DISASSEMBLY AND ASSEMBLY (Section 6)

⚠ WARNING

DISCONNECT BATTERIES BEFORE PERFORMANCE OF ANY SERVICE WORK.

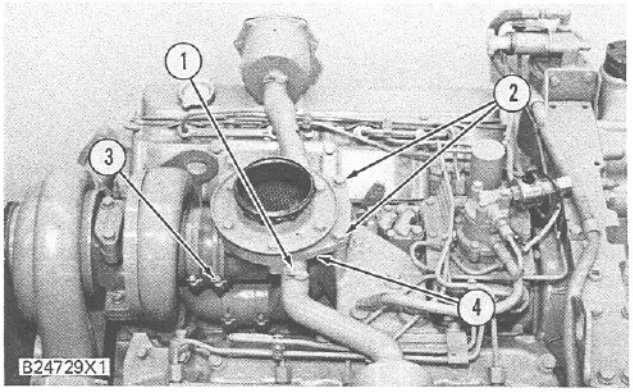
AIR INLET MANIFOLD

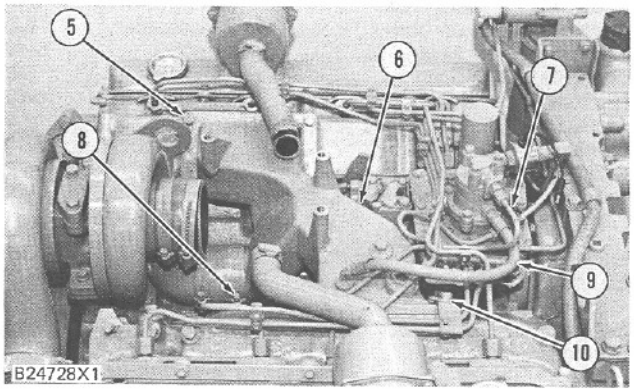
REMOVE AIR INLET MANIFOLD 1058-11

1. Loosen clamps (1) and (3). Disconnect the hoses.
2. Remove bolts (2) and elbow (4).
3. Loosen clamps (8) and then slide the hose on to the turbocharger.
4. Disconnect hose (9) from the manifold.
5. Remove fuel line (7) from the fuel ratio control.
6. Remove bolts (5). Loosen bolt (10).

NOTE: NOTE: Manifold (6) has an opening (slot) in it for bolt (10).

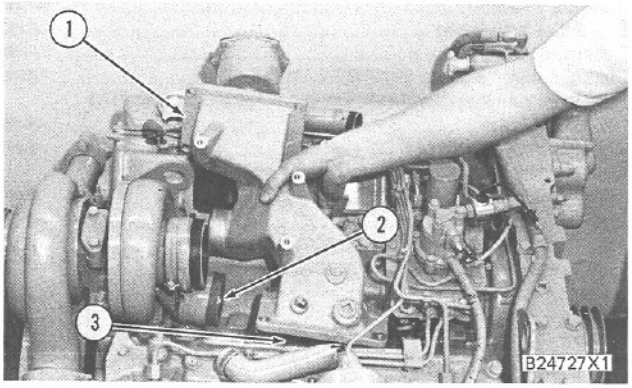
7. Remove manifold (6) and its gaskets.

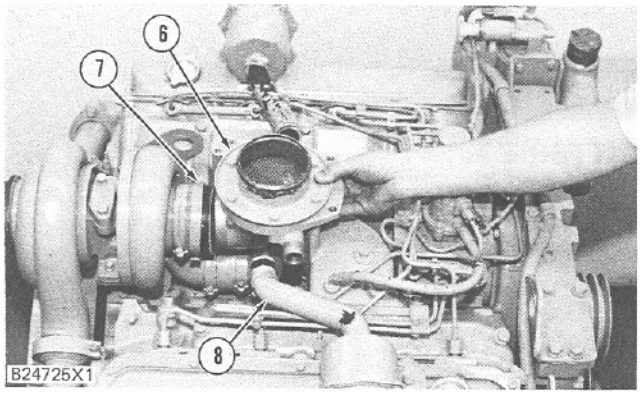


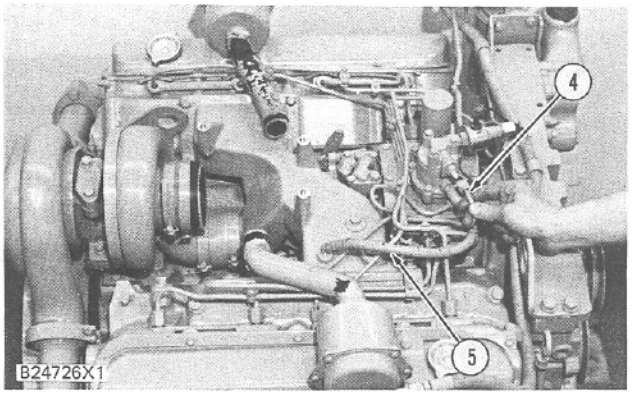


INSTALL AIR INLET MANIFOLD 1058-12

1. Put gaskets (3) and manifold (1) in position and install the bolts that hold it.
2. Put hose (2) in position and tighten the clamps.
3. Install fuel line (4) on the fuel ratio control. Connect hose (5) to the manifold.
4. Put elbow (6) in position on the manifold and install the bolts that hold it.
5. Connect crankcase ventilator hoses (8) to the elbow and tighten the hose clamps.
6. Connect hose (7) to the manifold and tighten the hose clamp.







AIR INLET MANIFOLD (LATER)

REMOVE AIR INLET MANIFOLD 1058-11

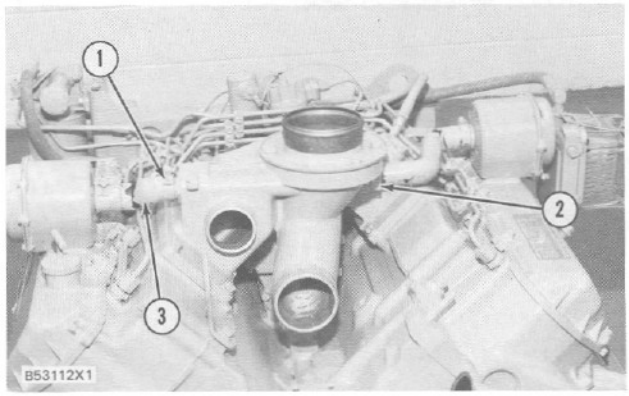
start by:
a) remove turbocharger

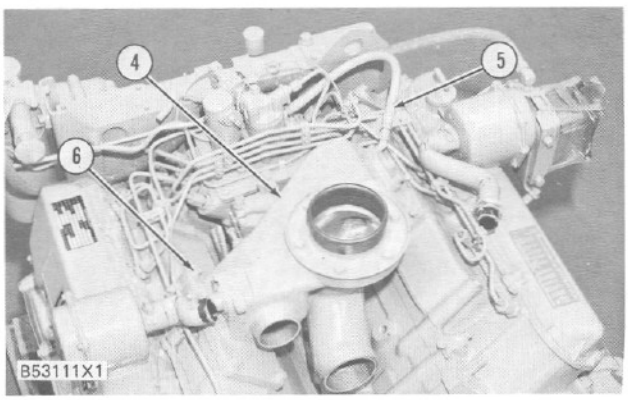
1. Loosen clamps (1) and (2). Disconnect the hoses (3) from the manifold.

2. Remove seven bolts (6). Loosen one bolt (manifold has an opening [slot] in it for this bolt).

3. Disconnect fuel line (5).

4. Remove air inlet manifold (4) and its gaskets.





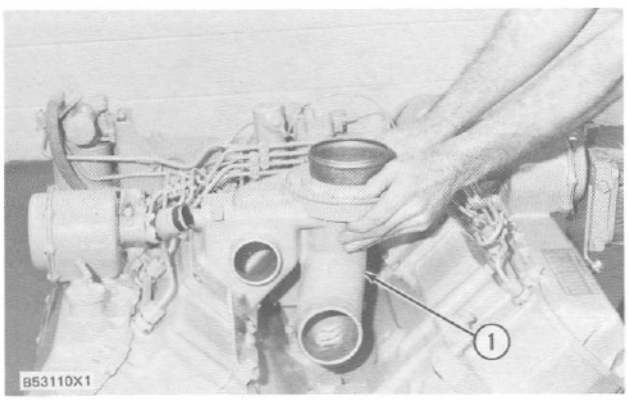
INSTALL AIR INLET MANIFOLD 1058-12

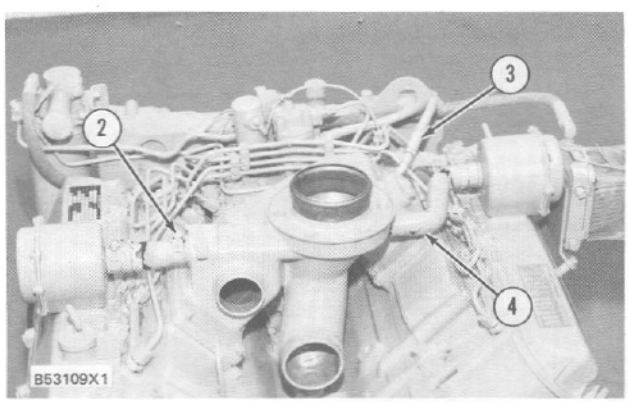
1. Put the air inlet manifold (1) in position on cylinder block and install the seven bolts that hold the manifold in place. Tighten the one bolt (one in manifold slot).

2. Connect the fuel line (3) to the manifold.

3. Connect hoses (4) to the manifold and tighten clamps (2).

end by:
a) install turbocharger



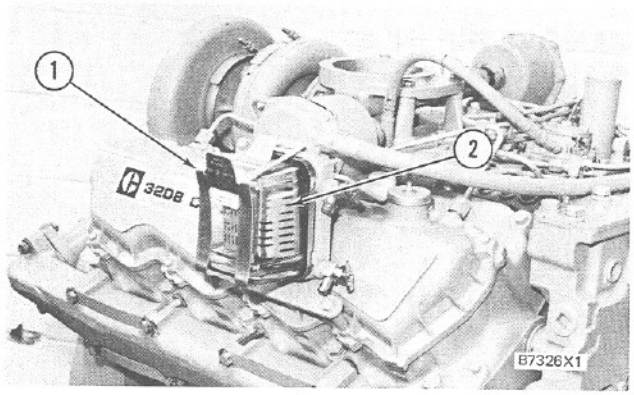


WATER SEPARATOR

REMOVE WATER SEPARATOR 1263-11

NOTICE
Element (2) is free to fall when clamp (1) is released.

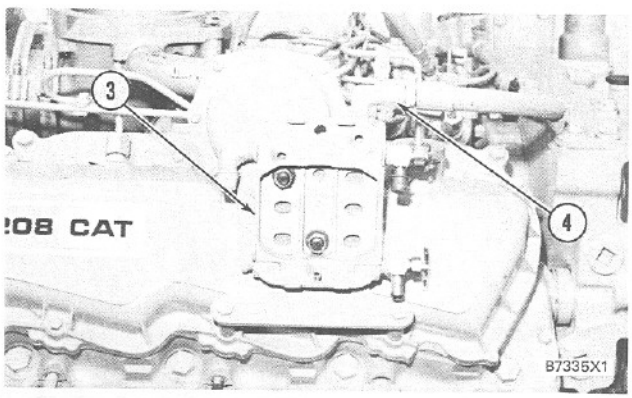
1. Remove clamp (1) and element (2).
2. Disconnect line (4) from the water separator base.
3. Remove the two nuts and water separator base (3).
4. Remove three bolts (6), bracket (5) and spacers.

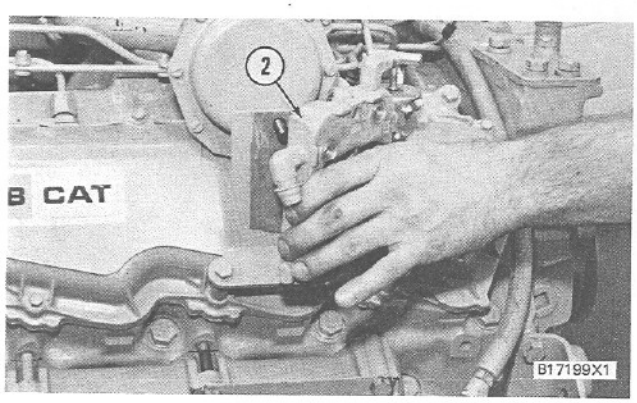


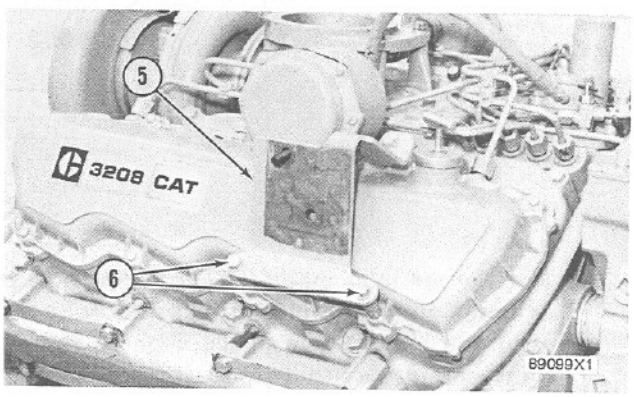
INSTALL WATER SEPARATOR 1263-12

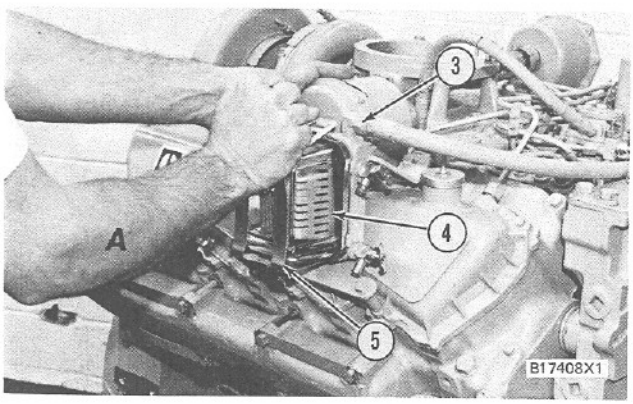
1. Put bracket (1) and three spacers in position. Install the three bolts. Tighten the bolts to a torque of 14 ± 3 N•m (10 ± 2 lb.ft.).
2. Put base (2) in position and install the nuts.
3. Connect line (3) to the base.
4. Put element (4) in position and install clamp (5).

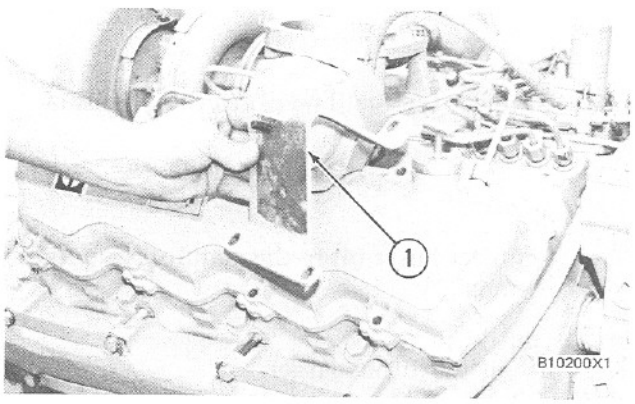
NOTE: Make sure clamp (5) is tight because element (4) is free to fall.









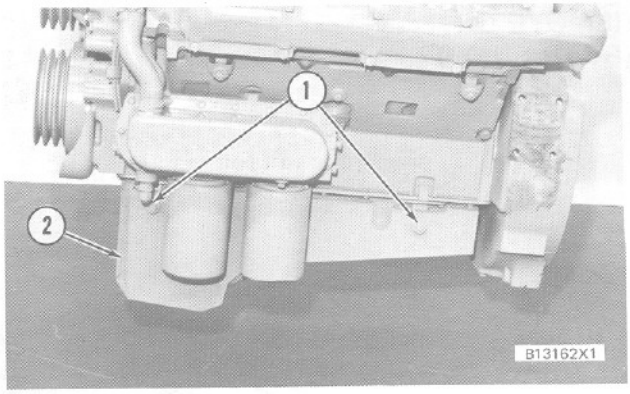


OIL PAN

REMOVE OIL PAN 1302-11

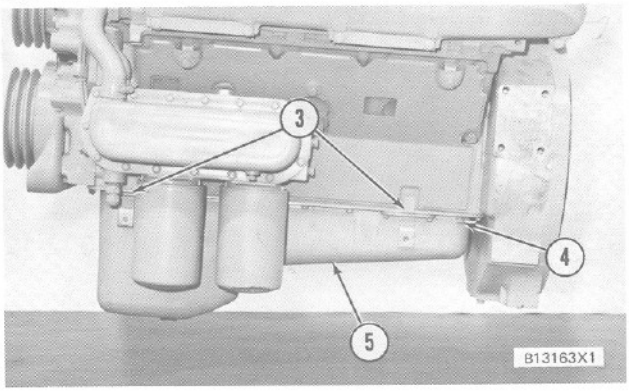
1. Drain the oil from the engine.

2. Remove four bolts (1) and sound suppression (2) from the oil pan.



3. Remove four brackets (3).

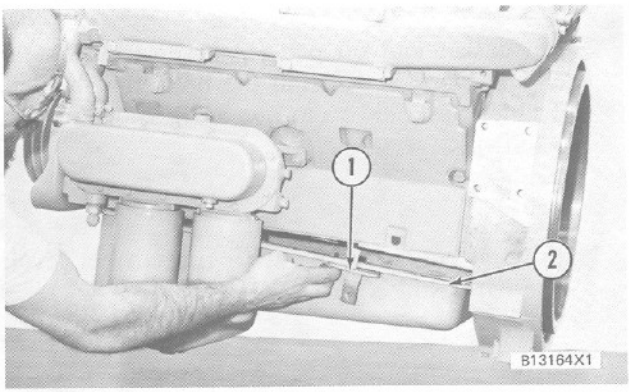
4. Remove bolts (4), oil pan (5) and the gasket.



INSTALL OIL PAN 1302-12

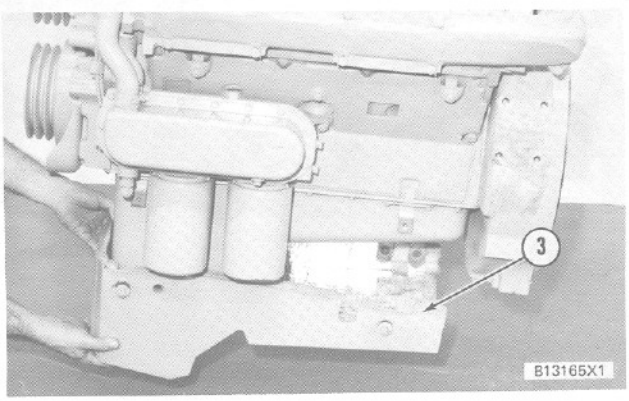
1. Inspect the oil pan gasket. Install a new gasket if needed.

2. Put brackets (1) and oil pan (2) in position.



3. Install the bolts that hold the pan in place. Tighten the bolts to a torque of 23 ± 4 N•m (17 ± 3 lb.ft.).

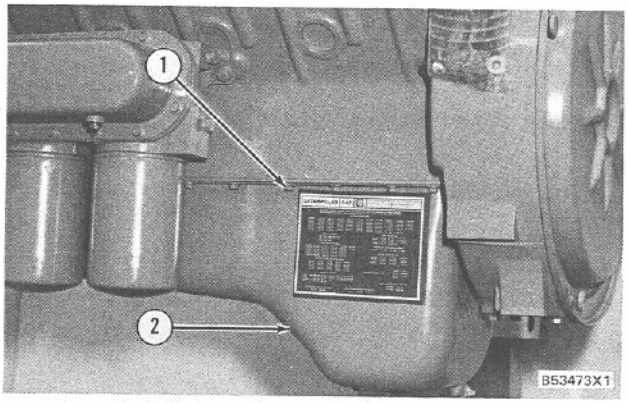
4. Put sound suppression (3) in position and install the bolts that hold it.



5. Fill the engine with oil to the correct level.

OIL PAN (REAR SUMP)

REMOVE OIL PAN (REAR SUMP) 1302-11

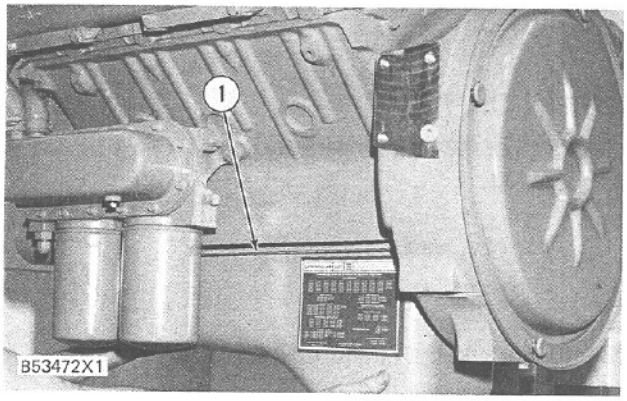


1. Put the engine on a suitable engine stand.

2. Drain the oil from the engine.

3. Remove bolts (1) and then remove oil pan (2) and gasket. Make an inspection of the gasket.

INSTALL OIL PAN (REAR SUMP) 1302-12



1. Install a new gasket if necessary.

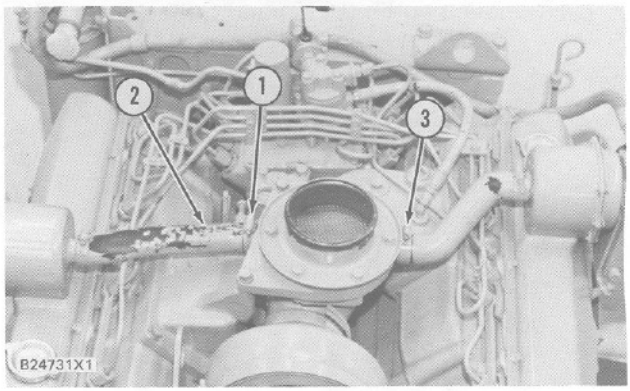
2. Put gasket and oil pan (1) in position on the engine block and install the bolts that hold it. Tighten the bolts to a torque of 23 ± 4 N•m (17 ± 3 lb.ft.).

3. Fill the engine with oil to the correct level. See MAINTENANCE GUIDE.

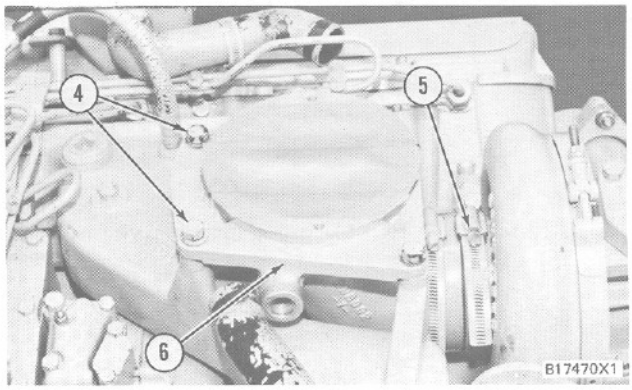
TURBOCHARGER

REMOVE TURBOCHARGER 1052-11

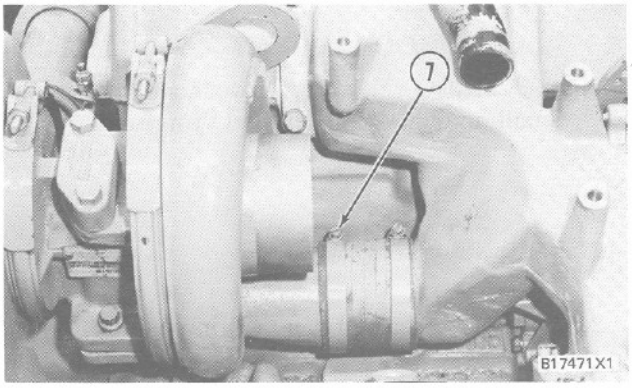
1. Loosen two clamps (1) and (3) and disconnect hoses (2) from the inlet manifold.



2. Loosen clamp (5).

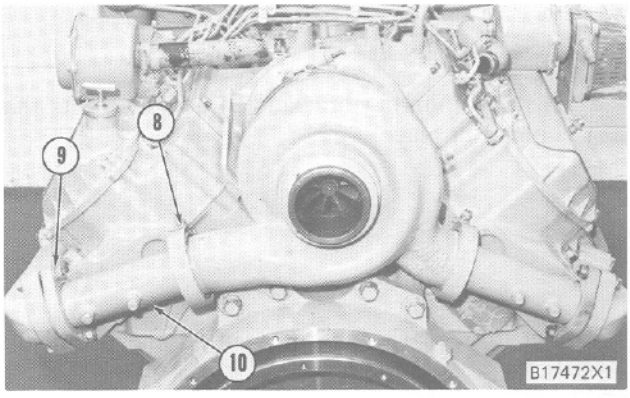


3. Remove three bolts (4) and elbow (6) from the turbocharger.



4. Loosen clamp (7) on the inlet manifold hose.

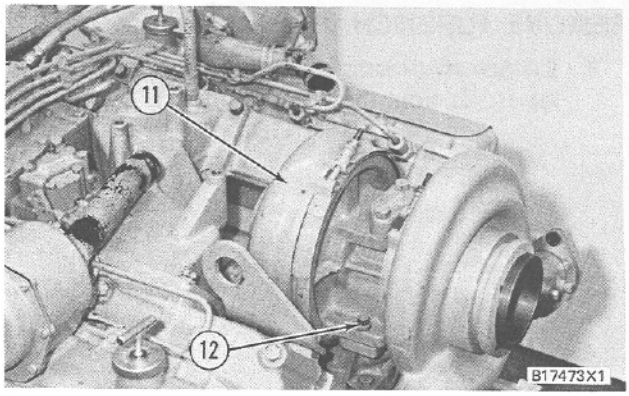
5. Loosen clamp (8) and slide it on to the turbocharger.



6. Loosen bolts and nuts (9) and slide tubes (10) into the exhaust manifold flanges to get clearance for the removal of the turbocharger.

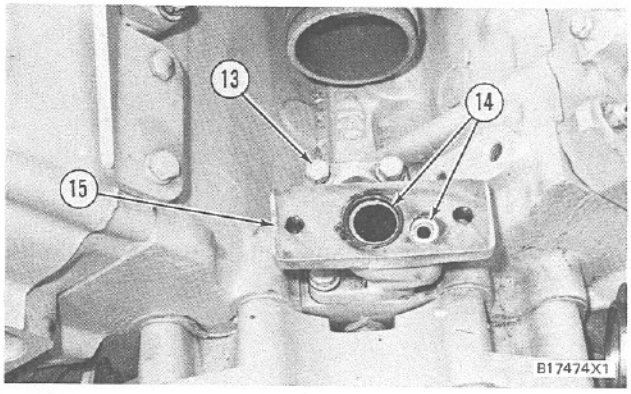
TURBOCHARGER

7. Remove two bolts (12) and turbocharger (11).



8. Remove two O-ring seals (14).

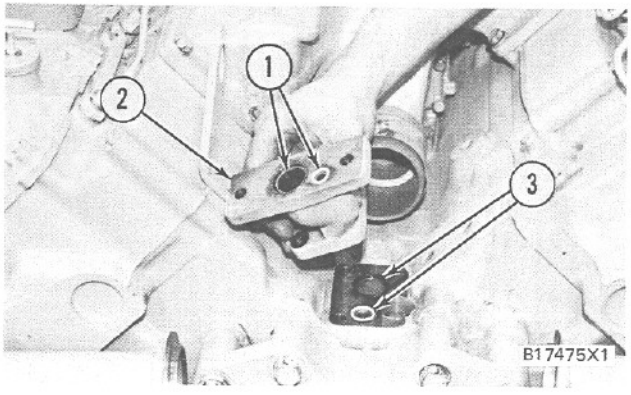
9. Remove three bolts (13) and mounting bracket (15).



10. Remove the two O-ring seals from the cylinder block.

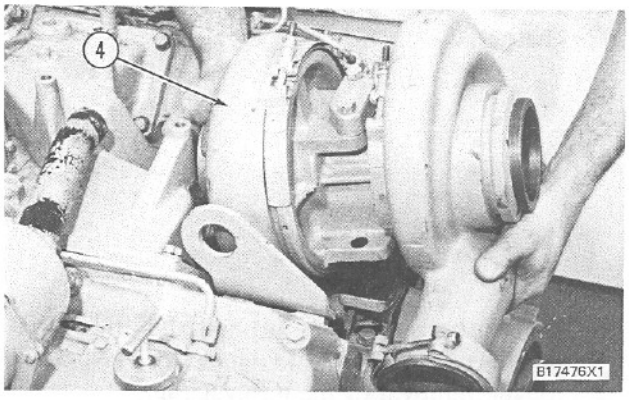
INSTALL TURBOCHARGER 1052-12

1. Inspect all O-ring seals for wear or damage. Put a small amount of oil on the O-ring seals.



2. Put O-ring seals (1) and (3) in position.

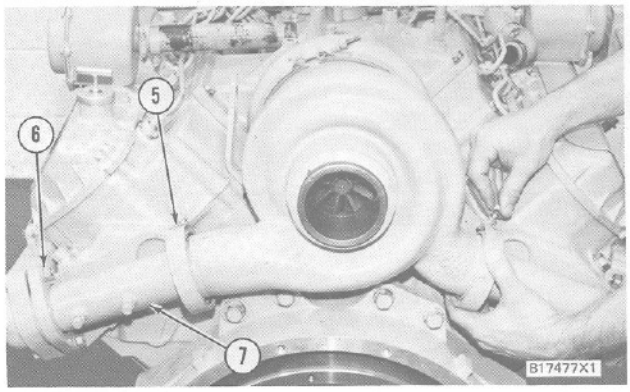
3. Install mounting bracket (2) and the bolts that hold it in place.



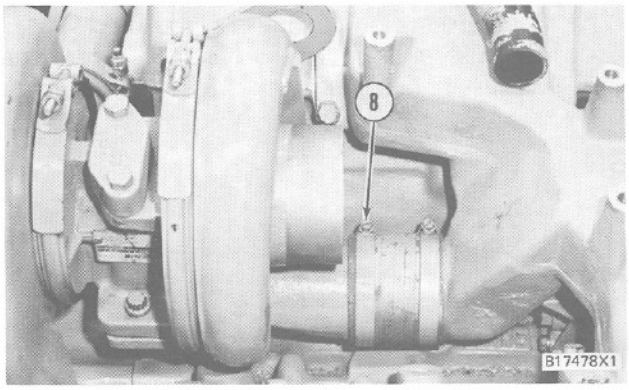
4. Put turbocharger (4) in position and install the bolts.

TURBOCHARGER

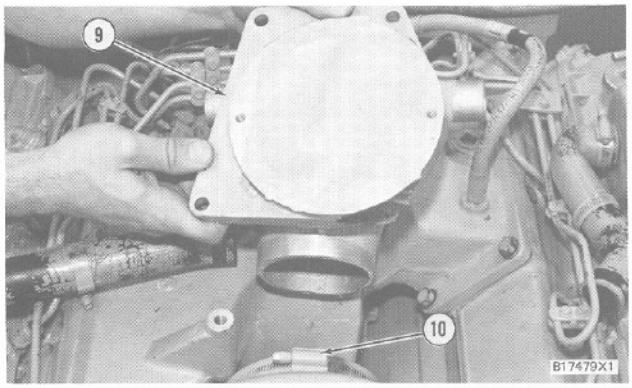
5. Put tube (7) in position and install clamps (5).



6. Put 5P3931 Anti-Seize on the threads of bolts (6). Install bolts (6) and the nuts.

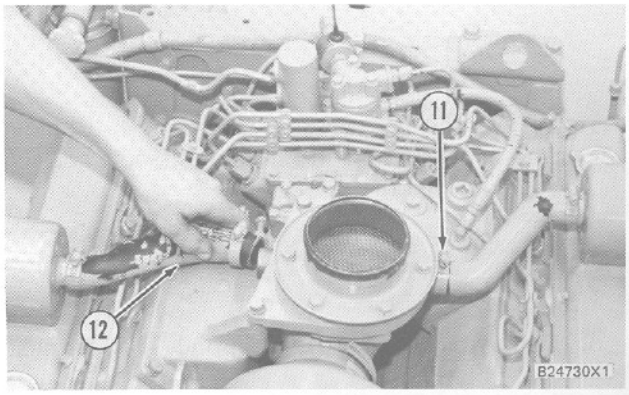


7. Put clamp (8) in position and tighten it.



8. Put elbow (9) in position and install the bolts.

9. Tighten clamp (10).



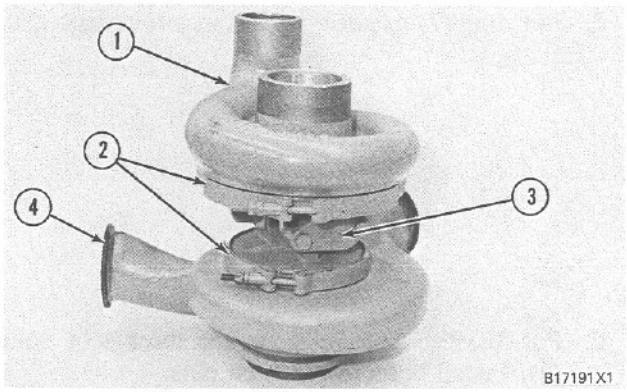
10. Put hoses (12) in position and tighten clamps (11).

TURBOCHARGER (SCHWITZER 4TF555)

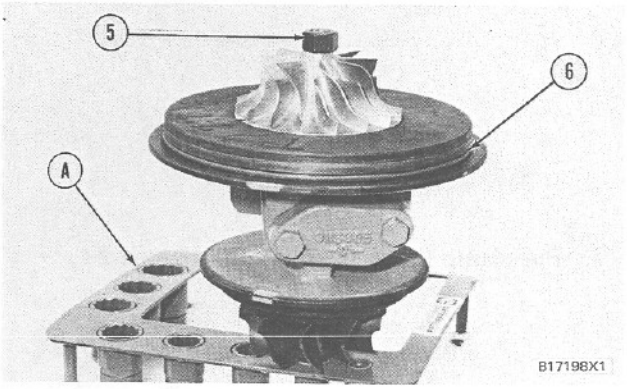
DISASSEMBLE TURBOCHARGER (SCHWITZER 4TF555)

	Tools Needed	A	B	C
9S6343	Fixture Assembly	1		
1P1862	Snap Ring Pliers		1	
1P1863	Snap Ring Pliers			1

start by:
a) remove turbocharger

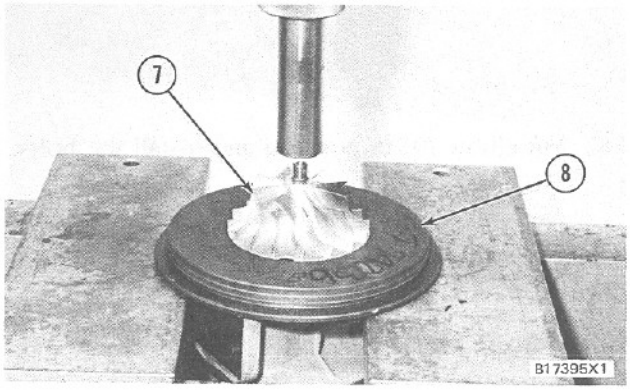


1. Make a mark on compressor housing (1), cartridge assembly (3) and turbine housing for correct installation.



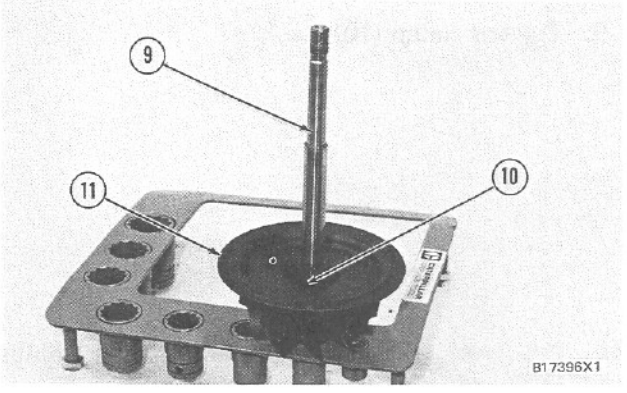
2. Loosen clamp assemblies (2). Remove compressor housing (1) and cartridge assembly (3) from the turbine housing.

3. Put the cartridge assembly in tooling (A).



NOTICE
When nut (5) is loosened, do not put a side force on the shaft.

4. Remove nut (5) and O-ring seal (6).

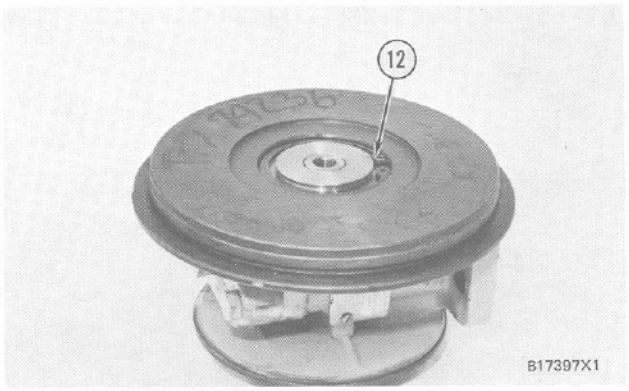


5. Put the cartridge assembly in a press. Remove the shaft assembly from compressor wheel (7) and cartridge (8).

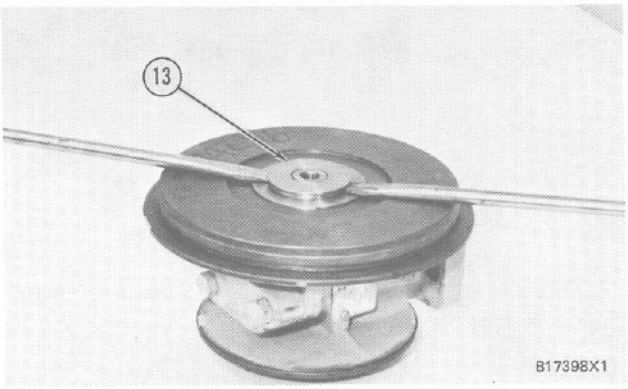
6. Remove seal ring (10) and shroud (11) from shaft assembly (9).

TURBOCHARGER (SCHWITZER 4TF555)

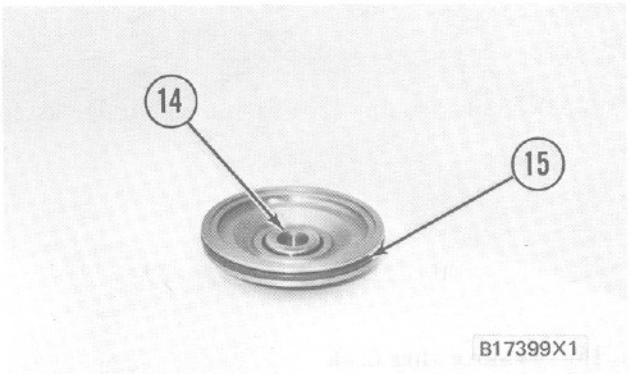
7. Use tooling (B) to remove snap ring (12).



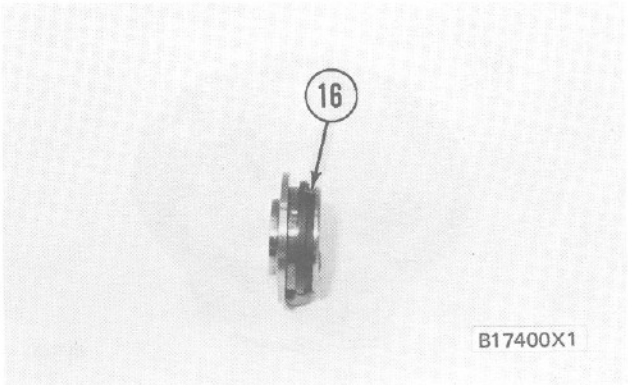
NOTICE
Do not cause damage to insert (13) when it is removed.



8. Install screwdrivers as shown. Carefully lift insert (13) out of the cartridge assembly.



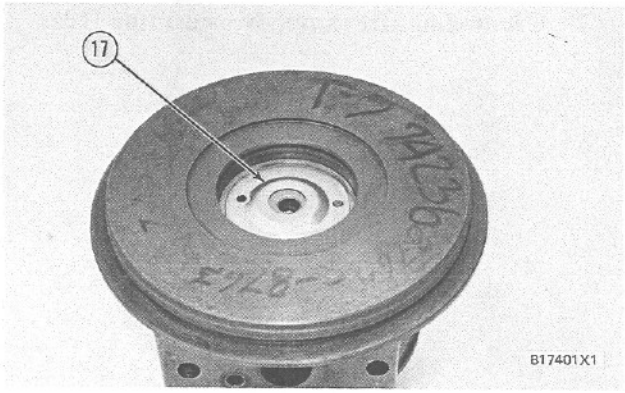
9. Remove sleeve (14) and O-ring seal (15) from the insert.



10. Remove two seal rings (16) from the sleeve.

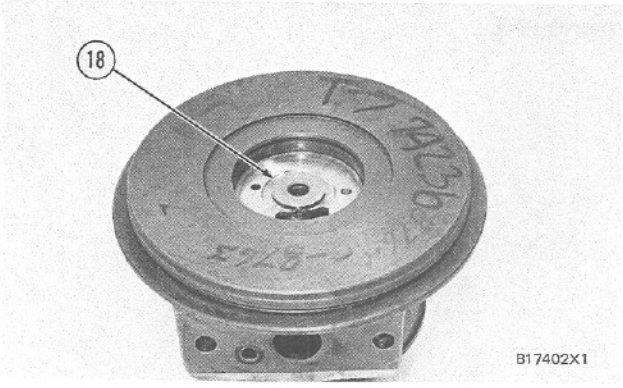
TURBOCHARGER (SCHWITZER 4TF555)

11. Remove deflector (17) from the cartridge assembly.



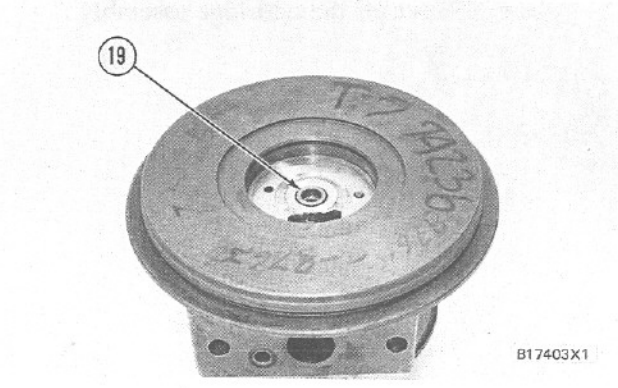
12. Remove ring (18).

13. Remove sleeve (19) from the cartridge assembly.

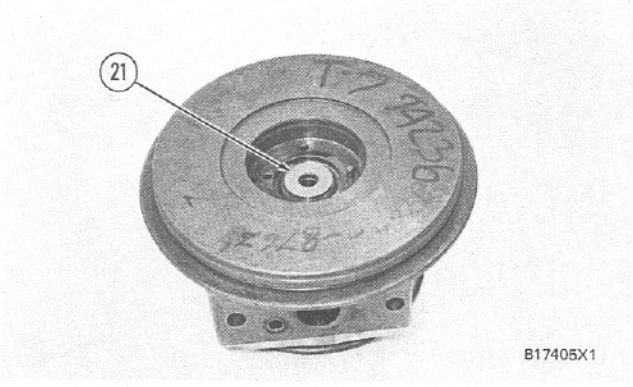


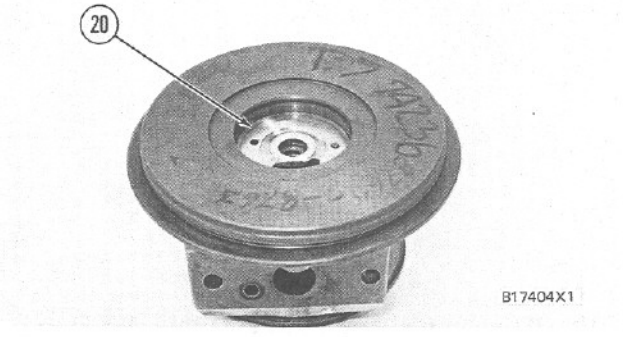
NOTE: Make an identification of the position of bearing (20) for assembly purposes.

14. Remove bearing (20) from the cartridge assembly.



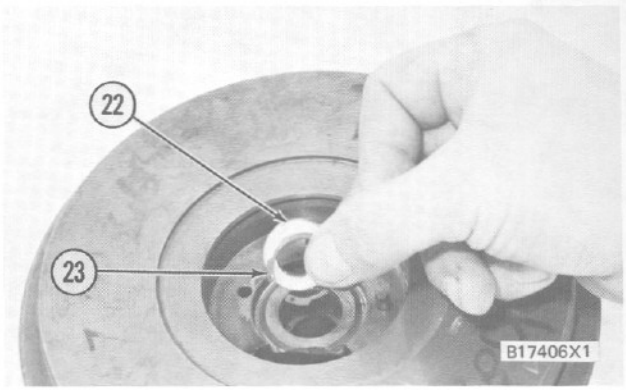
15. Remove ring (21).





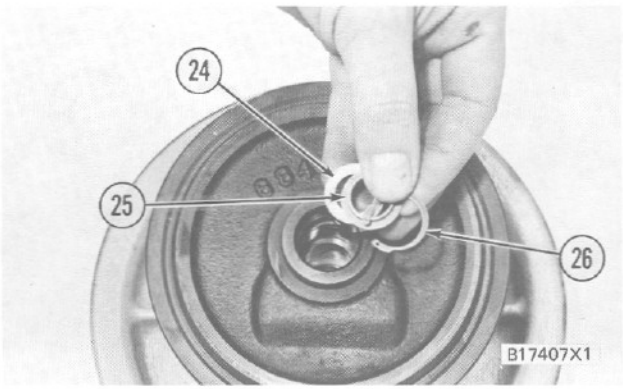
TURBOCHARGER (SCHWITZER 4TF555)

16. Use tooling (C) to remove snap ring (23). Remove sleeve (22) and the lower snap ring.



17. Turn the cartridge housing over. Remove snap ring (26) with tooling (C).

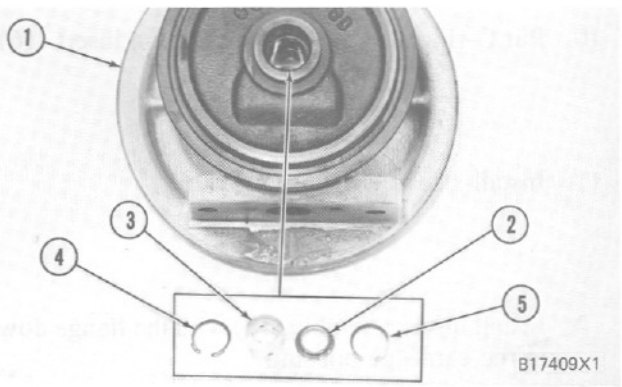
18. Remove bearing (25), sleeve (24) and the lower snap ring.



ASSEMBLE TURBOCHARGER (SCHWITZER 4TF555)

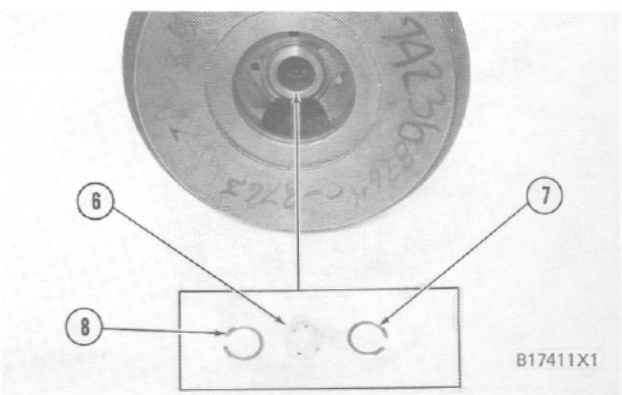
	Tools Needed	A	B	C	D
1P1863	Snap Ring Pliers	1			
1P1852	Snap Ring Pliers		1		
8S2328	Dial Test Indicator Group			1	
9S6343	Fixture Assembly				1

NOTE: Make sure all of the oil passages in the turbocharger cartridge housing are clean and free of dirt and foreign material. Put clean engine oil on all parts of the cartridge assembly.



1. Install snap ring (4) with tooling (A) in cartridge housing (1).

2. Put sleeve (3) and bearing (2) in position. Install snap ring (5) with tooling (A).

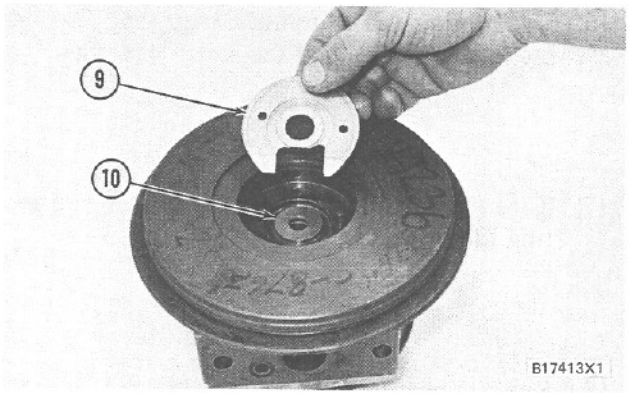


3. Turn the cartridge housing over. Install snap ring (8) with tooling (A).

4. Install sleeve (6) and snap ring (7).

TURBOCHARGER (SCHWITZER 4TF555)

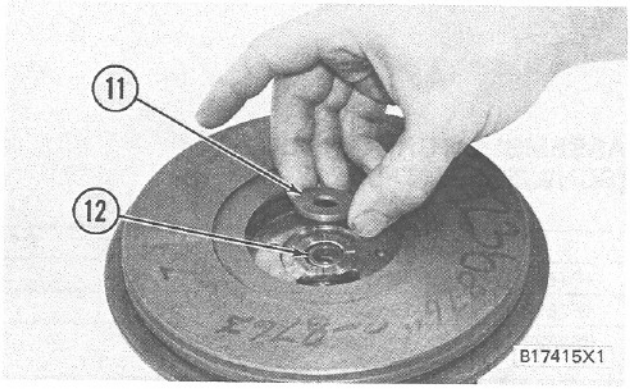
5. Put ring (10) in position in the cartridge housing.



6. Install bearing (9) with grooved side up.

NOTE: Make an alignment of the dowel in the housing with the hole on the right side of the notch.

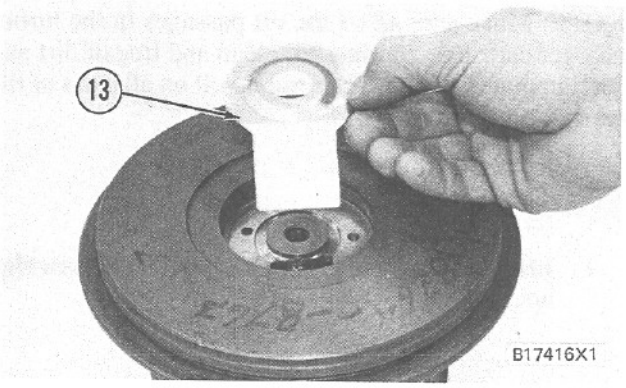
7. Put sleeve (12) in position. Install ring (11).



8. Put deflector (13) in position as shown.

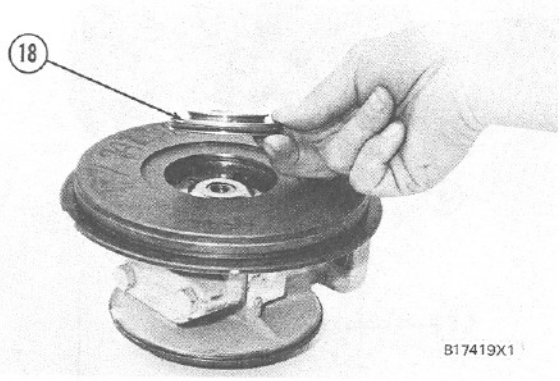
9. Put two seal rings (15) in position on sleeve (14).

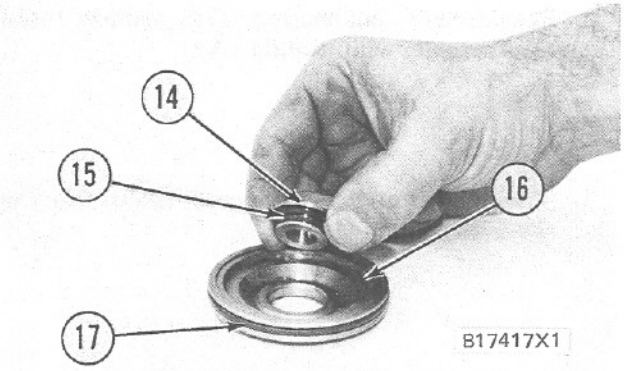
10. Put O-ring seal (17) in position on insert (16).



11. Install sleeve (14) in insert (16).

12. Install insert assembly (18) with the flange down in the cartridge housing.



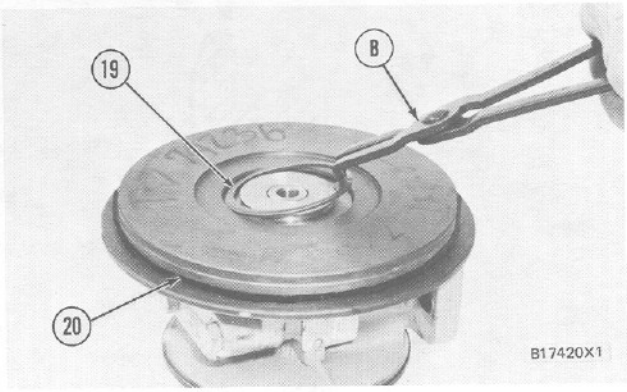


TURBOCHARGER (SCHWITZER 4TF555)

13. Put O-ring seal (20) in position.
14. Install snap ring (19) with tooling (B).
15. Put shaft assembly (22) in tooling (D).

NOTE: Put 6V2055 High Vacuum Grease in the groove for seal ring (23) at assembly to one half or more of the depth of the groove all the way around the groove.

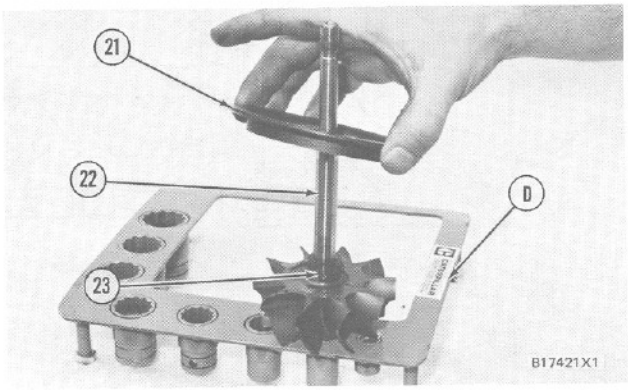
16. Put seal ring (23) in position on the shaft assembly.
17. Install shroud (21) on the shaft assembly (22).
18. Lightly oil the wheel face that will be under the nut. Put compressor wheel (24) in position.



NOTICE

Do not put a side force on the shaft when the nut is tightened.

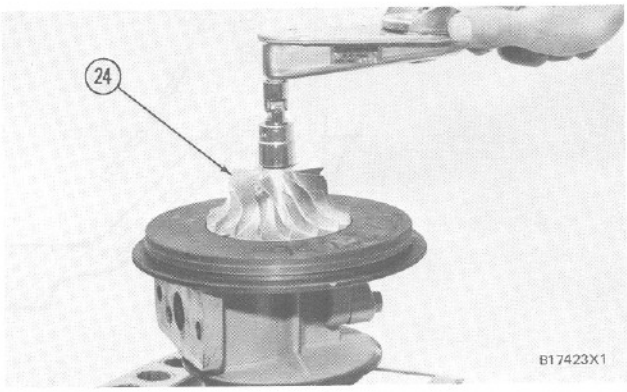
19. Install the nut and tighten the nut to a torque of 28 ± 3 N•m (22 ± 2 lb.ft.).
20. Remove the nut. Apply 9S3265 Retaining Compound to the shaft threads.

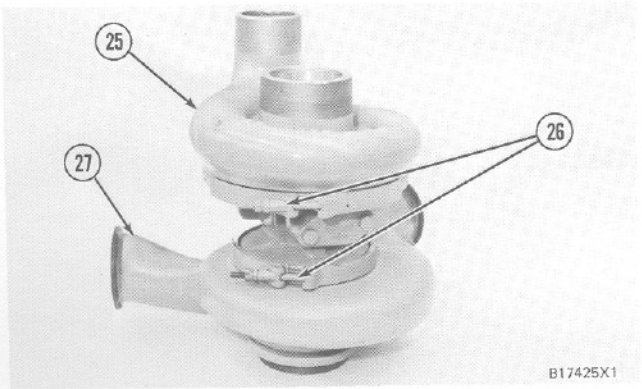


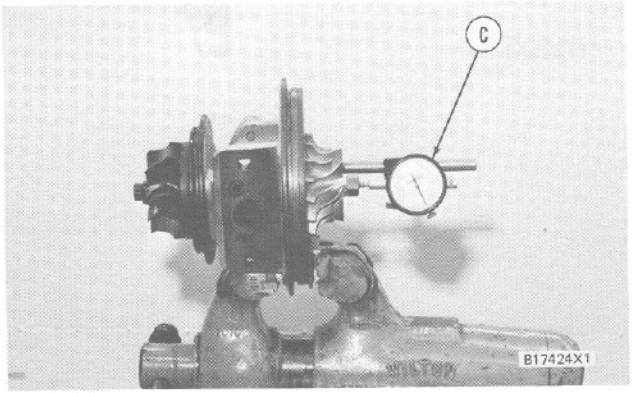
NOTICE

Do not put a side force on the shaft when the nut is tightened.

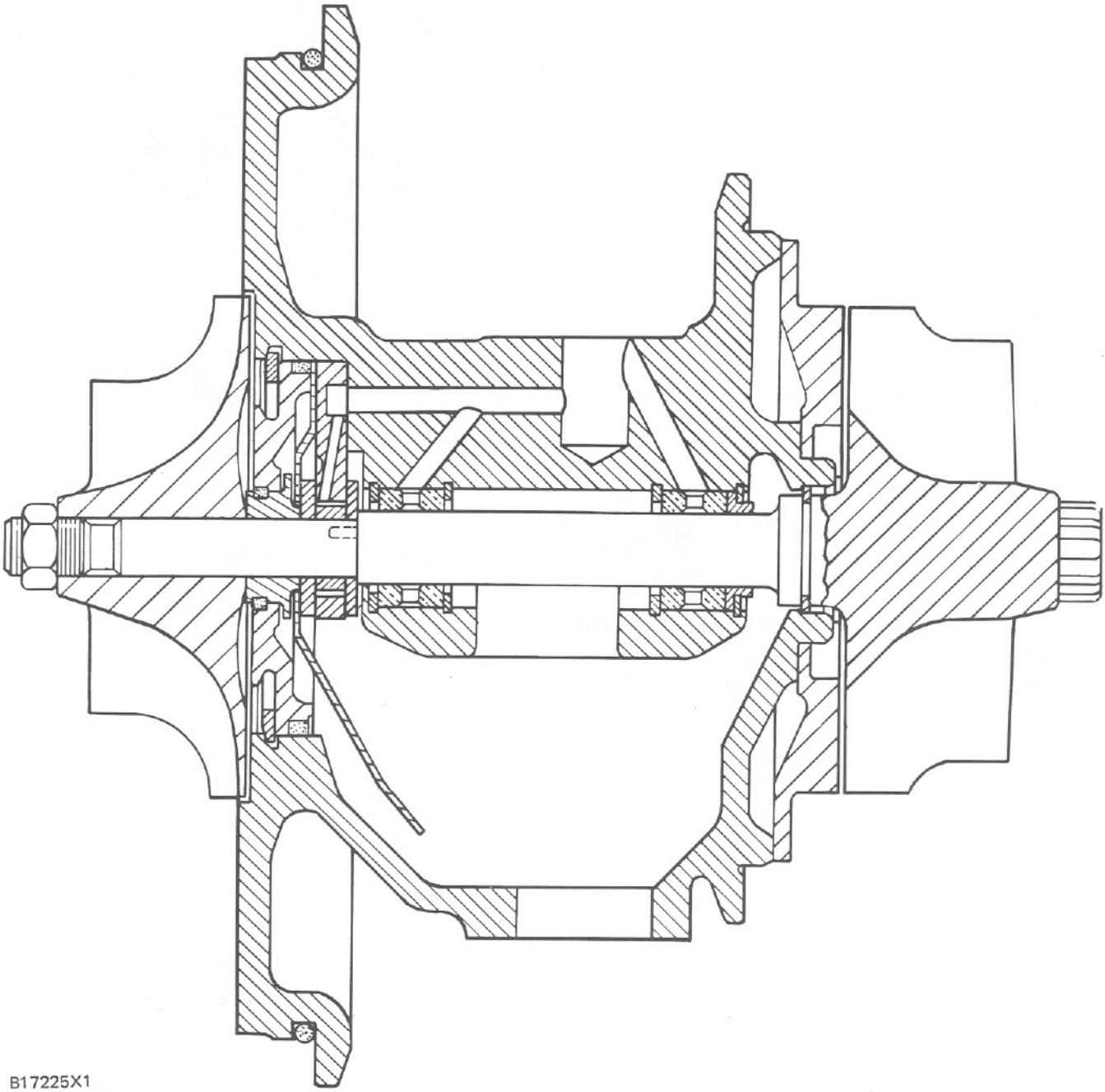
21. Install the nut and tighten it to a torque of 28 ± 3 N•m (22 ± 2 lb.ft.).
22. Put the cartridge assembly in a vise. Use tooling (C) to check end play. The end play must be 0.08 to 0.15 mm (.003 to .006 in.).
23. Put the cartridge assembly in position on compressor housing (27).
24. Put clamp assemblies (26) and turbine housing (25) in position.
25. Tighten clamp assemblies (26) to a torque of 13.6 N•m (120 lb.in.).







TURBOCHARGER (SWITZER 4TF555)



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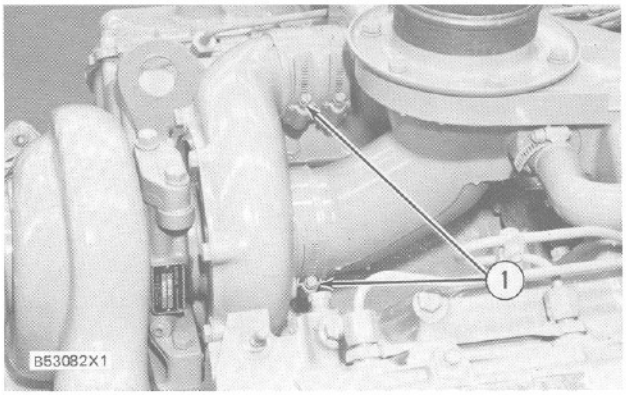
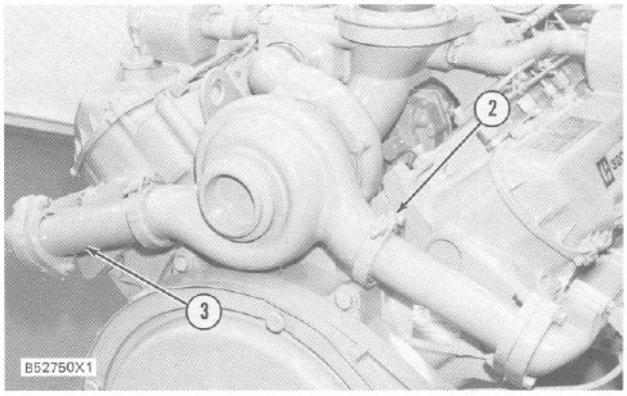
TURBOCHARGER

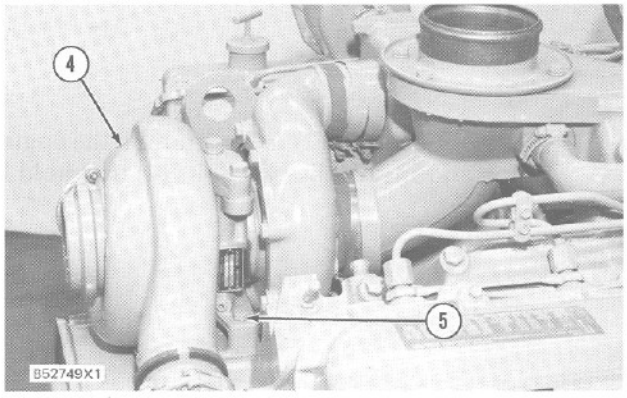
REMOVE TURBOCHARGER 1052-11



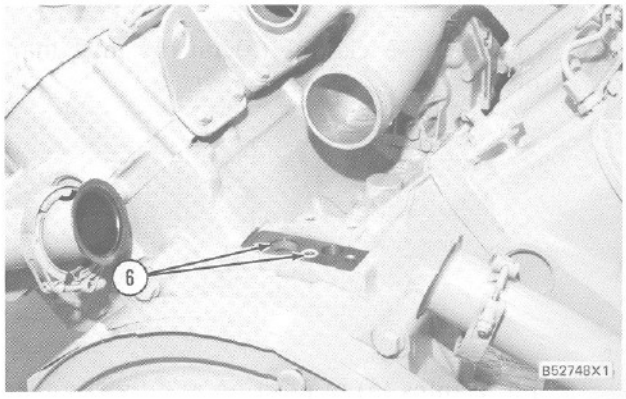
1. Loosen hose clamps (1) on the inlet manifold.



2. Loosen clamps (2) and slide them back on tubes (3).



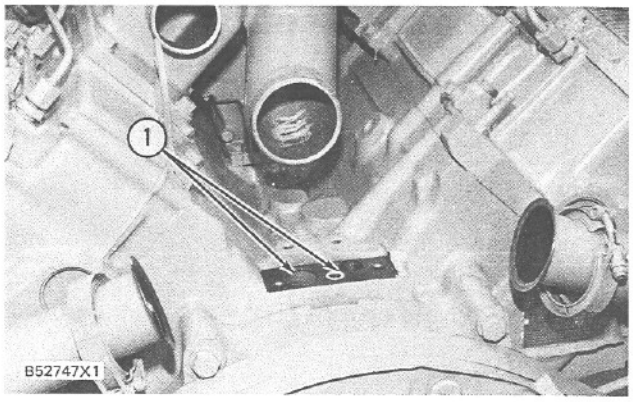
3. Remove two bolts (5) and then remove the turbocharger (4) from the engine block and inlet manifold.



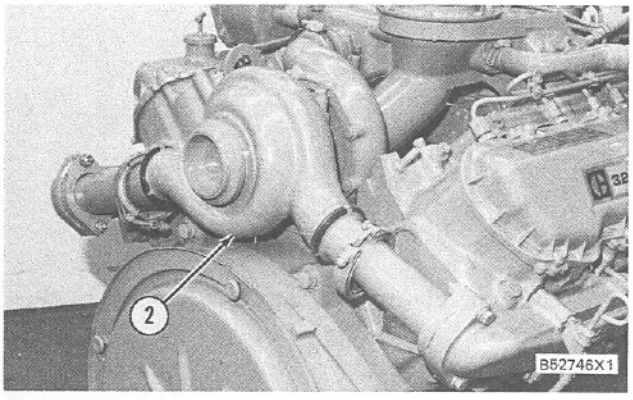
4. Remove the two O-ring seals (6) from the engine block.

TURBOCHARGER

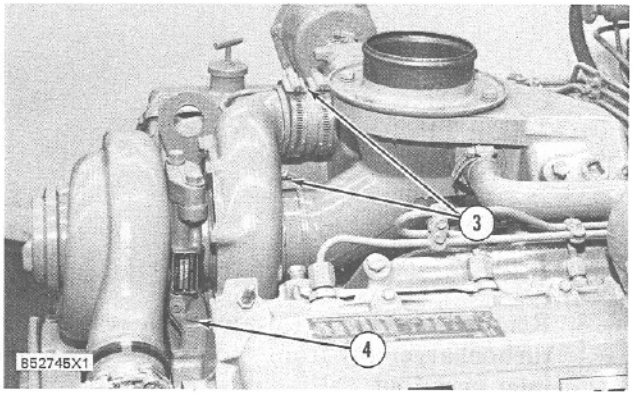
INSTALL TURBOCHARGER 1052-12



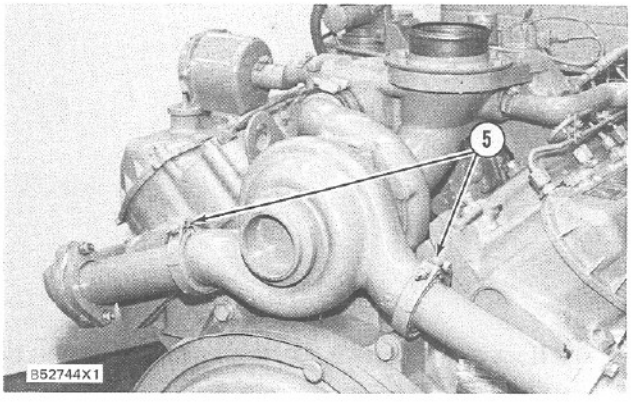
1. Inspect all O-ring seals for wear or damage. Put a small amount of oil on the O-ring seals.



2. Put O-ring seals (1) in position in the engine block.



3. Put turbocharger (2) in position on the engine block and install the two bolts (4) that hold it.



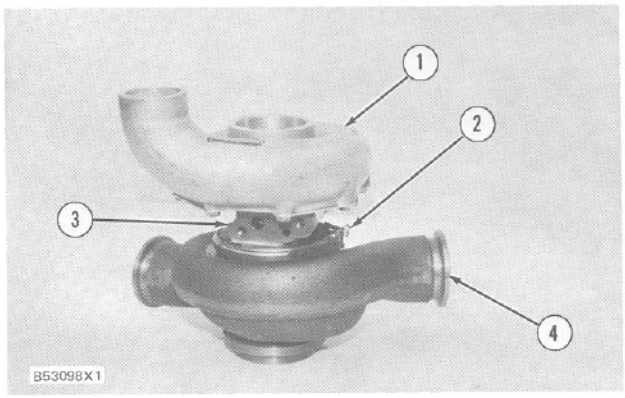
4. Tighten hose clamps (3) on the inlet manifold.

5. Put clamps (5) in position and tighten them.

TURBOCHARGER (AIR RESEARCH TM)

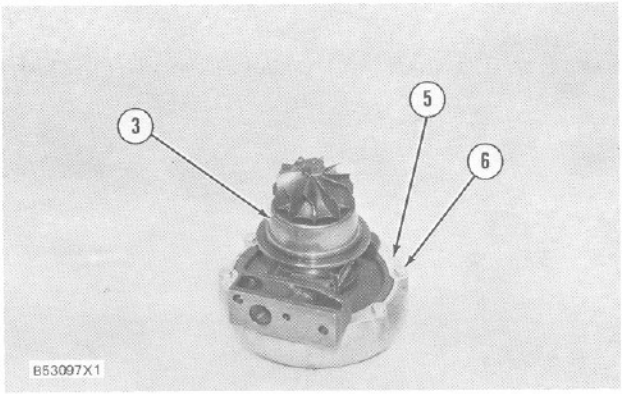
DISASSEMBLE TURBOCHARGER 1052-15

	Tools Needed	A	B	C
9S6343	Fixture Assembly	1		
1P1863	Snap Ring Pliers		1	
5S9566	T-Wrench			1

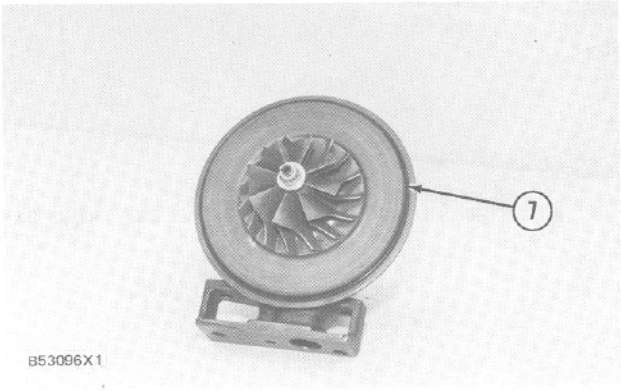


start by:
a) remove turbocharger

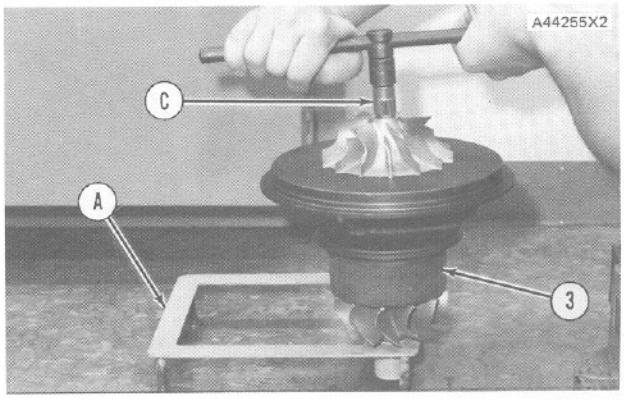
1. Make a mark on compressor housing (1), cartridge assembly (3) and the turbine housing (4) for correct installation.



2. Loosen clamp assembly (2). Remove compressor housing (1) and cartridge assembly (3) from the turbine housing.



3. Remove bolts (6) and plates (5) that hold cartridge assembly in the compressor housing. Remove cartridge assembly (3).

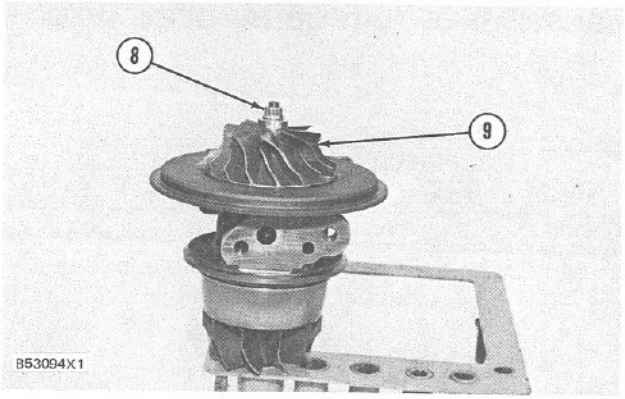


4. Remove O-ring seal (7) from the cartridge assembly.

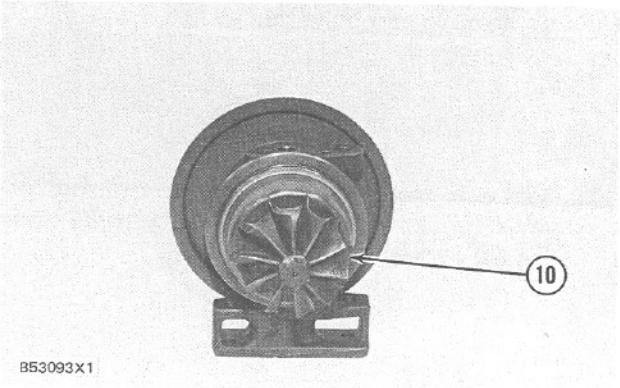
5. Put cartridge assembly (3) in position in tooling (A) and loosen nut on the compressor wheel with tooling (C).

TURBOCHARGER (AIR RESEARCH TM)

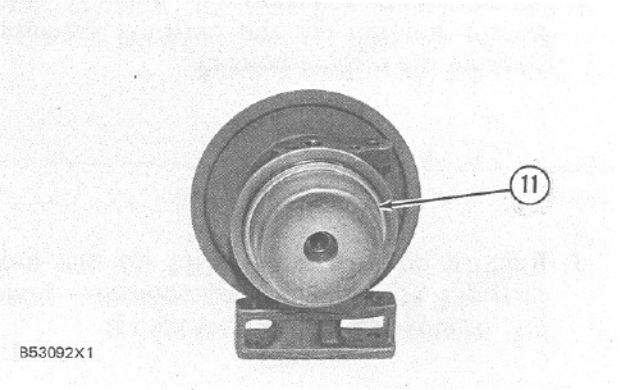
6. Remove nut (8) and the compressor wheel (9).



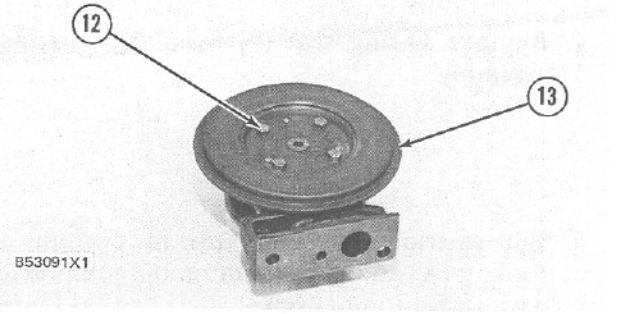
7. Remove shaft and wheel assembly (10) from the cartridge assembly.



8. Remove shroud (11) from the cartridge assembly.

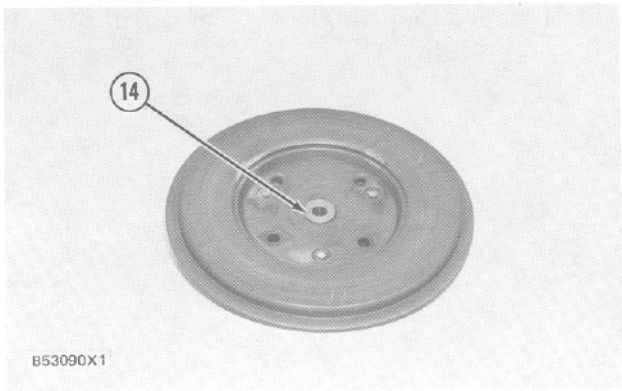


9. Remove four bolts (12) and then remove backplate (13) from the cartridge assembly.

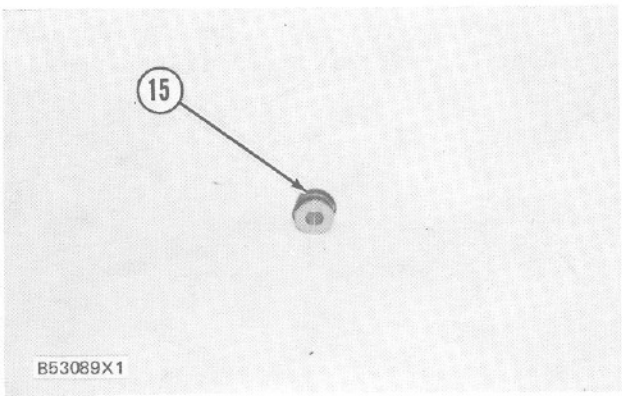


TURBOCHARGER (AIR RESEARCH TM)

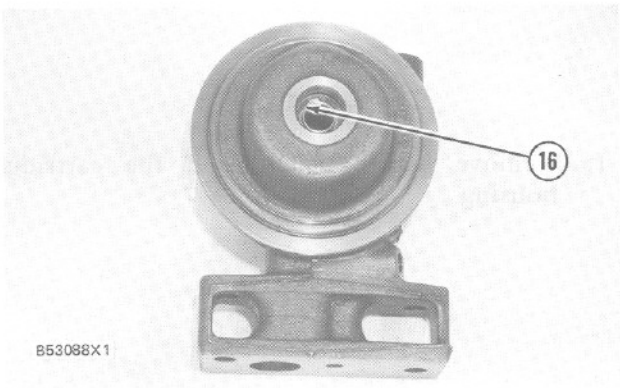
10. Remove spacer (14) from the backplate.



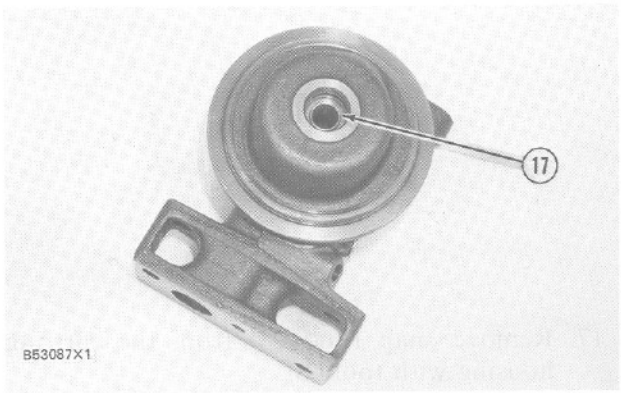
11. Remove two seal rings (15) from the spacer.



12. Remove snap ring (16) from cartridge housing with tool (B).

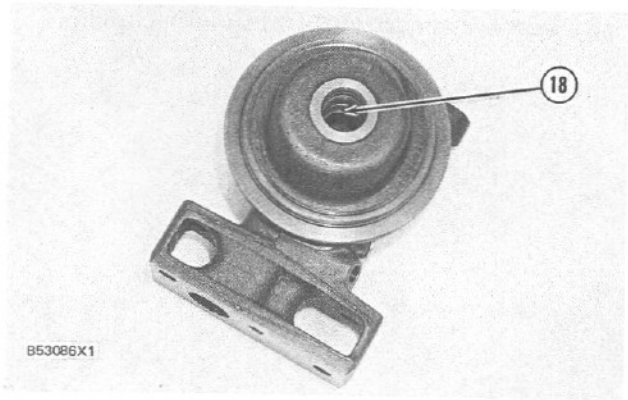


13. Remove bearing (17) and rings from the cartridge housing.

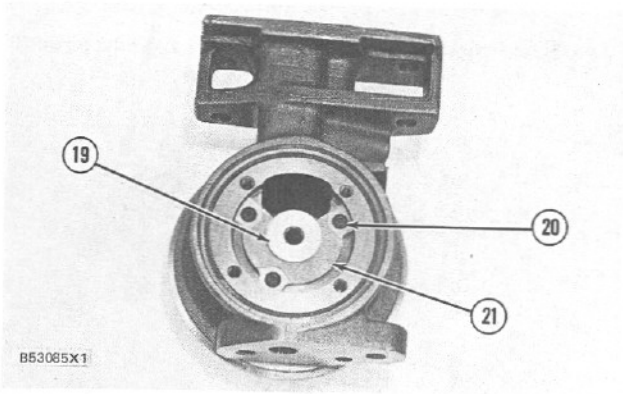


TURBOCHARGER (AIR RESEARCH TM)

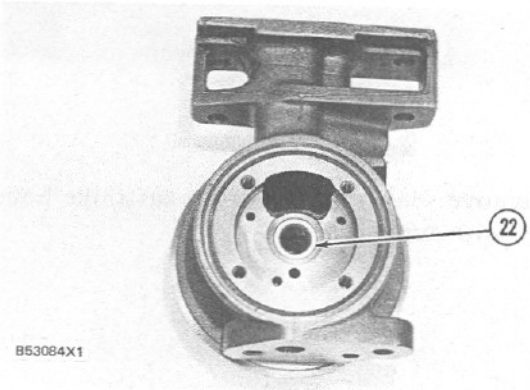
14. Remove snap ring (18) from cartridge housing with tool (B).



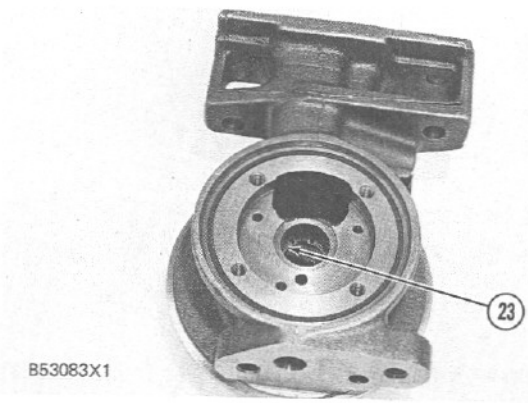
15. Turn the cartridge housing over and then remove screws (20), plate (21) and collar (19).



16. Remove bearing (22) from the cartridge housing.



17. Remove snap ring (23) from the cartridge housing with tool (B).



TURBOCHARGER (AIR RESEARCH TM)

ASSEMBLE TURBOCHARGER 1052-16

	Tools Needed	A	B	C
1P1863	Snap Ring Pliers	1		
9S6343	Fixture Assembly		1	
8S2328	Indicator Group			1

NOTE: Make sure all of the oil passages in the turbocharger cartridge housing are clean and free of dirt and foreign material. Put clean engine oil on all parts of the cartridge assembly.

1. Install snap ring (1) in the cartridge housing with tool (A).

NOTE: Make sure the oil hole in plate (5) is open and clean to prevent a bearing failure.

2. **Install bearing (2), collars (3), plate (5) and screws (4). Tighten the screws to a torque of 2.5 N•m (22 lb.in.).**

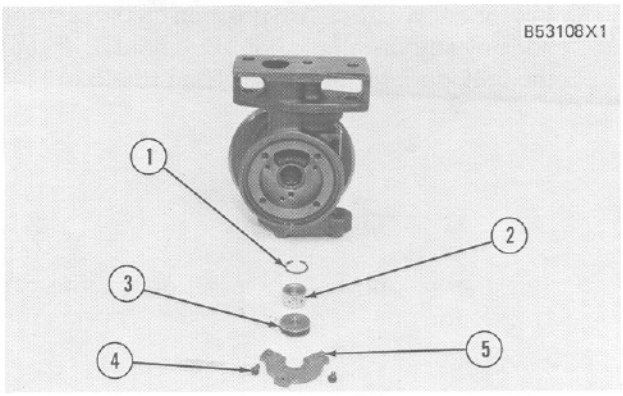
NOTE: Install the rings that hold bearings in position with the round edges of the rings toward the bearings.

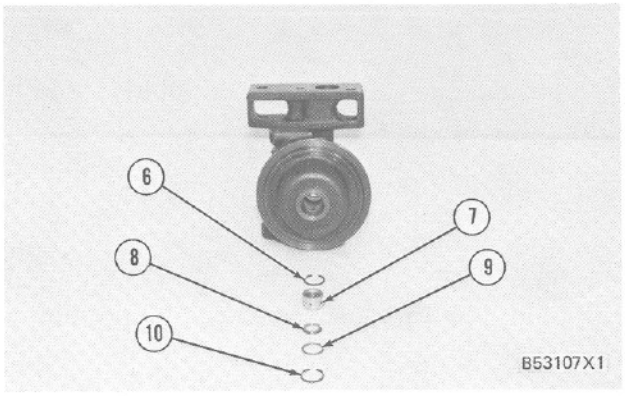
3. Turn the cartridge housing over. Install snap ring (6) in the cartridge housing with tool (A). Install bearing (7), ring (8) and ring (9) in the housing. Install snap ring (10) with tool (A).

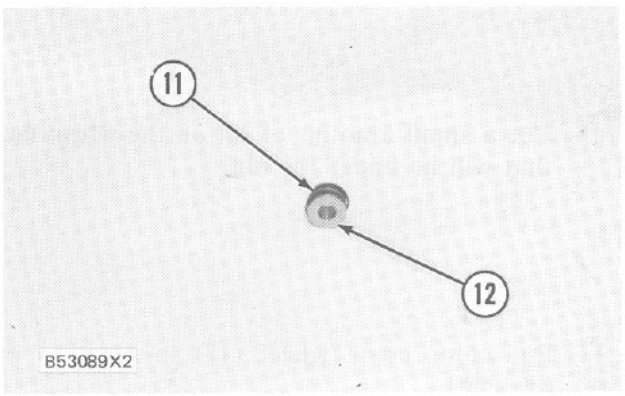
NOTE: Put 6V2055 High Vacuum Grease in the grooves for seal rings (11) at assembly to one half or more of the depth of the groove all the way around the grooves.

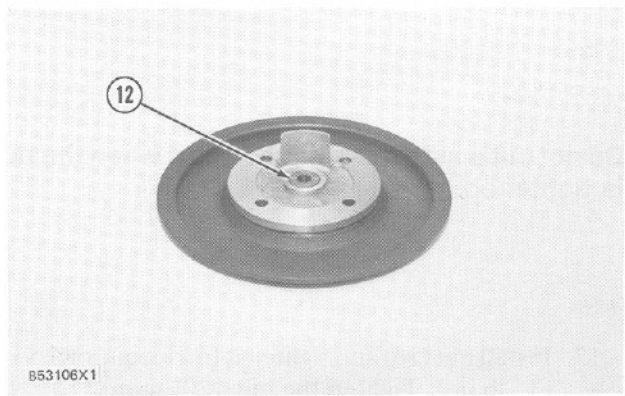
4. Install seal rings (11) on spacer (12).

5. Install spacer (12) in the backplate.



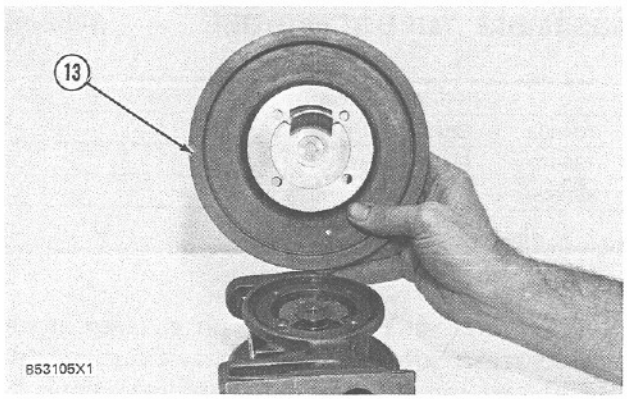






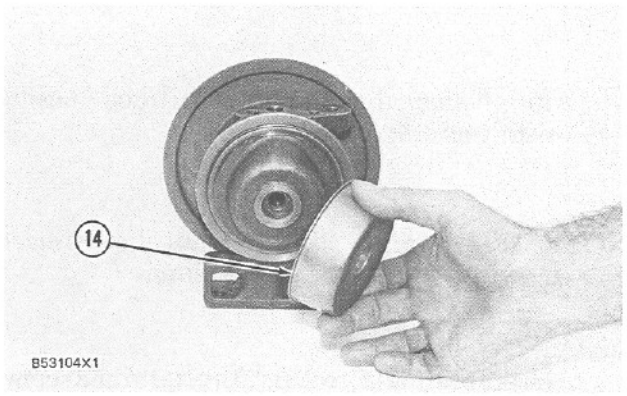
TURBOCHARGER (AIR RESEARCH TM)

6. Put the backplate (13) in position on the cartridge housing and install the bolts that hold it. Tighten the bolts to a torque of 9.5 N•m (84 lb.in.).



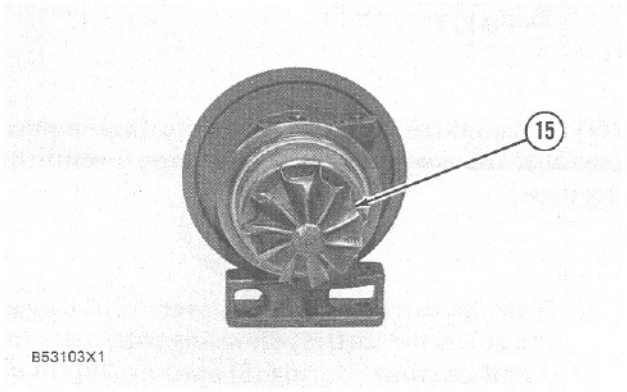
7. Put the shroud (14) in position on the cartridge housing.

8. Install shaft and wheel assembly (15) in the cartridge housing.



9. Put the cartridge assembly in position in tooling (B).

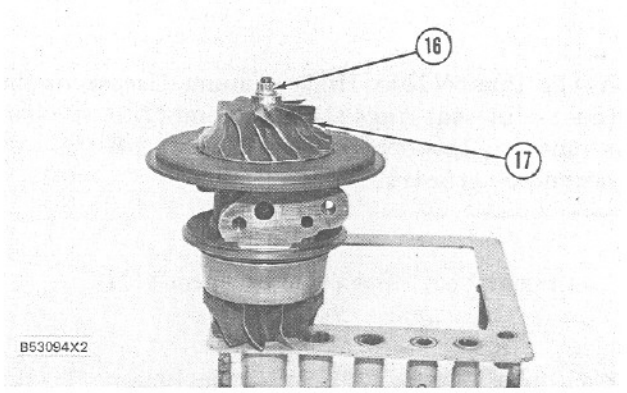
10. Put a small amount of oil on the wheel face that will be under the nut.



11. Put compressor wheel (17) in position on the shaft.

NOTICE

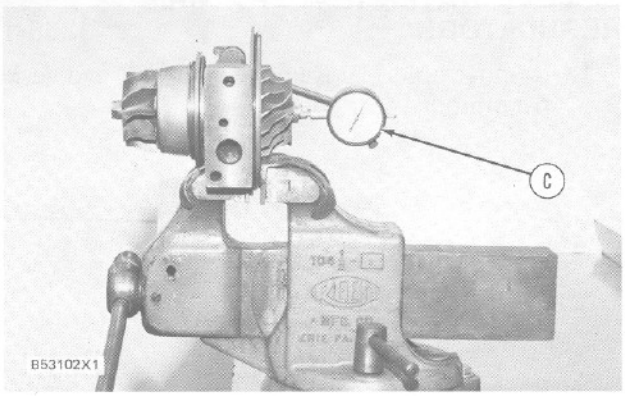
Do not put a side force on the shaft when the nut is tightened.



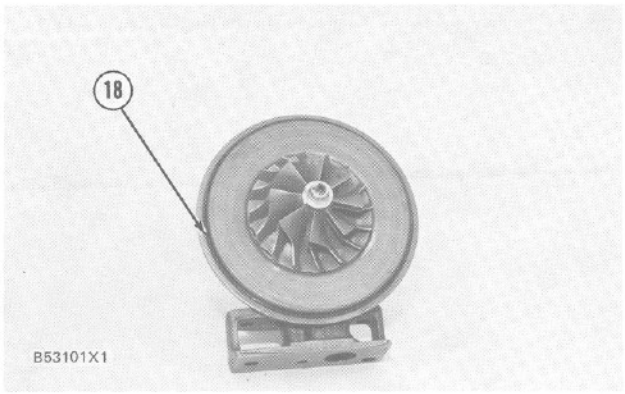
12. Install nut (16) and tighten it to a torque of 4 N•m (35 lb.in.). Tighten the nut 120° more.

TURBOCHARGER (AIR RESEARCH TM)

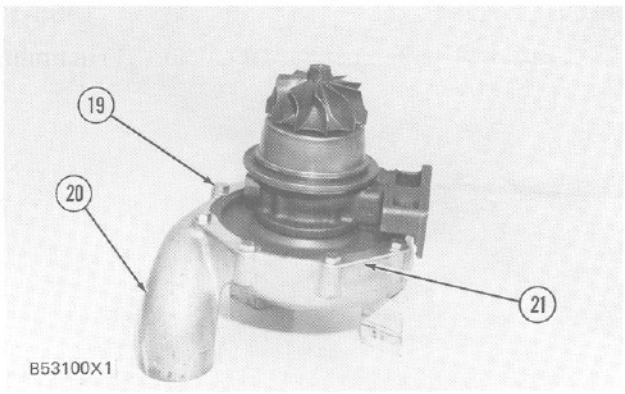
13. Put the cartridge assembly in a vise. Use tool group (C) to check end play. The end play must be 0.051 to 0.081 mm (.0020 to .0032 in.).



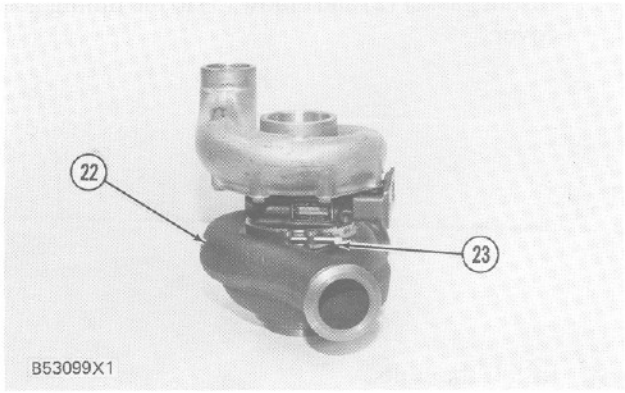
14. Put a small amount of oil on O-ring seal (18) and then install it on the cartridge housing.



15. Put the cartridge housing on the compressor housing (20) and install the plates (21) and bolts (19).



16. Put the turbine housing (22) in position on the cartridge housing and install the clamp (23) that holds it. Tighten the clamp to a torque of 14 ± 1 N•m (120 ± 12 lb.in.).

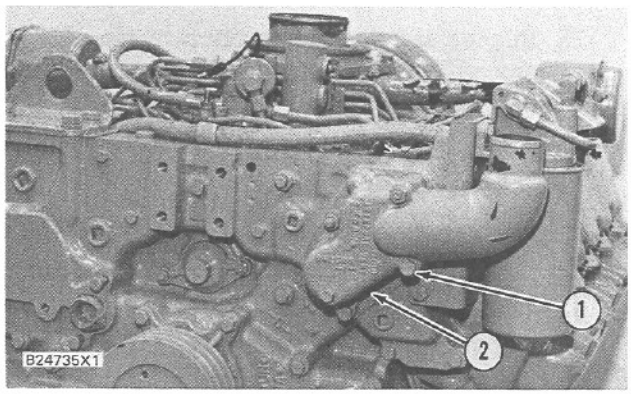


end by:
a) install turbocharger

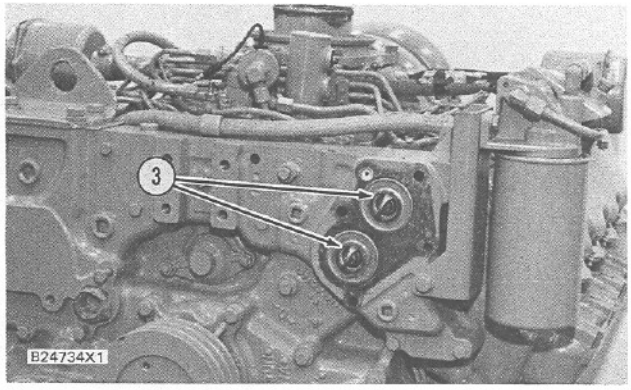
WATER TEMPERATURE REGULATORS

REMOVE WATER TEMPERATURE REGULATORS 1355-11

1. Remove bolts (1). Remove elbow (2) and gasket from timing gear cover.

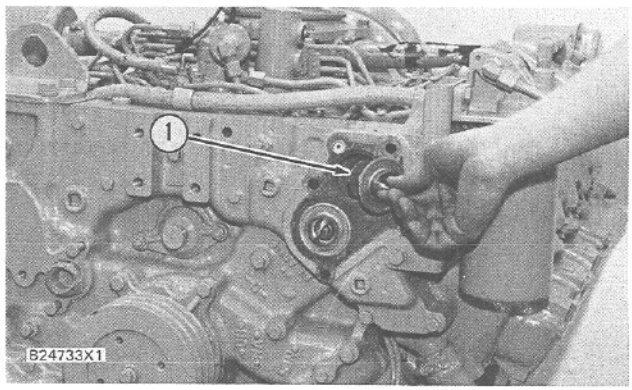


2. Remove water temperature regulators (3) from timing gear cover.

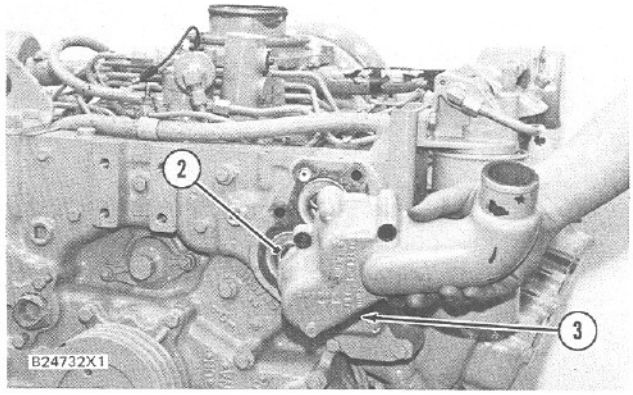


INSTALL WATER TEMPERATURE REGULATORS 1355-12

1. Install water temperature regulators (1) in timing gear cover as shown.



2. Install gasket (2) and elbow (3) to the timing gear cover.



3. Install the bolts.

FUEL FILTER AND BASE

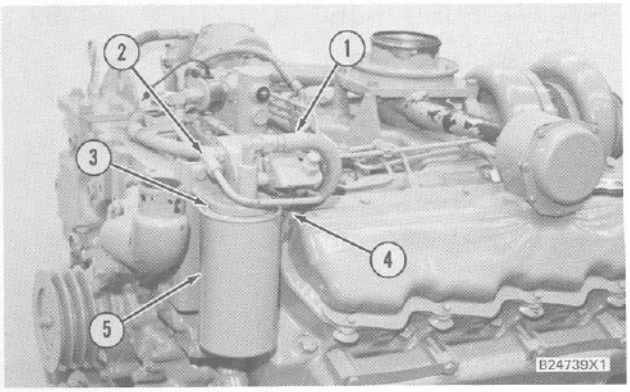
REMOVE FUEL FILTER AND BASE 1262-11

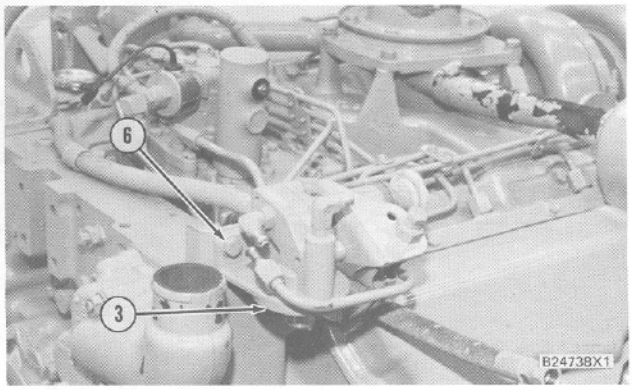
	Tools Needed	A
2P8250	Strap Wrench	1

1. Remove fuel filter element (5) from fuel filter base (3) with tool (A).

2. Disconnect fuel lines (1), (2) and (4) from fuel filter base.

3. Remove two bolts (6) and two nuts and remove fuel filter base from the bracket.





INSTALL FUEL FILTER AND BASE 1262-12

	Tools Needed	A
2P8250	Strap Wrench	1

1. Install fuel filter base (5) and nuts and bolts (2).

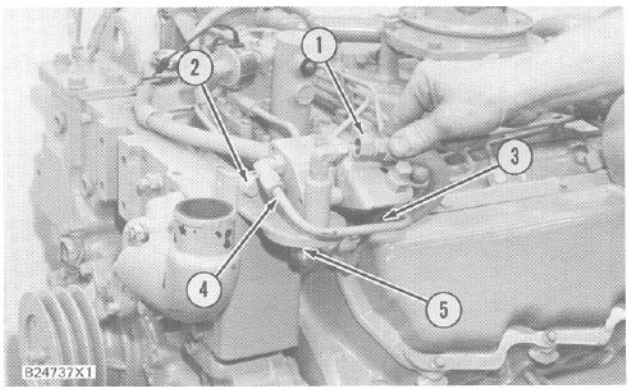
2. Connect fuel lines (1), (3) and (4) to fuel filter base (5).

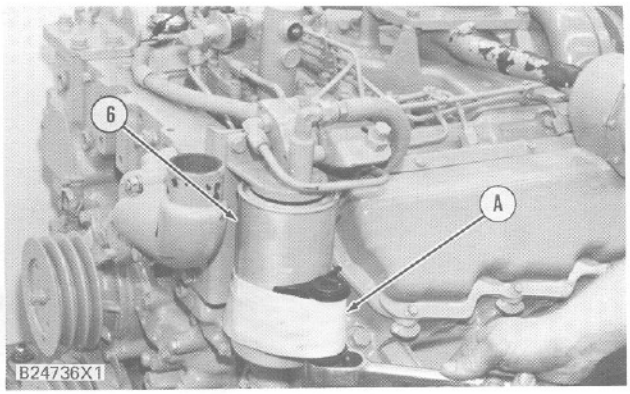
3. Clean filter base surface. Be sure old gasket is removed.

4. Put clean diesel fuel on the filter gasket.

5. Install fuel filter element (6) with tool (A).

6. Tighten ½ to ¾ turn after filter gasket makes contact with the base.





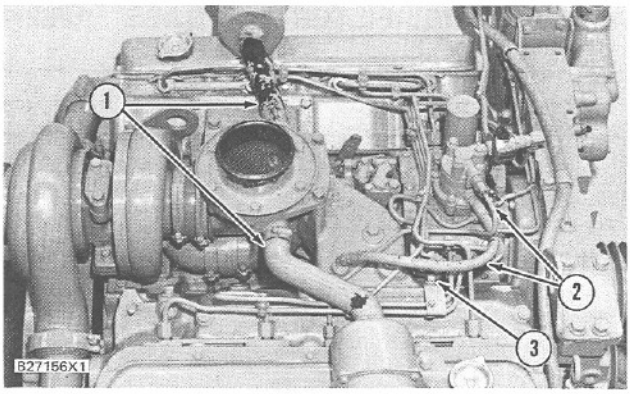
FUEL INJECTION LINES

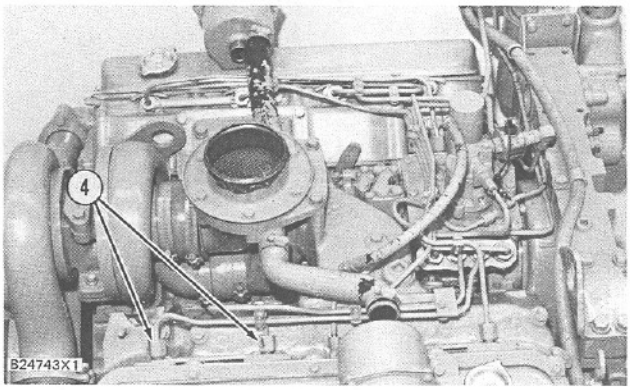
REMOVE FUEL INJECTION LINES 1252-11

1. Disconnect lines (1) and (2).

2. Remove bolt (3) from the bracket.

3. Loosen nuts (4) at the cylinder head and the fuel injection pump. Remove the fuel lines and install caps or plugs on all openings.





INSTALL FUEL INJECTION LINES 1252-12

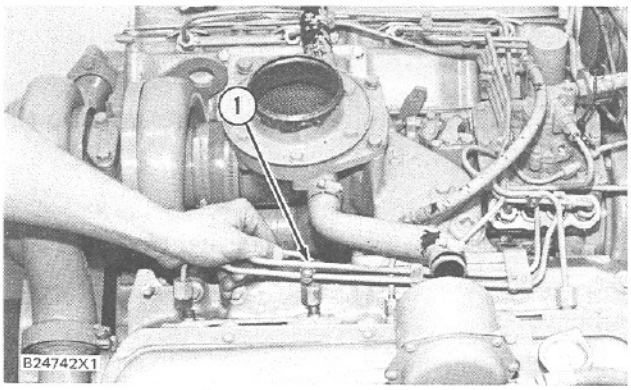
	Tools Needed	A
5P144	Socket	1

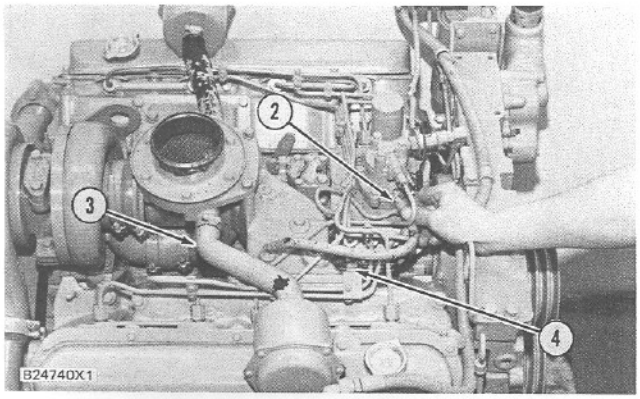
1. Put fuel injection lines (1) in position.

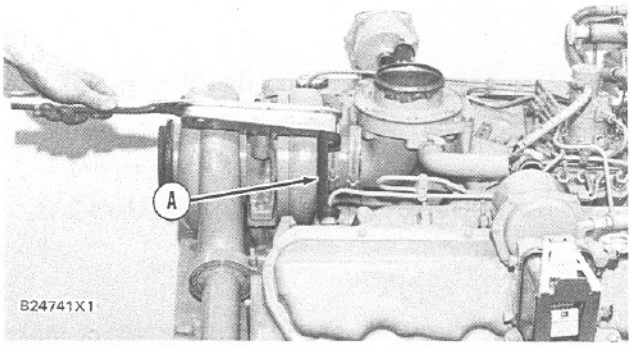
2. Tighten the nuts with tooling (A) to a torque of 40 ± 7 N•m (30 ± 5 lb.ft.).

3. Connect two lines (3) and line (2).

4. Install bolt (4) in the bracket.





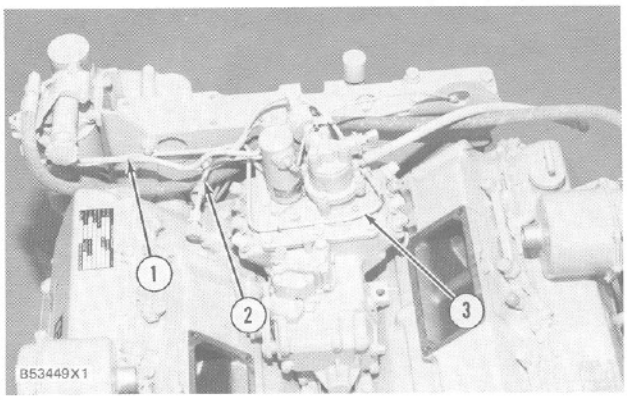


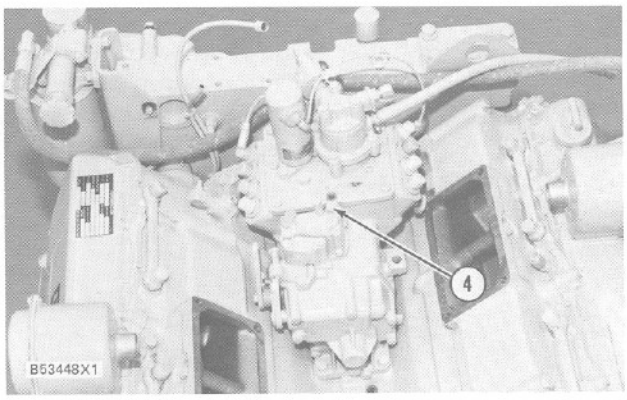
FUEL INJECTION PUMP HOUSING AND GOVERNOR

REMOVE FUEL INJECTION PUMP HOUSING AND GOVERNOR 1286-11

	Tools Needed	A	B
3P1544	Timing Pin	1	
6V4069	Body Group		1

start by:
a) remove fuel lines
b) remove air inlet manifold

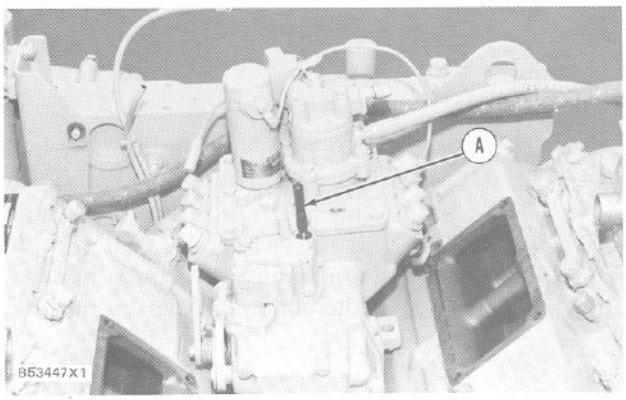




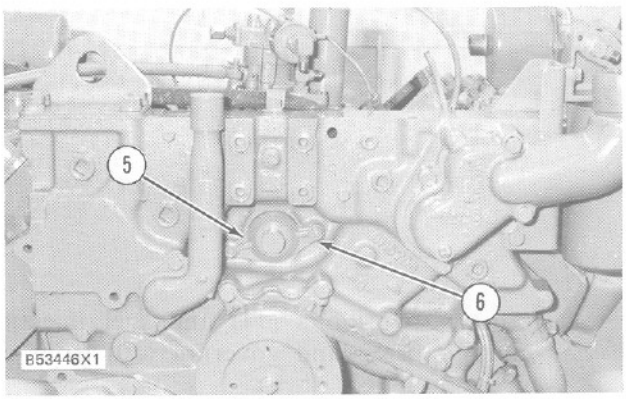
NOTICE
Make sure all foreign material is kept out of the inlet manifold openings.

1. Remove fuel lines (1), (2) and (3) from the engine.

2. Remove bolt (4).



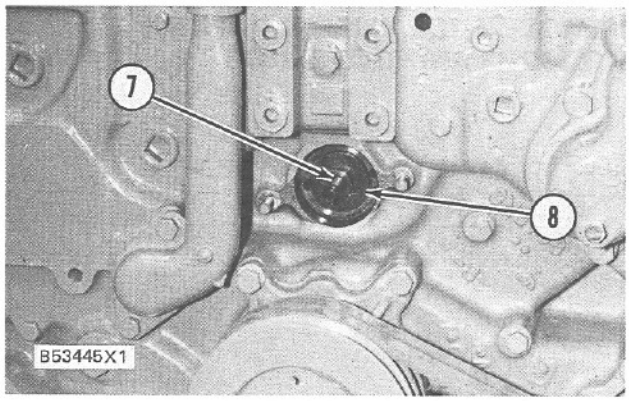
3. Install tool (A). Turn the crankshaft clockwise (as seen from the front of the engine) until the timing pin drops into the groove (slot) in the injection pump camshaft. For the correct timing procedure, see TESTING AND ADJUSTING, FUEL SYSTEM ADJUSTMENTS.



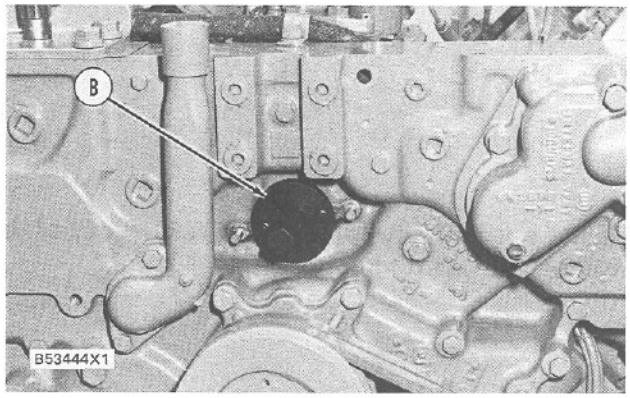
4. Remove nuts (6), then remove the tachometer cover (5).

FUEL INJECTION PUMP HOUSING AND GOVERNOR

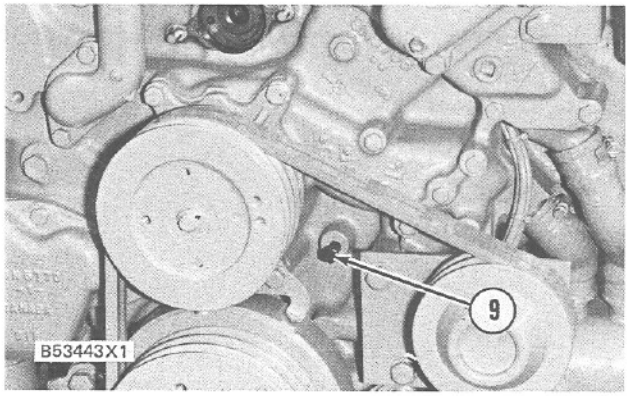
5. Remove tachometer drive shaft (7) and washer (8).



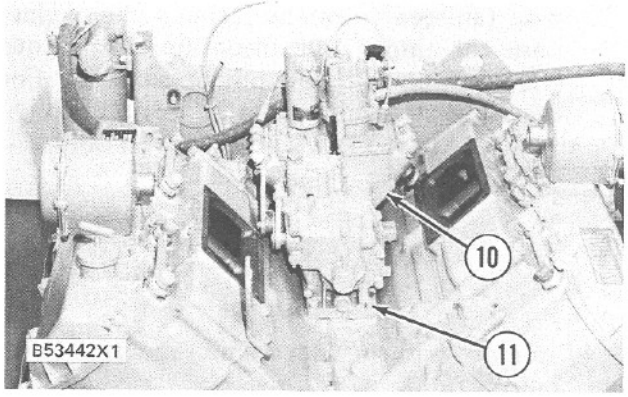
6. Install tooling (B) into the camshaft drive gear for the fuel injection pump. Turn tooling (B) until the drive gear is free of the shaft. Remove tooling (B).



7. Remove the plug from the timing hole in the front cover and install a 5/16″-18 NC bolt (9) 2-1/2 in. long. Turn the crankshaft (clockwise as seen from the front of the engine) until bolt (9) can be installed into the timing gear and is in the center of the timing hole.



8. Remove two bolts (11) and fuel injection pump housing and governor (10) from the engine.



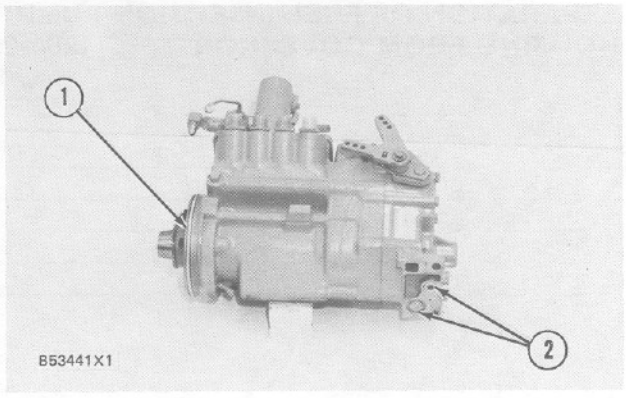
FUEL INJECTION PUMP HOUSING AND GOVERNOR

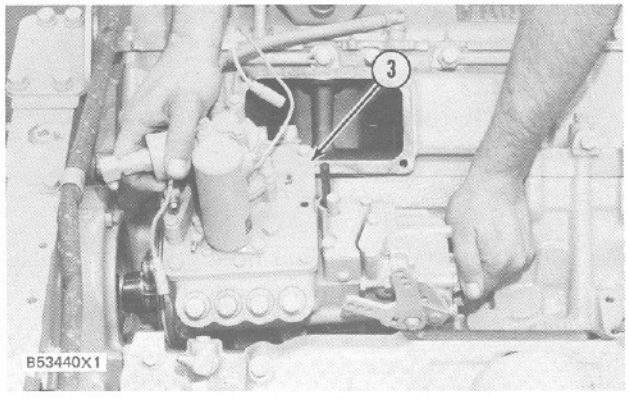
INSTALL FUEL INJECTION PUMP HOUSING AND GOVERNOR 1286-12

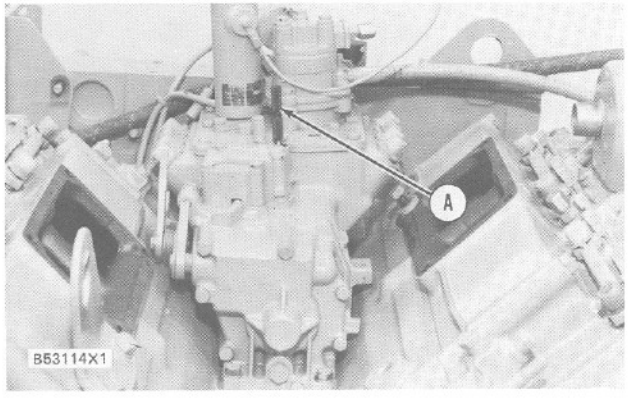
Tools Needed		A
3P1544	Timing Pin	1

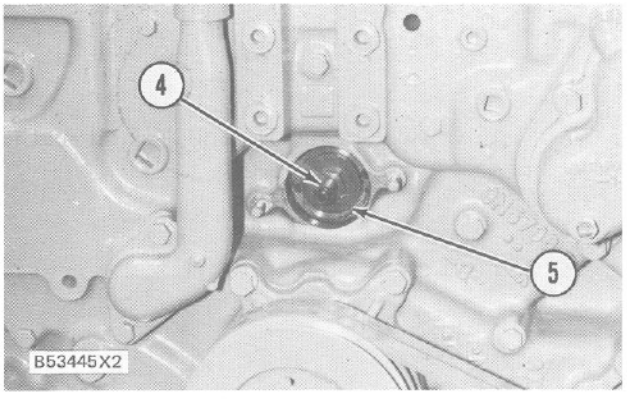
1. Make sure O-ring seals (1) and (2) are in position.
2. Put fuel injection pump housing and governor (3) in position and install the bolts that hold it.
3. Install the washer (5) and tachometer drive shaft (4). Tighten the shaft to a torque of 149 ± 14 N•m (110 ± 10 lb.ft.).
4. Check the timing, see FUEL SYSTEM ADJUSTMENTS in TESTING AND ADJUSTING.
5. Install the tachometer cover (6) and the nuts (7) that hold it in place.
6. Remove tool (A) from the pump and install bolt (10).
7. Install fuel lines (8), (9), (11) and the clips that hold them.

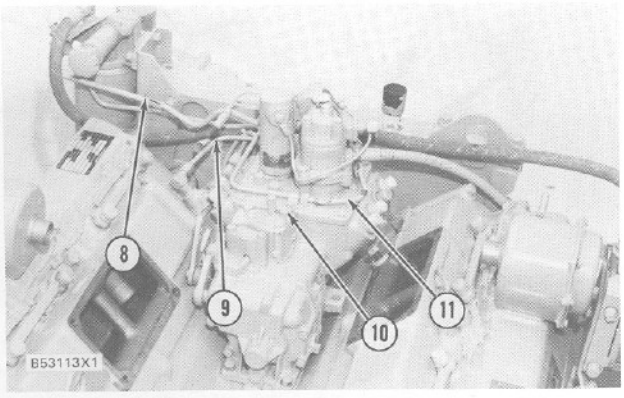
   end by:
   a) install air inlet manifold
   b) install fuel lines

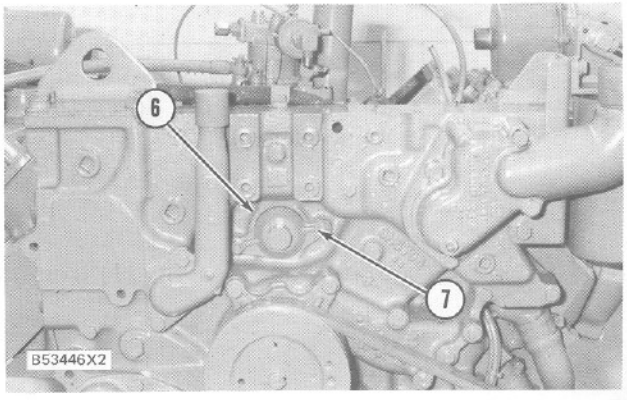








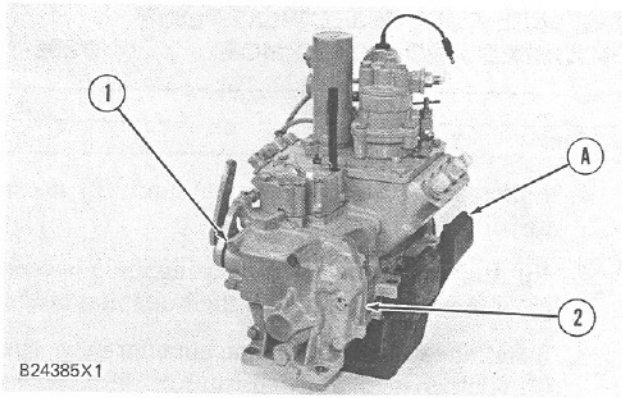




FUEL INJECTION PUMP HOUSING AND GOVERNOR

SEPARATION OF FUEL INJECTION PUMP HOUSING FROM GOVERNOR 1264-29

	Tools Needed	A	B	C	D
2P8315	Bracket Assembly	1			
1P1855	Snap Ring Pliers		1		
5P302	Bar			1	
3P1544	Timing Pin				1

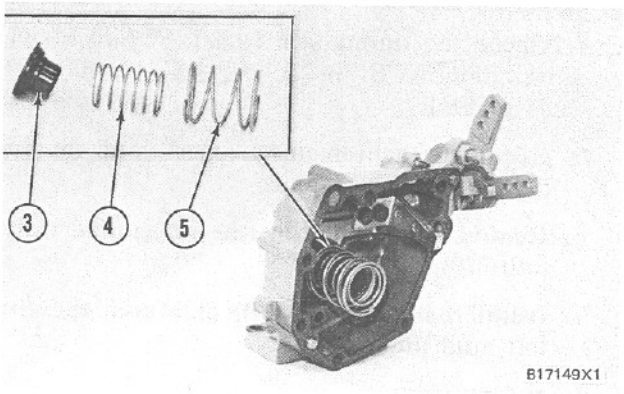


start by:

a) remove fuel injection pump housing and governor

1. Install the fuel injection pump housing on tool (A).

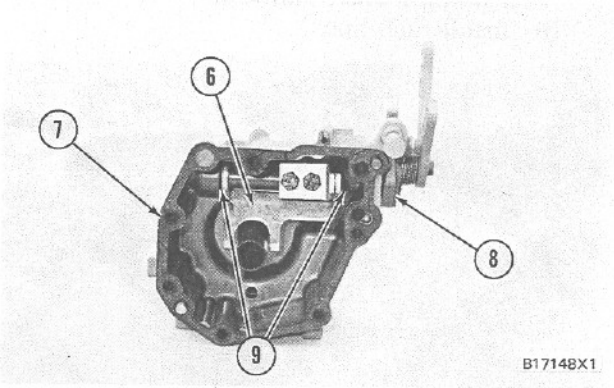
2. Remove bolts (1) that hold governor housing assembly (2) to the fuel injection pump housing.



3. Remove governor housing assemblies (2) and gasket.

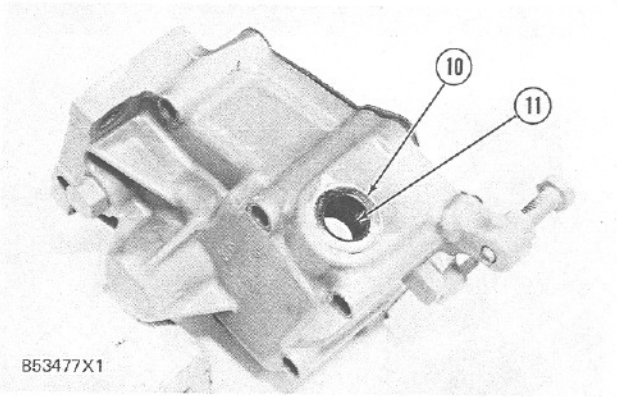
4. Remove two springs (5) and (4) and seat (3).

5. Remove the springs from the seat.



6. Remove the bolts from the shaft.

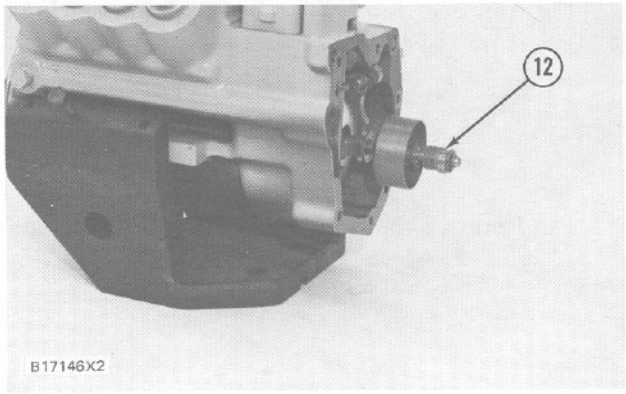
7. Remove shaft assembly (8), lever (6) and washers (9) from housing (7).



8. Remove seal (10) and bushing (11) from the governor housing.

FUEL INJECTION PUMP HOUSING AND GOVERNOR

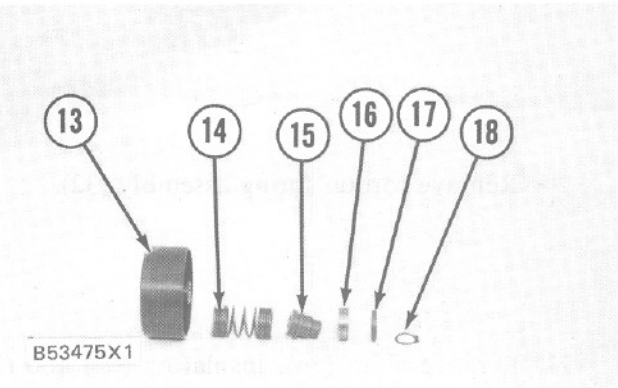
9. Remove piston assembly (12).



10. Remove spring (14) from seat (13) and seat (15).

11. Remove snap ring (18) from seat (15) with tooling (B).

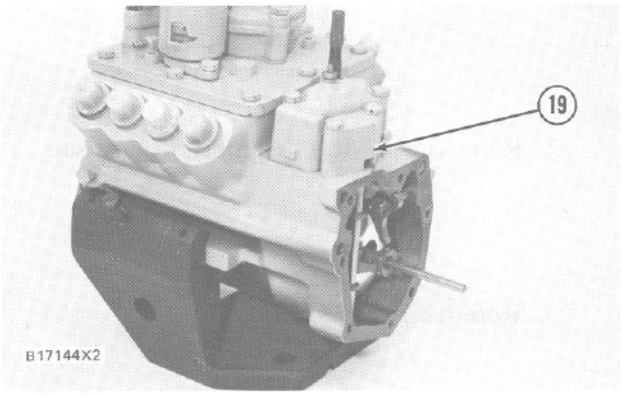
12. Remove ring (17) and spool (16) from the seat.



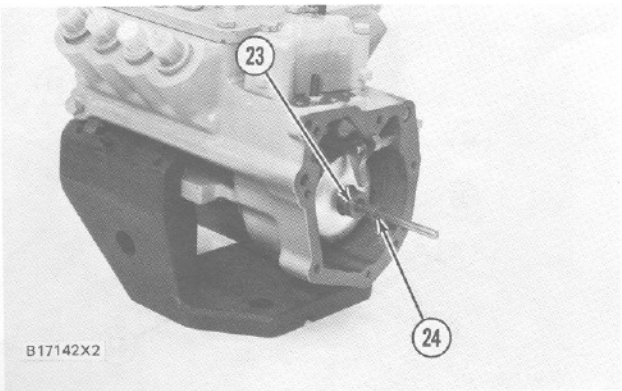
13. Remove the bolts and cover (19).

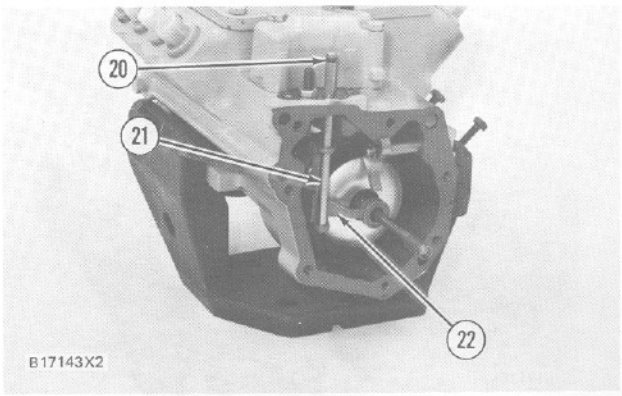
14. Remove shaft (21) and lever (22).

15. Remove O-ring seal (20) from the shaft.



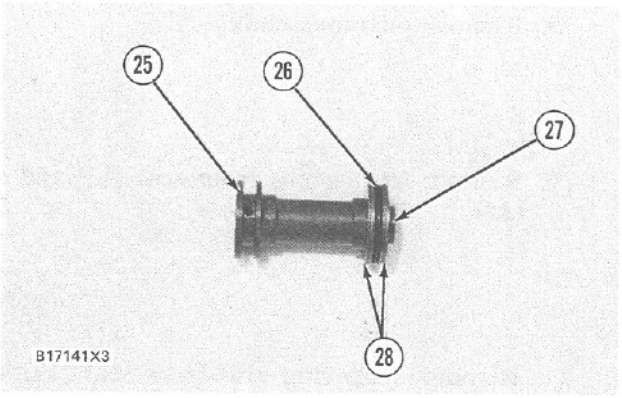
16. Remove spring (23) and riser assembly (24).





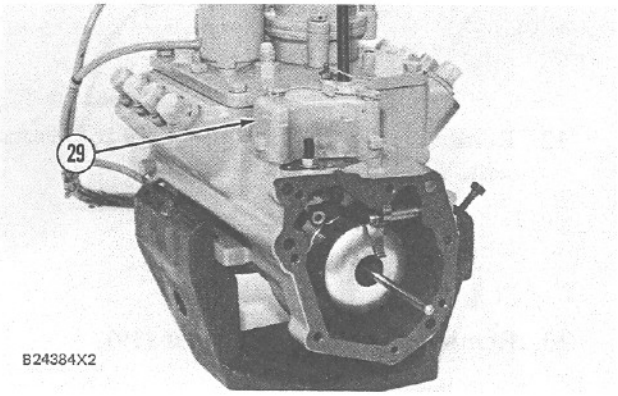
FUEL INJECTION PUMP HOUSING AND GOVERNOR

17. Remove ring (27), races (28) and bearing (26) from riser (25).



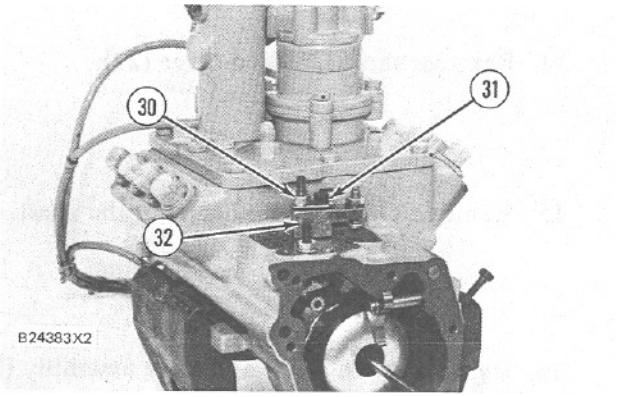
18. Remove the bolts, cover (29) and the gasket.

19. Remove nut (30) and bolt (31).



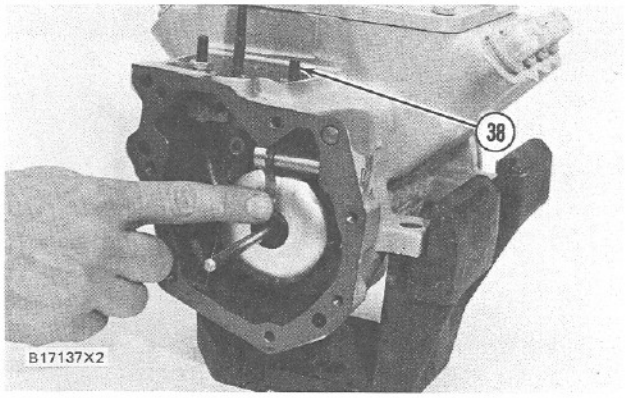
20. Remove torque spring assembly (32).

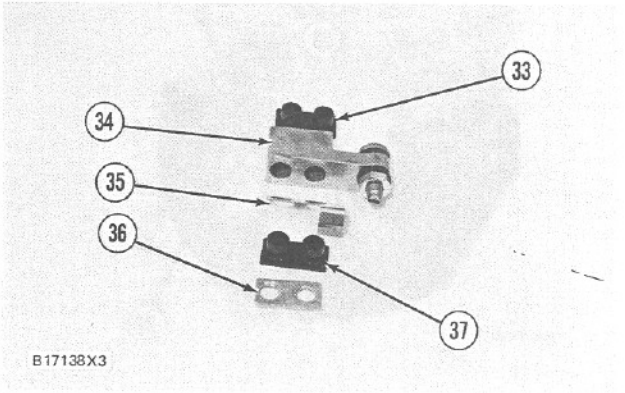
21. Remove shim (36), insulators (33) and (37), and contact (35) from bar (34).



22. Remove the stop assembly if necessary.

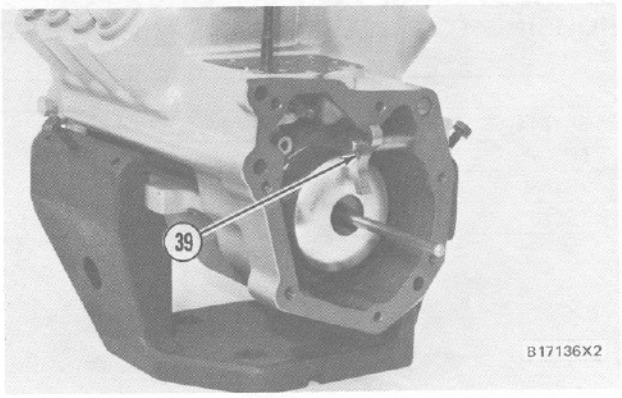
23. Remove rod (38).





FUEL INJECTION PUMP HOUSING AND GOVERNOR

24. Remove lockring (39) and the lever.

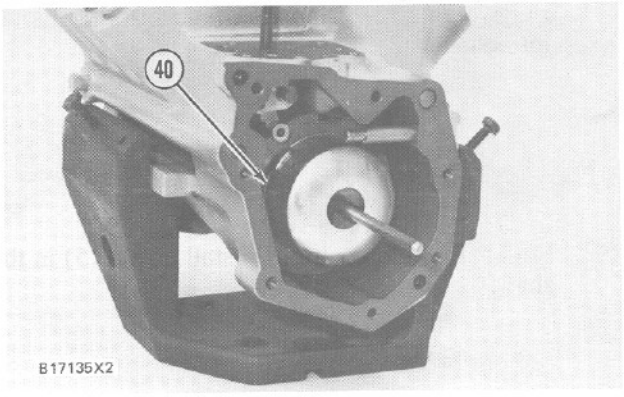


NOTICE

Pull on the shield only a small amount in each location so it will not have distortion or damage. The metal of the shield is moved (staked) around the camshaft and the shield can be damaged when it is removed. If the shield has damage, use a new part for replacement.

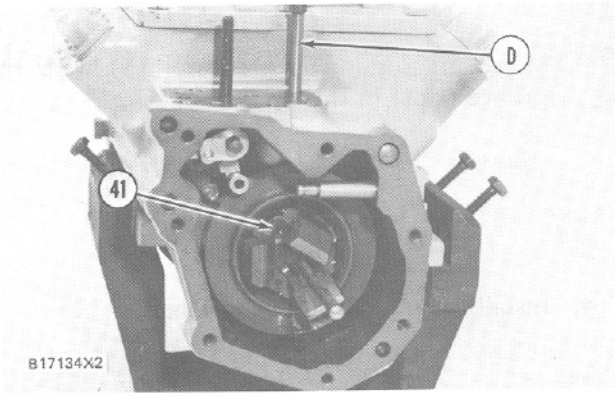
25. Remove shield (40) from the camshaft with tooling (C).

26. Install tooling (D) into the camshaft.

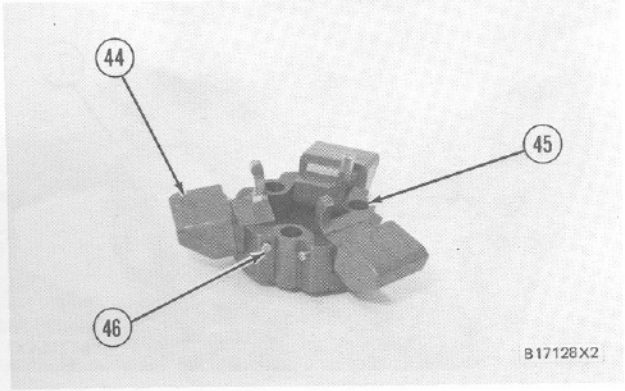


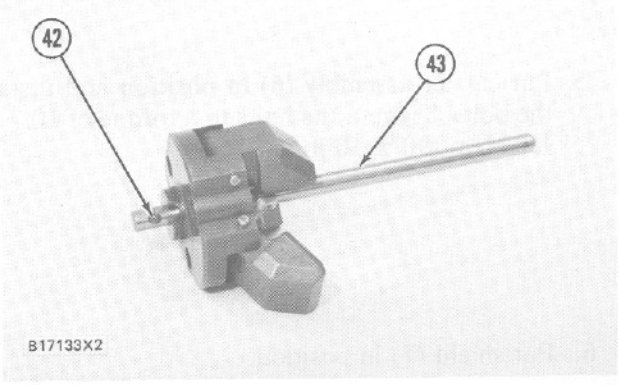
27. Remove three bolts (41) and the carrier assembly.

28. Remove dowel (42) from rod (43). Remove rod (43).



29. Remove pins (46) and weight (44) from carrier (45).

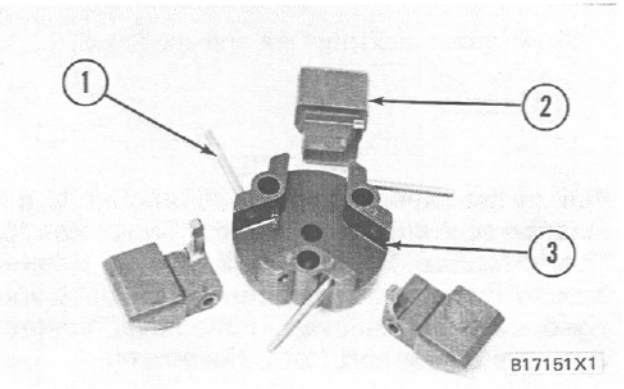




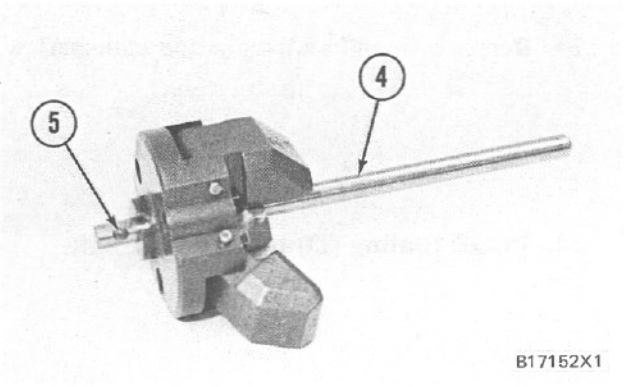
FUEL INJECTION PUMP HOUSING AND GOVERNOR

CONNECTION OF FUEL INJECTION PUMP HOUSING TO GOVERNOR 1264-29

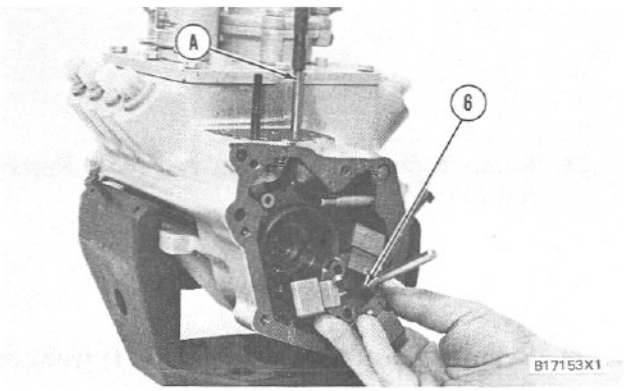
	Tools Needed	A	B	C	D
3P1544	Timing Pin	1			
5P301	Driver		1		
1P1855	Snap Ring Pliers			1	
1P510	Driver Group				1



1. Put weights (2) in position and install pins (1) into carrier (3).

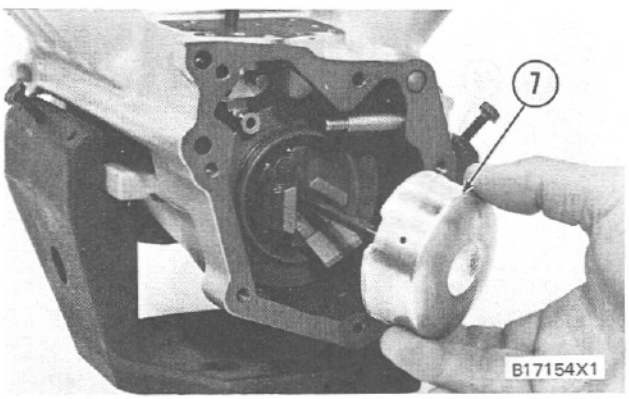


2. Put shaft (4) in position. Install dowel (5) in the shaft.



3. Make an alignment of dowel (5) with the groove (slot) in the carrier.

4. Install tooling (A) in the camshaft.

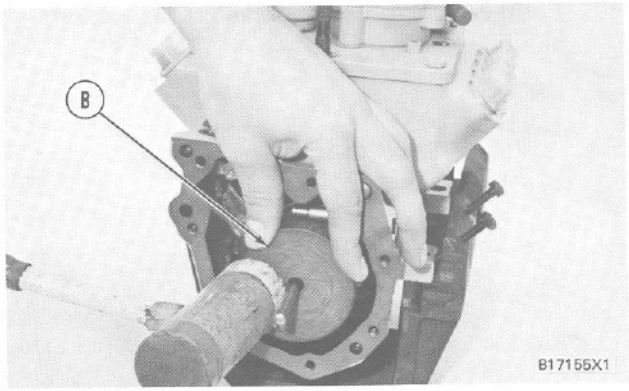


5. Put carrier assembly (6) in position and install the bolts. Tighten the bolts to a torque of 10.2 ± 1.1 N•m (90 ± 10 lb.in.).

6. Put shield (7) in position.

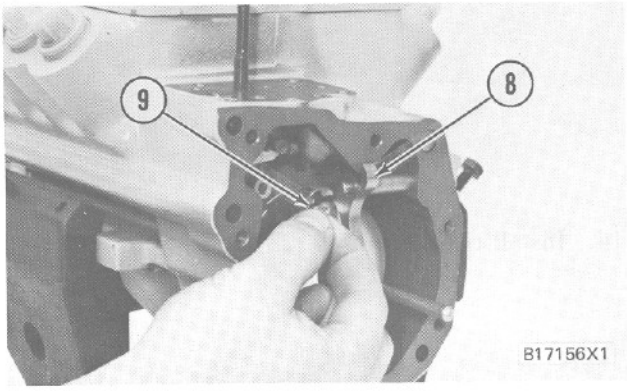
FUEL INJECTION PUMP HOUSING AND GOVERNOR

7. Install the shield with tooling (B). Move the metal over on (stake) the shield on to the camshaft in alignment with the groove on the camshaft. Use an 1/8'' screwdriver with a taper ground on the bottom edge so the screwdriver fits evenly against the flyweight assembly cover to stake it in two places 180° ± 5° apart.

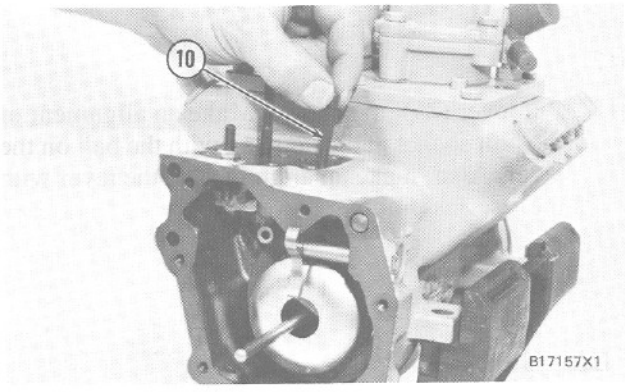


8. Put lever (8) in position and install lockring (9).

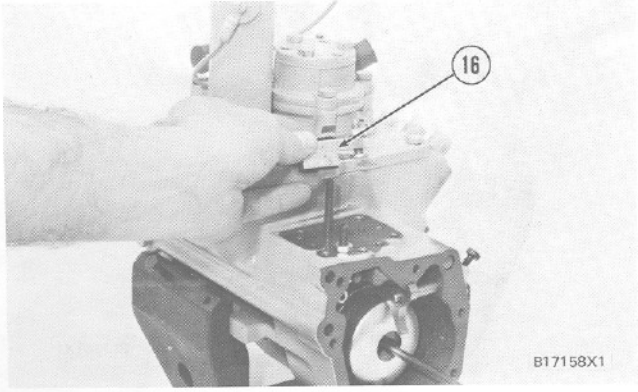
9. Install pin (10).

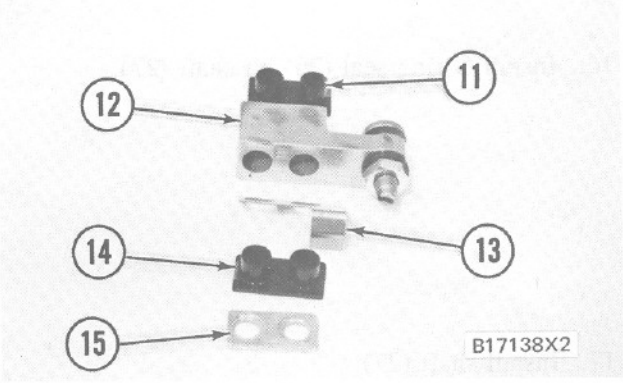


10. Put contact (13), insulators (11) and (14) and shim (15) in position on bar (12).



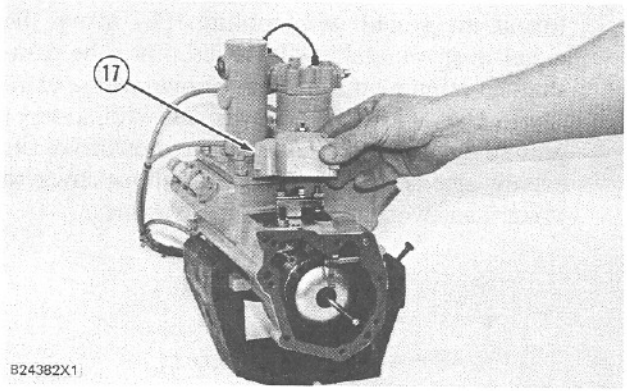
11. Install torque spring assembly (16). Install the nut and bolt.



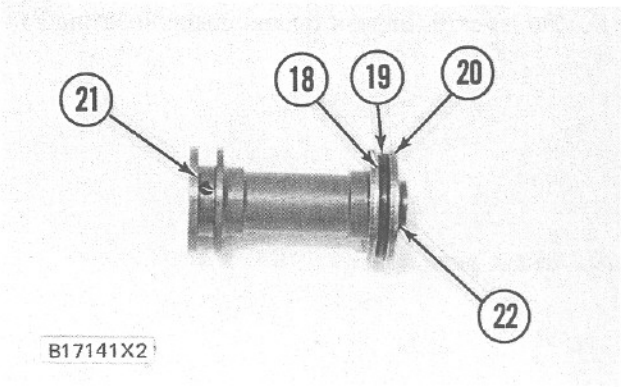


FUEL INJECTION PUMP HOUSING AND GOVERNOR

12. Put the gasket in position and install cover (17) and the bolts.

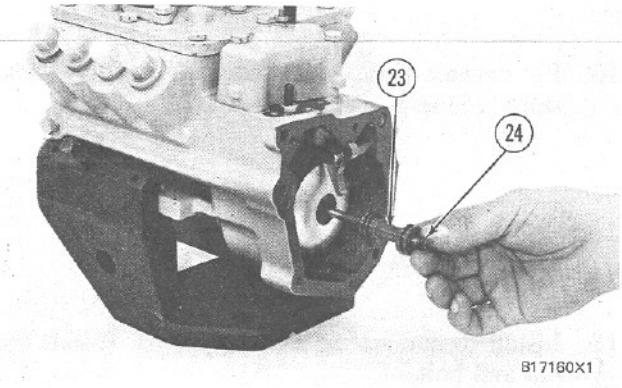


13. Put race (18), bearing (19), race (20) and ring (22) on riser (21).

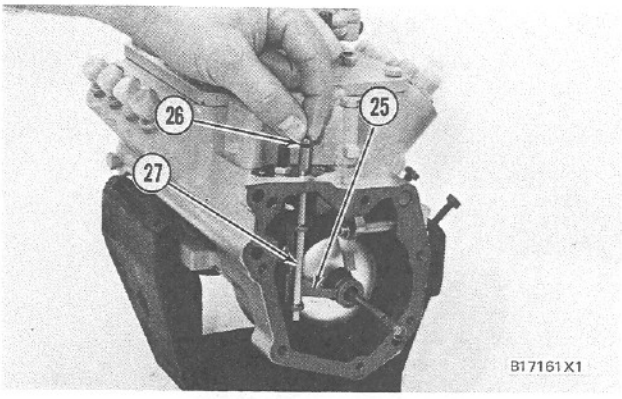


14. Install riser assembly (23) and spring (24).

15. Put lever (25) in position. Make an alignment of the bolt socket in the housing with the ball on the lever. Also, make an alignment of the lever with the riser assembly.



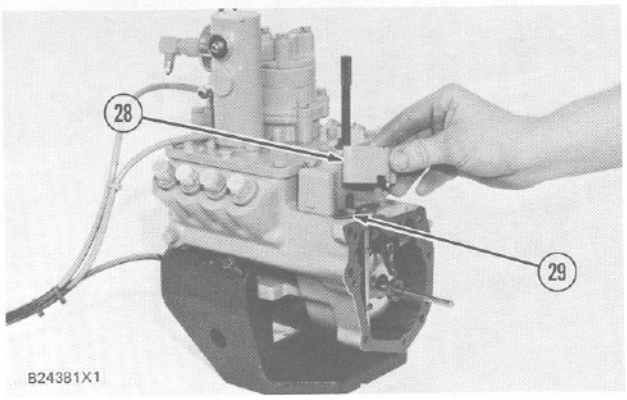
16. Install O-ring seal (26) on shaft (27).



17. Install shaft (27).

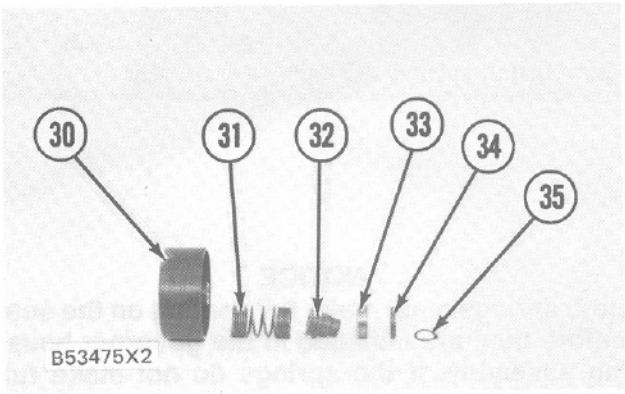
FUEL INJECTION PUMP HOUSING AND GOVERNOR

18. Put gasket (29) in position. Install cover (28) and the bolts.

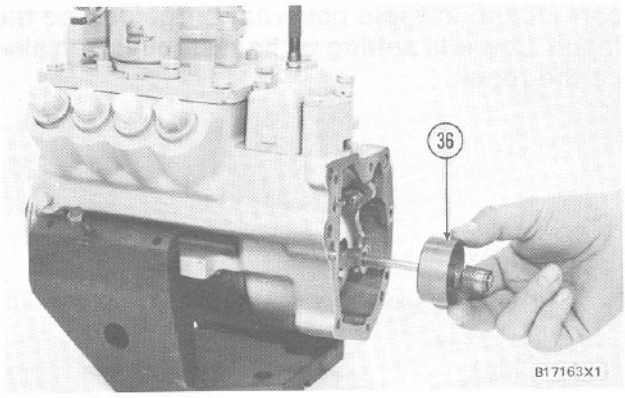


19. Put spool (33) and ring (34) in position and install snap ring (35) with tooling (C) on seat (32).

20. Install spring (31) on seats (30) and (32).

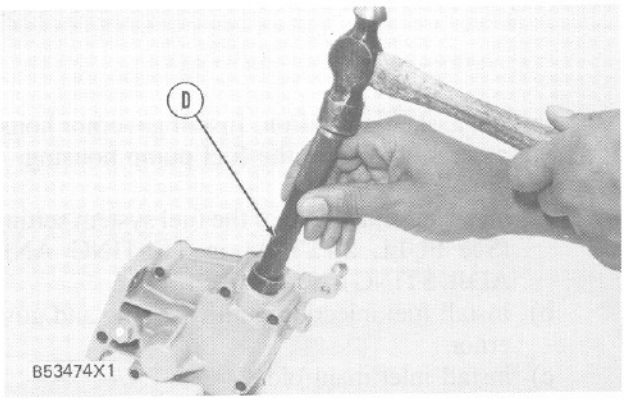


21. Install piston assembly (36).



NOTE: Make a layer on the outside diameter of the seal with 5S1454 Sealant before the seal is installed.

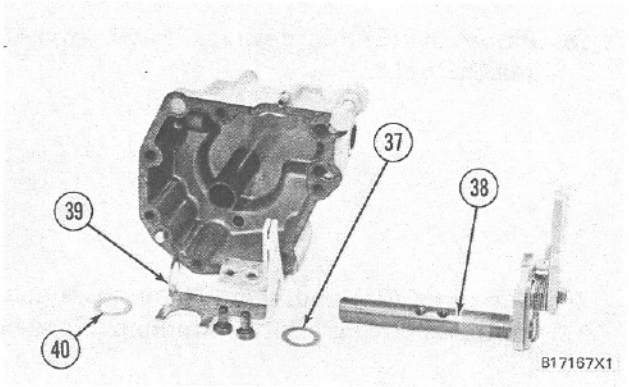
22. Use tooling (D) to install the bushing and seal in the governor housing. Install the seal with the lip of the seal toward the inside of the housing.



23. Remove the excess sealant. Put diesel fuel as a lubricant on the lip of the seal.

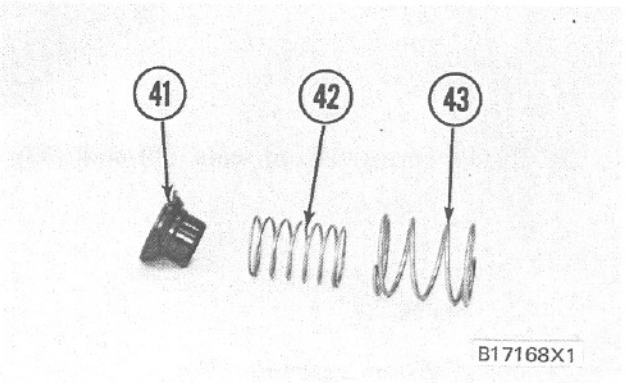
FUEL INJECTION PUMP HOUSING AND GOVERNOR

24. Install shaft assembly (38), washer (37), lever (39) and washer (40).



25. Install the bolts that hold the lever to the shaft assembly.

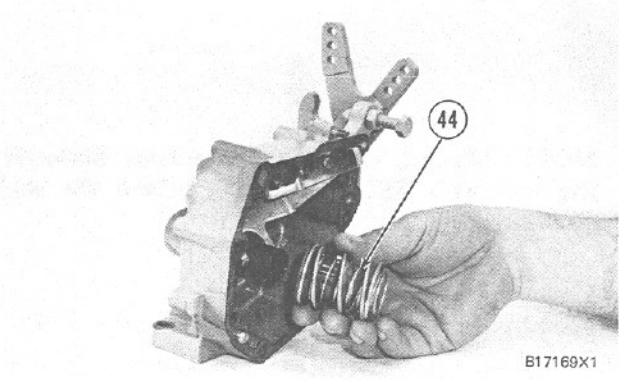
26. Install springs (42) and (43) on seat (41).



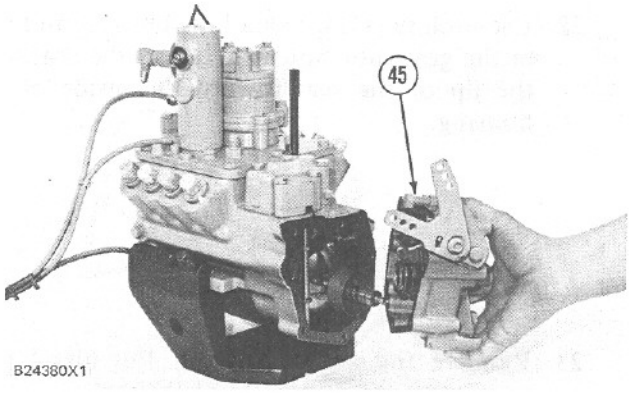
NOTICE

Both springs must make full contact on the seat before they are installed in the governor housing assembly. If the springs do not make full contact on the seat, high idle speed will not be correct and low idle governor surge can be the result. Low idle setting without stability can also be the result.

27. Install seat assembly (44) in the governor housing.



28. Put the gasket in position. Install governor housing assembly (45) on the fuel pump housing. end by:
    a) make an adjustment of the fuel system setting (See FUEL SYSTEM in TESTING AND ADJUSTING)
    b) install fuel injection pump housing and governor
    c) install inlet manifold

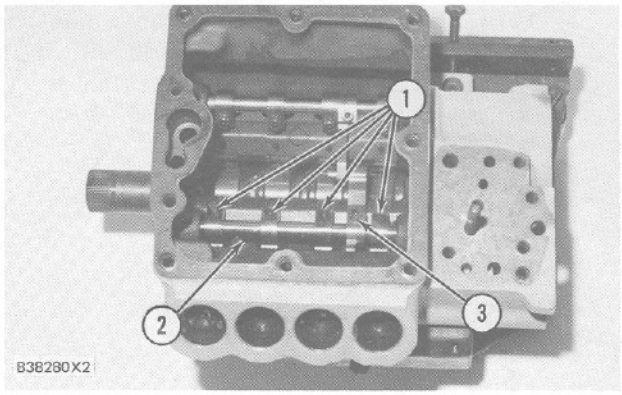


FUEL INJECTION PUMP HOUSING

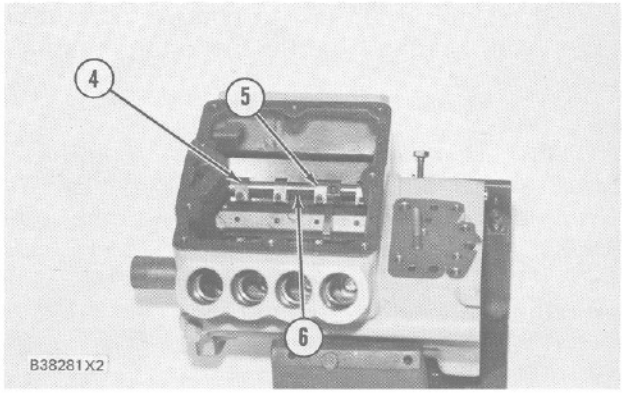
DISASSEMBLE FUEL INJECTION PUMP HOUSING 1253-15

	Tools Needed	A
1P510	Driver Group	1

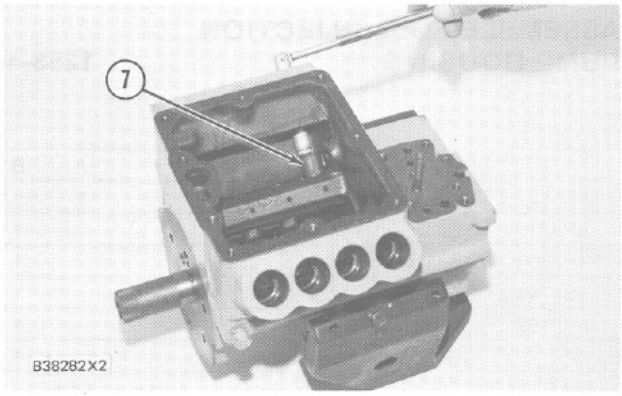
start by:
a) remove fuel injection pumps
b) separation of governor from fuel injection pump housing
c) remove fuel transfer pump



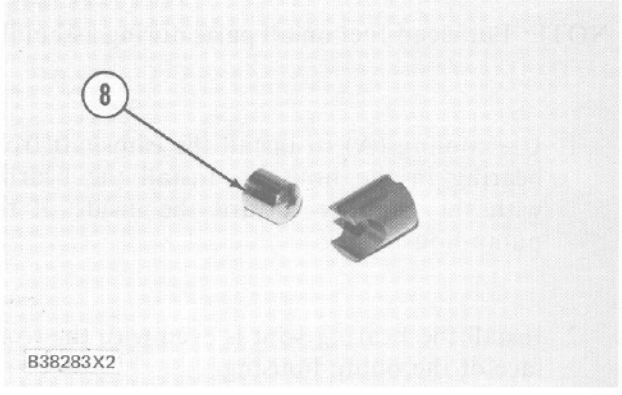
1. Loosen screws (1) in the levers and remove screw (3) in the crossover lever. Slide shaft assembly (2) out of the housing.



2. Loosen screws in levers (4) and remove the screw in crossover lever (5). Slide shaft (6) out of the housing.



NOTE: Put identification on lifters (7) and rollers (8) for installation in their respective bores in the housing.

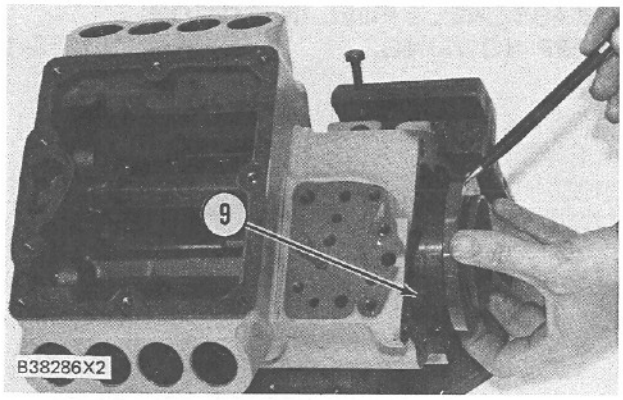


3. Use a magnet to remove eight lifter assemblies (7).

4. Remove roller (8) from each lifter assembly.

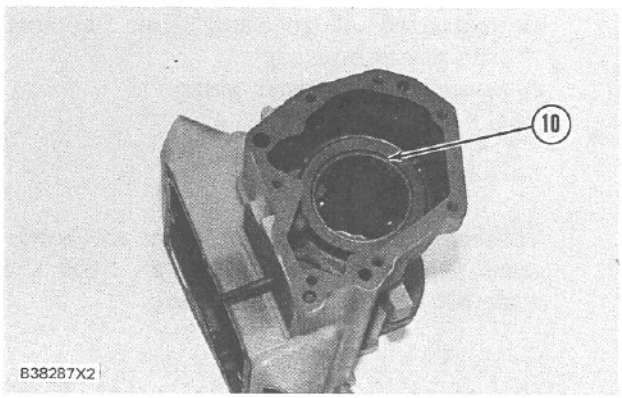
FUEL INJECTION PUMP HOUSING

5. Turn the camshaft so the groove (slot) for the timing pin is in the position shown and carefully remove camshaft (9). Remove the thrust washer from the housing.



6. Remove camshaft rear bearing (10) from the fuel pump housing. Be careful not to damage the bearing bore in the housing.

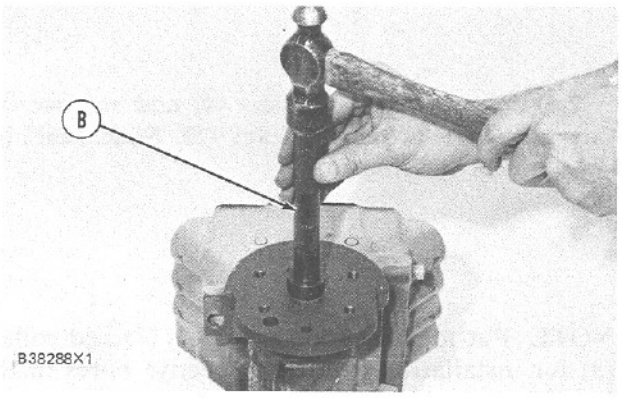
7. Use tool group (A) to remove the camshaft front bearing from the fuel pump housing.



NOTE: Earlier fuel pump housings do not have a thrust washer for the camshaft. The 6V4068 Tool Group can be used to machine the housing so the 9N5822 Thrust Washer can be used. See SPECIAL INSTRUCTION Form No. SMHS7897 for the procedure to machine the housing.

ASSEMBLE FUEL INJECTION PUMP HOUSING 1253-16

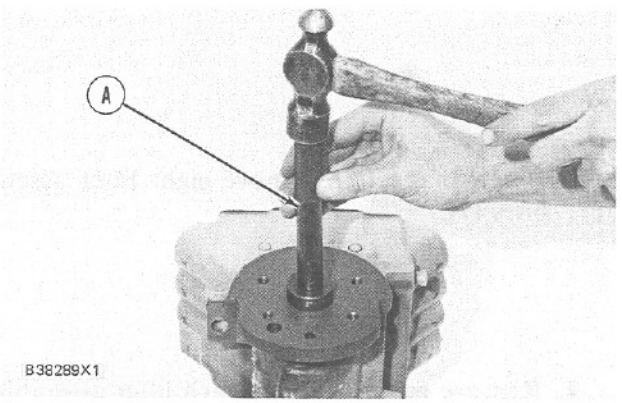
	Tools Needed	A	B
1P510	Driver Group	1	
5P3516	Reaming Tool Group		1
1P2363	Swivel Joint		1
9S1744	Adapter		1
5P2169	Master Gauge		1
5P2170	Dial Gauge Group		1



NOTE: Put clean fuel on all parts during assembly.

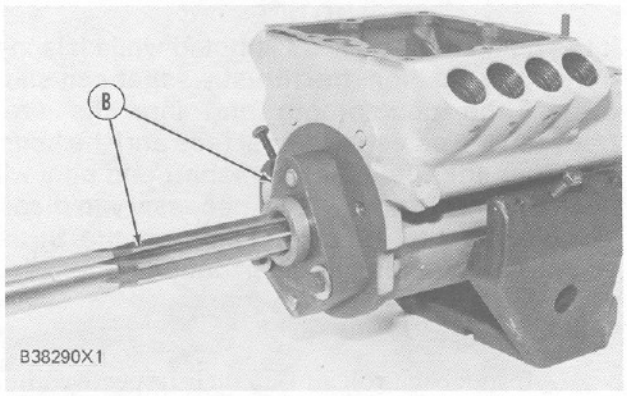
1. Use tooling (A) to install the camshaft front bearing in the housing. Install the bearing with the chamfer toward the inside of the pump housing.

2. Install the bearing so it is even with the front face of the pump housing.

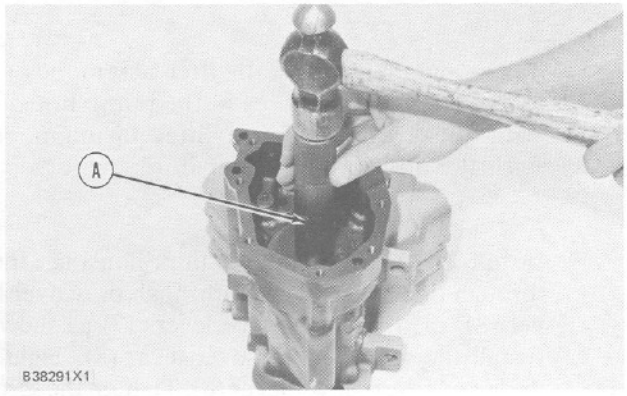


FUEL INJECTION PUMP HOUSING

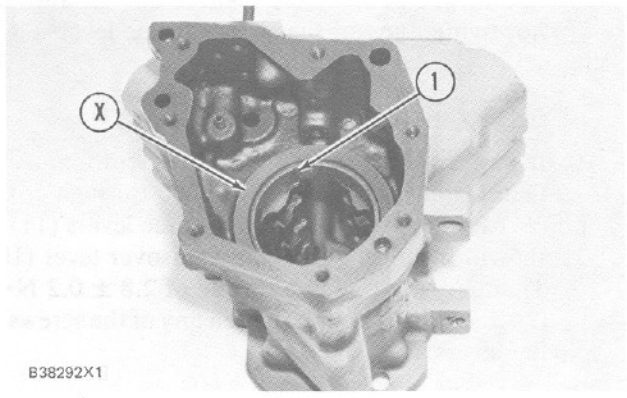
3. Use tooling (B) to machine the bore in the camshaft front bearing to the correct size. See SPECIAL INSTRUCTION Form No. SMH6735 for the procedure to machine the new camshaft front bearing. The bore in the bearing must be 25.413 ± 0.013 mm (1.0005 ± .0005 in.).



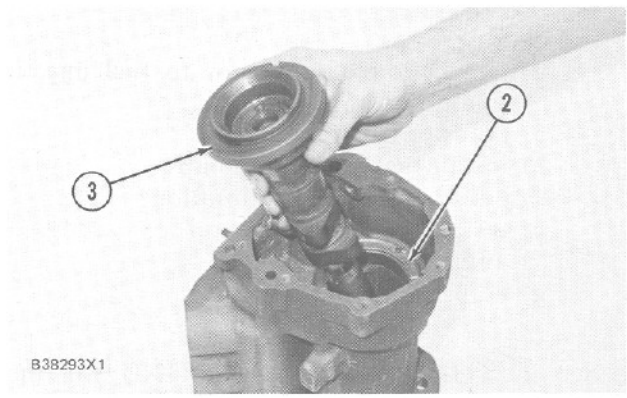
4. Use tooling (A) to install the camshaft rear bearing in the housing. Install the bearing so groove (1) in the bearing is in the position shown. On earlier pump housings without a thrust washer install the bearing into the bore so the outer face of the bearing is 0.114 ± 0.025 mm (.0045 ± .0010 in.) below face (X) on the housing. On later pump housings with a thrust washer install the bearing into the bore so the outer face of the bearing is 0.43 ± 0.13 mm (.017 ± .005 in.) below the counterbore for the thrust washer.



5. Install thrust washer (2) in the housing with the ear on the thrust washer in the hole in the pump housing so the thrust washer will not turn.



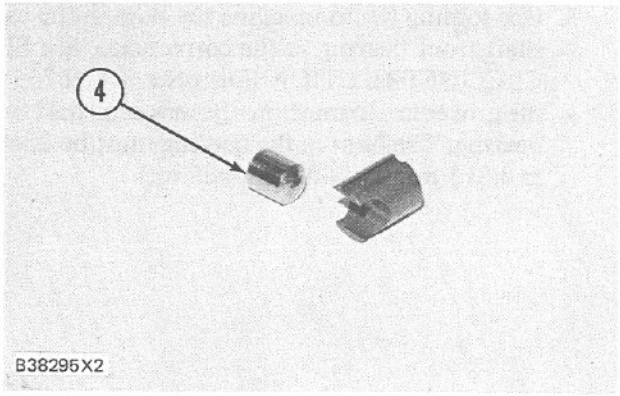
6. With the pump housing in a vertical position as shown, carefully install camshaft (3). To make sure that the thrust washer will be kept in its correct installation location, keep the pump housing in a vertical position and install the fuel transfer pump and camshaft sleeve. See FUEL TRANSFER PUMP INSTALLATION for the procedure to install the fuel transfer pump and camshaft sleeve.



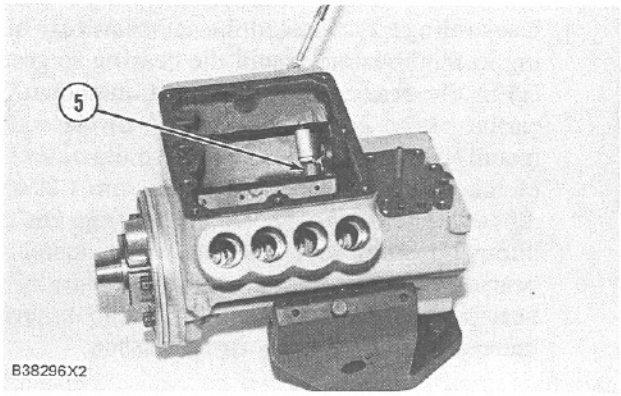
FUEL INJECTION PUMP HOUSING

NOTICE

If the pump housing is assembled while it is in a horizontal position, the thrust washer can slide out of the counterbore and into the area between the camshaft thrust face and the housing. Then the fuel pump camshaft end play will not be correct and it will be necessary to disassemble the fuel pump housing so the thrust washer can be installed correctly.

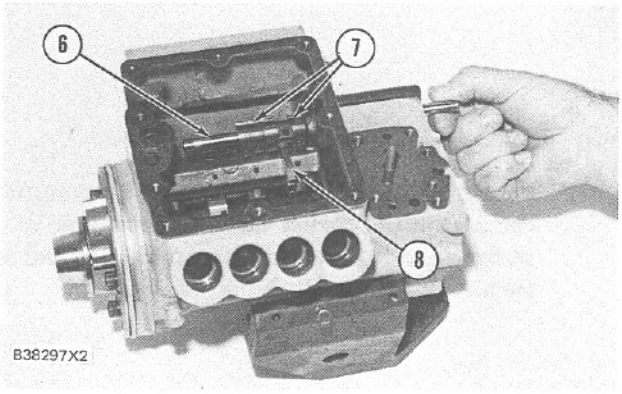


7. Install each roller (4) in their respective lifters.

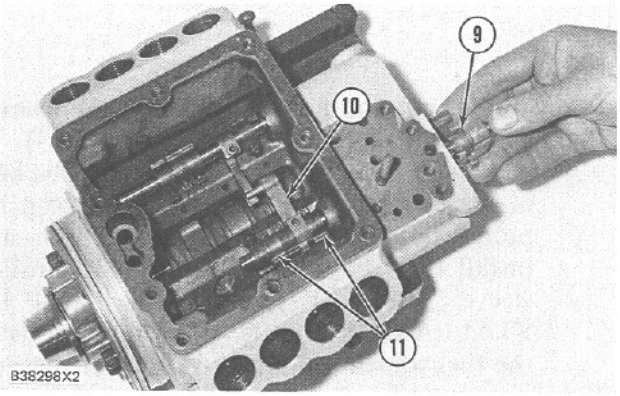


8. Use a magnet to install lifter assemblies (5) in their respective bores in the pump housing with the groove in each lifter in alignment with the dowel in the lifter bore.

9. Install shaft (6) in the pump housing, then through one lever (7), then through crossover lever (8), then through three levers (7) as shown. Install the screw in crossover lever (8). Tighten the screw in crossover lever (8). Tighten the screw to a torque of 2.8 ± 0.2 N•m (24 ± 2 lb.in.). Do not tighten any of the screws in the levers.



10. Install shaft assembly (9) in the pump housing, then through one lever (11), then through crossover lever (10), then through three levers (11) as shown. Install the screw in crossover lever (10). Tighten the screw to a torque of 2.8 ± 0.2 N•m (24 ± 2 lb.in.). Do not tighten any of the screws in the levers.



end by:

a) connection of governor to fuel injection pump housing
b) adjust crossover levers*
c) install fuel injection pumps
d) adjust fuel pump calibration*
e) install fuel transfer pump
f) adjust fuel setting*
g) adjust high and low idle*

*See TESTING AND ADJUSTING for these procedures.

FUEL RATIO CONTROL

REMOVE FUEL RATIO CONTROL 1278–11

1. Remove two bolts (1).
2. Remove fuel ratio control and gasket.

INSTALL FUEL RATIO CONTROL 1278–12

1. Put gasket (2) in position.

NOTE: Make an alignment with the lever in the shut-off housing with the plunger in the fuel ratio control. control.

2. Install fuel ratio control (1) and the bolts that hold it.

DISASSEMBLE FUEL RATIO CONTROL 1278–15

start by:

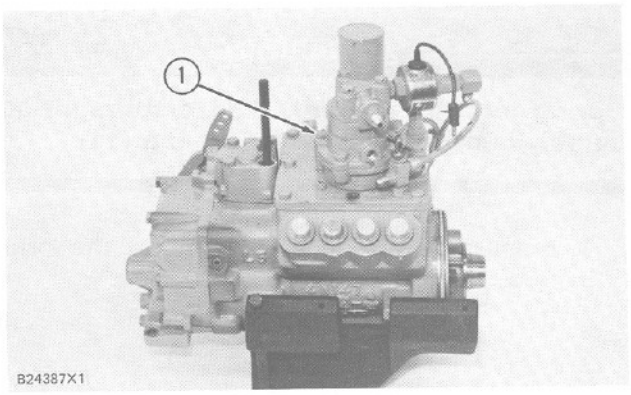
a) remove fuel ratio control

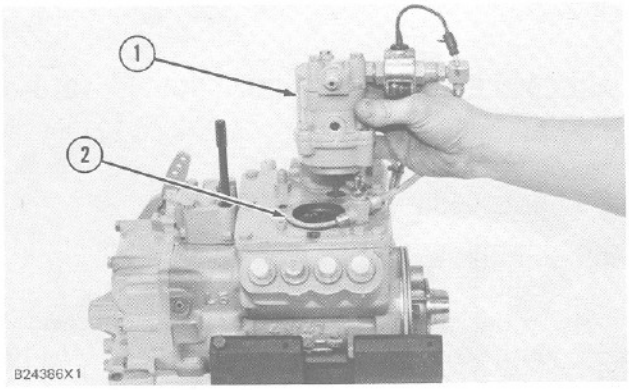
1. Remove solenoid (1) from the fuel ratio control.
2. Remove bolts (3) and covers (2) and (4). Remove diaphragm (11) and piston (17). Remove gasket (16) from cover (4).

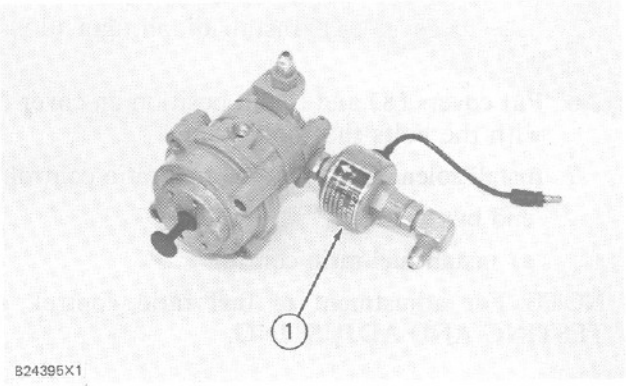
⚠ WARNING

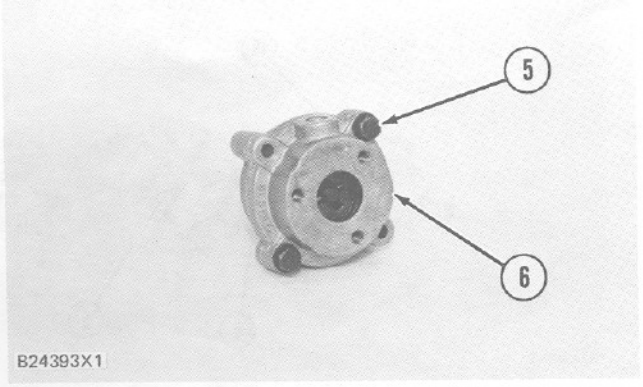
Spring force is present. Slowly loosen the two bolts to release the force.

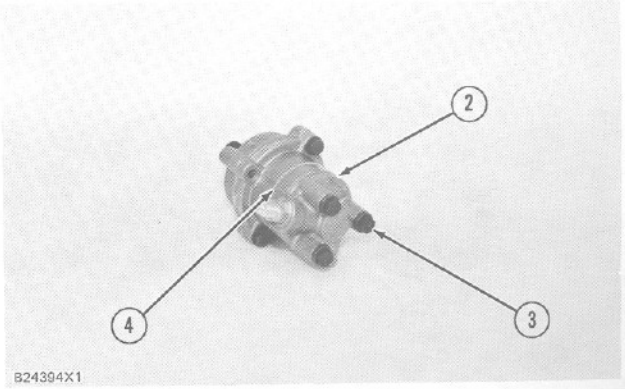
3. Remove two bolts (5), cover (6) and spring (15).









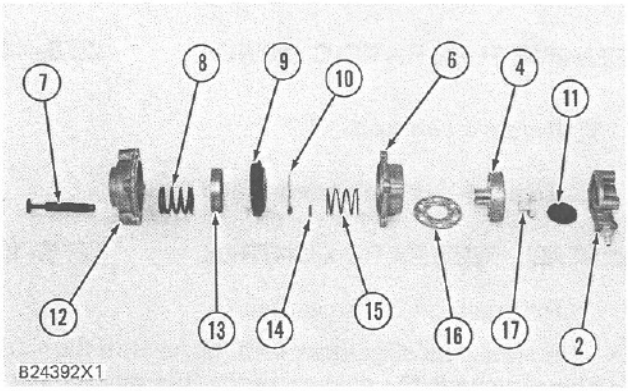


FUEL RATIO CONTROL

⚠ WARNING

Spring force is present. Hold diaphragm assembly in position and remove pin (14).

4. Remove pin (14) and slowly release the spring force.
5. Remove spring (8) and bolt(7) from housing (12).
6. Remove washer (10) and diaphragm (9) from retainer (13).



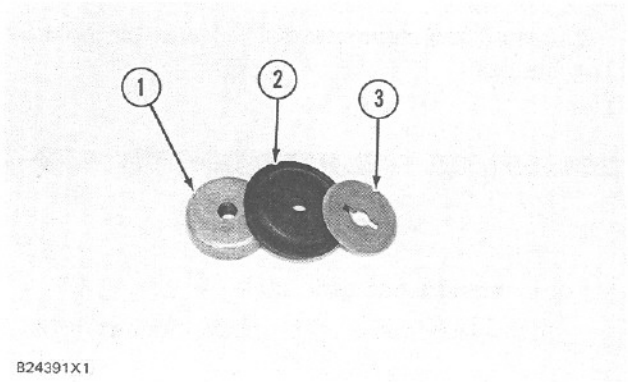
ASSEMBLE FUEL RATIO CONTROL 1278–15

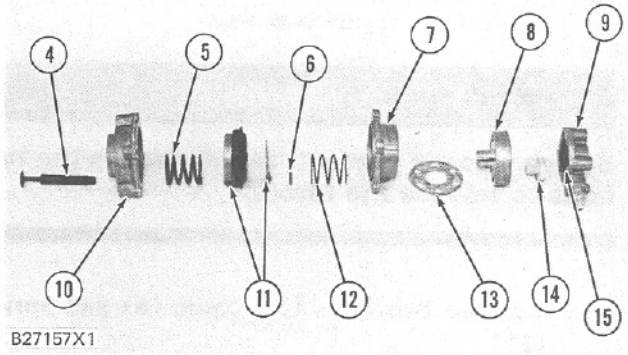
1. Assemble washer (3), diaphragm (2) and retainer (1).
2. Install bolt (4) in housing (10).
3. Install spring (5), diaphragm assembly (11) and pin (6) in housing (10).
4. Install spring (22) in cover (7). Install cover (7) on housing (10) with the two bolts (16) that hold it.
5. Install gasket (13) on cover (8). Install piston (14) to cover (8). Install diaphragm (15) in cover (9).
6. Put covers (8) and (9) in position on cover (7) with the bolts that hold them.
7. Install solenoid (17) on the fuel ratio control.

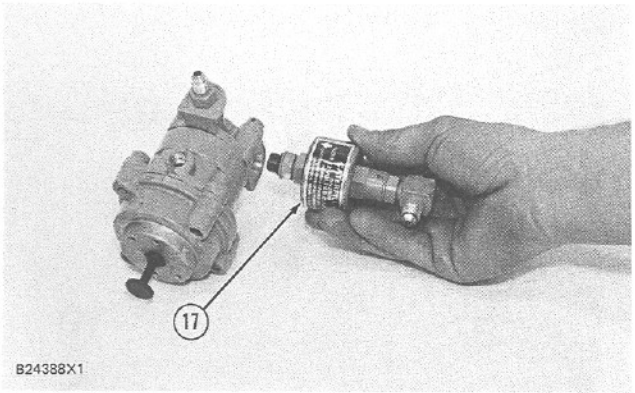
end by:

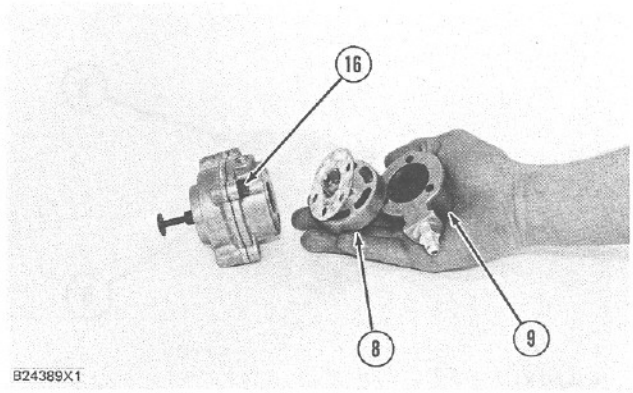
a) install fuel ratio control

NOTE: For adjustment of fuel ratio control, see TESTING AND ADJUSTING.









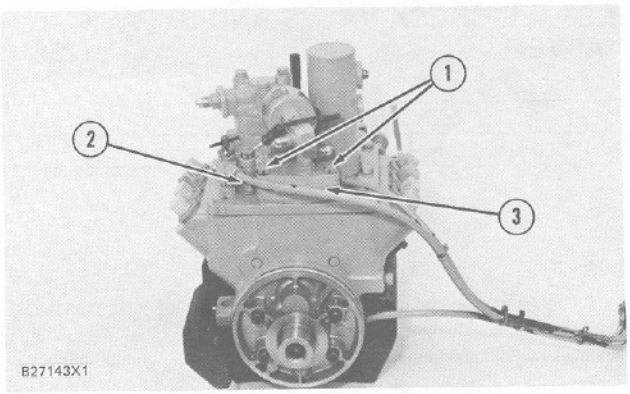
CHECK VALVE AND BYPASS VALVE

REMOVE CHECK VALVE AND BYPASS VALVE 1256-11

NOTICE

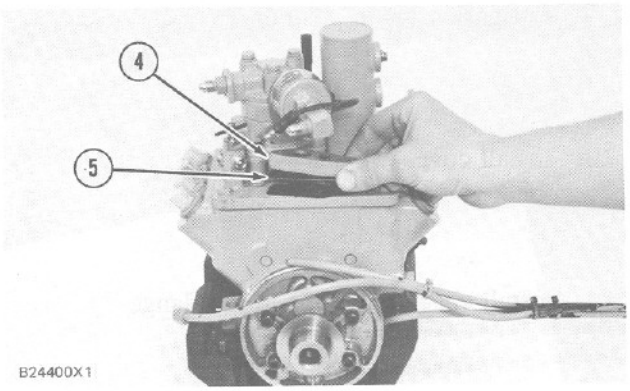
Before any service work is done on the fuel system, the outer surface of the injection pump housing must be clean.

NOTE: Illustrations show fuel injection pump housing and governor removed from engine. Service work can be done with it installed on engine.



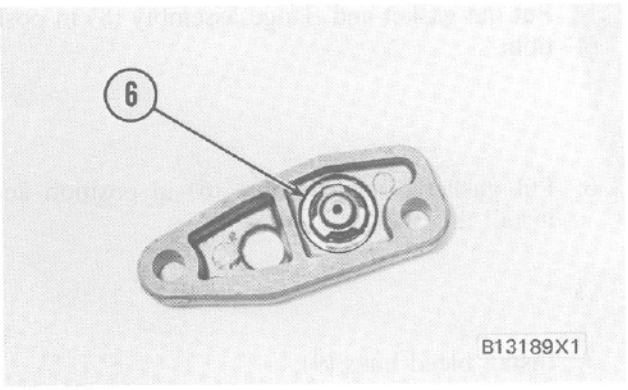
1. Remove three bleed lines (2).

2. Remove bolts (1), flange (3) and the gasket.



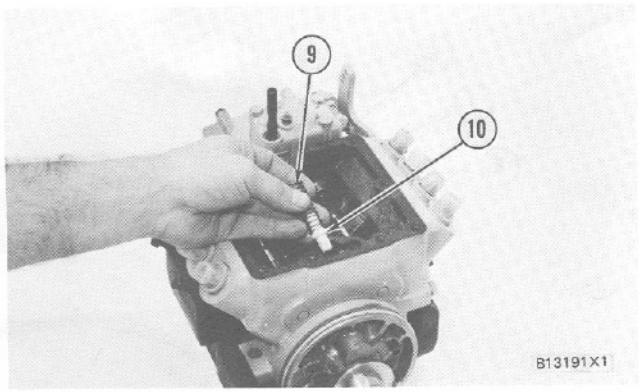
3. Remove flange assembly (4) and gasket (5).

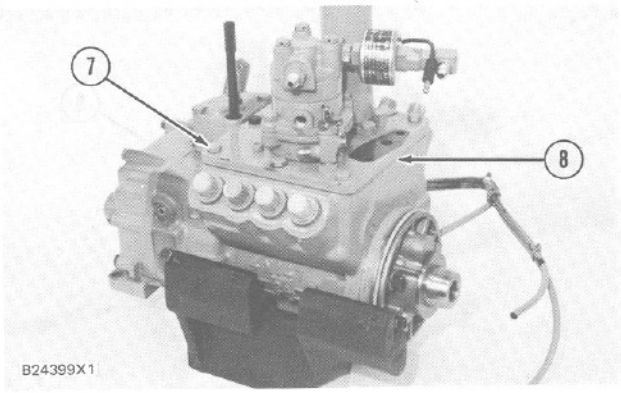
4. Remove check valve (6) from the flange assembly.



5. Remove bolts (7) and cover (8).

6. Remove spring (9) and bypass valve (10).



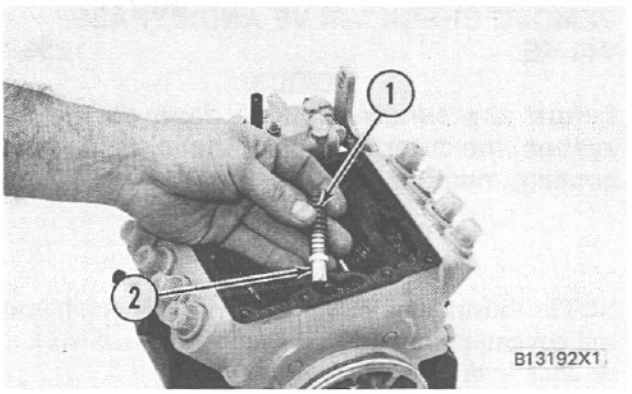


CHECK VALVE AND BYPASS VALVE

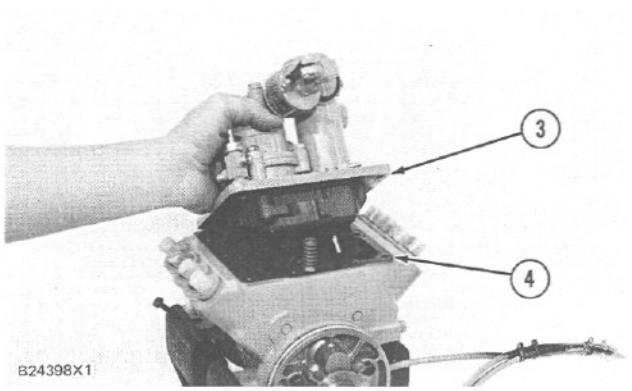
INSTALL CHECK VALVE AND BYPASS VALVE 1256-12

	Tools Needed	A
1P500	Driver Group	1

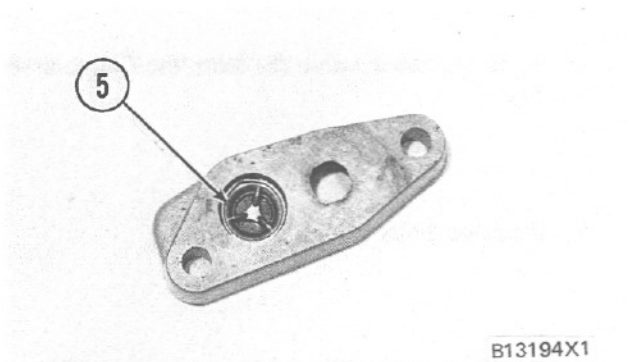
1. Put bypass valve (2) and spring (1) in position.



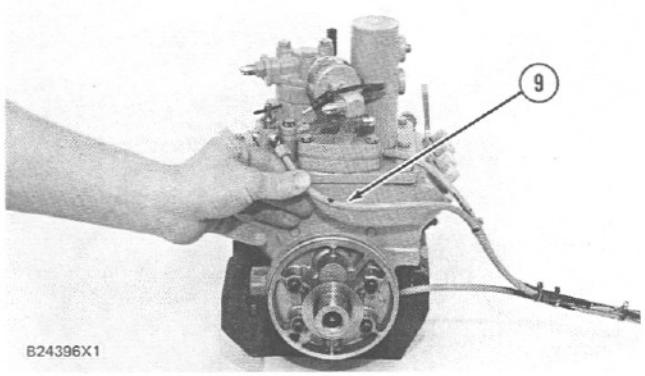
2. Put gasket (4) in position.
3. Install cover (3) and the bolts.

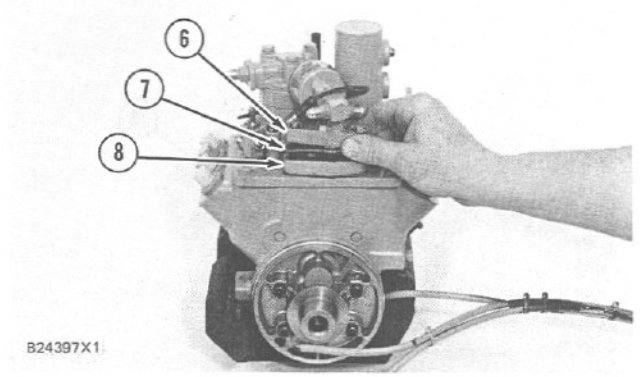


4. Install check valve (5) in the flange.
5. Put the gasket and flange assembly (8) in position.



6. Put gasket (7) and flange (6) in position and install the bolts.
7. Install bleed lines (9).





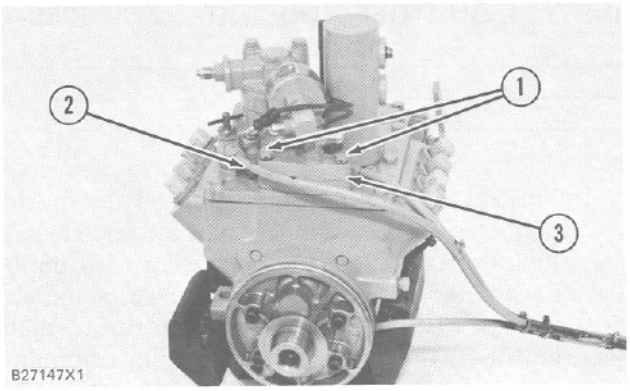
SHUTOFF HOUSING

REMOVE SHUTOFF HOUSING 1259-11

NOTICE

Before any service work is done on the fuel system, the outer surface of the injection pump housing must be clean.

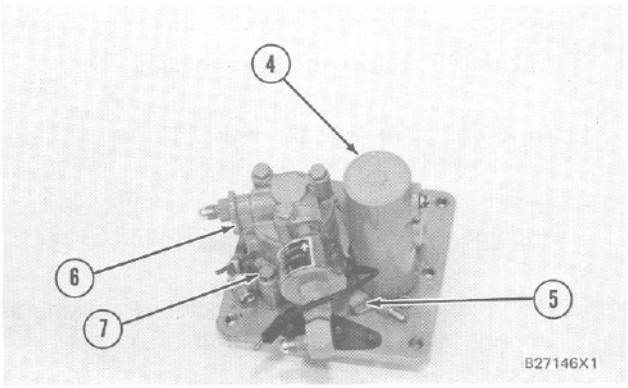
NOTE: Illustrations show fuel injection pump housing and governor removed from engine. Service work can be done with it installed on engine.



1. Remove air bleed lines (2).

2. Remove bolts (1), flange (3), the flange assembly and the gaskets.

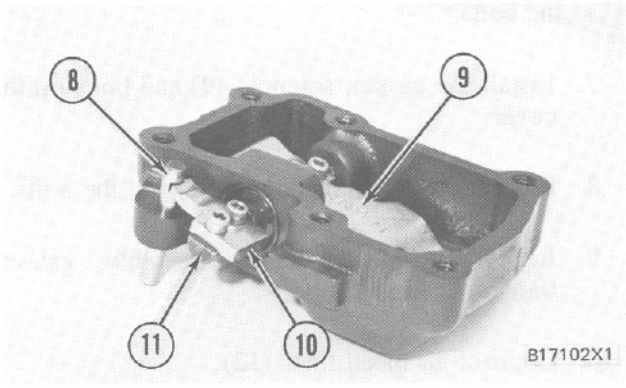
3. Remove the bolts and the cover.



4. Remove bolts (5), solenoid (4) and the gasket.

5. Remove two bolts (7) and fuel ratio control (6).

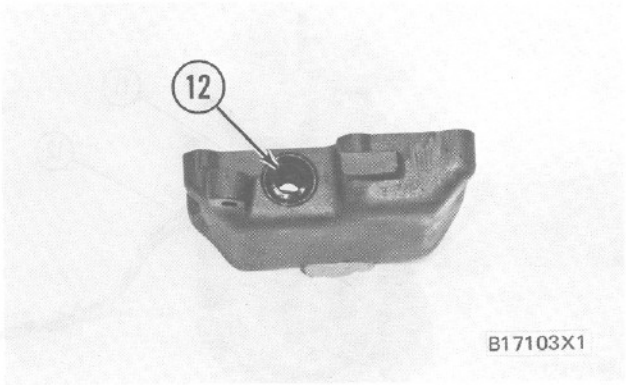
6. Remove the shutoff housing from the cover.



7. Remove the bolts, lever (10) and shaft (8).

8. Remove the bolts, lever (9) and shaft (11).

9. Remove seal (12) from the shutoff housing.

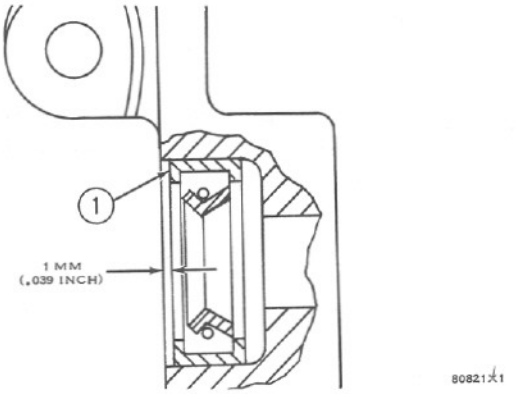


SHUTOFF HOUSING

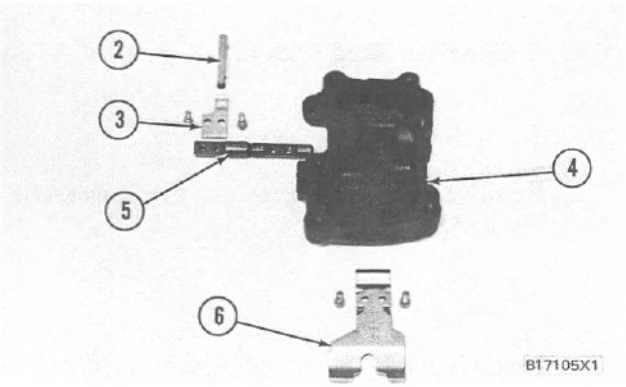
INSTALL SHUTOFF HOUSING 1259-12

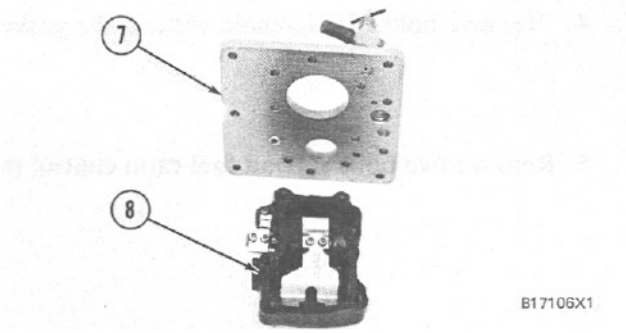
	Tools Needed	A
1P500	Driver Group	1

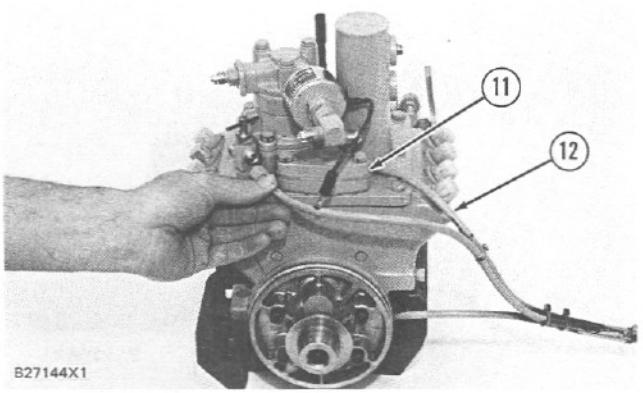
1. Put 5S1454 Sealing Compound on the outside diameter of the seal and install the seal (1) with tooling (A) in the shutoff housing with the lip toward the outside. The outer face of the seal must be 1.0 mm (.039 in.) below the surface of the housing. Remove the extra sealing compound from the housing and the seal after installation.

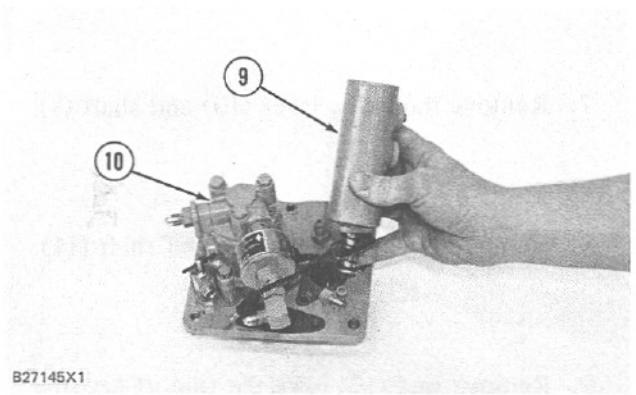


2. Put shaft (5) in position in housing (4).
3. Install lever (6) and the bolts.
4. Install shaft (2), lever (3) and the bolts. Make an alignment of the notch in shaft (2) with lever (3).
5. Put cover (7) in position on shutoff housing assembly (8) and install the bolts.
6. Put fuel ratio control (10) in position and install the bolts.
7. Install the gasket, solenoid (9) and bolts on the cover.
8. Put the cover in position and install the bolts.
9. Install the gasket, flange assembly, gasket, flange (11) and the bolts.
10. Connect air bleed lines (12).









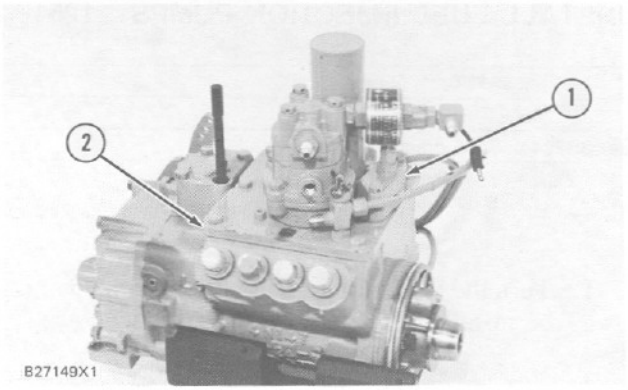
FUEL INJECTION PUMPS

REMOVE FUEL INJECTION PUMPS 1251-11

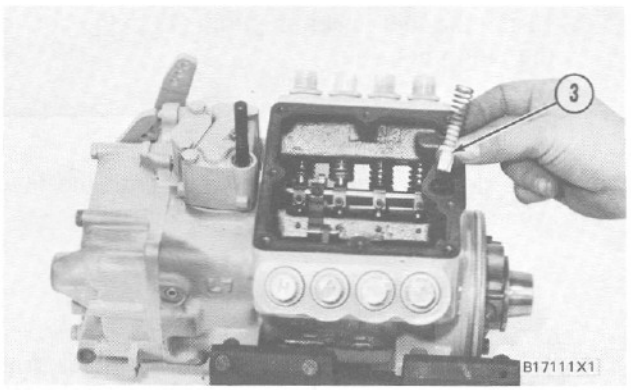
	Tools Needed	A
8S2243	Wrench	1
8S2244	Extractor	1

NOTICE

Before any service work is done on the fuel system, the outer surface of the injection pump housing must be clean.

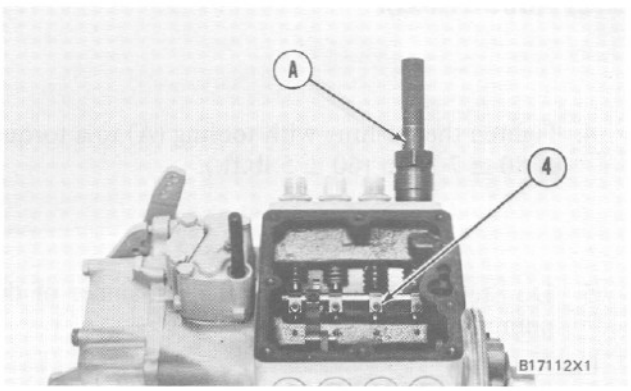


NOTE: The fuel injection pump housing and governor has been removed from the engine for illustration purposes.



1. Remove flange (1) and the flange assembly from the cover.

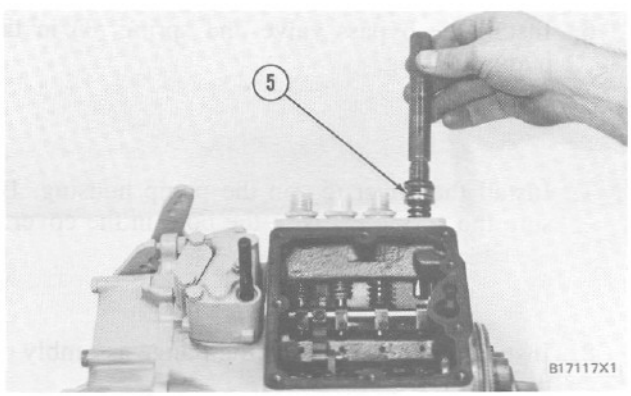
2. Remove cover (2) from the pump housing.



3. Remove the bypass valve (3) and springs from the pump housing.

4. Install tooling (A) on the fuel injection pump and loosen the bushing from the pump housing.

NOTE: Do not loosen screws (4) that hold the levers to the shaft when the pumps are removed or installed. If the levers are moved, fuel pump calibration will be changed.



5. Remove the fuel injection pump (5) from the pump housing. The sleeve on the plunger will slide off the lever as the pump is removed.

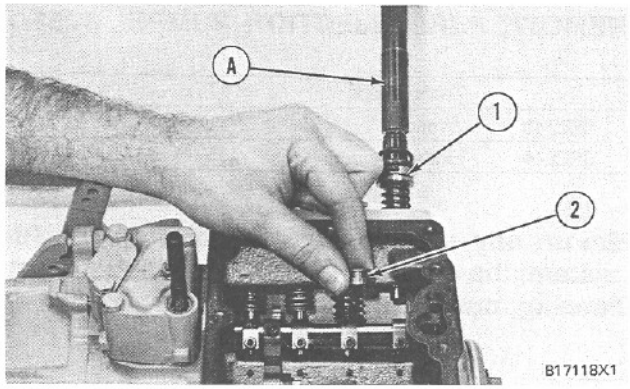
6. Do Steps 4 and 5 for the remainder of the pumps.

FUEL INJECTION PUMPS

INSTALL FUEL INJECTION PUMPS 1251-12

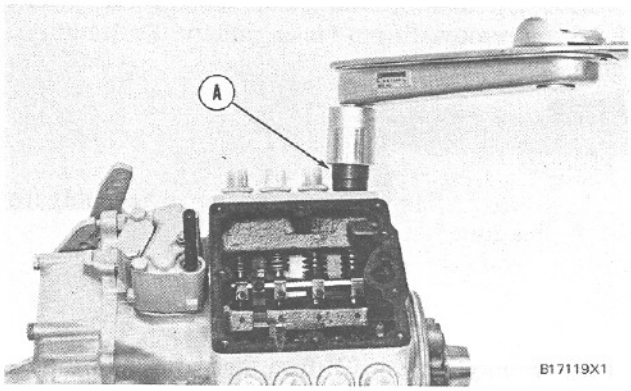
	Tools Needed	A
8S2243	Wrench	1
8S2244	Extractor	1

1. Turn the camshaft until the lifter for the pump to be installed is at its lowest position.



2. Install the fuel injection pump (1) in the bore of the pump housing.

3. The sleeve (2) will be engaged with the lever when the pump is installed correctly.

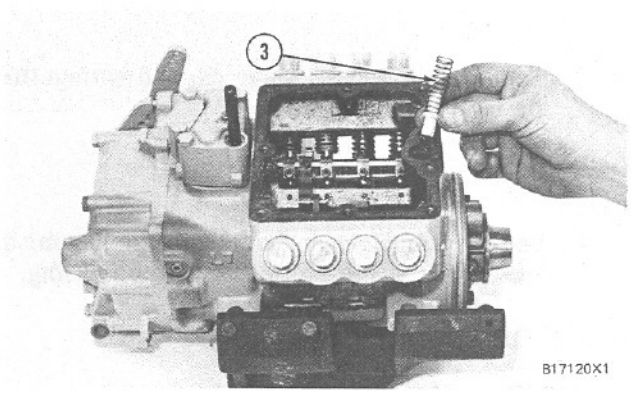


NOTICE

If the levers have been moved on the shaft, fuel pump calibration must be made. (See TESTING AND ADJUSTING).

4. Tighten the bushing with tooling (A) to a torque of 80 ± 7 N•m (60 ± 5 lb.ft.).

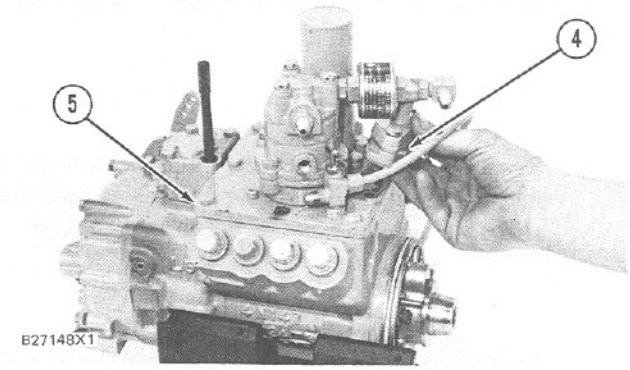
5. Do Steps 1 through 4 for the remainder of the pumps.



6. Install the bypass valve and spring (3) in the pump housing.

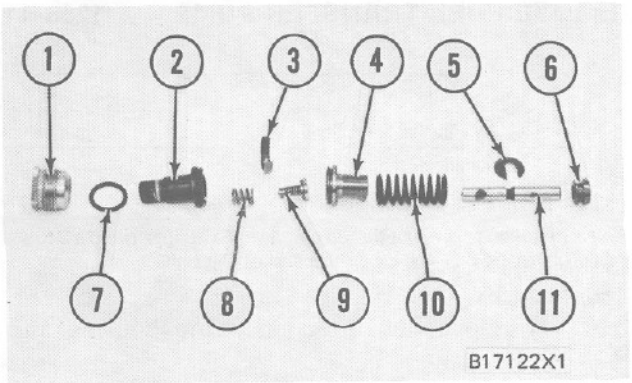
7. Install the cover (5) on the pump housing. Be sure the spring (3) is in the bore in the cover.

8. Install the flange (4) and the flange assembly on the cover.



FUEL INJECTION PUMPS

DISASSEMBLE FUEL INJECTION PUMPS 1251-15



1. Remove bushing (1) and O-ring seal (7) from bonnet (2).

2. Remove ring (3) from the bonnet and barrel (4).

3. Remove check valve assembly (9) and spring (8) from the bonnet.

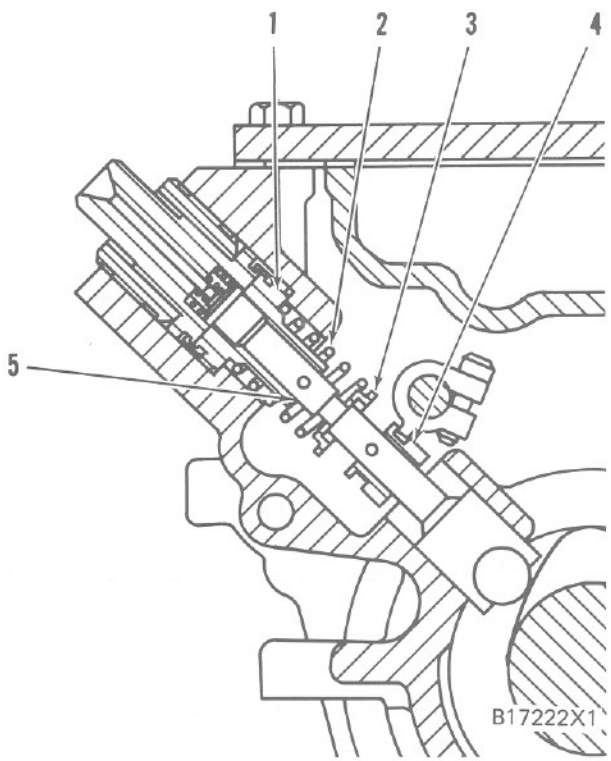
4. Remove spring (10) and retainer washer (5).

NOTICE

Keep the plunger and sleeve with their respective barrel for installation. Do not use plungers, sleeves and barrels with other plungers, sleeves and barrels.

5. Remove plunger (11) and sleeve (6).

ASSEMBLE FUEL INJECTION PUMPS 1251-16



1. Install the sleeve (4), plunger (5), spring (2) and washer (3) on barrel (1).

NOTICE

Be sure the sleeve and plunger are installed in their original barrel and the large hole in the plunger is up. The sleeve must be installed with the thin flange up.

2. Install the check valve assembly and spring in the bonnet. Connect the barrel and bonnet with the ring. Install the seal and bushing on the bonnet. end by:
   a) install fuel injection pumps

FUEL TRANSFER PUMP

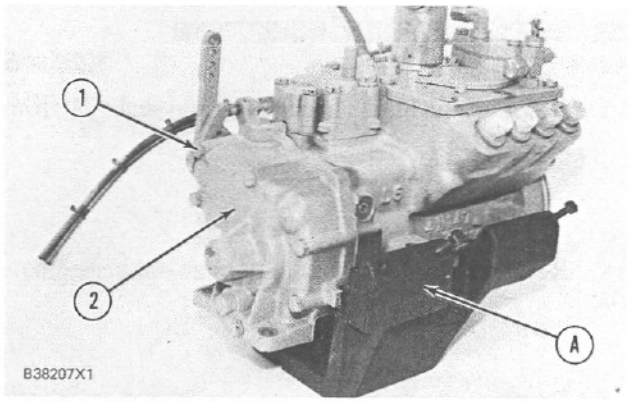
REMOVE FUEL TRANSFER PUMP 1256-11

	Tools Needed	A	B	C
2P8315	Bracket Assembly	1		
3P1544	Timing Pin		1	
*2H3740	Bolt (¾"-16 NF x 1 ¼ in.)			1

*Bolt is modified to prevent thread damage. To do this, grind a 2 to 4 mm (.079 to .157 in.) bevel on the end of the bolt.

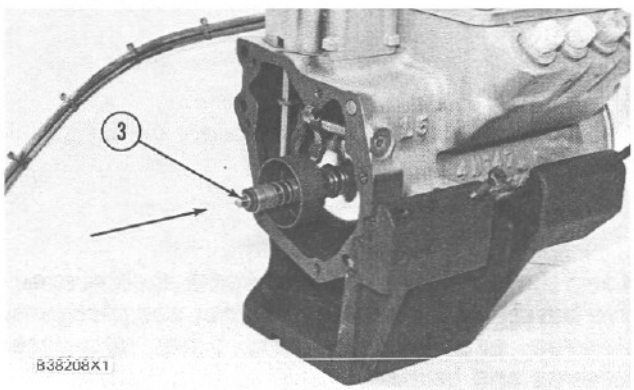
start by:

a) remove fuel injection pump housing and governor

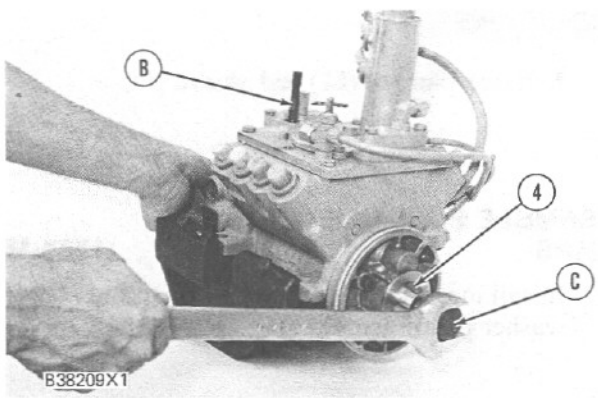


1. Install the fuel injection pump housing on tool (A).

2. Remove seven bolts (1) and governor housing (2).

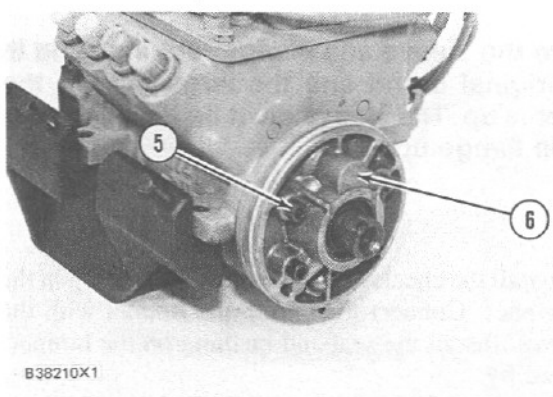


NOTE: Later fuel injection pump housings have a thrust washer for the fuel injection pump camshaft. The thrust washer is behind the flange for the flyweights on the camshaft. To hold the thrust washer in place governor shaft (3) and the camshaft must be held in toward the fuel transfer pump any time sleeve (4) is removed.



3. Remove the plug from the cover and install tool (B) in the hole as shown. Turn the injection pump camshaft until tool (B) can be pushed into the groove (slot) in the camshaft.

NOTE: Any time the drive sleeve is removed from the camshaft a new one must be installed. The camshaft has serrations (splines) that cut grooves into the drive sleeve when it is installed to give a positive drive connection. If a formerly used drive sleeve is installed again it can slip (slide around) on the camshaft.

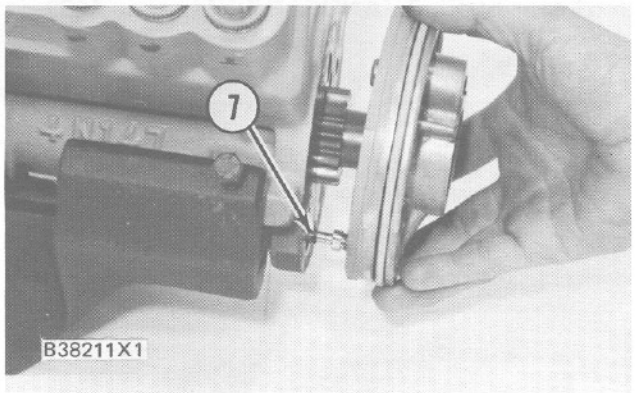


4. Install tool (C) in the threads of sleeve (4). Tighten the bolt until the sleeve can be removed.

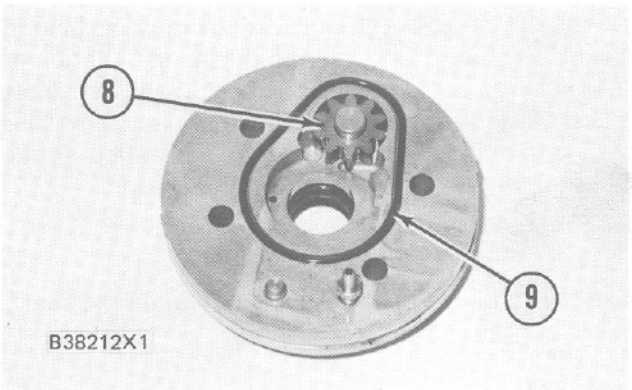
5. Remove four bolts (5) and fuel transfer pump body (6) from the housing.

FUEL TRANSFER PUMP

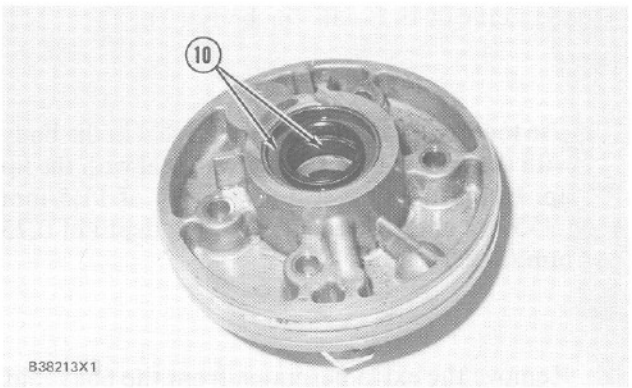
6. Disconnect drain line (7) from the fitting on the back of fuel transfer pump body.



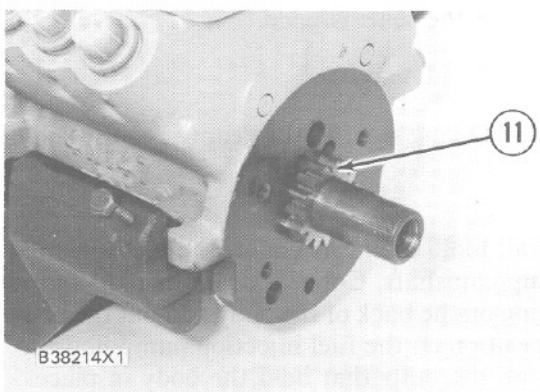
7. Remove gear (8) and O-ring seal (9) from the pump body.



8. Remove seals (10) from the pump body.



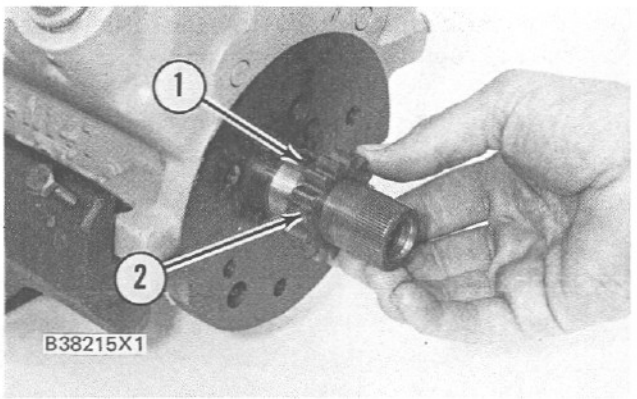
9. Remove drive gear (11) and the key from the camshaft.



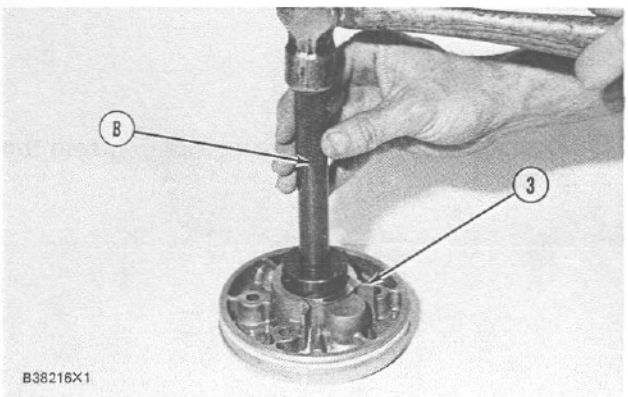
FUEL TRANSFER PUMP

INSTALL FUEL TRANSFER PUMP 1256-12

	Tools Needed	A	B	C	D	E
2P8315	Bracket Assembly	1				
1P510	Driver Group		1			
6V3071	Seal Guide			1		
S1603	Bolt (½"-20 NF x 1 ½ in.)				1	
4B4280	Washer				1	
3P1544	Timing Pin					1



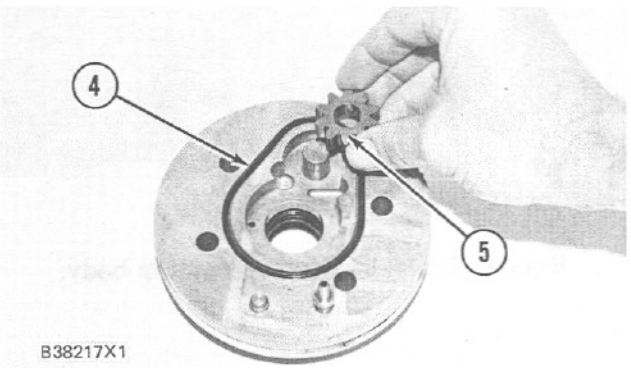
NOTE: The fuel injection camshaft must be held in toward the fuel transfer pump during installation of the fuel transfer pump parts to hold the camshaft thrust washer in its counterbore. The thrust washer will be damaged when the sleeve is installed on the camshaft if it is not in the correct position.



1. Install key (1) and drive gear (2) on the shaft.

2. Put No. 3 Aviation Permatex on the outside diameter of the seals for body (3).

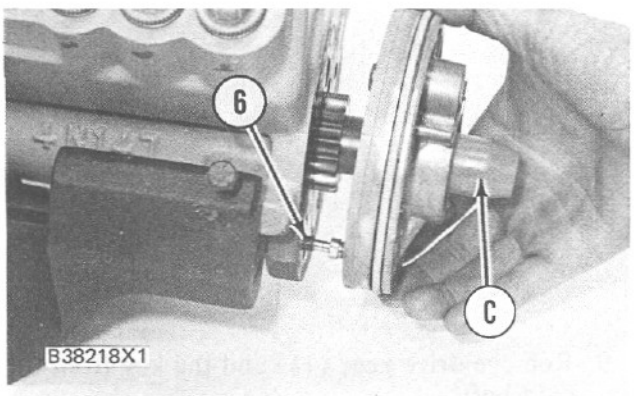
3. Use tooling (B) to install the first seal in the body with the lip down and the second seal with the lip up. Install the first seal to a depth of 11.5 mm (.453 in.) and the second seal to a depth of 0.75 mm (.030 in.).



4. Remove the extra permatex from the body and seals after installation. Be sure the drain hole between the seals is open.

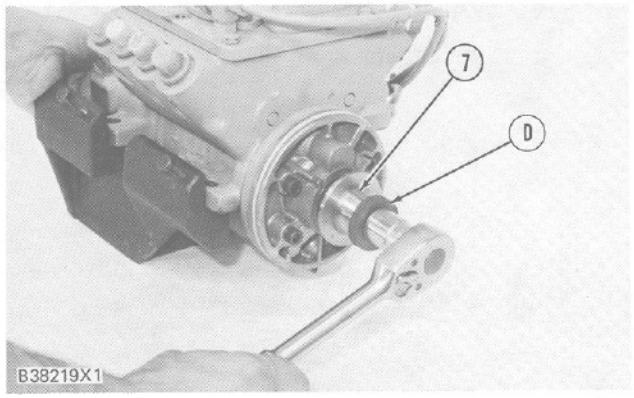
5. Install O-ring seal (4) and gear (5) on the body.

6. Install tool (C) in the end of the fuel injection pump camshaft. Connect drain line (6) to the fitting on the back of the body and put the body in position on the fuel injection pump housing. Install the bolts that hold the body in place.



FUEL TRANSFER PUMP

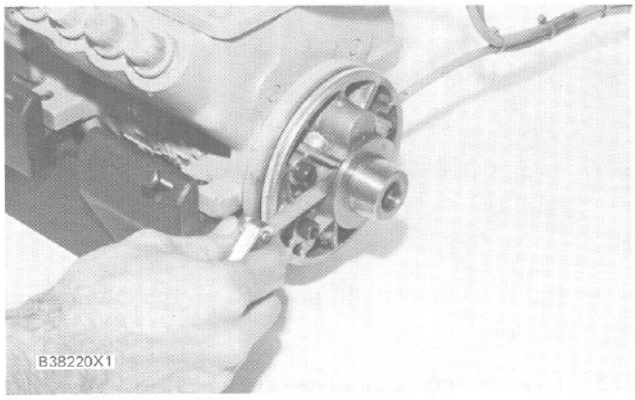
7. Install tool (E) in the camshaft so it will not turn.



8. Put a new sleeve (7) on the camshaft.

NOTE: A new drive sleeve must be installed because a used drive sleeve can slip (slide around) on the camshaft.

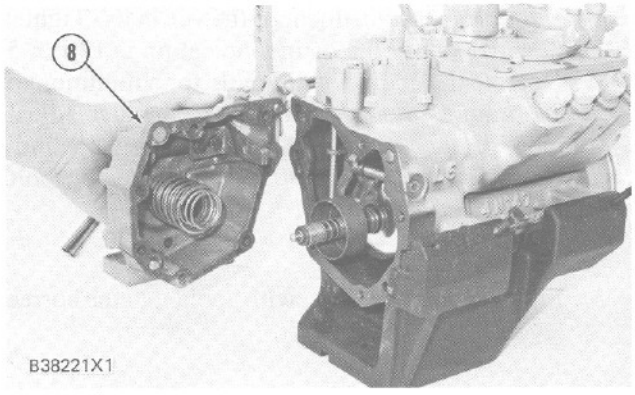
9. Tighten the sleeve into position on the shaft with the 4B4280 Washer of tooling (D) approximately 6.4 mm (.25 in.). Tighten the sleeve the remainder of the way with the 9N5022 Washer until the sleeve is at bottom. This is the washer which is on the tachometer drive shaft.



NOTICE

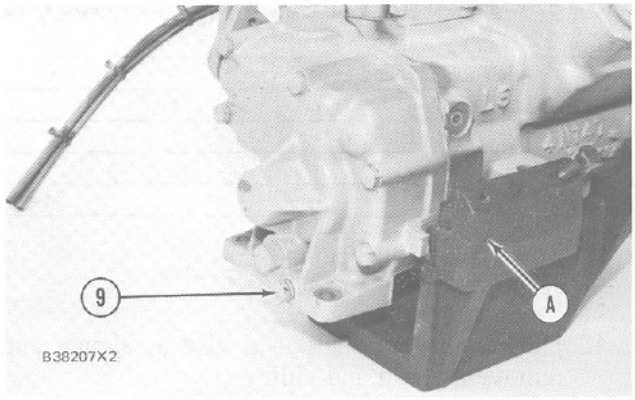
Do not hit the sleeve to install. Damage to the governor will be the result.

10. Use a feeler gauge to check the end play of the camshaft after the sleeve is installed. The end play of the camshaft must be 0.58 ± 0.46 mm (.023 ± .018 in.).



11. Be sure the governor springs and gasket are in position on governor housing (8). Install the governor housing on the fuel injection pump housing.

12. Be sure bolt (9) has the washer and O-ring seal on it when installed.



13. Remove the fuel injection pump housing from tool (A).
end by:
   a) install fuel injection pump housing and governor

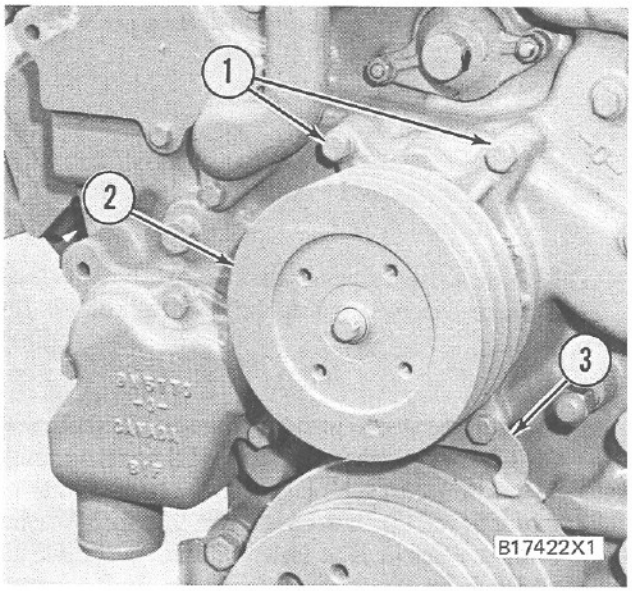
WATER PUMP

REMOVE WATER PUMP 1361-11

1. Drain the coolant from the cooling system.

2. Remove the vee belts from the front of the engine.

3. Remove bolts (1) and pointer (3). Remove water pump (2) from the timing gear cover.



INSTALL WATER PUMP 1361-12

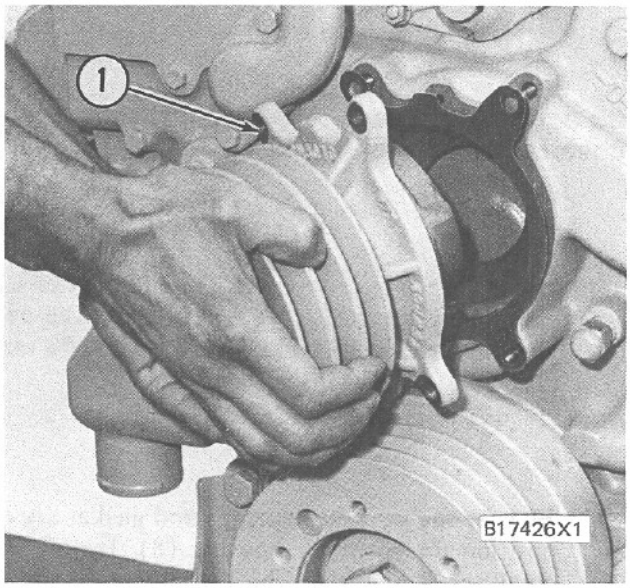
1. Put the gasket and water pump (1) in position in the timing gear cover.

2. Install the pointer and bolts to hold the water pump.

3. Put the vee belts in position on the engine.

4. Use a belt tension gauge such as Borroughs Tool Company Part No. BT-33-72C or an equivalent and make an adjustment of the vee belts. Tighten new belts until the gauge indication is 120 ± 5. Operate the engine at high idle for a minimum of 30 minutes after Step 5. Make another adjustment of the belt tension. The correct gauge indication for used belts is 90 ± 10. Tighten the bolts that hold the alternator.

5. Fill the cooling system with coolant to the correct level.

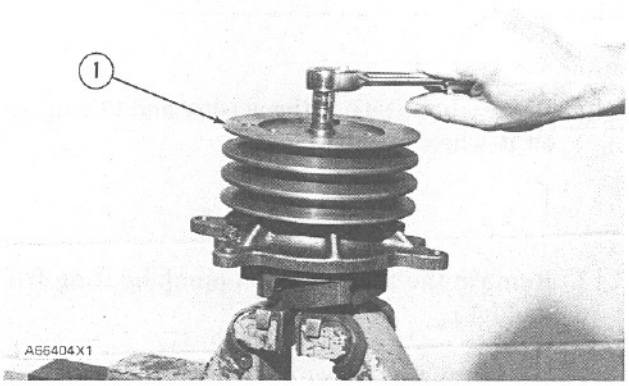


DISASSEMBLE WATER PUMP 1361-15

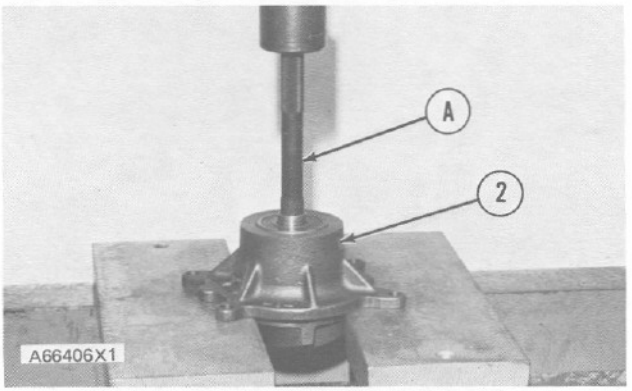
	Tools Needed	A	B	C
1P529	Handle	1		
1P460	Driver Plate	1		
1P1861	Pliers		1	
5P7354	Pin			1

a) remove water pump

1. Hold the pump shaft in a vise as shown and remove the bolt and pulley (1).



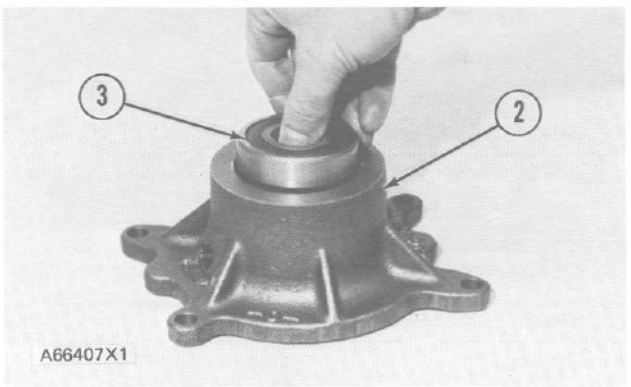
WATER PUMP



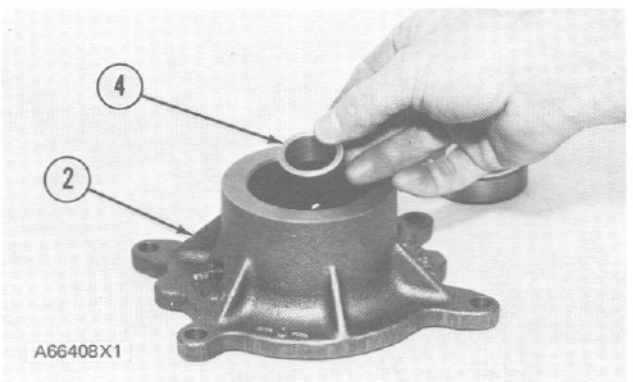
2. Use tooling (A) and a press to remove the shaft, seal and impeller from housing (2) as shown.

⚠ WARNING

The press must have a guard. The guard has been removed for photo illustration.



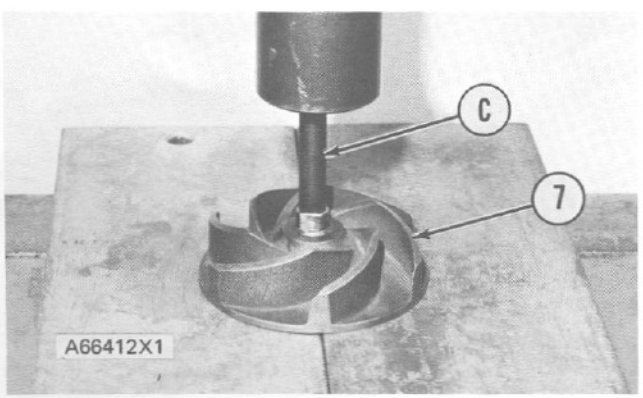
3. Remove bearing (3) from housing (2).

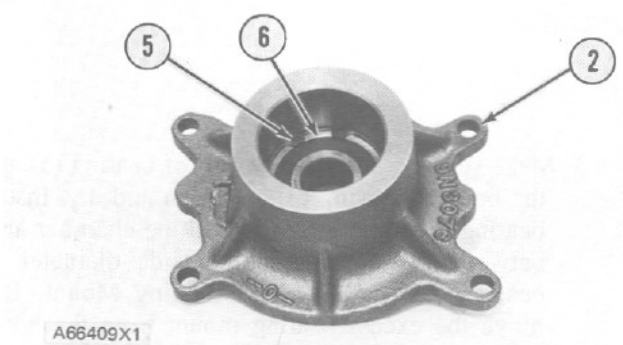


4. Remove spacer (4) from housing (2).

5. Use tool (B) to remove ring (5) from housing (2). Remove bearing (6) from housing (2).

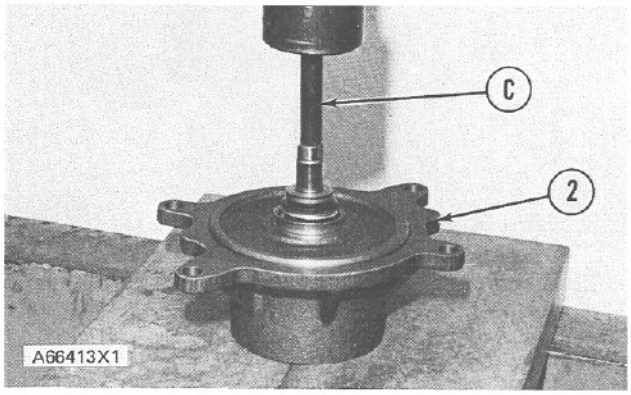
6. Use a press and tool (C) to remove the shaft and seal assembly from impeller (7) as shown.





WATER PUMP

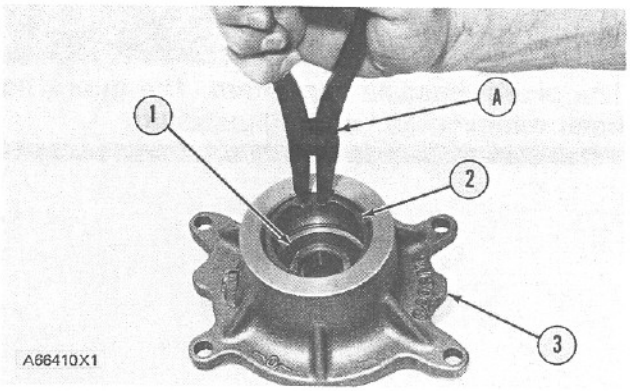
7. Install the seal assembly and shaft in housing (2) as shown. Use a press and tool (C) to remove the shaft from the seal assembly.



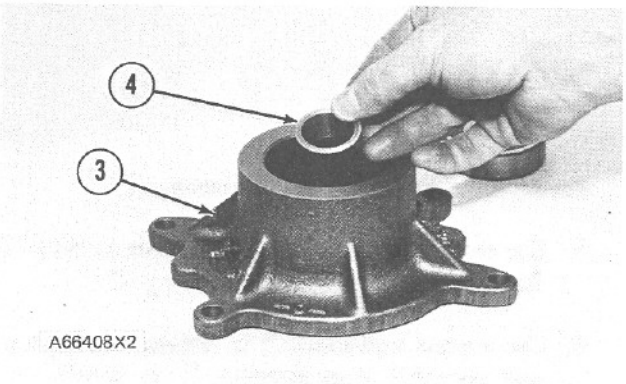
ASSEMBLE WATER PUMP 1361-16

	Tools Needed	A	B	C	D	E
1P1861	Pliers	1				
5P9722	Driver		1			
5P7353	Spacer			1		
5P7352	Spacer				1	
1P529	Handle					1
1P460	Driver Plate					1

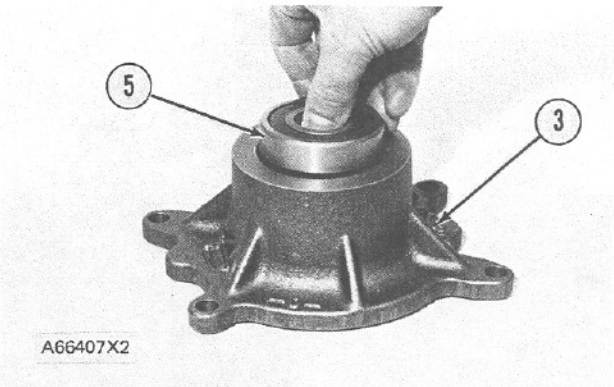
1 Install bearing (1) in housing (3). Use tool (A) to install ring (2) that holds bearing (1) in position.



2 Install spacer (4) in housing (3).



3 Make sure the outside diameter of bearing (5) and the bore in housing (3) are clean and dry. Install bearing (5) in housing (3). Fill the chamber area between the housing and outside diameter of bearing (5) with 7M7456 Bearing Mount. Remove the excess bearing mount from the housing.

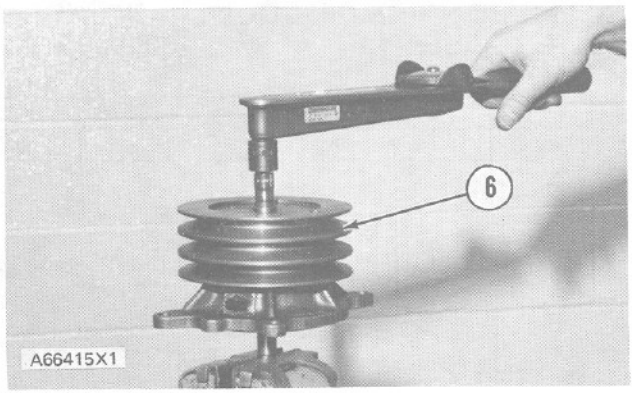


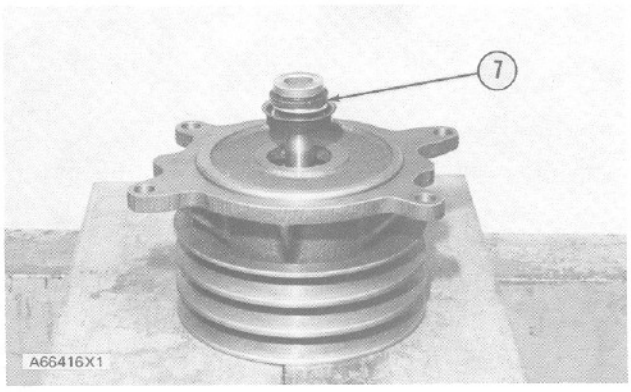
WATER PUMP

4. Turn the pump housing over and make sure that the bores in the bearings and spacer are in alignment. Install the shaft through the bearings from the impeller side of the housing.

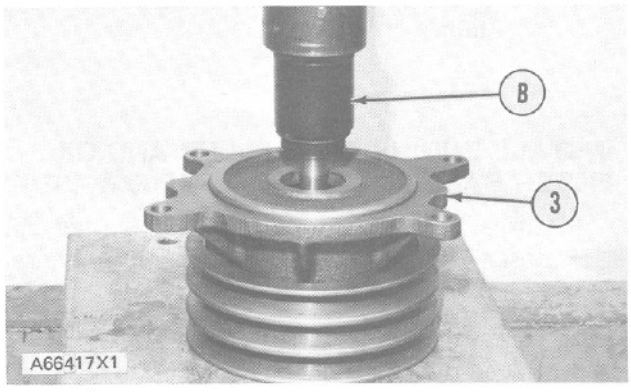
NOTE: The shaft to bearing clearance can be 0.018 mm (.0007 in.) loose to 0.008 mm (.0003 in.) tight. If it is necessary to use a press to install the shaft, make sure the inner races of the bearings have support.

5. Install pulley (6) on the shaft and tighten the bolt to a torque of 75 ± 7 N•m (55 ± 5 lb.ft.).





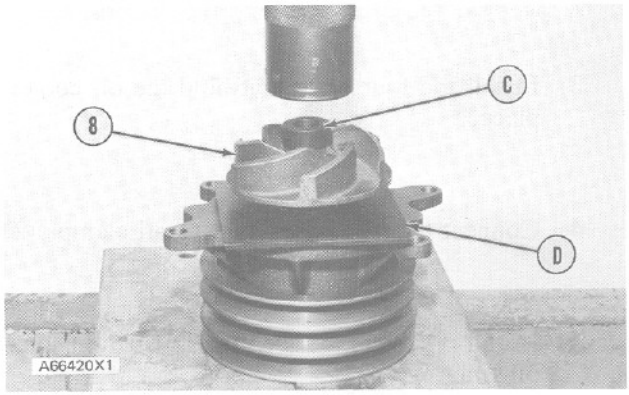
6. Put a new seal assembly (7) on the shaft as shown.



7. Use tool (B) and a press to install the seal assembly in housing (3). Do not use a hammer to install the seal.

8. Put tool (D) between impeller (8) and the pump housing.

9. Use a press and tool (C) to install impeller (8) on the shaft until tool (D) can just be moved between the housing and impeller.



10. If the impeller is installed too far and tool (D) cannot be removed, turn the pump over and remove the pulley. Use tooling (E) and press to push the shaft out of the bearings enough to remove tool (D). Install the pulley and tighten the bolt to a torque of 75 ± 7 N•m (55 ± 5 lb.ft.).

end by:
a) install water pump

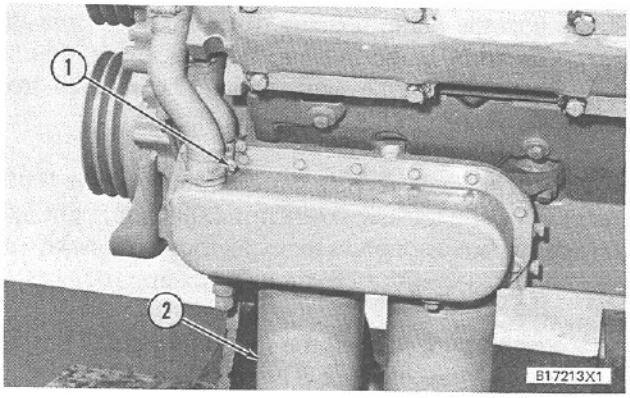
ENGINE OIL COOLER AND OIL FILTER BASE

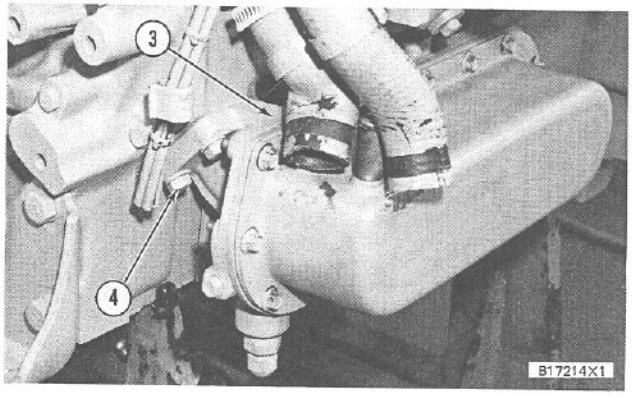
REMOVE ENGINE OIL COOLER AND OIL FILTER BASE 1306 & 1378-11

	Tools Needed	A
2P8250	Strap Wrench	1

NOTE: It is not necessary to remove the oil pan.

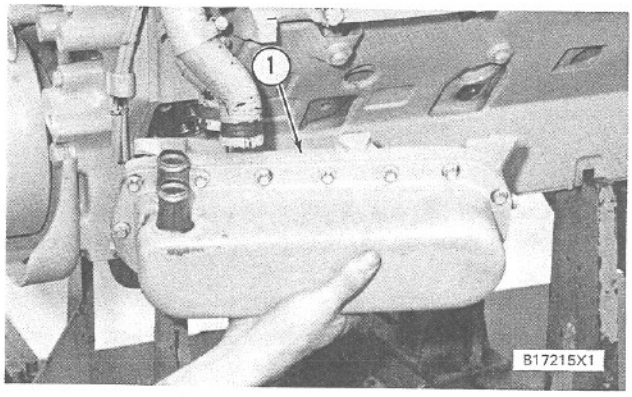
1. Remove the coolant from the cooling system.
2. Use tooling (A) and remove oil filter (2).
3. Loosen clamps (1) and disconnect the bases.
4. Remove bolt (4) and three bolts from behind the oil cooler.
5. Remove oil filter base and engine oil cooler (3) as a unit.

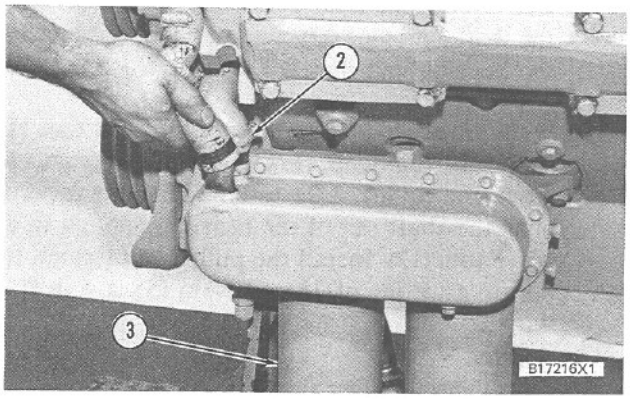




INSTALL ENGINE OIL COOLER AND OIL FILTER BASE 1306 & 1378-12

1. Inspect the O-ring seals in the oil filter base. Install new seals if needed. Put oil on the seal.
2. Put oil filter base and oil cooler (1) in position on the engine.
3. Install the four bolts that hold the oil cooler in place.
4. Connect the two hoses and install clamps (2).
5. Install oil filters (3). See the instructions on the oil filter.

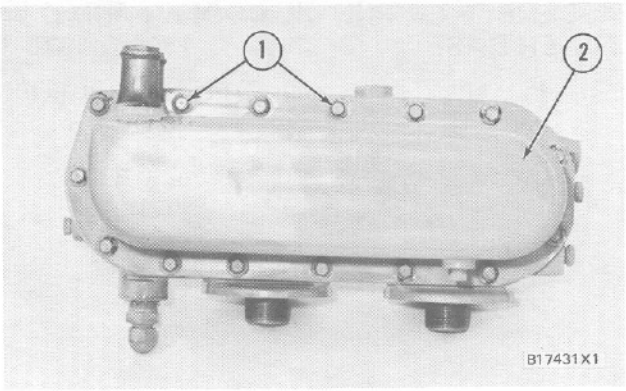




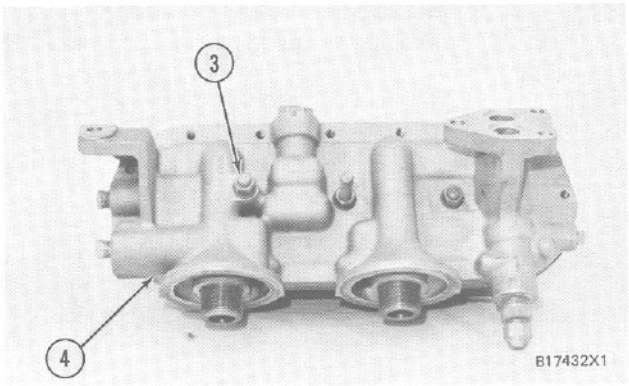
ENGINE OIL COOLER AND OIL FILTER BASE

DISASSEMBLE ENGINE OIL COOLER AND OIL FILTER BASE 1306 & 1378-15

start by:
a) remove engine oil cooler and oil filter base

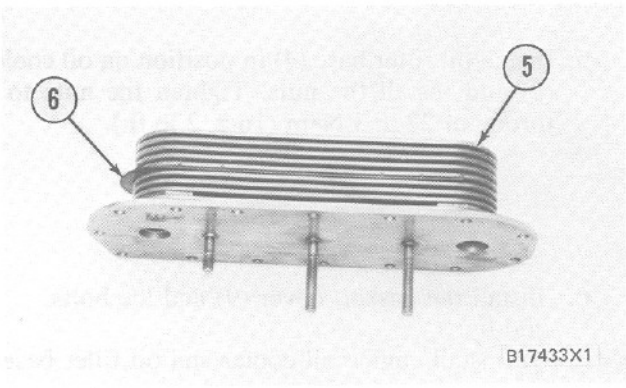


1. Remove bolts (1) and make a separation of cover (2) from the oil filter base.



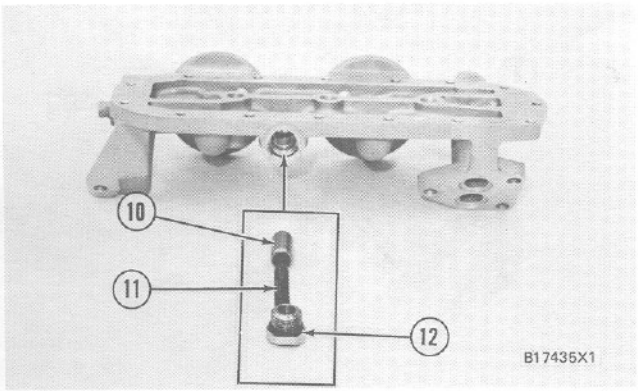
2. Remove nuts (3) and make a separation of the oil cooler from oil filter base (4).

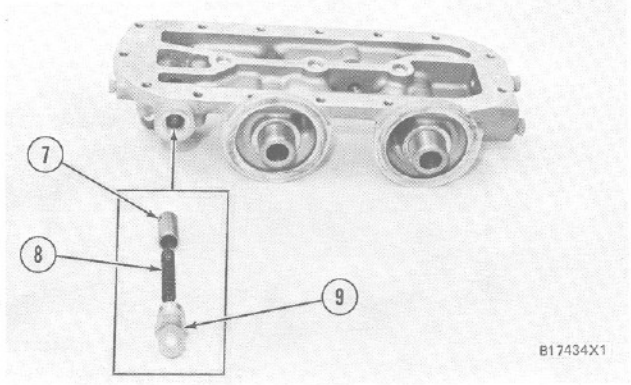
3. Remove divider (6) from oil cooler (5).



4. Remove plug (9), spring (8) and bypass valve (7).

5. Remove plug (12), spring (11) and bypass valve (10) from the oil filter base.

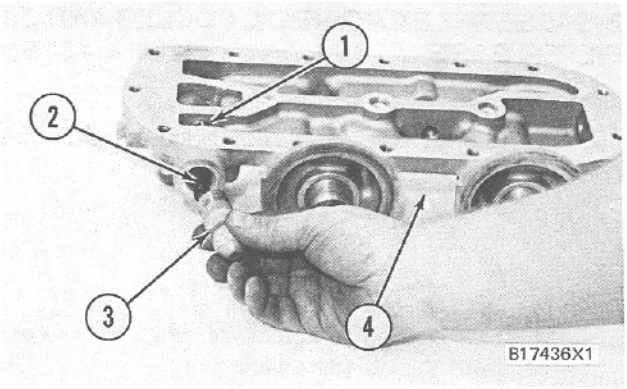




ENGINE OIL COOLER AND OIL FILTER BASE

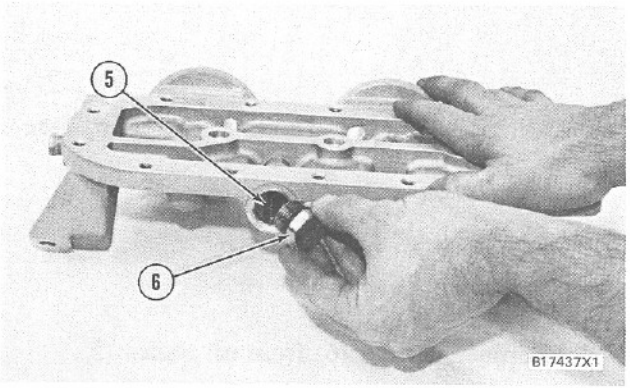
ASSEMBLE ENGINE OIL COOLER AND OIL FILTER BASE 1306 & 1378-16

1. Put valve (1) and spring (2) in position in oil filter base (4).



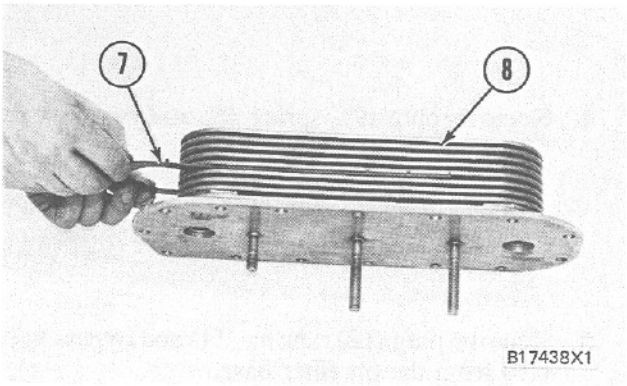
2. Install plug (3).

3. Put the valve and spring (5) in position and install plug (6).

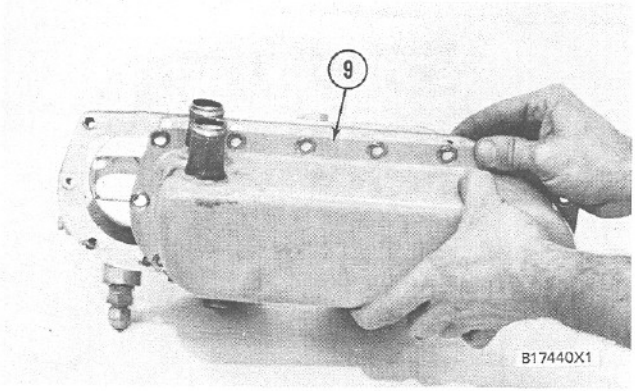


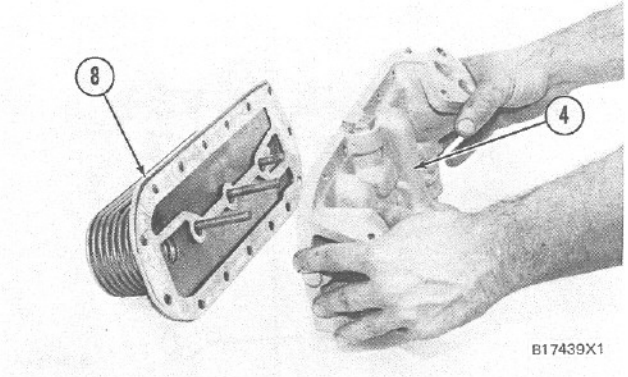
4. Put divider (7) in position between the fifth and sixth plates from the flange and on the same end as the short stud.

5. Install oil filter base (4) in position on oil cooler (8) and install the nuts. Tighten the nuts to a torque of 22 ± 3 N•m (16 ± 2 lb.ft.).



6. Install the gasket, cover (9) and the bolts. end by:
   a) install engine oil cooler and oil filter base

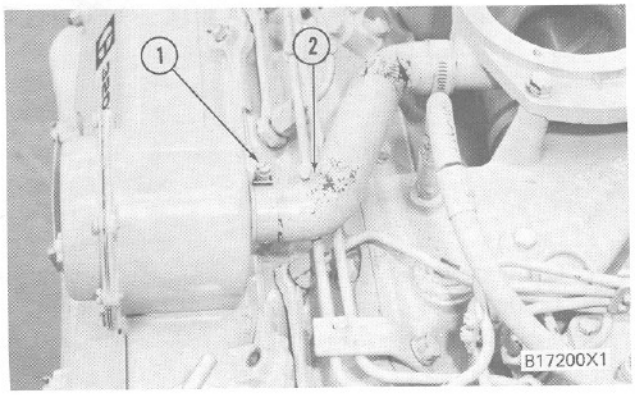




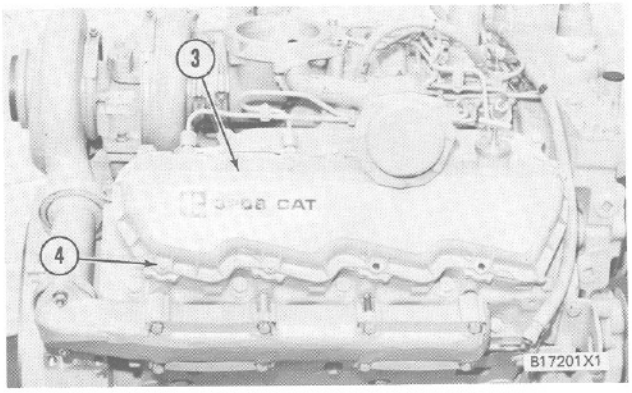
VALVE COVERS

REMOVE VALVE COVERS 1107-11

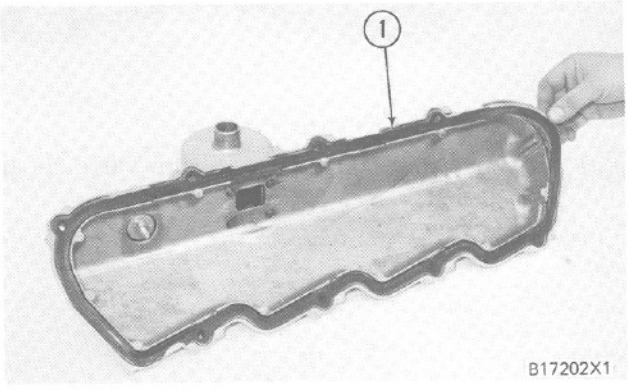
start by:
a) remove water separator



1. Loosen clamp (1). Slide hose (2) away from the crankcase ventilation valve.



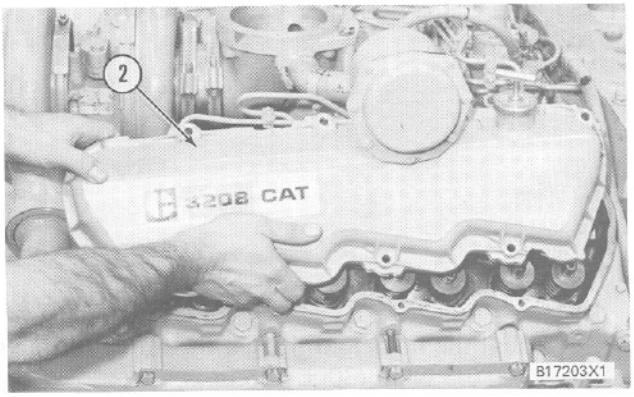
2. Remove bolts (4) and valve cover (3).



3. Remove the gasket from the valve cover.

4. Do Steps 1 through 3 for the other valve cover.

INSTALL VALVE COVERS 1107-12

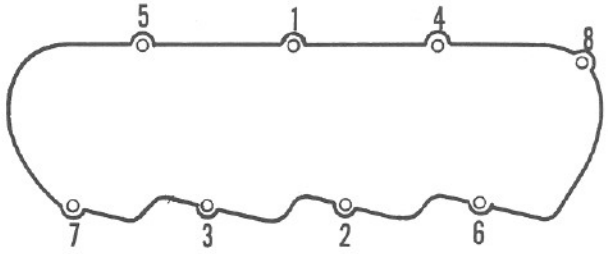


1. Put gasket (1) in position in the valve cover.

2. Put valve cover (2) in position. Install the bolts.

VALVE COVERS, CRANKCASE VENTILATOR VALVE

3. Tighten the bolts to a torque of 14 ± 3 N•m (120 ± 24 lb.in.) in the sequences shown.



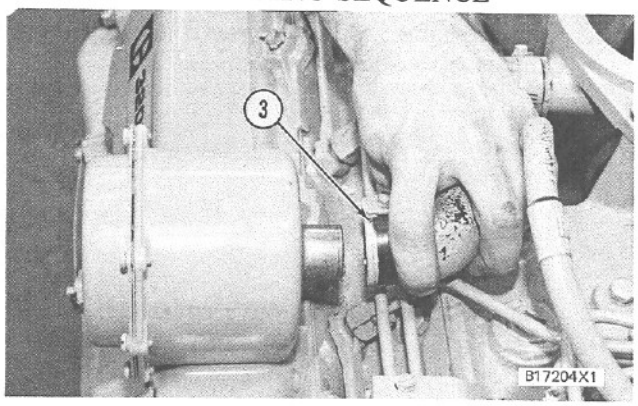
A50698X1

TIGHTENING SEQUENCE

4. Connect hose (3) to the crankcase ventilator valve. Put the hose clamp in position. Tighten the hose clamp to a torque of 2.3 ± 0.2 N•m (20 ± 2 lb.in.).

end by:

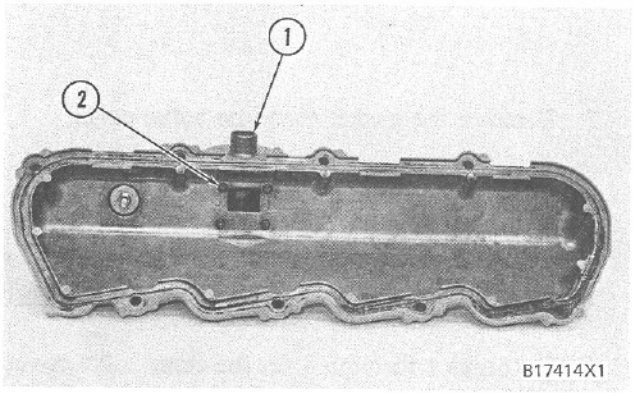
a) install water separator



REMOVE CRANKCASE VENTILATOR VALVE 1074-11

start by:

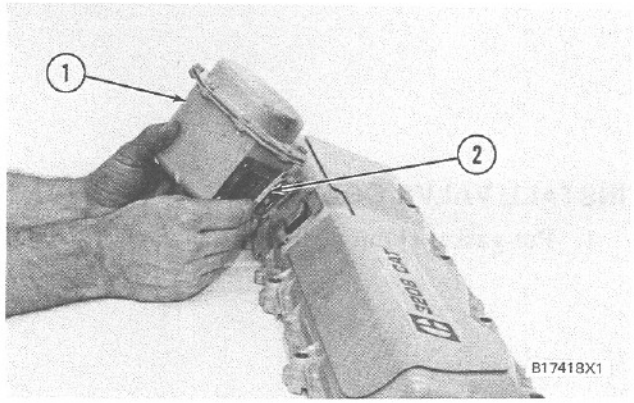
a) remove valve covers



1. Remove four bolts (2), ventilator valve (1) and the gasket.

INSTALL CRANKCASE VENTILATOR VALVE 1074-12

1. Put gasket (2) and ventilator valve (1) in position.

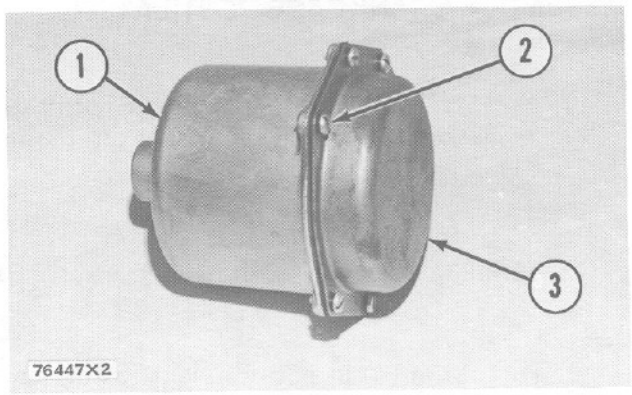


2. Install the bolts and tighten them to a torque of 3.4 ± 0.5 N•m (30 ± 4 lb.in.).

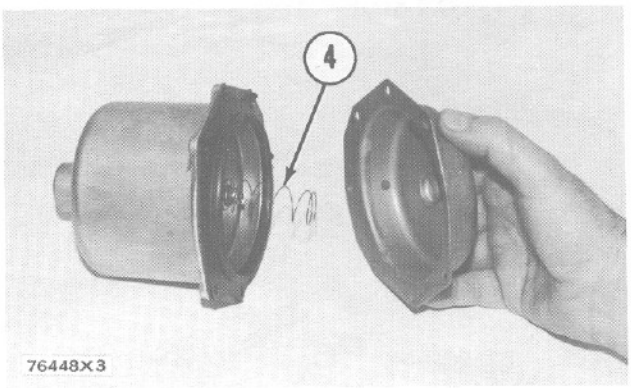
CRANKCASE VENTILATOR VALVE

DISASSEMBLE CRANKCASE VENTILATOR VALVE 1074-15

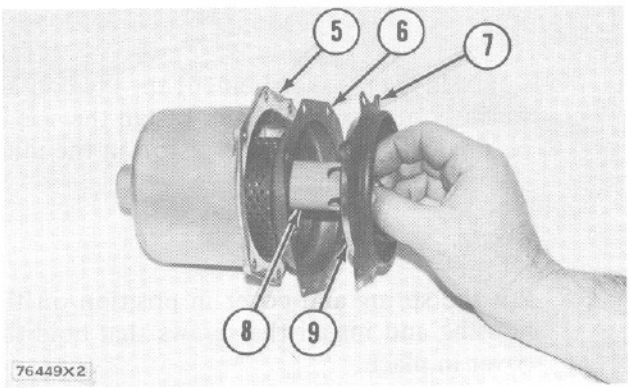
NOTE: The crankcase ventilator valve can be disassembled while installed on the engine. The valve was removed for better photo illustration.



1. Remove screws (2) that hold cover (3) on housing (1).

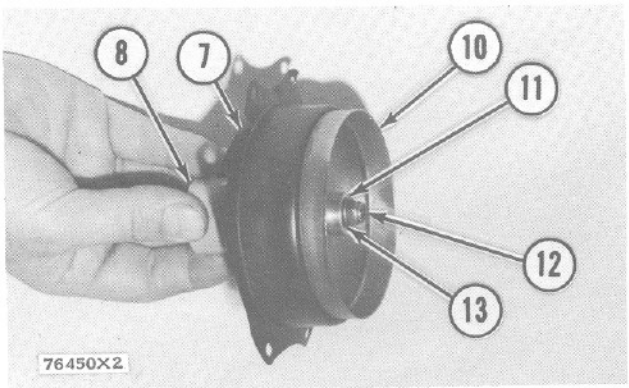


2. Remove cover (3) and spring (4) from the housing.



3. Remove the piston, sleeve (8), retainer (9), and diaphragm (7) from the housing as a unit.

4. Remove inner sleeve (6) and gasket (5) from the housing.



5. Remove nut (12), washer (13), spacer (11), piston (10), diaphragm (7), and the retainer from sleeve (8).

CRANKCASE VENTILATOR VALVE

ASSEMBLE CRANKCASE VENTILATOR VALVE 1074-16

1. Put 5H2471 Gasket Cement on both sides of gasket (2). Install the gasket on housing (1).

2. Install inner sleeve (3) in the housing.

3. Put piston (6) in position next to the side of diaphragm (4) that has identification "PISTON SIDE".

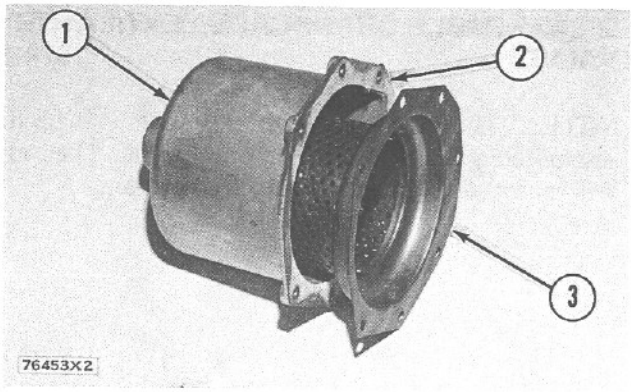
4. Put retainer (5) in the diaphragm.

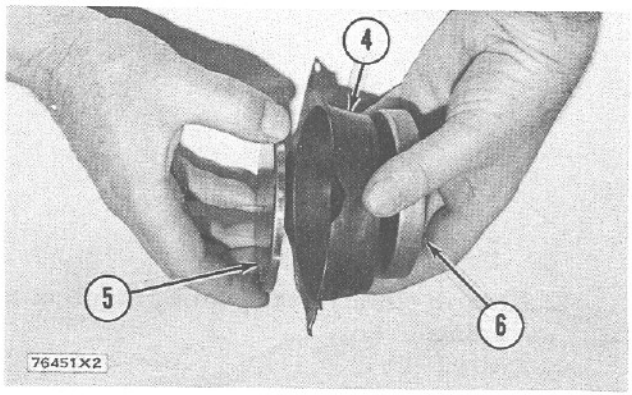
5. Put the screw through sleeve (7), retainer, diaphragm, and the piston.

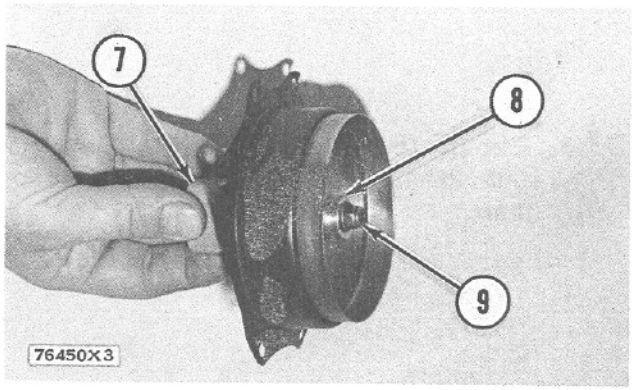
6. Install spacer (8), washer, and nut (9) on the screw.

7. Put 5H2471 Gasket Cement on the contact surfaces of the diaphragm. Install the sleeve, retainer, diaphragm, and piston in the inner sleeve and housing.

8. Put the spring and cover in position on the housing and install the screws that hold the cover in place.







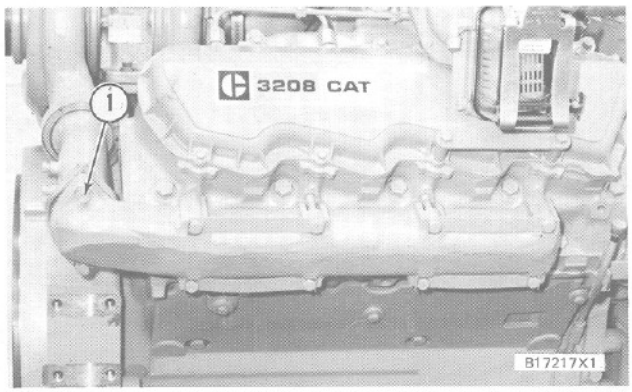
EXHAUST MANIFOLD

REMOVE EXHAUST MANIFOLD 1059-11

1. Remove two bolts (1) from the flanges.

2. Bend the tabs back on locks (2).

3. Remove the bolts, exhaust manifold (3) and the gasket.



INSTALL EXHAUST MANIFOLD 1059-12

1. Put the gasket and exhaust manifold (1) in position.

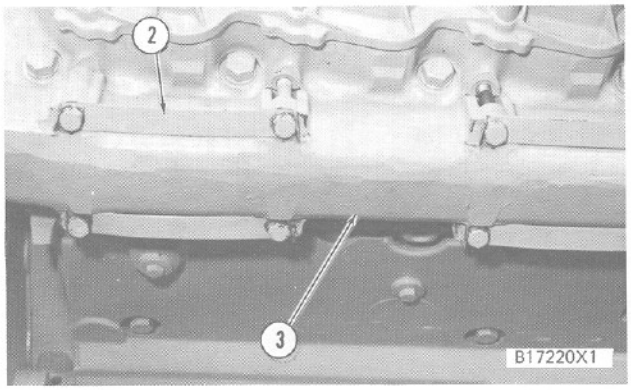
NOTE: Put 5P3931 Anti-Seize Compound on the bolt threads.

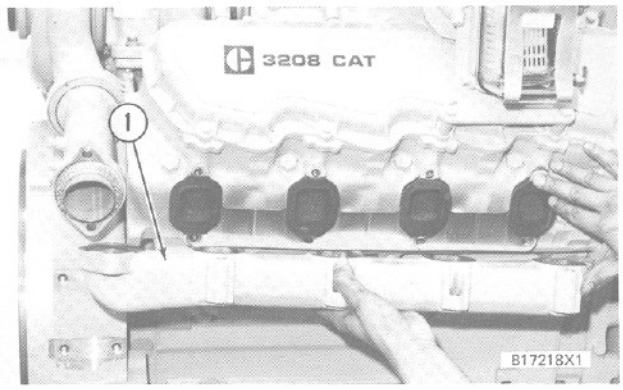
2. Install locks (2) and bolts (3).

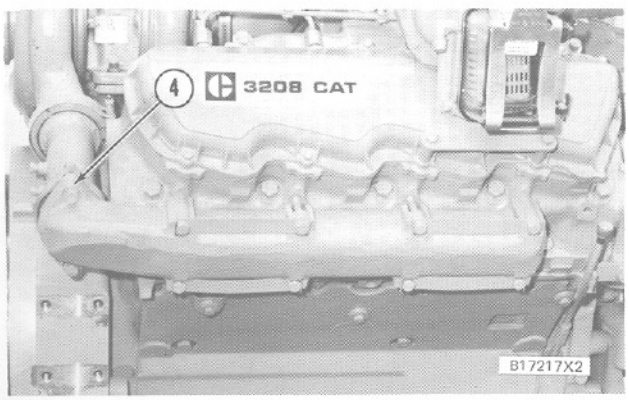
3. Tighten the bolts to a torque of 43 ± 7 N•m (32 ± 5 lb.ft.).

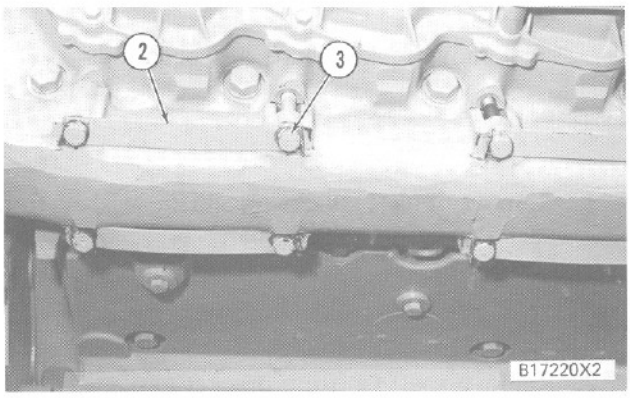
NOTE: The locks must be bent on a flat side of the bolt head. Bolts must be turned no more than 30° of a turn (in the direction of increased torque only) for the alignment of the locks with a flat side of the bolt head.

4. Put bolts (4) and the flange in position. Install the nuts.







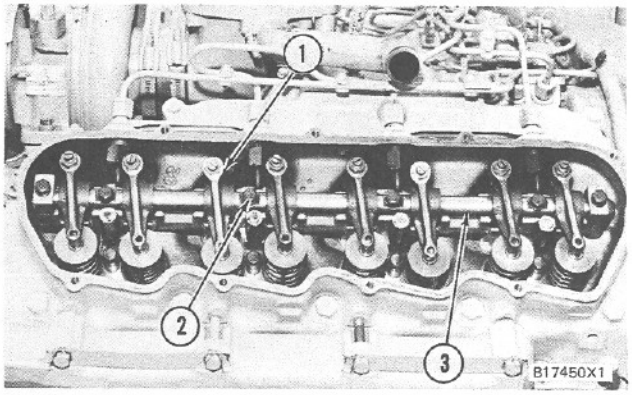


ROCKER SHAFTS AND PUSH RODS, ROCKER SHAFTS

REMOVE ROCKER SHAFTS AND PUSH RODS 1102 & 1208-11

start by:
a) remove the valve covers

1. Remove bolts (2) from rocker shaft (3) and remove rocker shaft. Remove push rods (1).

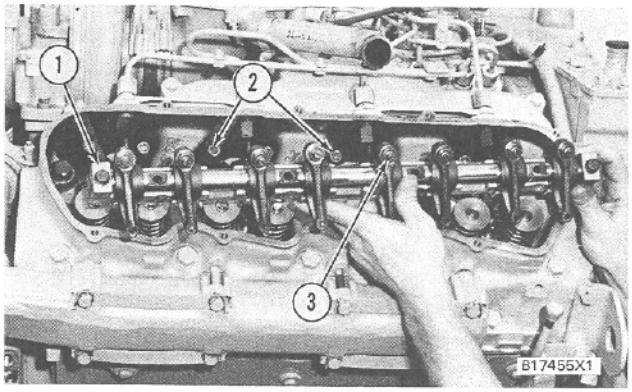


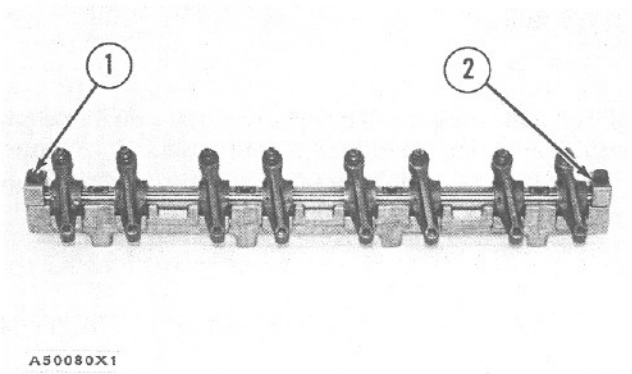
INSTALL ROCKER SHAFTS AND PUSH RODS 1102 & 1208-12

1. Install push rods (2). Put rocker shaft (1) in position on the engine. Tighten the bolts to a torque of 24 ± 7 N•m (18 ± 5 lb.ft.).

2. Make adjustment until the intake valve clearance is 0.38 mm (.015 in.) and the exhaust valve clearance is 0.64 mm (.025 in.). Tighten nuts (3) to a torque of 30 ± 7 N•m (24 ± 5 lb.ft.).

end by:
a) install valve covers



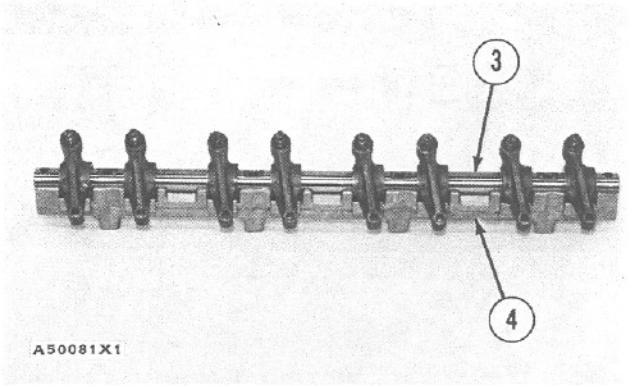


DISASSEMBLE ROCKER SHAFTS 1102-15

start by:
a) remove rocker shafts and push rods

1. Remove bolts (1), locks (2) and the washers from each end of the rocker shaft.

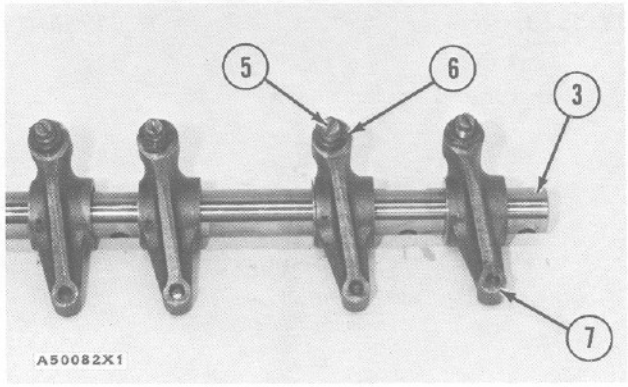
2. Remove shaft (3) from bracket (4).



ROCKER SHAFTS

3. Remove rocker arm assemblies (7) and the washers from shaft (3).

4. Remove screw (5) and nut (6) from rocker arm assemblies (7).

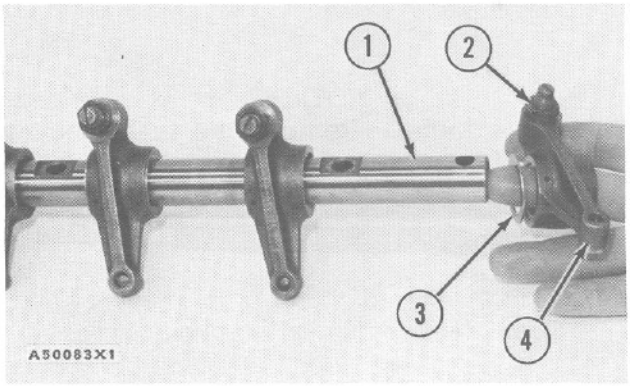


ASSEMBLE ROCKER SHAFTS 1102-16

1. Make sure the oil holes in the rocker arm assemblies, rocker shaft and bracket are clean and free of all dirt and foreign material.

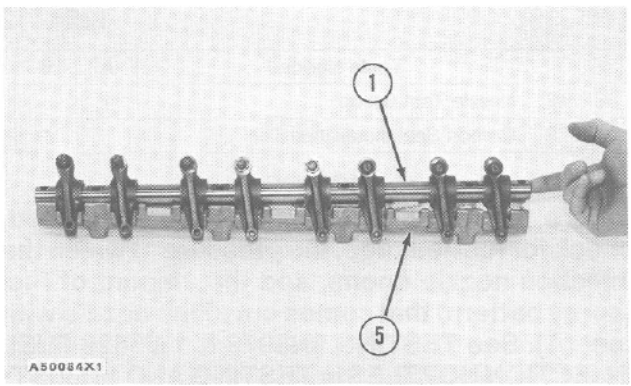
2. Measure the bore of the bushing in each of the rocker arms. The bore must be 21.852 ± 0.020 mm (.8603 ± .0008 in.). The maximum permissible bore is 21.920 mm (.8630 in.).

NOTE: Make a replacement of the arm and bushing as a unit if the bore is not correct. The arms and bushings can not be ordered separately.



3. Measure the diameter of the shaft at each of the rocker arm locations. The diameter must be 21.793 to 21.814 mm (.8580 to .8588 in.). The minimum permissible diameter is 21.768 mm (.8570 in.).

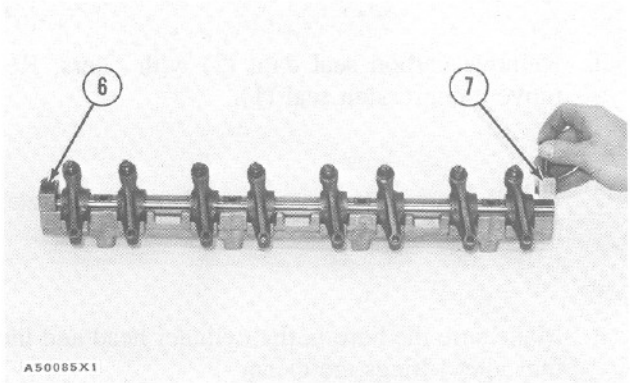
4. Install the screws and nuts (2) into rocker arm assemblies (4). Turn the screws until they are 11.2 mm (.44 in.) below the bottom of the rocker arm assemblies.



5. Install the rocker arm assemblies and washers (3) on shaft (1) as shown.

6. Put shaft (1) and the rocker arm assemblies in position on bracket (5) with the adjustment screws on the same side as the oil hole on the bottom of the bracket.

7. Make sure the flat surfaces on shaft (1) are turned up. Install locks (7), the washers and bolts (6). Tighten the bolts to a torque of 24 ± 7 N•m (18 ± 5 lb.ft.).



end by:
a) install rocker shafts and push rods

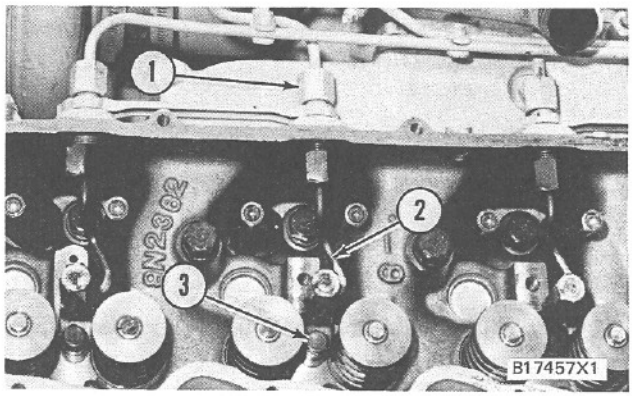
FUEL INJECTION NOZZLES

REMOVE FUEL INJECTION NOZZLES (9N3979 & 1W5829) 1254–11

start by:
a) remove rocker shafts

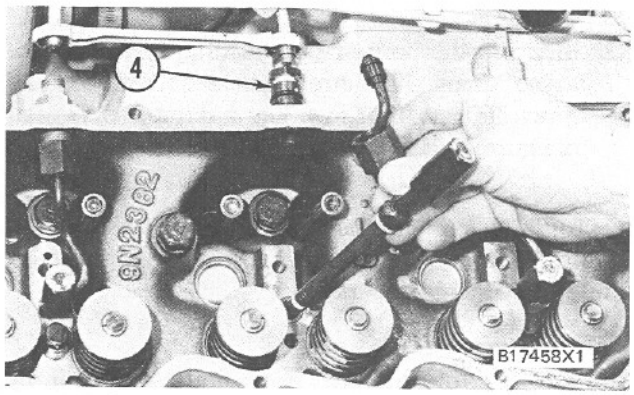
1. Thoroughly clean the area around each fuel line connection. Disconnect fuel injection line (1) from the adapter. Disconnect fuel injection nozzle (2) from the adapter.

2. Remove clamp (3) and the spacer that holds the fuel injection nozzle in place.



NOTICE
Never use force to remove the fuel injection nozzles. If necessary, turn and pull the fuel injection nozzle out of the cylinder head.

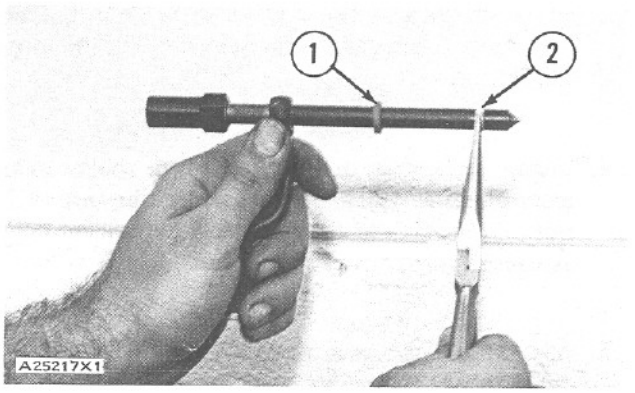
3. Remove the adapter (4) from the cylinder head. Remove the fuel injection nozzle.



INSTALL FUEL INJECTION NOZZLES (9N3979 & 1W5839) 1254–12

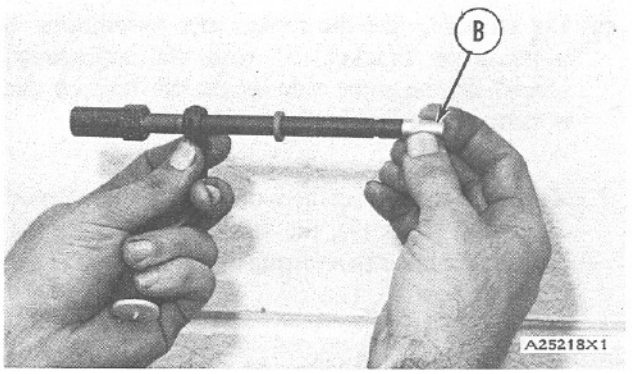
Tools Needed		A	B
8S2242	Nozzle Test Group	1	
6V4979	Carbon Seal Installation Tool		1

NOTICE
Before the fuel injection nozzles are installed, check for fuel leakage, the pressure at which the injection nozzle opens, and the amount of fuel (spray pattern) that comes out of the nozzle with tool (A). See TESTING 9N3979 & 1W5829 FUEL INJECTION NOZZLES in TESTING AND ADJUSTING.



1. Remove carbon seal dam (2) with pliers. Remove compression seal (1).

2. Install a new compression seal on the nozzle. Install a new carbon seal dam with tool (B).



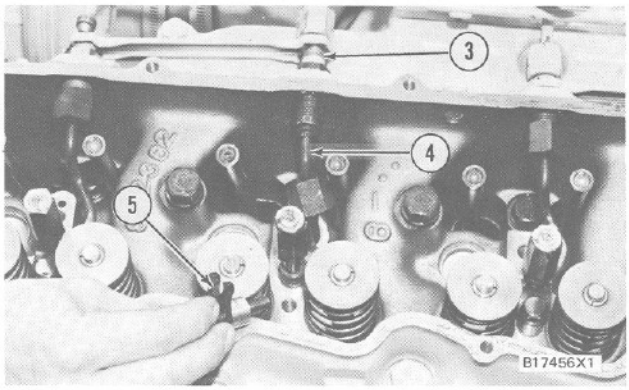
3. Make sure the bore in the cylinder head and the fuel inlet fittings are clean.

FUEL INJECTION NOZZLES

4. Install new O-ring seals on adapter (3) and fuel injection nozzle (4).
5. Install the fuel injection nozzle in the head. Turn and push the nozzle into its correct position. Never put lubricant on the nozzle or bore in the cylinder head.
6. Install the adapter in the head. Connect the nozzle and fuel injection line to the adapter. Tighten the nuts to a torque of 40 ± 7 N•m (30 ± 5 lb.ft.).
7. Install the spacer and clamp (5) that hold the nozzle to the cylinder head.

end by:

a) install rocker shafts



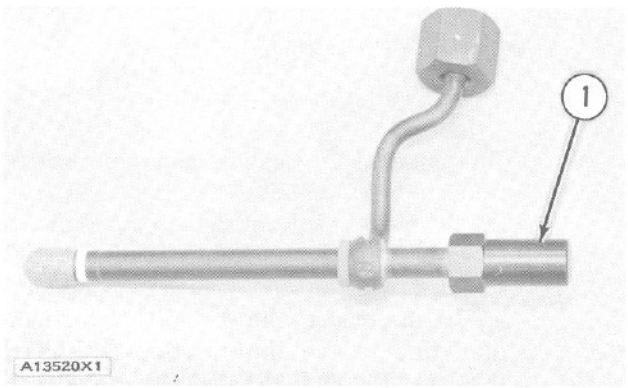
DISASSEMBLE FUEL INJECTION NOZZLES (9N3979 & 1W5829) 1254-15

	Tools Needed	A	B	C	D
8S2242	Nozzle Test Group	1			
8S2250	Nozzle Holding Tool		1		
5P958	Valve Retractor			1	
5P4813	Socket				1

start by:

a) remove fuel injection nozzles

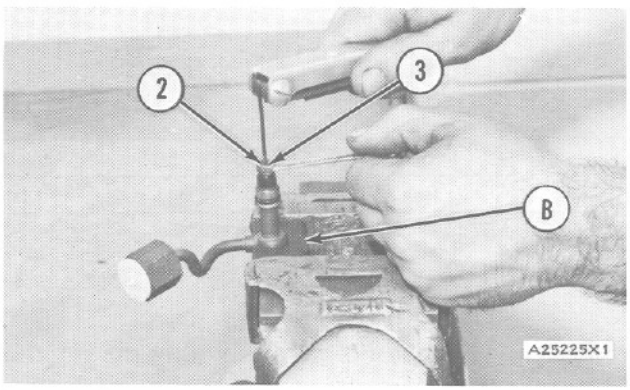
NOTE: Do not disassemble any nozzle until test has shown it is needed. Check each nozzle with tool (A) for leakage, the pressure, at which the nozzle opens, and the shape and amount of fuel (spray pattern) that comes out of the nozzle. Do not clean or make an adjustment to any nozzle that has a large (excessive) amount of return leakage. Excessive return leakage can be an indication of nozzle failures that cannot be corrected with an adjustment or cleaning and can cause engine damage. See TESTING 9N3979 & 1W5829 FUEL INJECTION NOZZLES in TESTING AND ADJUSTING.



NOTICE

Keep the work area and all tools extra clean. Be careful not to cause damage to the parts while the nozzles are disassembled and assembled.

1. Remove cap (1) from the fuel injection nozzle.
2. Put the nozzle in tool (B). Put tool (B) and the nozzle in a vise. Do not put any part of a nozzle directly in a vise. Loosen locknut (2) while the lift adjustment screw is held. Turn the lift adjustment screw (3) counterclockwise one turn. Hold the lift adjustment screw (3) with a 5/64'' hex wrench and remove the locknut (2).



NOTICE

If the lift adjustment screw is not turned counterclockwise one turn, the valve can be bent or the seat for the valve can be damaged when the pressure adjustment screw is turned.

FUEL INJECTION NOZZLES

3. Loosen the locknut (4) that holds the pressure adjustment screw. Use tool (D) to hold the pressure adjustment screw.

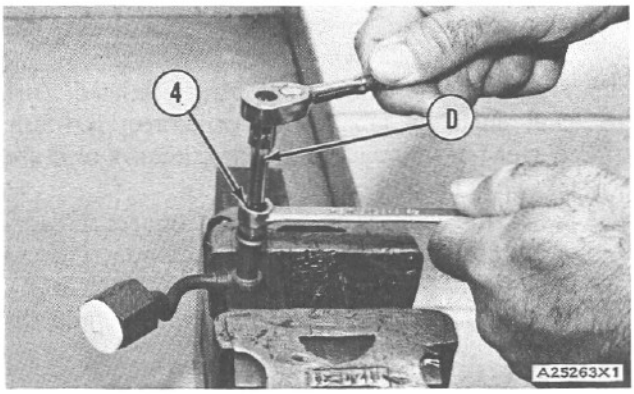
4. While the nozzle is held in one hand, tilt the nozzle and remove the pressure adjusting screw and locknut, spring, seat and valve.

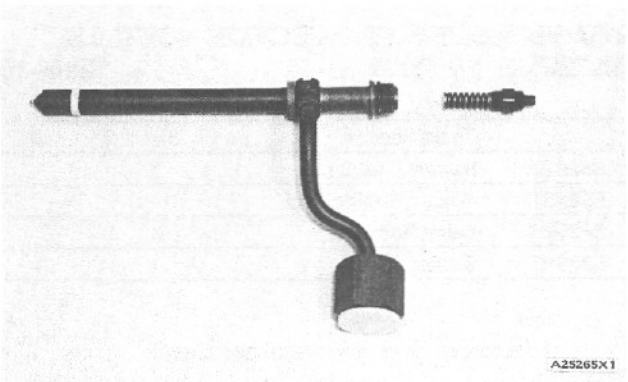
5. If the valve does not slide out of the nozzle, install tool (C) and remove valve as follows:

   a) Push valve into nozzle with tool (C) until valve is against bottom of nozzle.

   b) Push down on body of tool (C) to engage collet on valve with tool (C).

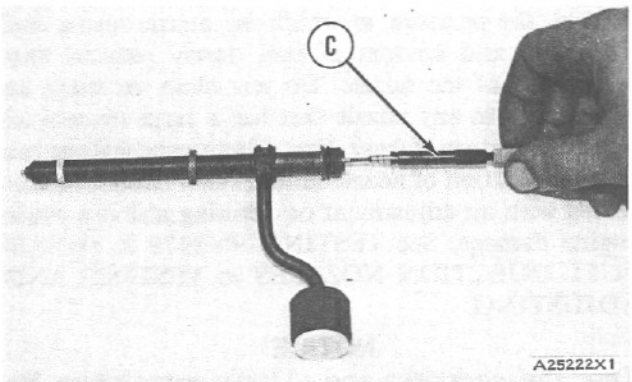
   c) Turn nut counterclockwise and remove valve from the nozzle body.
   Put the parts in solvent to loosen carbon and deposits of foreign material. The body is assembled with an epoxy material and must not be in contact with the solvent for more than one to two hours. See SPECIAL INSTRUCTION FORM NO. SEHS7292 for the correct method of cleaning the nozzle.





ASSEMBLE FUEL INJECTION NOZZLES (9N3979 & 1W5829) 1254–16

	Tools Needed	A	B	C
8S2250	Nozzle Holding Tool	1		
8S2242	Nozzle Test Group		1	
9S5031	Socket			1



NOTE: Make sure all of the parts have been thoroughly cleaned before assembling the nozzles. Flush the body to remove any debris or lapping compound.

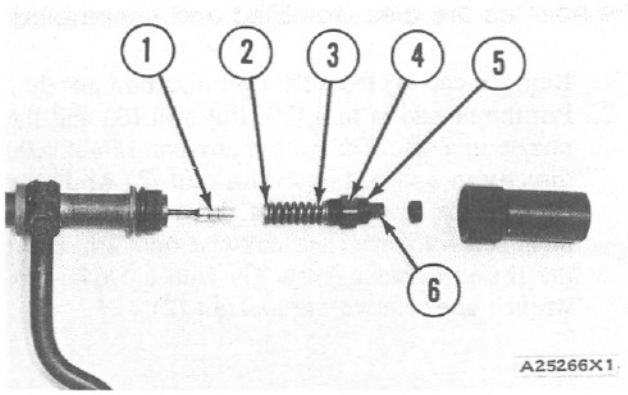
1. Put clean fuel on all of the parts.

2. Put valve (1) in position in the body as shown.

3. Install lift adjusting screw (6) into pressure screw (5). Turn the lift adjusting screw two or three turns. Install the locknut (4) on the pressure adjusting screw (5).

4. Put spring (3), and seat (2) in position on the adjusting screw (5).

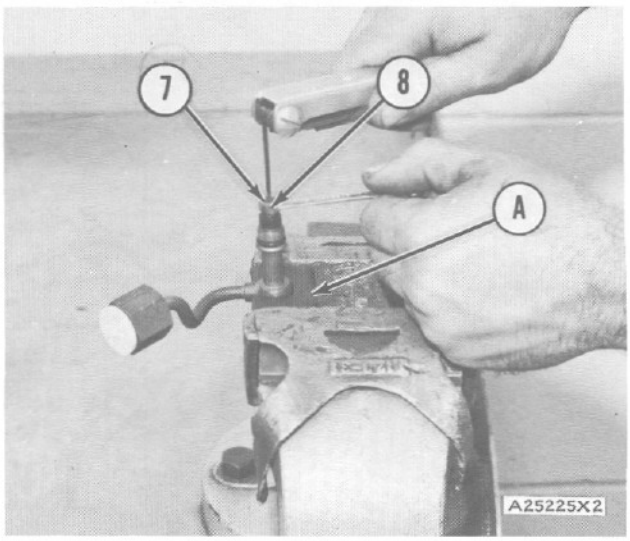
5. Put seat (2) in contact with the valve and push the valve into position in the body. Tighten the pressure screw by hand.



FUEL INJECTION NOZZLES

6. Make an adjustment to the opening pressure of the nozzle as controlled by the pressure adjusting screw with tool (B). See TESTING (9N3979 & 1W5829) FUEL INJECTION NOZZLES, OPENING PRESSURE TEST in TESTING AND ADJUSTING.

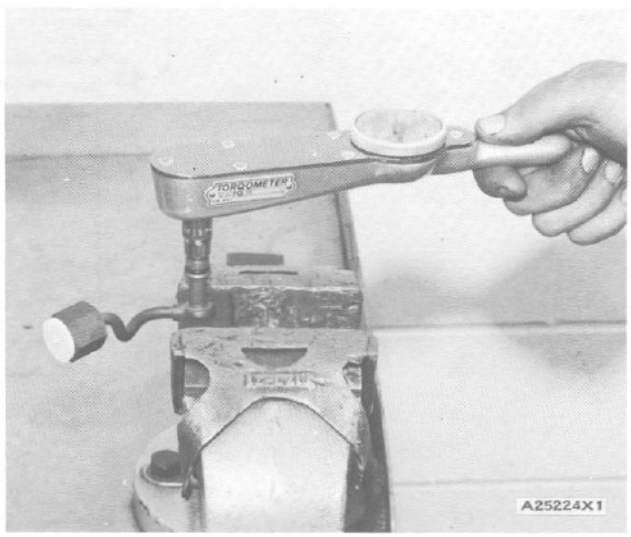
7. Make an adjustment to the valve lift as controlled by the lift adjusting screw with tool (B). See TESTING (9N3979 & 1W5829) FUEL INJECTION NOZZLES, VALVE LIFT ADJUSTMENT in TESTING AND ADJUSTING.



8. Put the nozzle in position in tool (A). Put tool (A) and the nozzle in a vise. Hold the lift adjustment screw (7) with a 5/64" hex wrench and tighten the locknut (8) until the adjusting screw will not turn.

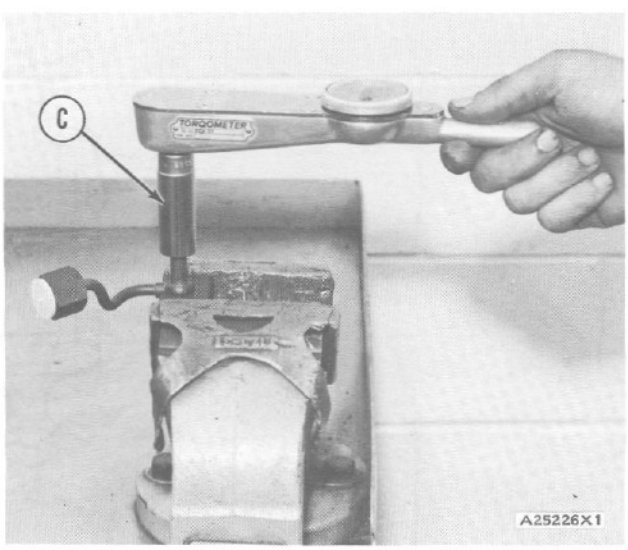
9. Tighten the locknut for the pressure adjustment screw to a torque of 8.0 to 9.1 N•m (70 to 80 lb.in.).

10. Tighten the locknut for the pressure adjustment screw to a torque of 4.0 to 5.1 N•m (35 to 45 lb.in.).

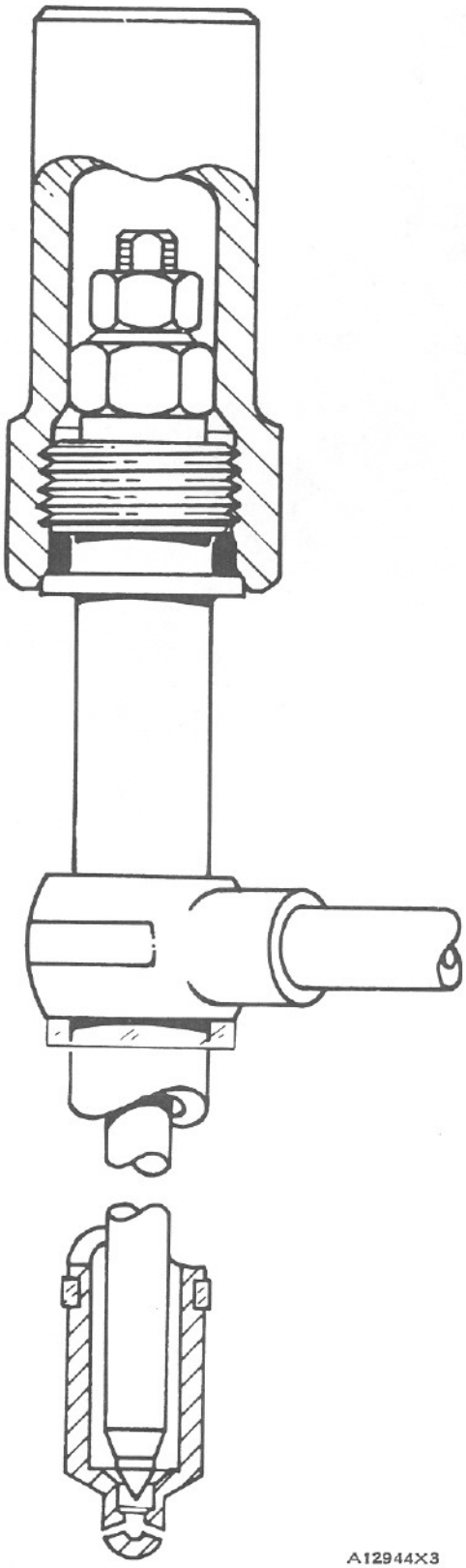


11. Install the cap on the fuel injection nozzle. Use tool (C) to tighten the cap to a torque of 12.4 to 13.6 N•m (110 to 120 lb.in.).

end by:
a) install fuel injection nozzle



FUEL INJECTION NOZZLES



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FUEL INJECTION NOZZLES

REMOVE AND INSTALL 7000 SERIES FUEL INJECTION NOZZLES 1254-010

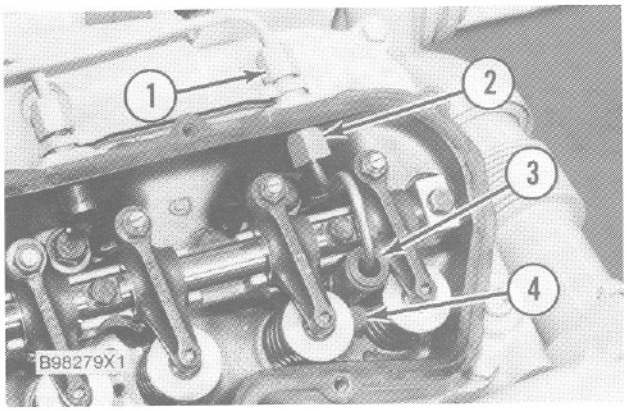
Tools Needed		A	B
8S2242	Nozzle Test Group	1	
6V4979	Carbon Seal Installation Tool		1

start by:

a) remove valve covers

1. Thoroughly clean the area around each of the fuel line connections. Disconnect fuel line connection (1). Disconnect fuel injection nozzle fitting (2) from the adapter.

2. Remove bolt (4), the clamp and spacer that hold the fuel injection nozzle in place.

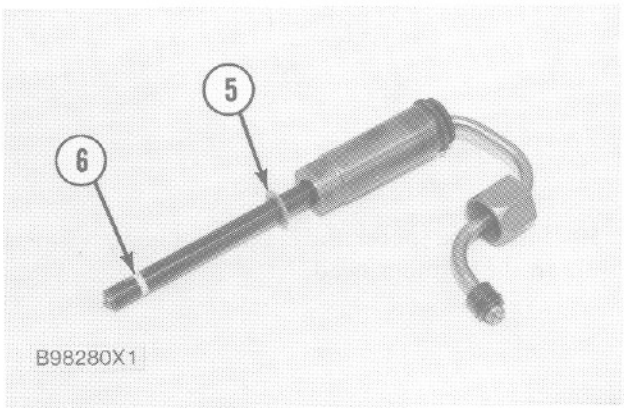


NOTICE

Never use force to remove the fuel injection nozzles. If necessary, turn and pull the fuel injection nozzles out of the cylinder head.

3. Slide the adapter from the cylinder head, and remove fuel injection nozzles (3).

4. Remove carbon seal dam (6) and compression seal (5).



NOTE: The following steps are for installation of the fuel injection nozzles.

NOTICE

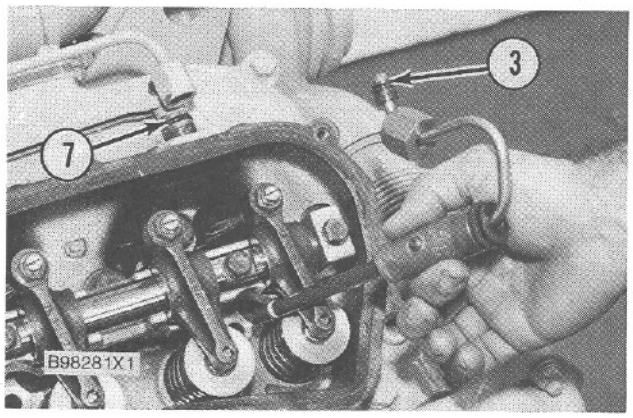
Before the fuel injection nozzles are installed, check for fuel leakage, the pressure at which the injection nozzle opens, and the amount of fuel (spray pattern) that comes out of the nozzle with tool (A). See Testing 7000 Series Fuel Injection Nozzles in Testing And Adjusting.

5. Install a new compression seal (5). Install a new carbon seal dam (6) with tool (B).

6. Make sure the bore in the cylinder head and the fuel inlet fittings are clean.

FUEL INJECTION NOZZLES

7. Install new O-ring seals on adapter (7) and fuel injection nozzle (3).



8. Install the fuel injection nozzle in the cylinder head. Never put lubricant on the nozzle or bore in the cylinder head.

9. Install the adapter in the cylinder head. Connect the nozzle and fuel injection line to the adapter. Tighten the nuts to a torque of 40 ± 7 N•m (30 ± 5 lb.ft.).

10. Install the spacer and clamp that hold the nozzles in the cylinder head.

end by:

a) install valve covers

CYLINDER HEADS

REMOVE CYLINDER HEADS 1101-11

Tools Needed		A	B
6V7860	Water Sleeve Tool	1	
5P9736	Bracket-Link		2

start by:

a) remove exhaust manifold

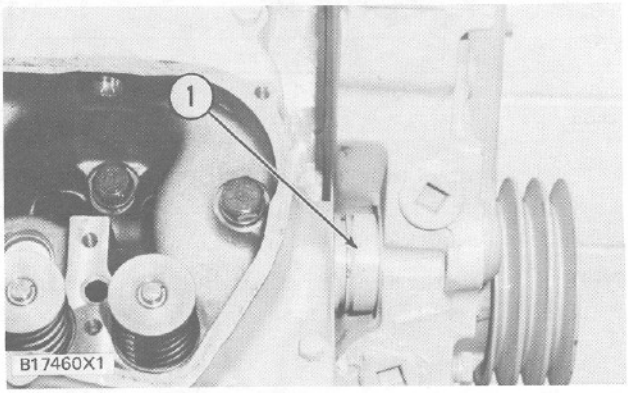
b) remove air inlet manifold

c) remove valve covers

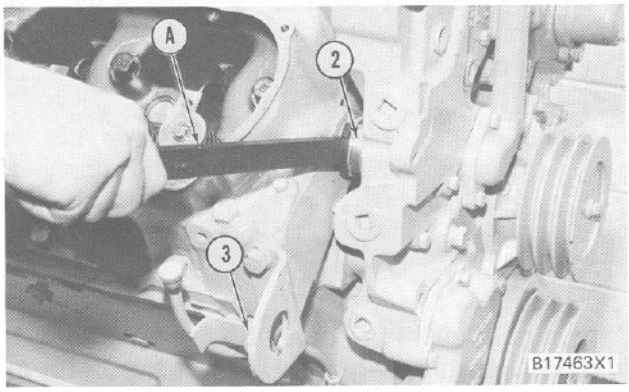
d) remove fuel injection lines

e) remove fuel injection nozzles

1. Remove the coolant from the cooling system.

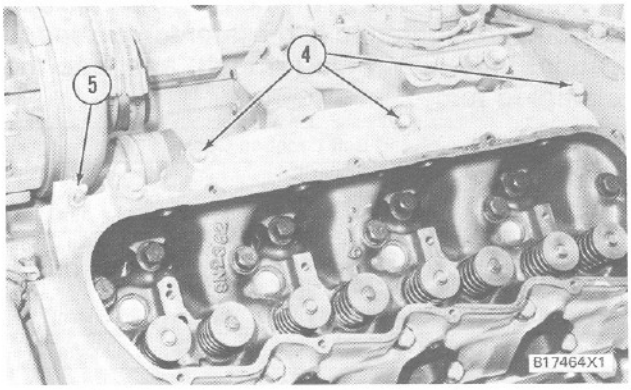


2. Remove clamp (2) from water sleeves (1) in each cylinder head. Push the water sleeves into the timing gear cover with tool (A) and a screwdriver.



3. Remove bolt (3) from the bracket on the dipstick tube.

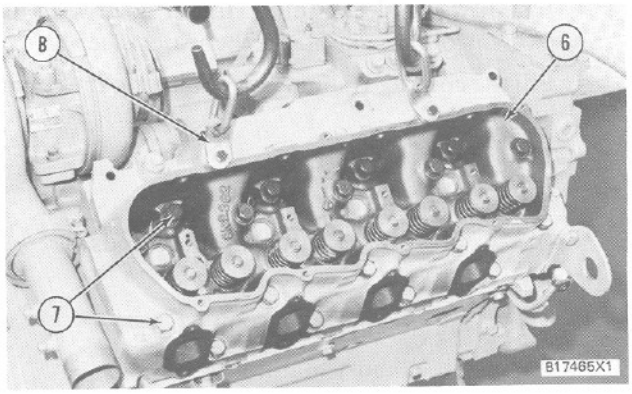
4. Remove bolts (4) and stud (5) from the heads.



NOTICE

Make sure the fuel injection nozzles are removed before the cylinder heads are removed. The fuel injection nozzles go through the cylinder heads and the nozzle tips can be broken off if the nozzles are not removed from the heads.

5. Install tooling (B) and fasten a hoist. Remove bolts (7), cylinder head (6) and the gasket. The weight of the cylinder head is 54 kg (120 lb.).



CYLINDER HEADS

INSTALL CYLINDER HEADS 1101-12

Tools Needed		A	B
6V7860	Water Sleeve Tool	1	
5P9736	Link Bracket		2

1. Clean the contact surfaces of the cylinder head and cylinder block. Make sure the surfaces are clean and dry. Install a new cylinder head gasket.

NOTE: Clean the bore in the cylinder head for the water sleeves. Put oil on the seals on the water sleeves.

2. Install tooling (B) in the cylinder head. Fasten a hoist and put the cylinder head in position on the cylinder block.

3. Put 6V4876 Molykote Lubricant on the bolt threads and install the bolts that hold the cylinder head in their correct location. Tighten the bolts in the cylinder head according to the HEAD BOLT TORQUE CHART.

NOTICE

The higher cylinder head bolt torque may be used on earlier engines ONLY if the bolts are replaced with the later higher strength bolts (seven dash marks on the bolt head). If the earlier bolts are tightened to the later torque specification, they may yield (stretch) and lose their clamping force.

Head Bolt Location Chart	
Location	Length
5, 2, 4, 10	5.25 in. (133.4 mm)
19, 20, 21	5.0 (127.0 mm)
16, 14, 12, 17	3.0 (76.2 mm)
7, 9, 3, 1, 6, 8	4.75 in. (120.6 mm)
18, 11, 13, 15	2.25 in. (57.2 mm)
22	Stud

4. Install water sleeve into cylinder head with tool (A). Install the clamp on the water sleeves.
5. Fill the cooling system with coolant to the correct level.

end by:

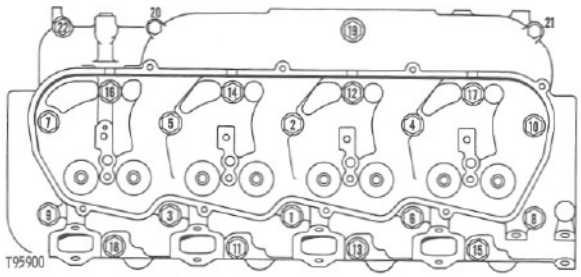
a) install fuel injection nozzles

b) install rocker shafts and push rods

c) install valve covers

d) install air inlet manifold

e) install exhaust manifold



Head Bolt Torque Chart		
Tightening Procedure	Earlier Bolts (with six dash marks)[1]	Later Bolts (with seven dash marks)[1]
Step 1. Tighten bolts 1 thru 18 in number sequence to:	130 ± 7 N.m (95 ± 5 lb.ft.)	150 ± 7 N.m (110 ± 5 lb.ft.)
Step 2. Loosen bolts 1 thru 18 until the washers can be turned freely.		
Step 3. Tighten bolts 1 thru 18 in number sequence to:	80 ± 14 N.m (60 ± 10 lb.ft.)	80 ± 14 N.m (60 ± 10 lb.ft.)
Step 4: Tighten bolts 1 thru 18 in number sequence to:	130 ± 7 N.m (95 ± 5 lb.ft.)	150 ± 7 N.m (110 ± 5 lb.ft.)
Step 5: Again tighten bolts 1 thru 10 in number sequence to:	130 ± 7 N.m (95 ± 5 lb.ft.)	165 ± 7 N.m (120 ± 5 lb.ft.)
Step 6. Tighten bolts 19 thru 22 in number sequence to:	43 ± 7 N.m (32 ± 5 lb.ft.)	43 ± 7 N.m (32 ± 5 lb.ft.)

[1] See Illustration 1 for identification of EARLIER and LATER bolts.

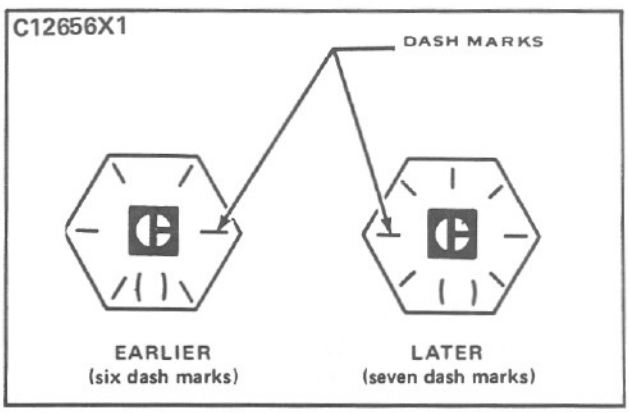


Illustration 1. Bolt head identification.

CYLINDER HEADS

DISASSEMBLE CYLINDER HEADS 1101—15

	Tools Needed	A	B	C	D
FT806	Cylinder Head Stand	1			
FT967	Adapter Plate	2			
8S2263	Valve Spring Tester		1		
5S1330	Valve Spring Compressor			1	
8S7170	Valve Seat Insert Puller Group				1

start by:

a) remove cylinder heads

1. Fasten a hoist and put the cylinder head in position on tool (A). Use adapter plates (1) from tooling (A) to hold the head in place.

2. Put the valve springs under compression with tool (C).

3. Remove the locks from the valves.

NOTE: Earlier engines have an inner valve spring. Later engines have only one valve spring and a spacer instead of inner spring.

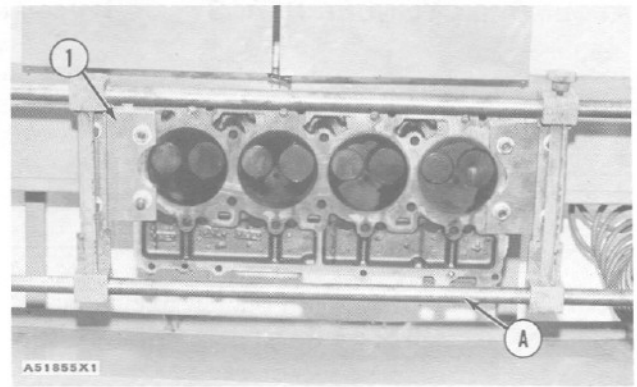
4. Remove tool (C), retainer, spring, washer and valve from the cylinder head. Put identification on the valve as to its location in the cylinder head.

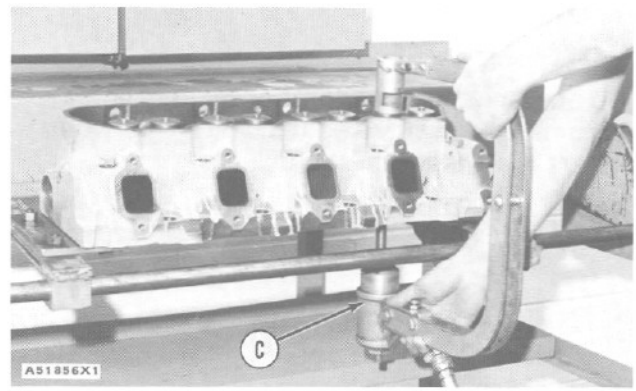
5. Check the valve spring force with tool (B). For the correct spring force, see the subject VALVES in SPECIFICATIONS.

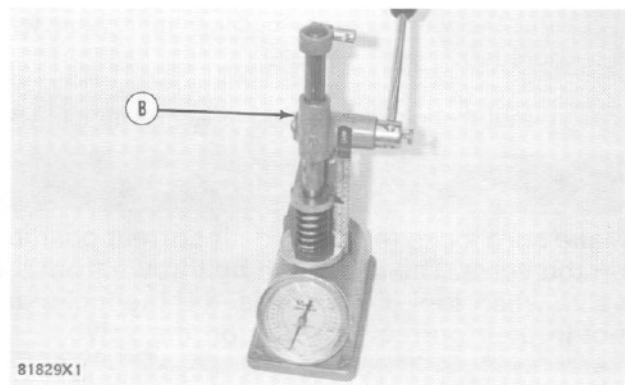
6. Do Steps 2 through 5 for the remainder of the valves.

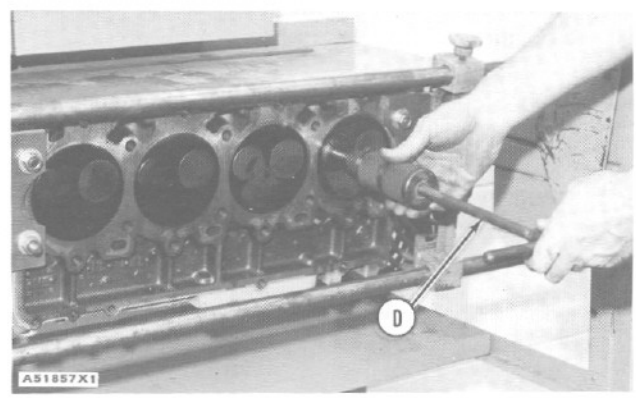
7. Remove the valve seat inserts with tooling (D).

NOTE: The valve guides are part of the cylinder head. Measure the bore in each valve guide 19.0 mm (.75 in.) from the outside edge on both ends of each valve guide. The bore must be 9.512 ± 0.013 mm (.3745 ± .0005 in.). The maximum permissible bore is 9.550 mm (.3760 in.). Valve guides worn more than the maximum specification can be made to the original size by knurling. To knurl the valve guides, see the topic CYLINDER HEAD AND VALVE COMPONENTS in the RECONDITIONING PROCEDURES.









CYLINDER HEADS

ASSEMBLE CYLINDER HEADS 1101—16

Tools Needed		A	B	C
8S7170	Valve Seat Insert Puller Group	1		
5S1322	Valve Keeper Inserter		1	
5P1330	Valve Spring Compressor			1

1. Clean and remove burrs and all foreign material from the valve seat bores.

2. Lower the temperature of the valve seat inserts and install them with tooling (A).

NOTICE

Do not make the diameter of the extractor (part of tooling A) in valve seat insert larger when the insert is installed in the cylinder head.

3. Grind the valve inserts according to the dimensions given in SPECIFICATIONS.

4. Put clean engine oil on the valve stem. Install the valve, washer (3), springs (2) and retainer (1) in the cylinder head.

5. Put the valve springs under compression with tool (C).

6. Install the locks on the valve stem with tool (B).

⚠ WARNING

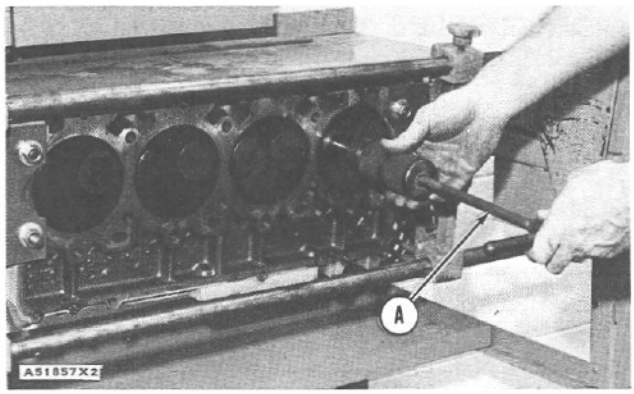
Make sure locks (4) are in their correct position on the valve. The locks can be thrown from the valve when tool (C) is released if the locks are not in their correct position on the valve.

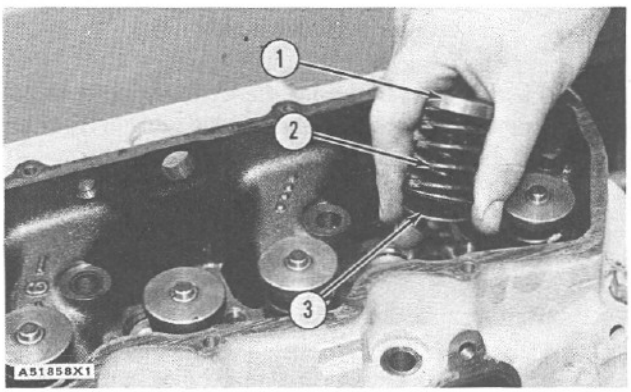
7. Remove tool (C) and hit the valve with a rubber hammer to be sure the locks are in their correct position.

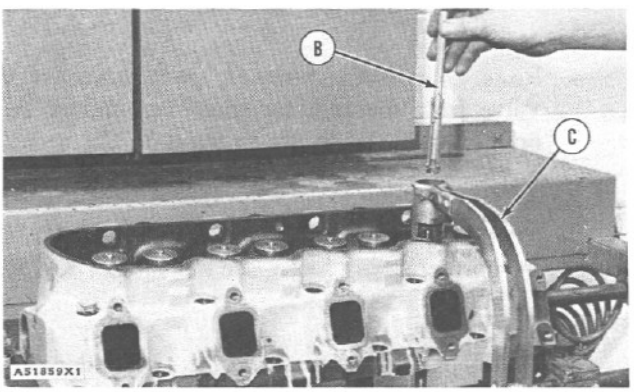
8. Do Steps 4 through 7 for the remainder of the valves.

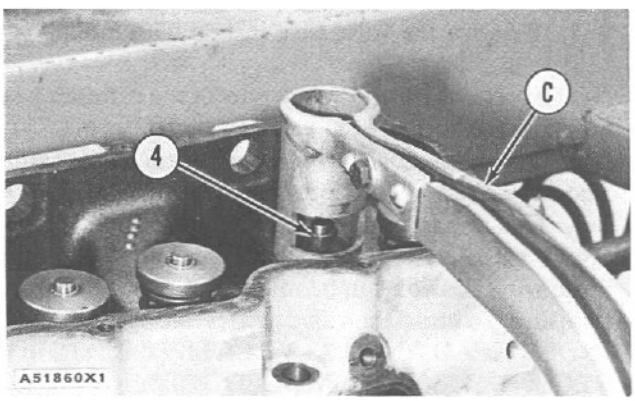
end by:

a) install cylinder heads









PISTON COOLING ORIFICES

REMOVE PISTON COOLING ORIFICES 1307-10

Tools Needed		A
FT1542	Driver Orifice	1

start by:
a) remove crankshaft and gear

NOTICE

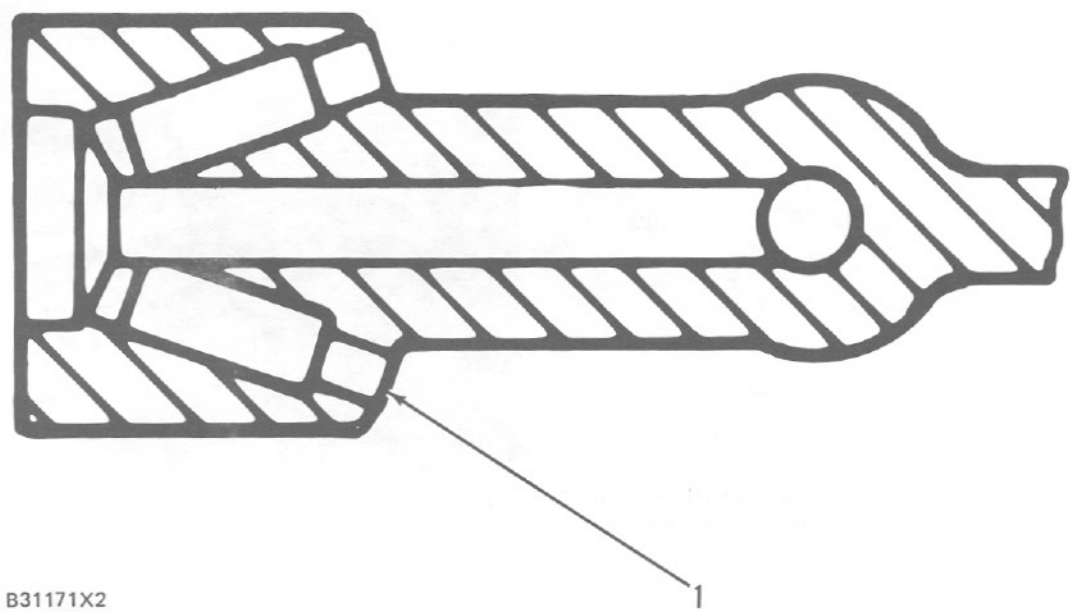
There are holes in the bores for the main bearing between the cylinders for piston cooling orifices. These holes must have orifices or plugs installed or low oil pressure will be the result. If the base for the oil cooler is 357.1 mm (14.06 in.) long, the engine has piston cooling orifices installed. If the base for the oil cooler is 268.2 mm (10.56 in.) long, the engine has plugs installed.

NOTE: A replacement of the piston cooling orifices is necessary only if they are damaged. Normally it will only be necessary to be sure the orifices are clean.

1. Use a soft punch to remove orifices (1) from the cylinder block.

2. Use tool (A) to install the orifices in the main bearing bores until they are against the counterbore. Be sure the orifices are open after they are installed.

end by:
a) install crankshaft and gear



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LIFTERS

REMOVE AND INSTALL LIFTERS (WITH ROLLERS) 1209-10

start by:
a) remove cylinder heads

1. Remove valve lifters (1).

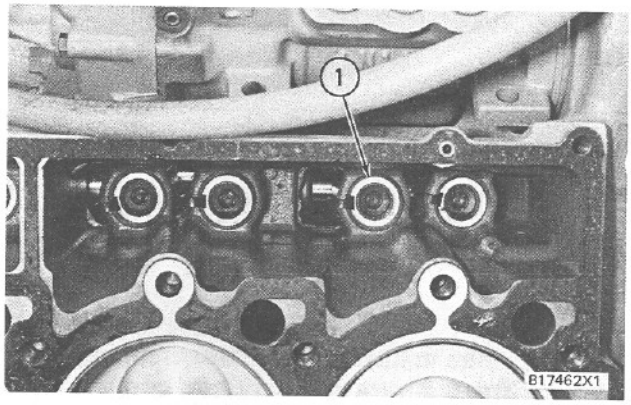
2. Put identification on each lifter as to its location in the engine for installation purposes.

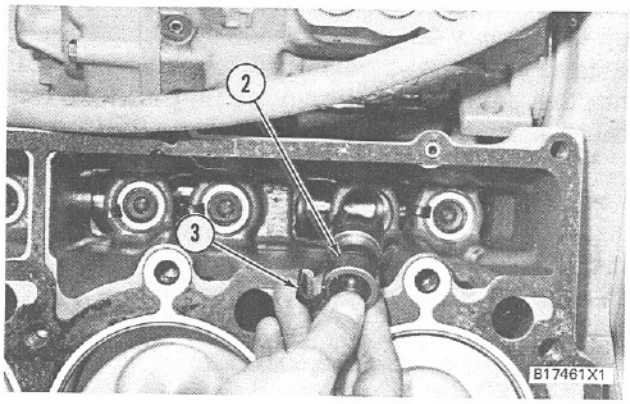
3. Put the valve lifters in clean engine oil before installation.

4. Put lifter (2) and spring (3) in position so the tab on the spring is within an area 4.8 mm (.190 in.) either side of the centerline of the cam and valve lifter bores.

NOTE: If necessary turn the camshaft so lifters can be pushed into correct position.

end by:
a) install cylinder heads





REMOVE AND INSTALL LIFTERS 1209-10

start by:
a) remove cylinder heads

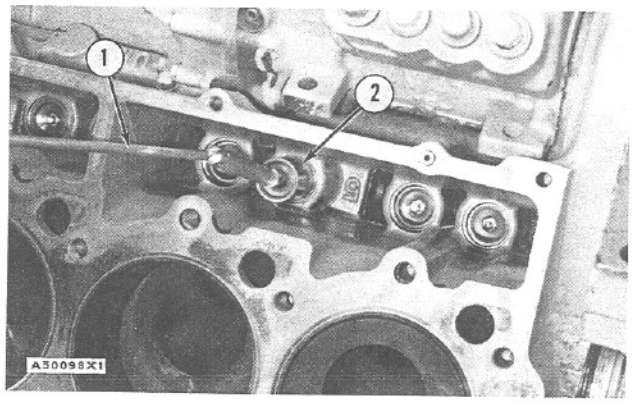
1. Remove valve lifters (2) with magnet (1).

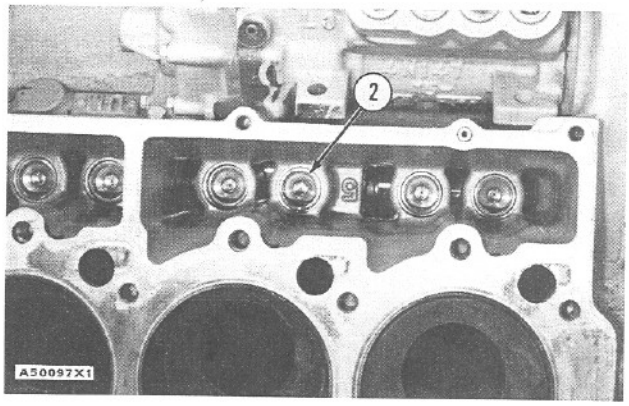
2. Put identification on each lifter as to its location in the engine for installation purposes.

3. Put clean engine oil on the valve lifters and camshaft lobes.

4. Install the valve lifters (2) in their original positions in the cylinder block.

end by:
a) install cylinder heads





CRANKSHAFT MAIN BEARINGS

REMOVE AND INSTALL CRANKSHAFT MAIN BEARINGS 1203-10

	Tools Needed	A	B	C	D
2P5518	Bearing Tool	1			
	Plastigage		*		
8S5131	Adapter			1	
8S2328	Dial Test Indicator Group				1

start by:
a) remove oil pan

1. Check each main bearing cap for its location on the engine. Each cap has a number which gives the location of that cap. Make a note that the number on each cap is toward the front of the cylinder block.

2. Remove the bolts and washers that hold main bearing cap (2) in place. Remove the bearing cap and the lower half of the main bearing. Use tool (C) to remove the bolts that hold the No. 1 main bearing cap in position.

3. Remove bearing (1) from the bearing cap.

NOTE: No. 1 main does not have an oil hole for insertion of tool (A).

4. Turn the crankshaft until tool (A) can be installed in the oil hole in the crankshaft journal. Install tool (A). Turn the crankshaft in the direction which will push the upper main bearing out, tab end first.

NOTICE

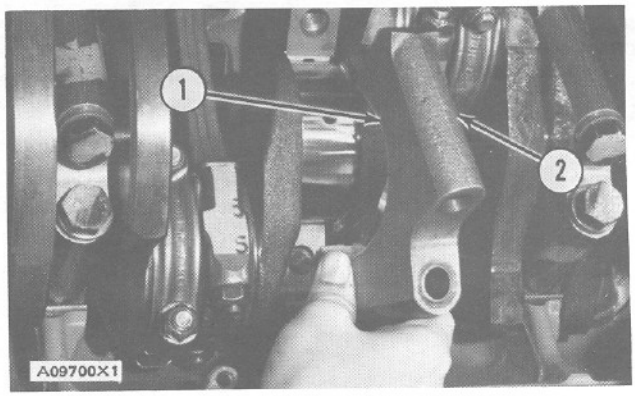
If the crankshaft is turned in the wrong direction, the tab of the bearing will be pushed between the crankshaft and the cylinder blocks. This will cause damage to the crankshaft and block.

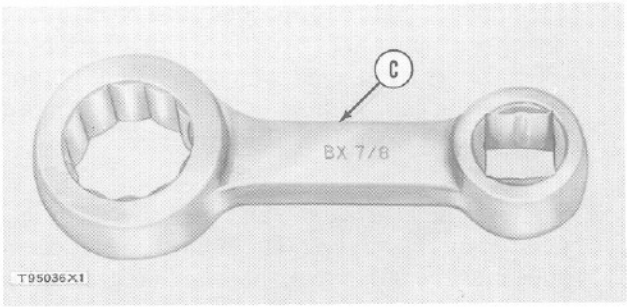
NOTE: Install the bearings dry when the clearance checks are made. Put clean engine oil on the bearings for final assembly.

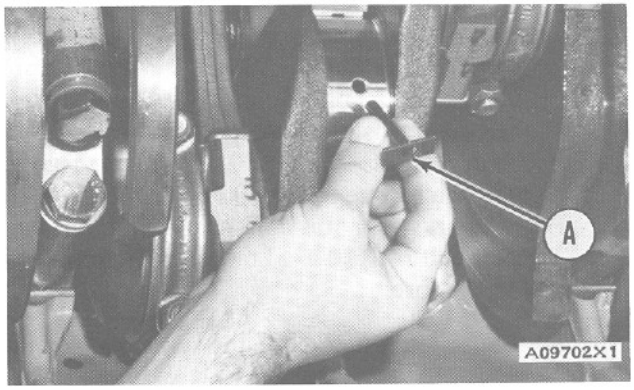
5. Install the lower bearing in the bearing caps. Install upper bearings (bearing with the oil hole) in the cylinder block with tool (A).

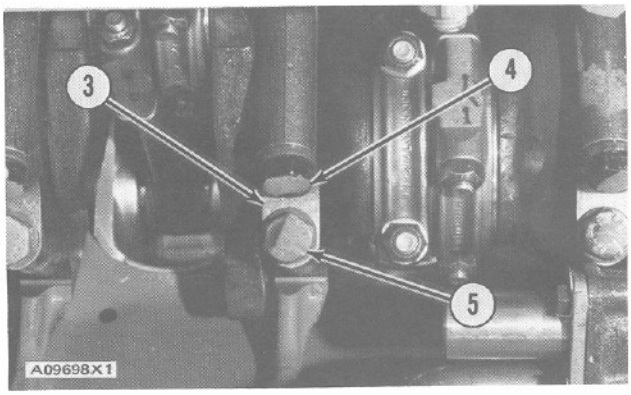
NOTICE

When bearing caps are installed, make sure the caps are installed with the part number toward the front of the engine and the number on the bottom of the cap is the same as the number on the camshaft side of the engine.



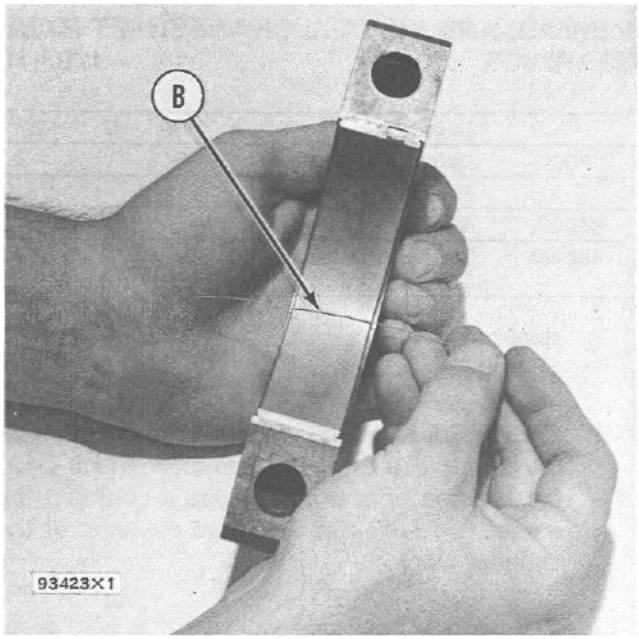






CRANKSHAFT MAIN BEARINGS

NOTE: When the bearing clearance is checked and the engine is in a vertical position, such as in the vehicle, the crankshaft will have to be lifted up and held against the upper halves of the main bearings to get a correct measurement with Plastigage (B). The Plastigage will not hold the weight of the crankshaft and give a correct indication. If the engine is in a horizontal position, such as on an engine stand, it is not necessary to hold the crankshaft up. Do not turn the crankshaft when Plastigage (B) is in position.



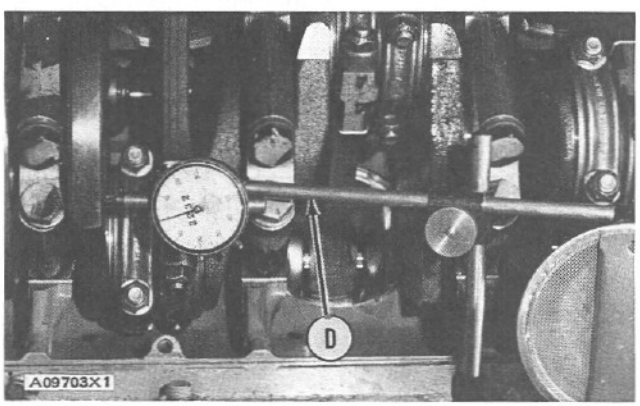
6. Check the bearing clearance with Plastigage (B) as follows:
   Put cap (3) in position and install the bolts. Tighten bolt (5) to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Tighten bolt (4) to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Put a mark on both bolt heads and the bearing cap. Tighten bolt (4) 120 ± 5° more. Tighten bolt (5) 120 ± 5° more.

7. Remove the bearing cap and measure the thickness of the Plastigage. The main bearing clearance must be 0.076 to 0.168 mm (.0030 to .0066 in.). The maximum permissible clearance is 0.18 mm (.007 in.).

8. Put 2P2506 Thread Lubricant on the bolt threads and washers faces. Put clean engine oil on the lower half of the main bearing. Put the bearing cap and lower half of the main bearing in position on the engine. Install the bolts. Tighten bolt (5) to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Tighten bolt (4) to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Put a mark on both bolt heads and the cap. Tighten bolt (4) 120 ± 5° more. Tighten bolt (5) 120 ± 5° more.

9. Do Steps 1 through 8 for the remainder of the bearings.

NOTE: When a replacement of the thrust plates on No. 3 main bearing is made, install the thrust plates with the identification "BLOCK SIDE" next to the block.



10. Check the crankshaft end play with tooling (D). The end play is controlled by the thrust bearing on No. 4 main bearing. The end play with new bearings must be 0.08 to 0.25 mm (.003 to .010 in.). The maximum permissible end play with used bearing is 0.36 mm (.014 in.).

end by:
a) install oil pan

CONNECTING ROD BEARINGS

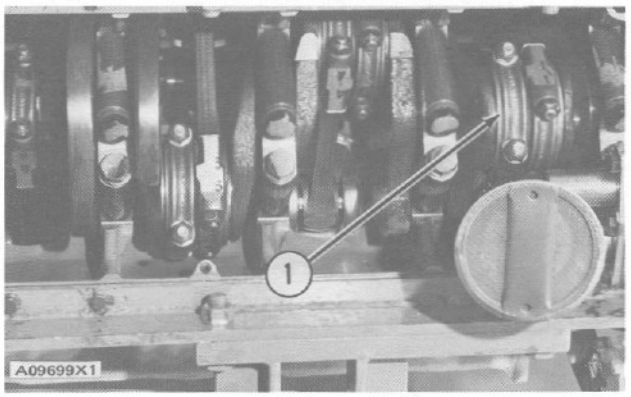
REMOVE AND INSTALL CONNECTING ROD BEARINGS 1219-10

Tools Needed	A
Plastigage	*

start by:

a) remove oil pan

1. Turn the crankshaft until two pistons are at bottom center. Remove connecting rod caps (1) from the two connecting rods. Remove the lower half of the bearings from the caps.
2. Push the connecting rods away from the crankshaft and remove the upper half of the bearings.

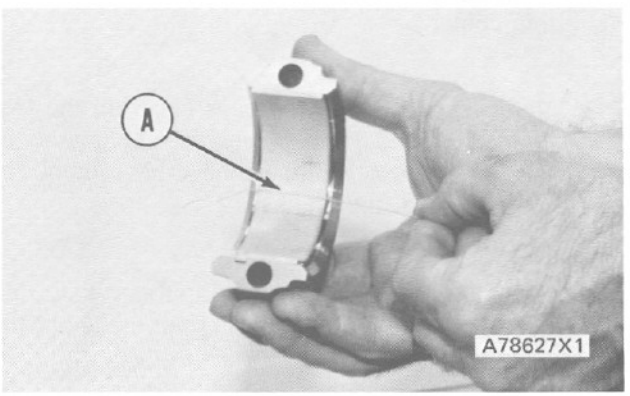


NOTICE

Be careful not to damage the crankshaft journals. Do not turn the crankshaft while any of the connecting rod caps are removed.

NOTE: Install the bearings dry when the clearance checks are made. Put clean engine oil on the bearings for final assembly.

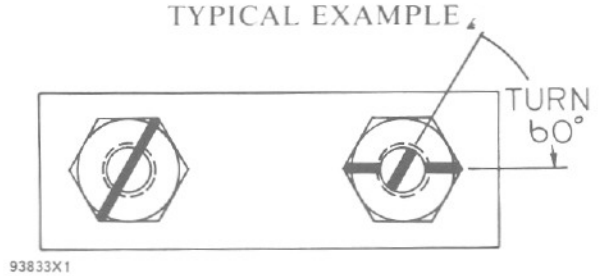
3. Clean the surfaces where the bearings fit. Install the upper half of the bearing in the connecting rod. Pull the connecting rod slowly on to the crankshaft.
4. Install lower half of the bearing in the cap.



NOTICE

When the connecting rod caps are installed, make sure that the numbers on the side of the caps are next to and respective with the number on the side of the connecting rods.

5. Check the bearing clearance with Plastigage (A). Put Plastigage (A) on the bearing.
6. Put 2P2506 Thread Lubricant on the threads of the rod bolts and seat surfaces of the nuts.

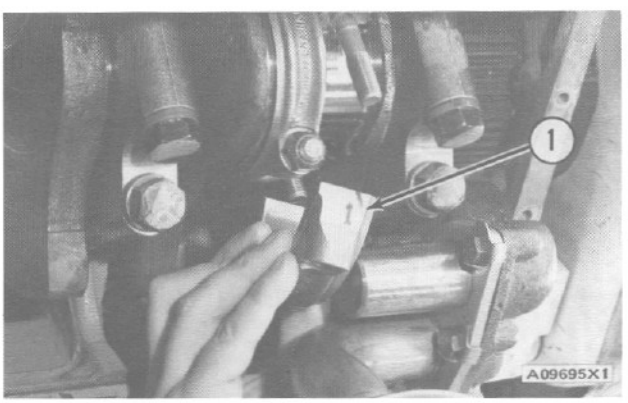


NOTICE

Do not use an impact wrench to tighten the nuts the additional 60 ± 5°.

NOTE: Do not turn the crankshaft when Plastigage (A) is in position.

7. Put caps (1) in position on the connecting rods and install the nuts. Tighten the nuts to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Put a mark on each nut and the end of each bolt. Tighten the nuts 60 ± 5° more.
8. Remove the cap. Measure the thickness of Plastigage (A). The rod bearing clearance must be 0.053 to 0.140 mm (.0021 to .0055 in.). The maximum permissible clearance is 0.15 mm (.006 in.).
9. Put the caps in position on the connecting rods and install the nuts. Tighten the nuts to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Put a mark on each nut and the end of each bolt. Tighten the nuts 60 ± 5° more.



10. Do Steps 1 through 9 again for other bearings.

end by:

a) install oil pan

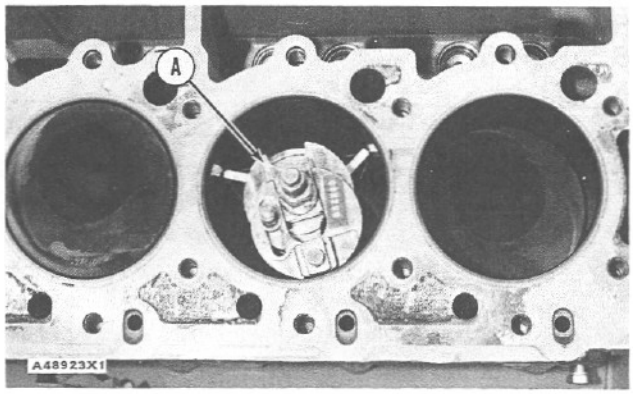
PISTONS

REMOVE PISTONS 1214-11

	Tools Needed	A
8S2269	Ridge Reamer	1

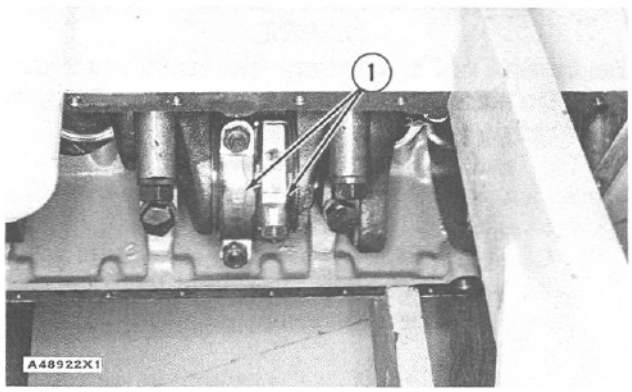
start by:
a) remove cylinder heads
b) remove oil pan

1. Remove the carbon from the top inside surface of the cylinders with tool (A).



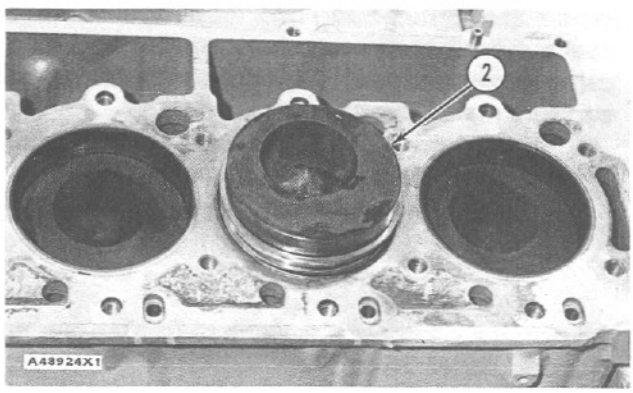
2. Turn the crankshaft until two pistons are at bottom center.

3. Remove connecting rod caps (1) from the two connecting rods. Put pieces of rubber hose or tape on the threads of the connecting rod bolts as protection for the crankshaft.



4. Push the pistons and connecting rods away from the crankshaft until the piston rings are above the cylinder block.

5. Remove the two pistons (2) and the connecting rods. Keep each connecting rod cap with its respective connecting rod and piston. Put identification on each connecting rod as to its location for use at installation.



NOTICE

Do not turn the crankshaft while any of the connecting rods are in the engine without the caps installed.

6. Do Steps 2 through 5 for the remainder of the pistons.

PISTONS

INSTALL PISTONS 1214-12

	Tools Needed	A	B
5P3524	Ring Compressor	1	
	Plastigage		*

NOTICE

Two different pistons are used in 3208 Truck Engines. One piston has a crater volume of 50.4 ± 1.3 cm³ (3.08 ± .07 in.³), and the other piston has a crater volume of 58.8 ± 1.2 cm³ (3.59 ± .07 in.³). Check the part number stamped on the top of the piston and refer to the parts book to be sure the correct replacement piston is used. The correct piston must be installed in the engine. If the wrong piston is installed, much damage to the engine will be the result.

1. Put clean engine oil on the piston rings, connecting rod bearings, cylinder walls and crankshaft bearing journals.
2. Turn the crankshaft until the bearing journal for the pistons to be installed is at bottom center.
3. Make sure the piston ring gaps are at least 120° apart on the piston.
4. Use tool (A) and install the piston in position in the same cylinder bore from which it was removed. The hole (crater) in the top of the piston must be toward (nearest) the center of the engine.

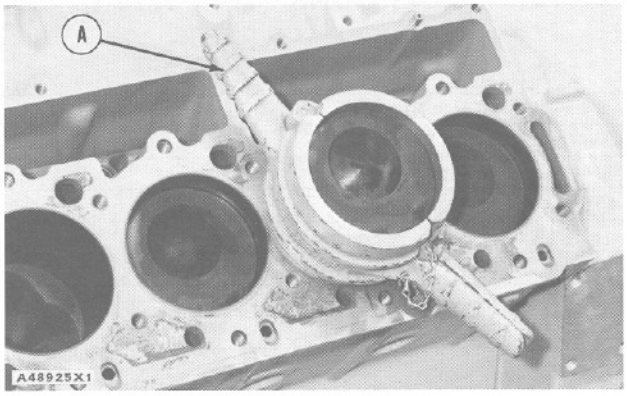
NOTE: For more detail about the installation of connecting rod bearings, see REMOVE AND INSTALL CONNECTING ROD BEARINGS.

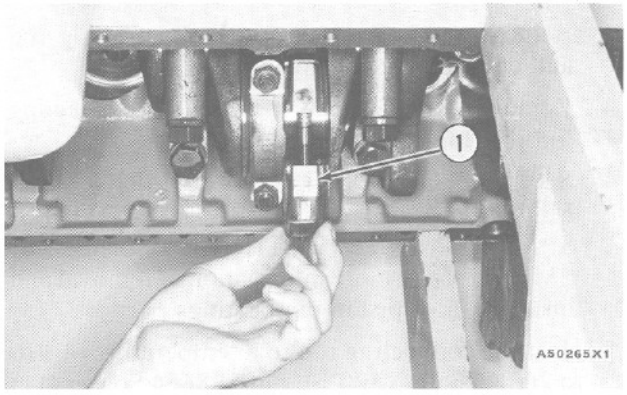
5. Check the bearing clearances with tool (B).
6. Put 2P2506 Thread Lubricant on the threads of the bolts and contact surfaces of the nuts for the connecting rod caps.

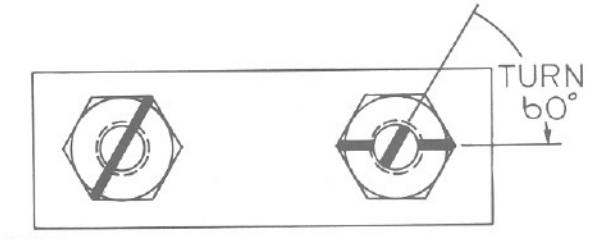
NOTICE

When the connecting rod caps are installed, make sure that the number on the side of the cap is next to and respective with the number on the side of the connecting rod.

7. Put the cap (1) in position on the connecting rod and install the nuts. Tighten the nuts to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.). Put a mark on each nut and the end of each bolt. Tighten the nuts 60 ± 5° more.







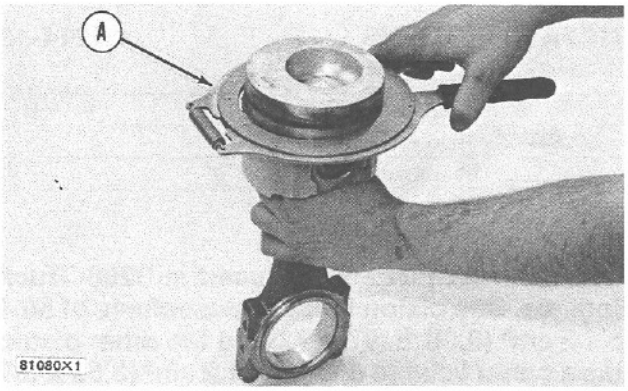
8. Check the side clearance between two connecting rods on the same crankshaft journal. Clearance must be 0.08 to 0.84 mm (.003 to .033 in.) for new rods.
9. Do Steps 1 through 8 for the remainder of the pistons.

end by:
a) install cylinder heads
b) install oil pan

PISTONS

DISASSEMBLE PISTONS 1214-15

	Tools Needed	A	B
5F9059	Ring Expander	1	
5P8639	Press Group		1
8F24	Hose Assembly		1
1P2375	Coupler Assembly		1
1P2376	Coupler Assembly		1
5P8719	Hand Pump		1
5P8652	Tool Group		1

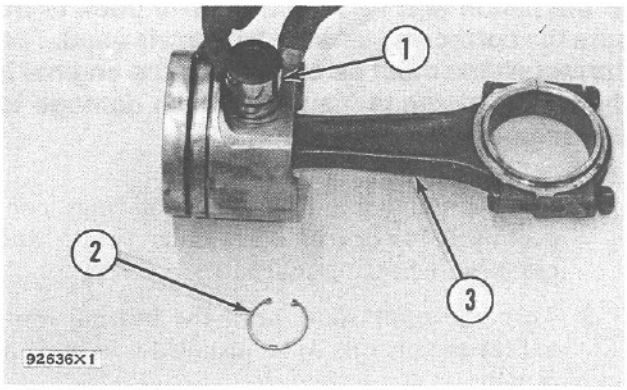


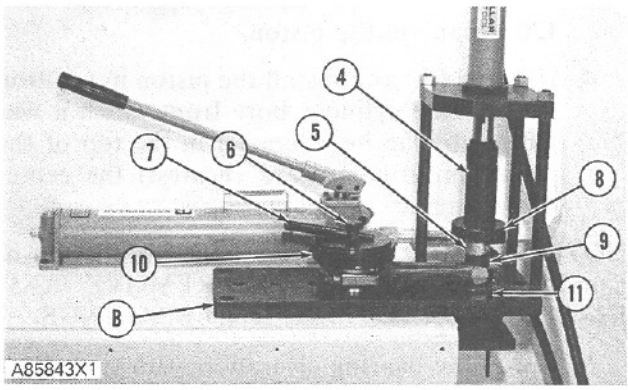
start by:
a) remove pistons

1. Remove the rings from the piston with tool (A).
2. Remove the bearings from the connecting rod and connecting rod cap.
3. Remove snap rings (2), pin (1) and connecting rod (3) from the piston.
4. See USE OF PISTON PIN BEARING REMOVAL AND INSTALLATION TOOLS, SPECIAL INSTRUCTIONS, Form No. SMHS7295 for more information of removal and installation of piston pin bearings.
5. Heat the connecting rod to a temperature of 176 to 260°C (350 to 500°F). Put 5P8654 Spacer (11) in the base plate. Put the connecting rod on the base plate of tooling (B).
6. Put the connecting rod piston pin bearing end in the center of the port assembly of tooling (B). Install pin (7) in the center of the bore for the connecting rod bearings.
7. Install 5P8653 Adapter (9). Put the hole in the adapter in alignment with the hole in the base plate of tooling (B).
8. Install clamp bar (10) and clamp pin (6).
9. Install new piston pin bearing (5) on adapter (9).

NOTE: The old bearing is pushed out by tooling (B) as the new bearing is installed.

10. Put 5P8645 Adapter (8) in position as shown with the taper side down. The piston pin bearing joint must be in alignment with the hole in adapter (9) and the base plate of tooling (B).
11. Put pusher (4) on adapter (8).
12. Use tooling (B) to push the new piston pin bearing into the connecting rod until adapter (8) of tooling (B) makes full contact with the connecting rod surface.



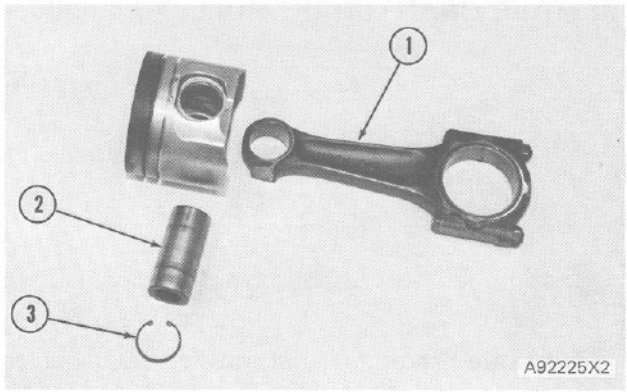


13. Remove the connecting rod and the old piston pin bearing from tooling (B).
14. Check the piston pin bearing bore diameter after the bearing is installed. The correct dimension is 38.125 ± 0.008 mm (1.5010 ± .0003 in.).

PISTONS

ASSEMBLE PISTONS 1214-16

	Tools Needed	A	B
8S2304	Piston Ring Groove Cleaner	1	
5F9059	Ring Expander		1

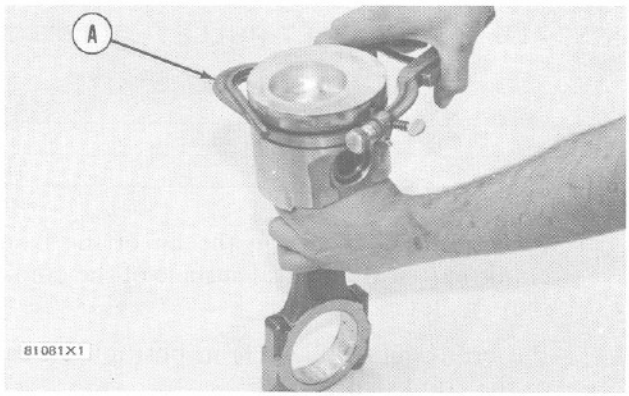


1. Install connecting rod (1) in the piston with the boss on small end of connecting rod on the same side as the hole (crater) in top of the piston.
2. Install piston pin (2) and snap ring (3).
3. When old pistons are to be used, clean the piston grooves with tool (A).
4. Install the spring for the oil ring. Install the oil ring with tool (B). The gap in the ring must be approximately 180° from the oil ring spring connections.
5. Install the compression ring with tool (B). The side of the ring that has the identification "TOP" must be toward the top of the piston. The gaps in the rings must be approximately 120° apart.

NOTE: Compression rings that do not have identification must be installed with the edge that has the bevel toward the top edge that has the bevel toward the top of the piston.

6. Install connecting rod bearings.

end by:
a) install pistons

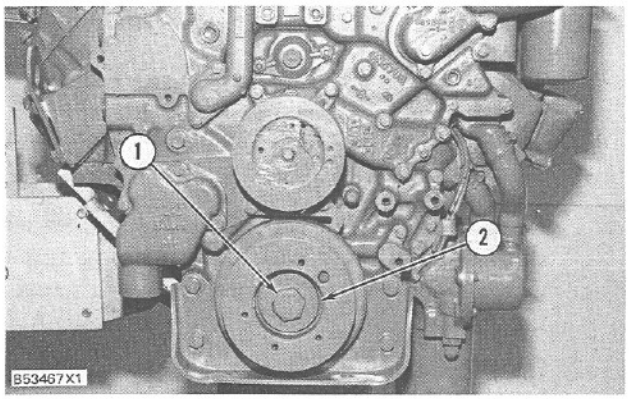


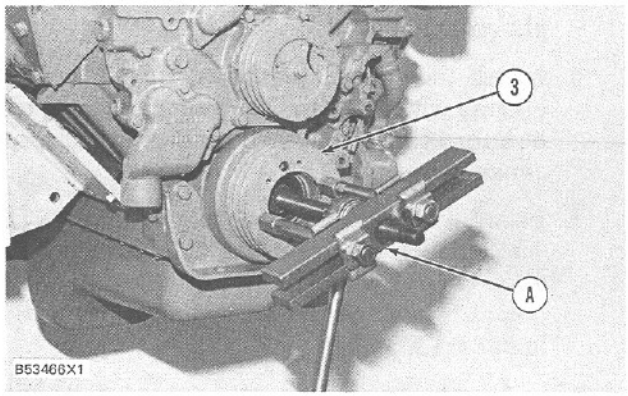
CRANKSHAFT PULLEY

REMOVE CRANKSHAFT PULLEY 1205-11

	Tools Needed	A
8B7548	Puller Assembly	1
8B7557	Adapter	2
8H684	Ratchet Box Wrench	1
8B7561	Step Plate	1

1. Remove the vee belts from the front of the engine.
2. Remove bolt (1) and washer (2) from the crankshaft.
3. Use tooling (A) to pull the crankshaft pulley (3) from the crankshaft.

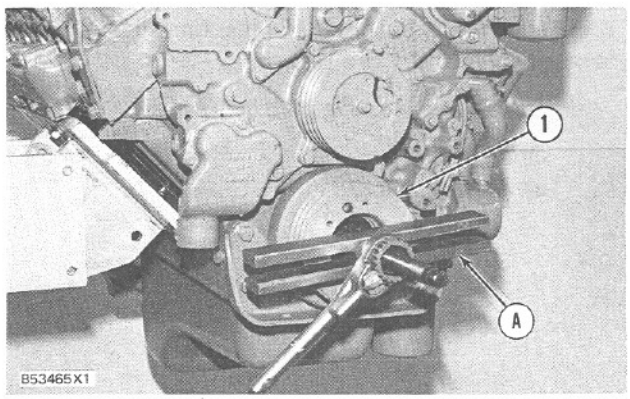




INSTALL CRANKSHAFT PULLEY 1205-12

	Tools Needed	A
8B7548	Puller Assembly (without legs)	1
8H684	Ratchet Box Wrench	1

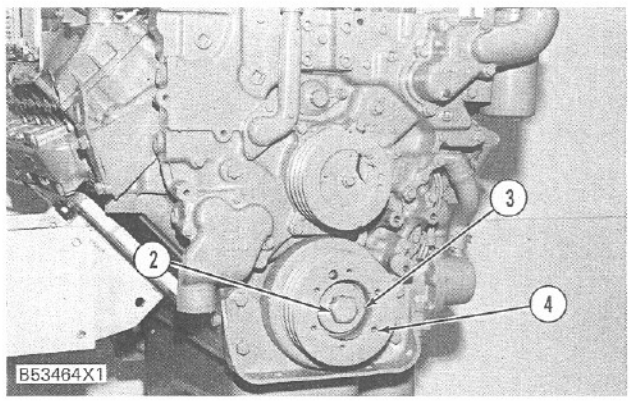
1. Put clean engine oil on the lip of the front crankshaft seal and seal surface of the crankshaft pulley.
2. Put crankshaft pulley (1) in position on end of the crankshaft.
3. Install the screw of tooling (A) in the end of the crankshaft. Put crossbar of tooling (A) on screw and against the pulley. Use tooling (A) to push the pulley on to crankshaft until it makes contact with the crankshaft gear inside timing gear housing. Remove tooling (A).



4. Install washer (3) and bolt (2) in the end of the crankshaft. Tigthen the bolt to a torque of 624 ± 80 N•m (460 ± 60 lb.ft.).

NOTE: When a front power take-off is used, tighten bolt (2) to a torque of 950 ± 50 N•m (700 ± 37 lb.ft.). Tighten bolts [for holes (4)] to a torque of 55 ± 7 N•m (40 ± 5 lb.ft.).

5. Install the vee belts and make an adjustment to the belt tension. See the V-BELT TENSION CHART in the SPECIFICATIONS.

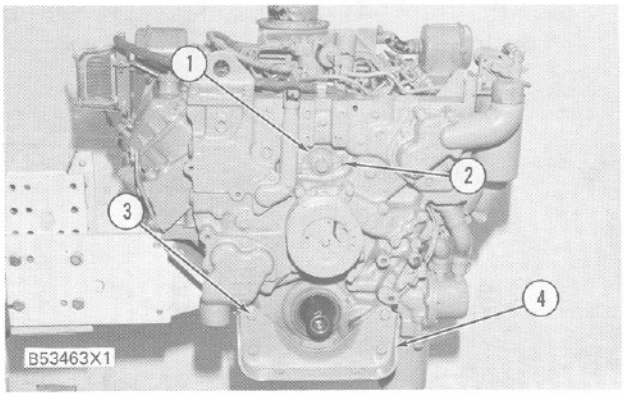


TIMING GEAR COVER AND OIL PUMP

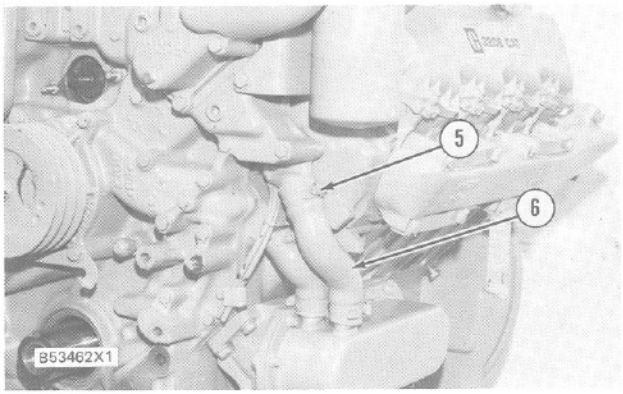
REMOVE TIMING GEAR COVER AND OIL PUMP 1166 & 1304-11

	Tools Needed	A	B
6V116	Water Sleeve Tool	1	
5P9736	Link Bracket		2

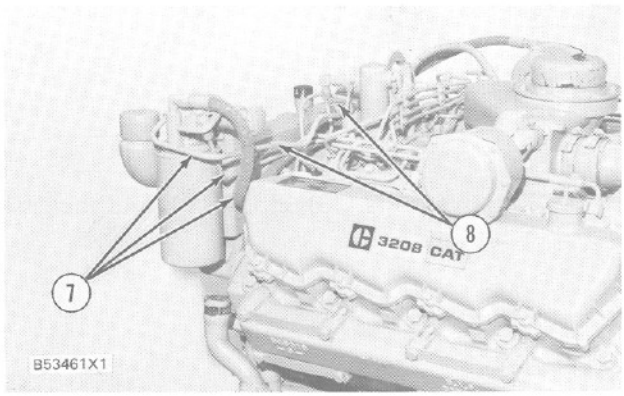
start by:
a) remove oil pan
b) remove crankshaft pulley



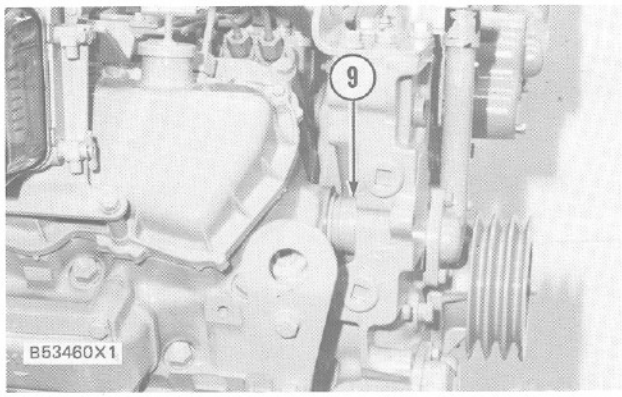
1. Remove nuts (2) and tachometer drive cover (1).



2. Remove bolts (3) and front support (4).



3. Loosen clamp (5) and disconnect hose (6) from the timing gear cover.

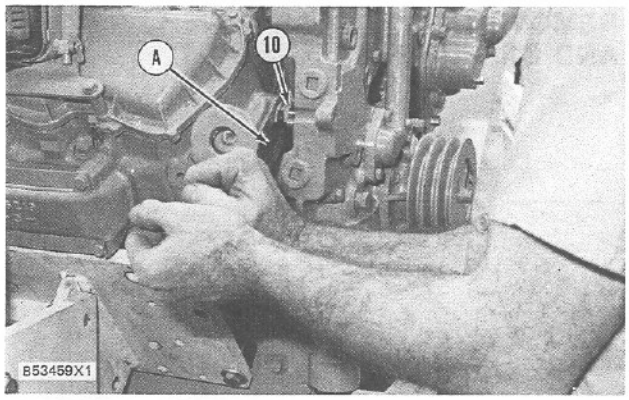


4. Remove clips (8) and then disconnect three lines (7).

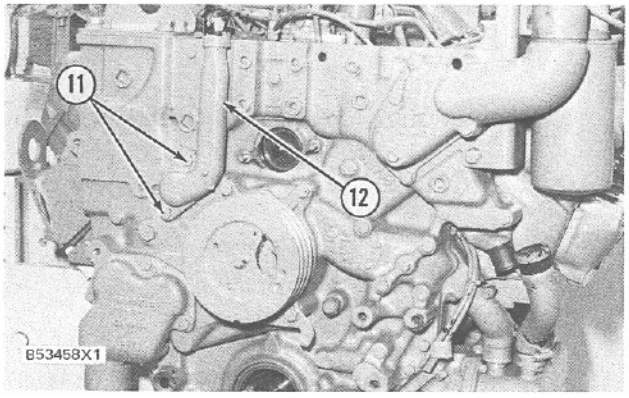
5. Remove clamp (9) from the water sleeve.

TIMING GEAR COVER AND OIL PUMP

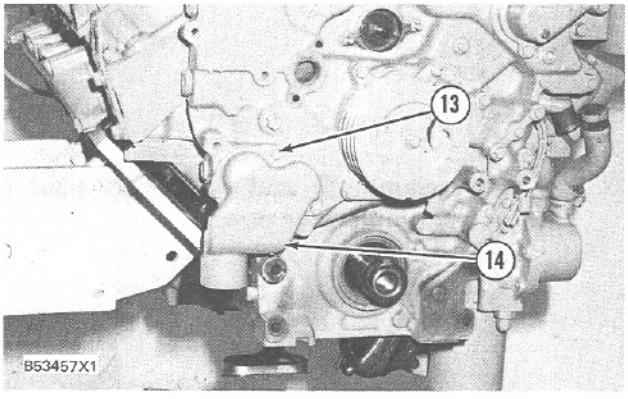
6. Install tool (A) on the water sleeve and then push water sleeve (10) into the front cover.



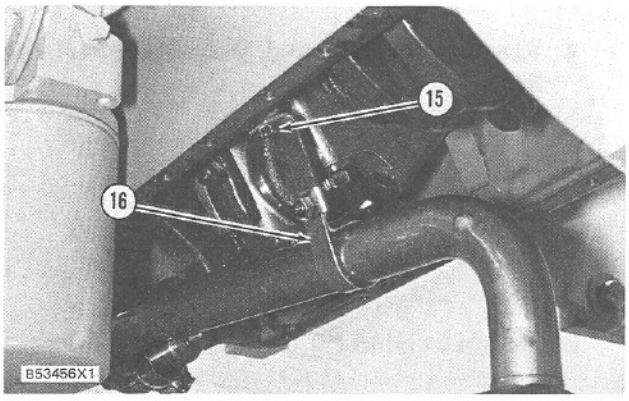
7. Remove two bolts (11), connector (12) and the gasket behind it.



8. Remove bolts (13), elbow (14) and the gasket behind it.

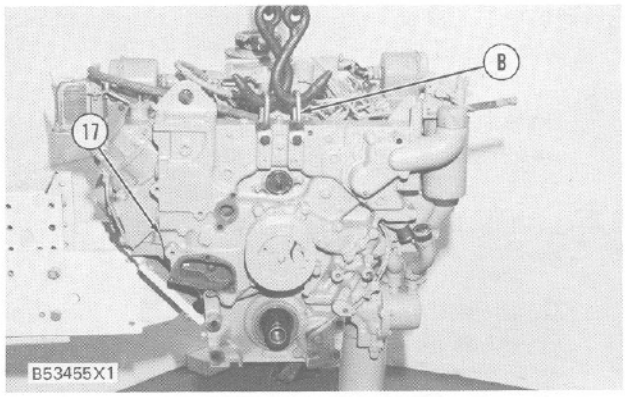


9. Remove bolt (15) and then disconnect clamp (16) that holds the oil pump sump tube.



TIMING GEAR COVER AND OIL PUMP

10. Install tooling (B) in the front cover and then fasten a hoist. Remove all the bolts that hold timing gear cover to the cylinder block. Remove the cover (17) and oil pump. The weight of the timing gear cover and oil pump is 62 kg (136 lb.).



NOTICE

Be extra careful not to cause damage to the crankshaft front seal during removal and installation of the timing gear cover.

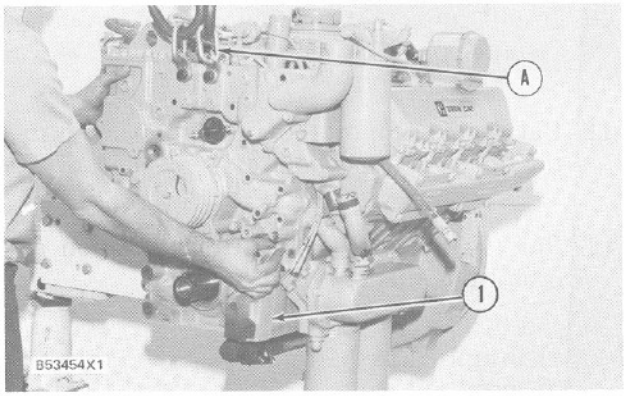
INSTALL TIMING GEAR COVER AND OIL PUMP 1166 & 1304-12

	Tools Needed	A	B
5P9736	Link Bracket	2	
6V116	Water Sleeve Tool		1

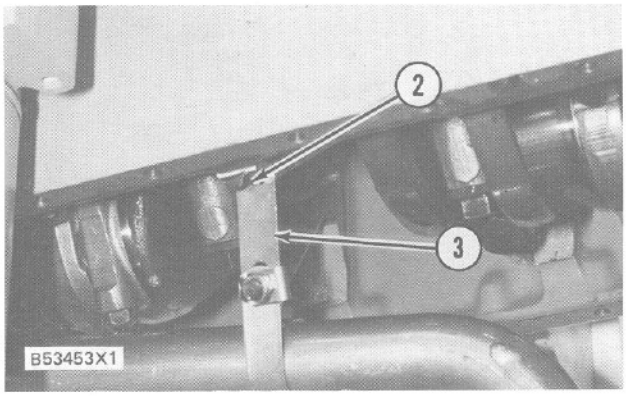
1. Clean the contact surfaces of the cylinder block and timing gear cover. Install the timing gear cover gasket on the cylinder block.

NOTE: Make sure the water sleeves are installed in the timing gear cover. Put oil on the seals on the water sleeves.

2. Install tooling (A) on timing gear cover (1).

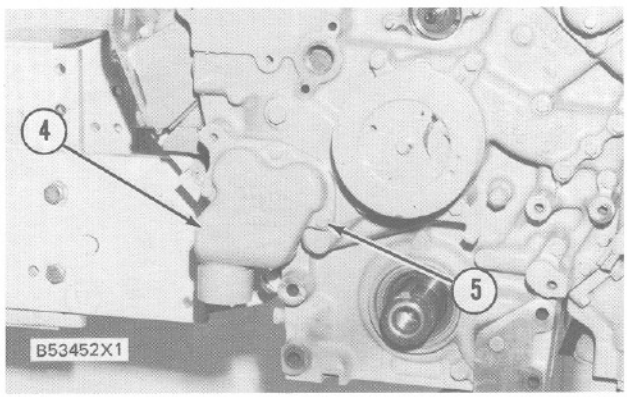


3. Put the cover in position and make an alignment of the dowels and their respective holes. Install the bolts that hold cover (1) to the cylinder block.



4. Connect clamp (3) that holds the oil pump sump tube. Install bolt (2).

5. Install gasket and elbow (4) on the timing gear cover with the bolts (5) that hold it.



TIMING GEAR COVER AND OIL PUMP

6. Install gasket and connector (7) in the cover and install the bolts (6) that hold it.

7. Install tool (B) on water sleeve (8), then push water sleeve into the cylinder block.

8. Install clamps (9) on the water sleeve.

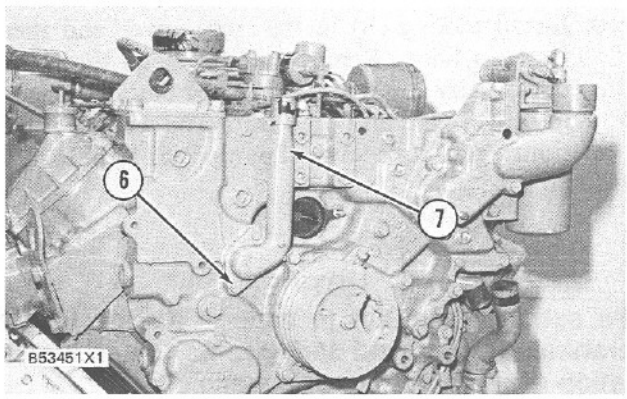
9. Connect three lines (10) and install the clips (11) that hold them.

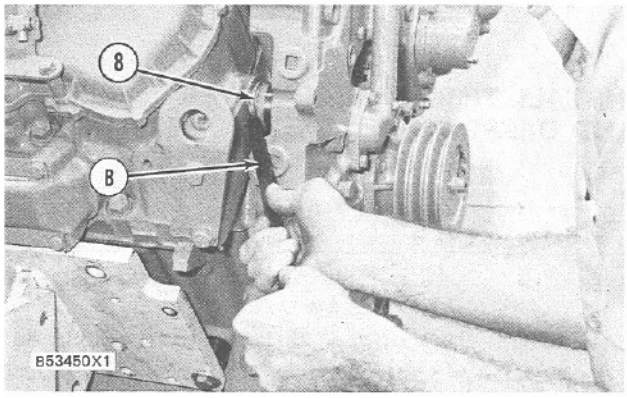
10. Install hose (13) on timing gear cover and install clamp (12).

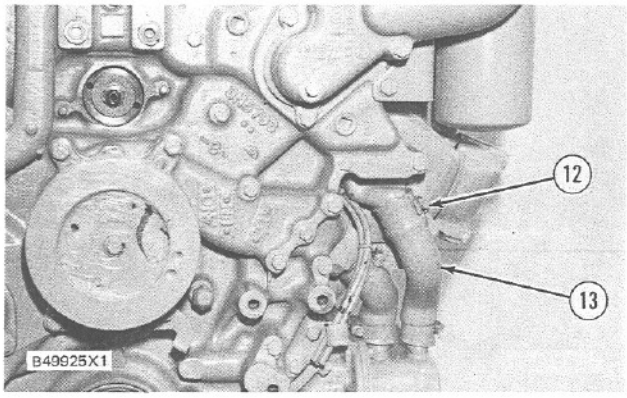
11. Put engine support (16) in position and install the bolts (17) that hold it.

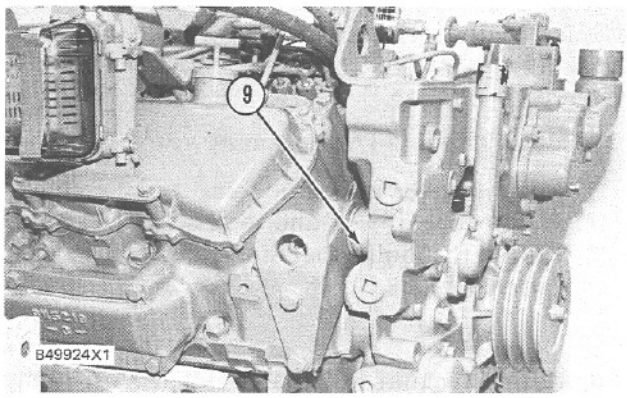
12. Put tachometer cover (15) in position and install the nuts (14) that hold it.

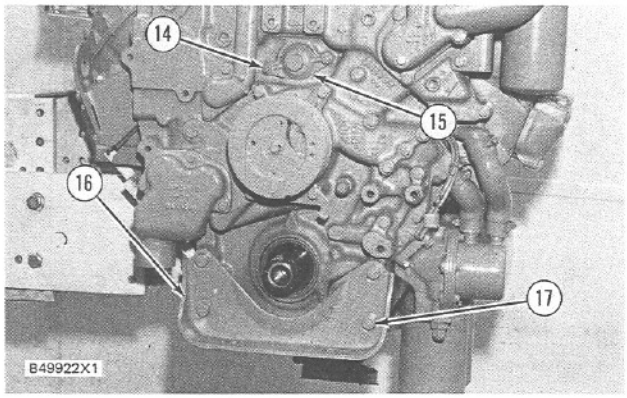
end by:
a) install crankshaft pulley
b) install oil pan

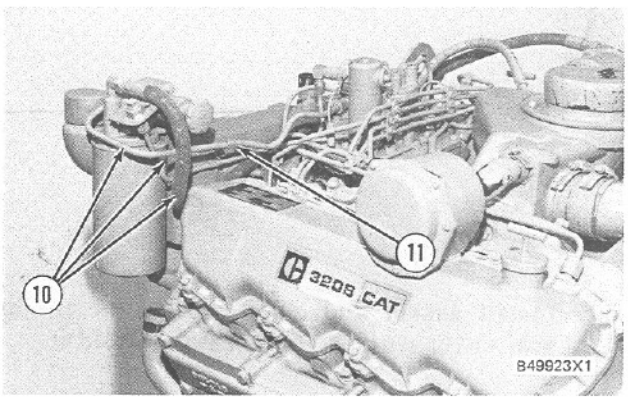










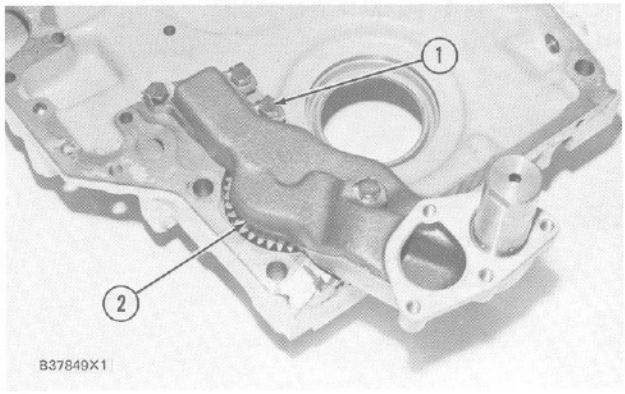


OIL PUMP AND RELIEF VALVE

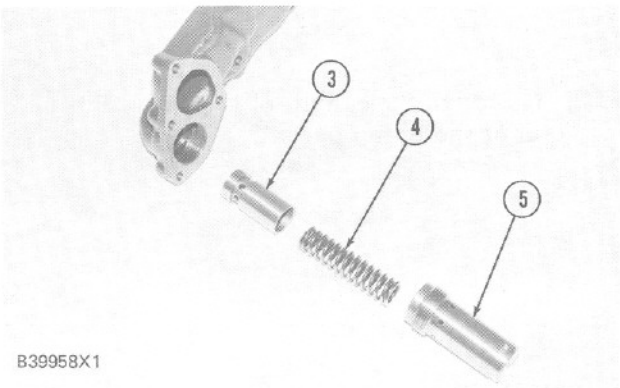
REMOVE OIL PUMP AND RELIEF VALVE 1304 & 1315-11

start by:
a) remove timing gear cover and oil pump

1. Bend the locks away from bolts (1) and remove the bolts. Remove cover (2) from the timing gear cover.

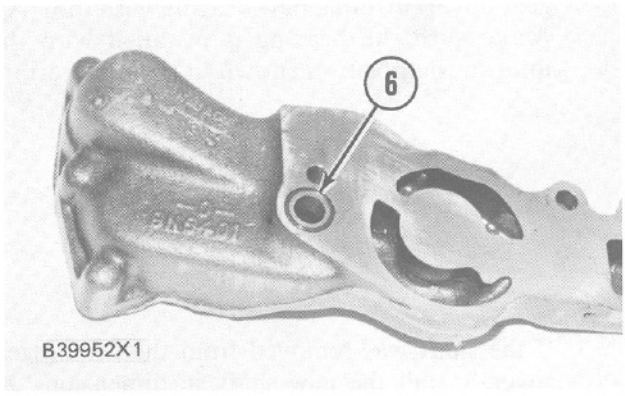


2. Remove guide (5), spring (4) and plunger (3) from the cover.

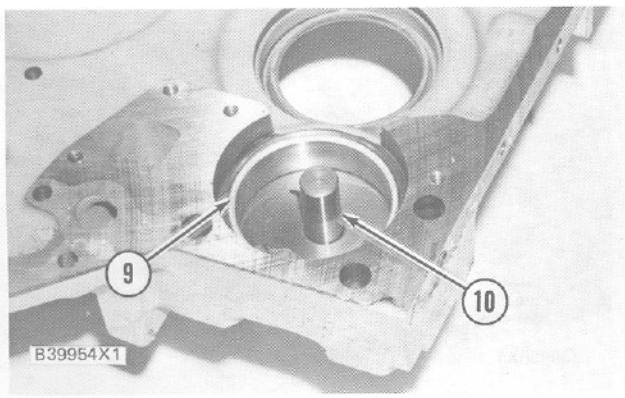


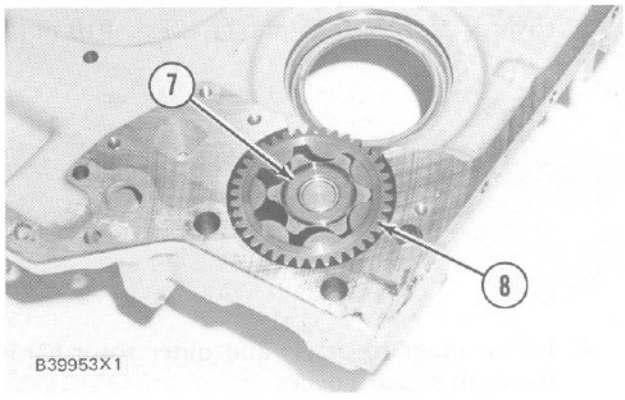
3. Remove O-ring seal (6) from the back of the cover.

4. Remove inner rotor (7) and outer rotor (8) from the timing gear cover.



5. Measure the inside diameter of bearing (9). The inside diameter must be 71.22 ± 0.05 mm (2.804 ± .002 in.). Remove bearing (9) only if a replacement is necessary. Remove shaft (10) if a replacement is necessary.

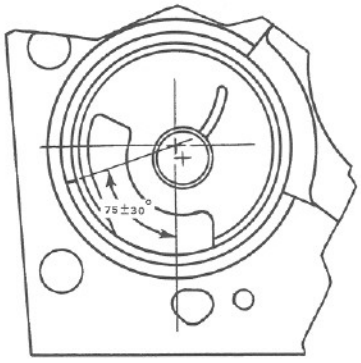




OIL PUMP AND RELIEF VALVE

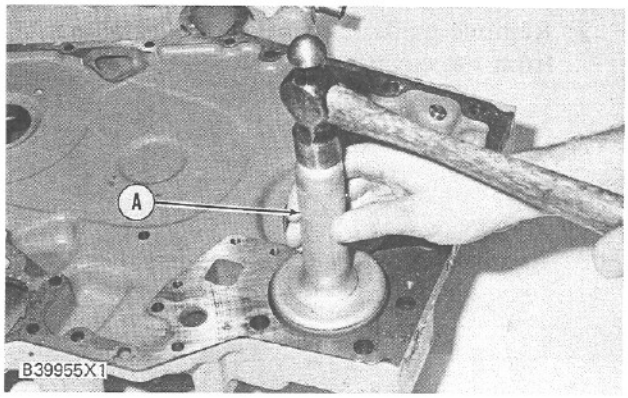
INSTALL OIL PUMP AND RELIEF VALVE 1304 & 1315-12

	Tools Needed	A
8S2285	Driver Assembly	1



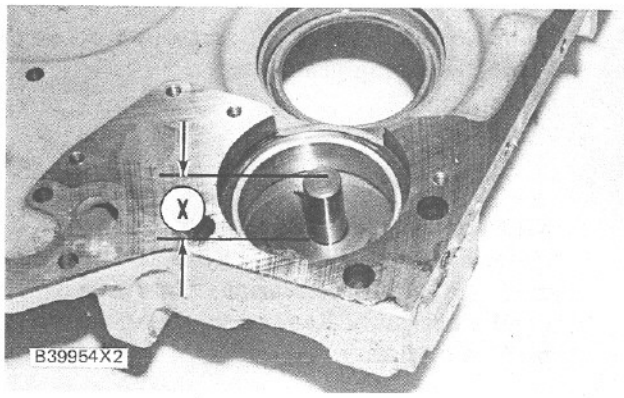
A51104X2

1. Thoroughly clean all of the parts. Put oil on all of the pump parts.



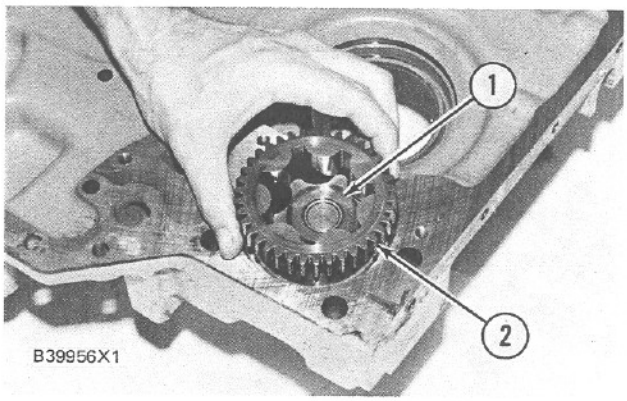
B39955X1

2. If the bearing was removed from the timing gear cover, install a new bearing with tool (A). Make sure the bearing is installed with the joint in the position shown in the illustration.



B39954X2

3. If the shaft was removed from the timing gear cover, install the new shaft so dimension "X" from the top of the shaft to the counterbore in the cover is 36.14 ± 0.25 mm (1.423 ± .010 in.).

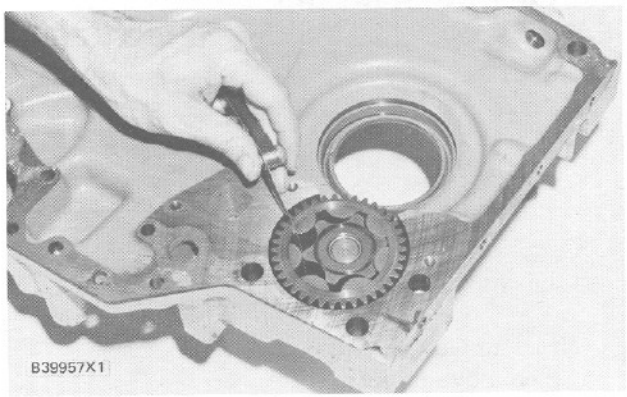


B39956X1

4. Install inner rotor (1) and outer rotor (2) in the timing gear cover.

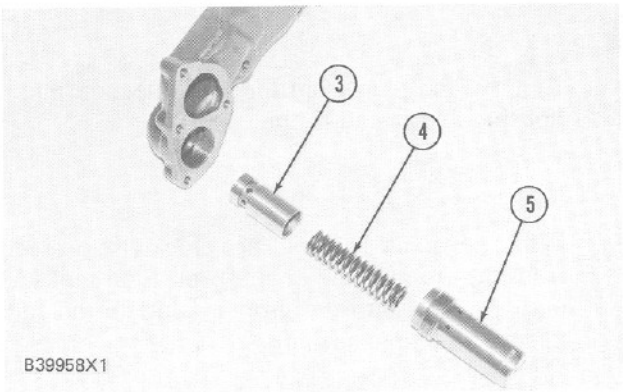
OIL PUMP AND RELIEF VALVE

5. Measure the clearance between the rotors with a feeler gauge. The clearance must be 0.05 to 0.20 mm (.002 to .008 in.). The maximum permissible clearance is 0.28 mm (.011 in.).

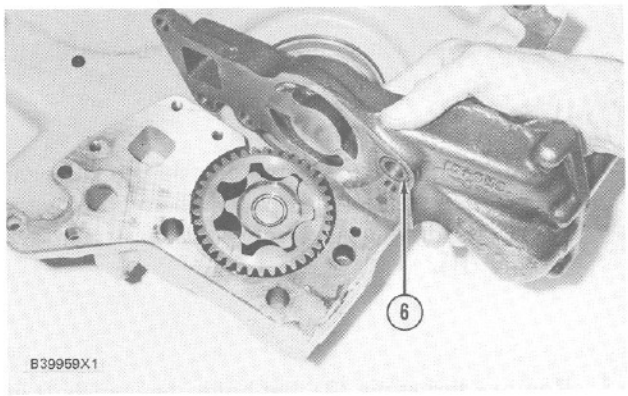


NOTE: Make a replacement of BOTH rotors if the clearance is not correct. The rotors can not be ordered separately.

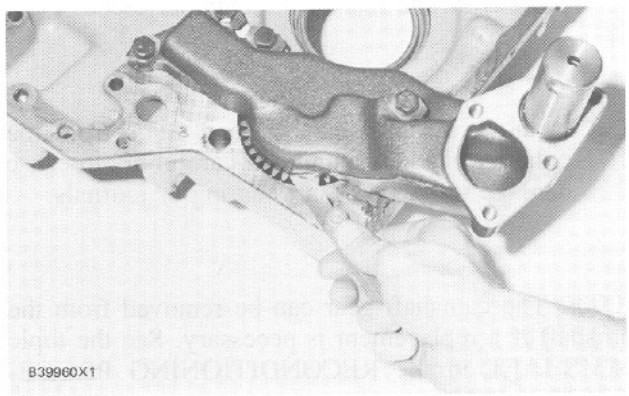
6. Put plunger (3), spring (4) and guide (5) in the cover. Use a 1-1/8 in. crowfoot wrench and torque wrench to tighten guide (5) to a torque of 41 ± 7 N•m (30 ± 5 lb.ft.). A slide rule type torque computer, Form No. SEHS7150, is available to find the torque wrench dial reading for different extensions.



7. Install O-ring seal (6) on the cover and put the cover in position on the timing gear cover. Install the locks and bolts that hold the cover in place.



8. Check the oil pump and clearance with a feeler gauge. The end clearance must be 0.069 to 0.135 mm (.0027 to .0053 in.).



NOTE: If the clearance is not correct, make a replacement of BOTH rotors or the cover.

end by:
a) install timing gear cover and oil pump

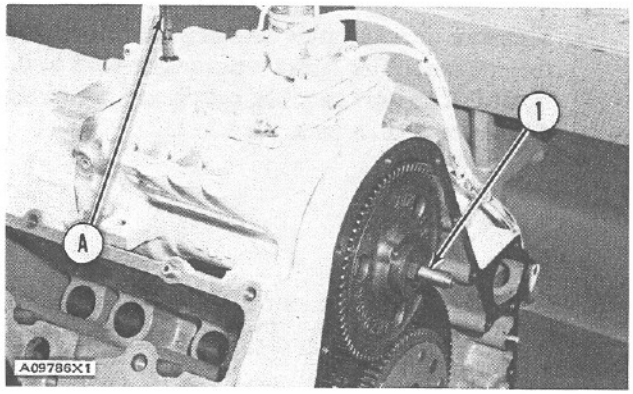
CAMSHAFT AND GEARS

REMOVE CAMSHAFT AND GEARS

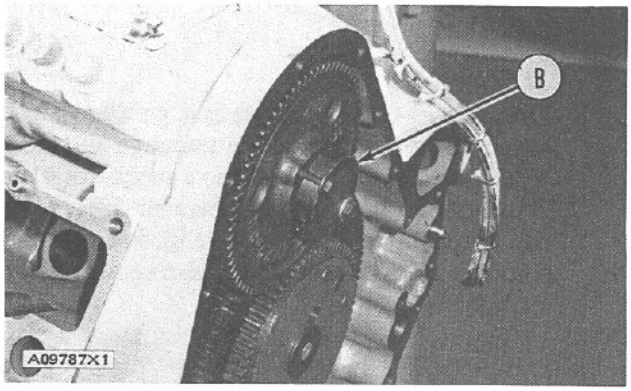
1210 & 1212-11

	Tools Needed	A	B
3P1544	Timing Pin	1	
5P2371	Puller Plate		1
	Bolt (¼"-20 NC x 1" long)		2
	Flat Washer ¼"		2

start by:
a) remove timing gear cover and oil pump
b) remove valve lifters
c) remove turbocharger

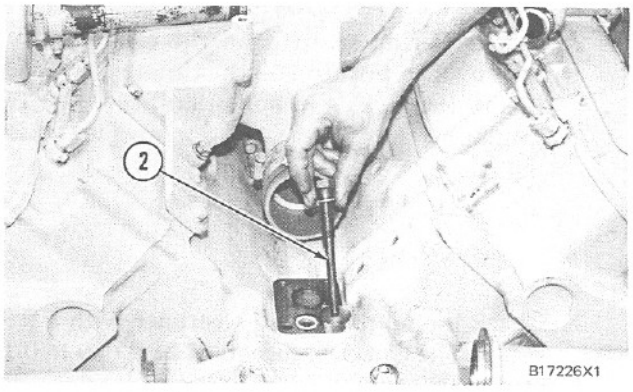


1. Remove the plug from the fuel injection pump housing and install timing pin (A).



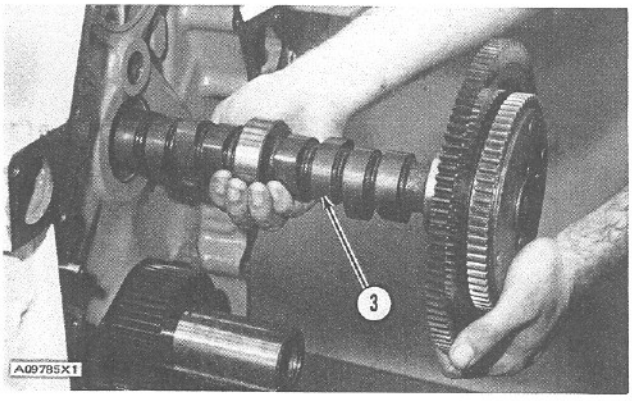
2. While the crankshaft is turned clockwise (as seen from the front of the engine), push on tool (A) until it slides into the groove (slot) in the fuel injection pump camshaft.

3. Remove the tachometer drive adapter shaft (1).



4. Install tooling (B) into the camshaft drive gear for the fuel injection pump. Turn both bolts evenly until the drive gear is free of the shaft. Remove tooling (B).

5. Remove thrust pin (2) that holds the camshaft in place from the rear of the cylinder block.



6. Remove the camshaft (3) and gears from the cylinder block as a unit. Be careful not to cause damage to the camshaft bearing or journals.

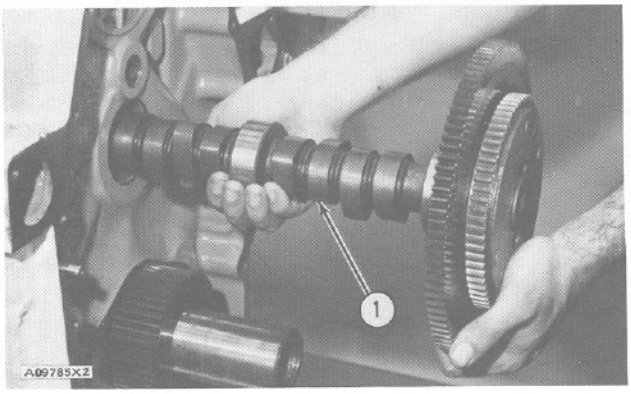
NOTE: The camshaft gear can be removed from the camshaft if a replacement is necessary. See the topic CAMSHAFT in the RECONDITIONING PROCEDURES.

CAMSHAFT AND GEARS

INSTALL CAMSHAFT AND GEARS 1210 & 1212—12

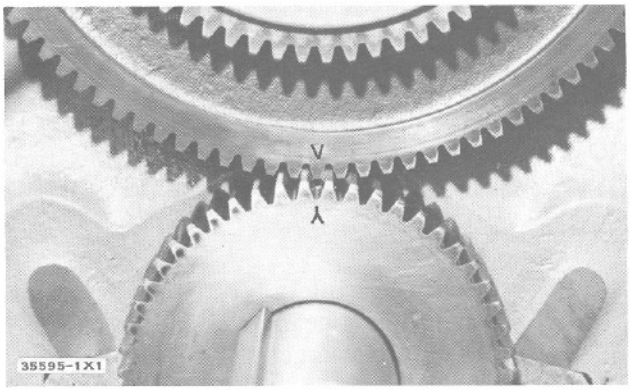
	Tools Needed	A
3P1544	Timing Pin	1

1. Install the camshaft gear on the camshaft if it was removed. Heat the gear to a maximum temperature of 315°C (600°F). Put the gear in position on the camshaft. Put clean engine oil on the camshaft lobes and journals. Install camshaft (1) and the gears as a unit. Make sure the timing marks on the crankshaft gear and camshaft gear are in alignment.



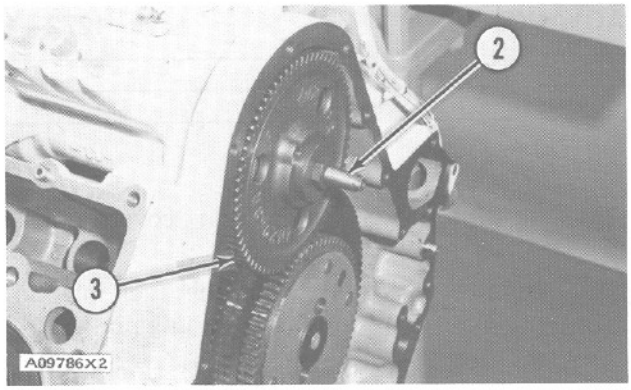
2. Install the thrust pin. Tighten the pin to a torque of 45 ± 7 N•m (35 ± 5 lb.ft.).

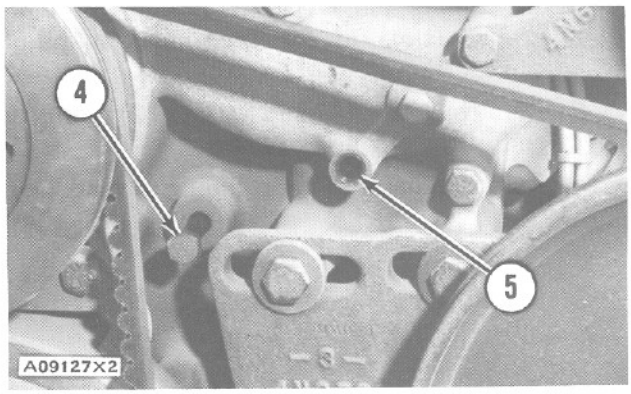
3. Put gear (3) in position and install tachometer drive adapter shaft (2). Tighten the shaft to the correct torque.



NOTE: For the correct torque, see the topic DRIVE GEAR FOR THE INJECTION PUMP in the SPECIFICATIONS.

4. After valve lifters and timing gear cover have been installed, check the timing as follows:
   a) Remove timing pin (A).
   b) Turn the crankshaft clockwise as seen from the front of the engine approximately 1/2 turn. Install timing pin (A) again.
   c) While turning the crankshaft clockwise, push on timing pin (A) until it slides into the groove (slot) in the fuel injection pump camshaft.
   d) Remove the plug from the timing hole in the front cover and install a 5/16"–18 NC bolt (4) 2 1/2 in. long. The cover bolt from hole (5) can be used. Turn the crankshaft clockwise until bolt (4) can be installed into the timing gear and is in the center of the timing hole. The camshaft for the fuel injection pump is now in correct time with the engine.
   e) Remove the bolt and install the plug. Remove timing pin (A) and install the plug.





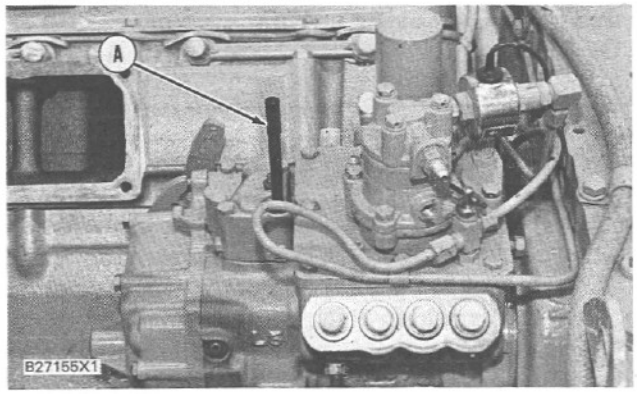
CAMSHAFT AND GEARS, AUTOMATIC TIMING ADVANCE

NOTE: If the bolt can not be installed in the hole of camshaft gear, the timing must be corrected as follows:

a) With timing pin (A) installed, remove the tachometer drive adapter housing and shaft.

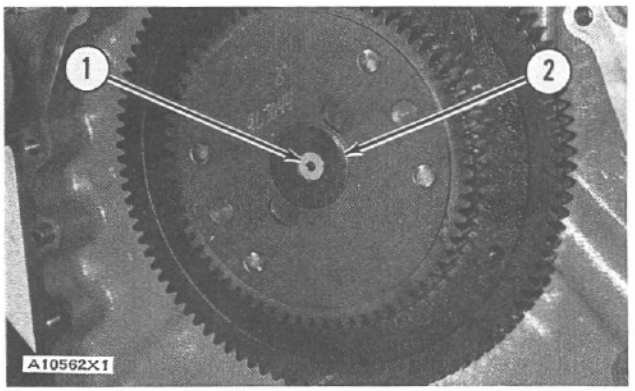
b) Loosen the gear from the fuel injection pump camshaft. Turn the crankshaft clockwise approximately two full turns until bolt (4) can be installed. Install the bolt.

c) Install tachometer drive adapter shaft and tighten it to the correct torque. Install adapter housing. Remove the bolt and timing pin and install the plugs.



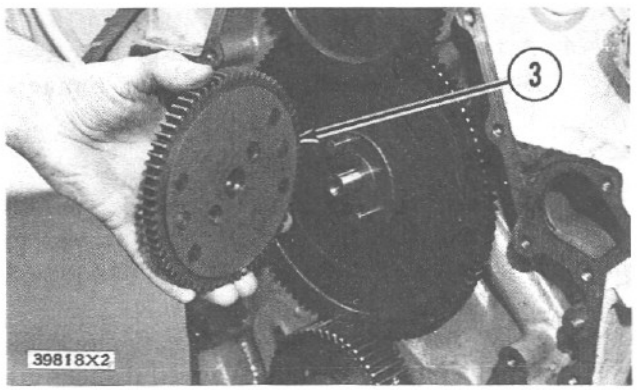
NOTE: For the correct torque, see the topic DRIVE GEAR FOR THE INJECTION PUMP in the SPECIFICATIONS.

end by:
a) install valve lifters
b) install timing gear cover and oil pump
c) install turbocharger



REMOVE AUTOMATIC TIMING ADVANCE 1272—11

	Tools Needed	A
3P1544	Timing Pin	1



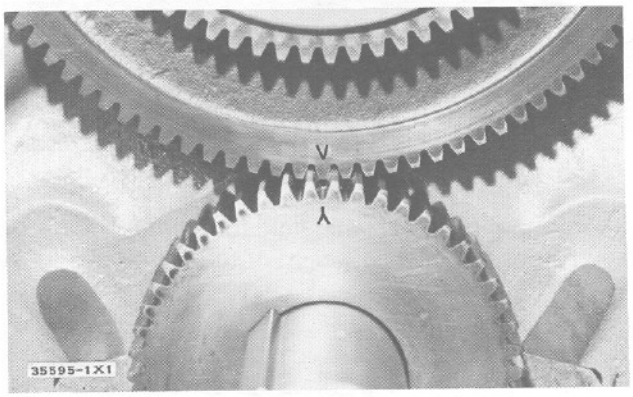
start by:
a) remove timing gear cover and oil pump

1. Remove the plug from the fuel injection pump housing and install timing pin (A).
2. While turning the crankshaft clockwise (as seen from the front of the engine), push on the timing pin (A) until it slides into the groove (slot) in the fuel injection pump camshaft.
3. Remove screw (1) and washer (2) from the end of the engine camshaft.
4. Remove the automatic timing advance (3).

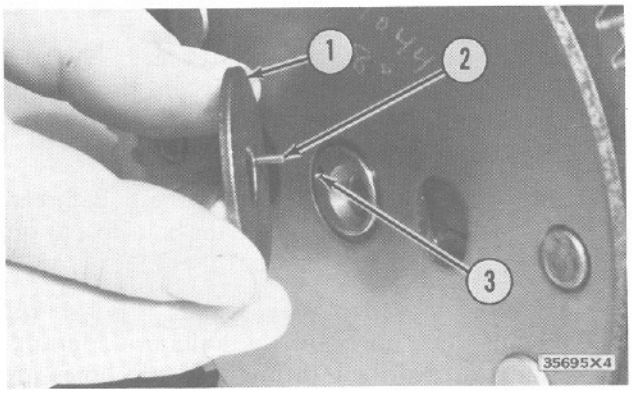
AUTOMATIC TIMING ADVANCE

INSTALL AUTOMATIC TIMING ADVANCE 1272—12

1. If the timing mark on the crankshaft and the timing mark on the camshaft gear are not in alignment, turn the crankshaft clockwise (as seen from the front of the engine) until the marks are in alignment.



2. Put the dowels in the gear in alignment with the holes in the weights and install the automatic timing advance .

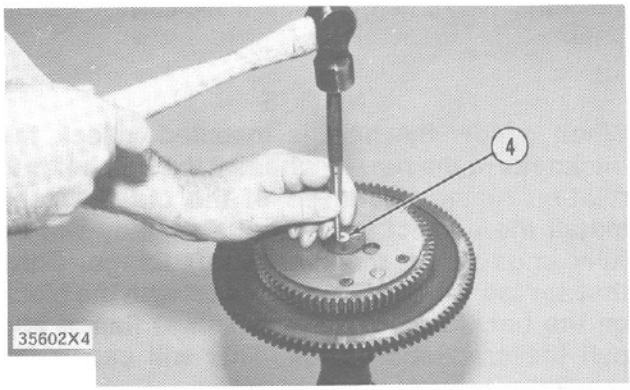


3. Put pin (2) in washer in alignment with hole (3) in the camshaft and install washer (1).

4. Install screw (4) and tighten it to a torque of 7.9 ± 0.6 N•m (70 ± 5 lb.in.). Put marks (stake) on the screw in two places with a hammer and punch.

NOTICE

Put marks (stake) on screw (4) carefully. Too much force pushes the shaft extension into the camshaft and takes away all end clearance.



CAMSHAFT REMOVED FOR PHOTO ILLUSTRATION

5. After marks (stake) are put on screw (4), the end clearance for the gear and weight assembly must be 0.08 to 0.94 mm (.003 to .037 in.). This end clearance will prevent binding against the washer, camshaft end, or camshaft gear.

end by:

a) install timing gear cover and oil pump

FLYWHEEL, FLYWHEEL HOUSING

REMOVE FLYWHEEL 1156-11

	Tools Needed	A
FT121	Lifting Bracket	1
S509	Bolt (3/8"-16 NC x 1 in. long)	1

1. Fasten tool (A) and a hoist to flywheel (2).
2. Remove bolts (1) that hold the flywheel. Remove the flywheel. The weight of the flywheel is 31 kg (60 lb.).

INSTALL FLYWHEEL 1156-12

	Tools Needed	A
FT121	Lifting Bracket	1
S509	Bolt (3/8"-16 NC x 1 in. long)	1

1. Install tooling (A) on the flywheel. Fasten a hoist and put flywheel (1) in position on the crankshaft. Make sure the marks on the flywheel and crankshaft are in alignment.
2. Put 8H5137 Gasket Sealer on the bolt threads and install the bolts. Tighten the bolts to a torque of 75 ± 7 N•m (55 ± 5 lb.ft.).

NOTE: Make sure the correct sealant is put on the bolt threads. The holes for the bolts in the crankshaft flange are drilled through so the holes are open to the oil in the engine. Leakage along the bolt threads can be the result if the correct sealant is not used.

NOTICE

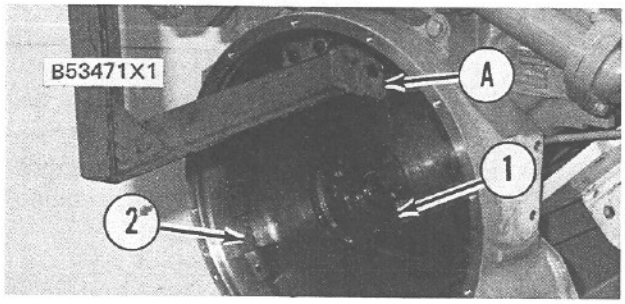
When a new flywheel is installed, check the thickness of the new flywheel at the bolt holes in relation to the thickness of the old flywheel. Install the correct length bolts so they will be fully engaged in the crankshaft flange. Bolts that are too long will make contact with the block on the back side of the crankshaft flange and pull the crankshaft back. This will cause the crankshaft thrust bearing to fail.

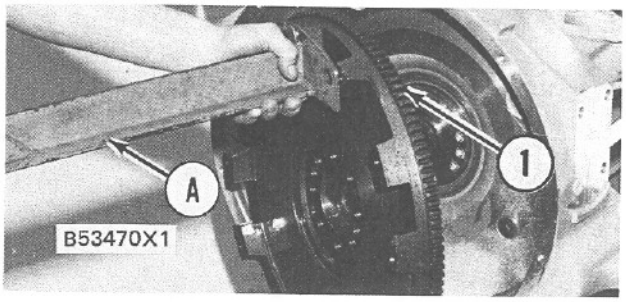
REMOVE FLYWHEEL HOUSING 1157-11

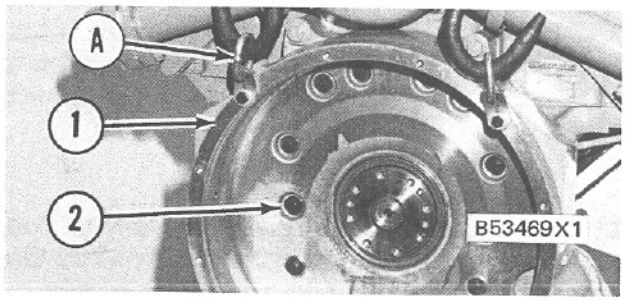
	Tools Needed	A
5P9736	Link Bracket	2

start by:
a) remove starter
b) remove flywheel

1. Loosen the bolts that hold the oil pan to the cylinder block. Remove the bolts that hold the oil pan to the flywheel housing. Fasten tooling (A) and a hoist to the rear of the engine. Lift the rear of the engine and install shims on each side of the cylinder block.







2. Remove the bolts (2) that hold the flywheel housing in place. Remove flywheel housing (1).

INSTALL FLYWHEEL HOUSING 1157-12

	Tools Needed	A
5P9736	Link Bracket	2

1. Clean the contact surfaces of the flywheel housing and cylinder block. Install a new gasket.
2. Put oil on the lip of the rear seal. Put flywheel housing in position and install the bolts.
3. Cut the gasket so it is even with the bottom of the block and flywheel housing. Remove the shims from each side of the block and tighten the bolts for the oil pan. Install remainder of bolts in oil pan.

end by:
a) install flywheel
b) install starter

CRANKSHAFT REAR SEAL AND WEAR SLEEVE

REMOVE CRANKSHAFT REAR SEAL AND WEAR SLEEVE 1161—11

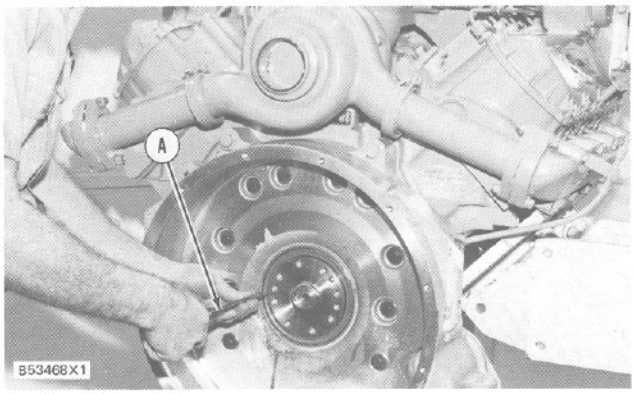
	Tools Needed	A	B	C
1P3075	Puller Assembly	1		
5P7312	Distorter		1	
5P7338	Ring			1

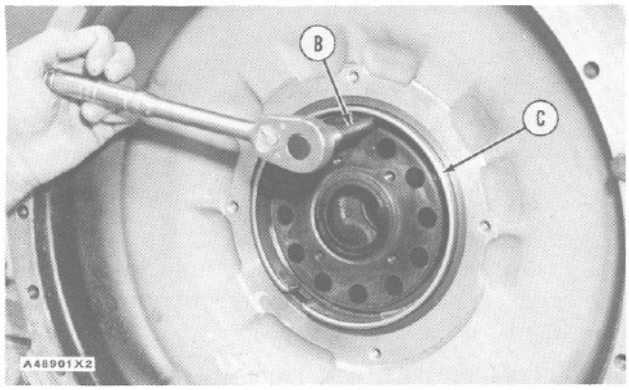
start by:

a) remove flywheel

NOTE: When a replacement of the rear seal is made, a replacement of the wear sleeve is to be made also.

1. Remove the crankshaft rear seal from the flywheel housing with tooling (A).
2. Install tool (C) in the rear seal bore.
3. Install tool (B) between tool (C) and the wear sleeve. Turn tool (B) until the edge of the tool makes a flat place (crease) in the wear sleeve. Do this in two or more places until the wear sleeve is loose.
4. Remove tool (C) and the wear sleeve by hand.



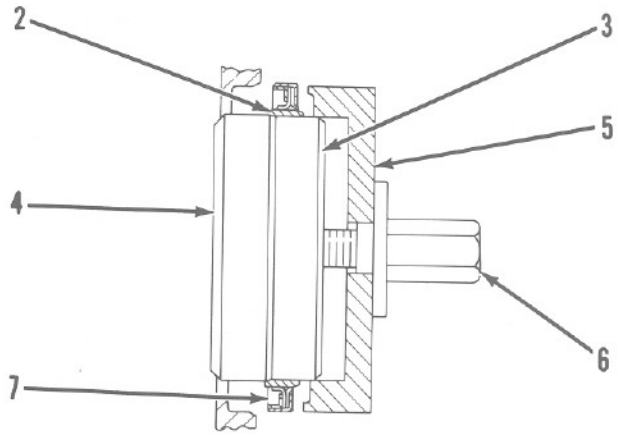


INSTALL CRANKSHAFT REAR SEAL AND WEAR SLEEVE 1161—12

	Tools Needed	A
5P7293	Installer	1
5P290	Locator	1
1P5515	Bolt	2
9S8858	Nut	1

NOTICE

The crankshaft seal and wear sleeve come as a set and must not be separated from each other at any time. Carefully read Special Instruction, Form No. SMHS8508, that is included with each seal and wear sleeve before any handling of the seal group is made.



B84143P4

1. Install the crankshaft rear seal and wear sleeve with tooling (A) as follows:
   a) Clean and make a preparation of the crankshaft outside diameter with 6V1541 Quick Cure Primer. Make an application of 9S3265 Retaining Compound to crankshaft outside diameter.
   b) Install locator (3) and the bolts on the rear of the crankshaft (4).
   c) Put the wear sleeve (2) and seal (7) as a unit on locator (3) with the outside diameter bevel of the wear sleeve toward the outside.
   d) Put installer (5) in position on the locator (3).
   e) Put clean engine oil on the face of nut (6) and install it on the locator. Tighten the nut until installer (5) is at bottom.
   f) Remove tooling (A) and check the wear sleeve and seal for the correct position after installation.

end by:

a) install flywheel

CRANKSHAFT AND GEAR

REMOVE CRANKSHAFT AND GEAR 1202 & 1204-11

	Tools Needed	A	B
	OTC Model 1730-A Engine Stand	1	
8B7551	Bearing Puller Attachment		1
1P820	Puller Group		1
8B7549	Leg		2
8B7561	Step Plate		1
3H465	Plate		4
1B4207	Nut		2
5P3100	Pump Group		1

start by:
a) remove flywheel housing
b) remove valve lifters
c) remove pistons
d) remove timing gear cover and oil pump

1. Fasten a hoist and put the engine in position on tool (A).
2. Turn the crankshaft until the timing mark on the crankshaft gear is in alignment with the timing mark on the camshaft gear.

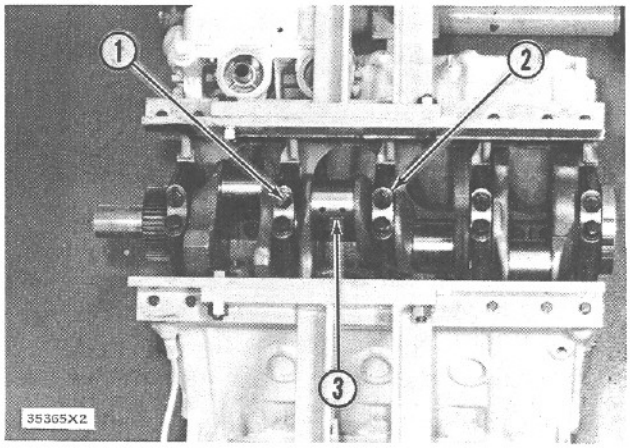
NOTE: For more detail about removal of main bearings see REMOVE AND INSTALL CRANKSHAFT MAIN BEARINGS.

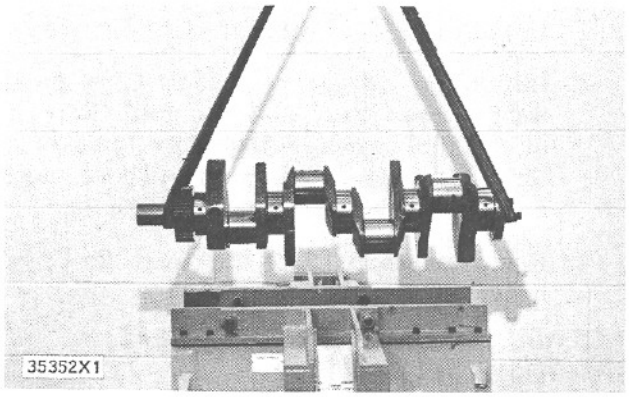
3. Remove bolts (1) and main bearing caps (2). Remove the lower halves of the main bearings from the caps.
4. Install two of the bolts that hold the flywheel in place in the end of crankshaft.
5. Fasten a hoist and remove crankshaft (3) from the engine. The weight of the crankshaft is 54 kg (120 lb.).

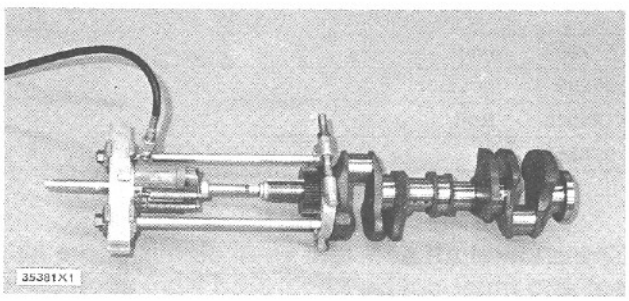
NOTICE

Be careful not to cause damage to the crankshaft journals when the crankshaft is removed.

6. Remove the upper halves of the main bearings from the cylinder block.
7. Install tooling (B) and remove the gear from the crankshaft.







CRANKSHAFT AND GEAR

INSTALL CRANKSHAFT AND GEAR 1202 & 1204-12

	Tools Needed	A	B
8S2328	Dial Test Indicator Group	1	
	Plastigage		*

1. Install the key for the crankshaft gear so it is even with the end of the crankshaft.
2. Heat the crankshaft gear to a maximum temperature of 260°C (500°F). Install the gear on the crankshaft with the timing mark on the gear toward the pulley end of the crankshaft.
3. Install the thrust bearing for the No. 4 main.

NOTE: Install the bearings dry when the clearance checks are made. Put clean engine oil on the bearings for final assembly.

4. Install the upper main bearings (the bearings with oil hole) into the engine block.
5. Install two of the bolts that hold the flywheel in place in the end of the crankshaft. Fasten a hoist and put the crankshaft in position in the block. Make sure the timing mark on the crankshaft gear is in alignment with the timing mark on the camshaft gear.

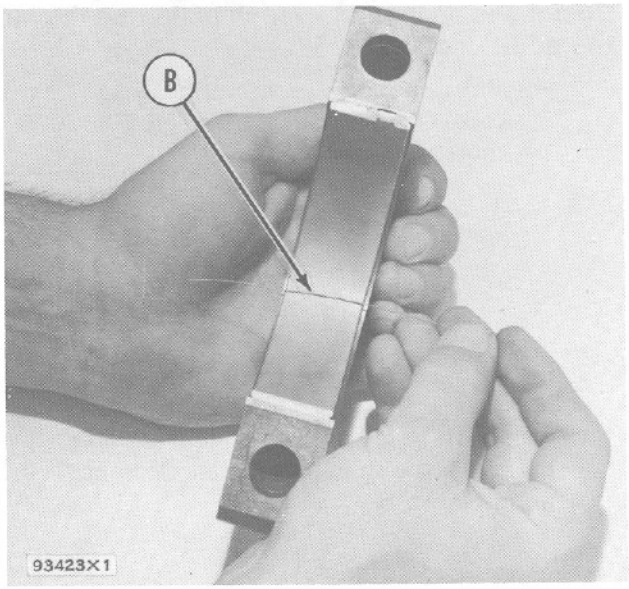
NOTE: For more detail about installation of main bearings see REMOVE AND INSTALL CRANKSHAFT MAIN BEARINGS.

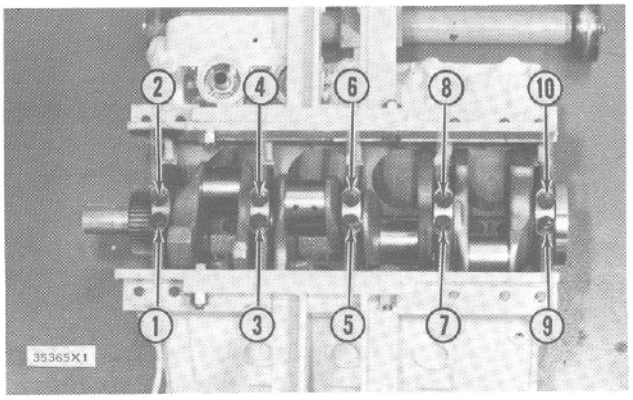
NOTICE

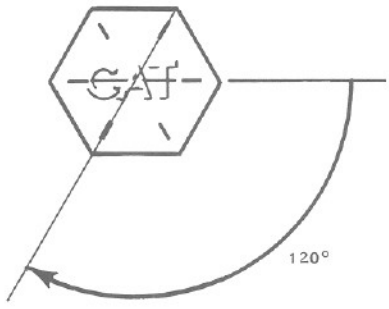
When the bearing caps are installed, make sure the number on the side of the cap is next to and respective with the number on the engine block.

NOTE: When the bearing clearance is checked and the engine is in a vertical position, the crankshaft will have to be lifted up with a force equal to the weight of the crankshaft and held against the upper halves of the main bearings to get a correct measurement with Plastigage. The Plastigage will not hold the weight of the crankshaft and give a correct indication. If the engine is in a horizontal position, such as on an engine stand, it is not necessary to hold the crankshaft up. Do not turn crankshaft when Plastigage is in position to check clearance.

6. Check the bearing clearance with Plastigage. Put the lower main bearings into the caps. Put the caps in position and install the bolts. Tighten the bolts in number sequence as follows:
   a) Tighten bolts 1 through 10 to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.).





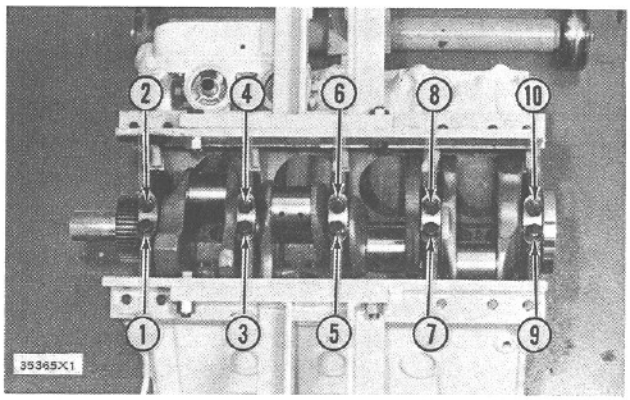


CRANKSHAFT AND GEAR

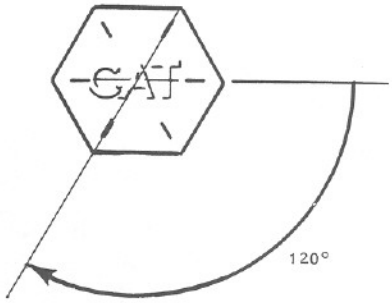
NOTICE

Do not use an impact wrench to tighten the nuts the additional 120 ± 5°.

b) Put a mark on each bolt head and bearing cap. Tighten bolts 1 through 10 120 ± 5° more.



7. Remove the bearing caps and measure the thickness of the Plastigage. The main bearing clearance must be 0.076 to 0.168 mm (.0030 to .0066 in.). The maximum permissible clearance is 0.18 mm (.007 in.).



8. Put 2P2506 Thread Lubricant on the bolt threads and washer faces. Put clean engine oil on the main bearings. Put the bearing caps in position and install the bolts. Tighten the bolts in number sequence as follows:
   a) Tighten bolts 1 through 10 to a torque of 40 ± 4 N•m (30 ± 3 lb.ft.).
   b) Put a mark on each bolt head and bearing cap. Tighten bolts 1 through 10 120 ± 5° more.

9. Install indicator group (A) and check the end play of the crankshaft. The end play is controlled by the thrust bearing on No. 4 main bearing. The end play with new bearing must be 0.08 to 0.25 mm (.003 to .010 in.). The maximum permissible end play with used bearing is 0.36 mm (.014 in.).

end by:
a) install timing gear cover and oil pump
b) install pistons
c) install valve lifters
d) install flywheel housing

CAMSHAFT BEARINGS

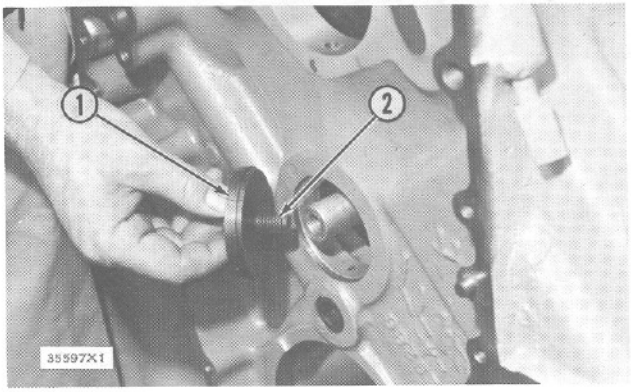
REMOVE CAMSHAFT BEARINGS 1211-11

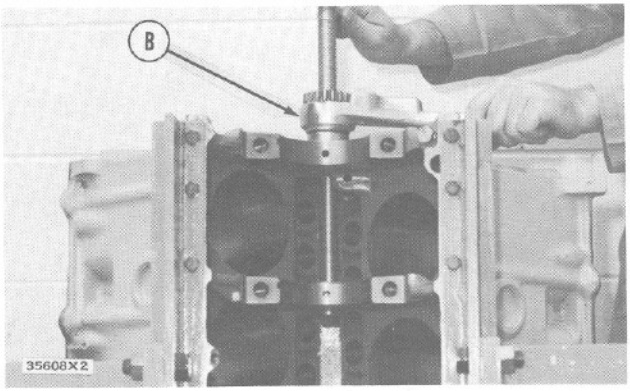
	Tools Needed	A	B
1P5545	Adapter Group	1	
8S2241	Camshaft Bearing Installation and Removal Group		1
8H684	Ratchet Box Wrench		1

start by:
a) remove crankshaft and gear
b) remove camshaft and gears

NOTE: The crankshaft does not have to be removed for removal and installation of the camshaft bearings, but must be removed to correctly clean the oil passages in the cylinder block.

1. Install tooling (B) through the flywheel housing end of the cylinder block.
2. Install washer (1) and bolt (2) from tool group (A) in the end of the shaft of tooling (B). Remove the bearings from the cylinder bolck. Start with the front bearing.
3. Thoroughly clean the oil passages and surfaces where the camshaft and bearings fit.

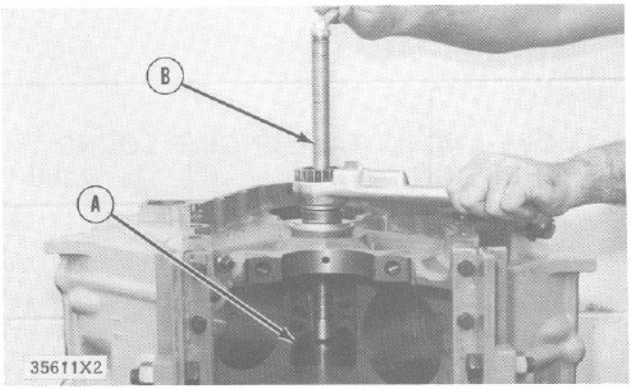




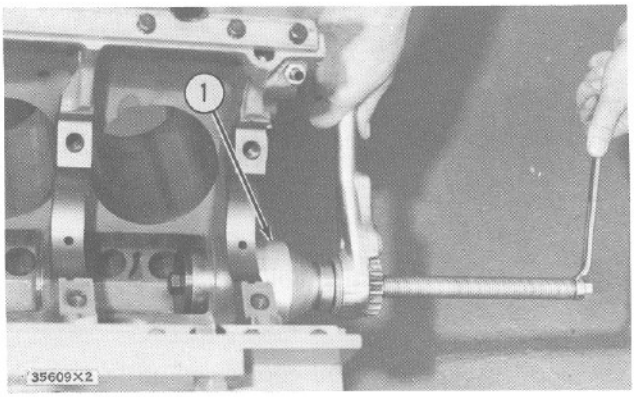
INSTALL CAMSHAFT BEARINGS 1211—12

	Tools Needed	A	B
1P5545	Adapter Group	1	
8S2241	Camshaft Bearing Installation and Removal Group		1
8H684	Ratchet Box Wrench		1

1. Start with the rear camshaft bearing and install the bearings in the cylinder block with tooling (A) and (B). Make sure the oil holes in the bearing are in alignment with the oil holes in the cylinder block.



2. To install the front camshaft bearing, put tube (1) from tool group (B) in position shown with the tube over the boss on the front of the cylinder block and pull the bearing into place. Make sure the oil holes in the bearings are in alignment with the oil holes in the cylinder block.
end by:
a) install camshaft and gears
b) install crankshaft and gear

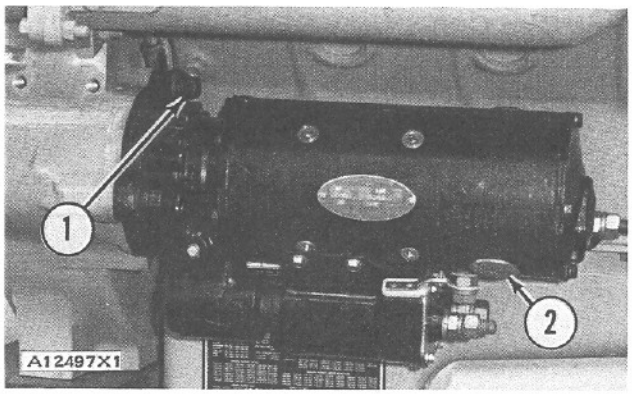


STARTER, ENGINE SOUND SUPPRESSION

REMOVE STARTER

1453-11

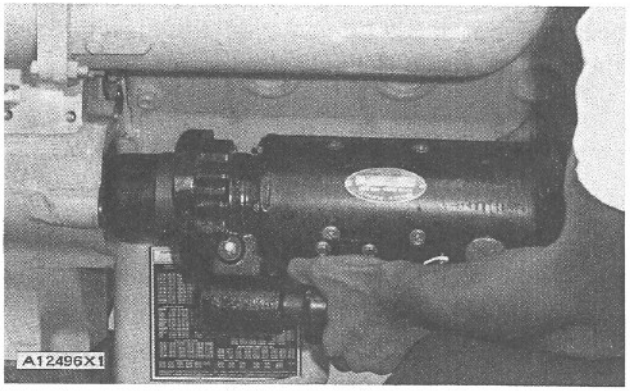
1. Disconnect the battery cables.
2. Disconnect and put identification on the wiring.
3. Remove bolts (1) and starter (2).



INSTALL STARTER

1453-12

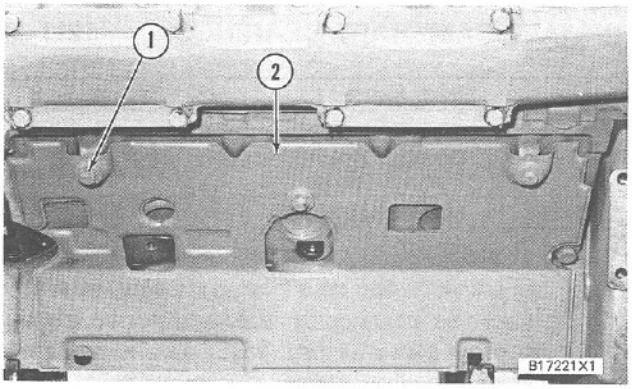
1. Put the starter in position on the engine.
2. Install the bolts.
3. Connect the wiring and battery cables.

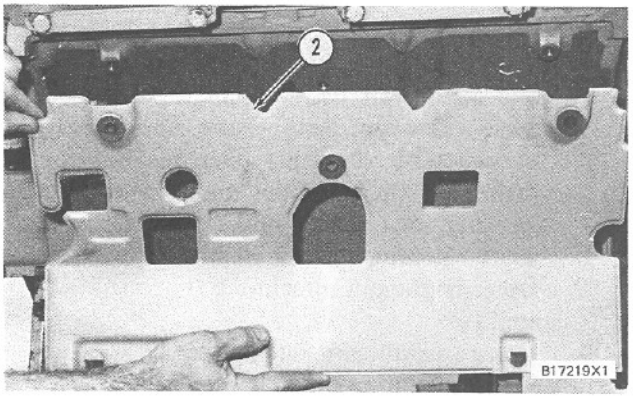


REMOVE AND INSTALL ENGINE SOUND SUPPRESSION 7260-10

start by:
a) remove engine oil cooler and oil filter base

1. Remove three bolts (1) and remove sound suppression (2).
2. Put sound suppression (2) in position.
3. Install the bolts that hold the sound suppression in place.
end by:
a) install engine oil cooler and oil filter base





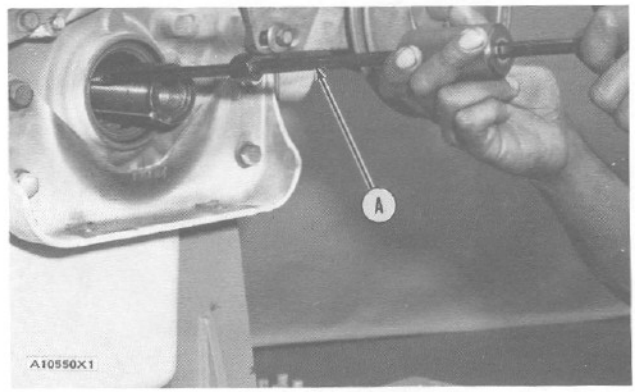
CRANKSHAFT FRONT SEAL

REMOVE CRANKSHAFT FRONT SEAL 1160—11

Tools Needed		A
1P3075	Puller Group	1

start by:
a) remove crankshaft pulley

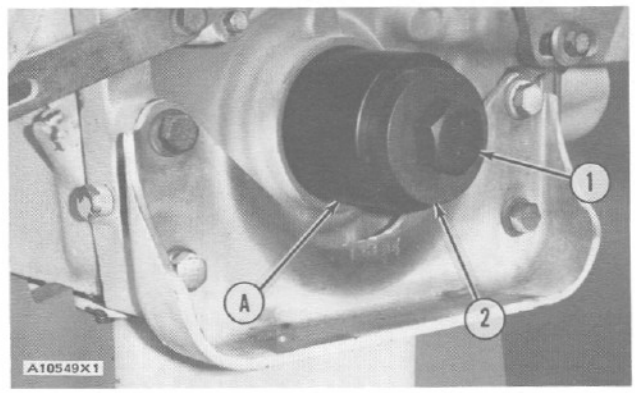
1. Remove the front seal with tool group (A).



INSTALL CRANKSHAFT FRONT SEAL 1160—12

Tools Needed		A
5P4194	Installer Assembly	1
2H3745	Bolt (1"-14 NF x 2 3/4 in. long)	1

1. Put 7F2770 Cement on the outer metal surface of the front seal. Put the seal in position on the short end of the installer assembly (A). The lip of the seal must be toward the inside of the engine.



NOTE: If a new wear surface for the front seal is needed, put the spacer from tooling (A) between the seal and flange of the installer assembly.

2. Put the seal and installer assembly in position on the end of the crankshaft. Install washer (2) that is used to hold the crankshaft pulley and the 2H3745 Bolt (1). Tighten the bolt until the installer assembly makes contact with the crankshaft gear. Remove tooling (A) and washer (2).

end by:
a) install crankshaft pulley