

**300 and 400 Series
Diesel Engines and
Fuel Systems**

Service Manual

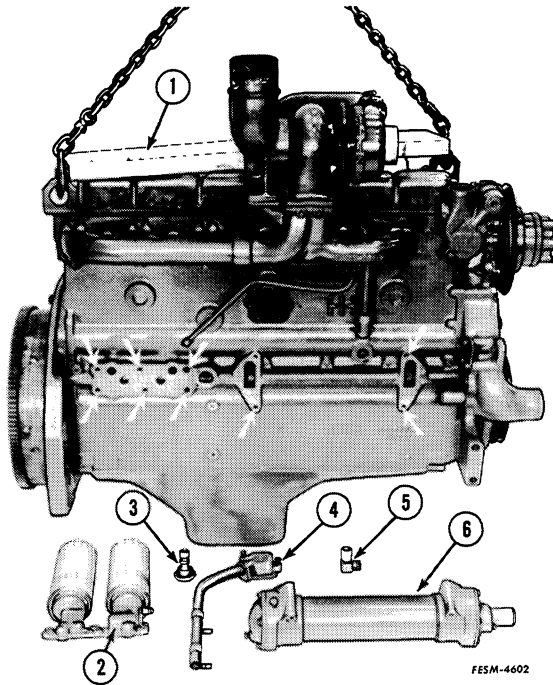
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CASE

MOUNTING THE ENGINE TO THE STAND

NOTE: Refer to the appropriate chassis manual for information on engine removal.

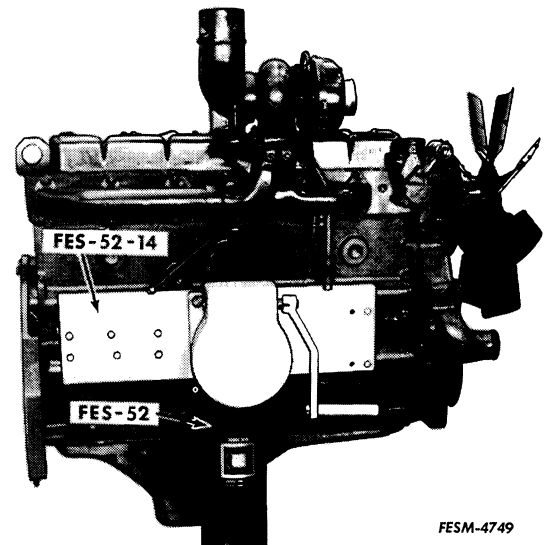


1. 2 x 4
2. Oil filter base
3. Pressure regulator valve
4. Crankcase ventilation tube
5. Turbocharger oil return elbow
6. Oil cooler

Remove the crankcase ventilation tube (4), oil cooler (6), pressure regulator valve (3), turbocharger oil return elbow (5) and the oil filter base (2) with filters from the crankcase.

The crankcase bolt holes pointed out are to be used when installing the engine attaching plate FES 52-14.

Mount the engine in the engine stand FES 52.



MANIFOLDS

GENERAL

INTAKE MANIFOLD

The intake manifold, located on the left side of the engine, serves as a passage for filtered air to enter the combustion chamber. Manifold design and configuration varies with application (Turbocharger vs. naturally aspirated).

EXHAUST MANIFOLD

The exhaust manifold, mounted on the right side of the engine, contains six passages which remove exhaust gases from each cylinder.

Air flows through the intake manifold (with the boost of a Turbocharger on some engine models) into the cylinder head combustion chamber. By special cylinder head design the air swirls to bring about high turbulent air-to-fuel mixing.

Correct torque values are necessary when installing manifolds to avoid leaks and assure full "boost" by turbocharged engines.

INTERCOOLER

The intercooler is a heat exchanger that removes heat generated by compression of air in the turbocharger and transfers the heat to the cooling system. Cooling the air intake charge increases the effectiveness of fuel/air mixture.

IMPORTANT: Installing intercoolers on engines not so equipped will increase the cooling load on the cooling system and may cause overheating in high ambient conditions.

PATCH TYPE INTAKE MANIFOLD MOUNTING BOLTS

A prevailing torque type bolt with plastic patch (Fig. 2) has replaced the standard intake manifold mounting bolt. The new patch type bolt provides a more secure retention with the intake manifold and cylinder head.

In the event of intake manifold repair, the standard type bolt should be replaced by the patch type bolt.

IMPORTANT: Refer to appropriate parts catalog for the particular application when ordering bolts so the correct length(s) are obtained.

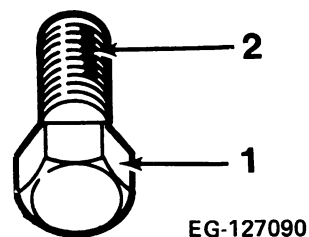


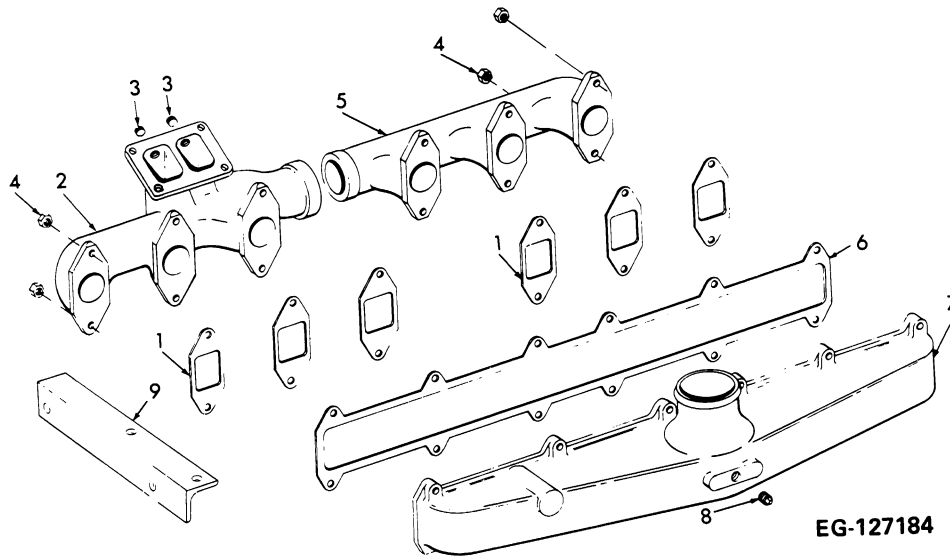
Figure 2 – Patch Type Bolt

1. Bolt
2. Plastic Patch

SPECIFICATIONS

Intake Manifold Bolt	
Torque Data	27 N·m (20 lbf-ft)
Exhaust Manifold Nut	
Torque Data	77 N·m (57 lbf-ft)
Exhaust Manifold	
Flange Thickness	19.05 mm (.75 in.)

MANIFOLDS



Intake and Exhaust Manifold (400 Series Turbocharged Shown)*

1. Exhaust Manifold Gaskets (6)
2. Front Exhaust Manifold
3. Plug (2)
4. 7/16" Nut & Special Hardened Washer (12)
5. Rear Exhaust Manifold
6. Intake Manifold Gasket
7. Intake Manifold
8. Square Head Pipe Plug
9. Either Starting Support

***NOTE: Engine application variations exist which may alter the appearance of front exhaust manifold and intake manifold, from that shown above.**

() Denotes quantity

EXHAUST MANIFOLD PIPE PLUGS – 400 SERIES ENGINES

The exhaust manifold pipe plugs are now made of brass instead of steel as previously specified. This material change will ease removal of the exhaust manifold plugs when performing engine diagnostic tests. When performing these tests, if the displaced steel plugs are removed, it is suggested that they be replaced with the new brass plug, item 3 above.

NEW PARTS

444 614
444 614

DESCRIPTION

Plug, Pipe (1/8" – 27 NPT)
Plug, Pipe (1/8" – 27 NPT)

DISPLACED PARTS

444 612
445 684

MANIFOLDS

REMOVAL AND DISASSEMBLY

Remove Manifolds as Follows:

INTAKE MANIFOLD – (D and DT Engines)

1. Disconnect Turbocharger crossover tube (2, Fig. 3 or Fig. 3a) (if equipped) from intake manifold (1).
2. Remove fuel lines (as an assembly) as follows:
 - a. Disconnect fuel lines (3, Fig. 3 or 3, Fig. 3a) at injection nozzles and pump.
 - b. (Engines equipped with UTDS* Model 100 Fuel Injection Pump only) Loosen clamp (4) securing fuel lines to the hose connecting final fuel filter to injection pump.

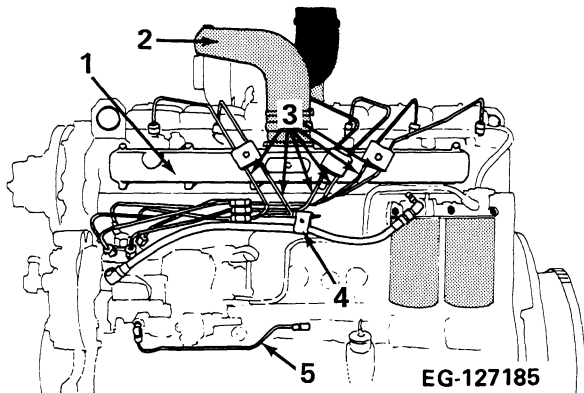


Figure 3 – Left Side View DT-466 (w/UTDS* Model 100 Fuel Injection Pump)

1. Intake Manifold
2. Outlet Pipe
3. Fuel Lines
4. Clamp
5. Lube Oil Tube

- c. After removing fuel lines cap all injection nozzle openings, pump and line openings to prevent dirt from entering.
3. Remove cap screws securing intake manifold to cylinder head; then remove manifold and manifold gasket.

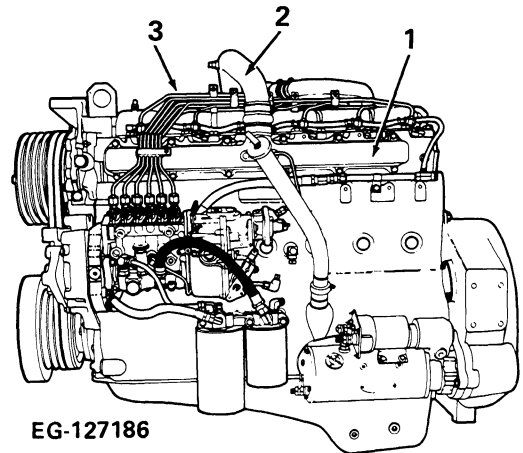


Figure 3a – Left Side View DT-466C
(w/Robert Bosch Model MW Fuel Injection Pump)

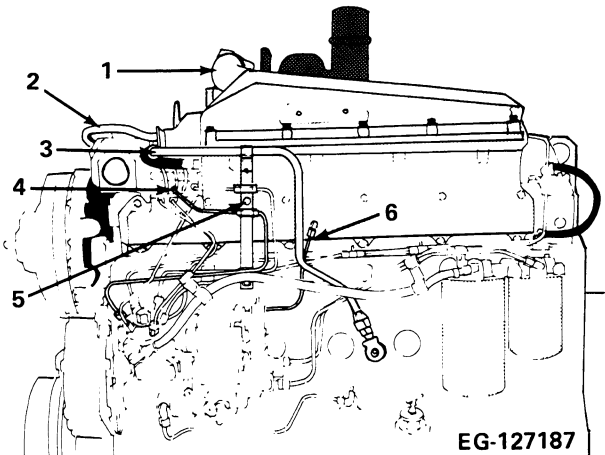
1. Intake Manifold
2. Outlet Pipe
3. Fuel Lines

*United Technologies Diesel Systems
(formerly AMBAC)

MANIFOLDS

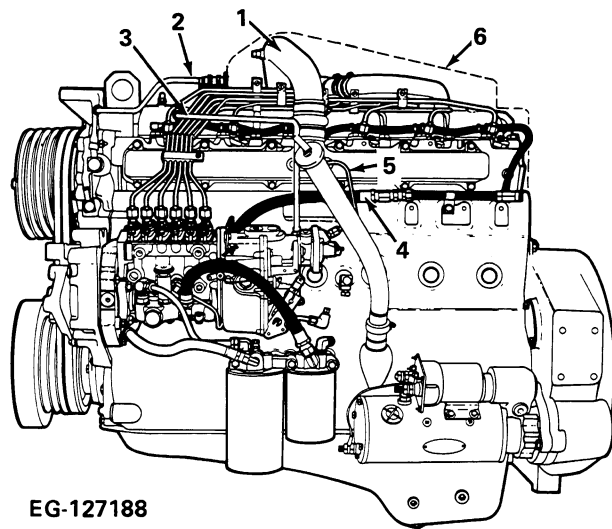
Intake Manifold – (DTI Engines)

1. Remove turbocharger to intercooler pipe (1, Fig. 4 or 4a).
2. Disconnect water inlet (2) and outlet hoses (3) at intercooler.
3. Remove fuel lines (as an assembly) as follows:
 - a. disconnect fuel lines at injection nozzles and pump.
 - b. (Figure 4 only) loosen clamps (4 and 5) which secure fuel lines to the intercooler.
 - c. (Figure 4a only) disconnect fuel return line (4).
 - d. remove fuel lines and cap all openings.
4. Remove aneroid tube (6, Fig. 4 or 5, Fig. 4a) and cap openings.
5. Remove bolts securing intercooler to cylinder head; then remove intercooler gasket.



**Figure 4 – Left Side View (DTI-466B)
(with UTDS* Model 100 Fuel
Injection Pump)**

- | | |
|----------------------|-----------------|
| 1. Turbo Outlet Pipe | 4. Clamp |
| 2. Water Inlet Pipe | 5. Clamp |
| 3. Water Outlet Tube | 6. Aneroid Tube |



**Figure 4a – Left Side View (DTI-466C)
(with Robert Bosch Model MW
Fuel Injection Pump)
[With Intercooler]**

- | | |
|----------------------|--------------------------|
| 1. Turbo Outlet Pipe | 4. Fuel Return Line |
| 2. Water Inlet Pipe | 5. Aneroid Tube |
| 3. Water Outlet Tube | 6. Intercooler (outline) |

*United Technologies Diesel Systems
(formerly AMBAC)

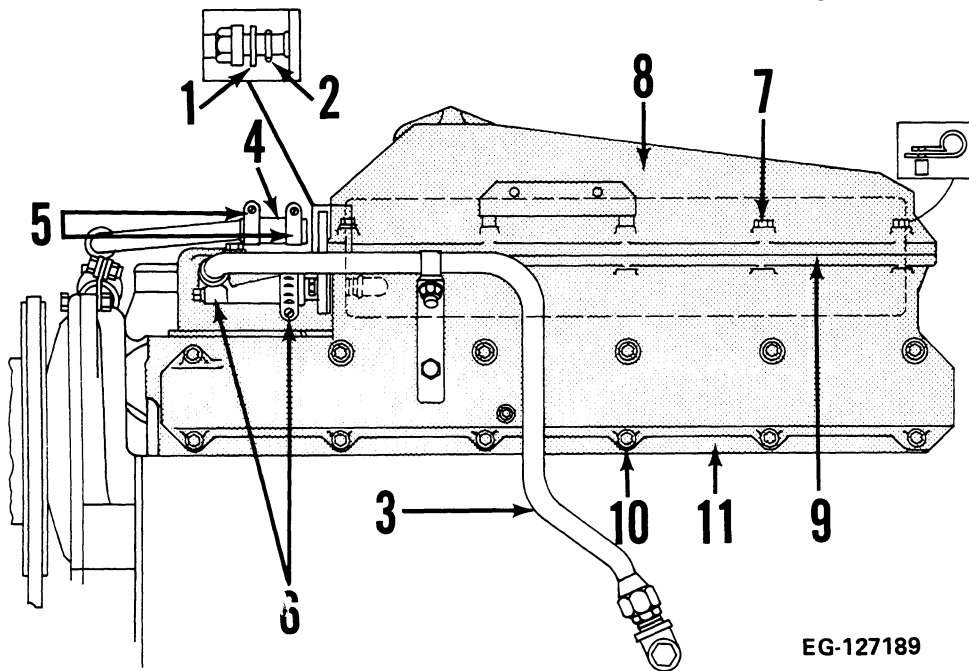
MANIFOLDS

Exhaust Manifold – (D, DT and DTI Engines)

1. Remove Turbocharger (if equipped). Refer to Section 1.
2. Remove stud nuts and washers securing the exhaust manifold to the cylinder head.
3. Remove manifold and manifold gaskets.

Disassemble Intercooler as Follows:

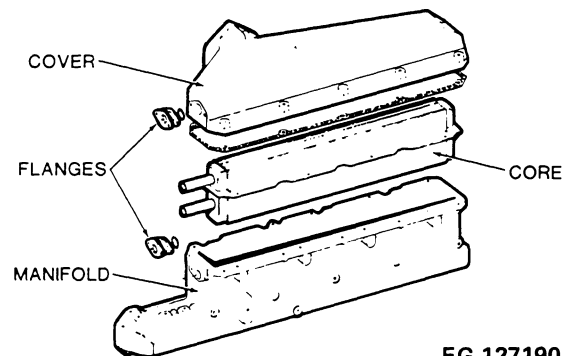
1. Remove flange (1, Fig. 5a), gaskets (2) and "O" rings on the intercooler coolant inlet 3 and outlet hoses (4).
2. Remove the cover bolts (7) then remove the cover (8) and gasket (9).
3. Remove the housing bolts (10) to disassemble the core (Fig. 5b) from the housing (11).



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Figure 5a – Intercooler Disassembly Sights
AE Application Shown (Others Similar)

1. Intercooler Water Flange
2. Intercooler Flange Gasket
3. Water Inlet Hose
4. Water outlet Hose
5. Outlet Hose Clamps
6. Inlet Hose Clamp
7. Intercooler Cover Bolts
8. Intercooler Cover
9. Intercooler Cover Gasket
10. Intercooler, Housing Bolts
11. Intercooler Housing



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Figure 5b – Intercooler Disassembly

MANIFOLDS

CLEANING, INSPECTION & REPAIR

Clean Manifolds as Follows:

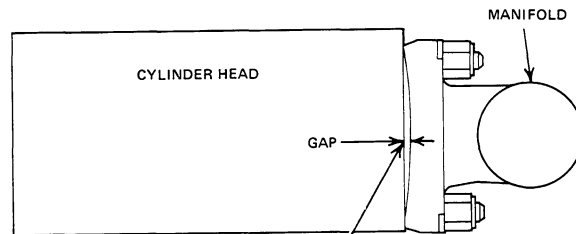
1. Steam clean intake or intercooler and exhaust manifolds (after removal and disassembly) to dislodge dirt and carbon deposits.

Inspect and Repair Manifolds as Follows:

1. Inspect the intercooler or intake manifold and exhaust manifold bodies and flanges for **CRACKS** and **DISTORTIONS**. Replace damaged parts.
2. Replace old gaskets with new gaskets at all mating surfaces.
3. **DTI ENGINE ONLY:** After disassembly, pressure check intercooler core for leaks at 380 kPa (55 psi) core leak check pressure.

4. Inspect exhaust manifold gasket flange for warpage as follows:

- a. Install all cleaned exhaust manifold sections (as a unit) to the cylinder head **without** gaskets. Tighten with washers and nuts. Torque to 81 N-m (60 lbf-ft).
- b. Measure gap between cylinder head and exhaust manifold gasket flange face with a 6 mm (1/4") wide feeler gauge. If 0.38 mm (0.015") feeler gauge will pass gap in region shown in Figure 6, resurfacing of exhaust manifold gasket flanges must be performed with all sections of manifold assembly together. **A maximum of 0.64 mm (0.025") material can be removed.**



FESM-11160

Figure 6 – Exhaust Manifold Warpage

Resurface Exhaust Manifold Gasket Flanges as Follows:

1. Assemble **ALL** exhaust manifold sections.
2. Grind a maximum of 0.64 mm (0.025 in) material from gasket flanges.
3. After grinding, wash all mating surfaces with solvent to remove loose material.

MANIFOLDS

INSTALLATION

D and DT ENGINES ONLY

Install Manifolds as Follows:

1. Install intake manifold with **NEW** gasket. Be sure manifold bolts are properly indexed with each gasket bolt hole. Failure to follow this procedure can result in gasket misalignment.
2. Secure intake manifold bolts with a torque of 27 N·m (20 lbf-ft).
3. Install exhaust manifold with **NEW** gasket.
4. Use only specially hardened washers between manifold studs & nuts. Manifolds may loosen if non-specified washers are used. Torque manifold stud nuts to 77 N·m (57 lbf-ft).
5. Reconnect fuel lines (3, Fig. 3 or 3, Fig. 3a) to injection nozzle and pump. Torque fuel line fittings to 47 N·m (35 lbf-ft).
6. Install the Turbocharger and outlet pipe (if equipped).

DTI ENGINES ONLY

Reassemble Intercooler as Follows:

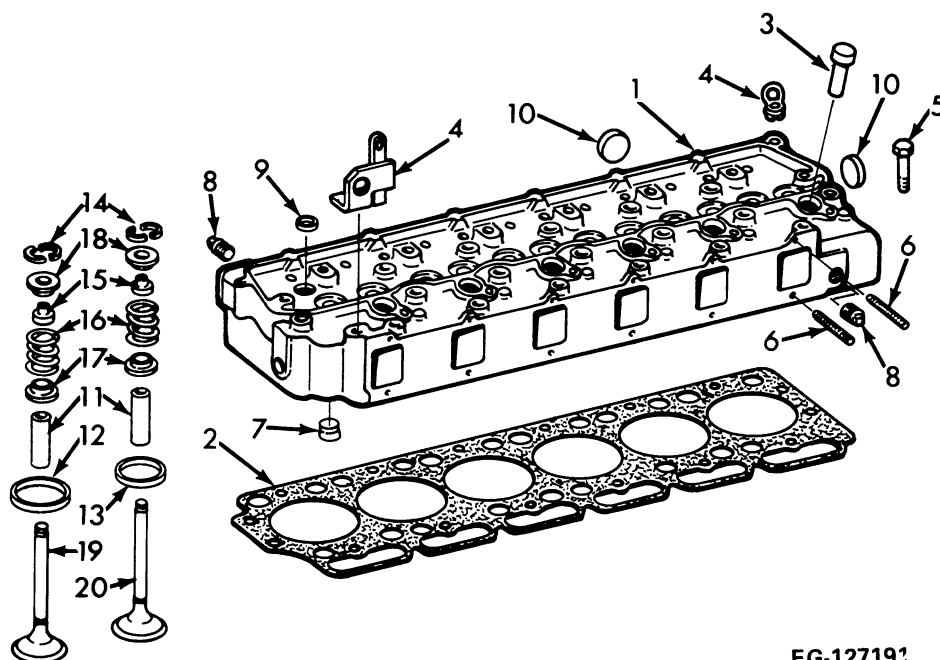
1. Install core into housing.
2. Install cover onto housing.
3. Install flanges onto water inlet and outlet ports, using new gaskets.

Install Intercooler and Exhaust Manifolds as Follows:

1. Install intercooler to cylinder head, using new gaskets.
2. Install aneroid tube (6, Fig. 4 or 5, Fig. 4a) and fuel injection lines.
3. Install exhaust manifold with a new gasket. Torque bolts to 77 N·m (57 lbf-ft).
4. Install the Turbocharger and outlet pipe. Refer to Turbocharger Section 1.

NOTE: *IH "NEVER SEEZ" is to be used on all exhaust system bolts, studs, fasteners, etc.*

CYLINDER HEAD & VALVES



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Figure 1 — Cylinder Head and Valves

CYLINDER HEAD PARTS

- 1. Cylinder Head Assembly
- 2. Cylinder Head Gasket
- 3. Injector Sleeve (6)
- 4. Lifting Eye (2)
- 5. Cylinder Head Short Bolt (20)
- 6. Exhaust Manifold Stud (12)
- 7. Water Director (12)
- 8. 1/2 Inch Pipe Plug
- 9. 1-1/8 Inch Cup Plug (6)
- 10. 1-1/2 Inch Cup Plug (6)

- 11. Valve Guide (12)

- 12. Intake Valve Insert
- 13. Exhaust Valve Insert

VALVE PARTS

- 14. Valve Spring Lock (24)
- 15. Oil Shield (12)
- 16. Valve Spring (12)
- 17. Valve Spring Seat (12)
- 18. Rotator (12)
- 19. Intake Valve (6)
- 20. Exhaust Valve (6)

() Indicates quantity

CYLINDER HEAD & VALVES

GENERAL

These engines are the overhead valve type with two valves per cylinder. All turbocharged engines are built with "STELLITE" exhaust valves, which have special wear characteristics.

NOTE: DO NOT use an exhaust valve from a naturally aspirated engine in a turbocharged engine. Non-stellite exhaust valves are used in naturally aspirated engines.

VALVE ROTATORS are used on all valves to prolong valve life.

The VALVE ARRANGEMENT in the cylinder head is intake-exhaust, intake-exhaust and so on, starting from the front of the engine. The exhaust VALVE FACE ANGLES are ground at 45 degrees and the intake at 30 degrees.

300 SERIES engines use valve seat inserts only on exhaust valves.

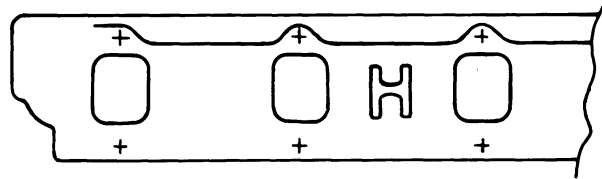
400 SERIES engines use valve seat inserts on both the intake and exhaust valves.

The VALVE LEVER and SHAFT ASSEMBLY is mounted to the cylinder head. The valve lever shaft is lubricated from the rear camshaft bearing through a drilled passage in the crankcase around the rear stud of the cylinder head.

IMPORTANT: Valve levers and valve lever shaft are subject to frictional wear and require continuous oiling. Make certain that the lube passage in the head and crankcase are clean during an engine overhaul. During engine overhaul check these parts against "Specifications". Correct installation of valve lever shaft is important to valve train lubrication.

The Cylinder Head is Identified as follows:

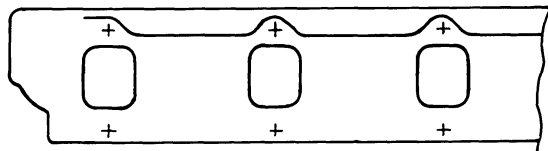
NATURALLY ASPIRATED ENGINES have a recessed letter "H" cast into the intake manifold side of the cylinder head, which designates "High Swirl."



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Figure 2 – "H" (High Swirl)

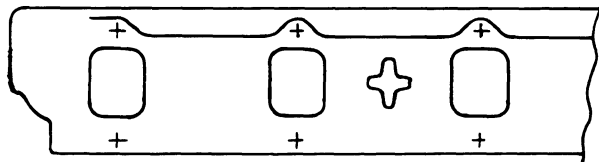
TURBOCHARGED ENGINES (except "B" & "C" Series) have NO markings, which designate "Low Swirl."



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Figure 3 – No Markings (Low Swirl)

TURBOCHARGED "B" & "C" SERIES ENGINES have a recessed cross "+" cast into the side of the cylinder head, which designates "Intermediate Swirl."

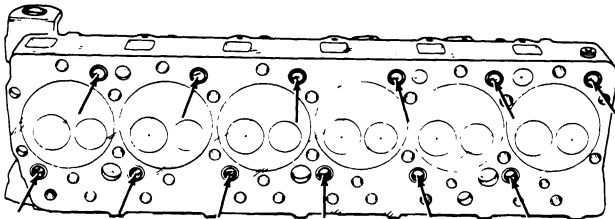


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Figure 4 – "+" (Intermediate Swirl)

CYLINDER HEAD & VALVES

The cylinder head, cylinder head gasket and cylinder head coolant directors have been revised for all 400 Series Engines. The 12 coolant holes in the bottom deck of the cylinder head have been enlarged from 19.05 mm (.750 in.) to 23.80 mm (.937 in.) in diameter (Refer to Fig. 5)

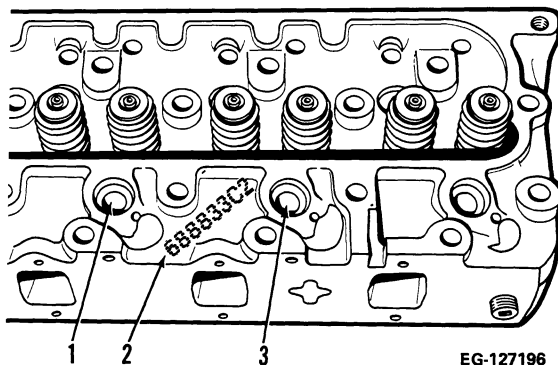


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Figure 5 – Cylinder Head Bottom View of Deck With Coolant Hole Locations

The outer diameter of the press-fit coolant directors used in these coolant holes has also been increased in size from 19.15 mm (.754 in.) to 23.90 mm (.941 in.).

The twelve cylinder head gasket coolant holes have been enlarged to accommodate the larger coolant hole size.



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Figure 6 – Cylinder Head Production Part No. Location

1. Number Four Nozzle Bore
2. Casting Number Location
3. Number Five Nozzle Bore

IMPORTANT: The new style cylinder head gasket (IH Part No. 676 108 C2) and cylinder head gasket package (IH Part No. 674 398 C95) may be used with either the old or new style cylinder head. The old style cylinder head gasket (IH Part No. 676 108 C1) and cylinder head gasket package (IH Part No. 674 398 C94) can only be used with the old style cylinder head.

The new style cylinder head can be identified by the casting number (see chart) located on top of the cylinder head at intake side between number four and five nozzle locations (Refer to Figure 6).

NEW STYLE CYLINDER HEAD CHART

Production Part No.	Engine Type
688 833 C2*	Turbocharged "B" and "C" Engines
680 426 C2*	Turbocharged "NON-B or C" Engines
680 427 C2*	Naturally Aspirated Engines.

The old style cylinder head can be identified by the casting number (see chart) located on top of the cylinder head at intake side between number four and five nozzle locations (Refer to Figure 6).

OLD STYLE CYLINDER HEAD CHART

Production Part No.	Engine Type
688 833 C1*	Turbocharged "B" Engines
680 426 C1*	Turbocharged "NON-B or C" Engines
680 427 C1*	Naturally Aspirated Engines.

*NON-SERVICEABLE Part Numbers.

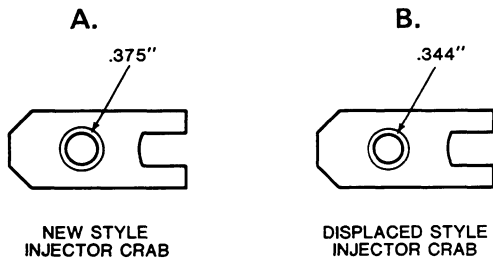
CYLINDER HEAD & VALVES

NEW INJECTOR CRAB AND INJECTOR CRAB BOLT.

INJECTOR CRAB

The new style injector crab provides an improved injector crab seating contact area resulting from the following changes:

1. Increased through hole diameter from 0.344 in. on the displaced style injector crab to 0.375 in. on the new style injector crab (Refer to Figures 8A and 8B).



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Figure 8A – Through Hole Diameter

Figure 8B – Through Hole Diameter

INJECTOR CRAB BOLT

The new style injector crab bolt (IH Part No. 691 105 C1) [Refer to Figure 7A] eliminates the hardened washer (IH Part No. 684 496 C1) and injector crab washer (IH Part No. 675 677 C1) [Refer to Figure 7B] with a full radius fillet [Refer to 1, Figure 7A].

IMPORTANT: DO NOT USE DISPLACED STYLE WASHERS WITH NEW STYLE BOLT. THE NEW BOLT MUST BE USED WITH NEW CRAB ONLY. DISPLACED BOLT MAY BE USED WITH NEW OR DISPLACED CRAB.

IMPORTANT: The torque remains the same for the new style and displaced style bolts, 27 N.m (20 lbf-ft).

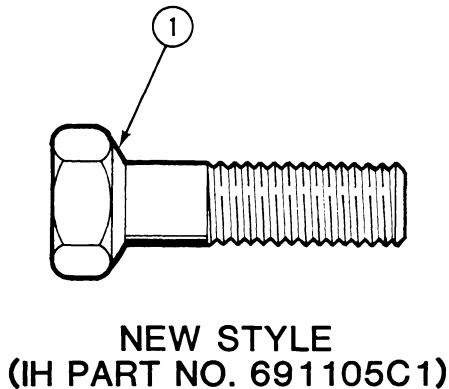


Figure 7A

1. Full Radius Fillet Shown on New Style Injector Crab Bolt (691 105 C1)

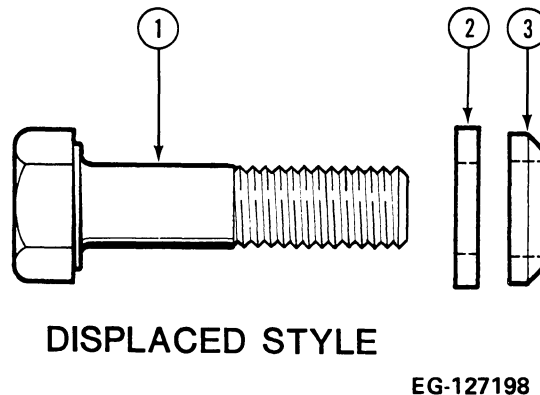


Figure 7B

1. Injector Crab Bolt (684 497 C1)
2. Hardened Washer (684 496 C1)
3. Injector Crab Washer (675 677 C1)

CYLINDER HEAD & VALVES

NEW CYLINDER HEAD BOLT AND TORQUE

Revised long and short cylinder head bolts with flange type heads (Figure 9a) have replaced the old style cylinder head bolts (Figure 9b) which required the use of a hardened washer (IH Part No. 252 018 R1).

Use of the new style flange type long and short cylinder head bolts results in the following changes:

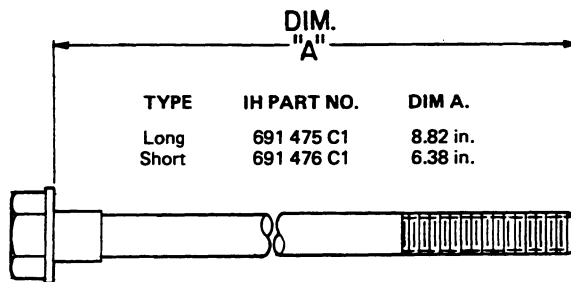


Figure 9a – “New Style” Cylinder Head Bolt (Flange type) (Washer not required)

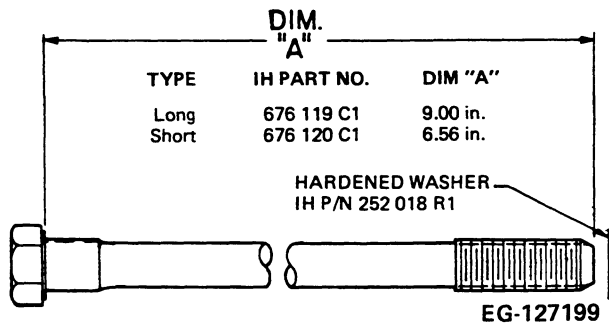


Figure 9b – “Old Style” Cylinder Head Bolt and Hardened Washer

New Style Cylinder Head Bolt

(IH P/N 691 475 C1 - Long)
(IH P/N 691 476 C1 - Short)

1. Washer NOT Required
2. Final Torque 225 N•m (165 lbf-ft)

Old Style Cylinder Head Bolt

(IH P/N 676 119 C1 - Long)
(IH P/N 676 120 C1 - Short)

1. Washer Required.
2. Final Torque 225 N•m (165 lbf-ft)

PARTS AFFECTED:

<u>New IH Part No.</u>	<u>Description</u>
691 475 C1	Long Cylinder Head Bolt
691 476 C1	Short Cylinder Head Bolt
-----	HARDENED Washer

Displaced IH Part No.

676 119 C1 676 120 C1 252 018 R1

CYLINDER HEAD & VALVES

SPECIFICATIONS

VALVES – 300 Series

Number of valves per cylinder:	
Intake	1
Exhaust	1
Head diameter:	
Intake	43.30 to 43.56 mm (1.705 to 1.715 in.)
Exhaust	36.83 to 37.08 mm (1.450 to 1.460 in.)
Face angle - degrees:	
Intake	30 ^o
Exhaust	45 ^o
Stem diameter	9.444 to 9.462 mm (.3718 to .3725 in.)
Clearance in guide038 to .081 mm (.0015 to .0032 in.)
Maximum allowable stem clearance in guide before reconditioning	
	0.15 mm (.006 in.)
Valve recession from face of cylinder	
Intake	0.00 to 0.36 mm (.000 to .014 in.)
Exhaust	0.00 to 0.36 mm (.000 to .014 in.)
Valve seat runout in cylinder head05 mm (.002 in.)
Valve face runout038 mm (.0015 in.)
Minimum valve face margin:	
Intake	1.73 mm (.068 in.)
Exhaust	1.14 mm (.045 in.)

VALVES – 400 Series

Number of valves per cylinder:	
Intake	1
Exhaust	1
Head diameter:	
Intake	49.91 to 50.16 mm (1.965 to 1.975 in.)
Exhaust	40.51 to 40.76 mm (1.595 to 1.605 in.)
Face angle -	
Intake	30 degrees 00 minutes - 30 degrees 15 minutes
Exhaust	40 degrees 00 minutes - 45 degrees 15 minutes
Stem diameter	9.444 to 9.462 mm (.3718 to .3725 in.)
Clearance in guide038 to .081 mm (.0015 to .0032 in.)

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