DOOSAN

K1049551BE
July 2011

EXCAVATOR

Shop Manual

DX140R / DX140LCR

Serial Number 5001 and Up

Track Excavator Safety

Edition 1

SUMMARY OF SAFETY PRECAUTIONS FOR LIFTING IN DIGGING MODE

DANGER

Unsafe use of the excavator while making rated lifts could cause serious, potentially fatal injuries or extensive damage to the machine or nearby property. Do not let anyone operate the machine unless they've been properly trained and understand the information in the Operation and Maintenance Manual.

To lift safely while in Digging Mode, the following items must be evaluated by the operator and the work site crew.

- Condition of ground support.
- Excavator configuration and attachments.
- Weight, lifting height and lifting radius.
- Safe rigging of the load.
- Proper handling of the suspended load.

Tag lines on opposite sides of the load can be very helpful in keeping a suspended load secure, if they are anchored safely to control points on the ground.

WARNING

NEVER wrap a tag line around your hands or body.

NEVER rely on tag lines or make rated lifts when wind gusts are more than 48.3 km/h (30 MPH). Be prepared for any wind gust when working with loads that have a large surface area.

Always engage the "Digging Mode" control on the Instrument Panel before using the excavator for lifting work.

WARNING

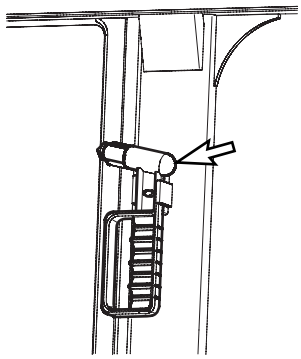
If you need more information or have any questions or concerns about safe operating procedures or working the excavator correctly in a particular application or in the specific conditions of your individual operating environment, please consult your local *DOOSAN* representative.

Emergency Exit

This machine is equipped with a glass breaking tool. It is on the upper left pillar of the cabin. This tool can be used in case of an emergency that requires the breaking of glass to exit from the operator's cabin. Grip the handle firmly and use the sharp point to break the glass.

WARNING

Protect your eyes when breaking the glass.



FG014380

Figure 12

ROPS Certification

This *DOOSAN* excavator has an operator's cabin that meets ROPS requirements. The seat belt must be worn for rollover protection.

The ROPS certification plate (Figure 24) is found on the left side of the cabin on most models. It may vary slightly in its location on some models.

Check the ROPS cabin, mounting, and hardware for damage.

Never modify the ROPS cabin. Replace the cabin and hardware if damaged. See your *DOOSAN* dealer for parts.

ROPS – Roll Over Protective Structure complies with ISO 12117-2:2008.

Figure 24

WARNING

Never modify the operator cabin by welding, grinding, drilling holes or adding attachments unless instructed by *DOOSAN*. Changes to the cabin can cause loss of operator protection from rollover and falling objects, and result in serious injury or death.

Protecting Cabin from Falling Object (Optional)

In a work site where falling objects or flying objects are expected, be sure to install adequate protective devices for covering the cabin.

When using a breaker, be sure to install the front window protection guard (1, Figure 25).

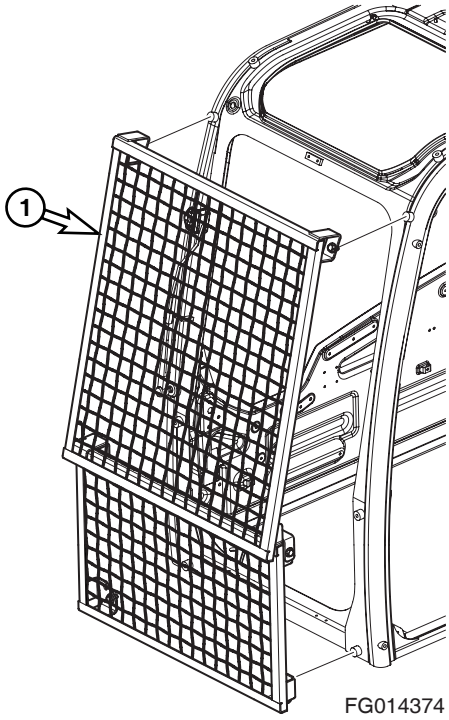


Figure 25

Action When Abnormality Is Found During Inspection

If any abnormality is found during inspection, always carry out repairs. In particular, if the machine is used when there are still problems with the brake or work equipment systems, it may lead to serious injury.

If necessary depending on the type of failure, please contact your *DOOSAN* distributor for repairs.

Precautions with High-pressure Lines, Tubes and Hoses

When inspecting or replacing high-pressure piping or hoses, check to verify that pressure has been released from the circuit. Failure to release the pressure may lead to serious injury. Always do the following:

- Wear protective glasses and leather gloves.
- Fluid leaks from hydraulic hoses or pressurized components can be difficult to see but pressurized oil has enough force to pierce the skin and cause serious injury. Always use a piece of wood or cardboard to check for suspected hydraulic leaks. Never use your hands or expose your fingers.
- Do not bend high-pressure lines. Do not strike high-pressure lines. Do not install lines, tubes or hoses that are bent or damaged.
- Make sure that all clamps, guards and heat shields are installed correctly to prevent vibration, rubbing against other parts, and excessive heat during operation.
  - If any of the following conditions are found, replace the part:
  - Damage or leakage from hose end.
  - Wear, damage, cutting of covering, or exposure of strengthening wire layer.
  - Cover portion is swollen in places.
  - There is twisting or crushing at movable parts of hose.
  - Foreign material is embedded in the covering.
  - Hose end is deformed.

  NOTE: *Refer to "Hose In-service Lifetime Limit (European Standard ISO 8331 and EN982 CEN)" in the Operation and Maintenance Manual, for additional European regulations.*

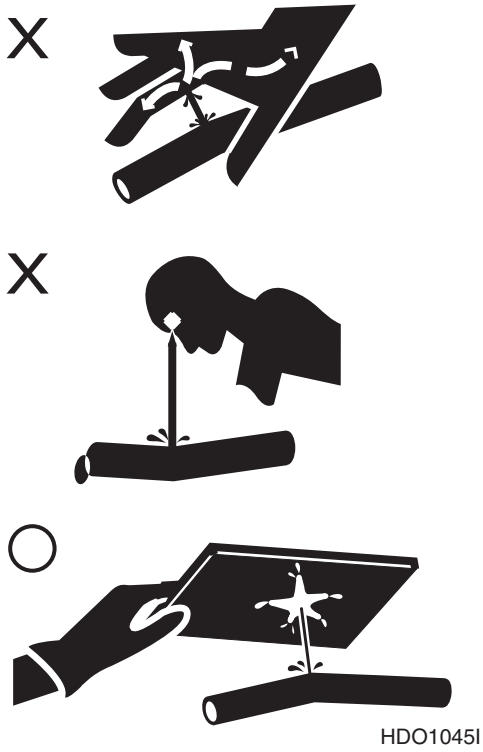


Figure 43

Table of Contents

Specification for DX140LCR

Overall Shipping Height (to top of cabin)	2,795 mm (9' 2")
Track Shipping Length	3,750 mm (12' 4")
Transport Trailer Capacity	20 tons (22 short tons), minimum load capacity
Transport Loading Ramp	
Allowable Slope	15° angle **CAUTION:** Refer to Transport Maximum Procedure for Safe Shipping Instructions.

Cylinder Performance Tests

NOTE: *All tests are performed with standard boom, arm and bucket configuration. The bucket should be empty.*

Boom Cylinders Test

The starting points for the test are with the boom and arm extended away from the excavator, and the bucket curled inward. The arm cylinder should be fully retracted; boom and bucket cylinders must be extended. Test movement in both directions, several times, and average results for both Standard Mode and Power Mode.

Arm Cylinder Test

Start with the boom up and the arm cylinder fully retracted. Test movement in both directions several times, between the "crowd" and "dump" positions, and average the results of both tests, in both standard and extra-duty power modes.

Bucket Cylinder Test

Start with the boom up and the teeth of the bucket hanging vertically, 500 mm (1-1/2' - 2') above the ground. Dump and crowd the bucket several times, and average results, for both standard and extra-duty power modes.

Operation	Standard Mode	Power Mode
Boom Up	2.9 - 3.7 sec	2.6 - 3.4 sec
Boom Down	2.3 - 2.9 sec	2.3 - 2.9 sec
Arm Dump	1.9 - 2.5 sec	1.7 - 2.3 sec
Arm Crowd	2.5 - 3.3 sec	2.4 - 3.2 sec
Bucket Dump	2.0 - 2.6 sec	1.8 - 2.4 sec
Bucket Crowd	3.6 - 4.4 sec	3.4 - 4.2 sec

Hydraulic Cylinder Natural Drop Test

To check boom and arm cylinder tightness against the specified performance standard for new cylinders, put a full load of dirt in the bucket and move the attachment cylinders so that the arm cylinder is extended 20 - 50 mm (1" - 2") and boom cylinders are retracted the same amount, 20 - 50 mm (1" - 2"). The top of the bucket should be approximately 2 m (6' - 7') off the ground.

Shut down engine and measure cylinder drop after 5 minutes. Bucket cylinder should not show more than 40 mm (1.57") change, while the arm and boom cylinders should not fall more than 10 mm (0.39").

⚠ CAUTION

Observe the following safety precautions:

1. **Use extra caution and adequate safety shielding when welding near fuel and oil tanks, batteries, hydraulic piping lines or other fire hazards.**
2. **Never weld when the engine is running. Battery cables must be disconnected before the welding procedure is started.**
3. **Never weld on a wet or damp surface. The presence of moisture causes hydrogen embrittlement and structural weakening of the weld.**
4. **If welding procedures are being performed near cylinder rods, operator's cabin window areas or any other assemblies that could be damaged by weld spatters, use adequate shielding protection in front of the assembly.**
5. **During equipment setup, always attach ground cables directly to the area or component being welded to prevent arcing through bearings, bushings, or spacers.**
6. **Always use correct welding rods for the type of weld being performed and observe recommended precautions and time constraints. AWS Class E7018 welding rods for low alloy to medium carbon steel must be used within two hours after removal from a freshly opened container. Class E11018G welding rods for T-1 and other higher strength steel must be used within 1/2 hour.**

HYDRAULIC SYSTEM - GENERAL PRECAUTIONS

Always maintain oil level in the system at recommended levels. Assemblies that operate under heavy loads, at high speed, with extremely precise dimensional tolerances between moving parts - pistons and cylinders, or shoes and swash plates, for example - can be severely damaged if oil supply runs dry.

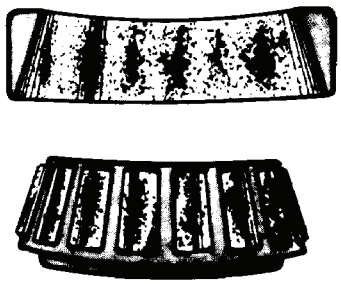
Assemblies can be run dry and damaged severely in a very short time when piping or hoses are disconnected to repair leaks and/or replace damaged components. Hoses that are inadvertently switched during disassembly (inlet for outlet and vice versa), air introduced into the system or assemblies that are low on oil due to neglect or careless maintenance, could all produce sufficient fluid loss to cause damage.

When starting the engine (particularly after long layoff or storage intervals), make sure that all hydraulic controls and operating

Fatigue Spalling

Flaking of surface metal resulting from fatigue.

Replace bearing - clean all related parts.



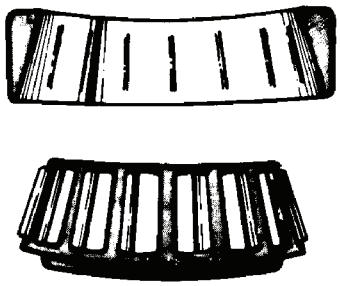
HASA530S

Figure 10

Brinelling

Surface indentations in raceway caused by rollers either under impact loading or vibration while the bearing is not rotating.

Replace bearing if rough or noisy.



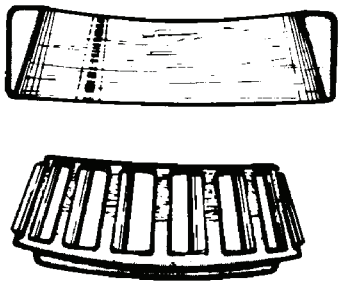
HASA540S

Figure 11

Cage Wear

Wear around outside diameter of cage and roller pockets caused by abrasive material and inefficient lubrication.

Replace bearings - check seals.



HASA550S

Figure 12

TORQUE VALUES FOR STANDARD U.S. FASTENERS

Type	S.A.E. Grade	Description	Bolt Head Marking
1	1 OR 2	WILL HAVE NO MARKINGS IN THE CENTER OF THE HEAD. Low or Medium Carbon Steel Not Heat Treated.	
5	5	WILL HAVE THREE RADIAL LINES. Quenched and Tempered Medium Carbon Steel.	
8	8	WILL HAVE 6 RADIAL LINES. Quenched and Tempered Special Carbon or Alloy Steel.	

Recommended torque, in foot pounds, for all Standard Application Nuts and Bolts, provided:

1. All thread surfaces are clean and lubricated with SAE-30 engine oil. (See Note.)
2. Joints are rigid, that is, no gaskets or compressible materials are used.
3. When reusing nuts or bolts, use minimum torque values.

NOTE: *Multiply the standard torque by:*

- 0.65 When finished jam nuts are used.
- 0.70 When Molykote, white lead or similar mixtures are used as lubricants.
- 0.75 When Parkerized bolts or nuts are used.
- 0.85 When cadmium plated bolts or nuts and zinc bolts w/waxed zinc nuts are used.
- 0.90 When hardened surfaces are used under the nut or bolt head.

NOTE: *When reusing bolts and nuts in service, use minimum torque values.*

Upper Structure

12. Remove floor mat (1, Figure 3).
13. Remove seat (2, Figure 3).

    NOTE: *Be careful not to damage seat covering.*

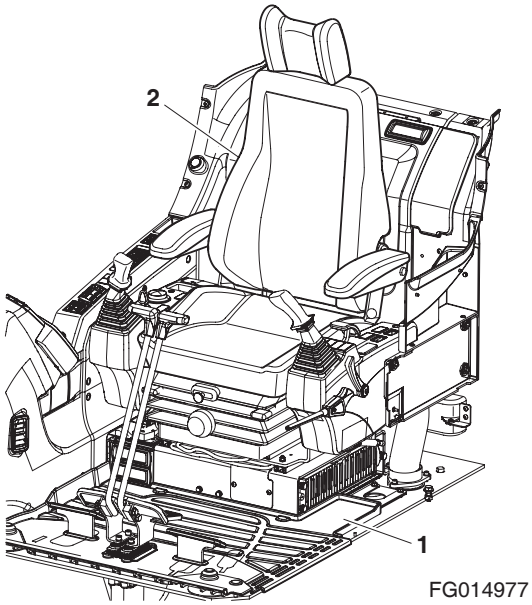


Figure 3

14. Disconnect the cabin main harness connector (1, Figure 4) and remove harness connection mounting bracket from floor.

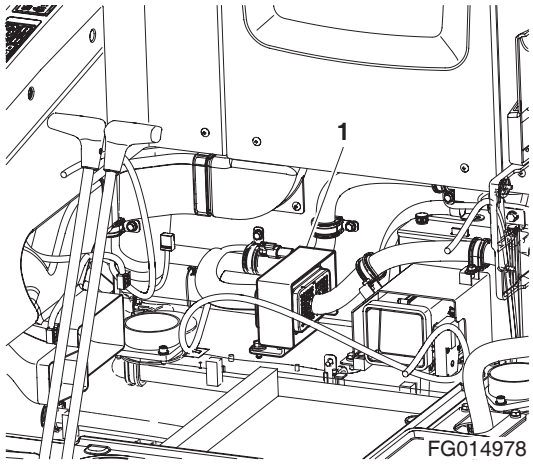


Figure 4

15. Remove joystick hose cover (1 and 2, Figure 5) and disconnect left / right control stand wiring harness connected inside them.
16. Disconnect control duct wiring connectors located on right side and back side of seat.

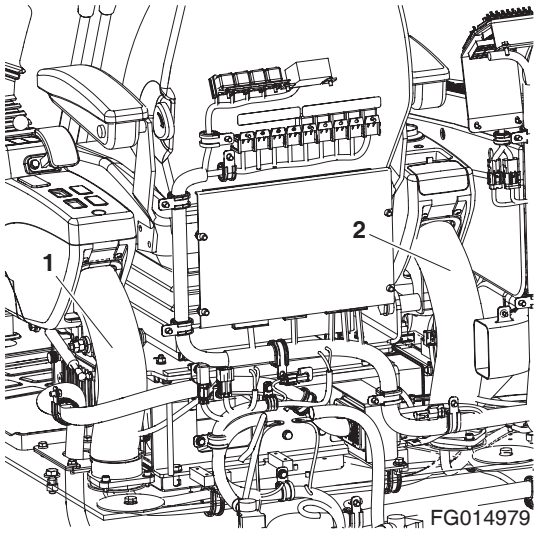


Figure 5

SAFETY PRECAUTIONS

CAUTION

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140LCR	5001 and Up
DX140LC	5001 and Up
DX180LC	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX340LC	5001 and Up

SAFETY PRECAUTIONS

CAUTION

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140LCR	5001 and Up

START-UP PROCEDURES

If engine does not start, the fuel system may need priming. Prime the fuel system using the following procedure:

1. Stop Engine.
2. Open right rear door and then there is fuel filter.

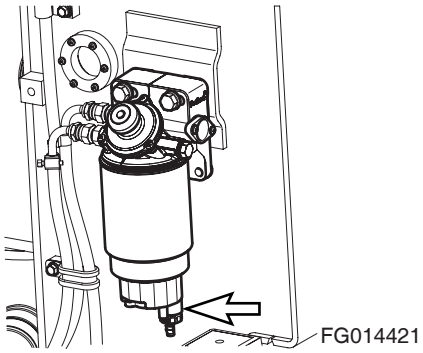


Figure 20

3. Loosen plug (1, Figure 21) on top of fuel filter head.
4. Pump hand operated primer pump (2, Figure 21) by the fuel injection pump. Pump primer until fuel is present at plug hole in fuel filter head.
5. Tighten plug in fuel filter head.
6. Continue to pump primer pump until a strong resistance is felt.
7. Start engine and look for signs of leaks.

Repeat procedure if necessary.

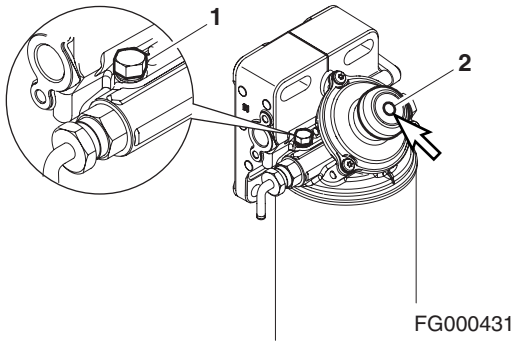


Figure 21

Swing Bearing

Edition 1

Swing Reduction Gear

Edition 1

Figure 4

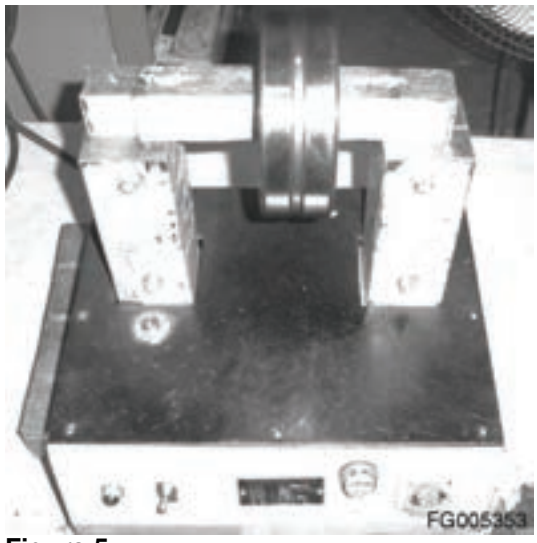


Figure 5

3. When bearing is heated up to 90°C - 100°C, remove it from the heater, hold it with both hands, and insert it into the shaft evenly.

   To do so, slowly insert bearing 4-5 mm that it seats itself and then push it strongly to contact the NILOS ring.

CAUTION

Do not heat bearing above 120°C.

4. After assembling the bearing, let it cooled fully in the air for 1 to 2 hours.

Figure 6

Figure 37

Figure 38

C. Remove the bearing press jig, align the support plate with the bolt tap of the case, and install 6 Loctite (#262) applied flat head bolts (M8 x 15 mm) and tighten them with torque wrench (torque :320 kg•cm).

Figure 40

E. Assemble the carrier #1 assembly in the same way as for the carrier #2.

Figure 73

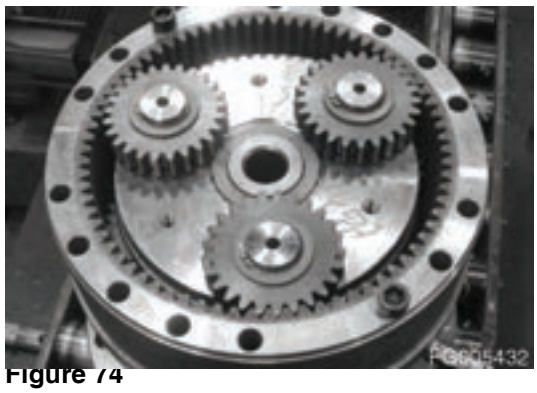


Figure 74

F. Assemble the sun gear #1.

Figure 75

Figure 76

C. Wipe grease and foreign substance with cloth and check the motor reassembly position again.

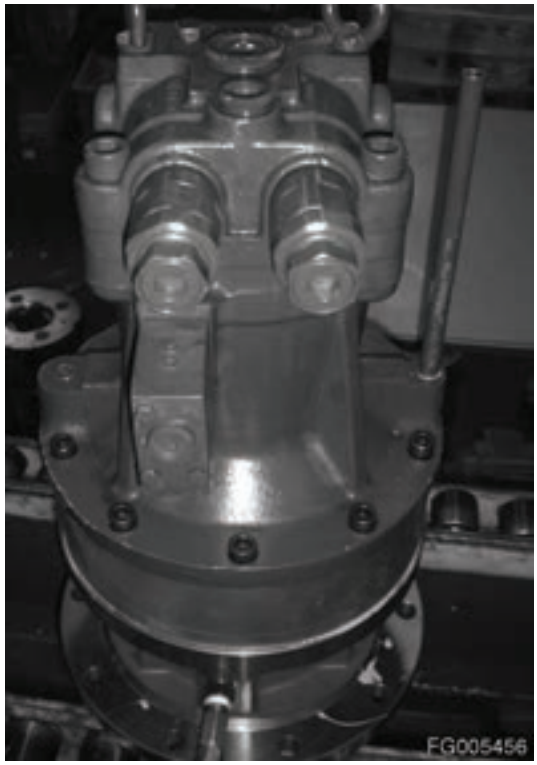


Figure 100

2. Measuring the distance (A, Figure 2) between the bottom of the side frame and the top of the lowest crawler shoe. Recommended tension for operation over most types of terrain is distance "B" on below table.

   NOTE: *This measurement can be thrown off if there is too much mud or dirt or other material in the track assembly. Clean off the tracks before checking clearance.*

3. Too little sag in the crawler track (less than clearance distance "C" on below table) can cause excessive component wear. The recommended adjustment can also be too tight causing accelerated stress and wear if ground conditions are wet, marshy or muddy.

4. The increased clearance recommended for muddy, sandy or snowy ground conditions is between distance "D" on below table.

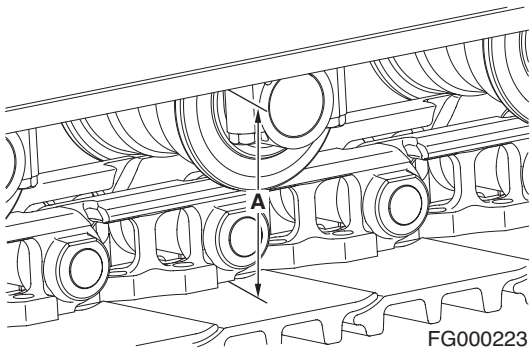


Figure 2

Terrain Type	Distance "A"
	DX140LC
Normal "B"	190 - 210 mm (7.50 - 8.27 in)
Minimum "C"	190 mm (7.50 in)
Muddy, Sandy or Snowy "D"	210 - 240 mm (8.27 - 9.45 in)

⚠ WARNING

The track adjusting mechanism is under very high-pressure. NEVER release pressure too suddenly. The grease cylinder valve should never be backed off more than 1 complete turn from the fully tightened down position. Bleed off pressure slowly and keep your body away from the valve at all times.

5. Track tension adjustments are made through the grease fitting (1, Figure 3) in the middle of each side frame. Adding grease increases the length of an adjustment cylinder (2). The longer the adjustment cylinder, the greater the pressure on the tension spring pushing the track idler wheel outward.

6. If there is not enough slack or clearance in the tracks and the adjustment is too tight, the idler wheel and adjusting cylinder can be retracted by bleeding off grease through hole in adjustment cylinder (2, Figure 3).

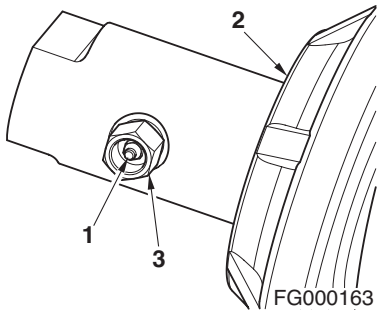


Figure 3

FRONT IDLER

Parts List

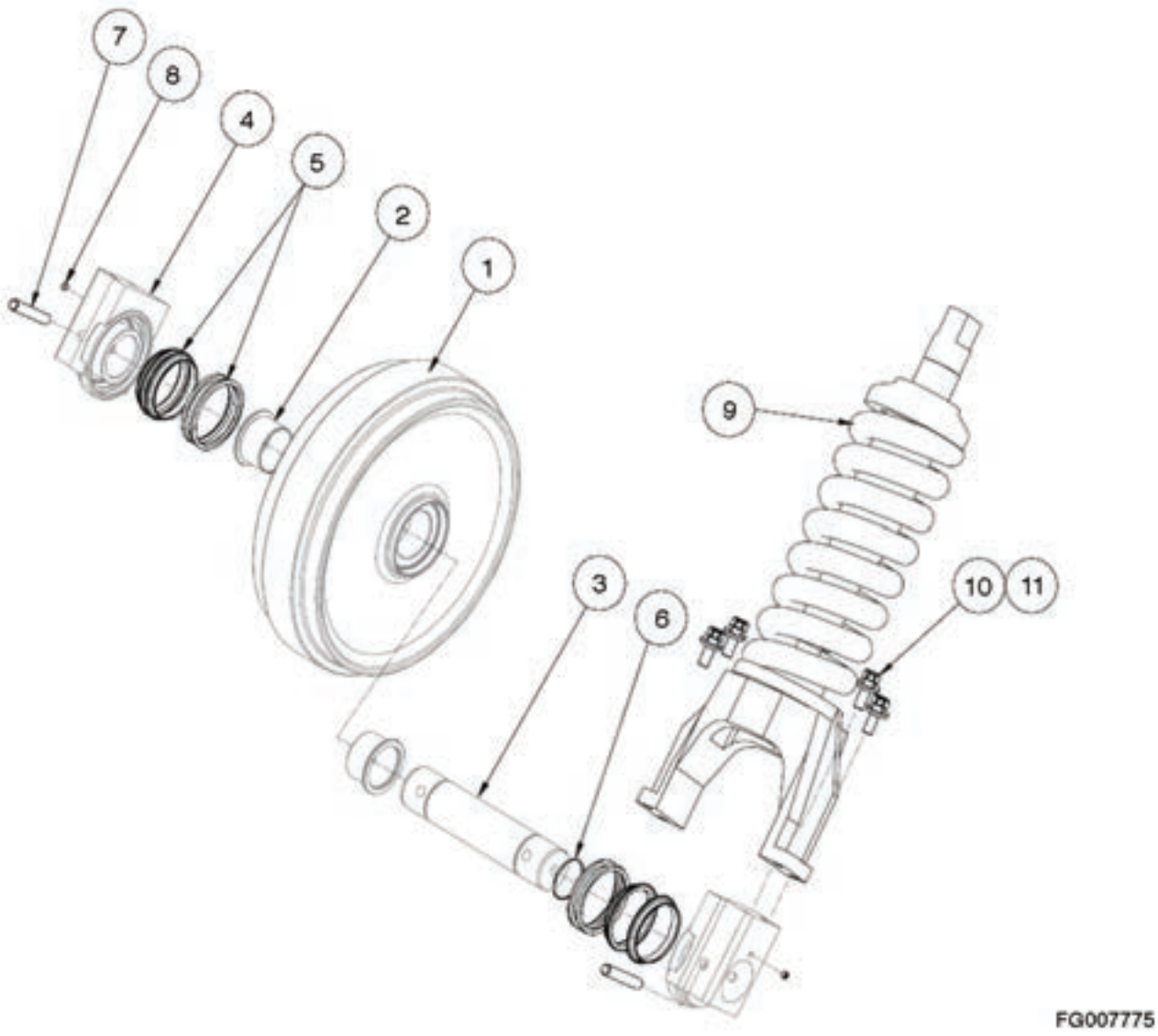
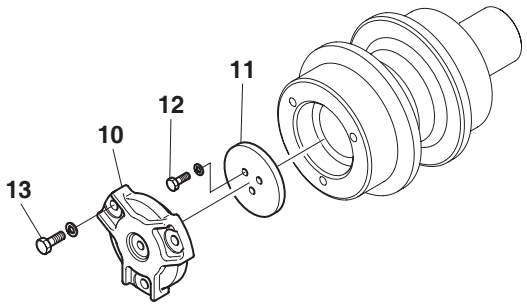


Figure 14

Reference Number	Description
1	Front
2	Bushing
3	Shaft
4	Bearing
5	Floating Seal
6	O-ring

Reference Number	Description
7	Pin
8	Plug
9	Track Spring Assembly
10	Bolt
11	Washer

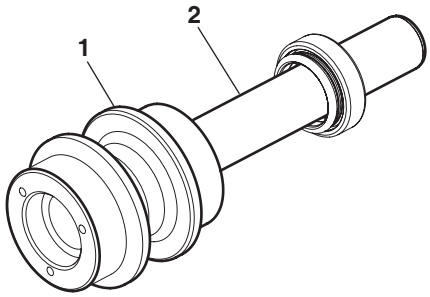
2. Remove the bolts (13, Figure 38) and cover (10). Detach bolts (12) and washer (11).



FG001495

Figure 38

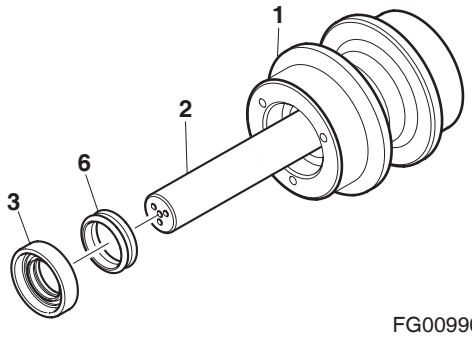
3. Separate the roller (1, Figure 39) from the axle (2).



FG009907

Figure 39

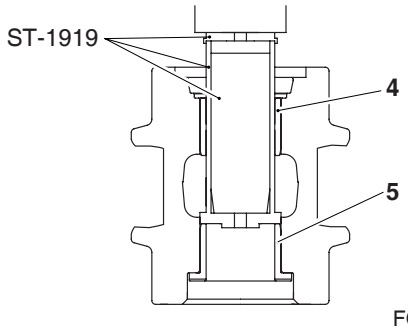
4. Separate the floating seal (6, Figure 40) from the roller.
5. Separate the O-ring (8) and thrust ring (3) from the axle.



FG009908

Figure 40

6. Separate the bushing (4 and 5, Figure 41) from the roller with a press and special tool (ST-1919).



FG009909

Figure 41

General Repair Instructions

General Information

This engine incorporates the latest technology at the time it was manufactured; yet, it is designed to be repaired using normal repair practices performed to quality standards.

- Cummins Inc. does not recommend or authorize any modifications or repairs to engines or components except for those detailed in Cummins Service Information. In particular, unauthorized repair to safety related components can cause personal injury or death. Below is a partial listing of components classified as safety-related:

1. Air Compressor
2. Air Controls
3. Air Shutoff Assemblies
4. Balance Weights
5. Cooling Fan
6. Fan Hub Assembly
7. Fan Mounting Bracket(s)
8. Fan Mounting Capscrews
9. Fan Hub Spindle
10. Flywheel
11. Flywheel Crankshaft Adapter
12. Flywheel Mounting Capscrews
13. Fuel Shutoff Assemblies
14. Fuel Supply Tubes
15. Lifting Brackets
16. Throttle Controls
17. Turbocharger Compressor Casing
18. Turbocharger Oil Drain Line(s)
19. Turbocharger Oil Supply Line(s)
20. Turbocharger Turbine Casing
21. Vibration Damper Mounting Capscrews

- Follow all safety instructions noted in the procedures

  Follow the manufacturer's recommendations for cleaning solvents and other substances used during the repair of the engine. Some solvents and used engine oil have been identified by government agencies as toxic or carcinogenic. Avoid excessive breathing, ingestion and contact with such substances. Always use good safety practices with tools and equipment.

Acronyms and Abbreviations

The following list contains some of the acronyms and abbreviations used in this manual.

API	American Petroleum Institute	**kPa**	Kilo Pascal
ASTM	American Society of Testing and Materials	**LNG**	Liquid Natural Gas
BTU	British Thermal Unit	**LTA**	Low Temperature After Cooling
°C	Celsius	**MPa**	Mega Pascal
CARB	California Air Resources Board	**mph**	Miles Per Hour
C.I.D.	Cubic Inch Displacement	**mpq**	Miles Per Quart
CNG	Compressed Natural Gas	**Nm**	Newton-meter
CPL	Control Parts List	**NG**	Natural Gas
cSt	Centistokes	**OEM**	Original Equipment Manufacturer
ECM	Electronic Control Module	**PID**	Parameter Identification Descriptions
EGR	Exhaust Gas Recirculation	**ppm**	Parts Per Million
EPA	Environmental Protection Agency	**psi**	Pounds Per Square Inch
°F	Fahrenheit	**PTO**	Power Takeoff
FMI	Failure Mode Identifier	**RGT**	Rear Gear Train
GVW	Gross Vehicle Weight	**rpm**	Revolutions Per Minute
LPG	Liquefied Petroleum Gas	**SAE**	Society of Automotive Engineers
Hg	Mercury	**SCA**	Supplemental Coolant Additive
hp	Horsepower	**STC**	Step Timing Control
H_2O	Water	**SID**	Subsystem Identification Descriptions
ICM	Ignition Control Module	**VS**	Variable Speed
km/l	Kilometers per Liter	**VSS**	Vehicle Speed Sensor

Fan Control

Feature Description

Various fan control features are available and while not all aspects of fan control are available on all engines, most (but not all) electronic controlled engines have some Electronic Control Module (ECM) fan control capability.

Fan control capability means that the ECM is able to turn the fan on or off in response to any of the following inputs:

Engine operating conditions (coolant temperature, intake manifold temperature, etc.)

- Control of fan overspeed
- Air conditioner operation
- Manual fan switch
- Engine performance requirements
  (Example: engine braking)

NOTE: *Many Industrial engines have fan controls as part of the ECM calibration that can not be adjusted using the service tool.*

Driver Activation/Deactivation

The driver can override the ECM to turn the fan on, using the manual fan switch installed in the cab by the vehicle manufacturer. When the driver places the manual fan switch in the ON position, the fan will be on regardless of other engine operating conditions. When the manual fan switch is in the OFF position, the fan will operate according to engine operating conditions and according to how the fan control parameters are configured.

Interaction with other Features and Parameters

ISB and ISC have a single pin on the ECM that provides Pulse Width Modulation.

This pin can be used to send a kick-down signal to an automatic transmission, in which case it must not be used to operate a variable speed fan.

Disadvantages

Due to heat rejection, the fan on during engine braking feature will appear inconsistent to some vehicle operators (Example: Consider an ISX calibration setting that the fan will engage 15 seconds after engine braking starts. It will be possible for the fan to sometimes come on sooner in response to air intake temperatures, coolant temperatures, or the air conditioner pressure switch).

Hot Shutdown Monitor

Feature Description

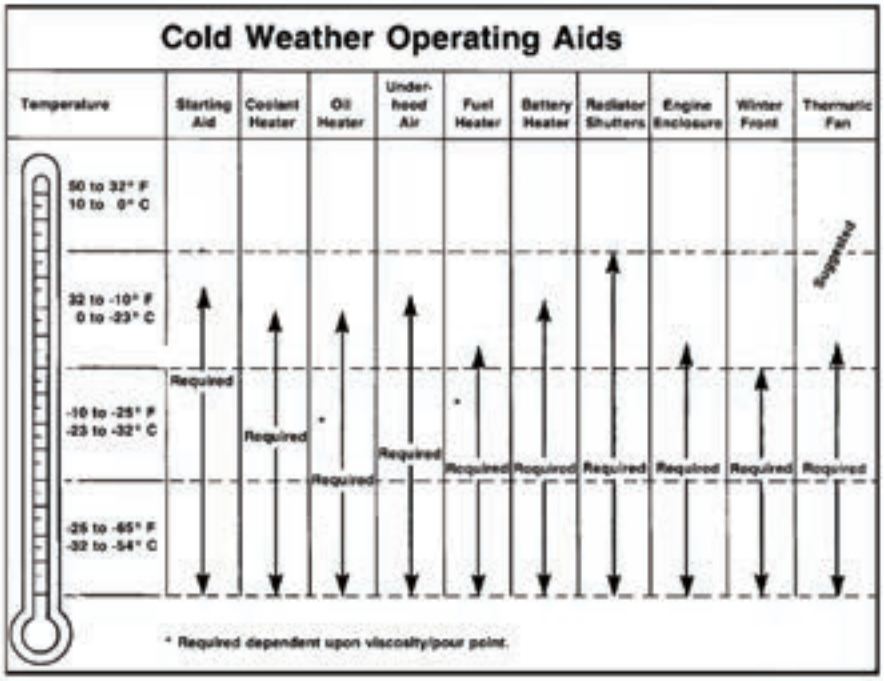
The Hot Shutdown Monitor will log a fault in the Electronic Control Module (ECM) if the engine is shut down, either by the key switch or by the engine protection feature or other Original Equipment Manufacturer (OEM) devices, while still hot.

The engine is considered hot if the load on the engine is above the hot shutdown minimum load set by Cummins INSITE¢,electronic service tool. Hot shutdown monitor is available on QSB, QSC, QSL9, QSM11, QSX15, QST30, QSK19, QSK45, QSK50, QSK38, QSK78, and QSK60 industrial engines.

The hot shutdown load percent is based on the duty cycle load factor that is determined from engine fueling levels. For example: If the hot shutdown load percent is set at 60 percent, every time the engine is shut down when the calculated engine load is over 60 percent, a hot shutdown fault will be logged.

Driver Activation/Deactivation

There is no operator activation or deactivation for hot shutdown monitor.



FG004745

Figure 32

Lubricating Oil Level

Maintenance Check

CAUTION!

Never operate the engine with oil level below the L (low) mark or above the H (high) mark. Poor engine performance or engine damage can occur.

The engine must be level when checking the oil level to make sure the measurement is correct.

Shut off the engine for an accurate reading.

Wait at least 15 minutes after shutting off the engine to check the oil level. This allows time for the oil to drain into the oil pan.

For additional lubricating oil recommendations and oil pan capacity information, refer to “Maintenance Specifications” on page-245.

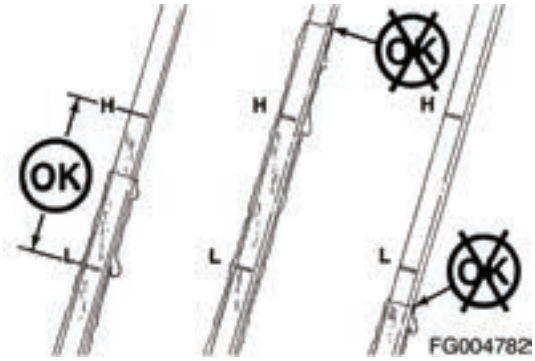


Figure 41

Drive Belts

Maintenance Check

Poly-Vee Belt

Inspect the belts daily. Check the belt for intersecting cracks. Traverse (across the belt width) cracks are acceptable. Longitudinal (direction of belt length) cracks that intersect with transverse cracks are not acceptable. Replace the belt if it is frayed or has pieces of material missing. Refer to Section A for belt adjustment and replacement procedures.

Belt damage can be caused by:

- Incorrect tension
- Incorrect size or length
- Pulley misalignment
- Incorrect installation
- Severe operating environment
- Oil or grease on the side of belts.

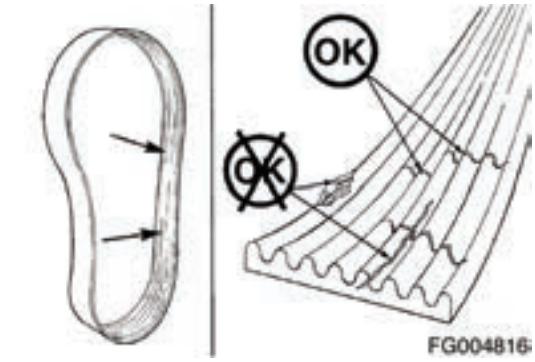


Figure 42

NOTE: *An alternate to using sodium carbonate, as outlined in this procedure, is to use Restore™.*

Restore™ is a heavy-duty cooling system cleaner that removes corrosion, silica gel, and other deposits. The performance of Restore™ is dependent on time, temperature, and concentration levels. An extremely scaled or flow-restricted system, for example, can require higher concentrations of cleaners, higher temperatures, or longer cleaning times, or the use of Restore Plus™ Up to twice the recommended concentration levels of Restore™ can be used safely. Restore Plus™ must be used only at its recommended concentration level. Extremely scaled or fouled systems can require more than one cleaning.

Figure 68

⚠ CAUTION!

Do not install the radiator cap. The engine is to be operated without the cap for this process.

Fill the system with a mixture of sodium carbonate and water (or a commercially available equivalent).

NOTE: *Adequate venting is provided for a fill rate of 19 liters (5 gal) per minute.*

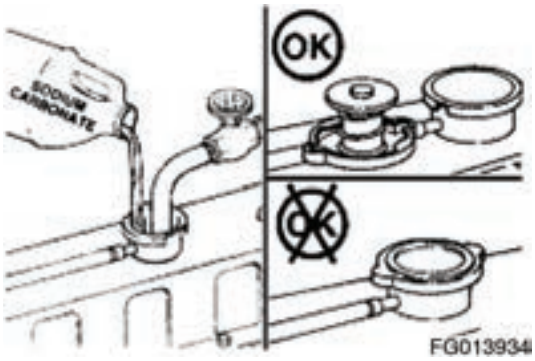


Figure 69

⚠ WARNING!

Coolant is toxic. Keep away from children and pets. If not reused, dispose of in accordance with local environmental regulations.

Operate the engine for 5 minutes with the coolant temperature above 80°C (176°F). Shut the engine off, and drain the cooling system.

Shut the engine off, and drain the cooling system.

Fill the cooling system with clean water.

NOTE: *Do not install the radiator cap.*

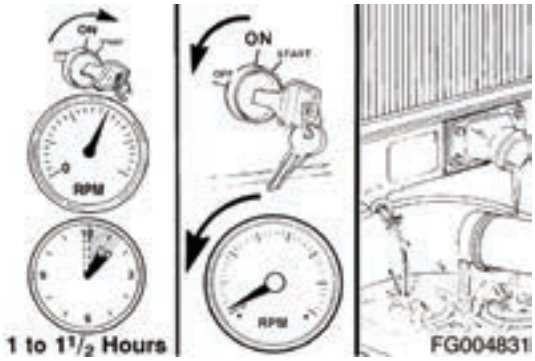


Figure 70

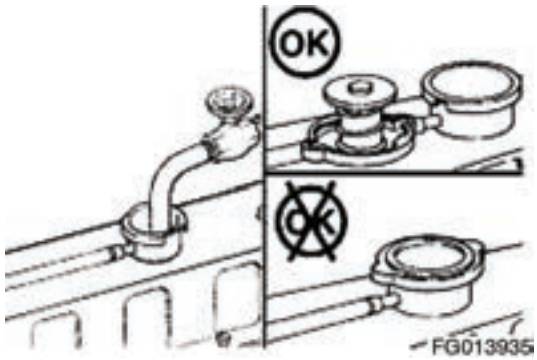


Figure 71

Measure the total carbon deposit thickness inside the air discharge line as shown. If the total carbon deposit (X + X) exceeds 2 mm [1/16 in], clean and inspect the cylinder head, the valve assembly, and the discharge line. Replace if necessary. Contact the Cummins Authorized Repair Location for procedures.

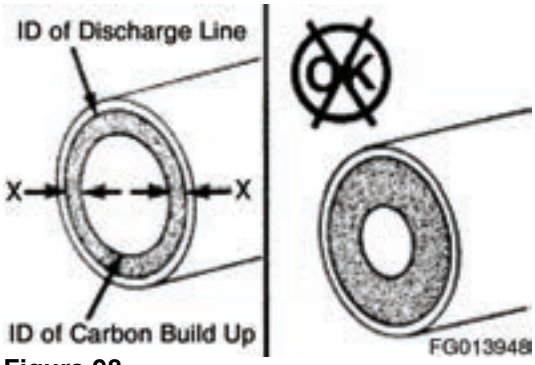


Figure 98

If the total carbon deposit exceeds specifications, continue checking the air discharge line connections up to the first tank until total carbon deposit is less than 2 mm [1/16 in]. Clean or replace any lines or connections that exceed this specification.

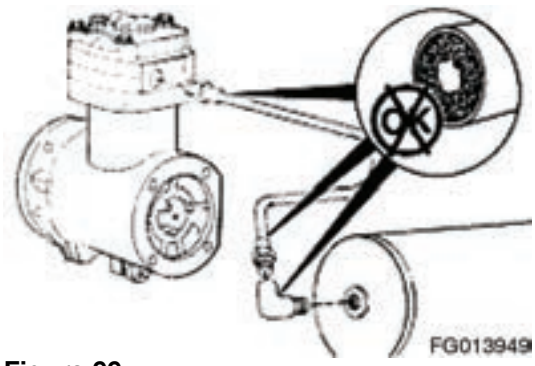


Figure 99

Inspect any air driers, splitter valves, pressure relief valves, and alcohol injectors for carbon deposits or malfunctioning parts. Inspect for air leaks. Maintain and repair the parts according to the manufacturer's specifications.

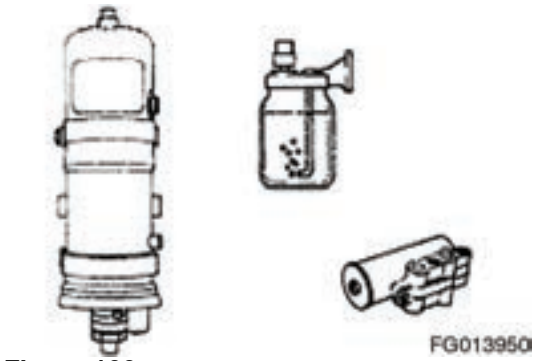


Figure 100

With the engine in this position, lash can be checked on the following rocker arms:

(E = exhaust, I = Intake)

Four-cylinder 1I, 1E, 2I, and 3E

Six-cylinder 1I, 1E, 2I, 3E, 4I, and 5E.

Lash Check Limits	
Intake	0.152mm MIN (0.006in)
Exhaust	0.381mm MAX (0.015in)
	0.381mm MIN (0.015in)
	0.762 MAX (0.030in)

NOTE: *Checking the overhead setting is usually performed as part of a troubleshooting procedure, and resetting is not required during checks as long as the lash measurements are within the above ranges.*

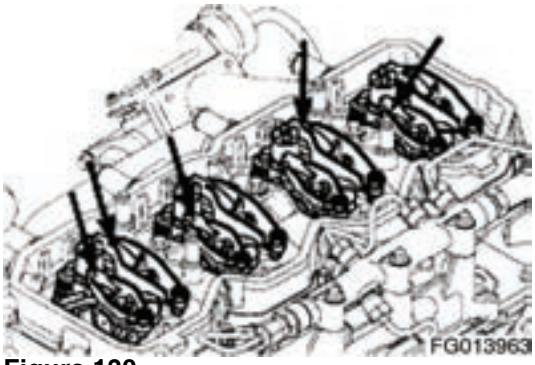


Figure 130

Figure 131

NOTE: *The clearance is correct when some resistance is "felt" when the feeler gauge is slipped between the crosshead and the rocker lever socket.*

Measure lash by inserting a feeler gauge between the crosshead and the rocker lever socket. If the lash measurement is out of specification, loosen the locknut, and adjust the lash to nominal specifications.

Lash Specifications		
	mm	in
Intake	0.254	0.010
Exhaust	0.508	0.020

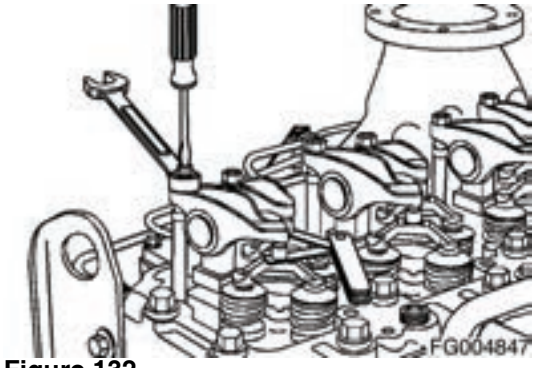


Figure 132

Tighten the locknut and remeasure.

- Torque Value 24 n.m (212 inlb)

Using barring tool, Part Number 3824591, rotate the crankshaft 360 degrees.

Inspect for Reuse

Inspect the charge air cooler for cracks, holes, or damage.

Inspect the tubes, the fins, and the welds for tears, breaks, or other damage. If any damage causes the charge air cooler to fail the air leak check mentioned earlier in this procedure, the charge air cooler must be replaced.

Install the charge air cooler and charge air cooler piping on the vehicle. Refer to the manufacturer's instructions.

NOTE: *Always clean and inspect the charge air cooler piping and hoses prior to installation.*

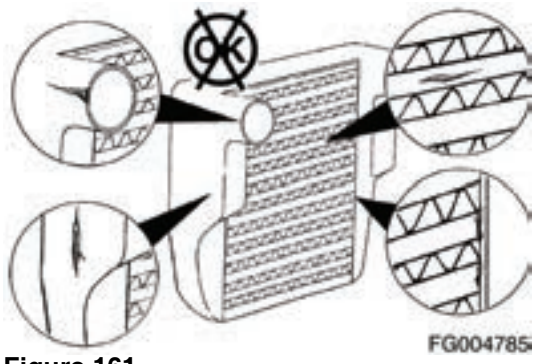


Figure 161

Leak Test

To check the charge air cooler for cracked tubes or header, remove the inlet and outlet hoses from the cooler. The charge air cooler does not have to be removed from the chassis.

WARNING!

To prevent possible injury if either plug blows off during the test, secure safety chains on the test plugs to any convenient capscrew on the radiator assembly. This test must not be performed without securely fastened safety chains.

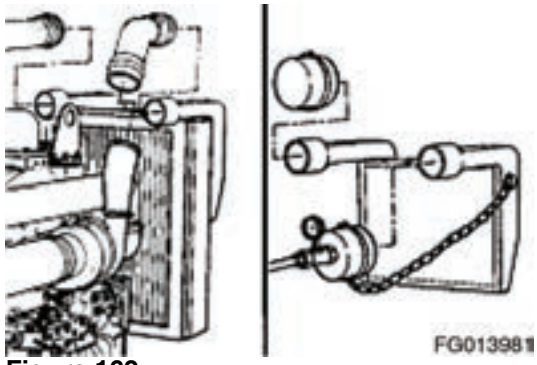


Figure 162

Install a plug or cap over the outlet side of the cooler. Install a pressure gauge and a regulated shop air supply line with a shutoff valve to the inlet side of the cooler.

Apply air pressure to the cooler until the pressure gauge reads a steady 207 kPa (30 psi) of air pressure.

Shut off the airflow to the cooler, and start a stopwatch at the same time. Record the leakage at 15 seconds.

If the pressure drop is 34 kPa (5 psi) or less in 15 seconds, the cooler is functioning properly.

If the pressure drop is greater than 34 kPa (5 psi) in 15 seconds, check all connections again.

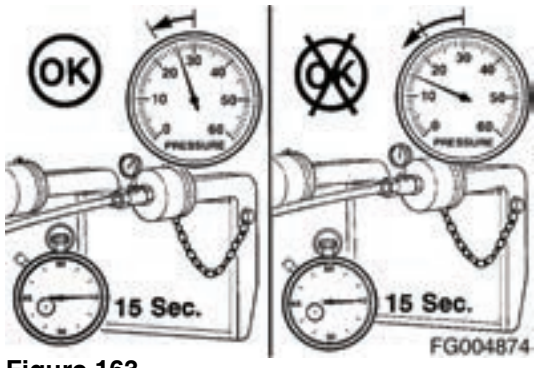


Figure 163

Drive Belt, Cooling Fan

Remove

Lift the tensioner to remove the drive belt.

NOTE: *The belt tensioner winds in the direction that the spring tang is bent over the tensioner body. To loosen the tension on the belt, rotate the tensioner to wind the spring tighter.*

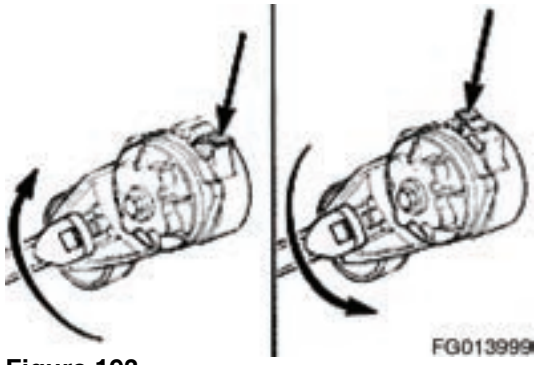


Figure 193

CAUTION!

Always vent the engine during filling to remove air from the coolant system, or overheating can result.

Inspect for Reuse

Inspect the drive belt for:

- Cracks
- Glazing
- Tears or cuts
- Hardening
- Excessive wear.

Figure 194

Install

CAUTION!

The belt tensioner is spring-loaded and must be pivoted away from the drive belt. Pivoting in the wrong direction can result in damage to the belt tensioner.

Lift the tensioner to install the drive belt.

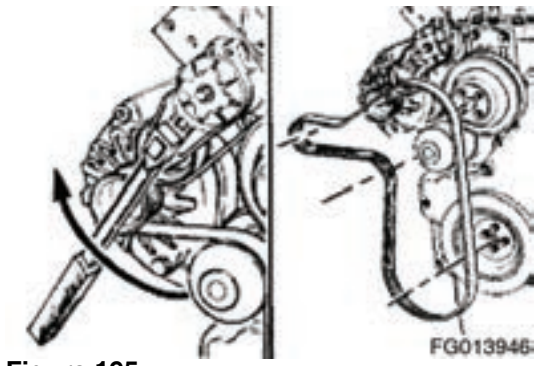


Figure 195

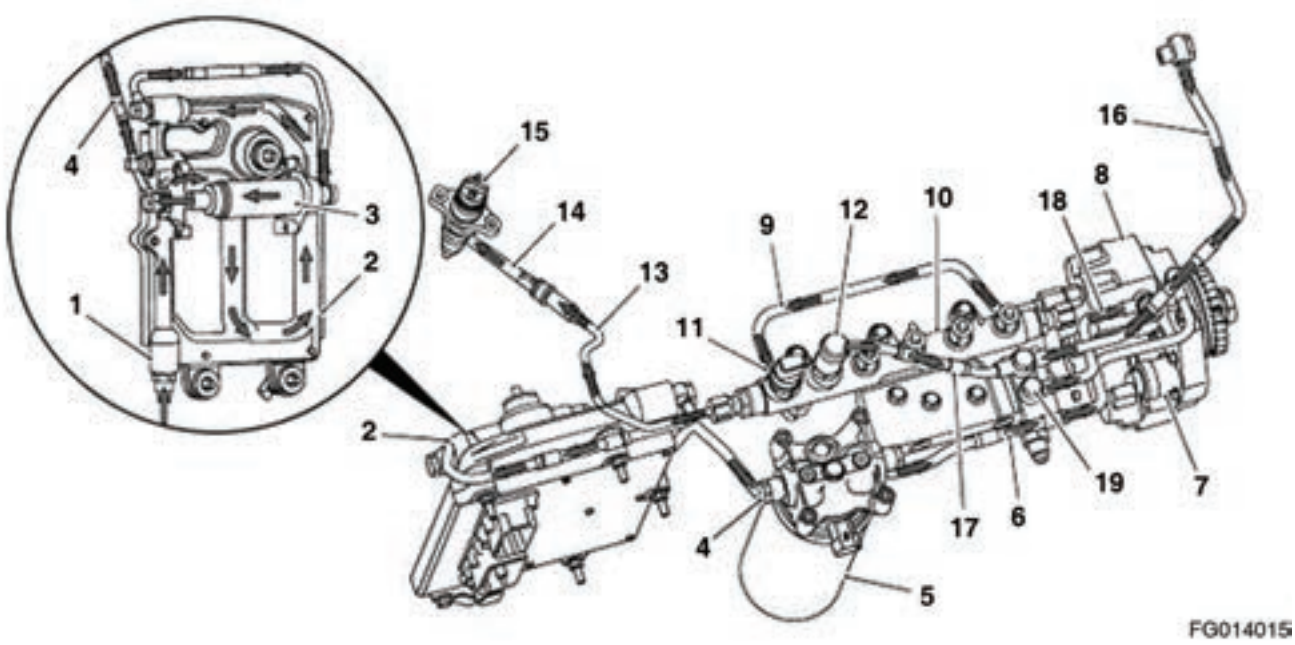


Figure 215

Reference Number	Description
1	Fuel Inlet -ECM Cooling Plate
2	ECM Cooling Plate
3	Lift Pump
4	Fuel Line (from Lift Pump to Fuel Filter)
5	Fuel Filter
6	Fuel Pump Inlet to Gear Pump
7	EFC Actuator
8	Fuel Pump
9	High-Pressure Fuel Line (Fuel Pump to Rail)
10	Fuel Rail

Reference Number	Description
11	Fuel Rail Pressure Sensor
12	Fuel Pressure Relief Valve
13	High-Pressure Fuel Line (Fuel Rail to Fuel Injector)
14	High-Pressure Connector to Fuel Injector
15	Fuel Injector
16	Injector Return Line
17	Pressure Relief Return Line
18	Fuel Pump Return Line
19	Fuel Return Manifold

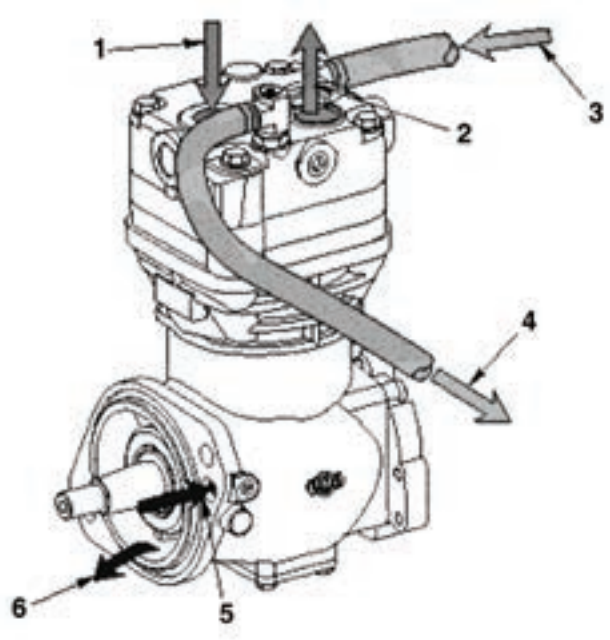


Figure 226

Reference Number	Description
1	Air In
2	Air out
3	Coolant In
4	Coolant Out

Reference Number	Description
5	Lubricating Oil in (Internal to the Gear Housing)
6	Lubricating Oil out (Internal to the Gear Housing)

SLP Mexico	Cummins, S. de R.L. de C.V.	Arquimedes No. 209 Col. Polanco Mexico, Distrito Federal ZIP / Postal Code: 11560 Mexico Telephone: (52-5) 254-3822 / 3783 / 3622 Telefax: (52-5) 254-3645
Russia-Moscow	Cummins Engine Company, Inc.	Park Place Office E708, 113/1 Leninskiy Prospect Moscow ZIP / Postal Code: 117198 Russia Telephone: (7-495) 956-51-22 / 23 Telefax: (7-495) 956-53-62
Singapore	Cummins Diesel Sales Corporation	8 Tanjong Penjuru Singapore ZIP / Postal Code: 609019 Singapore Telephone: (65) 6265-0155

Pennsylvania	Philadelphia	Cummins Power Systems, Inc. 2727 Ford Road Bristol, PA 19007 Telephone: (215) 785-6005 FAX: (215) 785-4085
Pennsylvania	Pittsburgh	Cummins Power Systems, Inc. 3 Alpha Drive Pittsburgh, PA 15138-2901 Telephone: (412) 820-8300 FAX: (412) 820-8308
Pennsylvania	Harrisburg	Cummins Power Systems, Inc. 4499 Lewis Road Harrisburg, PA 17111-2541 Telephone: (717) 564-1344 FAX: (717) 558-8217
Puerto Rico	Puerto Nuevo	Cummins de Puerto Rico, Inc. Calle 1 G1 Urb. Industrial, Barrio Palmas Catano ZIP / Postal Code: 00962 Puerto Rico Telephone: (787) 275-2000 FAX: (787) 275-2030
South Carolina	Charleston	Cummins Atlantic Inc. 231 Farmington Road Charleston, SC 29483 Telephone: (843) 851-9819 FAX: (843) 875-4338
South Carolina	Columbia	Cummins Atlantic, Inc. 2791 Shop Road Ext Columbia, South Carolina 29209 Telephone: (803) 799-2410 FAX: (803) 779-3427
South Dakota	Sioux Falls	Cummins Gentral Power, LLC 701 East 54th Street North Sioux Falls, SD 57104 Telephone: (605) 336-1715 FAX: (605) 336-1748
Tennessee	Memphis	Cummins Mid-South, LLC 670 Riverside Drive Memphis, TN 38173 Telephone: (901) 577-0600 FAX: (901) 522-8758
Tennessee	Chattanooga	Cummins South, Inc. 1509 East 26th Street Chattanooga, TN 37407-1095 Telephone: (423) 629-1447 FAX: (423) 629-1494
Tennessee	Knoxville	Cummins Cumberland, Inc. 1211 Ault Road Knoxville, TN 37914 Telephone: (423) 523-0446 FAX: (423) 523-0343
Tennessee	Memphis	Cummins Mid-South, LLC 1784 E. Brooks Road Memphis, TN 38116 Telephone: (901) 577-0666 FAX: (901) 522-8758
Tennessee	Nashville	Cummins Cumberland, Inc. 706 Spence Lane Nashville, TN 37217 Telephone: (615) 366-4341 FAX: (615) 366-5693

Regional Offices - International - Locations

Africa Regional Office - Daventry		
Cummins Engine Co. Ltd (Serving Czech Republic), (Middle East), (Africa) Royal Oak Way South Daventry, Northamptonshire ZIP / Postal Code: NN11 8NU		Brussels Telephone: (44-1327) 886 000 Fax: (44-1327) 886 100
Countrie		
Covered:	Burkina Faso	Burundi
	Cameroon	Central African Republic
	Chad	Congo (Democratic Republic),
	Congo (People's Republic)	Cote d'Ivoire (Ivory Coast)
	Djibouti	Equatorial Guinea,
	Eritrea	Ethiopia
	Gabon	Gambia
	Ghana	Guinea
	Guinea-Bissau	Kenya
	Liberia	Libya
	Mali	Malta
	Mauritania	Morocco
	Niger	Nigeria
	Rwanda	Sao Tome & Principe
	Senegal	Sierra Leone
	Somalia	Togo
	Tunisia	Uganda
	Cape Verde	

Czech Republic Regional Office - Daventry		
Cummins Engine Co. Ltd (Serving Czech Republic), (Middle East), (Africa) Royal Oak Way South Daventry, Northamptonshire ZIP / Postal Code: NN11 8NU		Brussels Telephone: (44-1327) 886 000 Fax: (44-1327) 886 100
Countrie		
Covered:	Austria	Czech Republic
	Hungary	Poland

BURKINA - FASO		- See North/West/East and Central Africa Regional Office - Daventry Cummins Engine Company Ltd Royal Oak Way South Daventry, Northants ZIP / Postal Code: NN11 5NUUnited Kingdom Telephone: (44-1327) 886000 Fax: (44-1327) 886106
BULGARIA		-See Germany Regional Office - Gross-Gerau Cummins Diesel Deutschland GmbH Odenwaldstrabe 23 Grob-Gerau, Hessen 64521 Germany Telephone: (49-6152) 174-0 Fax: (49-6152) 174-141
BURMA	Kuala Lumpur (Office In Malaysia)	Scott & English (M) Sdn Bhd 12 Jalan U1/15, Seksyen U1 Hicom-Glenmarie Industrial Park Shah Alam, Selangor Darul Ehsan 40150 Malaysia Fax: (60-3) 7803-5122
BURUNDI	Brussels (Office in Belgium)	Cummins Belgium N.V./S.A. Egide Walschaertsstraat, 2 Industriepark Zuid Mechelen 2800 Belgium Telephone: (32-15) 479 100 Fax: (32-15) 275 686
CAMBODIA		Scott & English (Cambodia) Ltd. No. 20A E0/E1 Russian Boulevard Phnom Penh Cambodia Telephone: (855-23) 723741 Fax: (855-23) 723741
CANARY ISLANDS	Madrid (Office in Spain)	Cummins Ventas y Servicio, S.A. Torrelaquna, 56 Madrid 28027, Spain Telephone: (34-91) 36720 00/367 24 04 Fax: (34-91) 407 66 04
CAPE VERDE		- See ECV Portugal Electro Central Vulcanizadora, Lda Rua Conselheiro Martins de Carvalho Lote 1480 Restelo Lisbon ZIP / Postal Code: 1400 Portugal Telephone: (351-21) 3034800 Fax: (351-21) 3034801 / 2
CENTRAL AFRICAN REPUBLIC		- See North/West Africa Regional Office - Daventry Cummins Engine Company Ltd Royal Oak Way South United Kingdom Telephone: (44-1327) 886000 Fax: (44-1327) 886106
CHAD		- See North/West/East and Central Africa Regional Office - Daventry Cummins Engine Company Ltd Royal Oak Way South Daventry, Northants NN11 5NU United Kingdom Telephone: (44-1327) 886000 Fax: (44-1327) 886106

LUXEMBOURG		Cummins Diesel Deutschland GmbH Odenwaldstrabe 23 Grob-Gerau, Hessen 64521 Germany Telephone: (49-6152) 174-0 Fax: (49-6152) 174-141
MACAU		- See Hong Kong Cummins Hong Kong Ltd. 2/F Unison Industrial Centre 27-31 Au Pui Wan Street, Fo Tan, Shatin, N.T.cccc Hong Kong, Hong Kong Hong Kong S.A.R. Telephone: (852) 2606-5678 Fax: (852) 2691-1641
MADAGASCAR		- See Southern Africa Regional Office Cummins Diesel South Africa (Pty) Ltd 13 Eastern Service Road Kelvin (Neighbourhood), Alexandra Gauteng, South Africa 2054 ZIP South Africa Telephone: (27-11) 321 8700 Fax: (27-11) 444 2012
MADEIRA ISLANDS		- See Portugal Electro Central Vulcanizadora, Lda Rua Conselheiro Martins de Carvalho Lote 1480 Restelo Lisbon 1400 Portugal Telephone: (351-21) 3034800 Fax: (351-21) 3034801 / 2
MALAYSIA	Kuala Lumpur	Scott & English (M) Sdn Bhd 12 Jalan U1/15, Seksyen U1 Hicom-Glenmarie Industrial Park Shah Alam, Selangor Darul Ehsan 40150 Malaysia Telephone: (60-3) 7805-1111 Fax: (60-3) 7803-5122
MALI		- See Senegal (Matforce) Matforce 10 Avenue Faidherbe Dakar Senegal Telephone: (221-8) 399500 Fax: (221-8) 399531 / 399550
MALTA	Valletta	International Machinery Ltd Regency House 254 Republic Street Valletta, Malta Malta Telephone: (356-21) 232620 / 233343 Fax: (356-21) 235484 / 247571
MARTINIQUE		Cummins Power South, LLC 9900 N.W. 77 Ave. Hialeah Gardens, FL 33016 Telephone: (305) 821-4200 Fax: (305) 557-2992
MEXICO	Guadalajara	Distribuidora Megamak de Occidente Metalurgia No. 2980 Fracc. Alamo Industrial Guadalajara, Jalisco 45560 Mexico Telephone: (52-3) 666-0329 / 666-0383 Fax: (52-3) 666-0333

TROUBLESHOOTING SYMPTOMS

Troubleshooting Procedures and Techniques

General Informatin

This guide describes some typical engine operating problems, their causes, and some acceptable corrections to those problems. Unless noted otherwise, the problems listed are those which an operator can diagnose and repair.

WARNING!

Performing troubleshooting procedures NOT outlined in this section can result in equipment damage or personal injury or death. Troubleshooting must be performed by trained, experienced technicians. Consult a Cummins Authorized Repair Location for diagnosis and repair beyond that which is outlined, and for symptoms not listed in this section. Before beginning any troubleshooting, refer to General Safety Instructions in Section i of this manual.

Follow the suggestions below for troubleshooting:

- Study the complaint thoroughly before acting
- Refer to the engine system diagrams
- Do the easiest and most logical things first
- Find and correct the cause of the complaint

Troubleshooting Symptoms Charts

General Information

Use the charts on the following pages of this section to aid in diagnosing specific engine symptoms. Read each row of blocks from top to bottom. Follow through the chart to identify the corrective action.

WARNING!

Troubleshooting presents the risk of equipment damage, personal injury or death. Troubleshooting must be performed by trained, experienced technicians.

Coolant Temperature Above Normal - Sudden Overheat

Cause	Correction
STEP 1 Coolant level is below specification	Inspect the engine and cooling system for external coolant leaks. Repair if necessary. Add coolant. Refer to “Section 3” on page-60.
OK Go To Next Step	
STEP 2 Electronic fault codes are active	For instructions on how to read active fault codes, refer to “Operating Instructions” on page-48. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK Go To Next Step	
STEP 3 Air in the cooling system	Inspect and vent the cooling system. Refer to “Section 7” on page-60.
OK Go To Next Step	
STEP 4 Fan drive belt is broken	Check the fan drive belt. Replace the belt, if necessary. Refer to Section A.
OK Go To Next Step	
STEP 5 Radiator cap is not correct, is malfunctioning, or has low-pressure rating	Check the radiator pressure cap. Refer to the OEM service manual
OK Go To Next Step	
STEP 6 Cooling system hose is collapsed, restricted, or leaking	Inspect the hoses. Refer to “Section 4” on page-60.
OK Go To Next Step	
STEP 7 Coolant temperature gauge is malfunctioning	Test the temperature gauge. Repair or replace the gauge, if necessary.
OK Go To Next Step	
STEP 8 Charge air cooler fins, radiator fins, or air conditioner condenser fins are damaged or obstructed with debris	Inspect the charge air cooler, air conditioner condenser, and radiator fins. Clean, if necessary. Refer to “Section 4” on page-60 and the OEM service manual.
OK Go To Next Step	
STEP 9 Cold weather radiator cover or winterfront is closed	Open the cold weather radiator cover or the winterfront. Maintain a minimum of 387 cm^2 (60 in^2) of opening at all times. Refer to “Operating Instructions” on page-48.
OK Go To Next Step	
STEP 10 Contact a Cummins Authorized Repair Facility	

Engine Power Output Low

Cause	Correction
STEP 1 Electronic fault codes are active.	For instructions on how to read active fault codes, refer to “Operating Instructions” on page-48. If fault codes are active, contact a Cummins Authorized Repair Facility
OK Go To Next Step	
STEP 2 Fuel grade is not correct for the application or the fuel quality is poor	Operate the engine from a tank of high-quality fuel. Refer to Fuel Recommendations and Specifications in “Maintenance Specifications” on page-245.
OK Go To Next Step	
STEP 3 Engine is operating above recommended altitude	Engine power decreases above recommended altitude. Refer to the OEM's altitude operation guidelines.
OK Go To Next Step	
STEP 4 Tachometer is not calibrated or is malfunctioning	Compare the tachometer reading with a handheld tachometer or an electronic service tool reading. Calibrate or replace the tachometer as necessary. Refer to the OEM service manual.
OK Go To Next Step	
STEP 5 Intake and exhaust system restricted	Check the intake and exhaust systems for restrictions. Inspect the intake air filter and replace as necessary.
OK Go To Next Step	
STEP 6 Air intake system restriction is above specification	Check the air intake system for restriction. Clean or replace the air filter and inlet piping as necessary. Refer to “Section 4” on page-60.
OK Go To Next Step	
STEP 7 Air intake or exhaust leaks	Check for loose or damaged piping connections and missing pipe plugs. Check the turbocharger and exhaust manifold mounting. Refer to“Section 4” on page-60.
OK Go To Next Step	
STEP 8 Air leak between the turbocharger and the intake manifold	Check for leaks in the air crossover tube, charge air cooler connections, hoses, or through holes in the manifold cover and repair or replace if necessary. Refer to the OEM service manual.
OK Go To Next Step	
STEP 9 Charge air cooler is restricted or leaking	Inspect the charge air cooler for air restrictions or leaks. Refer to “Section 4” on page-60.

Engine Vibration Excessive

Cause	Correction
STEP 1 Belt-driven accessories are malfunctioning	Check the fan hub, alternator, refrigerant compressor, and hydraulic pump for interference. Isolate belt-driven accessories and check for vibration. Refer to “Section 3” on page-60 and “Section 4” on page-60.
OK Go To Next Step	
STEP 2 Air compressor pumping time is excessive	Refer to the Air Compressor Cycles Frequently symptom tree.
OK Go To Next Step	
STEP 3 Engine idle speed is set too low (electronically controlled fuel systems)	Verify the correct idle speed setting. Increase the idle speed with the idle increment switch or an electronic service tool. Refer to “Operating Instructions” on page-48.
OK Go To Next Step	
STEP 4 Engine mounts are worn, damaged, or not correct	Check the engine mounts. Refer to the OEM service manual.
OK Go To Next Step	
STEP 5 Fan is loose, damaged, or has excessive hub bearing end play	Check the fan. Refer to “Section 3” on page-60.
OK Go To Next Step	
STEP 6 Engine is misfiring	Refer to the Engine Runs Rough or Misfires symptom tree.
OK Go To Next Step	
STEP 7 Electronic fault codes are active	For instructions on how to read active fault codes, refer to “Operating Instructions” on page-48. If fault codes are active, contact a Cummins Authorized Repair Facility.
OK Go To Next Step	
STEP 8 Vibration damper is damaged	Inspect the vibration damper. Refer to “Section 7” on page-60.
OK Go To Next Step	
STEP 9 Alternator bearing worn or damaged	Clean and replace the alternator. Refer to the OEM service manual.
OK Go To Next Step	
STEP 10 Contact a Cummins Authorized Repair Facility	

Lubricating Oil Consumption Excessive

Cause	Correction
STEP 1 Crankcase ventilation system is plugged	Check and clean the crankcase breather and vent tube. Refer to Procedure 003-018.
OK Go To Next Step	
STEP 2 Lubricating oil does not meet specifications for operating conditions	Change the oil and filters. Refer to Procedure 007- 002. Use the oil recommended in “Maintenance Specifications” on page-245.
OK Go To Next Step	
STEP 3 Lubricating oil drain interval is excessive	Verify the correct lubricating oil drain interval. Refer to Procedure 102-002.
OK Go To Next Step	
STEP 4 Lubricating oil leak (external)	Inspect the engine for external oil leaks. Tighten the cap screws, pipe plugs, and fittings. Replace gaskets, if necessary. Refer to Lubricating Oil Recommendations and Specifications.
OK Go To Next Step	
STEP 5 Verify the oil consumption rate	Check the amount of oil added versus the mileage.
OK Go To Next Step	
STEP 6 Air compressor is pumping lubricating oil into the air system	Check the air lines for carbon buildup and lubricating oil. Refer to Procedure 012-014.
OK Go To Next Step	
STEP 7 Contact a Cummins Authorized Repair Facility	

MAINTENANCE SPECIFICATIONS

General Engine

Listed below are the general specifications for this engine.

Item	Specifications
Bore x Stroke	107 mm (4.21 in) x 124 mm (4.88in)
Horsepower	Refer to engine data plate
Displacement	
Four-Cylinder Engine	4.5 liters (274 C.I.D.)
Six-Cylinder Engine	6.7 liters (409 C.I.D.)
Firing Order	
Four-Cylinder Engine	1.3.4.2
Six-Cylinder Engine	1.5.3.6.2.4
Engine Weight (with standard accessories):	
Dry Weight for 4.5 liters (274 C.I.D.)	374 kg (825 lb)
Dry Weight for 6.7 liters (409 C.I.D.)	485 kg (1070 lb)
Crankshaft Rotation (viewed from front of the engine)	Clockwise
Valve Clearance:	
Intake	0.254 mm (0.010 in)
Exhaust	0.508 mm (0.020 in)
NOTE: *The engine features a no-adjust overhead. The valve train is designed such that adjustment of the valve lash is not required for normal service during the first 241,402 km (150,000 mi, 5000 hr). The valve train operates acceptably within the limits of 0.152-to 0.381-mm (0.006-to 0.015-in) intake valve lash and 0.381-to 0.762-mm (0.015-to 0.030-in) exhaust valve lash. It is recommended that the valve lash be checked around 241,402 km (150,000 mi, 5000 hr) and every 81,000 km (50,000 mi, 2000 hr) thereafter.*	

The center section identifies the SAE oil viscosity grade.

Figure 228

As the engine oil becomes contaminated, essential oil additives are depleted. Lubricating oils protect the engine as long as these additives are functioning properly. Progressive contamination of the oil between oil and filter change intervals is normal. The amount of contamination will vary depending on the operation of the engine, kilometers or miles on the oil, fuel consumed, and new oil added.

Extending oil and filter change intervals beyond the recommendations will decrease engine life due to factors such as corrosion, deposits, and wear.

See the oil drain chart in “Maintenance Guidelines” on page-59 to determine which oil drain interval to use for your application.

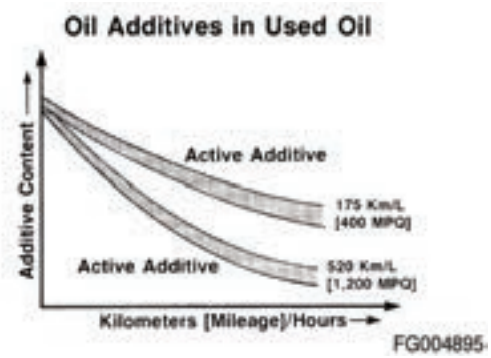


Figure 229

New Engine Break-in Oils

Special "break-in" engine lubricating oils are not recommended for new or rebuilt Cummins engines. Use the same type of oil during the break-in as is used in normal operation.
Additional information regarding lubricating oil availability throughout the world is available in the EMA Lubricating Oils Data Book for Heavy-Duty Automotive and Industrial Engines. The data book can be ordered from the Engine Manufacturers Association, Two North LaSalle Street - Suite 2200, Chicago, IL, U.S.A. 60602. The telephone number is (312) 827-8733.

CAUTION!

A sulfated ash limit of 1.85 percent has been placed on all engine lubricating oils recommended for use in Cummins engines. Higher ash oils can cause valve and/or piston damage and lead to excessive oil consumption.

CAUTION!

The use of a synthetic-base oil does not justify extended oil change intervals. Extended oil change intervals can decrease engine life due to factors such as corrosion, deposits, and wear.

Cummins' Responsibilities

During The Base Engine Warranty

Cummins will pay for all parts and labor needed to repair the damage to the Engine resulting from a Warrantable Failure.

Cummins will pay for the lubricating oil, antifreeze, filter elements, and other maintenance items that are not reusable due to the Warrantable Failure.

Cummins will pay reasonable costs for mechanics to travel to and from the equipment site, including meals, mileage and lodging, when the repair is performed at the site of the failure.

Cummins will pay reasonable labor costs for Engine removal and reinstallation when necessary to repair a Warrantable Failure.

During The Extended Major Components Warranty

Cummins will pay for the repair or, at its option, replacement of the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered part.

Owner's Responsibilities

During The Base Engine Warranty

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items provided during warranty repairs unless such items are not reusable due to the Warrantable Failure.

During The Extended Major Components Warranty

Owner is responsible for the cost of all labor needed to repair the Engine, including the labor to remove and reinstall the Engine. When Cummins elects to repair a part instead of replacing it, Owner is not responsible for the labor needed to repair the part.

Owner is responsible for the cost of all parts required for the repair except for the defective Covered Part and any Covered Part damaged by a Warrantable Failure of the defective Covered Part.

Owner is responsible for the cost of lubricating oil, antifreeze, filter elements and other maintenance items replaced during repair of a Warrantable Failure.

During The Base Engine and Extended Major Components Warranties

Owner is responsible for the operation and maintenance of the Engine as specified in the applicable Cummins Operation and Maintenance Manual. Owner is also responsible for providing proof that all recommended maintenance has been performed.

Before the expiration of the applicable warranty, Owner must notify a Cummins distributor, authorized dealer or other repair location approved by Cummins of any Warrantable Failure and make the Engine available for repair by such facility. Locations in the United States and Canada are listed in the Cummins Off Highway Authorized Dealer Directory.

Owner is responsible for communication expenses, meals, lodging and similar costs incurred as a result of a Warrantable Failure.

Owner is responsible for non-Engine repairs, "downtime" expenses, cargo damage, fines, all applicable taxes, all business costs and other losses resulting from a Warrantable Failure.

Drive Coupling (Main Pump)

Edition 1

1. Install spring pin (1) and then insert (2) with bolt (3) into engine fly wheel (4).

   NOTE: *Tighten the bolt using the torque Ta value specified in the table.*

2. Install two spring pins (5) and then insert (6) in bolt (8) of hub (7).

   NOTE: *Tighten the bolt using the torque Ta value specified in the table.*

3. Install the fly wheel cover in the main pump with bolts.

4. Connect hum (7) with pump shaft (9) as referred to as Measure H in Table 1 and fix its position with screws (10).

   NOTE: *Tighten the screws using the torque Tb value specified in the table.*

   NOTE: *Apply Loctite #262 to fixing screws (10).*

5. Install element (11) in between the engine fly wheel (4) and the insert.

6. Install the main pump and hub (7) by gently pushing them with element (11).

7. Bolt down the fly wheel cover and the pump housing on the fly wheel housing.

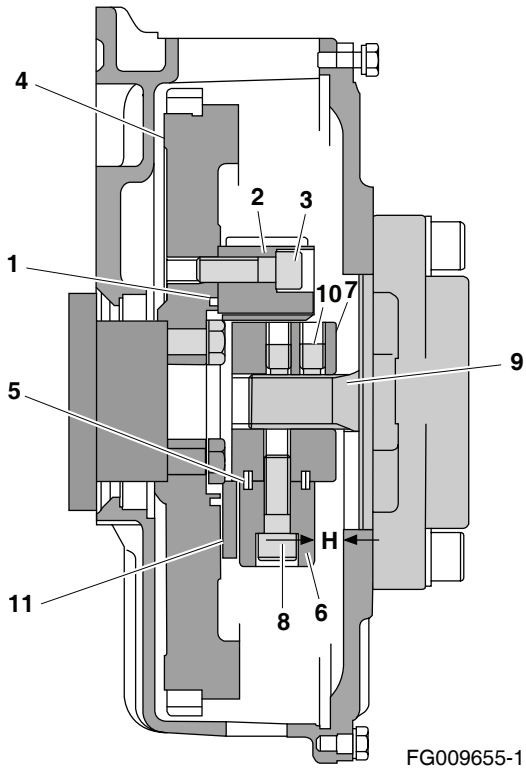


Figure 5

⚠ CAUTION

Apply the adhesive to bolts (3 and 8) to prevent the loosening of seals. Do not use additional adhesive nor any oil or cleaning solvent. As element (11) cannot resist adhesive, oil, and grease, take care not have it exposed to such materials.

Remove oil and dust on the fly wheel cover and the pump shaft before assembly.

Adjust the arrangement allowance between the pump and the engine at below 0.6 mm (0.023 in).

HYDRAULIC SCHEMATIC

The hydraulic schematic(s) is available in the "Hydraulic and Electrical Schematic Shop Manual." This manual is a collection of diagrams and schematics for a number of models.

General Notes

When referring to the schematic, refer to the following items:

- As shown in the schematic, the main pump assembly is driven by the engine. Mechanical energy is converted to hydraulic power, generating the required hydraulic flow which drives the system. Two main pumps (a right side pump and a left side pump) make up the main pump assembly.
- Hydraulic output from the right side pump is transmitted to the right side of the control valve. Output from the left side pump is transmitted to the valve spools on the left side of the control valve. Hydraulic output from the pilot pump is used to control the pump and to operate pilot and solenoid valves.
- The right half of the hydraulic control valve, supplied by the right pump in the pump assembly, operates valve spools for left travel, bucket, boom up and arm functions. The amount of oil flow to the actuators at the output end of each of those circuits is regulated through the movement of each individual valve spool.
- The left half of the hydraulic control valve, fed by the left pump in the pump assembly, has control spools for right travel, swing, boom and arm function.
- Two-stage operation is a feature of boom and arm function. All of these circuits can be operated using the output of only one half of the hydraulic pump assembly (one pump or the other), or – since both halves of the control valve have a spool and available circuit for these functions – the output of both pumps can be combined, allowing higher speed operation. Boom up, arm crowd and dumping functions can operate in any one of the two available power modes – the standard or general duty mode, the high speed/ rapid cycling mode.
- Whenever the right travel or left travel control spools are shifted, output from the main pump assembly flows through the center joint to one or both of the axial piston motors driving the side frame crawler tracks. A pilot valve connected to the swash plate of each travel motor changes motor capacity (and output) in direct proportion to the position of the travel switch selected by the operator.

POWER MODE VALVE

Current Signal and Hydraulic Pressure Adjustments

⚠ WARNING

This procedure should be done with two people. To reduce the chance of accident or unintended start-up, one person should remain at the operator's control stand while checks and adjustments are made.

The electromagnetic pressure proportioning control (EPPR) "power mode" valve is on the underside of the inclined plate, located main frame center, above center joint. To test and adjust power shift current and pressure through the power mode valve a multilead jumper harness is required. The jumper harness (which is available through *DOOSAN* After Sales Service, or could be spliced together from commonly available, purchased parts) has extra leads so that a VOM meter can be connected to the circuit.

To set up the testing equipment, shut down engine and disconnect the single electrical lead from the power mode valve. Attach the jumper harness to the terminal on the valve, connect the test leads of the multimeter to the extra leads on the harness and reconnect the valve electrical lead.

Vent the lever on top of the hydraulic tank to relieve pressure and connect an in-line "T-style" adapter to the valve pressure port. Install a 60 bar (1,000 psi) test gauge in the adapter.

Restart the engine and increase engine rpm by turning the speed control to the maximum speed setting. Warm up the engine and hydraulic system until hydraulic oil temperature is at least 45°C (113°F). Select Power Mode on the Instrument Panel. Check current readings (in milliamps) on the VOM meter and hydraulic pressure gauge readings and make sure both conform to the values in the table below.

NOTE: *If recorded values do not conform to the specified current or pressure in the table, back off the lock nut on the end of the valve, turn the adjusting screw 1/4 turn and recheck current and pressure. Repeat adjustment as required to obtain specified performance and retighten the valve lock nut.*

Mode	Engine RPM	Current	Pressure
Power Mode	High Idle: 1,900 rpm	150 ± 20 mA Mid-range value corresponding to engine rpm for both current and hydraulic pressure readings.	0 bar (0 psi)
Standard Mode	High Idle: 1,850 rpm	250 mA	9 bar (130.5 psi)

SWING SYSTEM TROUBLESHOOTING

Precautions/Initial Checks

1. Stop work. Release all weight or any type of load safely before proceeding. Avoid risking injury or adding to damage.
2. Shut down engine and disengage control functions until initial tests are ready to be made.

WARNING

Prevent possible injury and/or loss of operating control. Stop work and park the excavator at the first indication of:

1. **Equipment breakdown.**
2. **Inadequate control response.**
3. **Erratic performance.**

Stop the machine, put the boom and arm in the inoperative (overnight park) position and begin by making the fastest, simplest checks first:

- Check oil level.
- Check for overheating, oil leaks, external oil cooler clogging or broken fan belt. Consult service record for prior repair/service work.
- Drain some tank oil into a clean, clear container. Look for metal shavings/grit, cloudiness/water or foam/air bubbles in the oil.

  NOTE: *Dispose of drained fluids according to local regulations.*

- Check for wobble through the engine/pump flex coupling. Run engine with the pump input hydraulic power control nut turned to the lowest power to check the engine.
- Investigate unusual operating noises or vibration. Check for loose bolts, connections.

Accumulator

Edition 1

Table of Contents

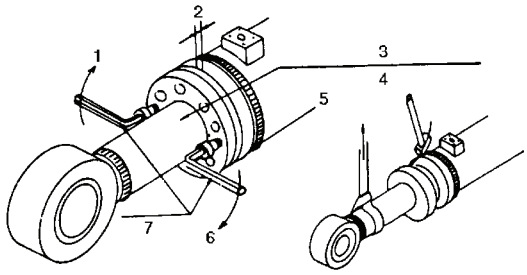
Center Joint (Swivel)

Table of Contents

Cylinders

MODEL	CYLINDER	A (±0.1)	∅B	∅C	∅D	MODEL (CYLINDER)
DX140LC / DX140LCR	BOOM	80.0 mm (3.15 in)	11.0 mm (0.43 in)	58.0 mm (2.28 in)	110.0 mm (4.33 in)	
	ARM	80.0 mm (3.15 in)	11.0 mm (0.43 in)	58.0 mm (2.28 in)	110.0 mm (4.33 in)	
	BUCKET	70.0 mm (2.76 in)	11.0 mm (0.43 in)	46.0 mm (1.81 in)	95.0 mm (3.74 in)	
DX180LC	BOOM	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	
	ARM	96.0 mm (3.78 in)	13.0 mm (0.51 in)	69.0 mm (2.72 in)	130.0 mm (5.12 in)	
	BUCKET	80.0 mm (3.15 in)	11.0 mm (0.43 in)	58.0 mm (2.28 in)	110.0 mm (4.33 in)	
DX225LC	BOOM	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	
	ARM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	75.0 mm (2.95 in)	140.0 mm (5.51 in)	
	BUCKET	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.54 in)	
DX225NLC	BOOM	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.53 in)	
	ARM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	75.0 mm (2.95 in)	140.0 mm (5.51 in)	
	BUCKET	90.0 mm (3.54 in)	11.0 mm (0.43 in)	63.0 mm (2.48 in)	115.0 mm (4.54 in)	
DX255LC	BOOM	96.0 mm (3.78 in)	13.0 mm (0.51 in)	69.0 mm (2.72 in)	130.0 mm (5.12 in)	
	ARM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	76.0 mm (2.99 in)	140.0 mm (5.51 in)	
	BUCKET	96.0 mm (3.78 in)	13.0 mm (0.51 in)	69.0 mm (2.72 in)	130.0 mm (5.12 in)	
DX300LC	BOOM	110.0 mm (4.33 in)	13.0 mm (0.51 in)	76.0 mm (2.99 in)	140.0 mm (5.51 in)	
	ARM	120.0 mm (4.72 in)	13.0 mm (0.513 in)	85.0 mm (3.35 in)	150.0 mm (5.91 in)	S/ARM
	BUCKET	110.0 mm (4.33 in)	13.0 mm (0.51 in)	76.0 mm (2.99 in)	140.0 mm (5.51 in)	S/BUCKET
DX340LC	BOOM	120.0 mm (4.72 in)	13.0 mm (0.51 in)	85.0 mm (3.35 in)	150.0 mm (5.91 in)	OPT BOOM
	ARM	130.0 mm (5.12 in)	13.0 mm (0.513 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	OPT ARM
	BUCKET	120.0 mm (4.72 in)	13.0 mm (0.51 in)	85.0 mm (3.35 in)	150.0 mm (5.91 in)	OPT BUCKET
DX420LC	BOOM	130.0 mm (5.12 in)	13.0 mm (0.51 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	
	ARM	130.0 mm (5.12 in)	13.0 mm (0.513 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	
	BUCKET	130.0 mm (5.12 in)	13.0 mm (0.51 in)	93.0 mm (3.66 in)	165.0 mm (6.50 in)	

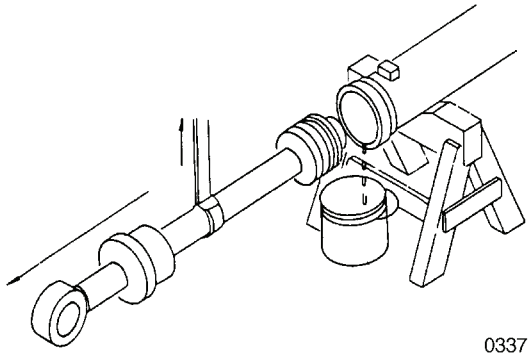
4. Tap two bolts into cover of cylinder head, 180° apart. Tighten them in a staggered, even sequence, to back off piston rod end cover from edge of cylinder wall. Look for adequate clearance between cover and end of cylinder wall before using a plastic or other soft-faced hammer for final disassembly.



HAOF610S

Figure 15

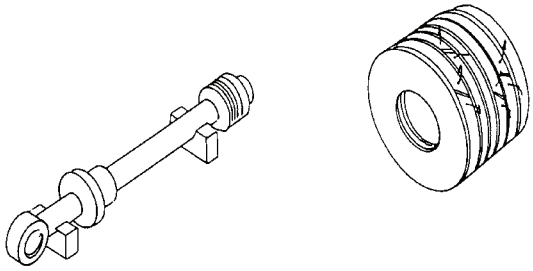
5. Begin withdrawing piston rod assembly, away from cylinder. Attach a lifting support when final 1/3 of rod is still inside barrel of cylinder. Prepare support blocks for piston rod before it has been completely withdrawn.



0337

Figure 16

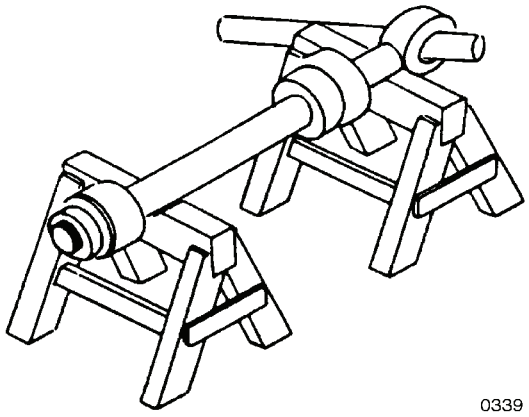
6. Lower piston rod to support blocks and detach wear ring (outer surface) (19) from end of rod.



HAOF620S

Figure 17

7. Immobilize piston rod by inserting a wooden or other nonscoring, nonmetallic support through end of rod.



0339

Figure 18

Table of Contents

Swing Motor

3. Swing Reactionless Valve

By the spool's shift in the main control valve, oil is supplied to Hydraulic motor's A port (or B port), and moving the poppet of reactionless valve, blocks the bypass and operates swing-device. (Figure 5-(1))

Returning the spool to neutral position, block the two ports of Hydraulic motor, but the swing-device tends to swing by inertia-force. The swing force is transmitted to hydraulic motor by reduction gear. After stops the swing-device by brake pressure which is created in B port (or A port) and tends to shift to the opposite direction. Because of the brake pressure, the swing device stop, first, and tends to reverse. Although the oil pressure of B port tries to shift the poppet to left side, delays the operating by the orifice of the A port. At this time, forms bypass between A port and B port, and the pressure oil in B port flows into A port through the bypass. (Figure 5-(2))

And the B side poppet moves to left side till blocking the bypass. (Figure 5-(3)) At the reverse pressure generating process of B port, this process prevents the reverse and stop the motor by bypassing the pressure oil to A port.

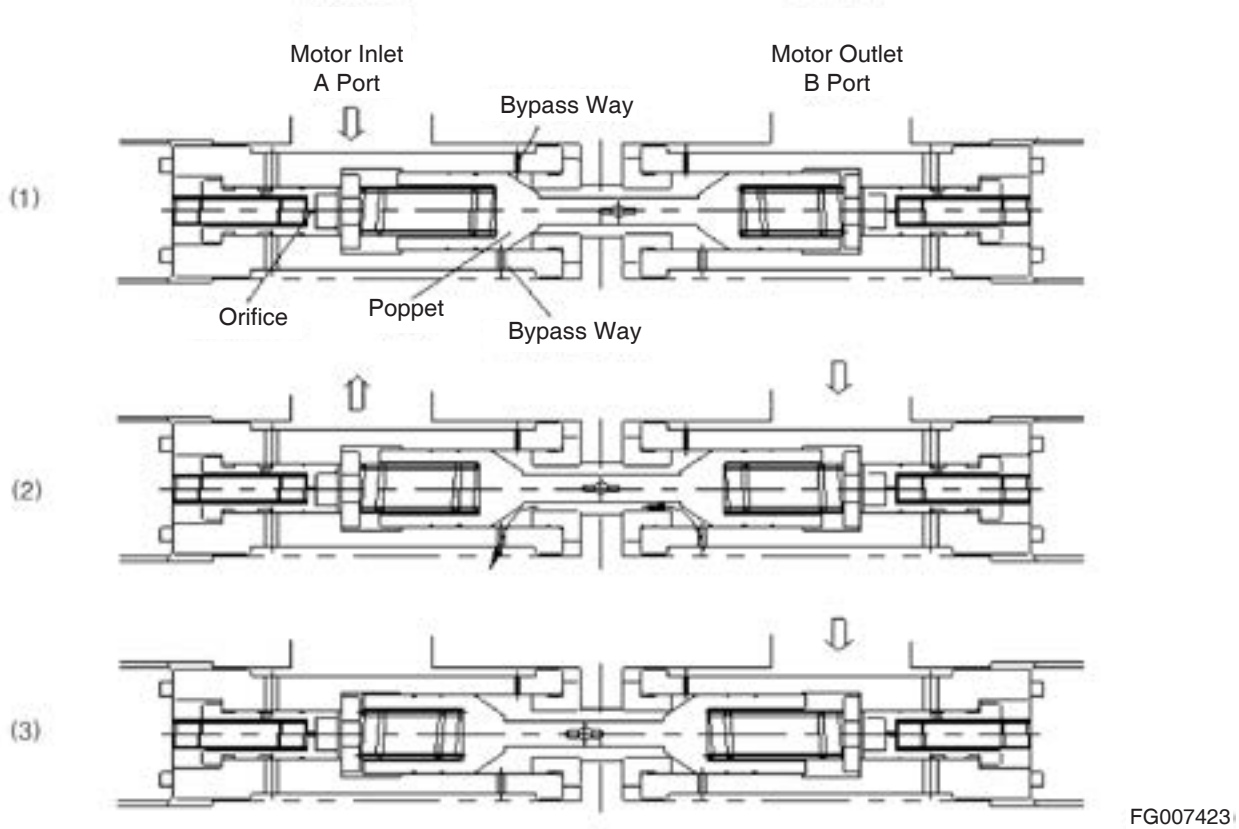


Figure 5 Swing Reactionless Valve Working Description

Necessary Tools

In table 2, 3 Figure 11. is shown necessary tools for disassembling and reassembling.

Table 2

( ) : TSM72

Name	Size	2-face width	Application part	Tool
Hexagon bolt	M6	10	Brake valve	Hexagon wrench socket wrench
Hexagon socket bolt	M20 (M16)	17 (14)		Hexagon wrench
Plug	M22	10	RO plug	Hexagon wrench
Plug	M36 (M24)	17 (12)	RO plug	Hexagon wrench
Plug	VP-1/4	19	VP plug	Hexagon wrench socket wrench
		36	Relief valve	Hexagon wrench socket wrench

Table 3 etc.

( ) : TSM72

Spec. / Tool	Dimensions
Pliers (For lock ring)	For Ø65 axis (Ø50)
Driver	- Type 2EA
Steel rod	About 10 x 8 x 200 1EA
Hammer	One each of plastic hammer and metal hammer.
Torque wrench	Torque range • For 100 - 450 kg•cm • For 400 - 1,800 kg•cm • For 1,200 - 4,800 kg•cm
Slide hammer bearing pliers	
Special tool for removing the break piston	25page reference

16. Assemble valve plate (231) to valve casing (101) and fit O-ring (113).

    Be careful to note the direction of the valve plate.

    Mount the valve plate with its round part toward the opposite side of the flange.

    Coat lightly with grease.

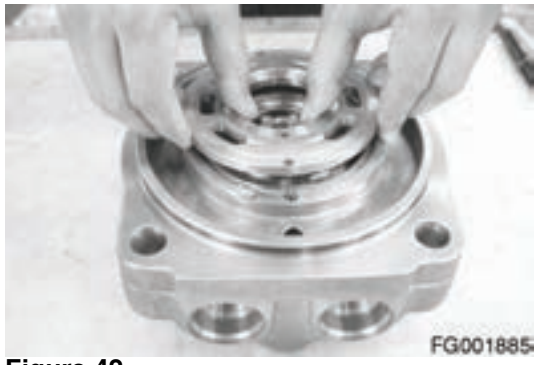


Figure 42

17. Mount valve casing (101) to casing (301) and tighten hex socket bolts (109, 110) to specification.

    Be careful to note the mounting direction of the valve casing.

    (Reference to the drawing)

    Be careful not to drop the valve plate or let the brake springs pop out.

    Tighten the bolts evenly.

Figure 43

18. Install plunger (104) and spring (103) to valve casing (101) and tighten RO plug (102) with O-ring (106).

    Confirm the smooth movement of the plunger before installing the plug.

Figure 44

19. Install swing reactionless valve ass'y (105) to valve casing (101).

    Confirm the spring in the swing reactionless valve ass'y (105).

Figure 45

EXTERNAL DIMENSIONS

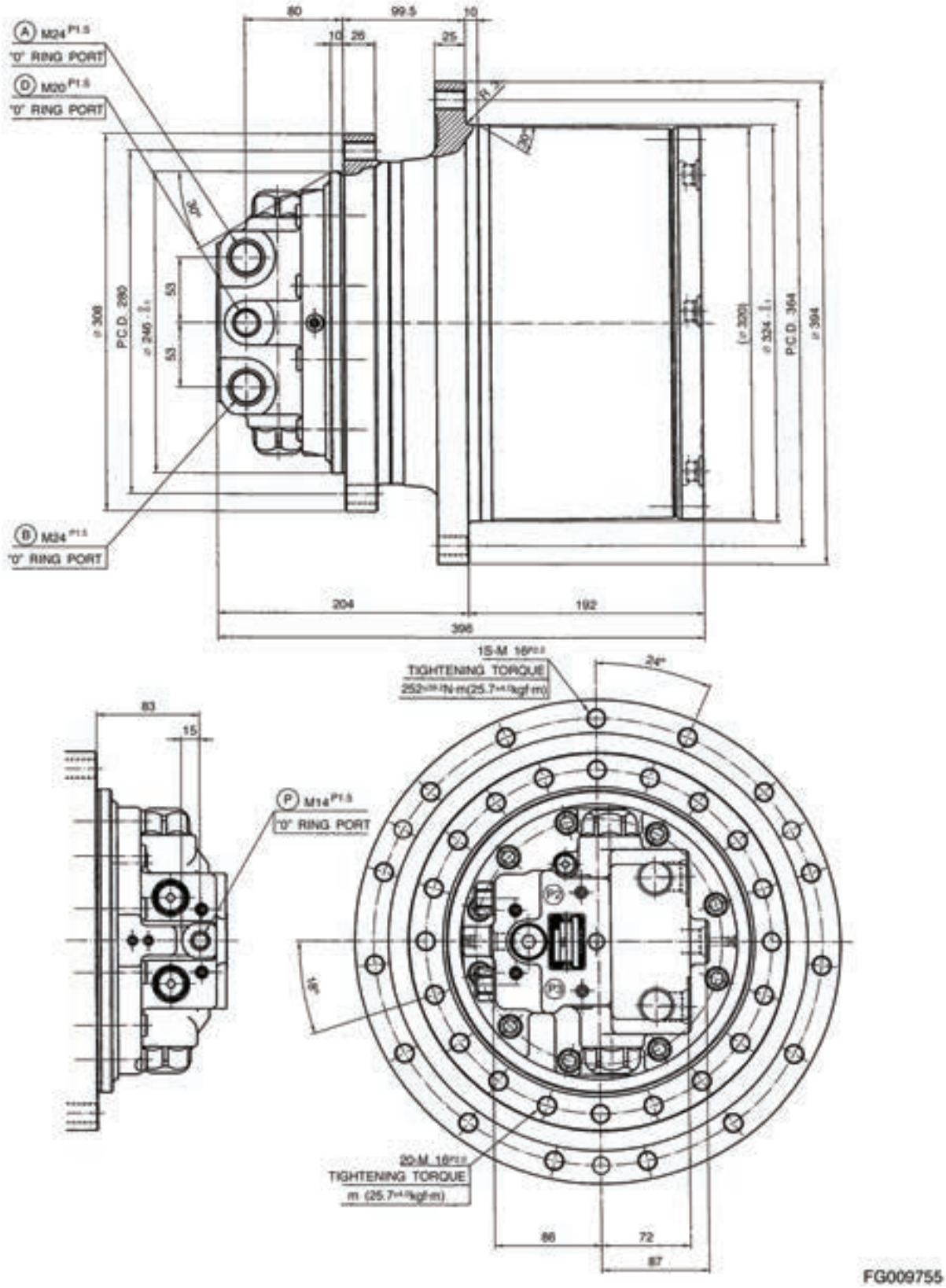


Figure 1

C. Self-traveling

While machine is being operated, as the travel speed is increased due to steep slope, the oil flow rate of the hydraulic motor is higher than the supply flow rate of the hydraulic oil pump.

The rotation of the hydraulic motor in this case is called a self-traveling. (Overrun)

While self-traveling, the pressure is lowered similar to the stopping condition. Then brake valve is moved similar to the stopping condition, throttles passage in the return side of hydraulic motor, and generate backing pressure.

In addition, the force of inertia decreases the revolution of hydraulic motor to revolution having a balance with the supply flow rate of pump.

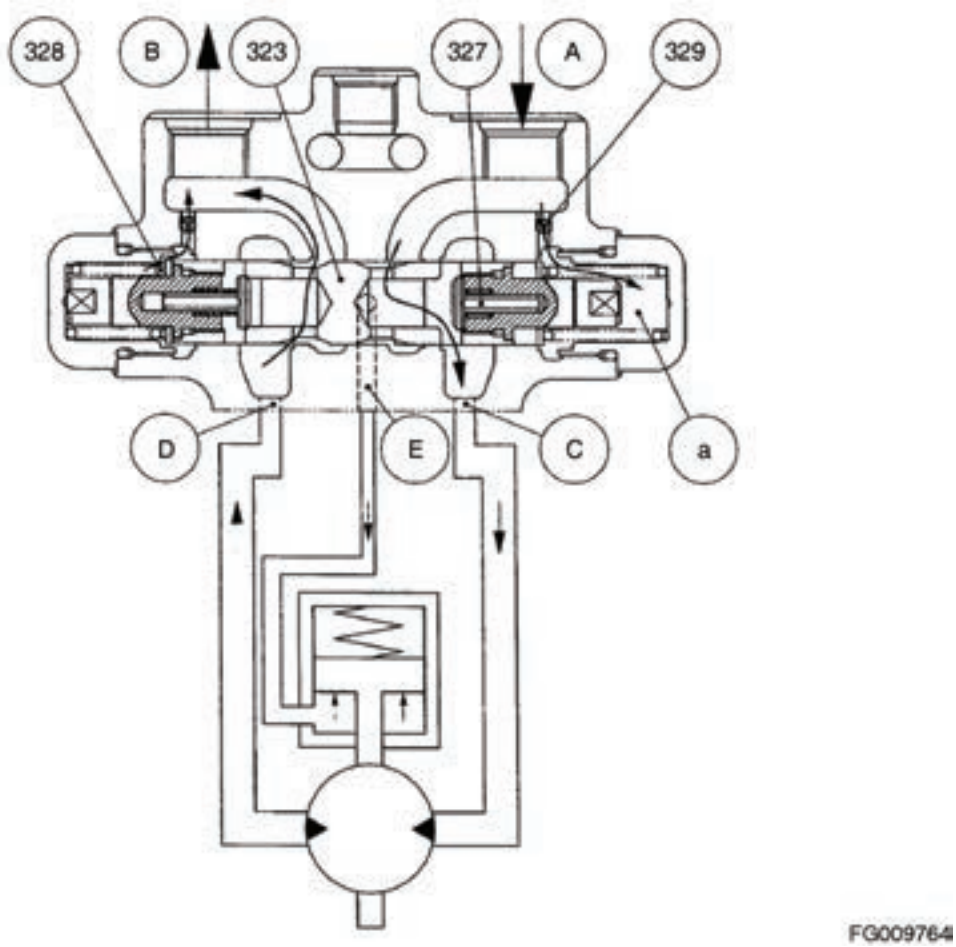


Figure 7

Problem 1	Problem 2	Possible Cause	Action	
Meanders when used as drive motor	Occurs at low pressure	Left-right ejection volume imbalance	Repair pump	
		Left-right hydraulic motor drain volume imbalance	Replace GM motor	O
	Occurs at high pressure	Left-right ejection volume imbalance	Repair pump	
		Left-right hydraulic motor drain volume imbalance	Replace GM motor	O
		Left-right brake valve operation imbalance	Replace brake valve	O
		Left or right control valve has low relief pressure	Set pressure correctly, or replace relief valve	
Speed too slow	Pump ejection volume too low	Pump not operating property	Repair or replace pump	
		High oil leakage outside pump	Repair or replace pump	
		High oil leakage outside hydraulic motor	Replace GM motor	O
Abnormal sounds	From GM motor	Hydraulic motor or reduction gear damage	Replace GM motor	O
	From tubing	Tubing vibration occurring	Clamp tubing	
2 -speed switching does not function	Does not switch low to high speed	High pressure selection check valve malfunction	Inspect, repair or replace	O
		Switching valve malfunction	Repair or replace	O
		Pilot pressure too low	Set to required pressure	
		2-speed switching piston malfunction	Repair or replace	O
	Does not switch from high to low speed	Switching valve malfunction	Repair or replace	O
		2-speed switching piston malfunction	Repair or replace	O

5. Removing the Thrust Plate

A. Remove the Thrust Plate (13).

Figure 26

6. Removing the 1st Stage Gears

A. Remove the Sun Gear (1, 4).

NOTE: *Take care not to drop the Sun Gear (1) down, which is slippery with lubricant.*

Figure 27

B. Join bolts in the three M12 Tabs on the Carrier (1, 3). Lift the Carrier Assembly (1) with crane and move it.

NOTE: *When lifting the Carrier (1) Assembly up, align the center lines of the Hub (1) and the Carrier Assembly (1), and lift up slowly in order to prevent the end of the Planetary Gear (1, 5) damaging the teeth inside the Hub.*

Figure 28

7. Removing the Coupling

A. Remove the Coupling (15) from the Shaft (102).

Figure 29

G. From the Retainer Plate (107), take the Piston Assemblies (105, 106) out (9 sets).

Figure 60

H. Remove the Thrust Ball (108) from the Cylinder Block (104).

Figure 61

I. Remove the three Collars (151) from the Cylinder Block (104).

Figure 62

21. Removing the Spring from the Cylinder Block

A. Place the Cylinder Block (104) on the press work bench.

NOTE: *Spring (114) should be taken out only for replacement.*

To remove the Spring (114), align the axes of the press tool(•×) and the Washer (110), to prevent damage to the Cylinder Block (104) by contact.

Cover the Cylinder Block (104) up with vinyl sheet to prevent damage on the surface of the Cylinder Block (104).

Figure 63

3. Adjusting the Pre-pressure of the Angular Ball Bearing

NOTE: *When the Hub (1), Angular Ball Bearing (24) or Spindle (2) is replaced, carry out pre=pressure adjustment. If the pre-pressure is not appropriate, the Angular Ball Bearing may be fractured soon.*

A. Insert the Lock Washer (22) in the Spindle (2), and measure size C.

B. Measure the width D of the Angular Ball Bearing.

NOTE: *Turn Hub (1) and Angular Ball Bearing (24) by a few rounds to remove loose, before measuring the size.*

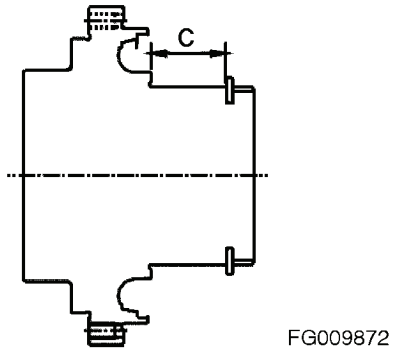


Figure 80

C. Deduct size C with D. Select the Seam (23) for which the skimmer is +0.13 mm ~ +0.17 mm in the Table below.

Symbol	T mm
A	0.9
B	1.0
C	1.1
D	1.2
E	1.3
F	1.4
G	1.5
H	1.6
I	1.7
J	1.8
K	1.9
L	2.0

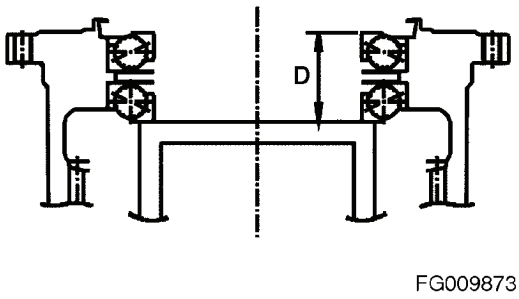


Figure 81

D. Mount the Seam (23) on the Spindle (2).

Figure 82

D. Tighten the Plug (352) by specified torque.

Torque : 12.3 ± 2.45 N•m (1.25 ± 0.25 kgf•m)

Figure 117

E. Tighten the Plug (357) by specified torque.

Torque : 98.1 ± 19.6 N•m (10.0 ± 2.0kgf•m)

Figure 118

17. Assembling the Relief Valve Assembly

A. Mount the two Relief Valve Assemblies (including 203).

Figure 119

B. Tighten the two Relief Valve Assemblies (including 203) by specified torque.

Torque : 98.1 ± 19.6 N•m (10.0 ± 2.0 kgf•m)

Figure 120

SAFETY PRECAUTIONS

CAUTION

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140LCR	5001 and Up

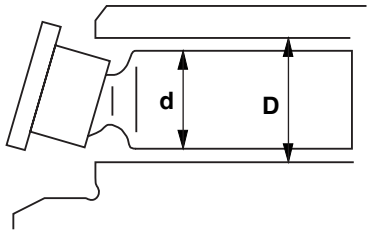
PUMP MAINTENANCE CRITERIA

Worn Part Replacement Criteria

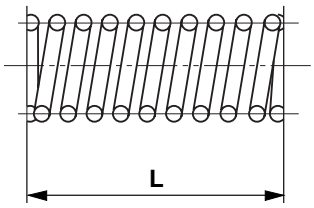
When a part exceeds any of the following criteria, replace of readjust it.

However, when a part is damaged seriously in appearance, replace it without fail.

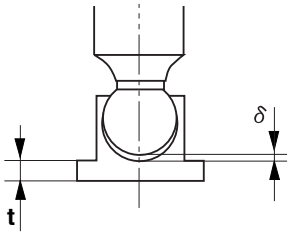
Part name & inspection	Standard Dimension / Recommended replacement vale	Countermeasures
	Pump type	
	K7V63	
Clearance between Piston & cylinder bore (D-d)	0.032 / 0.056	Replace piston or cylinder.
Play between piston & shoe0calking section (δ)	0~0.1 / 0.3	Replace assembly of piston & shoe.
Thickness of shoe (t)	3.9 / 3.7	Replace assembly of piston & shoe.
Free height of cylinder spring (L)	41.1 / 40.3	Replace cylinder spring.
Combined height of set plate & spherical bush (H-h)	17.0 / 15.8	Replace set plate or spherical bush



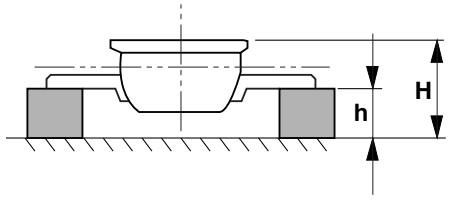
Clearance between piston & cylinder bore (D-d)



Free height of cylinder spring : L



Play between piston & shoe : δ
Thickness of shoe : t



Combined height of set plate & spherical bush : H-h

FG015048

Figure 24

Service Spool Movement

Remove the stopper plug of both pilot caps before using this section.

When necessary, replace the shut-off valve with an overload relief valve and remove the plug at port (P4).

When the spool is moved by being pressurized through the pilot port (pb2) (pa2) of the first service (Section 2), the neutral path (L1) will be closed. The oil supplied through port (P1) flows through the parallel path (L3) load check valve (S2-1), path (S2-2), and spool head to port (B2) (A2). Lubricant oil returns from (A2) (B2) to the tank path Ta via the spool head.

This section makes use of the load check valve which allows external joining at the (P4) port.

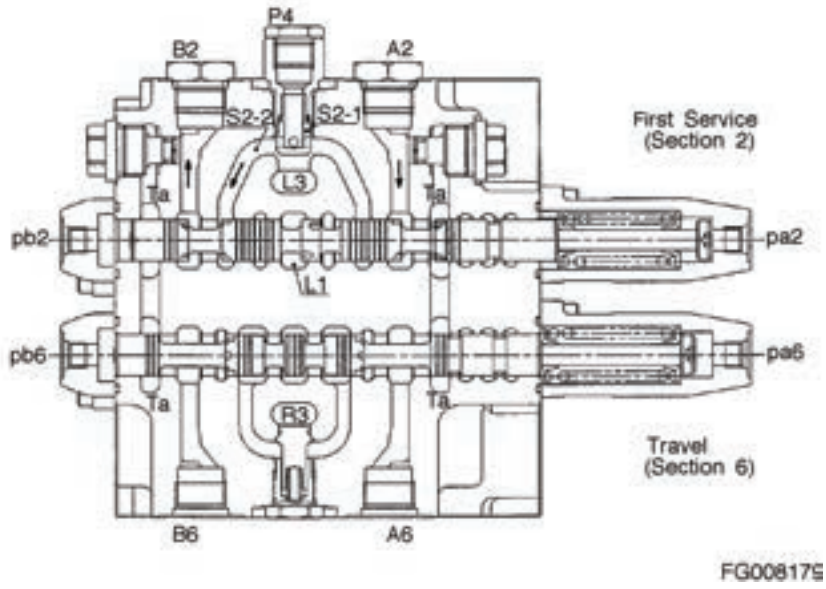


Figure 2

Relief Valve

1. Main Relief Valve in the Body

   The oil supplied through ports P1 and P2 is guided to the main relief valve via the poppet (LP), and via the poppet (RP) and path (3) respectively. The maximum pressure of the P1 and P2 side pumps is controlled by activation of the main relief valve.

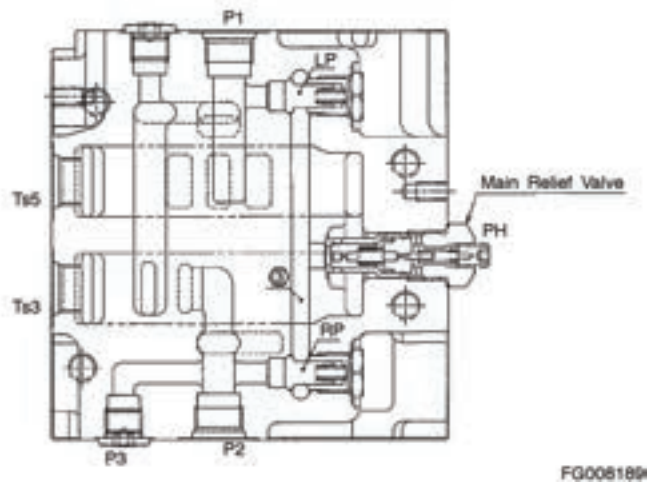


Figure 14

2. Relief Valve for Add-on Pr

   The oil supplied through port Pr is guided to the main relief valve. The maximum pressure of the Pr pump is controlled by activation of the main relief valve.

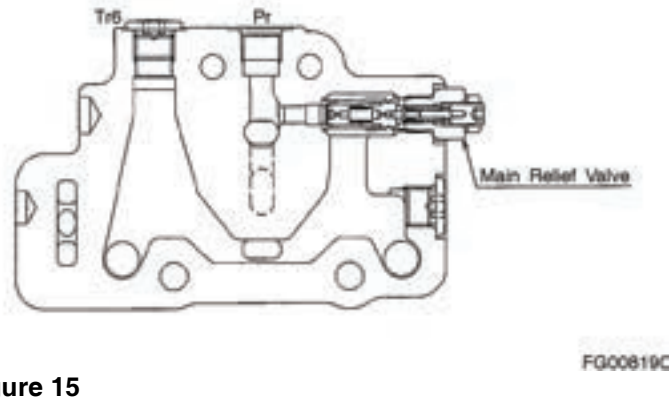


Figure 15

3. Overload Relief Valve

   Each cylinder port of each section is installed with overload relief valves which prevent excessive pressure in the actuator generated by external force.

   Additionally, these relief valves prevent cavitation by sucking in oil from the tank when the cylinder port pressure is negative.

WASHING

All disassembled parts have to be washed clean with mineral oil.

Dry with compressed air. Place them on a clean sheet of paper or a vinyl sheet.

INSPECTION

Carry out a visual inspection on all parts for any foreign matter, scratches, or other defects.

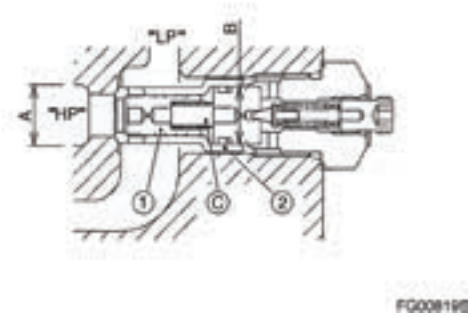
1. Inspect the seat of the load check valve in the valve housing for any scratches, dents, dust, or corrosion. Small scratches may be removed with an oil stone.
2. Inspect the spool for any scratches or dents. Small scratches may be removed with an oil stone.
3. Test sliding surfaces by moving lightly. All grooves and paths must be free from foreign matter.
4. If a spring is broken, seriously deformed, or worn, replace it immediately.
5. If the performance of the relief valve is unsatisfactory, check in accordance with Clause 6, Relief Valve Maintenance.
6. All removed O-rings and back-up rings must be replaced with new ones.
7. Remove the cap and plug, check for any residual painting around the body holes or plugs positions (paint or coating debris left in the valve will cause malfunctions or oil leaks).

RELIEF VALVE

Main Relief Valve

Body Main Relief Valve Operation

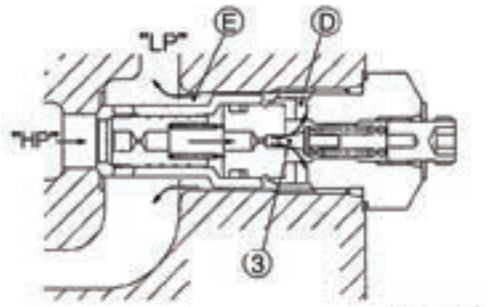
1. This relief valve is inserted between the neutral path "HP" and low pressure path "LP", oil is filled in the inner space (C) through the orifice of the main poppet (1). The sleeve (2) and main poppet (1) are securely seated by the areal difference between "A" and "B".



FG008195

Figure 21

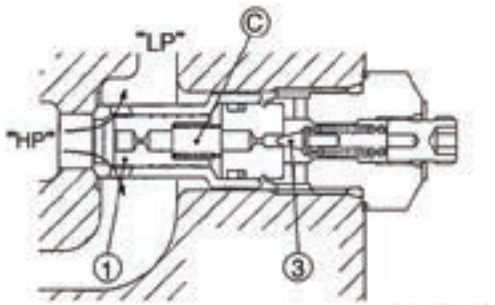
2. When the pressure in the neutral path "HP" reaches the preset pilot spring force, the pilot poppet will be opened. Oil flows around the pilot poppet (3), through the drill hole (D) and circular gap (E), and is guided to the tank path "LP".



FG008196

Figure 22

3. When the pilot poppet (3) is opened, the pressure in the inner space (C) is decreased to open the main poppet (1). Therefore, the oil in "HP" flows directly through path "LP".



FG008197

Figure 23

3. Turn the adjuster clockwise until the desired pressure is reached.

   21.2MPa of pressure is increased by each turn of the adjuster.

4. When the specified pressure is reached, press the adjuster so that it does not rotate, and tighten the lock nut.

   Torque: 27~31N.m

5. Raise the pressure again to check the rated pressure has been obtained.

INSTALLATION

1. Piping should not exert unnecessary force on the valves.
2. Bolts must be tightened uniformly.
3. Welding work near the valves may damage the seals due to excessive heat or flame.
4. Keep the ports covered until connected with a pipe in order to prevent dust.

OPERATION

1. Check that the hydraulic circuit and oil are clean before operation.
2. Oil must be hydraulic oil, with an aniline point of 82~113°C
3. Keep the relief valve below the specified pressure.
4. The pressure difference between the main relief valve and the overload relief valve should be set at a minimum of 2.0MPa.
5. Perform deaeration and warming up before operation.
   - In particular, when the temperatures of the hydraulic oil and valve are low, observe the following instructions in order to prevent the stick of the spool by thermal shock;
   - Do not operate the main relief valve and overload relief valve abruptly without a proper time interval. Let the hydraulic oil circulate in each actuator to warm up all the parts uniformly.
   - Fine or complex operations which may cause local overheating at the orifices of each part should not be done abruptly at low temperature.

GENERAL DESCRIPTION

Theory of Operation

Structure

The remote control valve contains four push rods, spring holders, spools and return springs, which are in the valve casing. The valve works as a pressure reduction valve.

The housing has six ports, which include input port P, tank port T, and four secondary pressure ports.

The electric horn button is installed in the valve handle.

Gear pump pressure is used for operating control spools.

Function

1. Neutral Position

   When the lever is in neutral mode, the spool is pushed upward by return spring. The force of balancing spring, which determines the secondary discharge pressure, is not transmitted to the spool. The input port is closed and the pressure of the output port is the same as the pressure of the tank port T.

2. Control Switch

   Pressing of the push rod starts to press the balance spring, whose force is transferred to the spool to connect the P and T ports, transferring the pilot pressure. Output pressure acts on the bottom of the spool and press the spool upwards until it is balanced with the force of the balance spring.

   In short, the second pressure (output pressure) changes in proportion to the pressing force of the balance spring.

6. Assemble plug kit insert rod seal (18), O-ring (17), and push rod (12) into plug (16) in proper order.

FG013511

Figure 25

FG013512

Figure 26

7. Assemble four springs (11) and stoppers and insert assembled set in case (1) to form a plug kit assembly.

   NOTE: *Pay attention to measurement specifications of stoppers (1 and 3, 2 and 4).*

FG013499

Figure 27

FG013501

Figure 28

SAFETY PRECAUTIONS

CAUTION

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

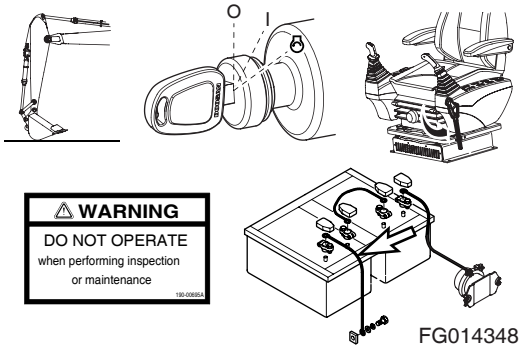
APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140LC	5001 and Up
DX140LCR	5001 and Up
DX180LC	5001 and Up
DX225LC	5434 and Up
DX225NLC	5001 and Up
DX225LL	5001 and Up
DX300LL	5001 and Up
DX300LC	7440 and Up
DX340LC	5980 and Up
DX350LC	5980 and Up
DX380LC	5109 and Up
DX420LC	5327 and Up
DX480LC	5221 and Up
DX520LC	5117 and Up

REMOVAL

1. Park on firm and level ground.
2. Lower front attachment (bucket) to ground.
3. Shut down engine.
4. Set safety lever on "RELEASED" position.
5. Turn starter switch to "I" (ON) position.



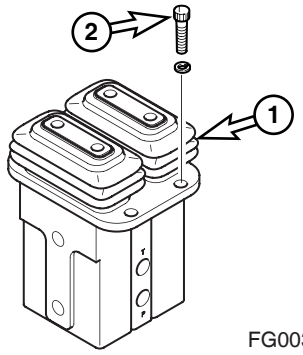
FG014348

Figure 5

WARNING

If engine must be running while performing maintenance, always use extreme caution. Always have one person in the cab at all times. Never leave the cab with engine running.

6. Fully stroke work levers (joysticks) in all directions to relieve any pressure from accumulators.
7. Set safety lever on "LOCK" position.
8. Turn key to "O" (OFF) position and remove from starter switch.
9. Hang a maintenance warning tag on controls.
10. Disconnect negative (-) battery cable leading to frame from battery.
11. Remove cabin under cover by loosening bolts.
12. Tag and disconnect hoses from pedal valve (1, Figure 6). Plug and cap hoses and ports to prevent contamination from entering hydraulic system or component.

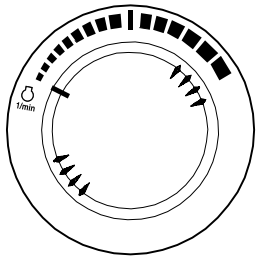


FG003016

Figure 6

START-UP PROCEDURES

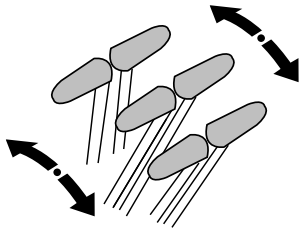
1. Start engine and set throttle at "LOW IDLE."
2. Set safety lever on "UNLOCK" position.



HAOB290L

Figure 39

3. Slowly push and pull both travel lever about five times without a load to vent air from pilot lines.

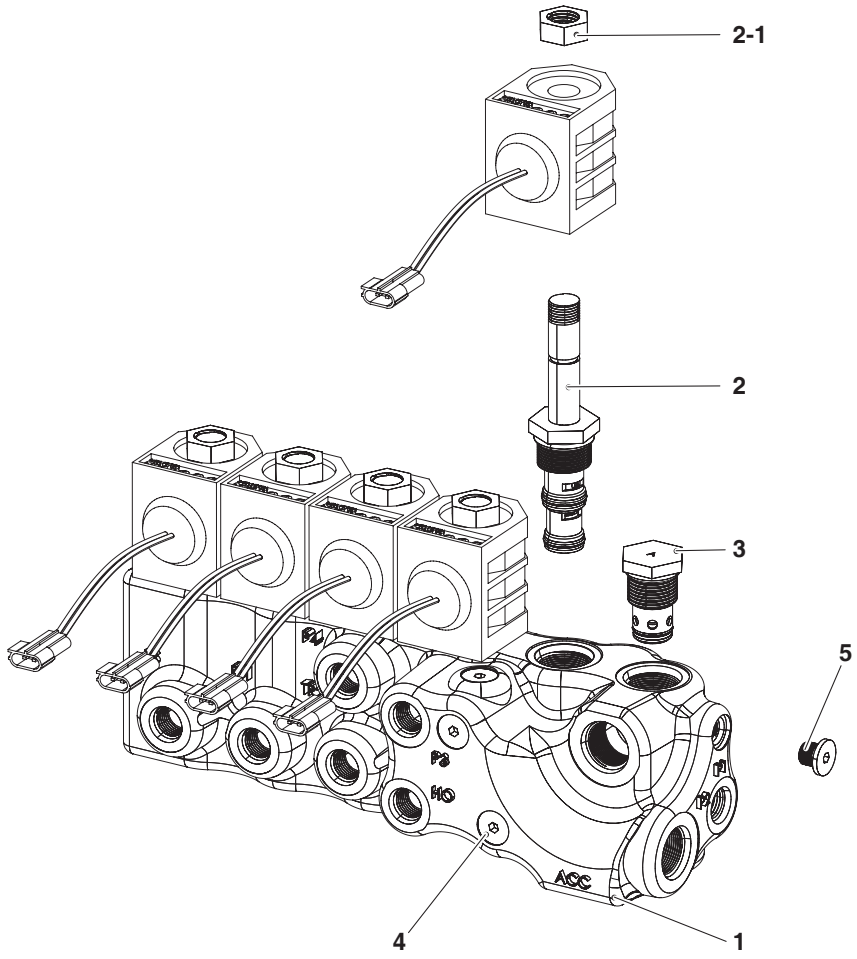


HAOB903L

Figure 40

Assembly Diagram and Tools Required

Table 1 shows assembly torques recommended for components of the solenoid valve package. Designated tools and torques should be followed.



FG015154

Figure 2

Reference Number	Components	Screw Sizes	Torques (kg/cm)	Tools
2	Solenoid valve	UNF7/8 - 14"	200 ± 25	Hex torque wrench/1", socket
2-1	Coil Lock Nut	UNF1/2 -20"	60 ± 2	Hex torque wrench/19 mm, socket
3	Check Valve	UNF7/8 - 14"	400 ± 2	Hex torque wrench/1", socket
4	PT 1/4" Plug	PF 1/4 19"	250 ± 25	Torque wrench/ 19 mm, socket
5	PT 1/8" Plug Bolt	PT 1/8 28"	280	Torque wrench/ 5 mm, wrench socket

SAFETY PRECAUTIONS

CAUTION

Follow all safety recommendations and safe shop practices outlined in the front of this manual or those contained within this section.

Always use tools and equipment that are in good working order.

Use lifting and hoisting equipment capable of safely handling load.

Remember, that ultimately safety is your own personal responsibility.

APPLICABLE MODELS

The contents of this section apply to the following models and serial number ranges.

MODEL	SERIAL NUMBER RANGE
DX140LC	5001 and Up
DX140LCR	5001 and Up
DX140W	5001 and Up
DX160W	5001 and Up
DX180LC	5001 and Up
DX210W	5001 and Up
DX225LC	5001 and Up
DX225NLC	5001 and Up
DX255LC	5001 and Up
DX300LC	5001 and Up
DX340LC	5001 and Up
DX420LC	5001 and Up
DX480LC	5001 and Up
DX520LC	5001 and Up

Table of Contents

Hydraulic Schematic (DX140LCR)

ENGINE PREHEATING SYSTEM

An air heater (8) is installed in the intake manifold of the engine. When the starter switch (5) is turned "ON," the current flows from the battery (1) → fusible link (3) → fuse box (6) → "B" terminal of starter switch (5) → "BR" terminal of starter switch (5) → "1-39" terminal of engine controller (12), causing current to flow though "1-16" terminal of engine controller (12) → "C and D" terminals of preheat relay (7) → "1-04" terminals of engine controller (12) → ground.

This current flow causes the coil in preheat relay (7) to be activated, closing contacts.

When the contacts of the preheat relay (7) are closed, the heating coils of the air heating device (8) are heated by current flowing from the battery (1) → battery relay (2) → preheat relay (7) → air heater (8) → ground.

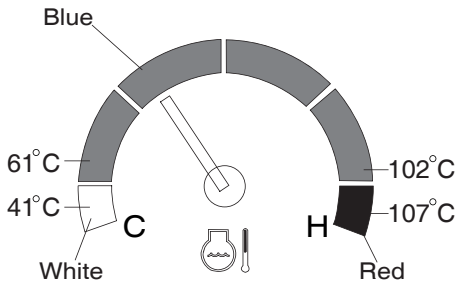
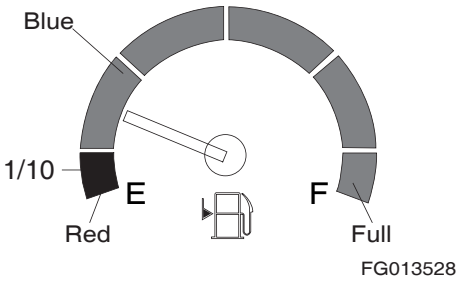
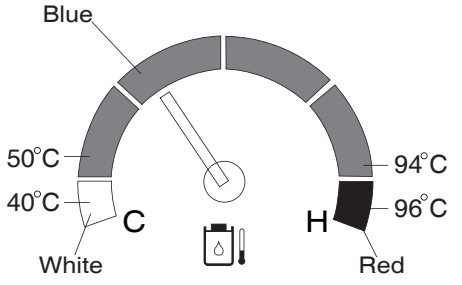
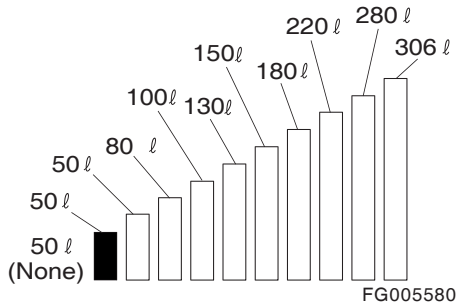
The duration of the heating cycle depends on the temperature of engine coolant. The preheat indicator light in the instrument panel (9) will turn "ON" during preheating cycle.

The preheat relay (7) is controlled by the engine controller (12) and operates only at temperatures of 10°C (50°F) and below.

The longer the preheating period, the lower the temperature of coolant is.

OPERATION

Instruments

Function	Display	Sensor Specification	
		Input Terminal	Input Specification
Coolant Temperature		ECU-CAN Communication	
Fuel Level		CN3-7 CN3-8	1/10 LCD (Red Zone) Blinking → over 5K ohms FULL → under 525 ohms
Hydraulic Oil Temperature		CN3-9 CN3-10	40°C (104°F) → 1,397 ohms 50°C (122°F) → 1,139 ohms 60°C (140°F) → 881 ohms 94°C (201°F) → 190 ohms 96°C (205°F) → 177 ohms (When reading increase)
Flow Adjusting		(Output Terminal) CN1-19 CN1-20	50 l/min → 615 mA 50 l/min → 519 mA 80 l/min → 482 mA 100 l/min → 409 mA (Default Set) 220 l/min → 335 mA 308 l/min → 300 mA

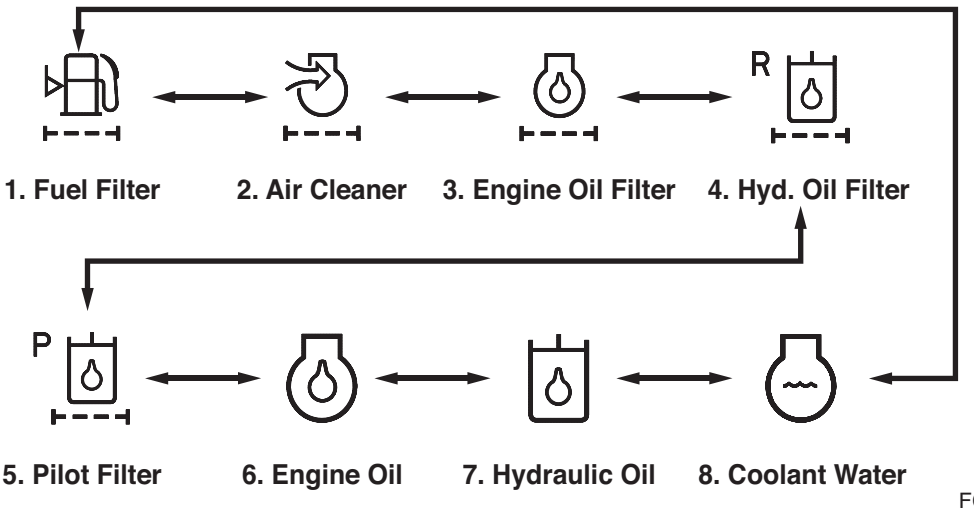


Figure 20

Adjust Display

Pressing the Enter Button (↵, 3 on Figure 12) in the main menu after putting cursor on Adjust Display brings Adjust Display.

Screen brightness, contrast, back light can be adjusted using the Up Arrow Button (▲, 1 on Figure 12) or the Down Arrow Button (▼, 2 on Figure 12).

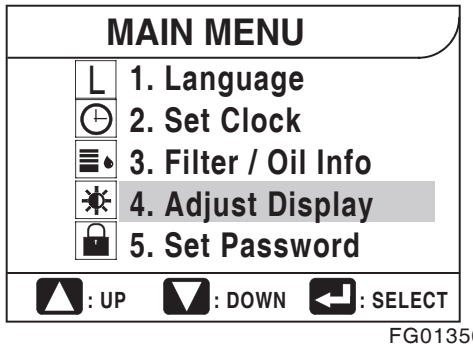


Figure 21

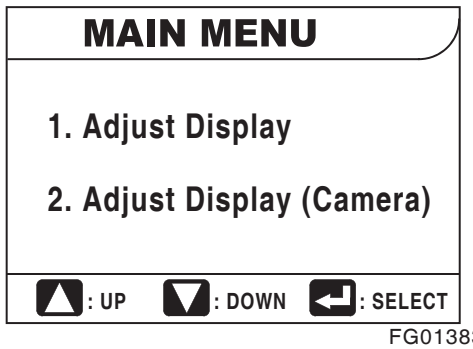


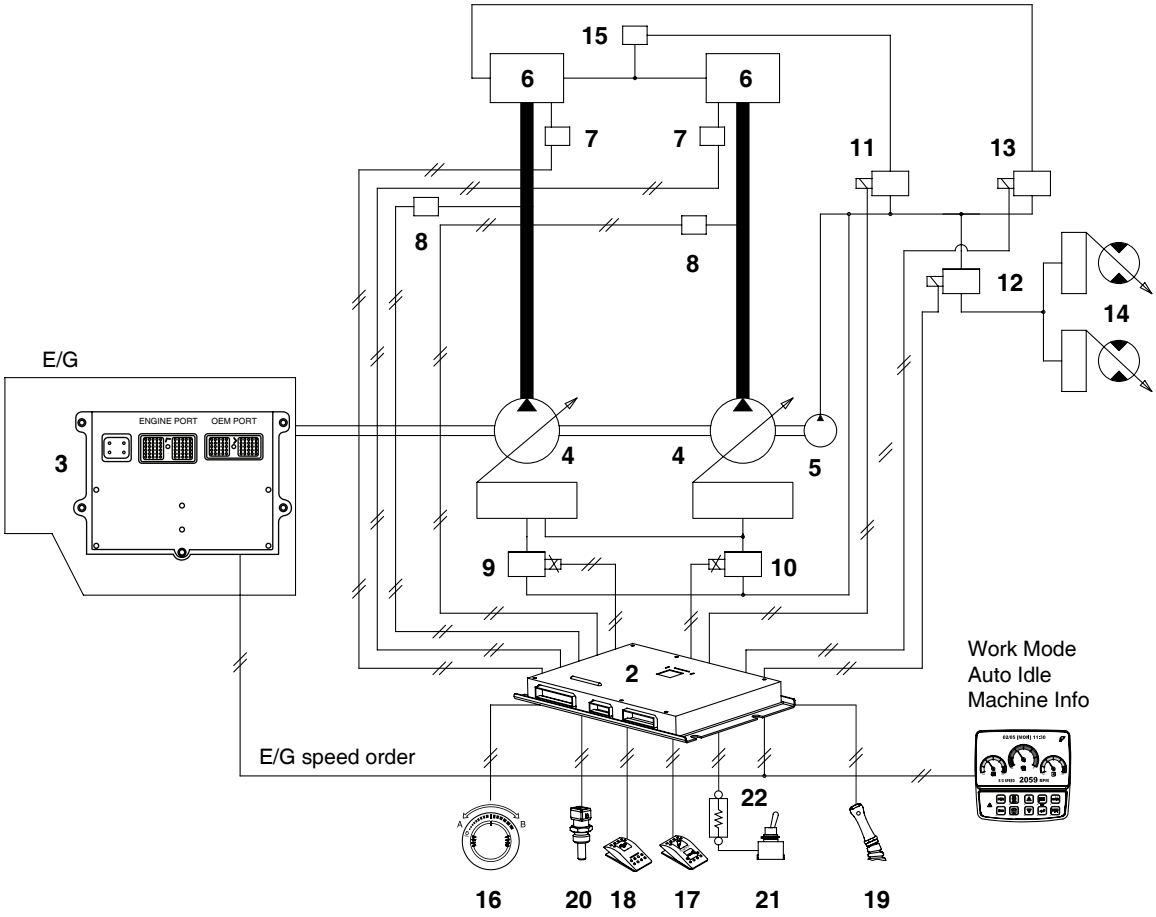
Figure 22

Failure Information Code at Machine Side

Code	Failure Component	Measuring Points	Correct Value		Remarks
			Active	Passive	
V201	Gauge Panel Communication Error	CN7-4 CN7-5	-	R = 60 ± 5 Ω	It is a composite resistance of CAN line. This value has to be measured by connected condition of CAN line.
V202	ECU Communication Error	CN4-4 CN4-5	-	R = 60 ± 5 Ω	
V210	Pump P/V	CN1-10 CN1-21	-	R = 18 ± 2 Ω (25°C (77°F))	Pump proportional pressure reducing valve.
V211	Cooling Fan P/V		-	-	N.A.
V212	Flow Control P/V	CN1-19 CN1-20	-	R = 14 ± 2 Ω (25°C (77°F))	Flow control proportional pressure reducing valve.
V213	Relief Pressure Up S/V	CN1-1 CN1-11	V = V_volt (Note 4.)	R = 26.2 ± 2 Ω (25°C (77°F))	Breaker/boost/ shear selector switch has to be selected as a boost function and the boost switch on the right-hand joystick is "ON" status.
V214	High Speed S/V	CN1-1 CN1-12	V = V_volt	R = 26.2 ± 2 Ω (25°C (77°F))	Voltage is only measured when the pressure switch (Py) is turned "ON."
V216	Reverse Fan Speed S/V		-	-	N.A.
V217	Starter Relay	CN1-1 CN1-15	V = V_volt	-	It has to be measured in engine start up state.
V218	After Heat Relay	1-16 1-04	-	-	N.A.
V220	Front Pump Press. Sensor	CN3-1 CN3-2	V = 1V	-	It has to be measured in engine stop state.
V221	Rear Pump Press. Sensor	CN3-3 CN3-4	V = 1V	-	

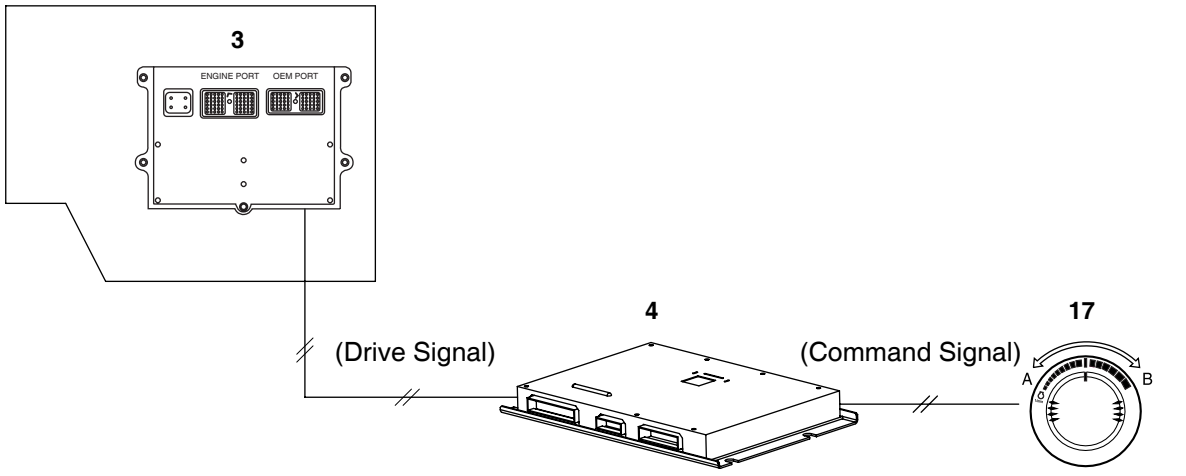
ELECTRONIC HYDRAULIC CONTROL SYSTEM (e-EPOS)

Control System Schematic



FG015090

Figure 51



FG015092

Figure 59

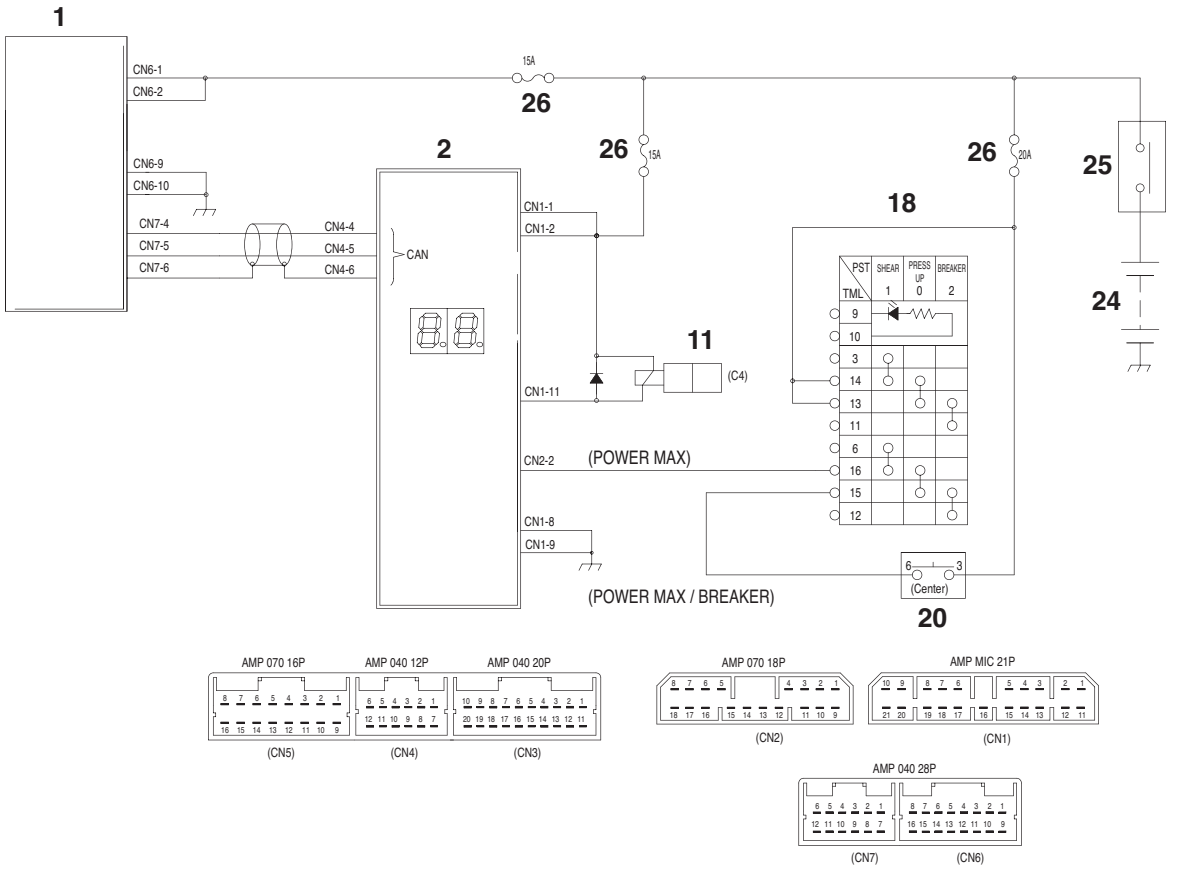
Reference Number	Description
3	Engine Controller
4	e-EPOS Controller

Reference Number	Description
17	Engine Control Dial

When the engine control dial is moved the output voltage changes according to the dial position.

The e-EPOS controller converts this output voltage of dial to digital signal and sends it to the engine controller by CAN line. According to the dial command, the quantity of fuel injection is adjusted.

Power Boost Control - Circuit Diagram



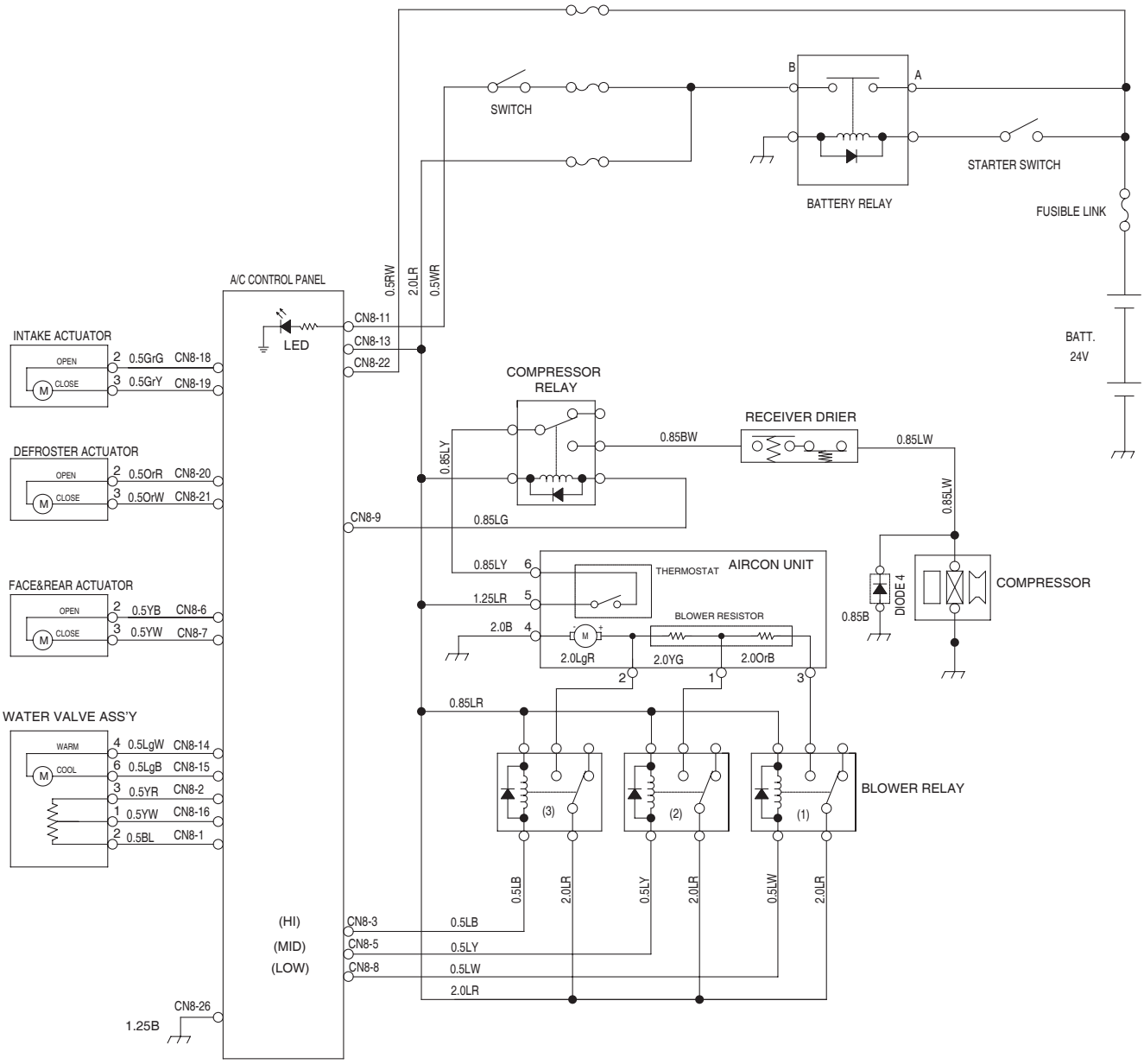
FG000586

Figure 65

Reference Number	Description
1	Instrument Panel
2	e-EPOS Controller
11	Solenoid Valve (Pressure Up)
18	Breaker/Boost/Shear Selector Switch

Reference Number	Description
20	Power Boost Switch (Top of Right Work Lever)
24	Battery
25	Battery Relay
26	Fuse

Air Conditioner/heater Circuit Diagram

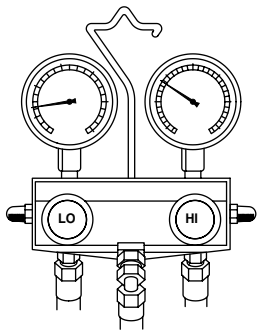


FG015071

Figure 73

Refrigerant Pressure Check

1. Open all doors and windows.
2. Install manifold gauge set.
3. Start engine and maintain engine speed at 1,800 - 2,000 rpm.



HDA6074L

Figure 84

4. Check high / low-pressure of refrigerant.

1	**High-pressure: 8.0 - 10.0 kg/cm^2 (114 - 142 psi)** **Low-pressure: Approximately 1.0 kg/cm^2 (14 psi)**		
Possible Cause: Low Refrigerant Level			
Step	**Inspection Item**		**Remedy**
1	Check for traces of refrigerant oil.	Yes	Reassemble using correct tightening torque.
		No	Go to next step.
2	Using a leak detection device or soapy water check for refrigerant leakage at all major components and joints.	Yes	Repair leaking component.
		No	Recharge system to correct pressure.

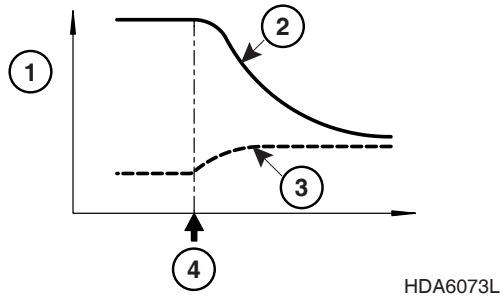
2	**High-pressure: Over 23 kg/cm^2 (327 psi)** **Low-pressure: Approximately 2.5 - 3.0 kg/cm^2 (36 - 43 psi)**		
Possible Cause: Overcharge, Frost on condenser			
Step	**Inspection Item**		**Remedy**
1	Check for condenser pin damage or contamination.	Yes	Clean, repair or replace condenser.
		No	Refrigerant overcharge.

3	**High-pressure: Approximately 20 - 25 kg/cm^2 (285 - 356 psi)** **Low-pressure: Approximately 2.5 - 3.5 kg/cm^2 (36 - 50 psi)**
Possible Cause: Air in system.	
1. Recover any remaining refrigerant. 2. Vacuum out system. 3. Recharge system. **NOTE:** *If the system has been exposed to the air for a long period of time, replace the receiver dryer.*	

Inspecting System For Leakage

After completing charging procedures, clean all joints and connections with a clean dry cloth. Using a refrigerant leak detecting device or soapy water, inspect system for leaks starting from the high-pressure side.

NOTE: *When the refrigerant circulation has been stopped the high-pressure will start to decrease and the low-pressure will start to increase until they are equalized. Starting the inspection from the high side will result in a accurate test.*



HDA6073L

Figure 93

Reference Number	Description
1	Pressure
2	High-pressure
3	Low-pressure
4	Compressor Stop

Inspection Procedure

1. High-pressure Side

   Compressor outlet → condenser inlet → receiver dryer inlet → air conditioner unit inlet.

2. Low-pressure side

   Compressor inlet → air conditioner unit outlet.

3. Compressor

   Compressor shaft area, bolt hole area and magnetic clutch area.

4. Receiver dryer

   Pressure switch and plug area.

5. Connection valve area

   Inspect all valve areas.

   Verify all valves are capped to prevent leaking.

   Check for foreign material inside of valve cap.

6. Interior of air-conditioning unit.

   After stopping engine, insert detector probe into drain hose. (Leave inserted for 10 seconds minimum.)

   NOTE: *When inspecting leakage from the air-conditioning unit, perform the inspection in a well ventilated area.*