

Supplement

Up-rated 3500 Engines

 **WARNING**

IMPORTANT SAFETY NOTICE

Proper repair is important to the safe and reliable operation of this product. This Service Manual outlines basic recommended procedures, some of which require special tools, devices or work methods. Although not necessarily all inclusive, a list of additional skills, precautions and knowledge required to safely perform repairs is provided in the SAFETY section of this Manual.

Improper repair procedures can be dangerous and could result in injury or death.

READ AND UNDERSTAND ALL SAFETY PRECAUTIONS AND WARNINGS BEFORE PERFORMING REPAIRS

Basic safety precautions, skills and knowledge are listed in the SAFETY section of this Manual and in the descriptions of operations where hazards exist. Warning labels have also been put on to provide instructions and identify specific hazards which if not heeded could cause bodily injury or death to you or other persons. These labels identify hazards which may not be apparent to a trained mechanic. There are many potential hazards during repair for a untrained mechanic and there is no way to label the product against all such hazards. These warnings in the Service Manual and on the product are identified by this symbol:

 **WARNING**

Operations that may result only in mechanical damage are identified by labels on the product and in the Service Manual by the word **NOTICE**.

Caterpillar can not anticipate every possible circumstance that might involve a potential hazard. The warnings in this Manual are therefore not all inclusive. If a procedure, tool device or work method 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 procedures you choose.

IMPORTANT



The information, specifications and illustrations in this book are on the basis of information available at the time it was written. The specifications, torque, pressures of operation, measurements, adjustments, illustrations and other items can change at any time. These changes can affect the service given to the product. Get the complete and most current information before you start any job. Caterpillar Dealers have the most current information available. For a list of the most current modules and form numbers available for each Service Manual, see the SERVICE MANUAL CONTENTS MICROFICHE REG1139F.

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GENERAL TIGHTENING TORQUE FOR BOLTS, NUTS AND TAPERLOCK STUDS

The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in other sections of the Service Manual where needed.



THREAD DIAMETER		STANDARD TORQUE	
inches	millimeters	lb. ft.	N·m*
 <p>Standard thread</p>		<p>Use these torques for bolts and nuts with standard threads (conversions are approximate).</p>	
1/4	6.35	9 ± 3	12 ± 4
5/16	7.94	18 ± 5	25 ± 7
3/8	9.53	32 ± 5	45 ± 7
7/16	11.11	50 ± 10	70 ± 15
1/2	12.70	75 ± 10	100 ± 15
9/16	14.29	110 ± 15	150 ± 20
5/8	15.88	150 ± 20	200 ± 25
3/4	19.05	265 ± 35	360 ± 50
7/8	22.23	420 ± 60	570 ± 80
1	25.40	640 ± 80	875 ± 100
1 1/8	28.58	800 ± 100	1100 ± 150
1 1/4	31.75	1000 ± 120	1350 ± 175
1 3/8	34.93	1200 ± 150	1600 ± 200
1 1/2	38.10	1500 ± 200	2000 ± 275
<p>Use these torques for bolts and nuts on hydraulic valve bodies.</p>			
5/16	7.94	13 ± 2	20 ± 3
3/8	9.53	24 ± 2	35 ± 3
7/16	11.11	39 ± 2	50 ± 3
1/2	12.70	60 ± 3	80 ± 4
5/8	15.88	118 ± 4	160 ± 6
 <p>Taperlock stud</p>		<p>Use these torques for studs with Taperlock threads.</p>	
1/4	6.35	5 ± 2	7 ± 3
5/16	7.94	10 ± 3	15 ± 5
3/8	9.53	20 ± 3	30 ± 5
7/16	11.11	30 ± 5	40 ± 10
1/2	12.70	40 ± 5	55 ± 10
9/16	14.29	60 ± 10	80 ± 15
5/8	15.88	75 ± 10	100 ± 15
3/4	19.05	110 ± 15	150 ± 20
7/8	22.23	170 ± 20	230 ± 30
1	25.40	260 ± 30	350 ± 40
1 1/8	28.58	320 ± 30	400 ± 40
1 1/4	31.75	400 ± 40	550 ± 50
1 3/8	34.93	480 ± 40	650 ± 50
1 1/2	38.10	550 ± 50	750 ± 70

*1 newton meter (N·m) is approximately the same as 0.1 mkg.

TORQUE FOR FLARED AND O-RING FITTINGS

The torques shown in the chart that follows are to be used on the part of 37° Flared, 45° Flared and Inverted Flared fittings (when used with steel tubing), O-ring plugs and O-ring fittings.

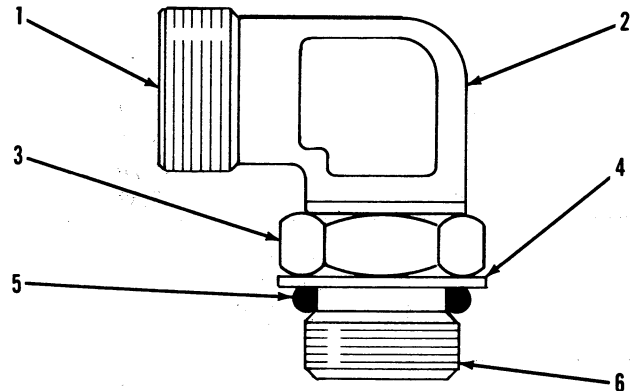
		INVERTED 45° FLARED					37° FLARED					45° FLARED					O-RING FITTING - PLUG		SWIVEL NUTS	
TUBE SIZE (O.D.)	mm	3.18	4.78	6.35	7.92	9.52	TUBE SIZE (O.D.)	mm	12.70	15.88	19.05	22.22	25.40	31.75	38.10	50.80				
	in.	.125	.188	.250	.312	.375		in.	.500	.625	.750	.875	1.000	1.250	1.500	2.000				
THREAD SIZE (in.)		5/16	3/8	7/16	1/2	9/16 5/8	THREAD SIZE (in.)		3/4	7/8	1 1/16	1 3/16 1 1/4	1 5/16	1 5/8	1 7/8	2 1/2				
TORQUE N-m		5 ±1	11 ±1	16 ±2	20 ±2	25 ±3	TORQUE N-m		50 ±5	75 ±5	100 ±5	120 ±5	135 ±10	180 ±10	225 ±10	320 ±15				
TORQUE lb.in.		45 ±10	100 ±10	145 ±20	175 ±20	225 ±25	TORQUE lb.ft.		35 ± 4	55 ± 4	75 ± 4	90 ± 4	100 ± 7	135 ± 7	165 ± 7	235 ± 10				

ASSEMBLY OF FITTINGS WITH STRAIGHT THREADS AND O-RING SEALS

- Put locknut (3), backup washer (4) and O-ring seal (5) as far back on fitting body (2) as possible. Hold these components in this position. Turn the fitting into the part it is used on, until backup washer (4) just makes contact with the face of the part it is used on.

NOTE: If the fitting is a connector (straight fitting) or plug, the hex on the body takes the place of the locknut. To install this type fitting tighten the hex against the face of the part it goes into.

- To put the fitting assembly in its correct position turn the fitting body (2) out (counterclockwise) a maximum of 359°. Tighten locknut (3) to the torque shown in the chart.



ELBOW BODY ASSEMBLY

1. End of fitting body (connects to tube). 2. Fitting body. 3. Locknut. 4. Backup washer. 5. O-ring seal. 6. End of fitting that goes into other part.

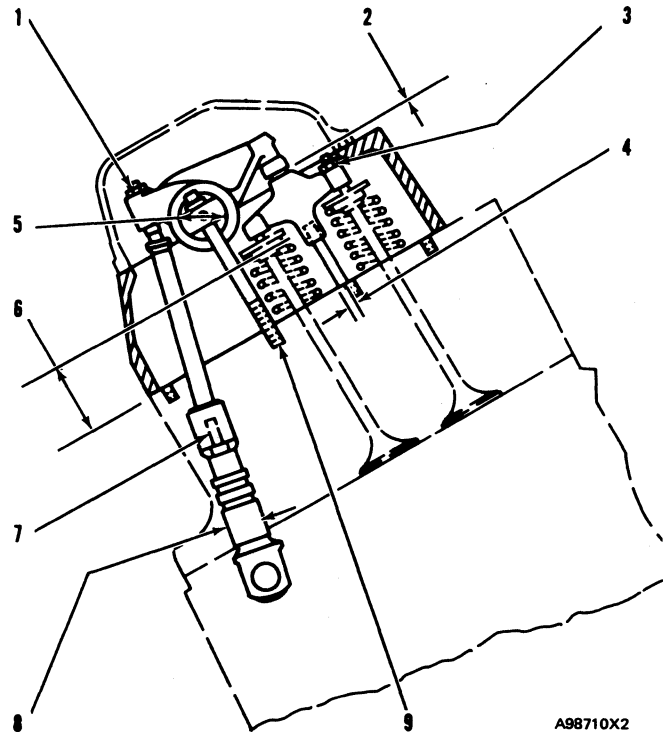
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INDEX

Camshafts	6
Crankshaft Wear Sleeves And Seals	13
Magnetic Pickup	11
Oil Cooler Bypass And Cooling Jet Sequence Valves	12
Oil Filter Bypass Valve	11
Rear Gear Group (3508)	14
Rear Gear Group (3512 & 3516)	15
Turbochargers	8-10
Turbocharger Impeller Installation	7
Valve Rocker Arms, Lifters, and Bridges	5
Vibration Damper Groups	16

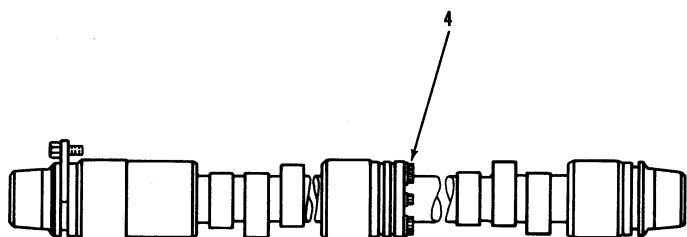
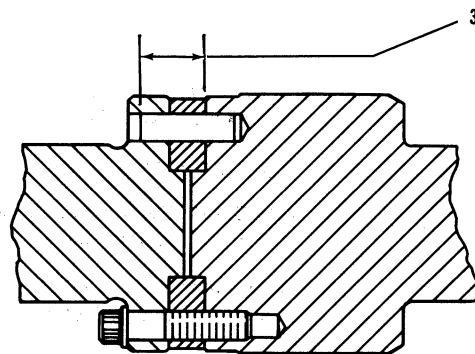
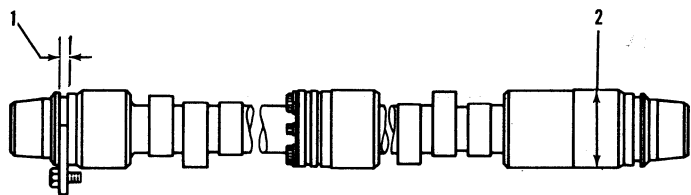
VALVE ROCKER ARMS, LIFTERS, AND BRIDGES

- (1) Torque for valve adjustment screw locknut $70 \pm 15 \text{ N}\cdot\text{m}$ ($50 \pm 11 \text{ lb}\cdot\text{ft.}$)
- (2) Clearance for valves:
 - Intake valves 0.38 mm (.015 in.)
 - Exhaust valves 0.76 mm (.030 in.)
- (3) Torque for bridge adjustment screw locknut $30 \pm 4 \text{ N}\cdot\text{m}$ ($22 \pm 3 \text{ lb}\cdot\text{ft.}$)
- (4) Diameter of dowel (new) $11.008 \pm 0.003 \text{ mm}$ (.4334 \pm .0001 in.)
 - Bore in bridge for dowel (new) $12.00 \pm 0.25 \text{ mm}$ (.472 \pm .010 in.)
 - Bore in head for dowel $10.968 \pm 0.020 \text{ mm}$ (.4318 \pm .0008 in.)
- (5) Diameter of rocker arm shaft $37.084 \pm 0.013 \text{ mm}$ (1.4600 \pm .0005 in.)
 - Bore in bearings for rocker arm shaft $37.140 \pm 0.015 \text{ mm}$ (1.4622 \pm .0006 in.)
- (6) Height to top of dowel $66.5 \pm 0.5 \text{ mm}$ (2.62 \pm .02 in.)
- (7) Guide springs must not be used again. Always install new guide springs.
- (8) Diameter of valve lifter (new) $29.937 \pm 0.010 \text{ mm}$ (1.1786 \pm .0004 in.)
 - Bore in head for valve lifter $30.000 \pm 0.025 \text{ mm}$ (1.1811 \pm .0010 in.)
- (9) Torque for rocker shaft mounting bolt $109 \pm 14 \text{ N}\cdot\text{m}$ (80 \pm 10 lb. ft.)



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CAMSHAFTS



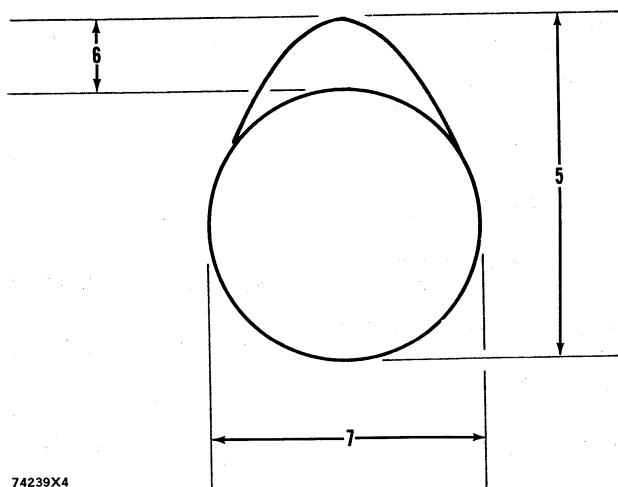
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- (1) Thickness of washer (new) 8.50 ± 0.05 mm (.335 ± .002 in.)
- Thickness of groove in camshaft (new) 8.75 ± 0.05 mm (.344 ± .002 in.)
- End play for the camshafts (new) 0.15 to 0.35 mm (.006 to .014 in.)

- (2) Diameter of the surfaces (journals) for the camshaft bearings (new) 85.88 ± 0.02 mm (3.381 ± .001 in.)
- Bore in the bearings for the camshafts (after assembly) 86.00 ± 0.06 mm (3.386 ± .002 in.)

- (4) 3512 and 3516 Engines:
Clean the threads of the bolts and the contact surfaces of the parts thoroughly. Put 9S3263 Thread Lock on the bolt threads and tighten to a torque of (hand tighten only)..... 55 ± 7 N·m (41 ± 5 lb. ft.)

- (5) Height of camshaft lobes.
To find lobe height, use the procedure that follows:
A. Measure camshaft lobe height (5).
B. Measure base circle (7).
C. Subtract base circle (STEP B) from lobe height (STEP A). The difference is actual lobe lift.



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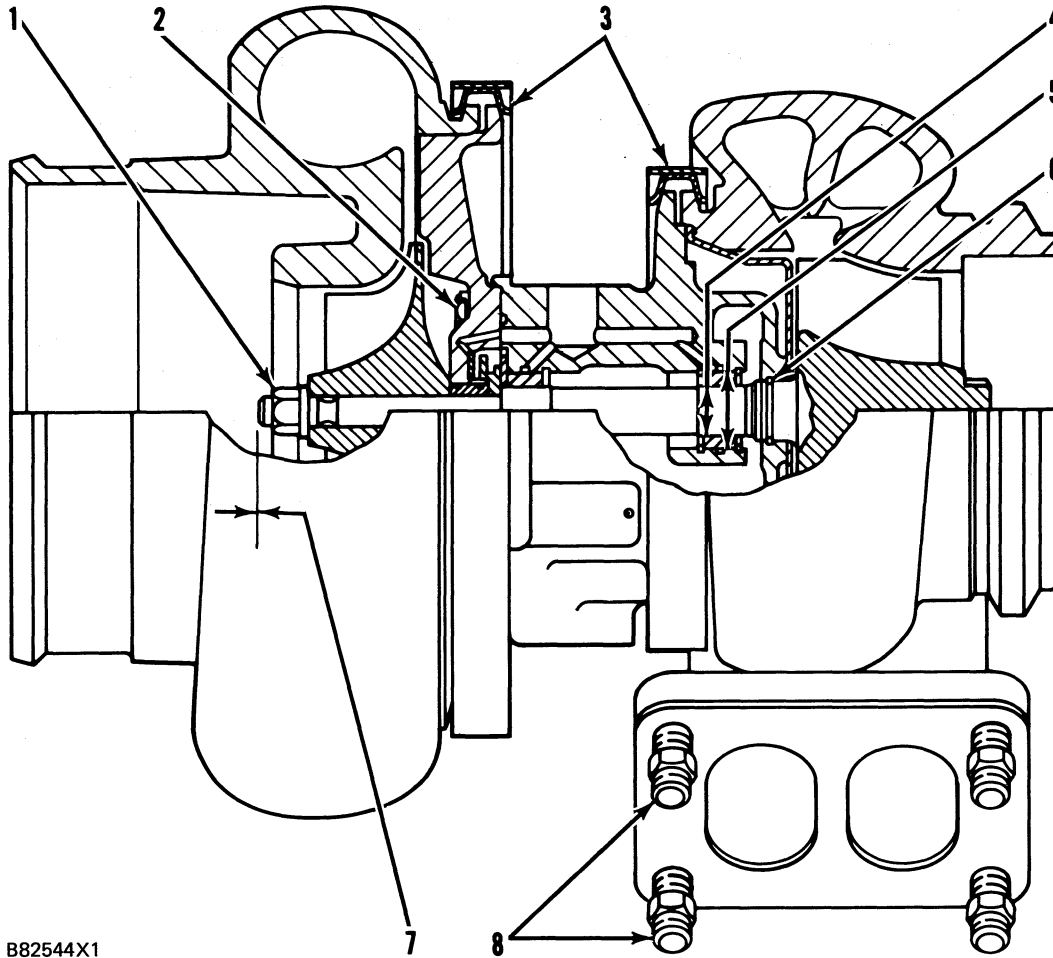
- D. Specified camshaft lobe lift (6) is:
 - a. Exhaust lobe 9.078 mm (.3574 in.)
 - b. Intake lobe 9.314 mm (.3667 in.)
 - c. Injector lobe:
 - Engines rated at 900 to 1300 rpm 13.574 mm (.5344 in.)
 - Engines rated at 1301 to 1800 rpm 13.731 mm (.5406 in.)

TURBOCHARGER IMPELLER INSTALLATION

INSTALLATION PROCEDURE CHART					
TURBOCHARGER MODELS					
Step by Step Procedure	T04, T04B, T04C, TW4B, TW4C, TL4B, TL4C	TM51, TM54	T12, TV61 TW61, TL61	T18, TV81, TW81, TL81, TV72, TW72, TL72, TV78, TW78, TL78	TV91, TW91 TL91, TV92, TW92, TL92
A. Put impeller on the shaft.					
B. Put a small amount of clean oil on the threads and impeller face area that contacts the nut.					
C. Install and tighten the nut to:	2.25 N•m (20 lb. in.)	5 N•m (50 lb. in.)	17 N•m (13 lb. ft.)	17 N•m (13 lb. ft.)	31 N•m (23 lb. ft.)
NOTICE Do not bend or add stress to the shaft when the nut is loosened or tightened.					
D. Loosen the nut on the shaft.	*	*			
E. Now tighten the nut to:	*	*	3.5 N•m (30 lb. in.)	3.5 N•m (30 lb. in.)	5 N•m (50 lb. in.)
F. Tighten the nut more:	110°	120°	120°	120°	135°
G. Remove the nut from the shaft.					
H. Use 6V1541 Quick Cure Primer on the threads of the shaft and nut.					
J. Put 9S3265 Retaining Compound on the threads of the shaft and nut.					
K. Install and tighten the nut to:	2.25 N•m (20 lb. in.)	5 N•m (50 lb. in.)	3.5 N•m (30 lb. in.)	3.5 N•m (30 lb. in.)	5 N•m (50 lb. in.)
L. Tighten the nut more:	110°	120°	120°	120°	135°

*Does not apply to these turbochargers.

**TURBOCHARGERS
(TV72 & TW72)
(TV78 & TW78)**



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- (1) Nut for impeller (See TURBOCHARGER IMPELLER INSTALLATION).

NOTICE

Do not bend or add stress to the shaft when the nut is loosened or tightened.

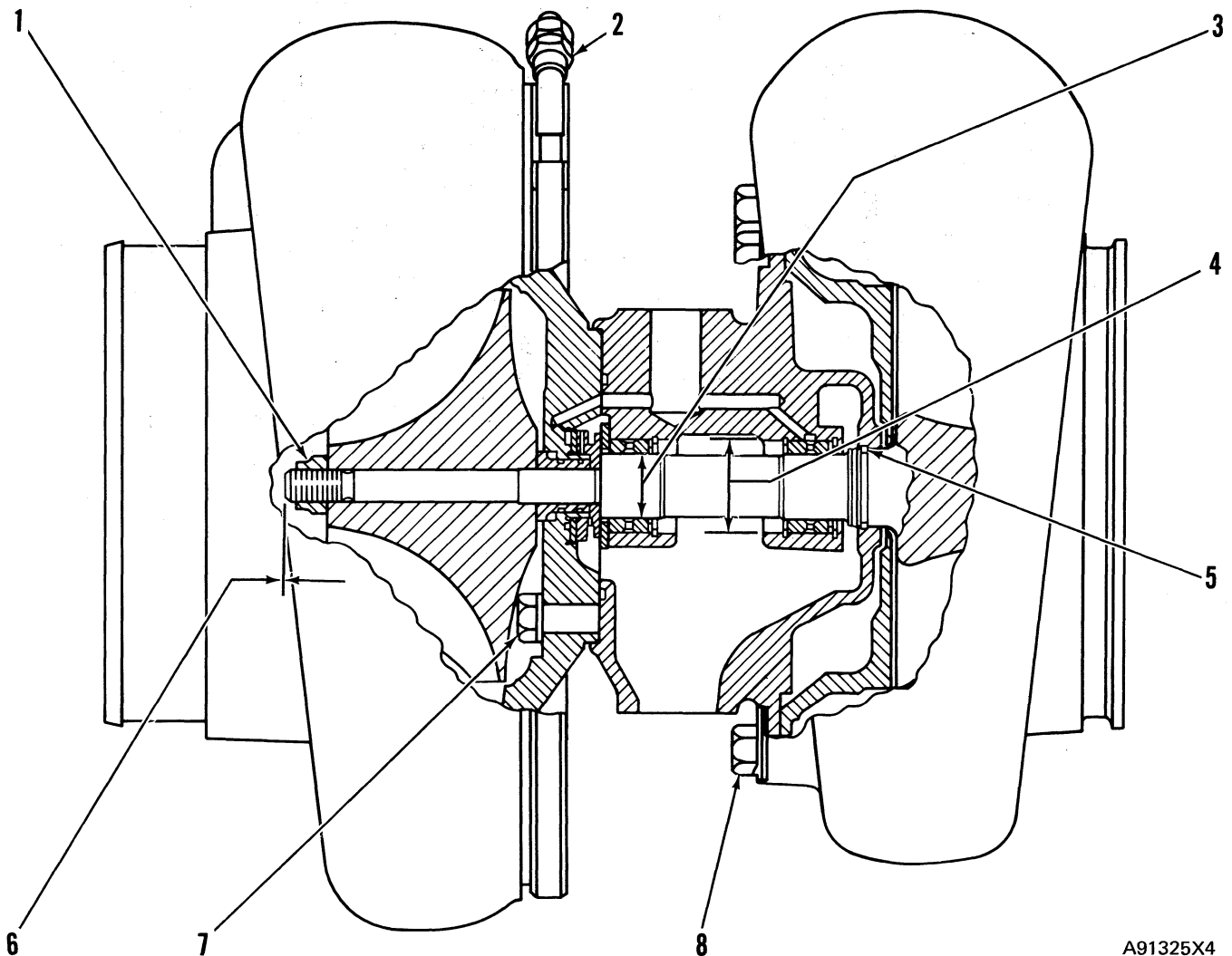
- (2) Torque for the bolts that hold the backplate $10 \pm 1 \text{ N}\cdot\text{m}$ ($90 \pm 10 \text{ lb}\cdot\text{in.}$)
- (3) Torque for the clamp bolts $18 \pm 3 \text{ N}\cdot\text{m}$ ($13 \pm 2 \text{ lb}\cdot\text{ft.}$)
Lightly hit all around clamp with a soft faced hammer and again tighten to $18 \pm 3 \text{ N}\cdot\text{m}$ ($13 \pm 2 \text{ lb}\cdot\text{ft.}$)

- (4) Bore in the bearings $15.921 \text{ to } 15.931 \text{ mm}$ (.6268 to .6272 in.)
Diameter for the surfaces (journals) on the shaft for the bearings $15.875 \text{ to } 15.885 \text{ mm}$ (.6250 to .6254 in.)

- (5) Bore in the housing $24.961 \text{ to } 24.973 \text{ mm}$ (.9827 to .9832 in.)
Outside diameter of the bearings $24.846 \text{ to } 24.859 \text{ mm}$ (.9782 to .9787 in.)
- (6) Clearance between the ends of the oil seal ring (when installed in its bore) $0.20 \text{ to } 0.38 \text{ mm}$ (.008 to .015 in.)
- (7) End play for the shaft $0.08 \text{ to } 0.25 \text{ mm}$ (.003 to .010 in.)
- (8) Torque for bolts and nuts that hold the turbocharger to the exhaust manifold (put 5P3931 Anti-Seize Compound on the threads) $54 \pm 5 \text{ N}\cdot\text{m}$ ($40 \pm 4 \text{ lb}\cdot\text{ft.}$)

NOTE: At assembly, put 5P3931 Anti-Seize Compound on the threads of the bolts that hold the oil lines to the turbocharger cartridge housing.

**TURBOCHARGERS
(TV92 & TW92)**



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(1) Nut for impeller (See TURBOCHARGER IMPELLER INSTALLATION).

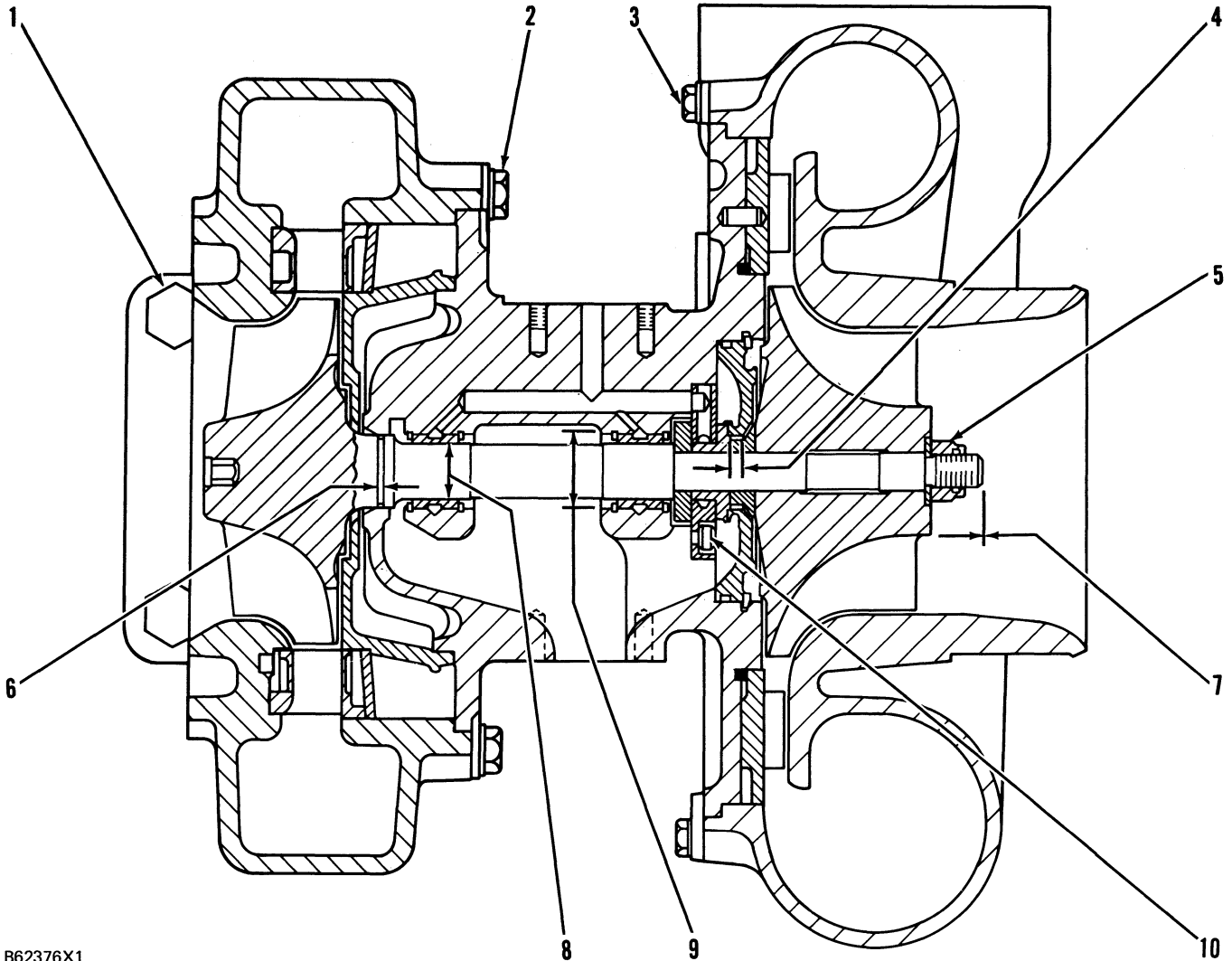
NOTICE

Do not bend or add stress to the shaft when the nut is loosened or tightened.

- (2) Torque for the clamp bolt 14.0 ± 1.5 N•m (10 ± 1 lb.ft.)
Hit lightly all around clamp with a soft faced hammer and again tighten to 14.0 ± 1.5 N•m (10 ± 1 lb.ft.)
- (3) Bore in the bearings 21.585 to 21.595 mm (.8498 to .8502 in.)
Diameter of the surfaces (journals) on the shaft 21.539 to 21.549 mm (.8480 to .8484 in.)
- (4) Bore in the housing 30.594 to 30.607 mm (1.2045 to 1.2050 in.)
Outside diameter of bearings 30.467 to 30.480 mm (1.1995 to 1.2000 in.)

- (5) Clearance between the ends of oil seal ring (when installed in its bore) 0.20 to 0.38 mm (.008 to .015 in.)
- (6) End play for the shaft 0.165 ± 0.063 mm (.0065 ± .0025 in.)
- (7) Torque for the bolts that hold the backplate 40 ± 2 N•m (30 ± 1 lb.ft.)
- (8) Torque for the bolts that hold the turbine housing to the cartridge housing (put 5P3931 Anti-Seize Compound on the threads) 40 ± 2 N•m (30 ± 1 lb.ft.)
Torque for the bolts and nuts that hold the turbocharger to the exhaust manifold (put 5P3931 Anti-Seize Compound on the threads) 54 ± 5 N•m (40 ± 4 lb.ft.)

**TURBOCHARGERS
(C153 & W153)**



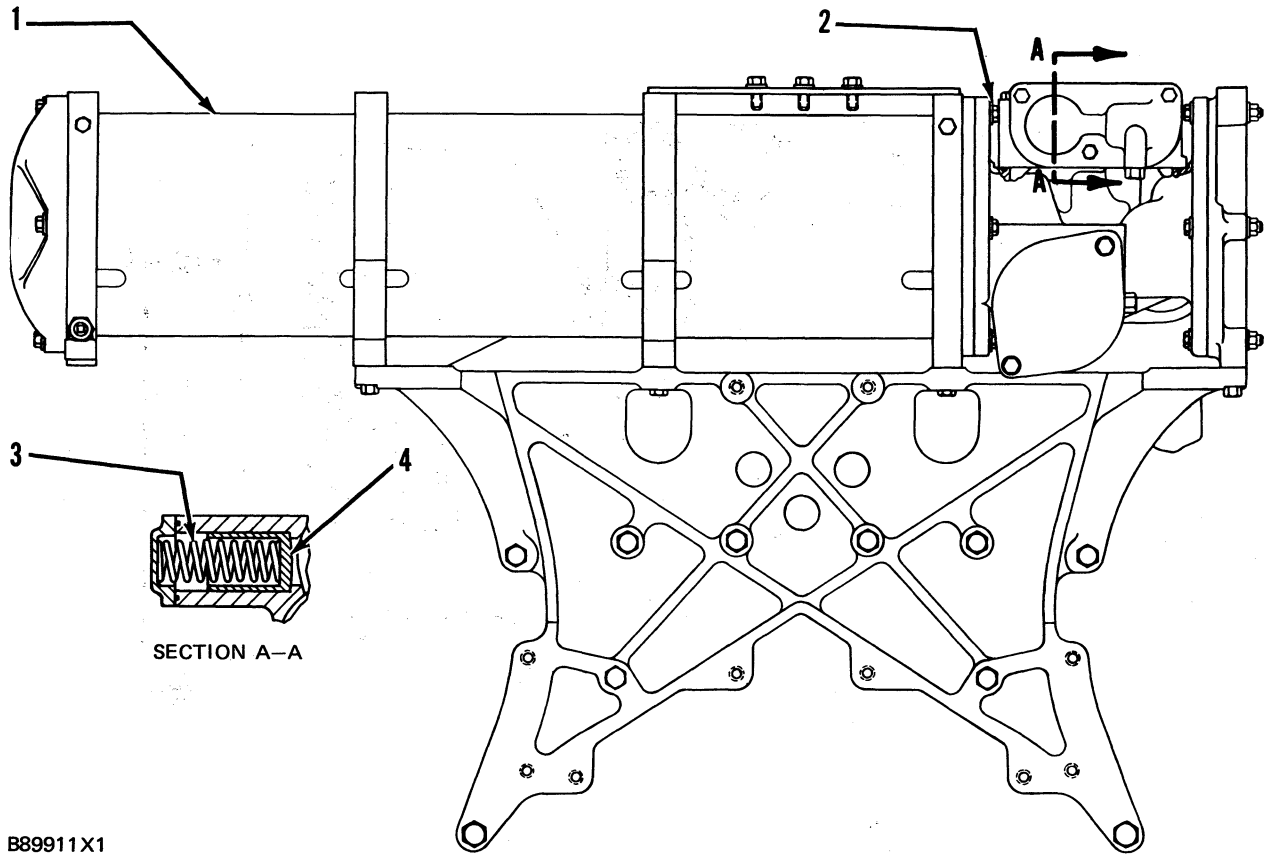
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| <p>(1) Torque for the bolts and nuts that hold the turbocharger to the exhaust manifold (put 5P3931 Anti-Seize Compound on threads) $270 \pm 25 \text{ N}\cdot\text{m}$ ($200 \pm 18 \text{ lb}\cdot\text{ft.}$)</p> <p>(2) Torque for the bolts that hold the turbine housing to the cartridge housing $48 \pm 3 \text{ N}\cdot\text{m}$ ($35 \pm 2 \text{ lb}\cdot\text{ft.}$)</p> <p>(3) Torque for the bolts that hold the compressor housing to the cartridge housing (put 5P3931 Anti-Seize Compound on the threads) $25 \pm 5 \text{ N}\cdot\text{m}$ ($18 \pm 4 \text{ lb}\cdot\text{ft.}$)</p> <p>(4) Width of oil seal ring at compressor end $2.500 \pm 0.010 \text{ mm}$ ($.0984 \pm .0004 \text{ in.}$)
Width of oil seal ring groove at compressor end $2.635 \pm 0.035 \text{ mm}$ ($.1037 \pm .0014 \text{ in.}$)</p> <p>(5) Turbocharger impeller installation:
a. Put impeller on the shaft.
b. Put a small amount of 2P2506 Thread Lubricant on the threads and impeller face that will be under the nut.
c. Tighten the nut to $95 \pm 5 \text{ N}\cdot\text{m}$ ($70 \pm 4 \text{ lb}\cdot\text{ft.}$)</p> | <p>(6) Width of oil seal ring at turbine end $2.500 \pm 0.010 \text{ mm}$ ($.0984 \pm .0004 \text{ in.}$)
Width of oil seal ring groove at turbine end $2.550 + 0.030 - 0.010 \text{ mm}$ ($.1004 + .0012 - .0004 \text{ in.}$)</p> <p>(7) End play for the shaft $0.090 \text{ to } 0.130 \text{ mm}$ ($.0035 \text{ to } .0051 \text{ mm}$)</p> <p>(8) Bore in the bearings $24.020 + 0.010 - 0.0 \text{ mm}$ ($.9457 + .0004 - .00 \text{ in.}$)
Diameter of the surfaces (journals) on the shaft $24.000 + 0.0 - 0.009 \text{ mm}$ ($.9449 + .00 - .0004 \text{ in.}$)</p> <p>(9) Bore in the housing $32.000 + 0.016 - 0.0 \text{ mm}$ ($1.2598 + .0006 - .00 \text{ in.}$)
Outside diameter of the bearings $31.890 + 0.0 - 0.010 \text{ mm}$ ($1.2555 + .00 - .0004 \text{ in.}$)</p> <p>(10) Torque for the three bolts that hold the thrust bearing $10 \pm 2 \text{ N}\cdot\text{m}$ ($7 \pm 1 \text{ lb}\cdot\text{ft.}$)</p> |
|---|--|

NOTICE

Do not bend or add stress to the shaft when the nut is loosened or tightened.

OIL FILTER BYPASS VALVE



B89911X1

- (1) Oil filter housing.
- (2) Torque for three bolts that hold bypass housing to filter housing $55 \pm 7 \text{ N}\cdot\text{m}$ ($41 \pm 5 \text{ lb}\cdot\text{ft}$.)
- (3) 2W1635 Spring for the filter bypass valve:
 - Length under test force 102 mm (4.02 in.)
 - Test force 518 N (115 lb.)
 - Free length after test 143.4 mm (5.65 in.)
 - Outside diameter 37.25 mm (1.470 in.)
- (4) Oil filter bypass valve must start to open at a pressure difference of $200 \pm 7 \text{ kPa}$ ($29 \pm 1 \text{ psi}$)

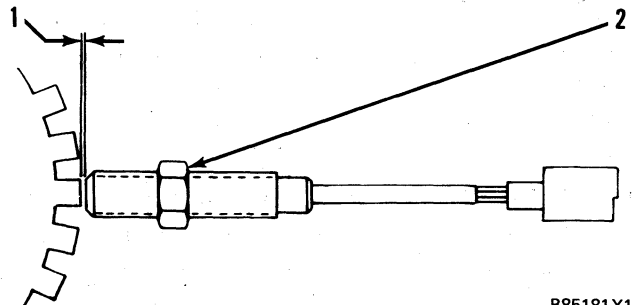
MAGNETIC PICKUP

For use with electric service meter

- (1) Distance between end of magnetic pickup and gear $0.56 \text{ to } .085 \text{ mm}$ ($.022 \text{ to } .033 \text{ in.}$)

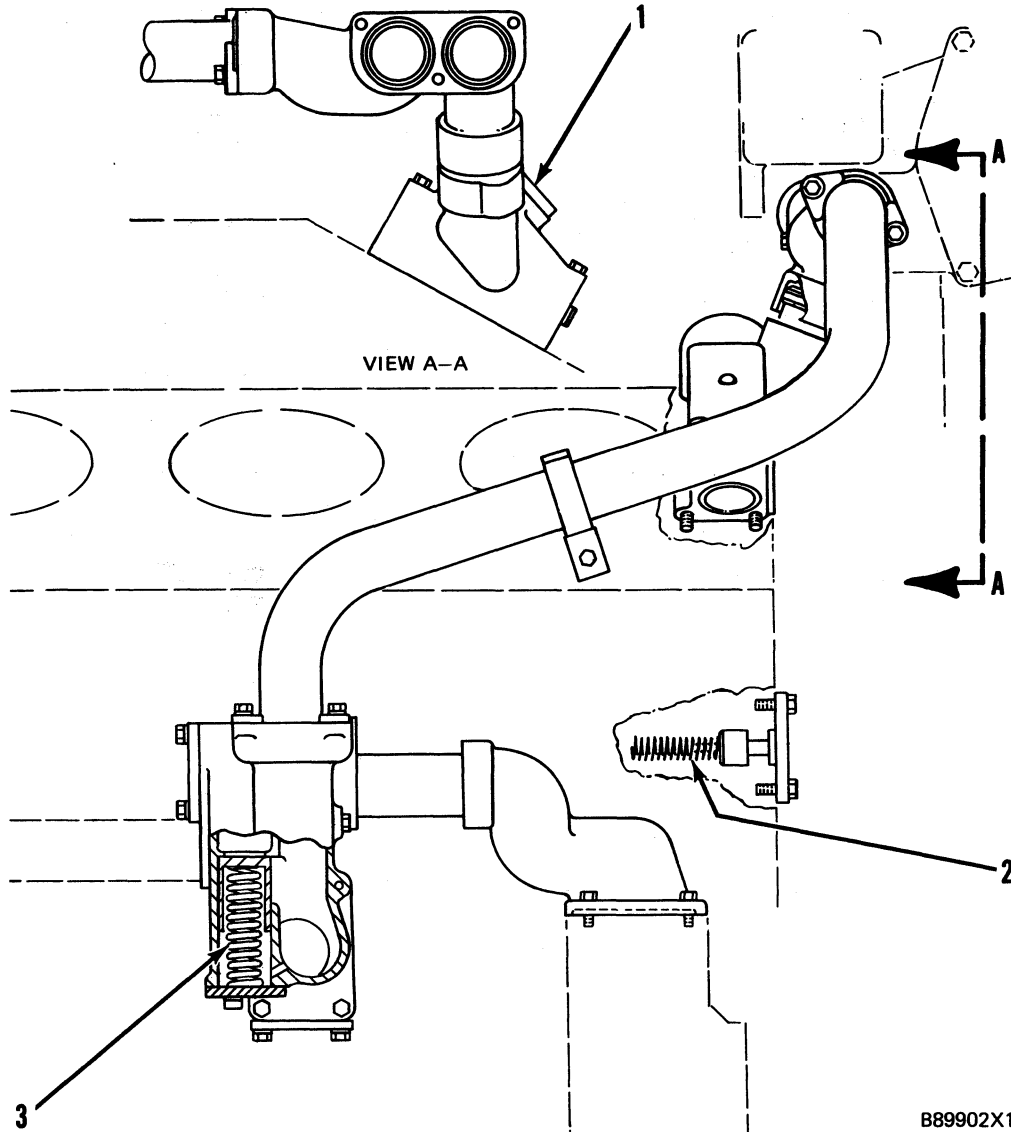
NOTE: This distance is set by turning magnetic pickup into threads until magnet is against the gear tooth while the engine is stopped. Now back magnetic pickup out one-half turn $\pm 30^\circ$ and tighten nut (2) as follows.

- (2) Nut. Tighten nut to a torque of $45 \pm 7 \text{ N}\cdot\text{m}$ ($33 \pm 5 \text{ lb}\cdot\text{ft.}$)



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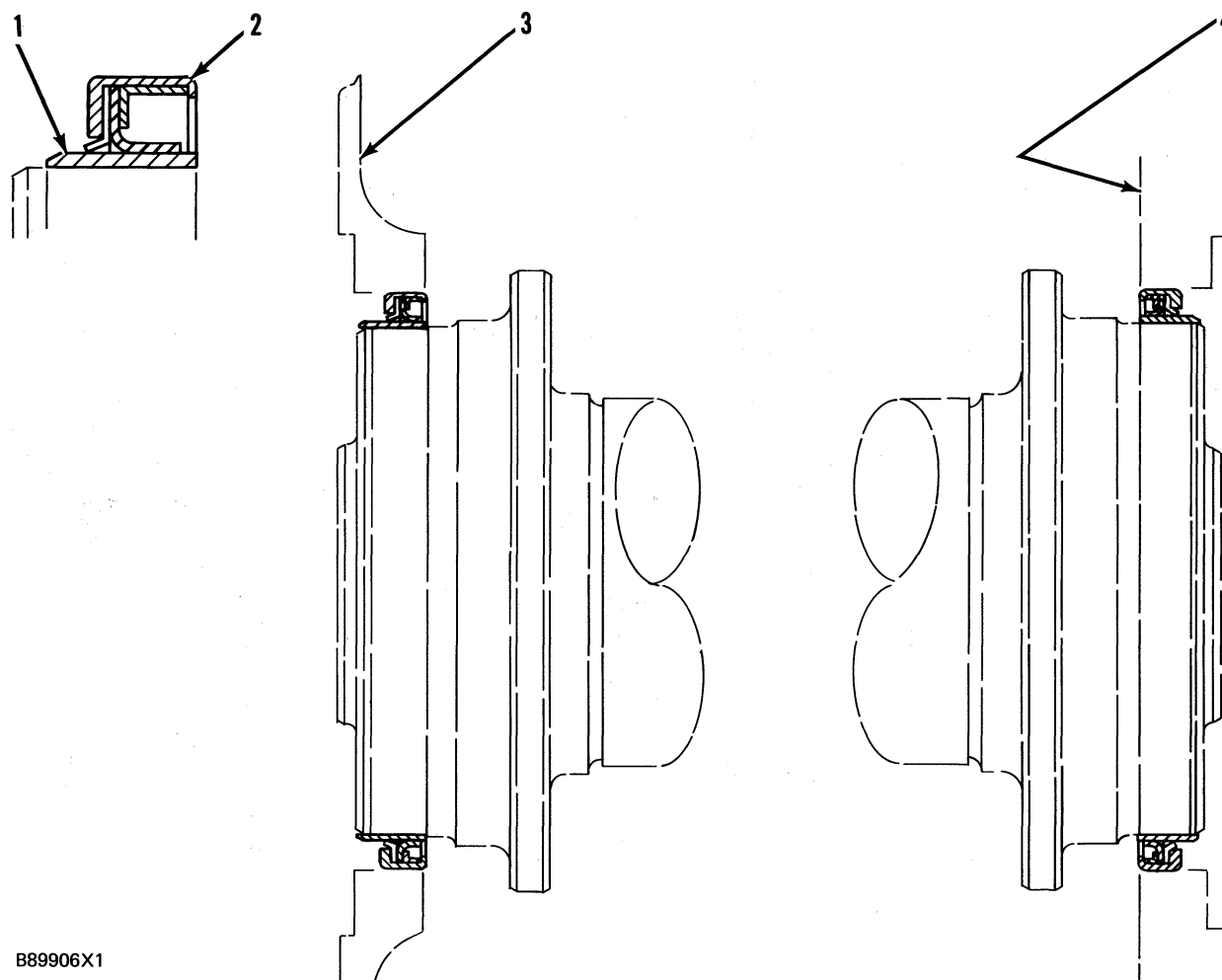
OIL COOLER BYPASS AND COOLING JET SEQUENCE VALVES



- (1) Tighten plug in elbow to a torque of $100 \pm 15 \text{ N}\cdot\text{m}$ ($75 \pm 11 \text{ lb}\cdot\text{ft.}$)
 - (2) 6B9202 Spring for cooling jet sequence valve (one at each end of block):
 - Length under test force 68.3 mm (2.69 in.)
 - Test force $85 \text{ to } 101.8 \text{ N}$ ($19 \text{ to } 22.4 \text{ lb.}$)
 - Free length after test 112.7 mm (4.44 in.)
 - Outside diameter 24.60 mm ($.969 \text{ in.}$)
- Both cooling jet sequence valves must start to open at a pressure difference of $130 \pm 30 \text{ kPa}$ ($19 \pm 4.5 \text{ psi}$) and must be fully open at $200 \pm 30 \text{ kPa}$ ($29 \pm 4.5 \text{ psi}$)

- (3) 2W1635 Spring for oil cooler bypass valve:
 - Length under test force 121 mm (4.76 in.)
 - Test force 280 N (63 lb.)
 - Free length after test 143.4 mm (5.65 in.)
 - Outside diameter 37.25 mm (1.467 in.)
- Oil cooler bypass valve must open with a pressure difference of $180 \pm 20 \text{ kPa}$ ($26 \pm 3 \text{ psi}$)

CRANKSHAFT WEAR SLEEVES AND SEALS



B89906X1

(1) Wear sleeve.

Removal:

- a. Remove the seals from each end of the engine.

NOTE: Seals and wear sleeves cannot be used again after the seals and wear sleeves are separated.

- b. Remove wear sleeves from each end of the engine.

Installation:

- a. **Do not** separate wear sleeves (1) from crankshaft seals (2). Once they are separated, they cannot be used again.

NOTE: See Special Instruction Form No. SMHS8301 for more information.

- b. Clean the outer surface of the crankshaft and the inner surface of wear sleeve (1) with 6V1541 Quick Cure Primer.
- c. Carefully put a thin coat of 9S3265 Retaining Compound on the inner surface of wear sleeve (1) and on crankshaft surface.
- d. Install seal (2) and wear sleeve (1) as a unit on the end of the crankshaft with the correct tools.

Tools Needed		
6V4003	Locator	(1)
2N5006	Bolt (1"-14 NF X 2.5 in. long)	(2)
8T3099	Installer	(1)
9S8858	Nut	(1)

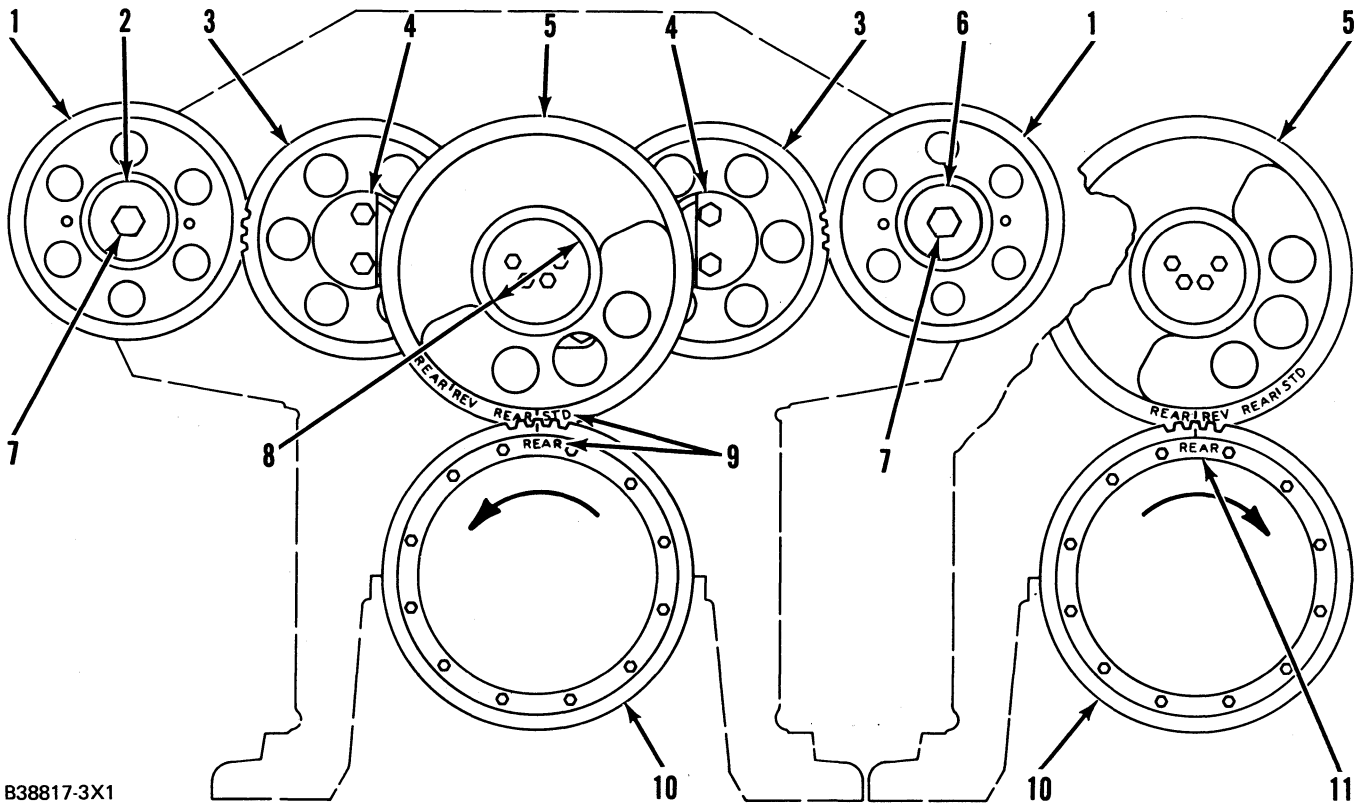
(2) Crankshaft seals:

Crankshaft seals must be installed with the lip of the seal toward the inside of the engine as shown. Make sure the correct seal is installed on each end of the crankshaft. For SAE Standard Rotation engines use 1W6974 Seal Group on the front and 1W6977 Seal Group on the rear. For SAE Opposite Rotation engines use 1W6977 Seal Group on the front and 1W6974 Seal Group on the rear.

(3) Flywheel housing.

(4) Front housing.

**REAR GEAR GROUP
(3508)**



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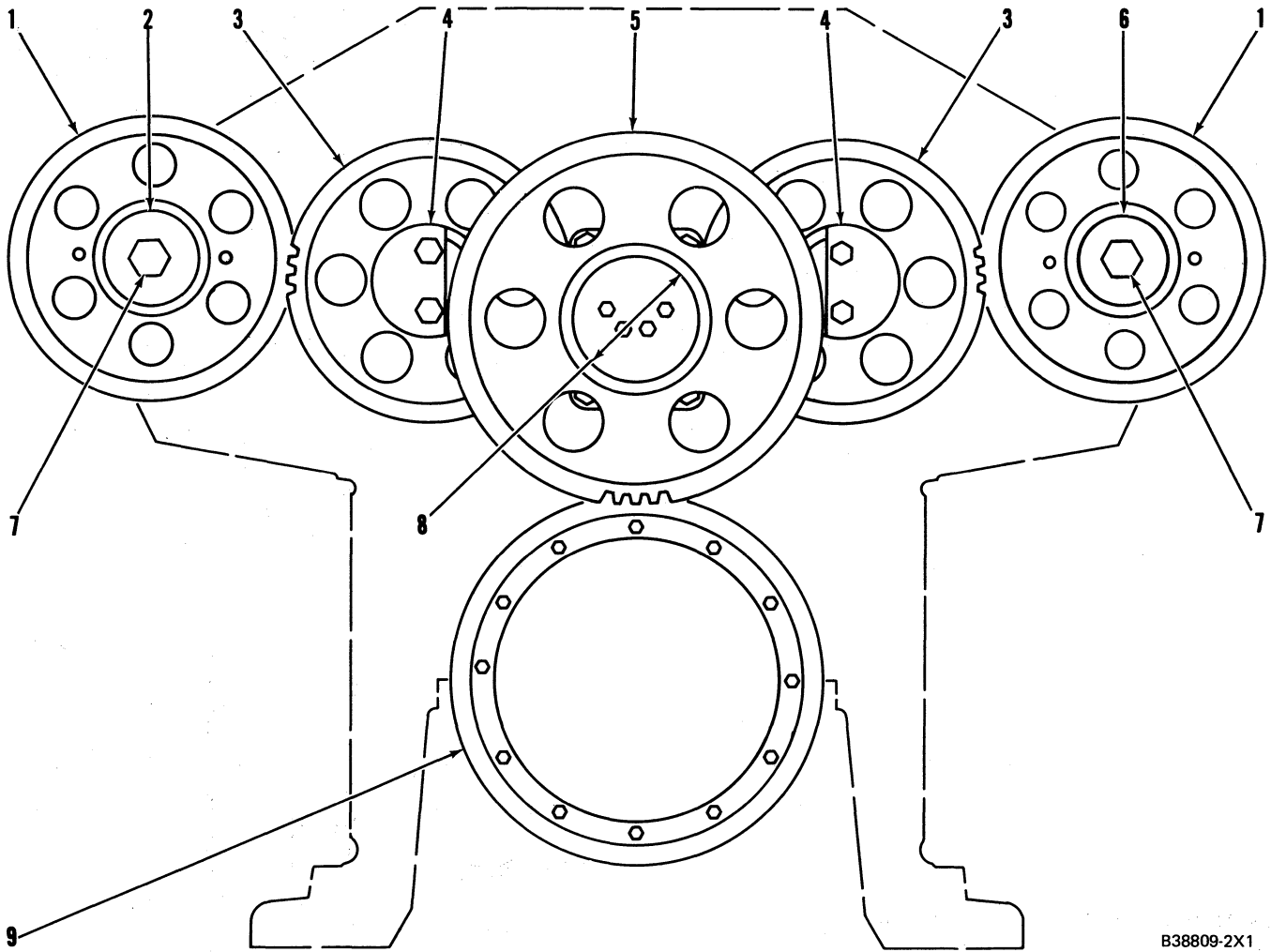
- (1) Camshaft drive gears.
- (2) Plate.
- (3) Camshaft idler gears.
- (4) Diameter of shafts
(new) 74.900 ± 0.015 mm (2.9488 ± .0006 in.)
Bore in bearings (after assembly) 75.000 ± 0.055 mm (2.9528 ± .0022 in.)
- (5) Cluster idler gear (balancer gear).
- (6) Plate. Replaced by gear for hydramechanical protective system drive or adapter for accessory drive.
- (7) Bolts that hold camshaft drive gears (1) in position. Install the gears as follows:
 - a. Pin both camshafts and put camshaft drive gears (1) in position on each camshaft taper.
 - b. For correct timing, all gear clearance (backlash) must be removed. Turn camshaft drive gears (1) in the same direction as crankshaft rotation and hold in this position.
 - c. Install plates (2) and (6) to hold the camshaft drive gears (1) to each camshaft.

- d. Tighten bolts (7) in steps to a torque of 360 ± 50 N•m (265 ± 35 lb.ft.)
- e. Hit bolts (7) and again tighten the bolts to a torque of 360 ± 50 N•m (265 ± 35 lb.ft.)

NOTE: If necessary, repeat Step 7e until the bolts hold torque (cannot be moved) to make sure the drive gears are in full contact with the taper on the camshafts.

- (8) Diameter of shaft
(new) 74.900 ± 0.015 mm (2.9488 ± .0006 in.)
Bore in bearing (after assembly) 75.000 ± 0.053 mm (2.9528 ± .0021 in.)
Bearing joint must be in center of heavy section in gear at assembly.
- (9) Balancer gear marks must be in alignment with crankshaft gear marks as shown for SAE standard rotation engines.
- (10) Crankshaft gear.
- (11) Balancer gear marks must be in alignment with crankshaft gear marks as shown for SAE opposite rotation engines.

**REAR GEAR GROUP
(3512 & 3516)**



B38809-2X1

- (1) Camshaft drive gears.
- (2) Plate.
- (3) Camshaft idler gears.
- (4) Diameter of shafts
(new) 74.900 ± 0.015 mm (2.9488 ± .0006 in.)
Bore in bearings (after assembly) 75.000 ± 0.055 mm (2.9528 ± .0022 in.)
- (5) Cluster idler gear.
- (6) Plate. Replaced by gear for hydramechanical protective system drive or adapter for accessory drive.
- (7) Bolts that hold camshaft drive gears (1) in position. Install the gears as follows:
 - a. Pin both camshafts and put camshaft drive gears (1) in position on each camshaft taper.
 - b. For correct timing, all gear clearance (backlash) must be removed. Turn camshaft drive gears (1) in the same direction as crankshaft rotation and hold in this position.
 - c. Install plates (2) and (6) to hold camshaft drive gears (1) to each camshaft.

- d. Tighten bolts (7) in steps to a torque of 360 ± 50 N•m (265 ± 35 lb.ft.)
- e. Hit bolts (7) and again tighten the bolts to a torque of 360 ± 50 N•m (265 ± 35 lb.ft.)

NOTE: If necessary, repeat Step 7e until the bolts hold torque (cannot be moved) to make sure the drive gears are in full contact with the taper on the camshafts.

- (8) Diameter of shaft
(new) 74.900 ± 0.015 mm (2.9488 ± .0006 in.)
Bore in bearing (after assembly) 75.000 ± 0.053 mm (2.9528 ± .0021 in.)
- (9) Crankshaft gear.

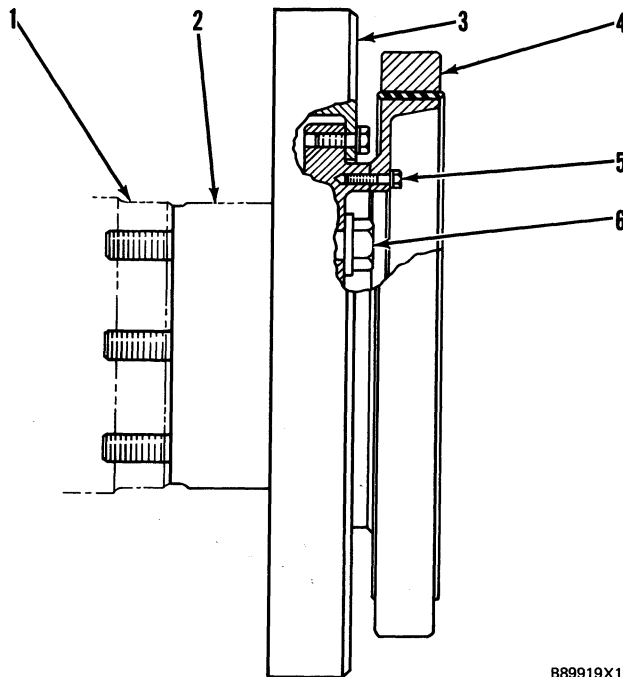
VIBRATION DAMPER GROUPS

4W278 Damper Group:

- (1) Crankshaft.
- (2) Adapter.
- (3) Damper (fluid).
- (4) Damper (rubber).
- (5) Bolts. Tighten all $\frac{3}{8}$ in diameter bolts to a torque of $55 \pm 7 \text{ N}\cdot\text{m}$ ($41 \pm 5 \text{ lb. ft.}$)

NOTE: Put mark of adapter (2) in alignment with mark on end of crankshaft (1) before installation of bolts (6).

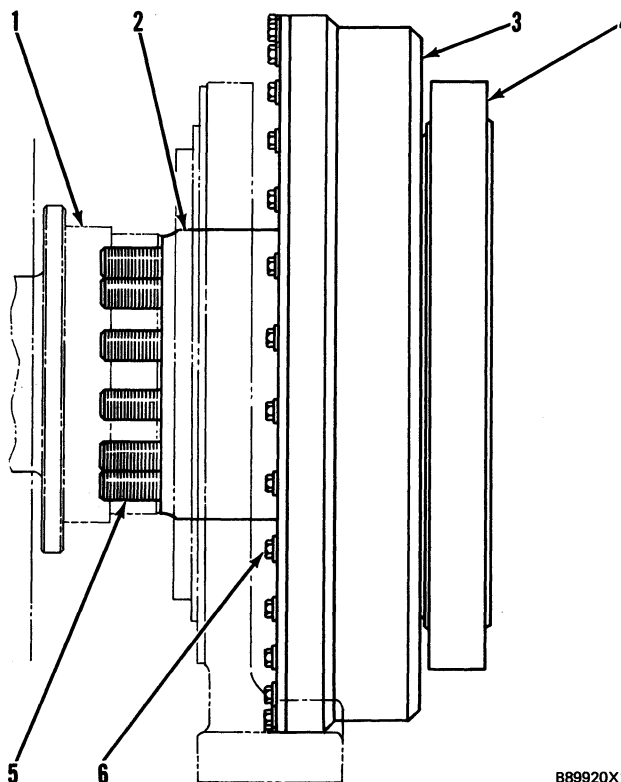
- (6) Bolts. Tighten bolts in the end of the crankshaft to a torque of $1125 \pm 100 \text{ N}\cdot\text{m}$ ($820 \pm 75 \text{ lb. ft.}$)



B89919X1

8N339, 4W3113 & 4W7754 Damper Groups:

- (1) Crankshaft.
- (2) Adapter.
- (3) Damper (fluid).
- (4) Damper (rubber).
- (5) Bolts. Tighten bolts in the end of the crankshaft to a torque of $1125 \pm 100 \text{ N}\cdot\text{m}$ ($820 \pm 75 \text{ lb. ft.}$)
- (6) Bolts. Tighten all $\frac{3}{8}$ in diameter bolts to a torque of $55 \pm 7 \text{ N}\cdot\text{m}$ ($41 \pm 5 \text{ lb. ft.}$)



B89920X1

4W7754 DAMPER GROUP SHOWN