers on all MSI Well Service Pumps. Therefore it is critical for safety and performance to ensure that there is always sufficient lubricant in the lubricant reservoir. Failure to do so may cause damage to equipment and void any warranty.

**ALL OPERATORS AND MAINTENANCE PERSONNEL SHOULD BE THOROUGHLY TRAINED
IN THE SAFE OPERATION, MAINTENANCE, AND INSPECTION OF THIS EQUIPMENT.**

SECTION 2 PRODUCT OVERVIEW

2.1 General Auto-Lube™ System Description

The MSI Auto-Lube™ System is a pneumatic-mechanical high pressure, non-electric, positive displacement packing lubrication system for use with oil or grease. Lubrication rates are mechanically controlled by the well service pump via a power take-off (PTO) from the crankshaft. Utilizing a PTO from the lubricated equipment allows the equipment itself, rather than a timer for example, to dictate the lubrication delivery rate. This eliminates over or under lubricating and ensures lubricant is supplied whenever the pump is in motion. The lubrication cycle is activated every 12.5 turns of the crankshaft. The Auto-Lube™ System can be used in conjunction with the MSI Lube Relief System™ to provide outstanding lubrication performance.

2.2 Gearbox Assembly Description

The Gearbox Assembly consists of an input shaft assembly, a speed reducer gearbox, an output shaft assembly, and an air valve. The Gearbox Assembly is responsible for controlling the cyclic rate at which the lubrication is supplied to MSI Well Service Pumps. The Gearbox Assembly input shaft is mechanically connected to the pump crankshaft and therefore the lubrication cycle (on and off) frequency has a linear relationship with respect to the pump's rpm. The faster the pump crankshaft turns, the more frequent the lubrication cycle is activated. The opposite also applies, as the pump speed decreases, the lubrication cycle decreases. See [Appendix A](#) for more information.

Approximate Gearbox Assembly weights are:

- Triplex – 28 lbs.
- Quintuplex – 38 lbs.

2.3 Panel Assembly Description

The Panel Assembly consists of the lubrication pumps (one per plunger), grease reservoir assembly, pressure regulators, cycle indicator bulb, and a system control valve. This sub-system is responsible for supplying precise small amounts of lubricant to MSI Well Service Pumps with each lubrication cycle of the Gearbox Assembly. The Panel Assembly lubrication rate is calibrated at the factory and adjustment or further calibration is not normally necessary. See [Section 5](#) for more information regarding lubrication rate settings.

Approximate Panel Assembly weights are:

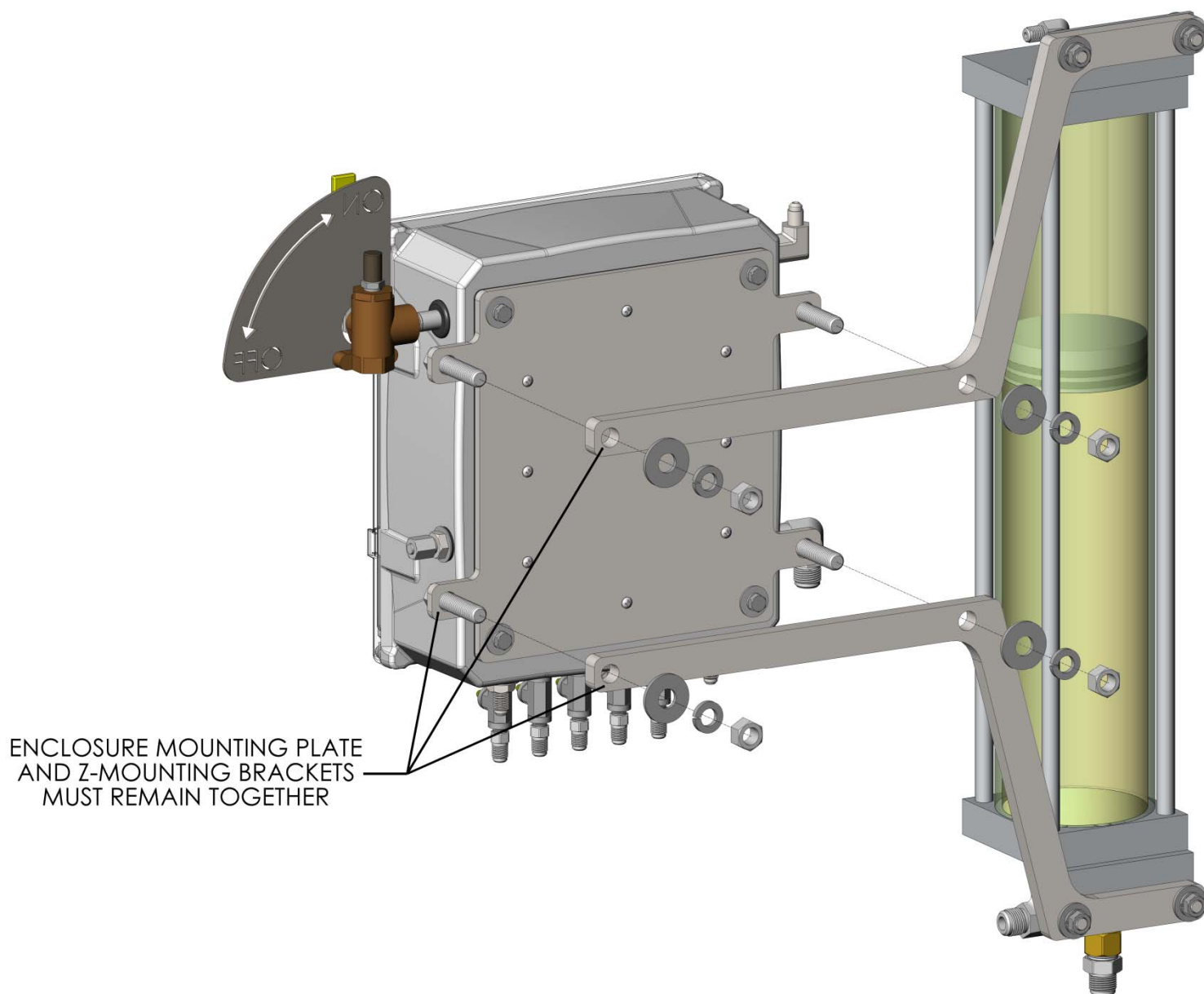
- Triplex – 42 lbs.
- Quintuplex – 44 lbs.

SECTION 3 INSTALLATION

3.1 Panel Assembly Installation

The Panel Assembly should be mounted close to the Well Service Pump and such that the system control valve is normally accessible. Mounting the Panel Assembly close to the pump will reduce the air hose pressure replenishment times which help the system operate properly.

The Panel Assembly is shipped with two 'Z' brackets connecting the reservoir through the panel mounting plate tabs. The brackets and plate are fastened together with extra long ½"-13 bolts at four locations. Mount the Panel Assembly using these bolts or with longer ½"-13 bolts if necessary. Do not install the reservoir separate from the panel, the two are to remain joined in installed state.



An indicator bulb has been provided inside the Panel Assembly and allows for visual indication of system operation. It is recommended that the Panel Assembly be oriented such that this bulb is visible from the pump control area. If this is not possible, an auxiliary indicator connection point is provided on the right side of the panel for connecting a remote indicator, see [Section 6](#). Auxiliary connection is a ¼”-37° Flared JIC male.

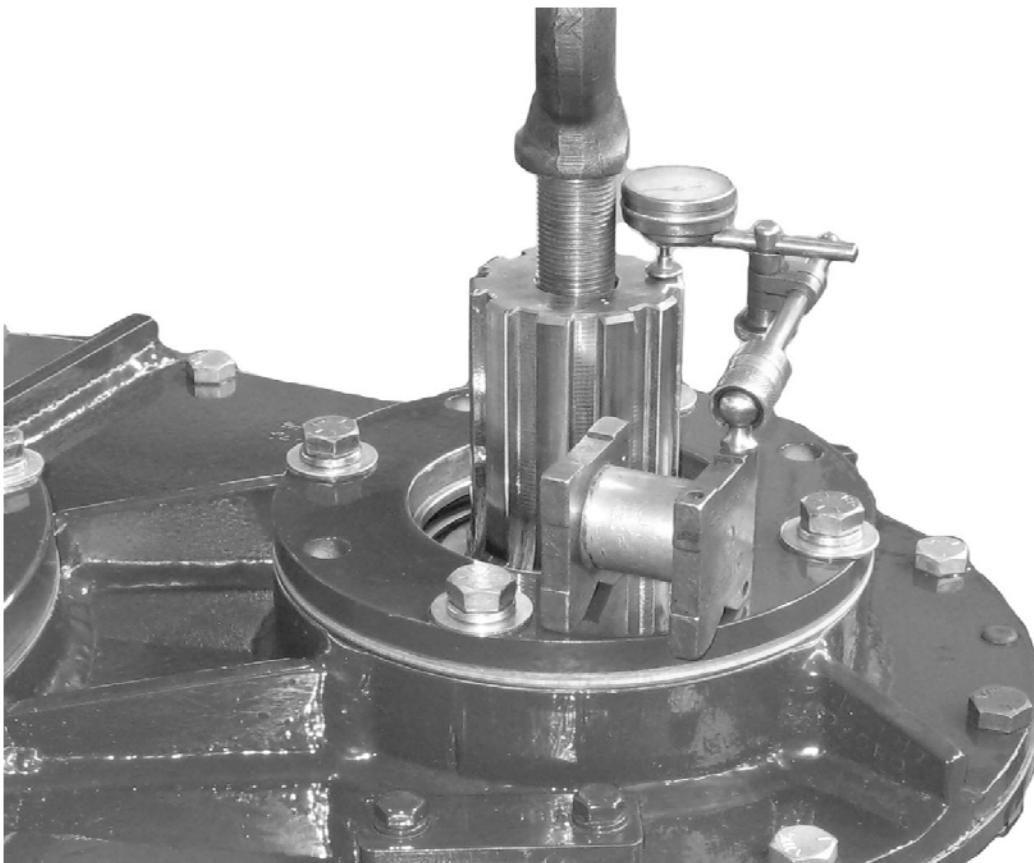
All through-box connections are sealed against moisture and internal components are corrosion resistant. Thus it is not necessary to take special precautions to keep precipitation off the Panel Assembly. MSI recommends however that periodic inspections (monthly) of the sealing elements are made to ensure they are in good working order.

3.2 Gearbox Assembly Installation

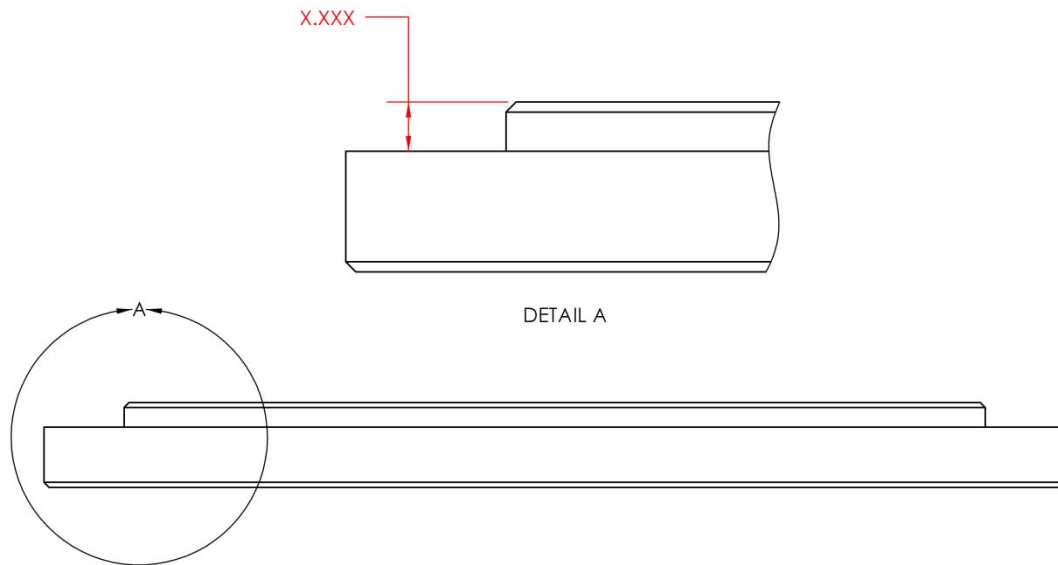
Upgrade installations may require replacing the bearing retainer plate with one that is prepped for receiving the Auto-Lube™ System. Some later pump models may have a retainer plate already prepped for upgrading to the Auto-Lube™ System. If this is the case, remove the external blanking cover and continue directly to **Step 6**.

It is crucial that bearing pre-load is properly set following the Auto-Lube™ system installation. Following the ensuing steps will help make certain that this is done correctly.

- 1) Before removing any components from the gear reducer, check the pinion shaft endplay using a dial indicator. Place the magnetic dial indicator on the pinion bearing retainer plate and move the pinion back and forth axially (install a bolt or bull ring into pinion end for grasping). Take note of whether the dial indicates any movement. If any movement is present the bearings will need to be shimmed to properly set the bearing preload at 0.003” – 0.005”. For example, if the indicated endplay is 0.007”, a total of 0.010” – 0.012” shim thickness should be removed. *Shim thickness adjustment of pinion may require adjustment of bull gear bearing shims, see **Step 3.a**.*



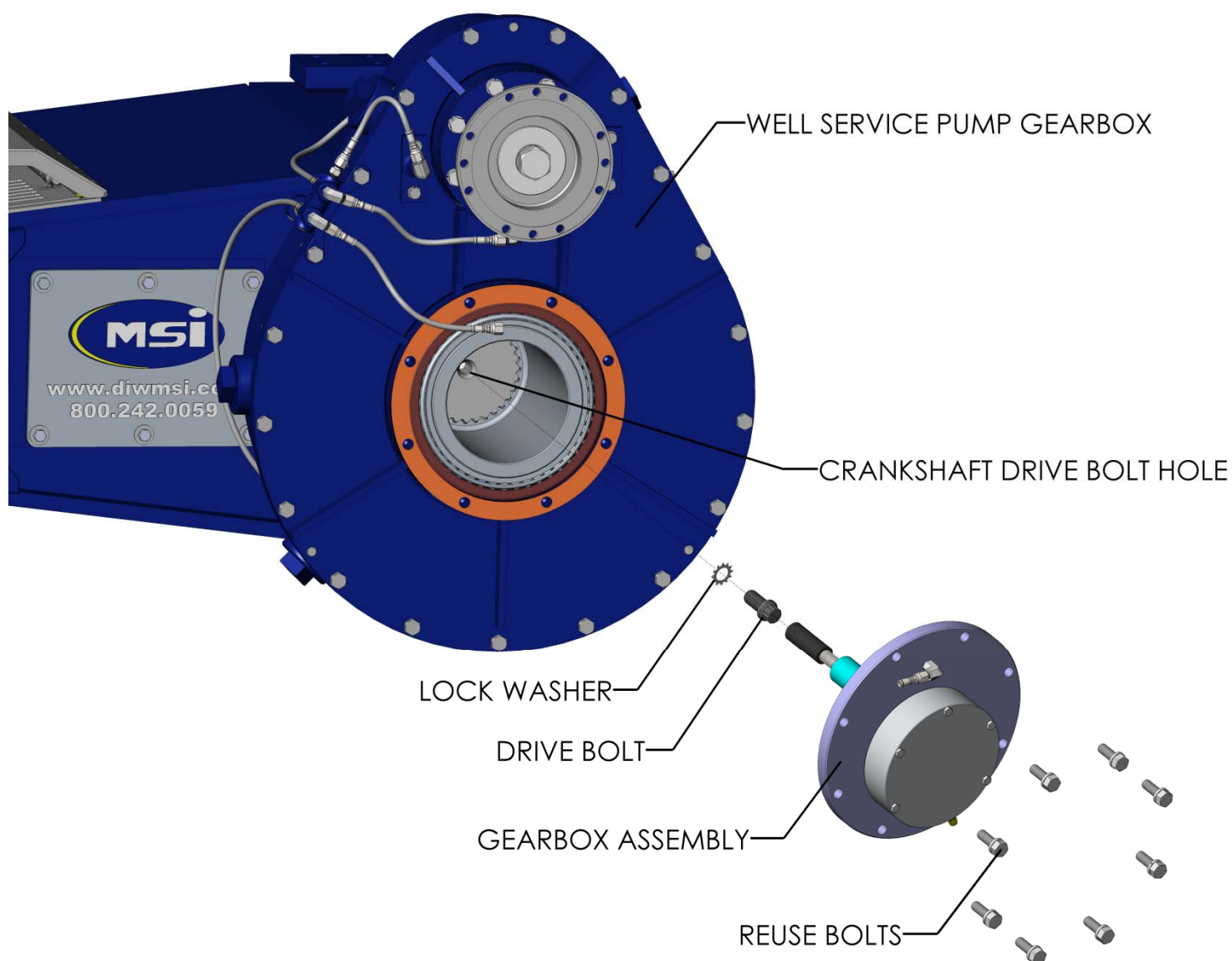
- 2) Disconnect bearing lubrication line from bearing retainer fitting.
- 3) Once the pinion bearing preload has been properly adjusted, the bull gear bearing retainer plate may be removed. Before installing the new Auto-Lube™ ready retainer plate, a measurement is required to determine the shims required to properly preload the bull gear bearings. This is done by checking the distance from the flange face to the bearing race lip face with a depth micrometer to the nearest thousandth of an inch (X.XXX"). See following image for reference.



If the new bearing retainer plate is within 0.001" of the old plate, no shim change is necessary, proceed to **Step 4**. If the distance is greater than 0.001" the shim thickness will need to be adjusted. A measured distance of the new retainer plate which is less than the old retainer plate will require shims to be removed at the same value. If the new retainer plate measures a distance greater than the old retainer plate, shims will need to be added at the same value. For example, if the old retainer plate measures 0.292 and the new retainer plate measures 0.287, a total of 0.005" shim thickness will need to be removed.

- a. *If in **Step 1** the pinion bearing shims required adjustment, the bull gear shims will need to be adjusted as well. Generally, the bull gear bearings will wear at a rate equivalent to the reduction ratio of 4.61:1. If for example 0.010" – 0.012" of shim stock was removed in step 1, then 1/4.61 of that should be removed from the bull gear bearing shim stack. Using the above example this would result in about 0.002" – 0.003" shim thickness reduction.*

- 4) Reconnect lubrication line that was disconnected in **Step 2**. A longer hose is supplied with the Auto-Lube™ to accommodate any possible change in mounting position that would result in the original lubrication line not reaching the fitting, or reaching but being tight or in a bind.
- 5) Install Gearbox Assembly drive bolt and lock washer onto crankshaft and torque bolt to 70 – 100 ft-lb_f. See following image for detail.



- 6) Stab the Gearbox Assembly into Well Service Pump gearbox until the drive socket makes contact with the bolt installed in **Step 6**. Rotate the assembly until the socket fully engages the bolt. It is important that the socket be fully engaged and not just resting on the top of the bolt head.
- 7) Orient the assembly such that the cover window and valve are pointing down. This will prevent rainwater or contamination such as dirt from accumulating which could potentially cause the air valve to malfunction. Reinstall bolts removed in **Step 3** and torque according to values in [Appendix C](#).

3.3 Plumbing Hoses

MSI does not supply the plumbing from the panel to the well service pump due to variations in individual installations. Supplying these hoses is the responsibility of the installer and shall include:

- System supply air (1/4" FNPT connection at control valve inlet)
- Valve air supply and return hoses (-4 braided stainless steel hose with 1/4"-37° Flared JIC male swivel fittings, rated to 200 psig)
- High pressure packing lubrication hoses, one per packing gland (-4 braided stainless steel hose with 1/4"-37° Flared JIC male swivel fittings, rated to 3000 psig)

Generally, the installed air hoses should not exceed about 30 feet (9 meters) in length. If necessary, the hose between the reservoir and grease pail may be replaced with a longer hose but should not exceed about 10 feet (3 meters) in length.

Route the hoses such that they are free of kinks, are not a tripping hazard, and are clear from danger of being snagged or entangled. Secure hoses to steel structures with clamps to avoid transmission of forces to the fittings on the Panel and Gearbox Assemblies should accidental contact occur. Ensure air valve hoses (supply and return) going from the Panel Assembly to the gearbox air valve are correctly connected. See routing diagrams on following pages, labels are provided on the Panel and Gearbox Assemblies to aid in correct hose routing.

3.4 System Air Supply

MSI strongly recommends that the air supplied to the Auto-Lube™ System utilize a water separator or filter to reduce or prevent moisture from entering the system. Moisture may cause some components to malfunction and should be eliminated if at all possible. Inlet air pressure should be 100 – 145 psig.

3.5 Lubrication

The lubricant should be selected based on what works best for the well service pump operating conditions. For most applications, MSI recommends using MSI Plunger Grease™. This is a water-resistant, non-soap, NLGI Grade 2 plating grease for operating temperatures between -18°F to 400°F. MSI Plunger Grease prevents metal to metal contact, reduces temperatures, and is resistant to oil separation.

Other greases may be used as long as they meet NLGI standards for Grades 000, 00, 0, 1, or 2. Oil may also be used with the Auto-Lube™ System and should have a Viscosity Index (per ASTM D2270) of at least 95. Oils in this category are usually machine way lubricants, rock drill oils, or conventional motor oils. MSI strongly recommends that any other lubricants are thoroughly tested prior to acceptance into operations.

MSI recommends that clean, unused lubricant always be used in the Auto-Lube™ Systems. Recycled lubricants may contain contaminants that could obstruct or damage the pumping elements or check valves and should be avoided. Always take care when replenishing the lubricant to prevent possible contamination.

SECTION 4 SYSTEM OPERATION

4.1 Initial Systems Check

The following procedure should be used to verify that all systems are functioning properly. This procedure is only necessary following the initial system installation and does not need to be done for every subsequent system start.

NOTE: The Panel Assembly and Gearbox Assembly were factory acceptance tested (FAT) using a small amount of MSI Plunger Grease. This testing is performed to ensure the internal connections are properly made, systems are all functioning correctly, and that air has been purged from the system and primed with grease.

Installation assurance checks:

- 1) Ensure all connections have been made.
 - a) System air supply.
 - b) Panel Assembly to Gearbox Assembly supply air.
 - c) Panel Assembly to Gearbox Assembly return air.
 - d) Packing lubricant supply lines (one per packing gland).
- 2) All lubrication supply lines must be primed using a lubricant that meets the requirements of [Section 3.5](#). There are grease fittings located on the Panel Assembly to allow priming all lines prior to startup. Using a hand operated grease or oil-dispensing gun, pump lubricant until there is a noticeable increase in resistance, this will indicate that lubricant has reached the packing nut.

NOTE: If using the MSI Lube Relief System™ the supplied relief pressure gauge may be used to indicate when a line has achieved prime. Once the gauge registers at least 40 psig pressure for the first primed line, move on to next line. The gauge will “blip” once each successive line is primed. Repeat this step for each lubrication line.

- 3) Enable system air supply and move control valve to the “ON” position as indicated by the indicator label. This valve will remain in the “ON” position at all times during pump operation.
- 4) Check for air leaks and tighten or replace fittings as necessary.
- 5) Verify pressure setting of regulators in Panel Assembly.
 - a) Non-adjustable regulator (left side of panel) should register 60 psig (+/- 3 psig).
 - b) Adjustable regulator (right side of panel) should register between 80 psig and 100 psig. This range is indicated by two green arrows in the pressure gauge dial.

4.2 Start-Up and Operation

During start-up, follow proper operating and safety procedures for dealing with rotating machinery and high pressure equipment.

- 1) Check lubricant levels before and during every job. Do not let reservoir get below about one quarter full. If additional lubricant is required use the bucket or grease fitting fill points. Make sure only new and clean lubricant is used that it and meets the requirements of [Section 3.5](#).

NOTE: It is recommended that the hose between the bulk lubrication supply and reservoir be primed with lubricant before it is connected to the reservoir check valve. This will limit the amount of air pumped into the reservoir. Entrapped air can be purged by pumping lubricant into the reservoir until the piston reaches the upper head and stops. As pressure builds check valves in the piston and in upper will allow air to escape.

Warning: Grease will shoot out the top of the reservoir once the air is removed, be prepared for this!

- 2) With prime mover at idle, engage transmission in lowest gear to allow well service pump to rotate.
- 3) As the pump is rotating check that the air cycle indicator trips at least every 30 seconds. If the air cycle indicator does not trip in this timeframe shut the unit down and consult the Troubleshooting Guide in [Appendix B](#), otherwise, proceed to the next step.
- 4) During operation, verify that lubricant is being supplied to the packing glands, this can be done in several ways:
 - a) Look for downward movement of reservoir piston.
 - b) Expulsion of lubricant from packing nut wiper seal. This only applies to pumps with a seal that is reverse installed to allow excess lubricant to be purged.
 - c) For units utilizing the Lube Relief System™, look for blips in the pressure gauge during Auto-Lube™ System cycling.
- 5) Monitor lubricant levels in Panel Assembly reservoir and replenish as needed. MSI suggests that the reservoir not operate below about ¼ full.

4.3 Shut-Down

After the well service pump has been completely shut down, move the control valve on the Panel Assembly to the “OFF” position. This will disable the system and vent all remaining air pressure through the valve exhaust port.

SECTION 5 SYSTEM ADJUSTMENT

5.1 Lubrication Rate Adjustment

The injector pumps have been preset at the factory to provide 0.00036 in³/crank revolution. In testing, this rate has proven to work well over a range of normal operating speeds. If desired, the rate may be changed to increase or decrease the amount of lubricant supplied per unit time. Below are the steps to adjust the lubrication rate.

- 1) Stop well service pump and turn Auto-Lube™ system to the “OFF” position.
- 2) Remove the four screws on the Panel Assembly door using a #2 Phillips head screwdriver and open case door.
- 3) Advance adjustment screw (turn CW) until it stops; the stem is now set to full close position. See [Section 6](#) Panel Assembly drawings for adjustment screw location.
- 4) Unscrew (turn CCW) adjustment screw to desired setting. See [Appendix A](#) for flow rates.

NOTE: Adjustment screw factory setting is 3 full turns out from full close position.

- 5) Close case door and secure by tightening the four screws.

CAUTION: Immediately following any adjustment of the injector pumps, the pump should be closely monitored to make certain that the lubrication rate is not flooding or starving the packing. Over or under lubricating may cause premature packing failure.

5.2 Air Pressure Adjustment

In certain cases such as high pump speeds or when long air hoses are used, it may be necessary to slightly increase the pressure of the air supplied to the Gearbox Assembly air valve. Doing so will increase the air replenishment rate, which may reduce lagging cyclic periods. This is done by performing the following steps.

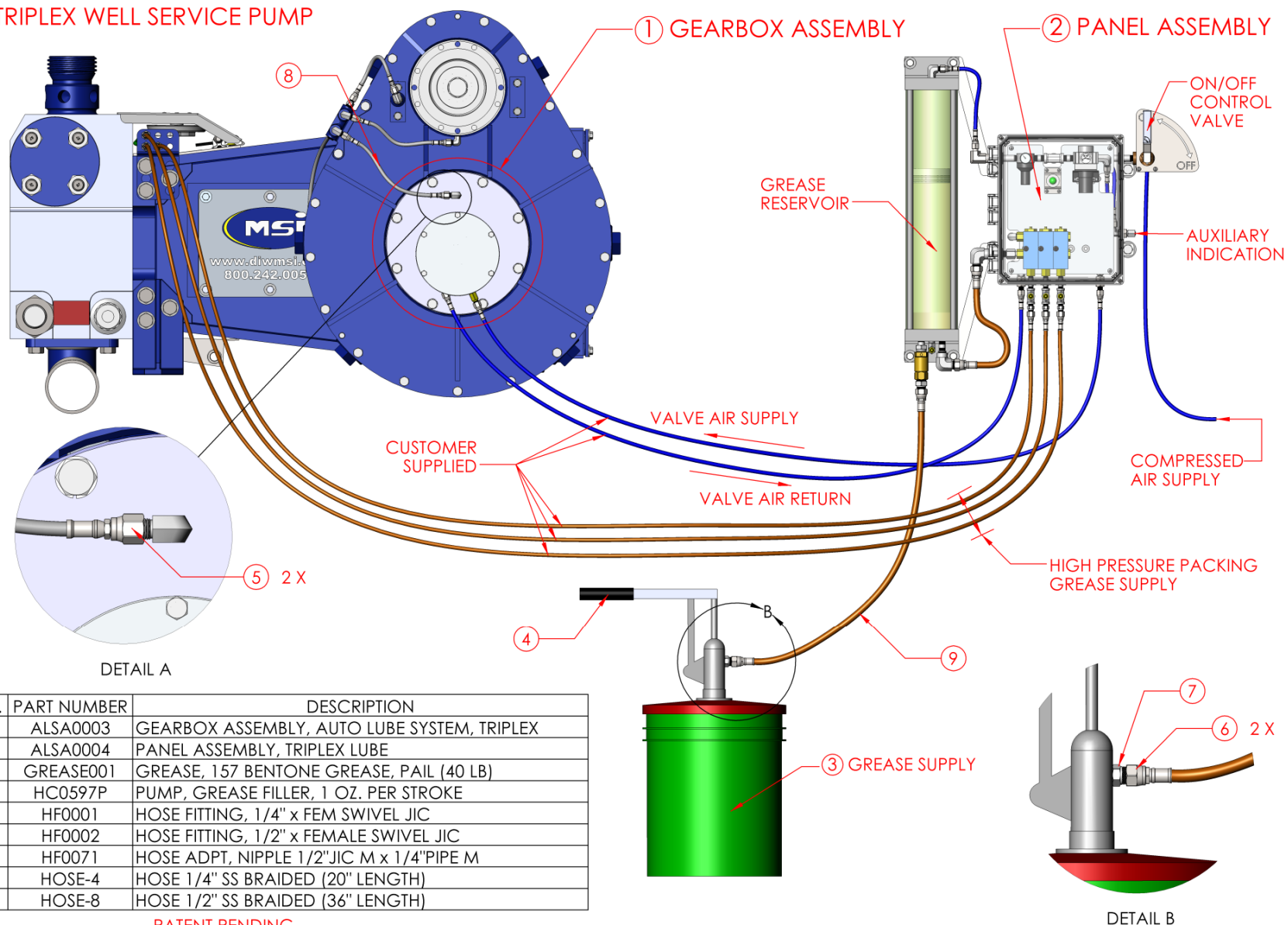
- 1) Stop well service pump and make sure Auto-Lube™ system is set to the “ON” position.
- 2) Remove the four screws on the Panel Assembly door using a #2 Phillips head screwdriver and open case.
- 3) On adjustable regulator (on right side of panel), pull cylindrical sleeve downward to disengage lock. There should be an orange band visible between the sleeve and regulator housing, this will indicate that the regulator is unlocked and in adjustment mode.
- 4) Screw sleeve in (CW) to increase valve air supply pressure.
- 5) Push sleeve upwards to lock pressure setting.
- 6) Close case door and secure by tightening the four screws.

SECTION 6 ASSEMBLY VIEWS

6.1 Triplex Auto-Lube™ System Assembly

The following is a view of the system installed on an MSI Triplex Well Service Pump (ALSA0001).

TRIPLEX WELL SERVICE PUMP

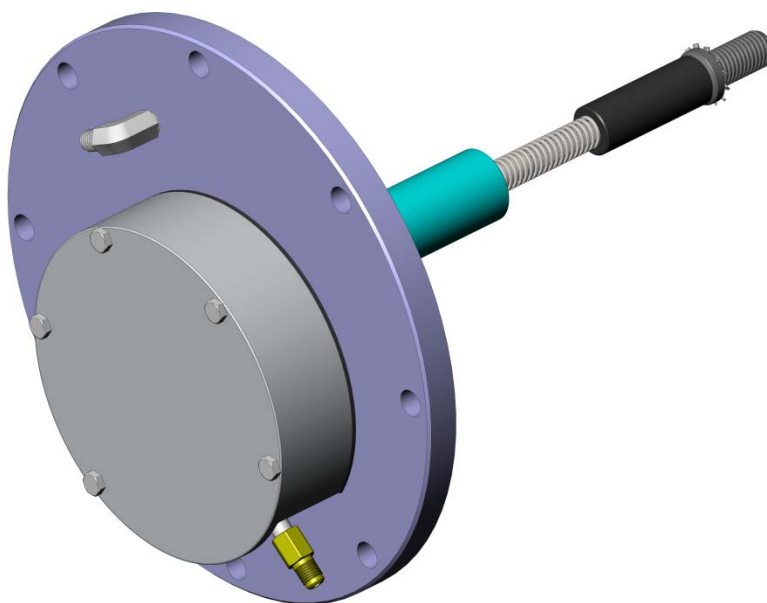


ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	ALSA0003	GEARBOX ASSEMBLY, AUTO LUBE SYSTEM, TRIPLEX
2	1	ALSA0004	PANEL ASSEMBLY, TRIPLEX LUBE
3	1	GREASE001	GREASE, 157 BENTONE GREASE, PAIL (40 LB)
4	1	HC0597P	PUMP, GREASE FILLER, 1 OZ. PER STROKE
5	2	HF0001	HOSE FITTING, 1/4" x FEM SWIVEL JIC
6	2	HF0002	HOSE FITTING, 1/2" x FEMALE SWIVEL JIC
7	1	HF0071	HOSE ADPT, NIPPLE 1/2" JIC M x 1/4" PIPE M
8	1	HOSE-4	HOSE 1/4" SS BRAIDED (20" LENGTH)
9	1	HOSE-8	HOSE 1/2" SS BRAIDED (36" LENGTH)

PATENT PENDING

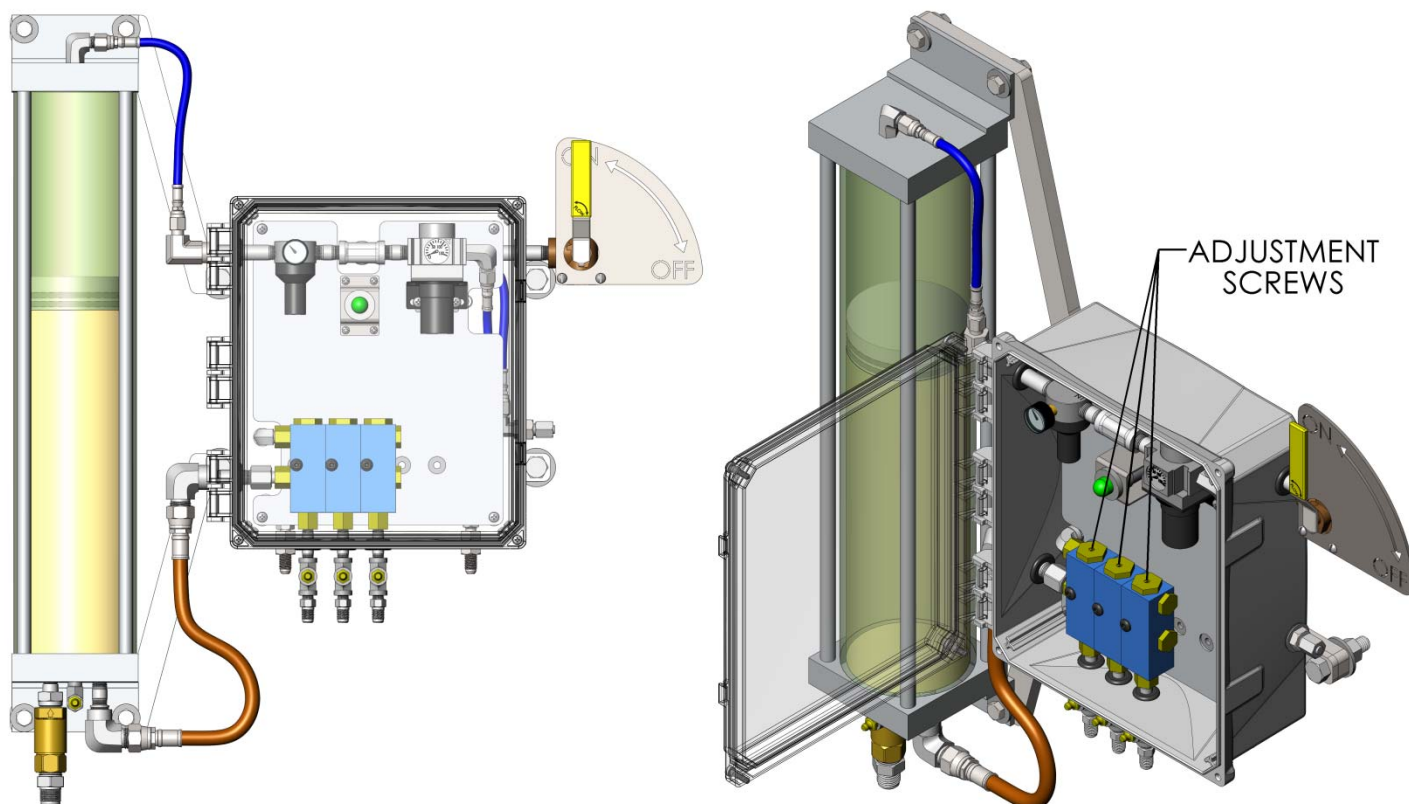
6.2 Triplex Gearbox Assembly

The following is a view of the Gearbox Assembly for the Triplex Auto-Lube™ System (ALSA0003).



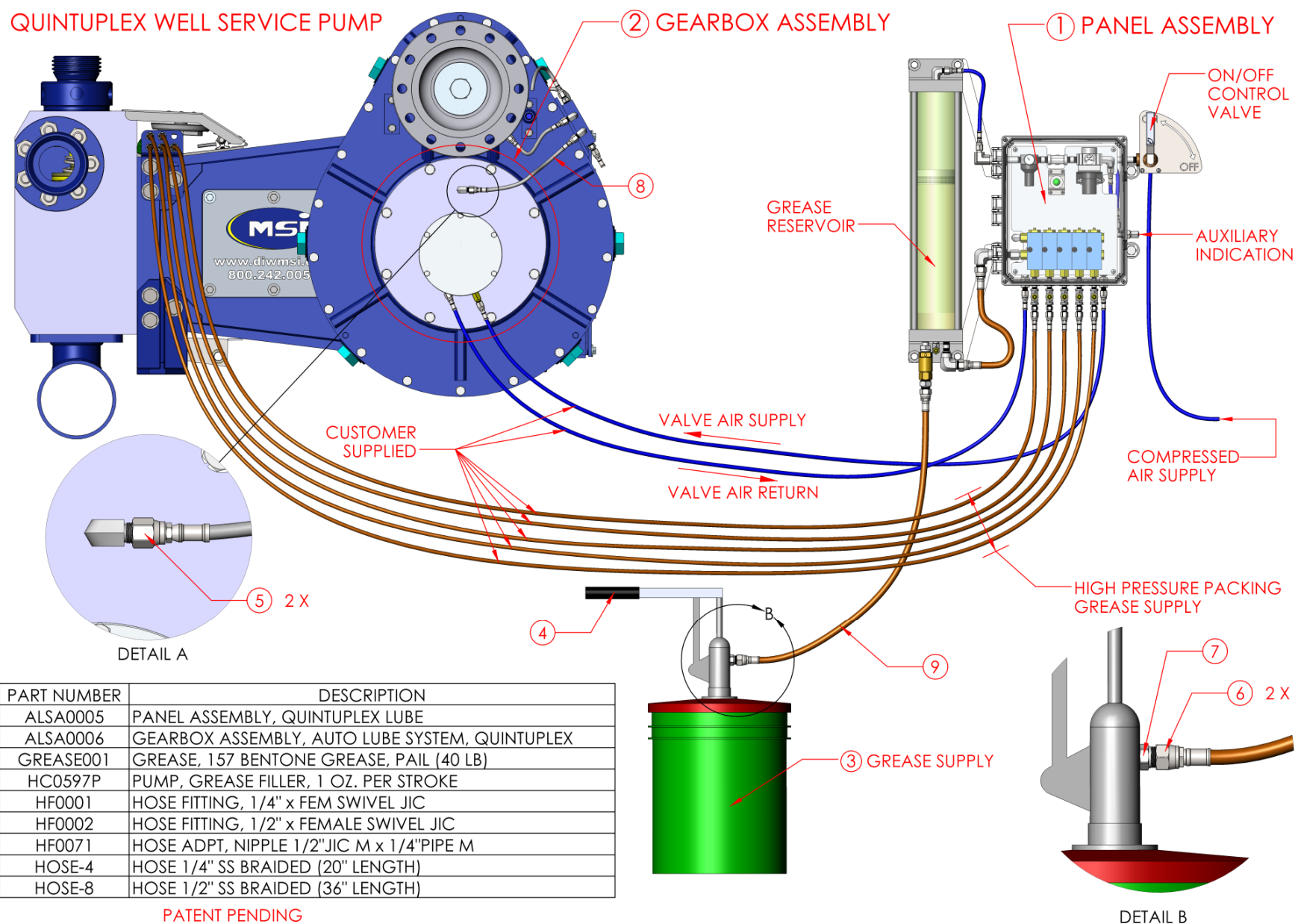
6.3 Triplex Panel Assembly

The following is a view of the Panel Assembly for the Triplex Auto-Lube™ System (ALSA0004).



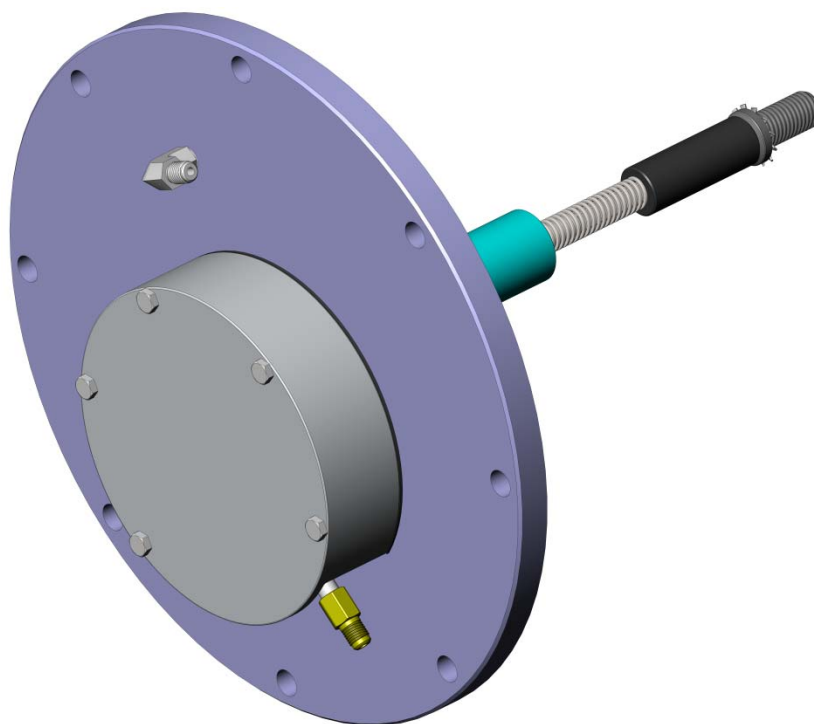
6.4 Quintuplex Auto-Lube™ System Assembly

The following is a view of the system installed on an MSI Quintuplex Well Service Pump (ALSA0002).



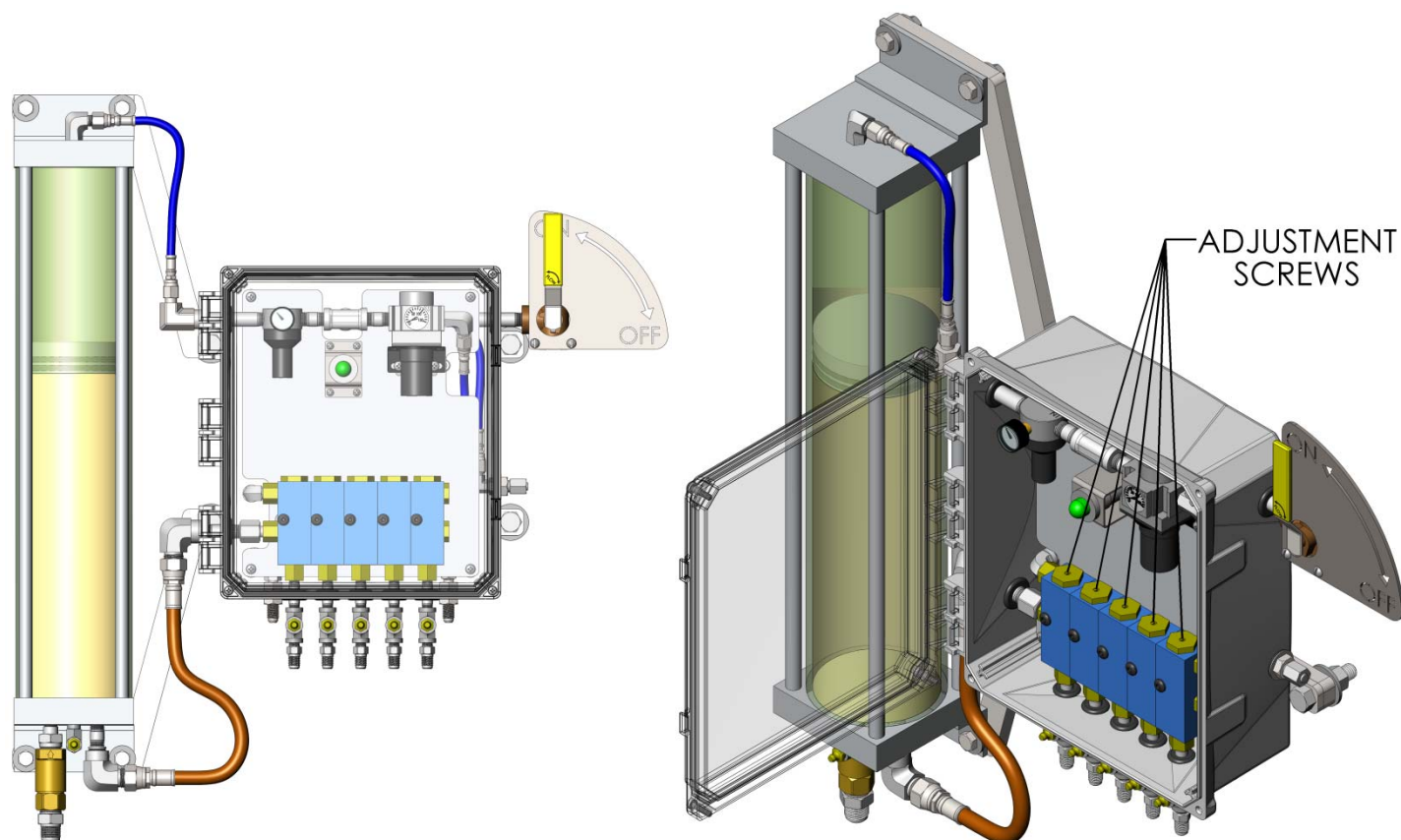
6.5 Quintuplex Gearbox Assembly

The following is a view of the Gearbox Assembly for the Quintuplex Auto-Lube™ System (ALSA0006).



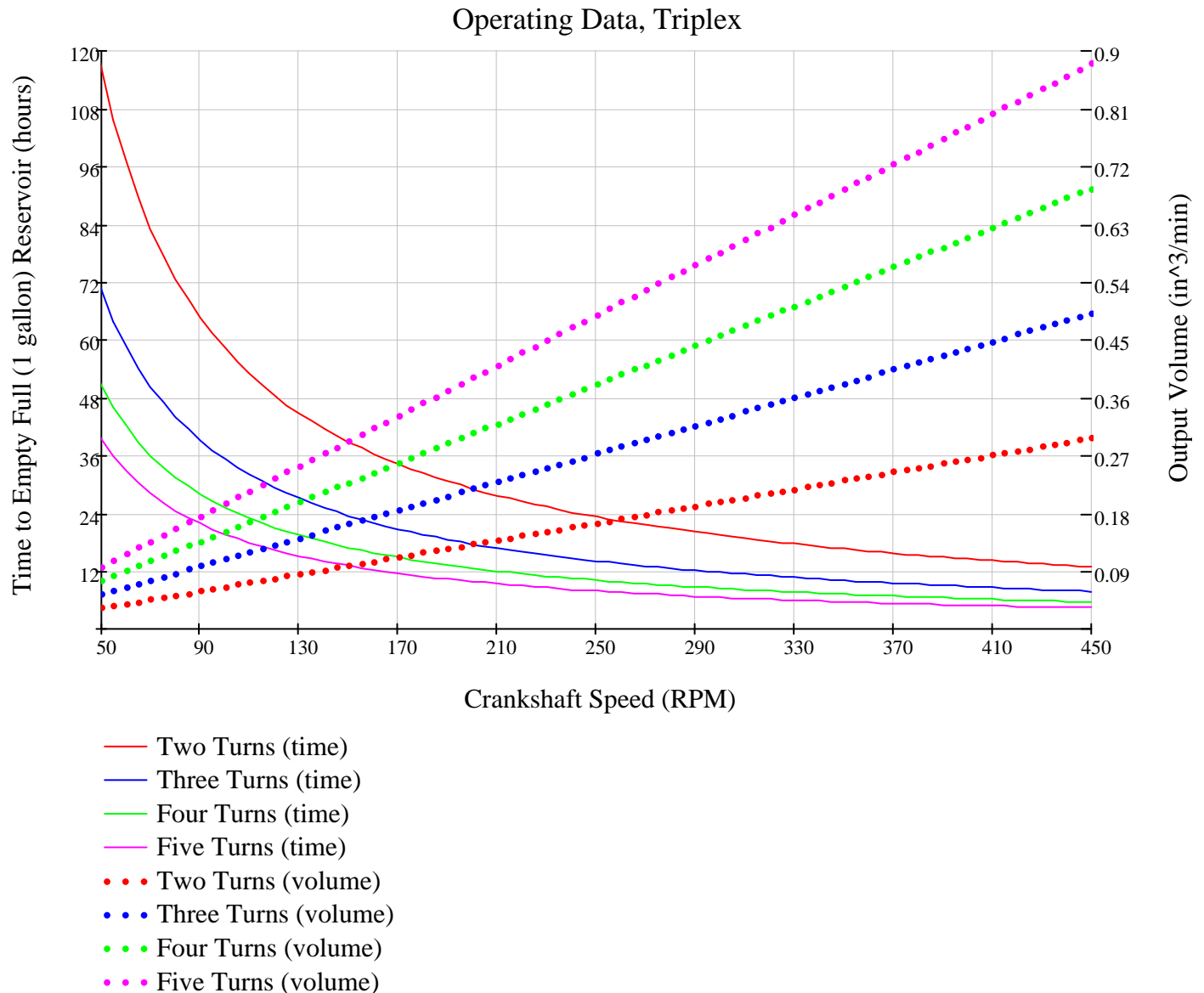
6.6 Quintuplex Panel Assembly

The following is a view of the Panel Assembly for the Quintuplex Auto-Lube™ lube System (ALSA0005).

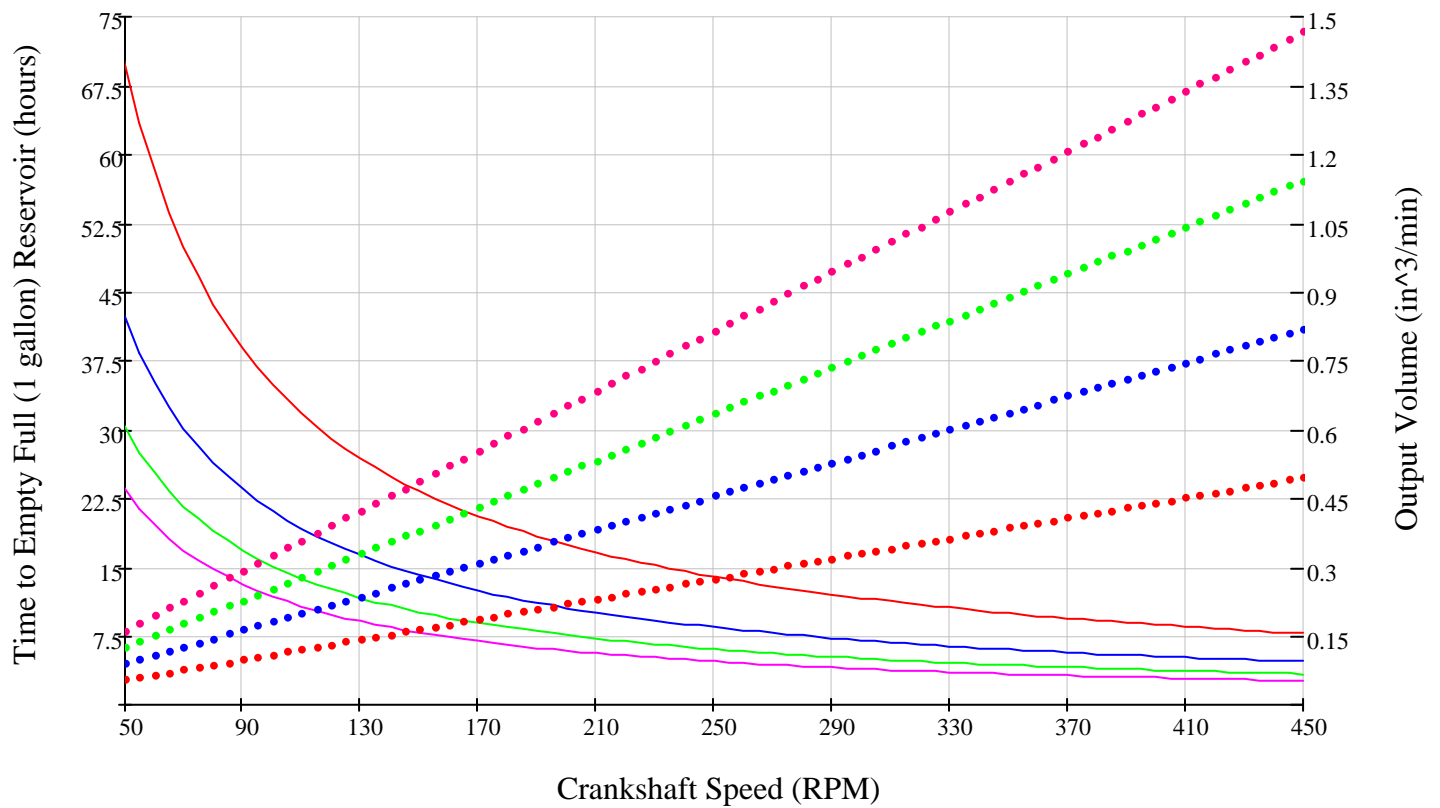


Appendix A TECHNICAL DATA

The following charts plot lubrication flowrate and consumption rates over time for variable output settings and crankshaft speeds. The plotted curves are based on turns of the pumping element adjustment screw from full close. This information may be used for fine tuning of the Auto-Lube™ System by determining what lubrication rates best fit the pumping conditions.



Operating Data, Quintuplex



Appendix B TROUBLESHOOTING

Listed below are some known possible malfunction symptoms and their solutions:

<i>Symptom</i>	<i>Likely Cause</i>	<i>Solution</i>
System not pumping grease on any cylinder (indicator bulb not tripping)	System is “OFF”	Turn system “ON”
	Cut, broken, or loose air hose	Inspect and tighten or replace damaged hoses
	Absent or insufficient air pressure	Ensure supply air pressure is at least 100 psig
	Air valve is stuck	Remove cover and inspect/clean air valve
	Lubrication reservoir empty or low	Replenish lubricant reservoir
System not pumping grease to individual cylinder(s) (indicator bulb tripping)	Obstruction in individual supply circuit	Check for obstructions from pump to packing nut and clear out if needed
Poor system response	High crankshaft speed (> 400 rpm)	Increase adjustable regulator pressure setting (max out)
	Very long air hoses to Gearbox valve	
High lubrication waste	Injector pumps set at rate excessive for pumping conditions	Restrict injector pump rates (see Section 4.4)
Overheating packing	Injector pumps set at rate insufficient for pumping conditions	Increase injector pump rates (see Section 4.4)

Appendix C BOLT TORQUE DATA

GENERAL TORQUE TABLE

Thread Diameter & Thread Pitch	Cap screws, nuts & bolts	
	SAE GRADE 5	
	Dry Threads Torque (ft*lbs)	Lubricated Threads Torque (ft*lbs)
1/4-20 UNC	6.7	5.1
3/8-16 UNC	24.7	16.5
1/2-13 UNC	60.3	45.2



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