SENR6557-01
January 1998

Specifications

3100 HEUI Diesel Truck Engine

8WL1-Up
1WM1-Up
4ES1-Up
2CW1-Up
8HW1-Up
7LZ1-Up

Engines Equipped With
Hydraulically Actuated Electronic Unit Injectors (HEUI)

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "WARNING" as shown below.

⚠ WARNING

The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning, explaining the hazard, can be either written or pictorially presented.

Operation that may cause product damage are identified by NOTICE labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warning in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. Caterpillar dealers have the most current information available. For a list of the most current publication form numbers available, see the Service Manual Contents Microfiche, REG1139F.

Index

Specifications

NOTE: Refer to the complete Service Manual for information not found here.

Introduction

The specifications given in this book are on the basis of information available at the time the book was written. These specifications give the torques, operating pressures, measurements of new parts, adjustments and other items that will affect the service of the product.

When the words "use again" are in the description, the specification given can be used to determine if a part can be used again. If the part is equal to or within the specification given, use the part again.

When the word "permissible" is in the description, the specification given is the "maximum or minimum" tolerance permitted before adjustment, repair and/or new parts are needed.

A comparison can be made between the measurements of a worn part and the specifications of a new part to find the amount of wear. A part that is worn can be safe to use if an estimate of the remainder of its service life is good. If a short service life is expected, replace the part.

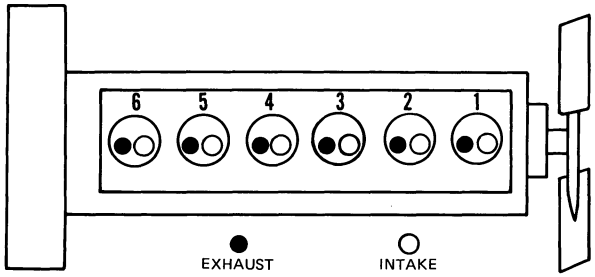
NOTE: The specifications given for "use again" and "permissible" are intended for guidance only and Caterpillar Inc. hereby expressly denies and excludes any representation, warranty or implied warranty of the reuse of any component.

Reference: See 3100 HEUI Diesel Truck Engine, SENR6558, for Systems Operation, Testing and Adjusting.

Specifications

Engine Design

8WL1-UP



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Cylinder And Valve Location

Bore ..... 105.025 ± 0.025 mm (4.134 ± 0.0010 in)

Stroke ..... 127 mm (5.0 in)

Displacement ..... 6.6 liter (403 cu in)

Number Of Cylinders 6

Cylinder Arrangement ..... In-line

Valves Per Cylinder 2

Valve Lash Setting

Intake ..... 0.38 mm (.015 in)
Exhaust ..... 0.64 mm (.025 in)

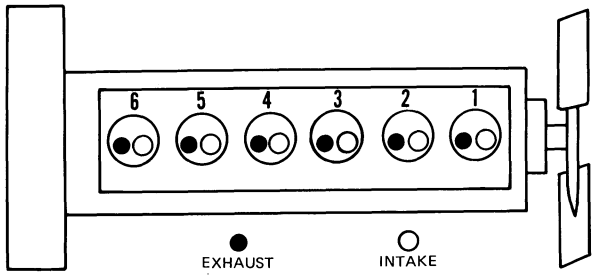
Type of Combustion ..... Direct Injection

Firing Order 1-5-3-6-2-4

Direction of Crankshaft Rotation (when viewed from flywheel end) ..... Counterclockwise

NOTE: Front end of engine is opposite the flywheel end. Left side and right side of engine are as viewed from flywheel end. No. 1 cylinder is the front cylinder.

1WM1-UP



C21097P1

Cylinder And Valve Location

Bore ..... 110.025 ± 0.025 mm (4.331 ± 0.0010 in)

Stroke ..... 127 mm (5.0 in)

Displacement ..... 7.25 liter (442 cu in)

Number Of Cylinders 6

Cylinder Arrangement ..... In-line

Valves Per Cylinder 2

Valve Lash Setting

Intake ..... 0.38 mm (.015 in)
Exhaust ..... 0.64 mm (.025 in)

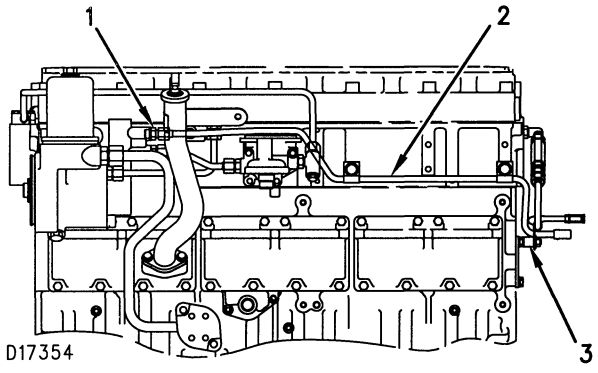
Type of Combustion ..... Direct Injection

Firing Order 1-5-3-6-2-4

Direction of Crankshaft Rotation (when viewed from flywheel end) ..... Counterclockwise

NOTE: Front end of engine is opposite the flywheel end. Left side and right side of engine are as viewed from flywheel end. No. 1 cylinder is the front cylinder.

Fuel Lines Group



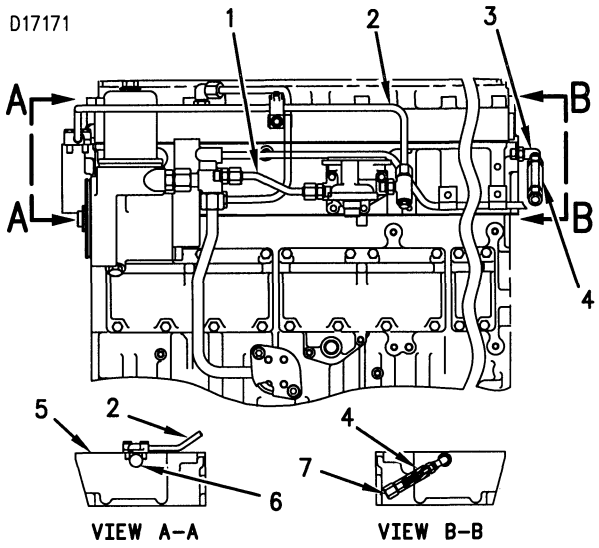
Left Side Of Engine

(1) Fuel inlet port.

(2) Tube assembly (fuel from tank).

(3) Spacer.

Fuel Filter Lines Group



Left Side Of Engine.

(1) Tube assembly (fuel transfer pump to fuel filter).

(2) Tube assembly (fuel filter to fuel gallery).

(3) Fitting (fuel return to tank).

(4) Regulating valve assembly (maintains minimum fuel system pressure).

Minimum at low idle ..... 400 kPa (58 psi)

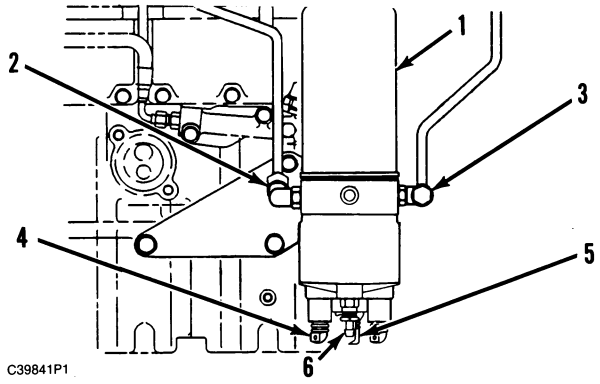
NOTE: Refer to the Testing and Adjusting Section of the Service Manual, for the procedure to check the fuel pressure.

(5) Cylinder head.

(6) Fuel gallery.

(7) Fuel outlet port.

Fuel Heater And Water Separator (If Equipped)



(1) Fuel filter.

(2) Fuel inlet.

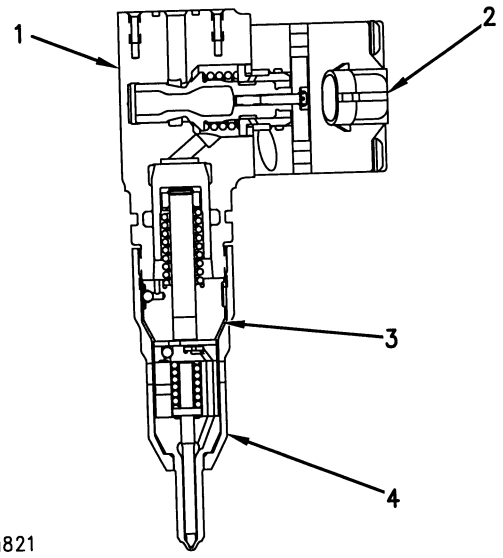
(3) Fuel outlet.

(4) Heater ..... 12 V/150 W

(5) Temperature sensor.
Fuel temperature 2°C (35°F) ..... ON
Fuel Temperature 7°C (45°F) ..... OFF

(6) Drain.

Hydraulic Electronic Unit Injector (HEUI)



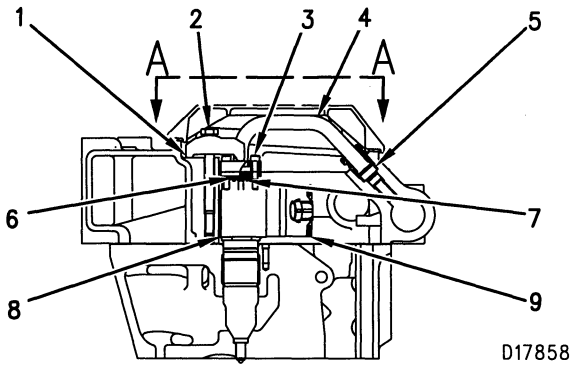
(1) Body group.

(2) Solenoid valve assembly.

(3) Barrel group.

(4) Nozzle group.
Six orifices evenly spaced.

Hydraulic Oil Lines



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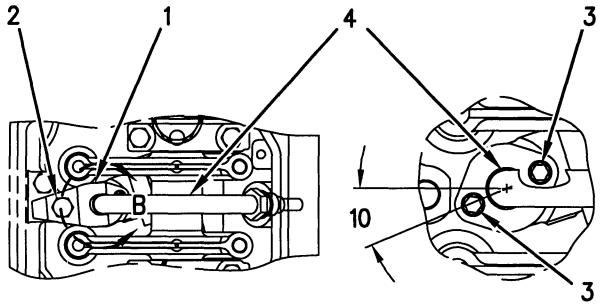

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DETAIL B

Section View A-A.

(1) Injector hold-down clamp.

(2) Bolt. Tighten to torque ..... 30 ± 7 N•m (22 ± 5 lb ft)

(3) Bolt. Tighten to torque ..... 5 ± 0.5 N•m (45 ± 4 lb in)

(4) Jumper tube assembly.
Tighten flare nut to ..... 40 ± 5 N•m (30 ± 4 lb ft)

NOTE: See jumper tube (installation) for injector orientation and installation in this module.

(5) Orifice fitting. Tighten to a torque ..... 25 ± 3 N•m (18 ± 2 lb ft)

(6) Seat.

(7) O-ring.

(8) Hydraulic electronic unit injector.

(9) Solenoid.

(10) Angle of bolt orientation with jumper tube assembly (4). ..... 26 ± 3 degrees

Hydraulic electronic unit injector orientation/jumper tube installation:

Rotate hydraulic electronic unit injector (8) until the solenoid (9) touches the rear rocker stand. Rotate the hydraulic electronic unit injector (8) back 1.0 to 6.0 mm (.039 to .236 in). This will orient the injector in the cylinder head correctly.

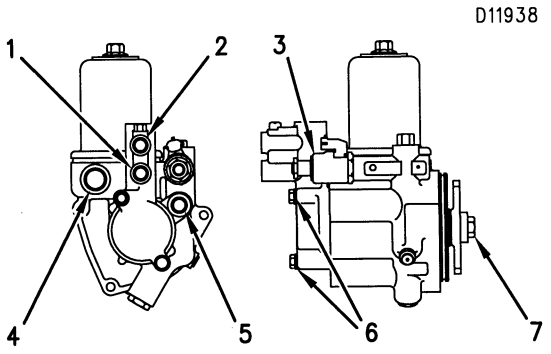
Install orifice fitting (5) with O-ring and tighten to a torque of 25 N•m (18 lb ft). Install O-ring (7) into the top groove of the hydraulic electronic unit injector.

Position flare seat on center of the hydraulic electronic unit injector (8). Install jumper tube assembly (4) into manifold end first, then onto flare seat on the hydraulic electronic unit injector. Start flare nut into manifold and tighten by hand ensuring the flare is seated on the fitting (5). Install the bolts (3) at the hydraulic electronic unit injector end of jumper tube assembly (4) making sure that seat (6) is correctly positioned under the injector end of the jumper tube assembly (4). Tighten evenly until hand tight. Install hydraulic electronic unit injector hold-down clamp (1) and tighten to 10 N•m (7 lb ft). This should "bottom" the hydraulic electronic unit injector (8) in its bore and position the jumper tube flange parallel to the hydraulic electronic unit injector's top surface.

NOTE: The jumper tube should not "rock" by hand after the bolt is torqued. If it does, increase torque up to 20 N•m (15 lb ft).

Torque flare nut at manifold end to 40 N•m (30 lb ft). Remove hydraulic electronic unit injector hold-down clamp (1). Torque the hydraulic electronic unit injector's bolts (3) to 2 N•m (18 lb in), then re-torque to 5 N•m (45 lb in). Install hold-down clamp (1) and torque bolt (2) to 30 N•m (22 lb ft).

Hydraulic Pump Group (Fuel Transfer And High Pressure Oil Pumps)



(1) Fuel pump outlet. Final installation into pump, tighten to a torque of ..... 35 ± 3 N•m (26 ± 2 lb ft)

(2) Fuel pump inlet. Final installation, tighten to a torque of ..... 35 ± 3 N•m (26 ± 2 lb ft)

(3) Injection actuation pressure control valve.

NOTICE

Removal procedure for the injection actuation pressure control valve requires extreme caution. First, disconnect electrical connection. Second, remove injection actuation pressure control valve's solenoid assembly. Third, remove the Injection actuation pressure control valve using the crow's foot with an extension.

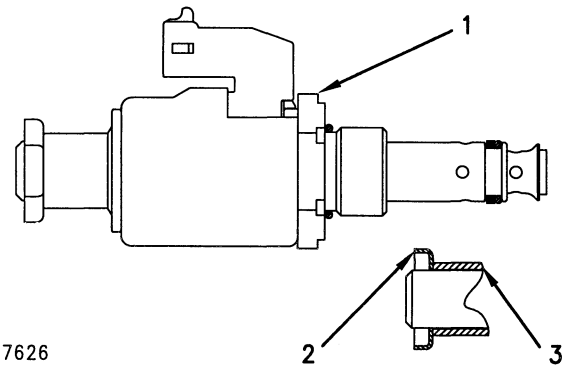
(4) Oil pump inlet fitting. Final installation, tighten to a torque of ..... 26 ± 3 N•m (19 ± 2 lb ft)

(5) Oil pump outlet fitting. Final installation, tighten to a torque of ..... 17 ± 2 N•m (13 ± 1 lb ft)

(6) Bolt. Tighten to a torque of ..... 25 ± 3 N•m (18 ± 2 lb ft)

(7) Bolt. Tighten to a torque of ..... 110 ± 14 N•m (80 ± 10 lb ft)

Injection Actuation Pressure Control Valve

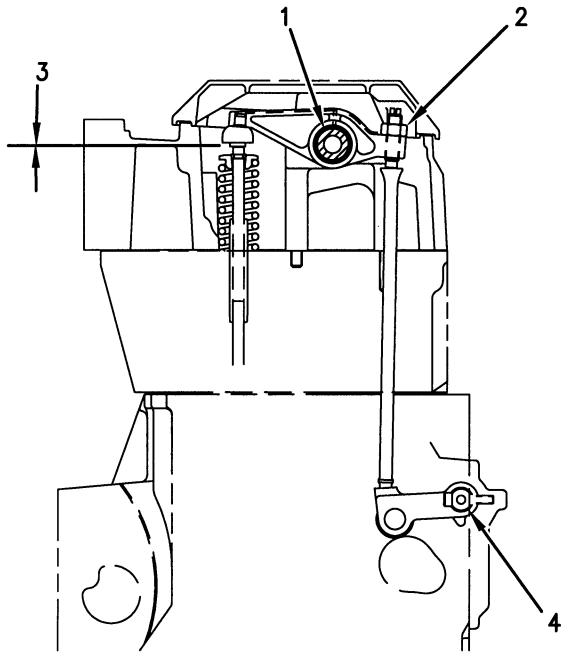


(1) Injection actuation pressure control valve. Final installation, tighten to a torque of ..... 50 ± 5 N•m (37 ± 4 lb ft)

(2) Spacer.

(3) Nut. Final installation, tighten to a torque of ..... 5.5 ± 1.5 N•m (49 ± 13 lb in)

Valve Rocker Arms And Lifters



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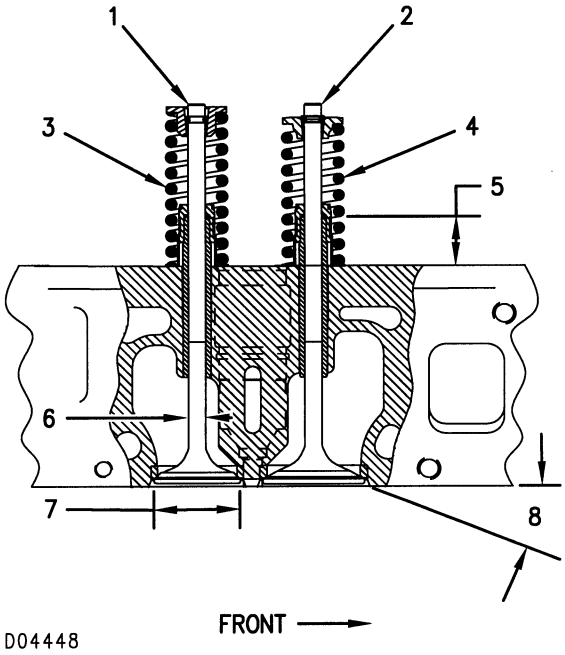
(1) Bore in rocker arm for shaft (new) .... 24.808 ± 0.020 mm (0.9767 ± 0.0008 in)
Diameter of shaft (new) ..... 24.755 ± 0.010 mm (0.9746 ± 0.0004 in)

(2) Torque for locknut ..... 25 ± 7 N•m (18 ± 5 lb ft)

(3) Valve lash:
Intake valves ..... 0.38 mm (0.015 in)
Exhaust valves ..... 0.64 mm (0.025 in)

(4) Bore in lifter arm for shaft (new) ..... 15.670 ± 0.012 mm (0.6169 ± 0.0005 in)
Diameter of shaft (new) ..... 15.620 ± 0.012 mm (0.6150 ± 0.0005 in)
Tighten bolts to a torque of ..... 13 ± 3 N•m (10 ± 2 lb ft)

Valves



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NOTE: Intake and exhaust valve stems are to be coated with engine oil prior to installation in the cylinder head.

NOTE: Intake and exhaust valve tips are to be coated with 8T2988 Camshaft Break In Lubricant (only after assembly of the retainer).

(1) Exhaust valve.

(2) Intake valve.

(3) 6I2307 Spring for exhaust valve.
Free length ..... 81.0 mm (3.19 in)
Assembled length ..... 70.8 mm (2.79 in)
Load at assembled length ..... 612 ± 31 N (140 ± 7 lb)
Minimum operating length ..... 59 mm (2.3 in)
Load at minimum operating length ..... 1325 ± 66 N (300 ± 15 lb)

(4) 7C4273 Spring for intake valve.
Free length ..... 71.0 mm (2.80 in)
Assembled length ..... 65.86 mm (2.593 in)
Load at assembled length ..... 217 ± 22 N (49 ± 5 lb)
Minimum operating length ..... 50.7 mm (2.00 in)
Load at minimum operating length ..... 858 ± 43 N (190 ± 10 lb)

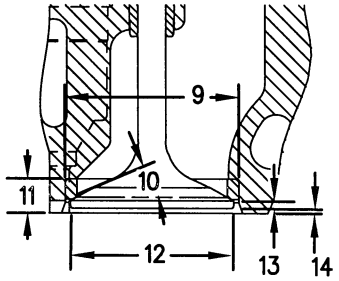
(5) Height to top of valve guides ..... 23.00 ± 0.50 mm (0.906 ± 0.020 in)
Install valve guide with 12.065 mm (0.4750 in) diameter on spring side of the head.

Assemble with seal seated against top of valve guide.

(6) Diameter of valve stems (new) ..... 8.000 ± 0.008 mm (0.3150 ± 0.0003 in)
"Use again" minimum diameter of valve stems ..... 7.965 mm (0.3136 in)
Bore in valve guides with guides installed in head ..... 8.072 ± .013 mm (0.3178 ± 0.0005 in)
"Use again" maximum bore in valve guides with guides installed in head ..... 8.080 mm (0.3181 in)

(7) Diameter of valve head:
Intake valve ..... 47.00 ± 0.13 mm (1.850 ± 0.005 in)
Exhaust valve ..... 40.00 ± 0.13 mm (1.575 ± 0.005 in)

(8) Angle of valve faces:
Intake valve ..... 29 ¾ ± ¼ degrees
Exhaust valve ..... 45 ± ¼ degrees



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(9) Diameter of valve seat inserts:
Intake valve ..... 50.000 ± 0.013 mm (1.9685 ± 0.0005 in)
Exhaust valve .. 43.000 ± 0.013 mm (1.6929 ± 0.0005 in)
Bore in head for valve seat insert:
Intake valve ..... 49.931 ± 0.013 mm (1.9658 ± 0.0005 in)
Exhaust valve .. 42.931 ± 0.013 mm (1.6902 ± 0.0005 in)
Valve seat insert must be shrunk by reduced temperature before installing in head.

(10) Angle of valve seat inserts:
Intake valve ..... 30 ¼ ± 1 degrees
Exhaust valve ..... 45 ½ ± 1 degrees

(11) Depth of bore in head for valve seat insert ..... 10.00 ± 0.13 mm (0.394 ± 0.005 in)

(12) Outside diameter of the seating face of the valve seat insert:
Intake valve ..... 44.029 ± 0.085 mm (1.733 ± 0.0033 in)
Exhaust valve .... 38.077 ± 0.046 mm (1.500 ± 0.0018 in)

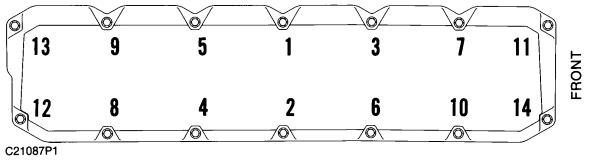
NOTE: Do not reuse or recondition valve seat inserts if the outside diameter is greater than specified.

(13) "Use again" thickness of valve lip:
Intake valve ..... 1.80 mm (0.071 in)
Exhaust valve ..... 1.50 mm (0.059 in)

(14) Distance from head of valve to the cylinder head face (valve closed):
Exhaust valve
Maximum permissible ..... 2.85 mm (0.112 in)
Minimum permissible ..... 2.67 mm (0.105 in)
Intake valve
Maximum permissible ..... 2.05 mm (0.081 in)
Minimum permissible ..... 1.13 mm (0.044 in)

NOTE: For further information refer to: Guidelines for Reusable Parts and Salvage Operations, SEBF8218.

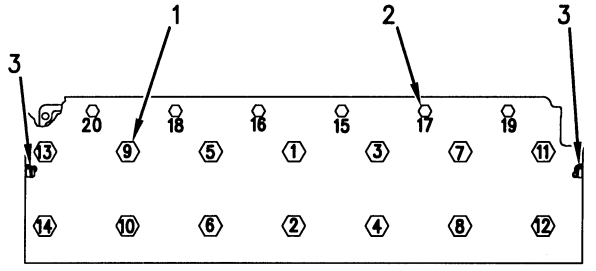
Valve Cover



Valve Cover Bolts Tightening Sequence

Tighten valve cover bolts in sequence shown to a torque of ..... 12 ± 3 N•m (9 ± 2 lb ft)

Cylinder Head



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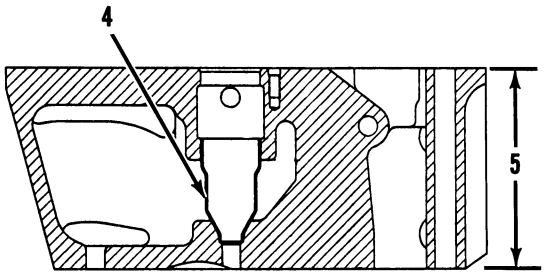
(1) Large bolts (M20).

(2) Small bolts (M10).

Instructions for installing bolts (1) and (2): Put engine oil on the threads of the bolts and tighten them as follows:

a. Tighten large bolts in number sequence shown to a torque of ..... 150 ± 15 N•m (110 ± 11 lb ft)
b. Tighten large bolts in number sequence shown to a torque of ..... 435 ± 20 N•m (320 ± 15 lb ft)
c. Retighten large bolts in number sequence shown to ..... 435 ± 20 N•m (320 ± 15 lb ft)
d. Tighten small bolts in number sequence shown to a torque of ..... 55 ± 7 N•m (41 ± 5 lb ft)

(3) Depth that all cup plugs are installed (measured from head face to top edge of plug) ..... 1.25 ± 0.25 mm (0.049 ± 0.010 in)



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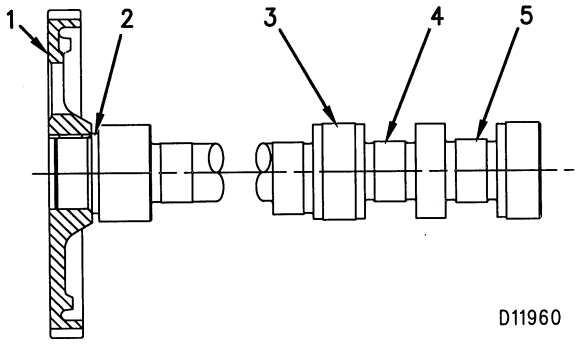
Cylinder Head Cross Section

(4) Sleeve. For replacement of a hydraulic unit injector sleeve, refer to Using The 122-7093 Sleeve Replacement Tool Group, Special Instruction SEHS9120.

(5) Height of cylinder head (new) ..... 103.00 ± 0.20 mm (4.055 ± 0.008 in)

Camshaft



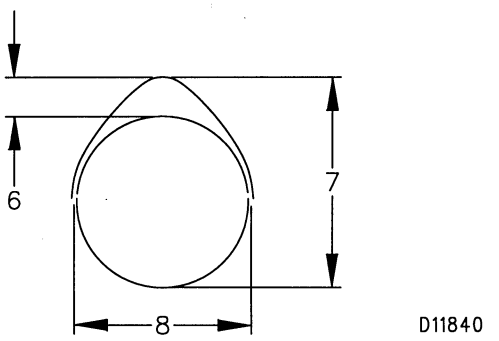
(1) Gear. Heat to install (do not use a torch). Do not heat above ..... 316°C (600°F)

(2) Distance between shoulder of camshaft and gear for thrust washer (new) ... 4.83 ± 0.05 mm (0.190 ± 0.002 in)
Thickness of thrust washer (new) ..... 4.70 ± 0.03 mm (0.185 ± 0.0012 in)
End play of the camshaft (new) ..... 0.13 ± 0.08 mm (0.005 ± 0.0032 in)
Maximum permissible end play (worn) ..... 0.46 mm (0.018 in)

(3) Diameter of camshaft journals (new) ..... 65.126 ± 0.013 mm (2.5640 ± 0.0005 in)

(4) Intake lobe.

(5) Exhaust lobe.



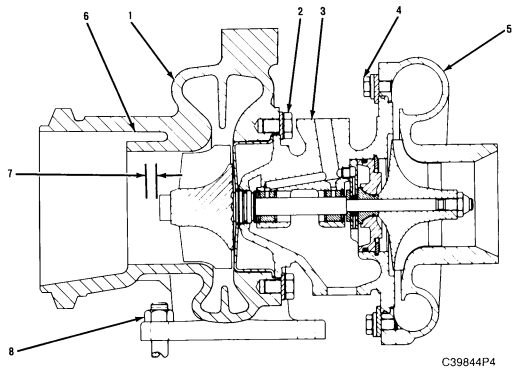
Typical Example

(6) Height of camshaft lobes.

To find lobe height, use the procedure that follows:

A. Measure camshaft lobe height (7).
B. Measure base circle (8).
C. Subtract base circle (STEP B) from lobe height (STEP A). The difference is actual lobe lift.
D. Specified camshaft lobe lift (6) is:
   Exhaust lobe ..... 7.497 mm (0.2952 in)
   Intake lobe ..... 9.299 mm (0.3661 in)

Turbocharger



Typical Example

(1) Turbine housing.

(2) Apply 5P3931 Anti-Seize Compound to threads of bolts that hold turbine housing to turbocharger. Tighten to a torque of ..... 15.8 ± 0.5 N•m (140 ± 4 lb in)

(3) Cartridge.

(4) Tighten bolts that hold compressor housing to turbocharger cartridge to a torque of ..... 7.3 ± 0.5 N•m (65 ± 4 lb in)

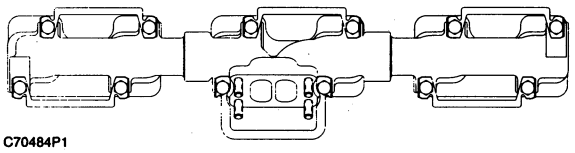
(5) Compressor housing.

(6) Wastegate passage (internal passage in turbine housing).

(7) End play for shaft ..... 0.051 to 0.083 mm (0.0020 to 0.0033 in)

(8) Apply 5P3931 Anti-Seize Compound. Tighten to a torque of ..... 54 ± 5 N•m (40 ± 4 lb ft)

Exhaust Manifold

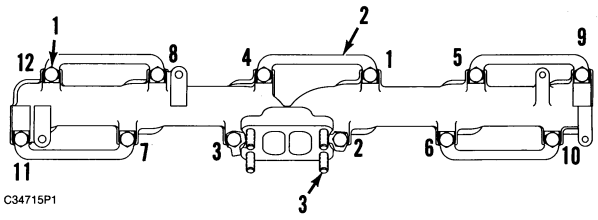


Typical Example Of A Three Piece Exhaust Manifold

NOTICE

The followed procedure should be used during assembly of the three piece exhaust manifold to the cylinder block. If 2P2333 Sealer is left on the inside of the exhaust manifold after assembly, it may cause damage to the turbocharger.

1. Coat inside diameter of female ends of manifold with engine oil.
2. Apply a thin coat of 2P2333 Sealer to outside diameter of the male ends of manifold before assembly. Do not apply sealer at tip of the male ends. Remove excess sealer from assembled joint.
3. Continue with procedure given for one piece exhaust manifold



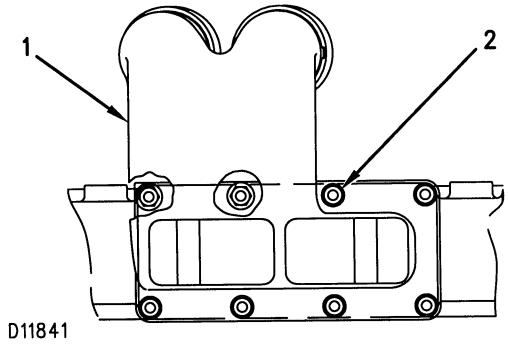
Typical Example Of A One Piece Exhaust Manifold

(1) Apply 5P3931 Anti-Seize Compound to the threads of bolts and tighten as follows:
   a. Tighten bolts 1 thru 12 in numerical sequence to ..... 4 ± 1 N•m (35 ± 9 lb in)
   b. Retighten bolts 1 thru 12 in numerical sequence to ..... 45 ± 5 N•m (33 ± 4 lb ft)

(2) Lock. Bend lock tabs over the flat of bolt heads.

(3) Tighten studs to a torque of ..... 35 ± 5 N•m (26 ± 4 lb ft)

Air Inlet Elbow

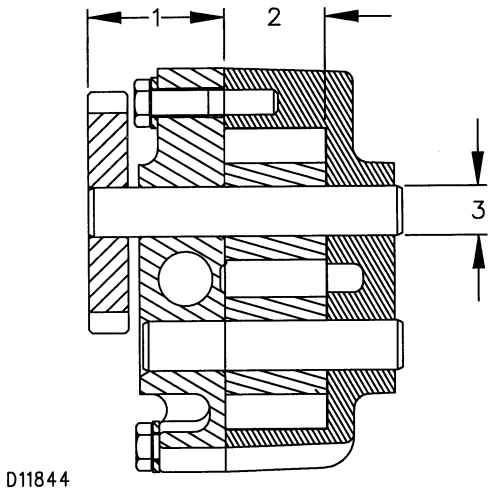


Typical Example.

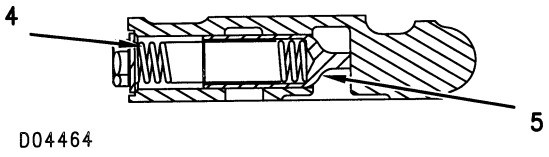
(1) Air Inlet Elbow. On elbow joint-face, clean face with solvent and apply 6V1541 Quick Cure Primer. Allow primer to air dry (three to five minutes minimum). Apply 1U8846 Gasket Maker to elbow joint-face and spread uniformly. Elbow must be assembled and tightened within ten minutes.

(2) Bolt. Tighten bolts to a torque of ..... 30 ± 7 N•m (22 ± 5 lb ft)

Oil Pump



Section View Through Pump Gears (Typical Example)



Section View Through Bypass Valve

(1) Distance between outside face of gear and joint face of body ..... 43.00 ± 0.25 mm (1.693 ± 0.010 in)

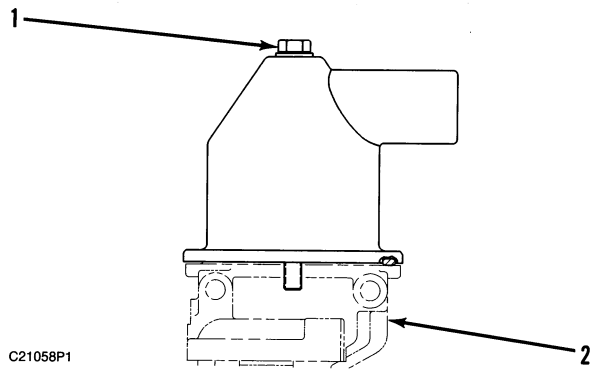
(2) Length of gears ... 33.000 ± 0.025 mm (1.300 ± 0.001 in)
Depth of bores for gears ..... 33.13 ± .016 mm (1.304 ± 0.0006 in)

(3) Diameter of gear shafts ..... 15.600 ± 0.005 mm (0.6142 ± 0.0002 in)
Bores in pump bodies for gear shafts ..... 15.641 ± 0.008 mm (0.6158 ± 0.0003 in)

(4) 105-1805 Spring for relief valve:
Outside diameter ..... 13 mm (0.51 in)
Free length ..... 64.98 mm (2.558 in)
Assembled length ..... 54.5 mm (2.15 in)
Load at assembled length ..... 51.99 ± 1.9 N (12 ± 0.4 lb)

(5) Relief valve plunger:
Diameter of plunger ..... 17.000 ± 0.013 mm (0.6693 ± 0.0005 in)
Bore in pump body for plunger ..... 17.100 ± 0.025 mm (0.6732 ± 0.0010 in)

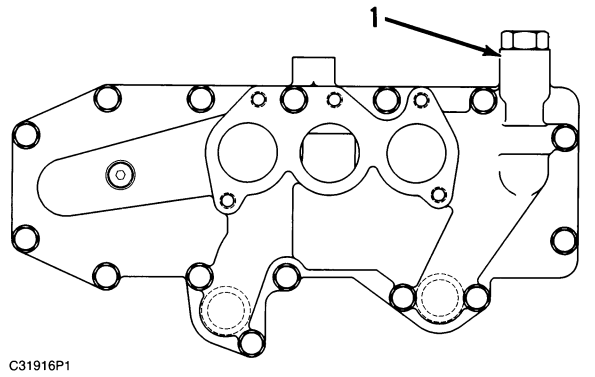
Breather (Crankcase)



(1) Bolt. Tighten to a torque of ..... 7 ± 2 N•m (62 ± 18 lb in)

(2) Fuel filter base.

Oil Cooler Bypass Valve

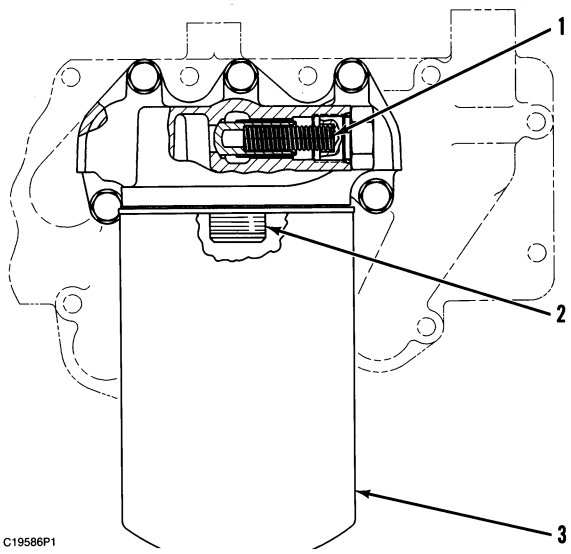


Typical Example

(1) Oil cooler bypass valve to open at ..... 125 ± 30 kPa (18 ± 4.5 psi)

9L9188 Spring for oil cooler bypass valve:
Outside diameter ..... 11.2 mm (0.44 in)
Free length ..... 57.9 mm (2.28 in)
Assembled length ..... 43.2 mm (1.70 in)
Load at assembled length ... 15.6 ± 1.3 N (3.50 ± 0.30 lb)

Oil Filter Base



Typical Example

(1) Oil filter bypass valve to open at ..... 125 ± 30 kPa (18 ± 4.5 psi)

9L9188 Spring for bypass valve:
Outside diameter ..... 11.2 mm (0.44 in)
Free length ..... 57.9 mm (2.28 in)
Assembled length ..... 43.2 mm (1.70 in)
Load at assembled length ..... 15.6 ± 1.3 N (3.50 ± .30 lb)

(2) Put 9S3263 Thread Lock on the last 7.5 ± 1.5 mm (0.30 ± 0.06 in) of the threads at base end of stud and tighten filter element stud to ..... 68 ± 7 N•m (50 ± 5 lb ft)

(3) Put clean engine oil on the filter seal. Tighten filter until seal makes contact with filter base. Turn the filter 270 degrees (¾ of one turn) more.

Engine Oil Pressure

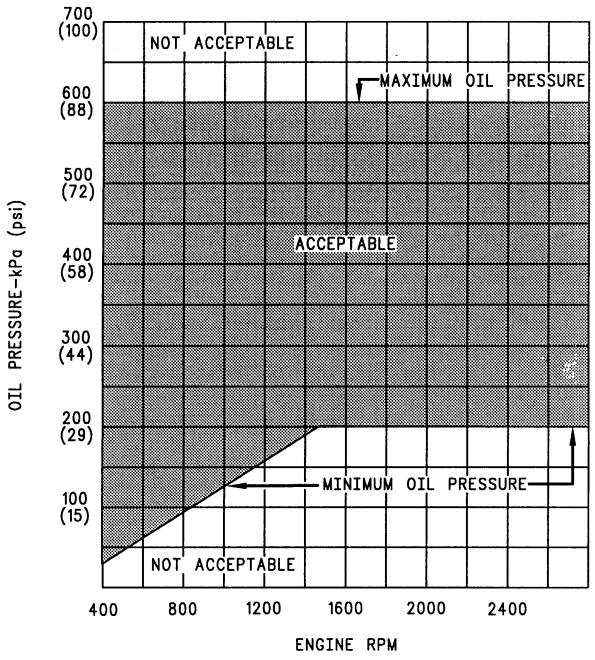
All steps of this procedure must be followed for the pressure findings to be usable.

1. Be sure that the engine is filled to the correct level with SAE 10W-30 oil. If any other viscosity of oil is used, the information in the Engine Oil Pressure Graph does not necessarily apply.
2. Remove the oil pressure switch and connect the 1U5470 Engine Pressure Group to the main oil manifold at the location from which the oil pressure switch was removed.
3. Run the engine to get the engine oil temperature at 99°C (210°F).

NOTE: A 3°C (5°F) increase in temperature gives approximately 7 kPa (1 psi) decrease in engine oil pressure.

NOTE: Make sure engine oil temperature does not go above 115°C (239°F).

4. Keep the engine oil temperature constant with the engine at its rated rpm and read the pressure gauge.
5. On the Engine Oil Pressure Graph, find the point that the lines for engine rpm and oil pressure intersect (connect).

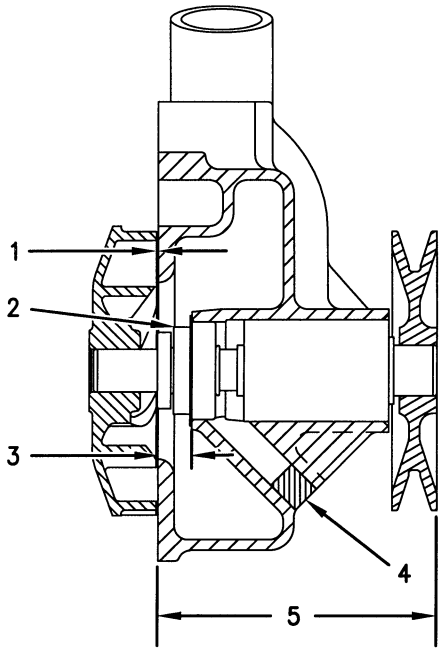


D17880

6. If the results do not fall within the "ACCEPTABLE" pressure range given in the graph, find the cause and correct it. Engine failure or a reduction in engine life can be the result if engine operation is continued with oil manifold pressure outside this range.

NOTE: A record of engine oil pressure, kept at regular intervals, can be used as an indication of possible engine problems or damage. If there is a sudden increase or decrease of 70 kPa (10 psi) in oil pressure, even though the pressure is in the "ACCEPTABLE" range on the graph, the engine should be inspected and the problem corrected.

Water Pump



D17663

Shown With Impeller Cover Removed

(1) Clearance between impeller and housing ..... 0.75 ± 0.25 mm (0.030 ± 0.010 in)

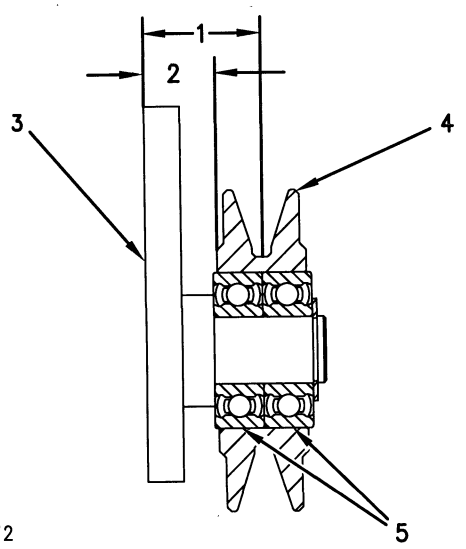
(2) Seal.

(3) Working height of seal ..... 12.83 ± 0.13 mm (.505 ± 0.005 in)

(4) Filter. Filter should not extend beyond the surface of the housing.

(5) Dimension from front face of pulley to face of housing ..... 103.8 ± 0.3 mm (4.09 ± 0.01 in)

Water Pump Belt Tightener



D17172

Idler Pulley Assembly

(1) Distance from back of plate assembly (3) to middle of pulley (4) ..... 26.0 ± 0.3 mm (1.02 ± 0.012 in)

(2) Distance from back of plate assembly (3) to back of pulley (4) ..... 16.0 ± 0.3 mm (0.63 ± 0.01 in)

(3) Plate Assembly.

(4) Pulley.

(5) Apply 9S3263 Thread Lock to the pulley bore before assembly.

BELT TENSION CHART

BELT SIZE	WIDTH BELT TOP		GAUGE READING				BORROUGHS GAUGE NUMBERS	
			BELT TENSION "INITIAL"*		BELT TENSION "USED"**		OLD GAUGE NUMBER	NEW GAUGE NUMBER
	MM	IN	N	LB	N	LB		
3/8	10.72	0.422	445 ± 22	100 ± 5	400 ± 22	90 ± 10	BT-33-95	BT-33-97
1/2	13.89	0.547	534 ± 22	120 ± 5	400 ± 44	90 ± 10	BT-33-95	BT-33-97
5V	15.88	0.626	534 ± 22	120 ± 5	400 ± 44	90 ± 10	BT-33-72	BT-33-72C
11/16	17.48	0.688	534 ± 22	120 ± 5	400 ± 44	90 ± 10	BT-33-72	BT-33-72C
3/4	19.05	0.750	534 ± 22	120 ± 5	400 ± 44	90 ± 10	BT-33-72	BT-33-72C
15/16	23.83	0.983	534 ± 22	120 ± 5	400 ± 44	90 ± 10	BT-33-72	BT-33-77
8K	27.92	1.099	800 ± 22	180 ± 5	489 ± 44	110 ± 10	-------	BT-33-109
6PK	20.94	0.824	667 ± 22	150 ± 5	467 ± 44	105 ± 10	-------	BT-33-109

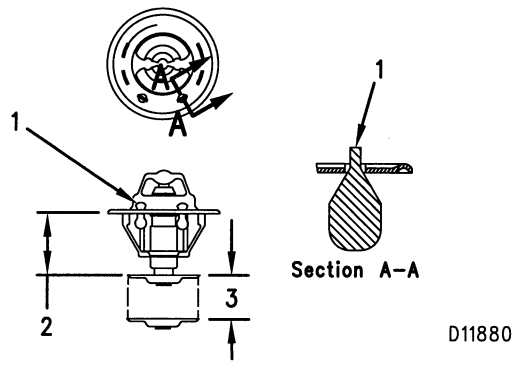
MEASURE TENSION OF BELT FARTHEST FROM ENGINE

* BELT TENSION "INITIAL" is for a new belt.

** BELT TENSION "USED" is for a belt with over 30 minutes of operation at rated speed.

D01599

Water Temperature Regulator



Full open temperature ..... 93°C (199°F)

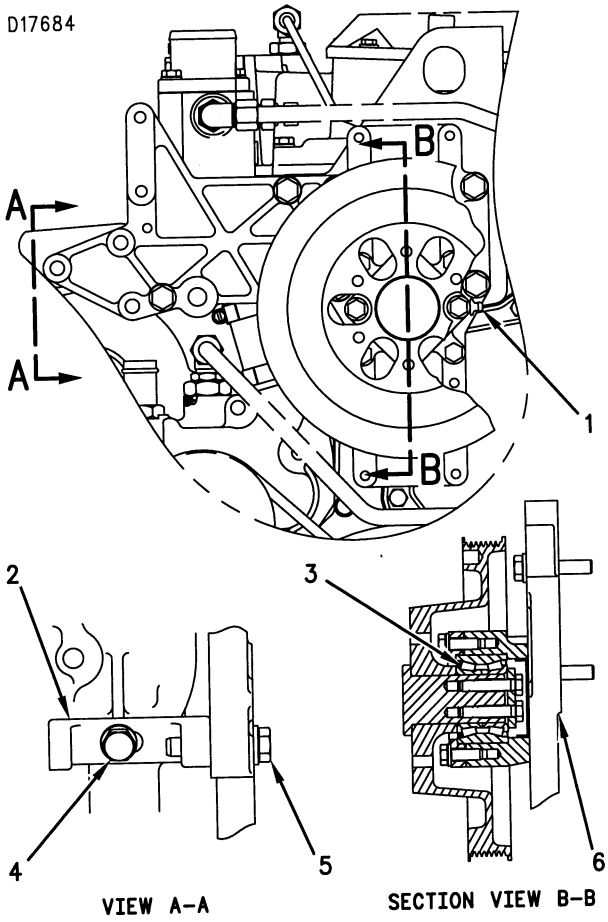
(1) Air vent valve

(2) Closed dimension ..... 29.5 ± 0.5 mm (1.16 ± 0.02 in)

(3) Minimum stroke at full open temperature ..... 8.0 mm (.32 in)

NOTE: Regulator is rated as 82.2°C (180°F).

Fan Drive



(1) Grease fitting. Fill bearing cavity with 20 grams (0.7 ounces) of 2S3230 Bearing Lubricant.

(2) Bracket. Assembly procedure for bracket.
   a. Tighten bolt (4) finger tight (into water temperature housing).
   b. Tighten bolt (5) finger tight into bracket (3).
   c. Tighten bolts (4) and (5) to 55 ± 10 N•m (40 ± 7 lb ft).

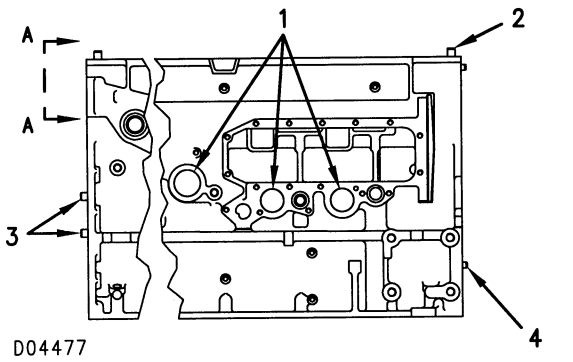
(3) Bearing assembly. Install lip seal forward.

(4) Bolt.

(5) Bolt.

(6) Support.

Cylinder Block



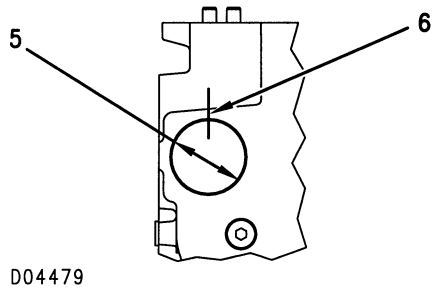
Right Side

(1) Depth that cup plugs are installed (measured from block face to top edge of plug) ..... 1.25 ± 0.25 mm (0.049 ± 0.010 in)

(2) Distance all dowels extend from top face ..... 14 ± 2 mm (0.55 ± 0.08 in)

(3) Distance two large dowels extend from rear face ..... 12.0 ± 0.5 mm (0.47 ± 0.02 in)

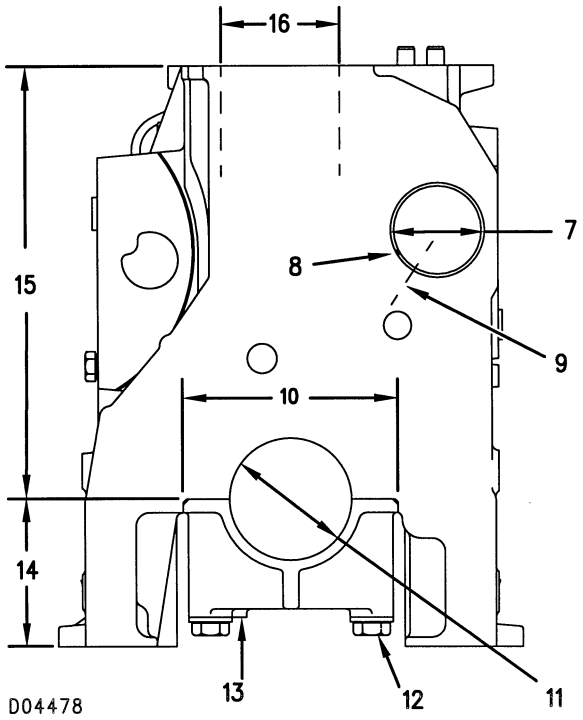
(4) Distance all dowels extend from front face ..... 8.0 ± 0.5 mm (0.31 ± 0.02 in)



View A-A (Rear Face)

(5) Bores in block for all camshaft bearings except front bearing ..... 69.000 ± 0.038 mm (2.7165 ± 0.0015 in)

(6) Locate bearing oil hole for all camshaft bearings (except front bearing) at top of bore.



Front Face

(7) Bore in block for front camshaft bearing ..... 70.000 ± 0.025 mm (2.7559 ± 0.0010 in)

(8) Front camshaft bearing joint location.

(9) Front camshaft bearing oil hole.

NOTE: Install front camshaft bearing with bearing oil hole (9) aligned with oil hole in block and bearing joint (8) positioned as shown.

(10) Width of main bearing cap ..... 159.995 ± 0.020 mm (6.2990 ± 0.0008 in)
Width of cylinder block for main bearing cap ..... 160.000 ± 0.018 mm (6.2992 ± 0.0007 in)

(11) Bore in block for main bearings ..... 95.000 ± 0.013 mm (3.7402 ± 0.0005 in)

(12) Main bearing cap bolts. Install as follows:
Install bearing caps with sequence number to the right, 1 through 7 (front to rear).
a. Before assembly, put 2P2506 Thread Lubricant on the bolt threads and washer face.
b. Tighten both bolts of each bearing cap to a torque of ..... 54 ± 7 N•m (40 ± 5 lb ft)
c. Then tighten bolts an additional ..... 90 ± 5 degrees (¼ turn)

(13) Location of bearing cap sequence number.

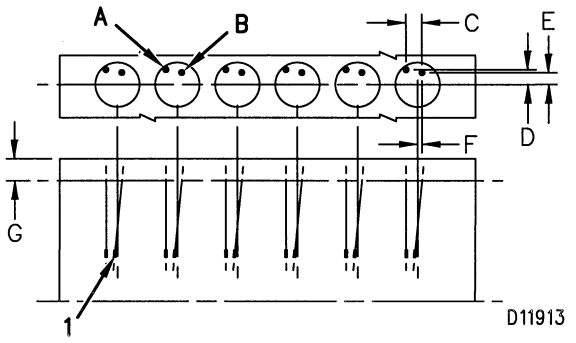
(14) Dimension from centerline of crankshaft bore to pan rail ..... 110.00 mm (4.331 in)

(15) Dimension from centerline of crankshaft bore to top of block ..... 322.00 mm (12.677 in)

(16) Cylinder bore size (8WL1-UP) ..... 105 mm (4.134 in)
Cylinder bore size (1WM1-UP) ..... 110 mm (4.331 in)

NOTE: Bore size must be checked with a 4C4377 Cylinder Head Stress Plate and gasket installed. Refer to Installation Of 7C6208 Cylinder Sleeve, Special Instruction SEHS9047.

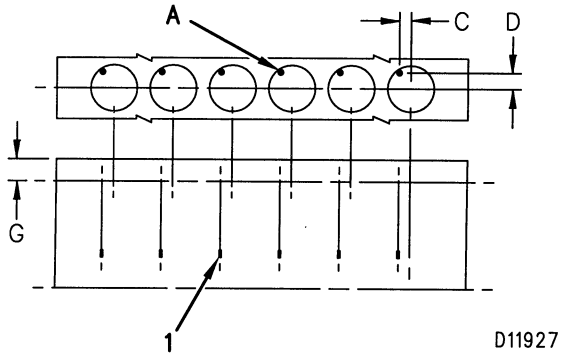
Piston Cooling Jet



(1) Piston Cooling Jet (8WL1-UP)

Check piston cooling jets by inserting a 1.3 mm (0.05 in) diameter drill rod into jet. Rods must pass through a 5.0 mm (0.20 in) diameter circle in location (A) and a 13.0 mm (0.51 in) diameter circle in location (B). Both circles are located at depth (G) 50.0 mm (1.97 in) below the top of the cylinder block.

Dimension (C) ..... 25.9 mm (1.02 in)
Dimension (D) ..... 33.4 mm (1.31 in)
Dimension (E) ..... 26.9 mm (1.06 in)
Dimension (F) ..... 9.8 mm (0.39 in)
Dimension (G) ..... 50.0 mm (1.97 in)

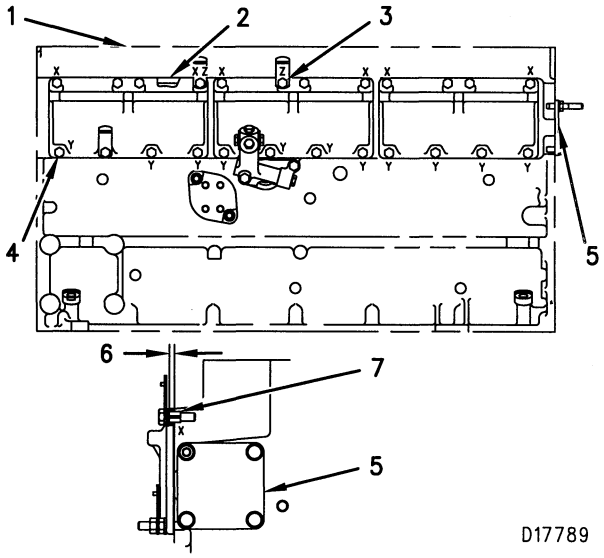


(1) Piston Cooling Jet (1WM1-UP)

Check piston cooling jets by inserting a 1.90 mm (0.075in) diameter drill rod into jet. Rods must pass through a 12.7 mm (0.50 in) diameter circle in location (A). The circle is located at depth (G) 50.0 mm (1.97 in) below the top of the cylinder block.

Dimension (C) ..... 25.9 mm (1.02 in)
Dimension (D) ..... 33.4 mm (1.31 in)
Dimension (G) ..... 50.0 mm (1.97 in)

Cylinder Block Cover Group



(1) Cylinder block.

(2) Gasket.

(3) Bolt (location marked "Z"). Length of bolt ..... 30.0 mm (1.18 in)

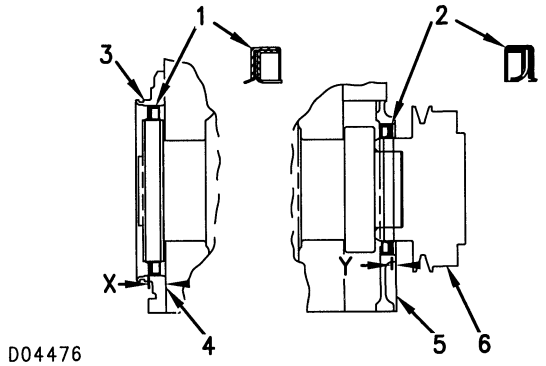
(4) Bolt (location marked "Y"). Length of bolt ..... 20.0 mm (0.79 in)

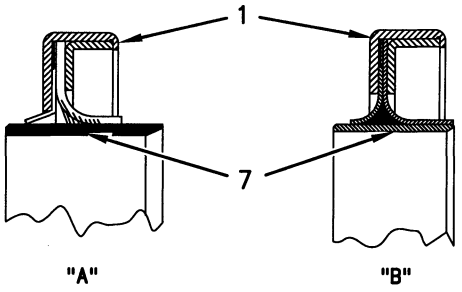
(5) Cover. Clean cover face with solvent. Apply 1U8846 Gasket Maker to cover. Spread uniformly on face and around the bolt holes. Cover must be installed and tightened within ten minutes.

(6) Length that sleeve (7) extends from face of cylinder block ..... 5.0 ± 0.5 mm (0.20 ± 0.02 in)

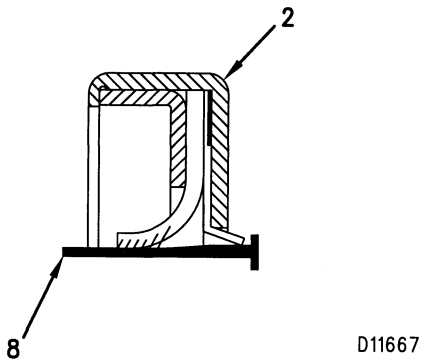
(7) Sleeve (location marked "X").

Crankshaft Seals





Rear Crankshaft Seal Groups:
"A"-Single Lip, "Dry" Applications
"B"-Double Lip, "Wet" Applications



Front Crankshaft Seal

Refer to Disassembly And Assembly for the complete procedure for removing and installing the crankshaft seal groups.

(1) Rear seal. Install with rear face of seal at dimension (X) from rear block face (4). Dimension (X) .... 15.4 ± 0.5 mm (0.61 ± 0.02 in)

NOTE: Rear seal runs directly on crankshaft flange as originally manufactured. Service Rear seal group has a wear sleeve (7) that is part of the replacement rear seal group.

(2) Front seal. Install with front face of seal at dimension (Y) from front face of front housing. Dimension (Y) ..... 2.5 ± 0.5 mm (0.10 ± 0.02 in)

(3) Carrier housing/Flywheel housing.

(4) Rear face of block.

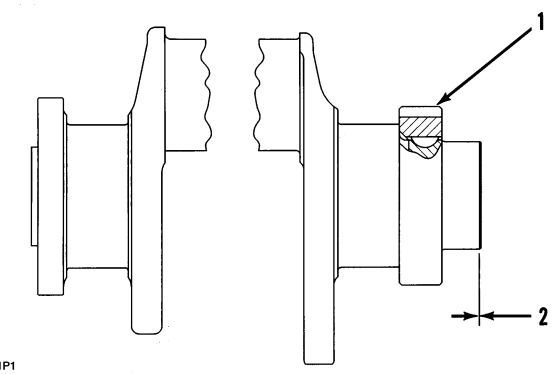
(5) Front housing.

(6) Pulley.

(7) Wear sleeves. Do not remove wear sleeves from seal group.

(8) Shipping sleeve for front seal. Remove shipping sleeve after installing front seal (2) in housing and immediately before installing pulley (6).

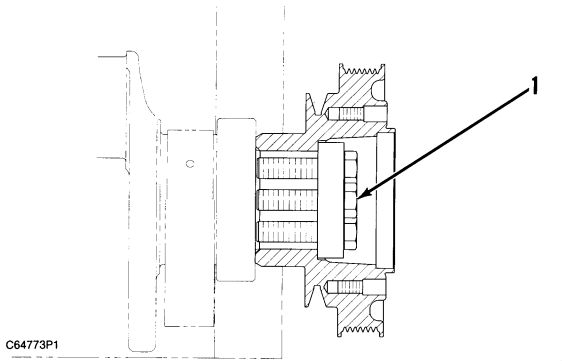
Crankshaft



(1) Gear.
For installation heat gear (do not use a torch) to ... 316°C (600°F)

(2) End play for crankshaft assembled in engine ..... 0.07 to 0.32 mm (0.003 to 0.013 in)

Crankshaft Pulley Group



Typical Example

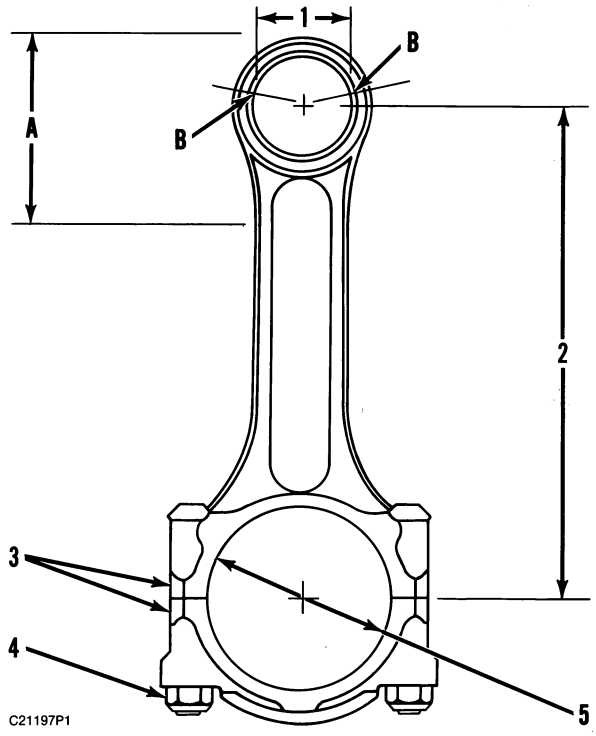
4P4454 Crankshaft Pulley Group

(1) Bolt. Tighten bolts to a torque ..... 200 ± 25 N•m (150 ± 18 lb ft)

4W5429 Crankshaft Pulley Group

(1) Bolt. Tighten bolts to a torque ..... 190 ± 30 N•m (140 ± 22 lb ft)

Connecting Rod



(1) Bore in bearing for piston pin
(new) ..... 40.028 ± 0.008 mm (1.5759 ± 0.0003 in)
To install bearing, rod may be heated at length (A) (do not use a torch) to ..... 175 to 260°C (347 to 500°F)
Length (A) ..... 75 mm (3 in)
Bearing joint must be at either location (B) at an angle above bore centerline of ..... 12.0 ± 5 degrees

(2) Distance between center of bearings ..... 200.00 mm (7.874 in)

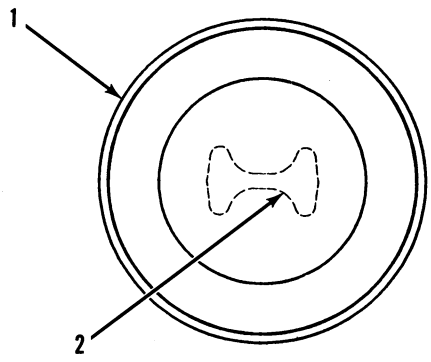
(3) Location for etching cylinder number on rod and cap after assembly. Etch numbers on same side of rod as bearing retainer notch.

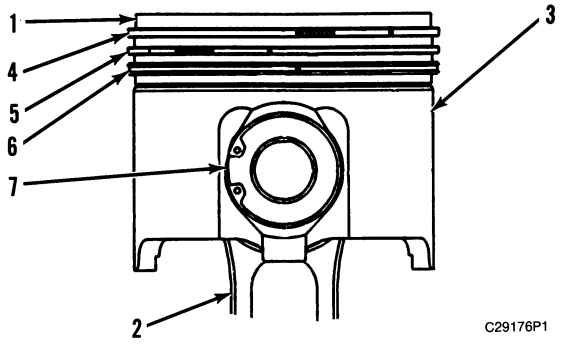
(4) Tighten connecting rod bolts as follows:
- a. Lubricate bolt threads, seating faces of cap and nut with engine oil before installing nut.
- b. Tighten each nut to ..... 54 ± 7 N•m (40 ± 5 lb ft)
- c. Put an alignment mark on cap and nut.
- d. Tighten each nut an additional ..... 60 ± 5 degrees (⅙ turn)

(5) Bore in connecting rod for bearing with bolts tightened to specification (4) ..... 75.000 ± 0.013 mm (2.9528 ± 0.0005 in)

Pistons And Rings

Two Piece Articulated Piston





(1) Crown assembly.

(2) Connecting rod.

NOTE: Install connecting rod and piston group with rod forging part number to the rear of the engine. The rear of the engine is the flywheel end. Thoroughly lubricate the piston group with clean engine oil just before inserting into block group.

(3) Piston skirt. Thoroughly lubricate piston crown assembly and skirt 360 degrees in zone "A" with clean engine oil just before inserting into block group.

Top And Intermediate Ring

Install piston ring with "UP" side toward top of piston (green color strip to right of ring gear).

(4) Top Ring has the mark "UP-1".
Clearance between ends of piston ring when installed in a cylinder with a bore size of 105 mm (4.134 in) ..... 0.525 ± 0.125 mm (0.0207 ± 0.0049 in)
Clearance between ends of piston ring when installed in a cylinder with a bore size of 110 mm (4.331 in) ..... 0.525 ± 0.125 mm (0.0207 ± 0.0049 in)
Increase in clearance between ends of piston ring for each 0.03 mm (0.001 in) increase in cylinder bore size ..... 0.09 mm (0.004 in)

Install intermediate ring with side marked "UP-2" toward top of piston (white color strip to right of ring end gap).

(5) Intermediate Ring has the mark "UP-2".
Clearance between ends of piston ring when installed in a cylinder with a bore size of 105 mm (4.134 in) ..... 0.825 ± 0.125 mm (0.0033 ± 0.0049 in)
Clearance between ends of piston ring when installed in a cylinder with a bore size of 110 mm (4.331 in) ..... 0.825 ± 0.125 mm (0.0033 ± 0.0049 in)
Increase in clearance between ends of piston ring for each 0.03 mm (0.001 in) increase in cylinder bore size ..... 0.09 mm (0.004 in)

Oil Control Ring

(6) Install Oil Control Ring with the gap in the spring 180 degrees away from the gap in the ring (light green colored portion of spring must be visible at the ring end gap).
Width of groove in piston for piston ring (new) ..... 4.041 ± 0.013 mm (0.1591 ± 0.0005 in)
Thickness of piston ring (new) ..... 3.982 ± 0.008 mm (0.1568 ± 0.0003 in)
Clearance between groove and piston ring (new) ..... 0.038 to 0.080 mm (0.0015 to 0.0031 in)
Clearance between ends of piston ring when installed in a cylinder with a bore size of 105 mm (4.134 in) ..... 0.45 ± 0.15 mm (0.018 ± 0.006 in)
Clearance between ends of piston ring when installed in a cylinder with a bore size of 110 mm (4.331 in) ..... 0.45 ± 0.15 mm (0.018 ± 0.006 in)
Increase in clearance between ends of piston ring for each 0.03 mm (0.001 in) increase in cylinder bore size ..... 0.09 mm (0.004 in)
After rings have been installed, rotate so end gaps are apart ..... 120 degrees

Piston Pin Bore

(7) Pin bore diameter in piston crown bearing ..... 40.031 ± 0.007 mm (1.5760 ± 0.0003 in)
Pin bore diameter in piston skirt ..... 40.020 ± 0.008 mm (1.5756 ± 0.0003 in)
Pin diameter .... 40.000 ± 0.005 mm (1.5748 ± 0.0002 in)
Pin length:
8WL1-UP ..... 85.00 ± 0.13 mm (3.346 ± .005 in)
1WM1-UP ..... 89.95 ± 0.13 mm (3.541 ± .005 in)
Thoroughly lubricate pin with clean engine oil before assembling to piston group and connecting rod.

Connecting Rod And Main Bearing Journals

Connecting Rod Bearing Journals

Diameter of crankshaft journal (bearing surface) for connecting rod	
Original Size Journal	70.000 ± 0.020 mm (2.7559 ± .0008 in)
Undersize Journal 0.25 mm (.010 in)	69.750 ± 0.020 mm (2.7461 ± .0008 in)
Undersize Journal 0.50 mm (.020 in)	69.500 ± 0.020 mm (2.7362 ± .0008 in)

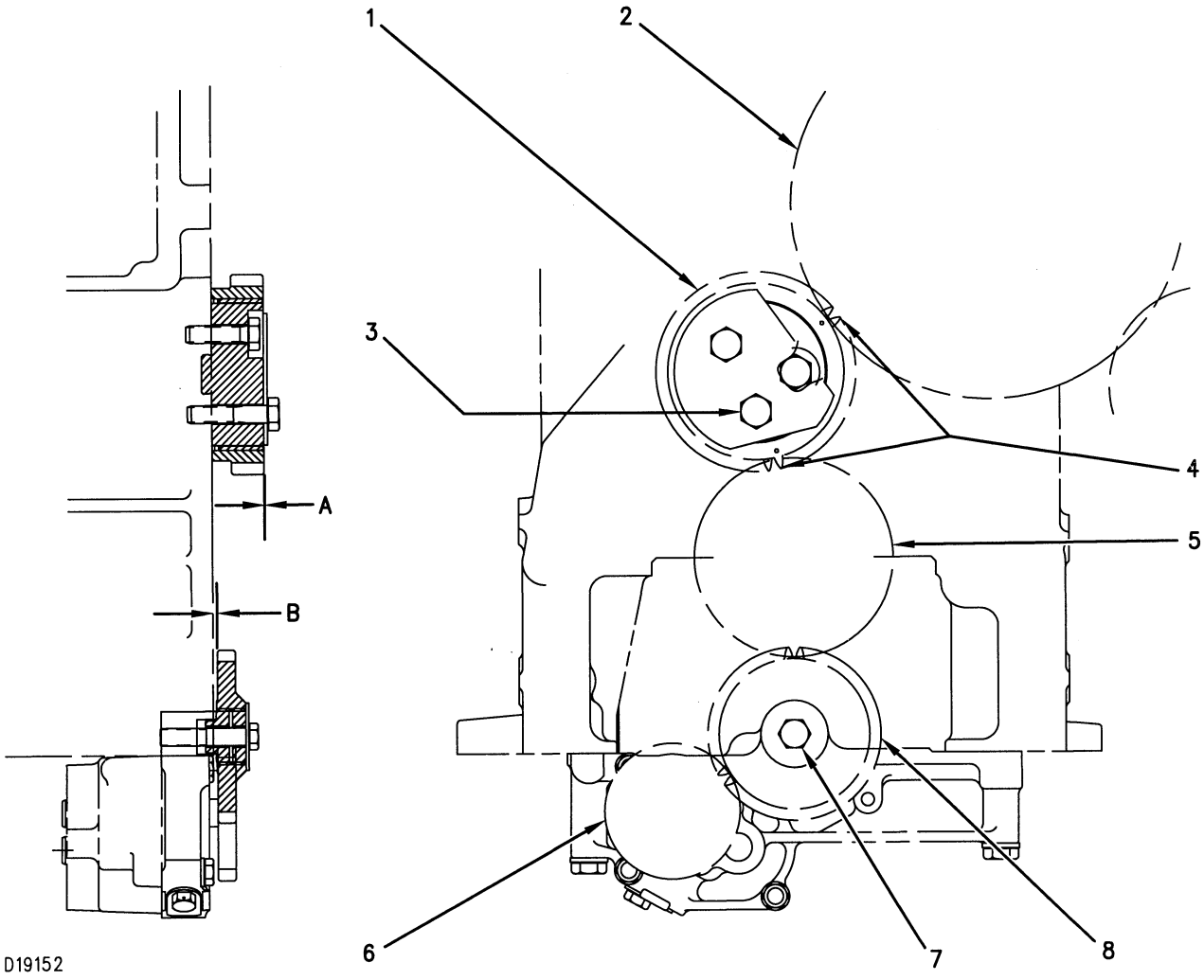
Clearance between bearing and journal (new) ..... 0.053 to 0.155 mm (0.0021 to 0.0061 in)

Main Bearing Journals

Diameter of crankshaft journal (bearing surface) for main bearings	
Original Size Journal	90.000 ± 0.020 mm (3.5433 ± .0008 in)
Undersize Journal 0.25 mm (.010 in)	89.750 ± 0.020 mm (3.5335 ± .0008 in)
Undersize Journal 0.50 mm (.020 in)	89.500 ± 0.020 mm (3.5236 ± .0008 in)

Clearance between bearing and journal (new) ..... 0.071 to 0.173 mm (0.0029 ± 0.0068 in)

Front Gear Group



(1) Camshaft idler gear.
Distance between front face of bearing in gear bore and front face of gear (dimension A) ..... 0.40 ± 0.25 mm (0.016 ± 0.010 in)
Diameter of shaft (new) ..... 80.000 ± 0.013 mm (3.1496 ± 0.0005 in)

(2) Camshaft gear.

(3) Tighten bolts of camshaft idler gear to a torque of ..... 70 ± 15 N•m (50 ± 11 lb ft)

(4) Align timing marks on camshaft idler gear (1) with holes on camshaft and crankshaft gears (2 and 5).

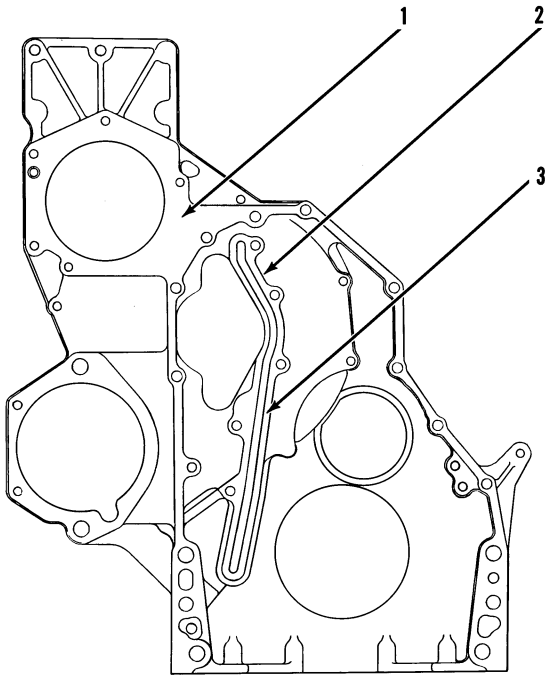
(5) Crankshaft gear.

(6) Oil pump drive gear.

(7) Apply 9S3263 Thread Lock to the threads of the oil pump idler gear bolt and tighten to a torque of ..... 70 ± 15 N•m (50 ± 11 lb ft)

(8) Oil pump idler gear.
Distance between rear face of bearing in gear bore and rear face of gear (dimension B) ..... 0.75 ± 0.25 mm (0.030 ± 0.010 in)
Diameter of shaft (new) ..... 28.644 ± 0.013 mm (1.1277 ± 0.0005 in)

Front Housing

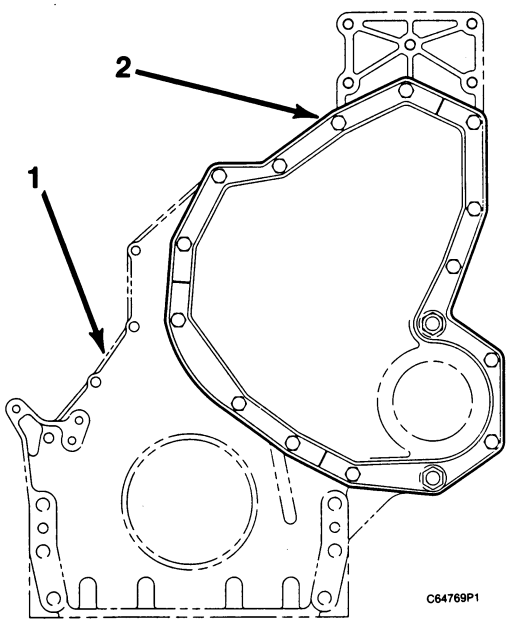


C21659P1

Block Mounting Face

Before assembling front housing to cylinder block, apply approximately 15 mL (.5 oz) of 1U8846 Gasket Maker to entire area of surfaces (1) and (2) where they contact the cylinder block. Do not allow gasket maker to plug oil passage (3). Cover must be assembled and tightened to the block within ten minutes.

Front Housing Cover

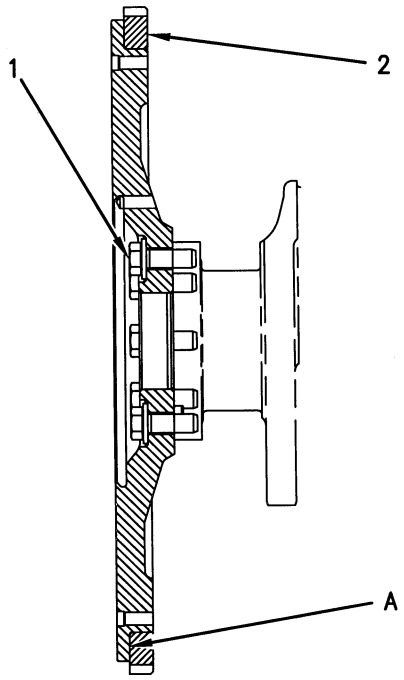


C64769P1

(1) Front Housing.

(2) Front Housing Cover. On gasket to cover joint face (one side only) Clean cover face of gasket with solvent. Apply 1U8846 Gasket Maker to gasket and spread uniformly and around bolt holes. The cover must be assembled and tightened within ten minutes.

Flywheel



D11929

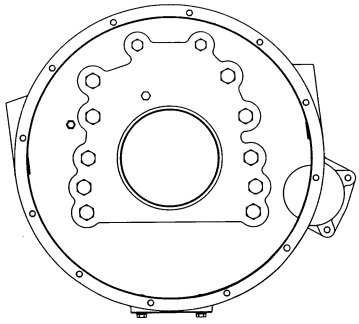
Typical Example

Refer to the topic, Flywheel Runout, for the correct method of flywheel inspection.

(1) Apply 9S3263 Thread Lock to the threads of bolts holding the flywheel to the crankshaft. Tighten bolts to a torque of ..... 125 ± 10 N•m (90 ± 7 lb ft)

(2) Ring gear. Install with Part No. on this side. Ring gear must be assembled against shoulder (A) of flywheel. Maximum temperature of ring gear before installing on flywheel (do not use a torch) ..... 204°C (400°F)

Flywheel Housing



C29180P1

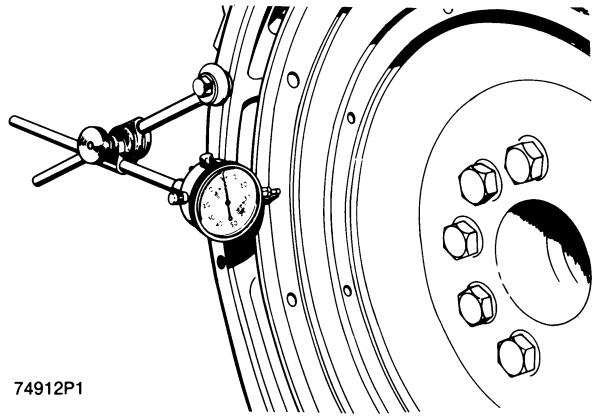
Typical Example.

See the topics, Flywheel Housing Runout and Flywheel Housing Bore, for the correct methods of flywheel housing inspection.

NOTE: Apply 1U8846 Gasket Maker to the entire cylinder block mounting face of the flywheel housing before assembling the flywheel housing to the cylinder block.

Flywheel Runout

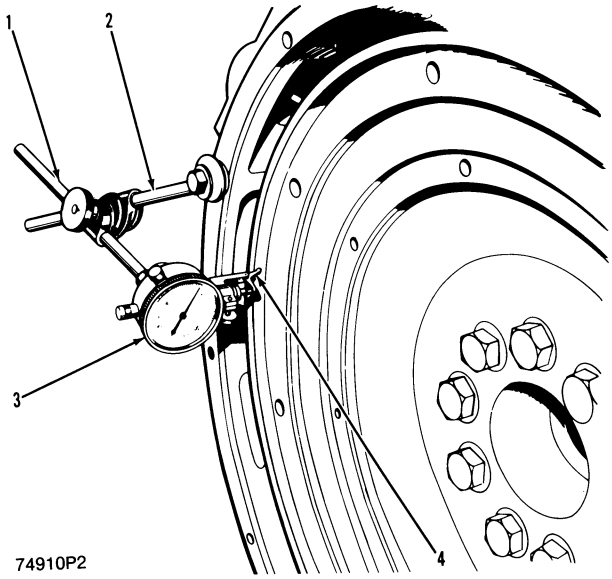
Face Runout (Axial Eccentricity) Of The Flywheel:



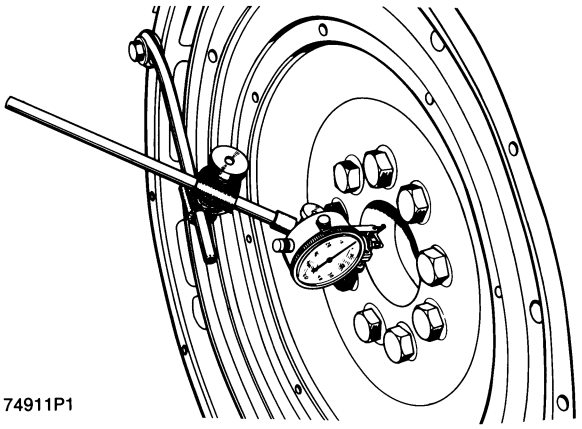
Checking Face Runout Of The Flywheel (Typical Example)

1. Install the dial indicator as shown. Put a force on the flywheel toward the rear.
2. Set the dial indicator to read 0.0 mm (.000 in).
3. Turn the flywheel and read the indicator every 90 degrees. Put a force on the flywheel to the rear before each reading.
4. The difference between the lower and higher measurements taken at all four points must not be more than 0.15 mm (.006 in) which is the maximum permissible face runout (axial eccentricity of the flywheel).

Bore Runout (Radial Eccentricity) Of The Flywheel:



Checking Bore Runout Of The Flywheel
(1) 7H1945 Holding Rod. (2) 7H1645 Holding Rod. (3) 7H1942 Indicator. (4) 7H1940 Universal Attachment.

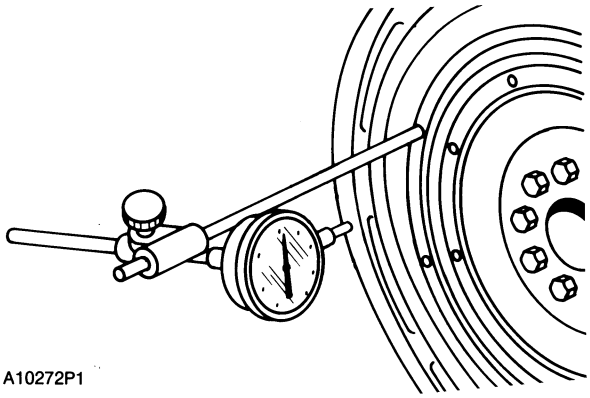


Checking Flywheel Clutch Pilot Bearing Bore (Typical Example)

1. Install the dial indicator (3) and make an adjustment of the universal attachment (4) so it makes contact as shown.
2. Set the dial indicator to read 0.0 mm (.00 in).
3. Turn the flywheel and read the indicator every 90 degrees.
4. The difference between the lower and higher measurements taken at all four points must not be more than 0.15 mm (.006 in), which is the maximum permissible bore runout (radial eccentricity) of the flywheel.
5. Runout (eccentricity) of the bore for the pilot bearing for the flywheel clutch, must not exceed 0.13 mm (.005 in).

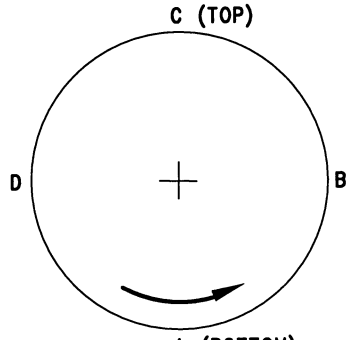
Flywheel Housing Runout

Face Runout (Axial Eccentricity) Of The Flywheel Housing:



A10272P1

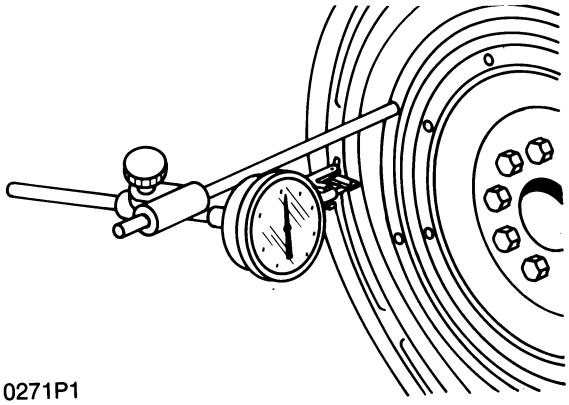
8T5096 Dial Indicator Group Installed
(Typical Example)



D15716

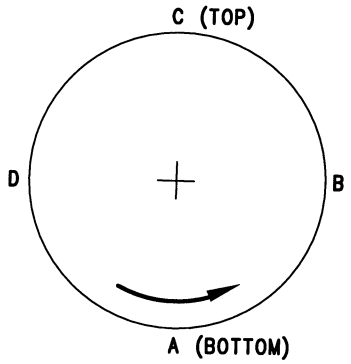
1. Fasten a dial indicator to the crankshaft flange so the anvil of the indicator will touch the face of the flywheel housing.
2. Put a force on the crankshaft toward the rear before reading the indicator at each point.
3. With dial indicator set at 0.0 mm (.000 in) at location (A), turn the crankshaft and read the indicator at locations (B), (C), and (D).
4. The difference between lower and higher measurements taken at all four points must not be more than 0.30 mm (.012 in), which is the maximum permissible face runout (axial eccentricity) of the flywheel housing.

Flywheel Housing Bore



A10271P1

Typical Example



D15716

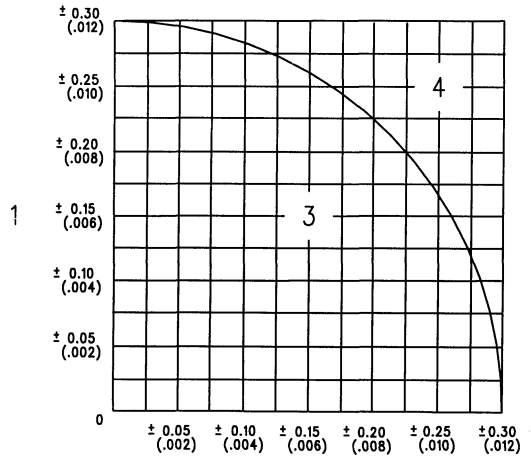
CHART FOR DIAL INDICATOR MEASUREMENTS					
	Position of dial indicator				
	Line No.	A	B	C	D
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	**	*	**

*Total Vertical eccentricity (out of round).
**Subtract the smaller No. from the larger No. The difference is the total horizontal eccentricity.

D15721

NOTE: Write the dial indicator measurements with their positive (+) and negative (–) notation (signs). This notation is necessary for making the calculations in the chart correctly.

1. Fasten the dial indicator to the flywheel so the anvil of the indicator will touch the flywheel housing bore. With the dial indicator in position at (C), adjust the dial indicator to "0" (zero). Push the crankshaft up against the top bearing. Write the measurement for bearing clearance on line 1 in column (C).
2. Divide the measurement from Step 1 by 2. Write this number on line 1 in columns (B) & (D).
3. Turn the crankshaft to put the dial indicator at (A). Adjust the dial indicator to "0" (zero).
4. Turn the crankshaft counterclockwise to put the dial indicator at (B). Write the measurement in the chart.
5. Turn the crankshaft counterclockwise to put the dial indicator at (C). Write the measurement in the chart.
6. Turn the crankshaft counterclockwise to put the dial indicator at (D). Write the measurement in the chart.
7. Add lines I and II by columns.
8. Subtract the smaller number from the larger number in line III in columns (B) & (D). The result is the horizontal "eccentricity" (out of round). Line III, column (C) is the vertical eccentricity.

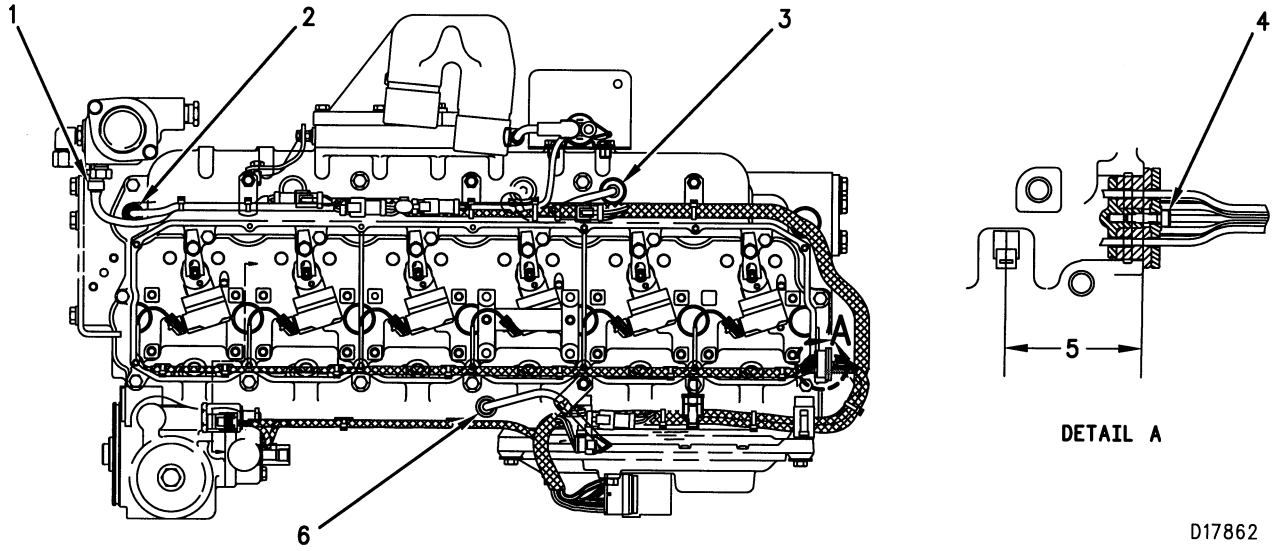


D15733

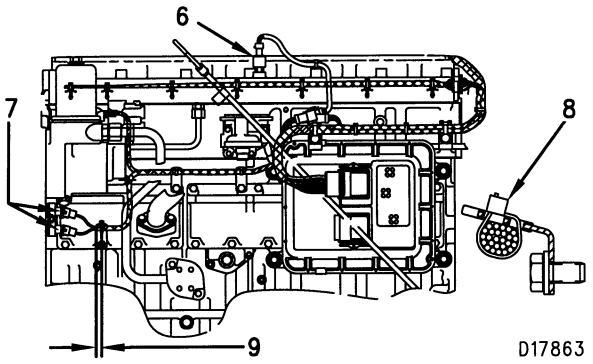
Graph For Total Eccentricity.
(1) Total Vertical Eccentricity [mm (in)]. (2) Total Horizontal Eccentricity [mm (in)]. (3) Acceptable. (4) Not Acceptable.

9. On the graph for total eccentricity find the point of intersection of the lines for vertical eccentricity and horizontal eccentricity.
10. If the point of intersection is in the range marked "Acceptable" the bore is in alignment. If the point of intersection is in the range marked "Not Acceptable" the flywheel housing must be changed.

Electronic Control Group (Wiring And Sensors)



Top View



Left Side View

(1) Coolant temperature sensor.

(2) Inlet manifold pressure (boost) sensor. Tighten to a torque of ..... 10 ± 2 N•m (90 ± 18 lb in)

(3) Inlet Air Temperature Sensor. Tighten to a torque of ..... 15 ± 3 N•m (11 ± 2 lb ft)

(4) Bolt (at wire feed-through). Tighten to a torque of ..... 0.9 ± 0.1 N•m (8 ± 1 lb in)

(5) Distance from center of harness clip to harness plug ..... 49.0 mm (1.93 in)

NOTE: Harness assembly must not contact manifold or rocker stand within this length.

(6) Injection actuation pressure control sensor. Tighten to a torque of ..... 40 ± 5 N•m (30 ± 4 lb ft)

(7) Speed/timing sensors.

NOTE: Speed/timing sensors are serviced as a pair/set only.

(8) Strap.

(9) Location of harness clip on braid ..... 10.0 ± 2.0 mm (.39 ± .08 in)