Sequence IIIG Engine Oil Certification Test
Engine Assembly Manual

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Revision 09
February 22, 2010

Table of Contents

Section 0

Hardware usage guidelines

All materials used in this test must conform to acceptance guidelines as specified in the ASTM Sequence IIIF Test Procedure accompanied by the direction and information contained in this Assembly Manual.

Any changes in procedures or substitutions of qualified parts or materials, must be approved by the Sequence IIIF / G Surveillance Panel prior to their use in non-reference and reference oil tests.

Any parts or materials specified in this document that are found to be unacceptable for testing, both pre and post test, must be reported to the Test Sponsor, the appropriate Critical Parts Distributor, and the ASTM Test Monitoring Center.

Unless otherwise directed, all parts and materials required for testing should be stored and used on a first in – first out basis following the guidelines outlined in the ASTM Test Monitoring Center Sequence IID and IIIE Information Letter #60 June 21, 1991.

Section 01

Revision Update Timeline

Sequence IIIG Engine Assembly Manual Update Revision Timeline

Latest Revision 9

Date 2/22/2010

Contact Person Rich Grundza TMC 412-365-1031

Bruce Matthews GM Pontiac 248-830-9197

Date	Sec.	Sheet	Topic	Comments	Info Letter
4/28/03	1	5A	Cleaning instructions	Removal of NAT50 / PDN50 soap residue	
4/28/03	3	8	Ring Color Code	Addition of color code identification	
4/28/03	4	1	Front Cover usage	Change to OHT epoxy impregnated front cover part #.	
4/28/03	4	12	Pan Gasket	Change to 2003 gasket part #.	
4/28/03	6	9	MAF part #	Add new mass airflow sensor part #.	
6/23/03	6	9	MAF part #	Add remanufactured part # 88961007	
6/23/03	7	6	MAF part #	Add remanufactured part # 88961007	
9/10/03	3	8	Ring Gap	Correct typo for top ring gap (0.064 to 0.64)	
9/10/03	5	1	Valve Spring Calibration	Change +/- load from 22N to 44N (5lbf. To 10lbf.)	IIIG-03-2
12/15/03	1	1	Block part #	Change block part # from drawing # to 24502286	IIIG-03-3
12/15/03	1	5	Solvent specification	Update to mineral spirit	
12/15/03	1	5A	Solvent specification	Update to mineral spirit	
12/15/03	1	6	Fastener	Update fastener usage	
12/15/03	2	7	Honer	Update ratchet feed setting	
12/15/03	2	8	Honer	Update honing procedure	
12/15/03	2	9	Honer	Update revised loads and target sizing	
12/15/03	2	10	Honer	New page, honer calibration requirements	
12/15/03	2	11	Honer	New page, honer maintenance requirements	
12/15/03	2	12	Honer	New page, honer maintenance requirements	
12/15/03	3	5	Solvent specification	Update to mineral spirit	
12/15/03	3	6	Fastener	Update fastener usage	
12/15/03	3	8	Rings	Update paint removal and solvent usage	
12/15/03	3	11	Camshaft	Update solvent usage and lubrication requirements	
12/15/03	4	5	Sealer	Update approved sealer specification	
12/15/03	4	12	Sealer	Update approved sealer specification	
12/15/03	5	1	Solvent specification	Update to mineral spirit	
12/15/03	6	1	Solvent specification	Update to mineral spirit	
12/15/03	6	2	Solvent specification	Update to mineral spirit	
12/15/03	6	6	Sealer	Update approved sealer specification	

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Date	Sec.	Sheet	Topic	Comments	Info Letter
12/15/03	6	11	Text	Update text block (injector flow testing) reference procedure	
12/15/03	7	4	Part #	Add new shield 24508586	
3/15/04	4	12	Silicone Sealer	Update sealer part numbers	IIIG-04-1
3/15/04	6	6	Sealer & Gasket	Update sealer and intake gasket part numbers	
11/3/04	3	7	Con Rod part numbers	Update to include Cast and PM part numbers	IIIG-04-3
11/3/04	3	9	Con Rod Torques	Update to include Cast and PM torque values	
11/3/04	4	1	Front Oil Seal	Update to new OHT part number	
11/3/04	4	5	Front Oil Seal	Update to new OHT part number	
11/3/04	4	9	Rear Oil Seal	Update to new OHT part number	
11/3/04	4	12	Oil Pan Gsket	Update to new OHT part number	
11/3/04	5	1	Exhaust Valve	Update to new SPO part number	
The following updates cover information letters IIIG-05 through IIIG-06-					
6/22/06	All Sections		Global text change from Mineral Spirits to Degreasing Solvent		
6/22/06	1	1	Bore alignment check	Change alignment check to optional	
6/22/06	1	6	Fastener Installation	Remove plastic mallet from usage text	
6/22/06	1	7	Torque Wrench	Add ETW-E180 torque wrench information	
6/22/06	2	8	Honing	Update according to S.P. direction 6/6/06	
6/22/06	3	2	Data recording	Add data recording Annex A.14	
6/22/06	3	5	Update	Update text and part numbers	
6/22/06	3	6	Update	Update view, fastener prep, and clearance spec.	
6/22/06	3	7	Piston & Rod	Update cleaning and rod orientation information	
6/22/06	3	8	Update and expand	Expand view and add additional sheet (8A)	
6/22/06	3	8A	New sheet	New sheet with expanded view and BC6 second ring info.	
6/22/06	3	9	Cast Rods	Remove cast rod information	
6/22/06	3	11	Fastener usage	Update fastener usage and inspection information	
6/22/06	3	12	Part number update	Update balance shaft part number	

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Date	Sec.	Sheet	Topic	Comments	Info Letter
6/22/06	4	2	Front Cover	Add usage information	
6/22/06	4	4	Oil filter adapter	Update sealer usage information	
6/30/06	4	7	Front Cover Assembly	Update view and part numbers	
6/30/06	4	8	Front Cover	Update fastener information	
7/20/06	4	9	Rear Cover	Update part numbers for rear cover and crankshaft seal	
7/20/06	4	10	Rear Cover	Update fastener usage	
2/1/06	4	11	Part number update	Update gasket part number	
2/5/06	4	13	Part number update	Update fastener part number information	
6/30/06	5	1	Valve & Springs	Update cleaning procedure and valve part number	
7/20/06	5	3	Cyl. Head fastener	Update part number information	
7/20/06	6	1	Lifter installation	Update cleaning info and installation information	
7/20/06	6	2	Pushron installation	Update cleaning info and degreasing solvent	
7/20/06	6	3	Rocker retainer	Update usage information	
7/20/06	6	6	Update	Upate intake gasket part number	
The following updates cover changes through April 1, 2007					
3/30/07	1	7	Cylinder Head Fastener Torque	Fastener torque procedure for honing deck plates	
3/30/07	3	9	Rod Bolt Torque	Connecting rod torque + angle update for PM rods	
3/30/07	3	11	Pre-test Camshaft Lubrication	Updated procedure for EF-411 vs test oil lubricating process	
3/30/07	4	6	Front Cover Gasket	Update gasket part number changes	
3/30/07	5	3	Cylinder Head Fastener Torque	Fastener torque procedure for cylinder head installation	
3/30/07	6	5	Rocker Cover	Update rocker cover part number change	
3/30/07	6	8	Upper Intake Gasket	Update upper intake gasket part number change	
The following updates cover changes through February 22, 2010					
2/22/10	1	5A	Block Cleaning	Changed washer temp to metric value and added tolerance	
2/22/10	1	7	Stress Plates	Updated head gasket and bolt p/n, added source for bolts	
2/22/10	2	10	Honing Machine	Changed wording from calibrated to verified	

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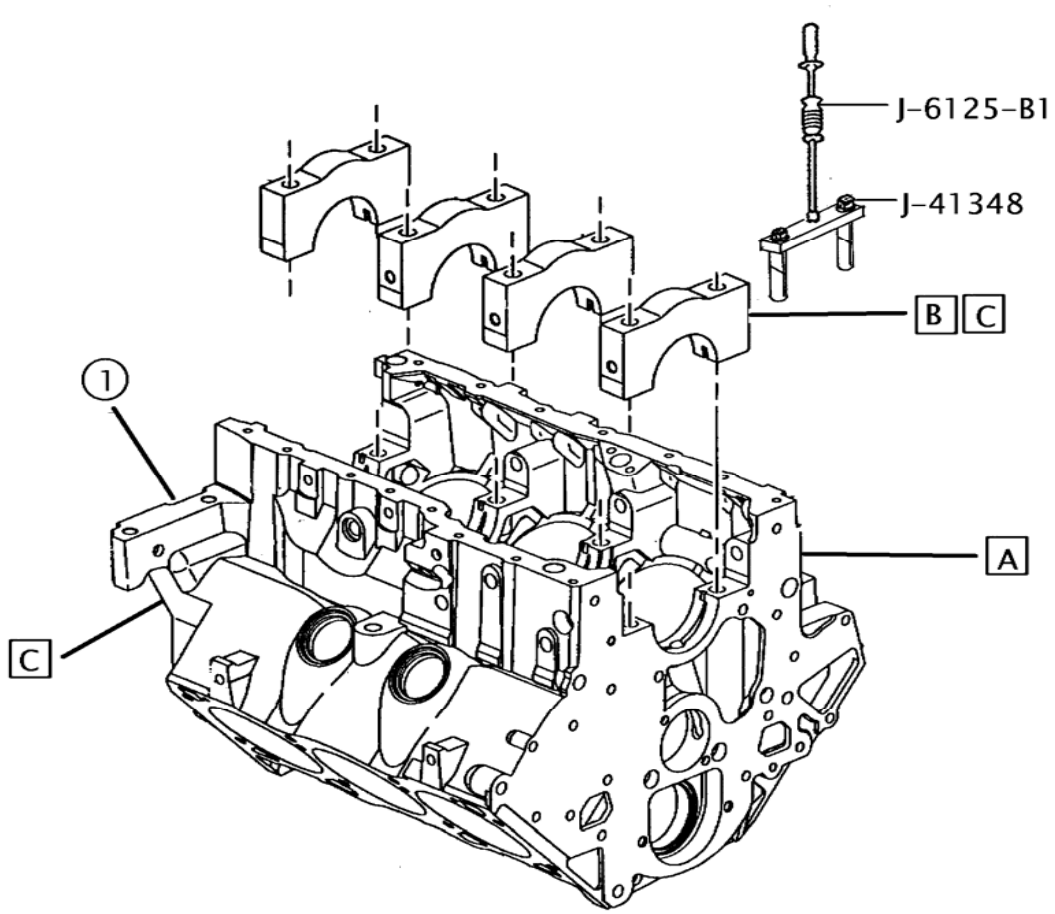
Date	Sec.	Sheet	Topic	Comments	Info Letter
2/22/10	3	6	Thread Lubrication	Deleted note prohibiting thread lubrication	
2/22/10	3	8	Ring Gap Measurement	Deleted OHT3F-gages, added measurement in block	
2/22/10	4	9	Seal Installation	Added Kenmore J38196 tool for rear seal installation	
2/22/10	4	10	Rear Seal Housing	Allowed bolts to be used along as they remain servicable	
2/22/10	5	3	Head Assembly	Corrected short bolt p/n	
2/22/10	6	8	Upper Intake	Deleted stud, 24502453 and increased to 2 bolt 24505205	

Section 1

Cleaning and Pre Hone Preparation



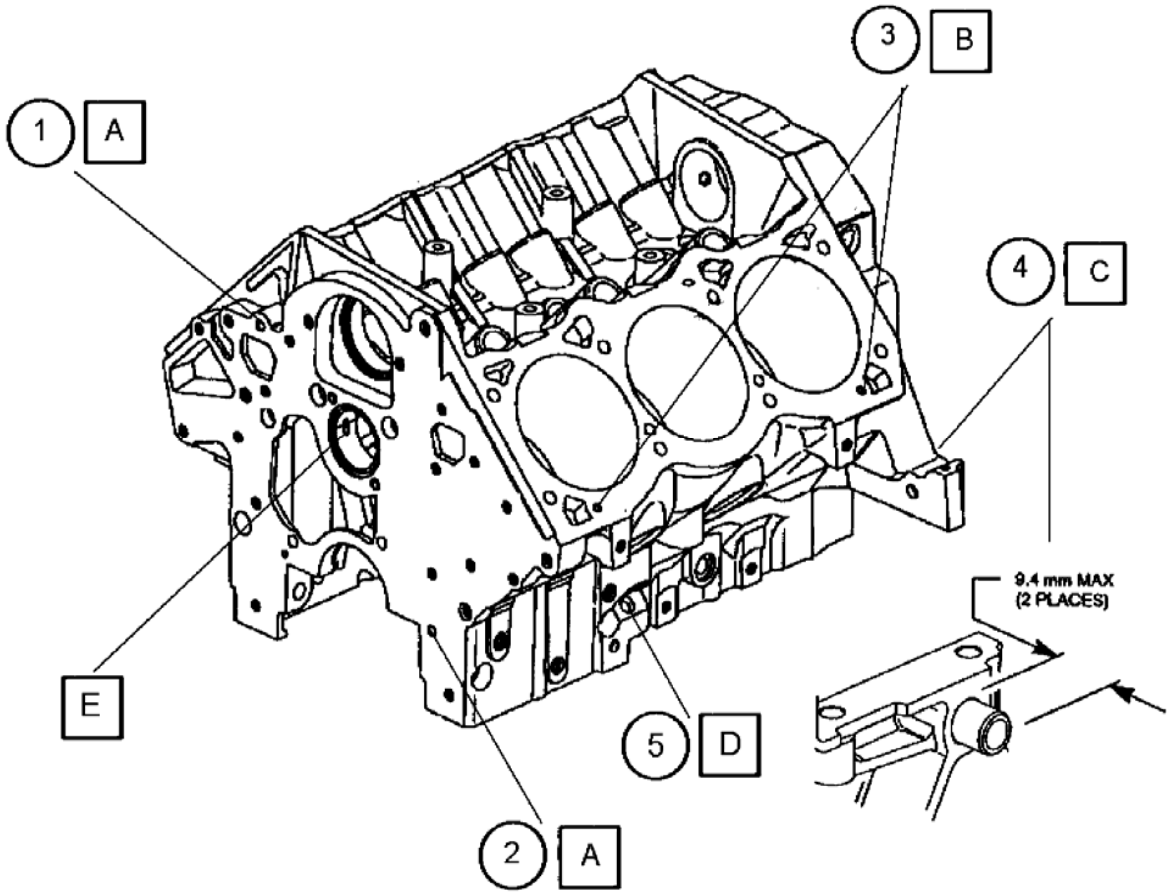
Description of Operation	
A	Upon introduction of a new block into the system, check for any damage to machined surfaces which might have occurred during shipping or handling. Optional: Check crankshaft main bore alignment using appropriate manderal.
B	Remove main cap side & main bolts. Use Kent-Moore J-41348 main bearing cap puller (12Nm) & J-6125-1B slide hammer to remove main caps. **Note: Main bearing caps are press fit. Do not hammer caps back and forth during removal. Damage to the caps may result in damage to engine bearings during test.**
C	Record engine serial number and or assign a laboratory number and mark necessary identification on engine block and crankshaft main caps. **Note: Do not use stamped tool set for marking identification on main caps.**

Specification	
1	24502286 Block Assembly

REV	Date	Revision History
1	12/31/97	Block-1
2	12/15/03	Change from engineering drawing part # (24506028) to actual part # 24502286
3	06/22/06	Change main bore alignment check to optional

View
Engine Block
New block and pre-hone prep Serial Number Locations

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	1



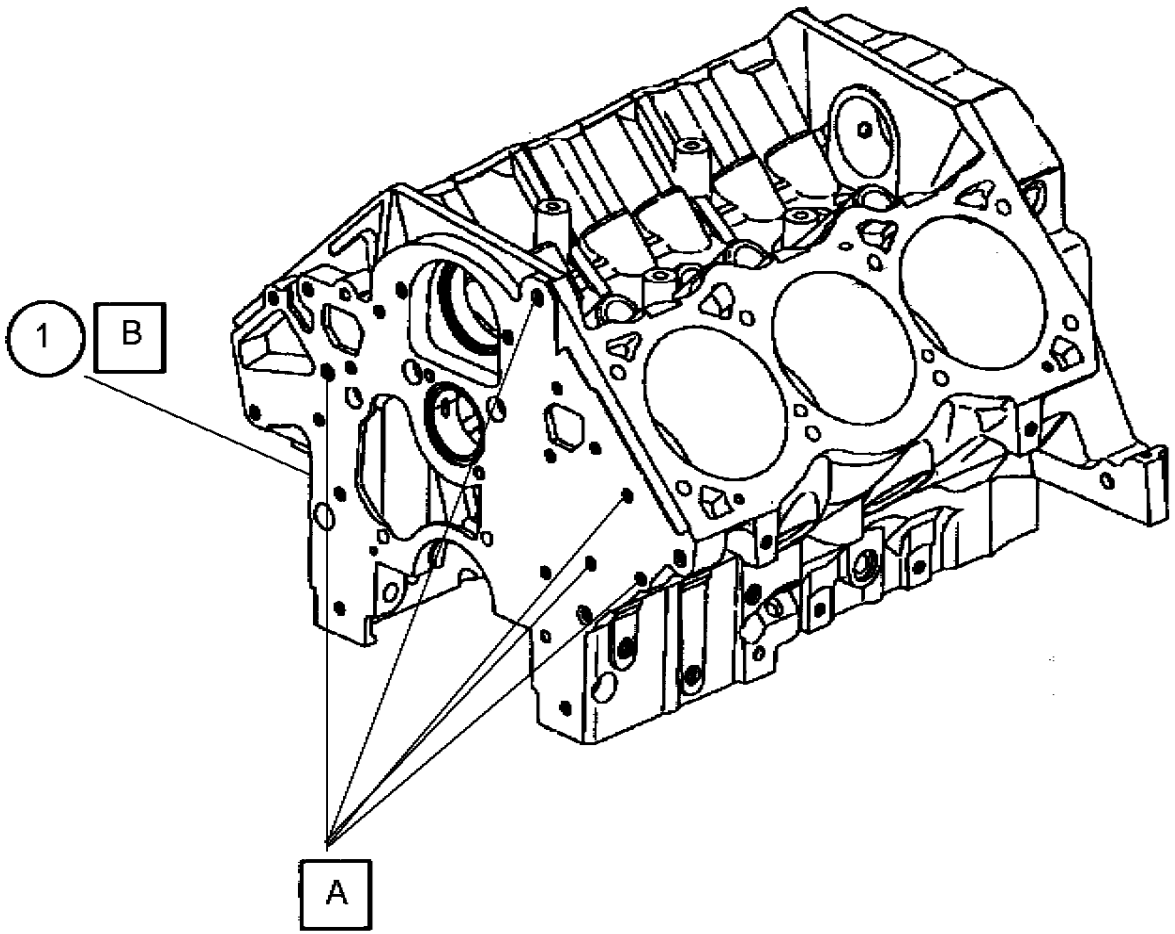
Description of Operation	
A	Install locating pins on front face.
B	Install locating pins on cylinder deck
C	Install locating pins on rear transmission mount face.
D	Use OHT3F-071-1 reamer to size dip stick hole for calibrated dip stick
E	Deburr all leading edges of camshaft tunnel bores and oil gallery cross drilled intersections through tunnel bores using emery cloth, rotory tool with carbide cutters, stones, or wire wheels as necessary to remove sharp edges.

Specification	
1	24501162 Pin Front Cover Upper
2	25536323 Pin Front Cover Lower
3	25536320 Pin Cyl. Head Location
4	12338076 Pin Trans. Location
5	OHT3F-071-1 Reamer

REV	Date	Revision History
1	12/31/97	Block-2

View
Engine Block
New block and pre-hone prep Locating pin installation Camshaft tunnel and dip stick prep

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	2



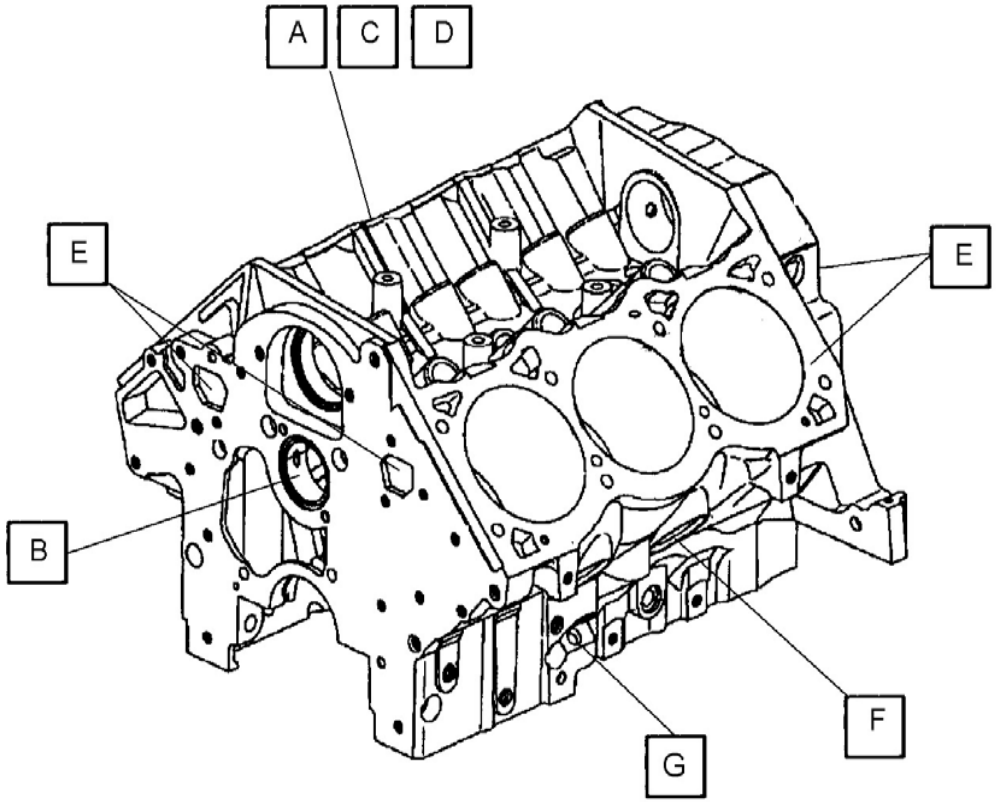
Description of Operation	
A	Install threaded fasteners with #2 Non-Hardening Permatex or Perfect Seal #4 in locations identified in view.
B	Install 1/4NPT plug in main oil gallery on the right front side of engine block. Note: This location is not to be used for temperature control or thermocoupled.

Specification	
1	444777 Plug Auto Hex Socket

REV	Date	Revision History
1	12/31/97	Block-3

View
Engine Block
New block and pre-hone prep Plugged holes in front of engine

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	3



Description of Operation	
A	Remove all casting slag and core sand deposits from the coolant passages on new blocks and check for core sand deposits on used blocks
B	Remove all camshaft bearings and oil gallery plugs.
C	Clean all gasket surfaces.
D	Chase all threaded holes for the main caps and cylinder head fasteners using a Class 2B Tap.
E	Install block-off plates over the coolant passages on the front face, rear face, and cylinder deck. (Fabricate in-house)
F	Install coolant Welch plugs.
G	Ream dip stick hole using OHT3F-071-1 reamer for calibrated dip stick.

Specification

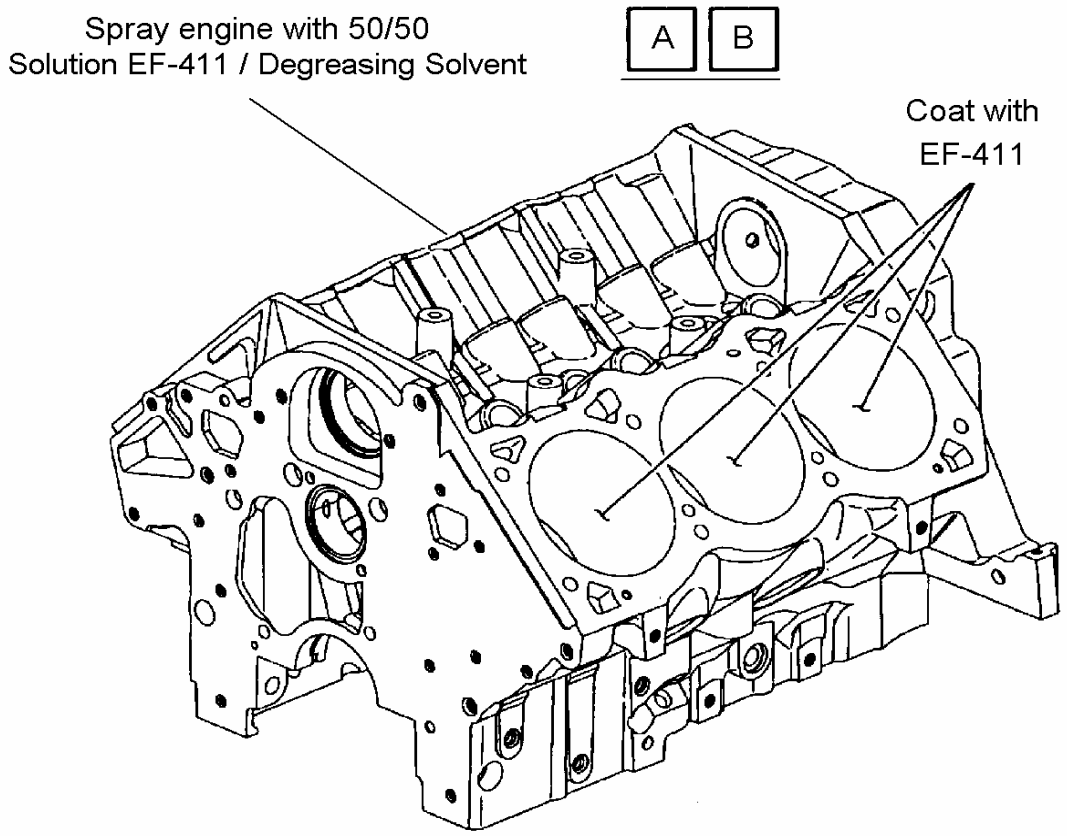
REV	Date	Revision History
1	12/31/97	Block-4

View

Engine Block

New block and pre-hone prep

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	4



Description of Operation	
A	The engine may be cleaned using an automated washing device, however, caution should be used to prevent oxidation flash over of the ferrous surfaces. Note: Do not use caustic chemicals or acid type baths. See 5A
B	The block must be thoroughly cleaned using brushes through the oil galleries, camshaft tunnel, and cylinder bores with degreasing solvent to remove any detergent residue before honing.
?	(Step Sec. 1 sheet 6) Repeat step "A & B" above after honing. Note: If this is the final cleaning after honing, spray the entire engine block using a 50/50 solution of EF-411 and degreasing solvent. Air dry to remove excess solution.
?	(Step Sec. 3 sheet 1)

Specification

REV	Date	Revision History
1	12/31/97	Block-5
2	12/15/03	Update, change to mineral spirits
3	6/22/06	Update change to degreasing solvent

View

Engine Block

Engine block cleaning

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	5

Automatic Parts Washer Procedure for IIIF Engine Blocks

1) Use only NAT-50-S or PDN-50 soap at a concentration of 16 pounds of soap per 100 gallons of water. The cleaning solution shall be changed at least every 6 months.

2) Set the temperature of the water to 60±10 degrees C.

3) Do not pre-condition the water that is being used in any way.

4) Prior to installing the engine in the parts washer, ensure that all coolant passages are blocked off to prevent cleaning solutions from entering the passages.

5) Allow the block to run through the cleaning cycle for a period of 30 to 40 minutes.

6) After the cycle is complete, immediately remove the block from the washer and spray it down with degreasing solvent.

7) Wipe cylinder bores out with a lint free towel.

8) Spray engine block with a mixture of 50/50 EF-411 and degreasing solvent.

Description of Operation

Specification

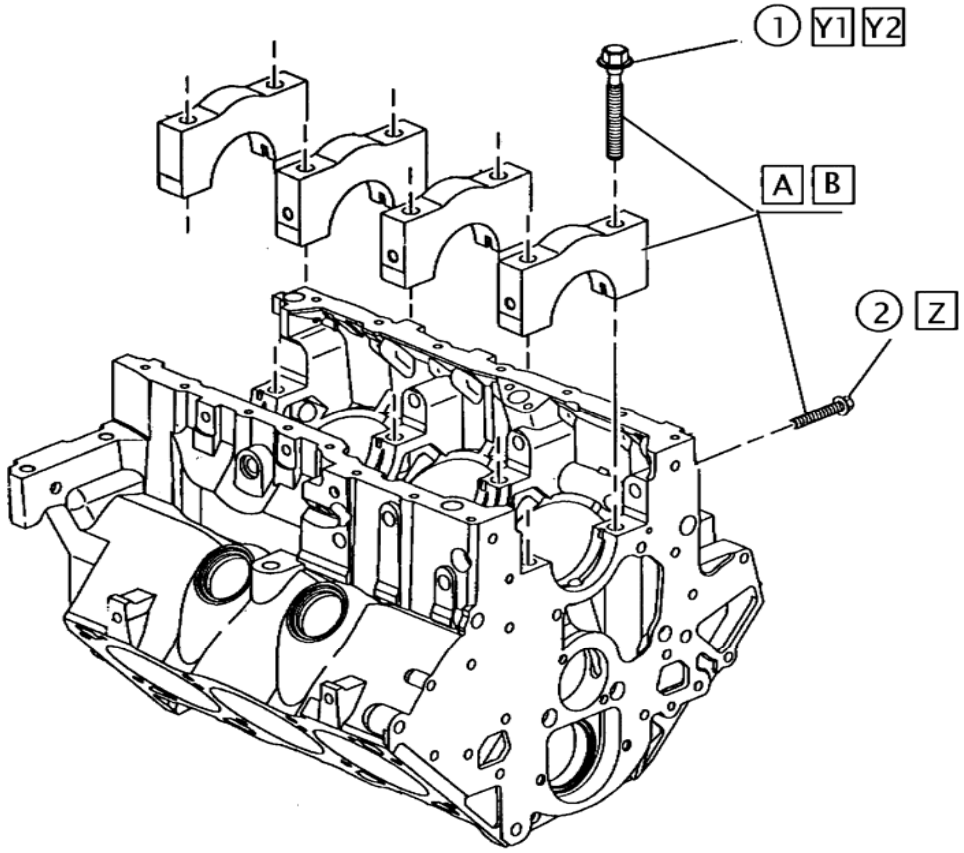
REV	Date	Revision History
1	9/5/00	Procedure for Better Engineering Jet Washer usage
2	12/15/03	Update change to mineral spirits
3	6/22/06	Update text change to degreasing solvent
4	2/22/10	Metricated water temperature and added tolerance

View

Engine Block

Engine block cleaning procedure for automated type jet washers

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	5A



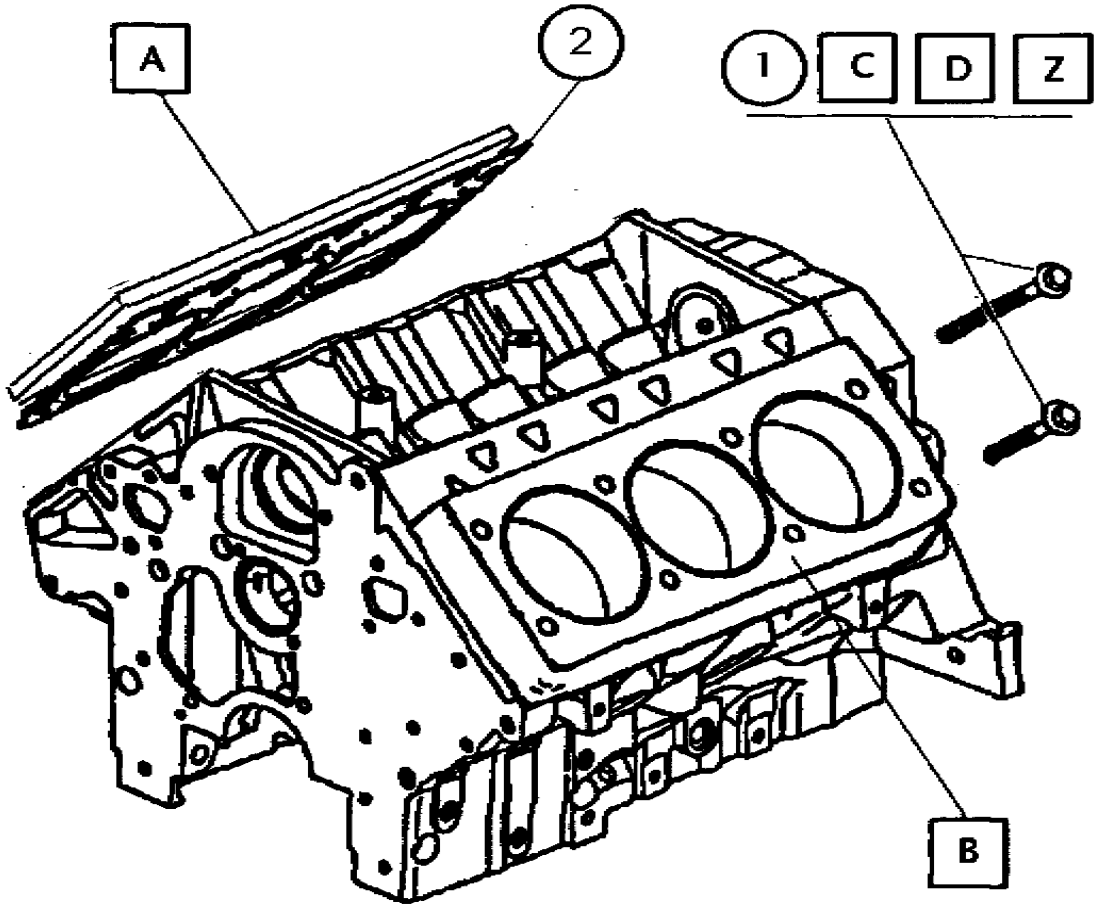
	Description of Operation
A	Clean and oil all main cap bolts (EF-411) and install main caps.Note: Do not use air tools to run main caps down.
B	Install main cap with fasteners as guides and draw into position with speed handle and socket in crisscross pattern.
C	Install main cap side bolts
Y1	Tighten all main bolts to 70 Nm to fully seat main caps and then loosen the bolts 360° counterclockwise.
Y2	Torque & Angle 20Nm then 40Nm + 35°+35°+35° (repeat 40Nm + 35° 3 times from center out)(use used fasteners for honing)
Z	Torque & Angle 15Nm + 45°

	Specification
1	24503056 Bolt (8) see note Y (Tighten before Z)
2	24505576 Bolt (6) see note Z (Tighten after Y)

REV	Date	Revision History
1	1/10/98	Block-6
2	12/15/03	Clarification, add 40Nm + 35° 3 times… and (use used fasteners for honing) to Y2
3	6/22/06	Remove use of plastic mallet from "B"

View
Engine Block
Main cap installation

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	6



Description of Operation	
A	Remove cylinder deck block off plates.
B	Install B-H-J Torque Plates w/gaskets (GM-3.8/3E-R-S-T-HT)
C	Note: When installing torque plates, 1) move the bottom row of fasteners to the top, 2) discard the top row of fasteners, 3) use the post test fasteners from the last teardown in the bottom row on the torque plates.
D	Torque fasteners from the center out using a crisscross pattern. 30Nm-50Nm-80Nm-123±9Nm
Z	(Step Sec.2 sheet 1)

Specification	
1	25527831K Bolt Cyl. Head (8)(Long) See note Z Use in upper and lower position with double hardened washers on lower row. Obtain washers from B-H-J. Obtain bolts from GM Racing
2	24503802 Gasket LH. 24503801 Gasket RH.

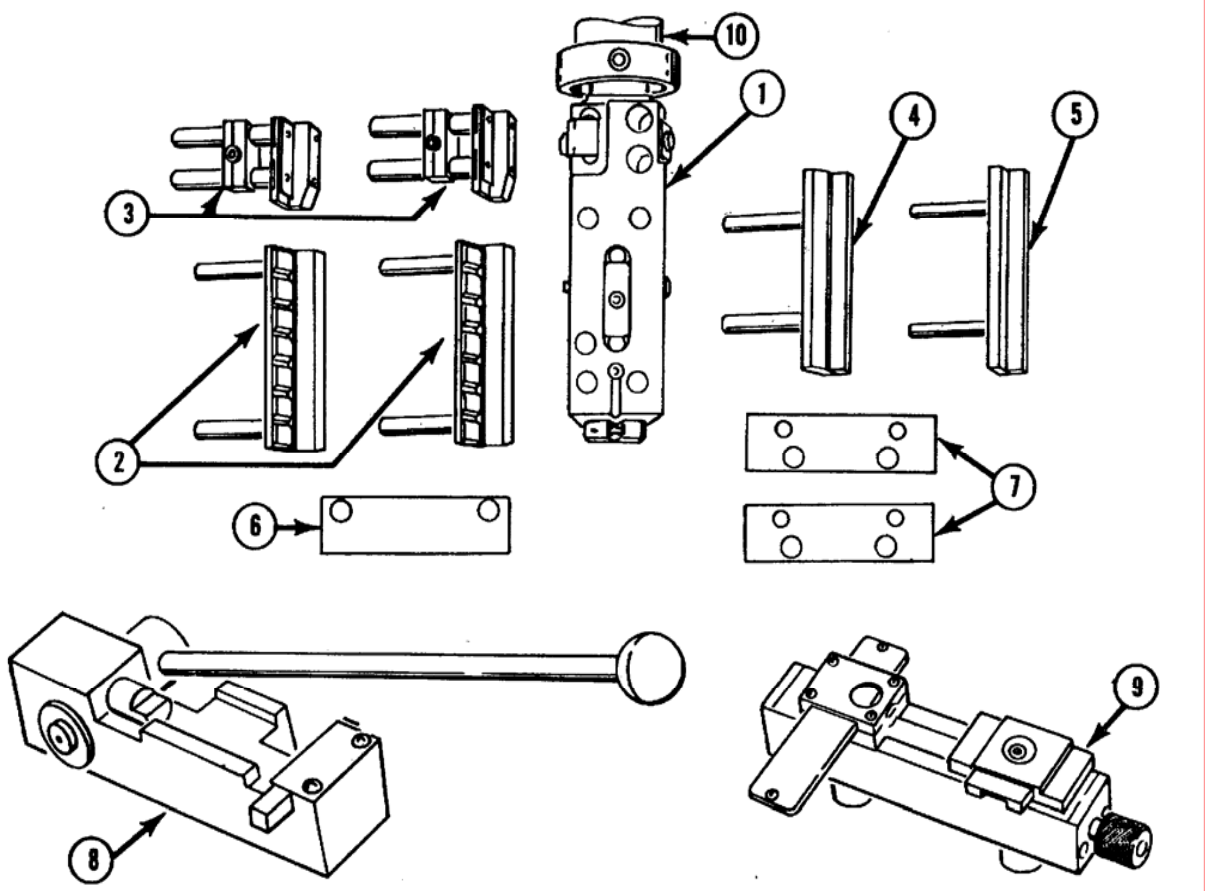
REV	Date	Revision History
1	1/1/98	Block-7
2	6/22/06	Update torque wrench information
3	3/30/07	Update fastener torquing procedure to 123Nm ± 9Nm final torque
4	2/22/10	Updated bolt number and source, corrected head gasket part numbers

View
Engine Block
B-H-J Torque Plate installation

New Block and Pre-Hone Prep	Sequence IIIG	Section	Sheet
		1	7

Section 2

Cylinder Block Honing



Description of Operation	
1	Hone Head
2	Stone Assemblies
3	Alignment Guides
4	Main Guide
5	Centering Guide
6	Stone Shims
7	Guide Shims
8	Stone Inserter
9	Setting Gage
10	Drive Tube

Specification

REV	Date	Revision History
1	1/7/98	Hone-1-1

View

Hone Unit Details

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	1

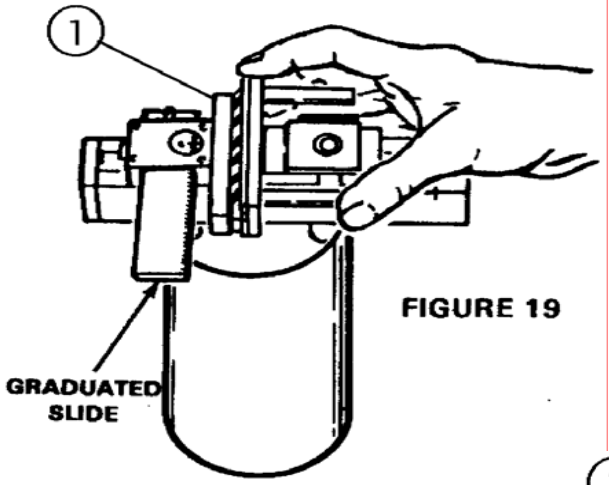


FIGURE 19

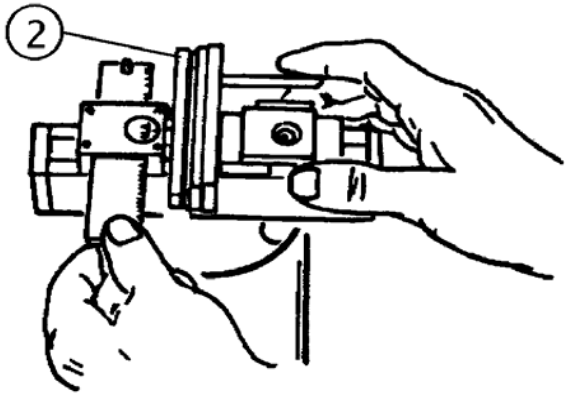


FIGURE 20

Description of Operation

Set the turret block to the standard position and adjust the setting block snugly in the cylinder bore.

19 Place the stone assembly in the setting gage with the slide scale set at "0". Add shims as necessary to adjust to 1 - 2 on the slide scale for the stone and guide assemblies.

20 Place the plateau honing tool in the setting gage with the slide scale set at "0". Add shims as necessary to adjust to 3 - 4 on the slide scale.

Note: The alignment guides are not used during honing of IIIF blocks.

Specification

1 EHU 512 Stone

2 C30-PHT-731 Plateau Honing Tool

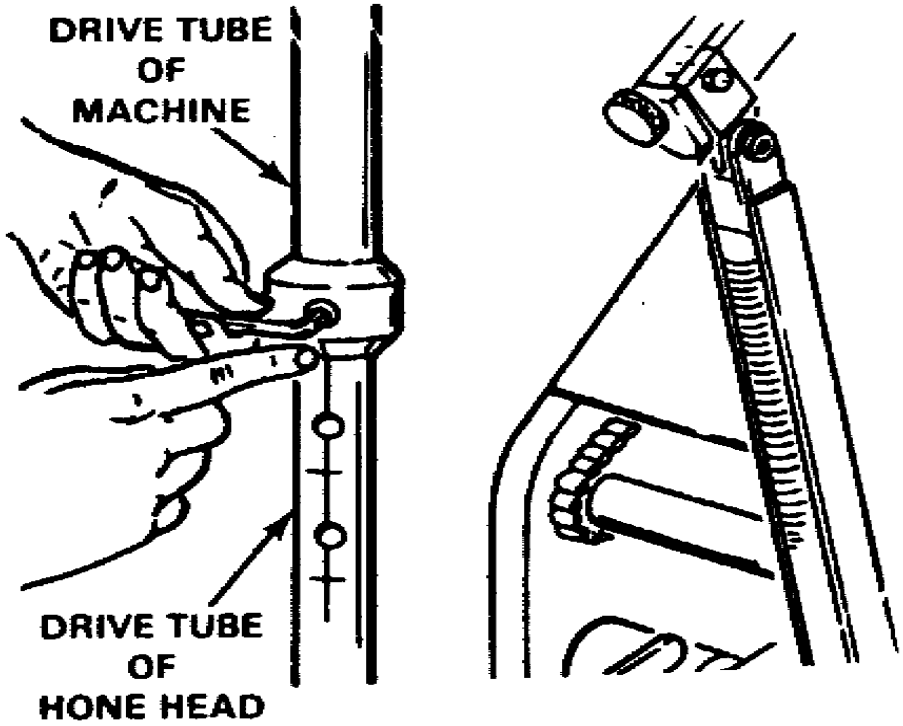
REV	Date	Revision History
1	1/7/98	Hone-3-1 & 3-2

View

Stones & Guides

Stone and guide adjustment

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	2



Description of Operation

Slip the Drive Tube of the Hone Head into the Drive Tube of the CV-616-46 and tighten the set screw with the first set of index marks in line.

Specification

REV	Date	Revision History
1	1/7/98	Hone-2-2

View

Drive Tube

Drive tube adjustment

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	3

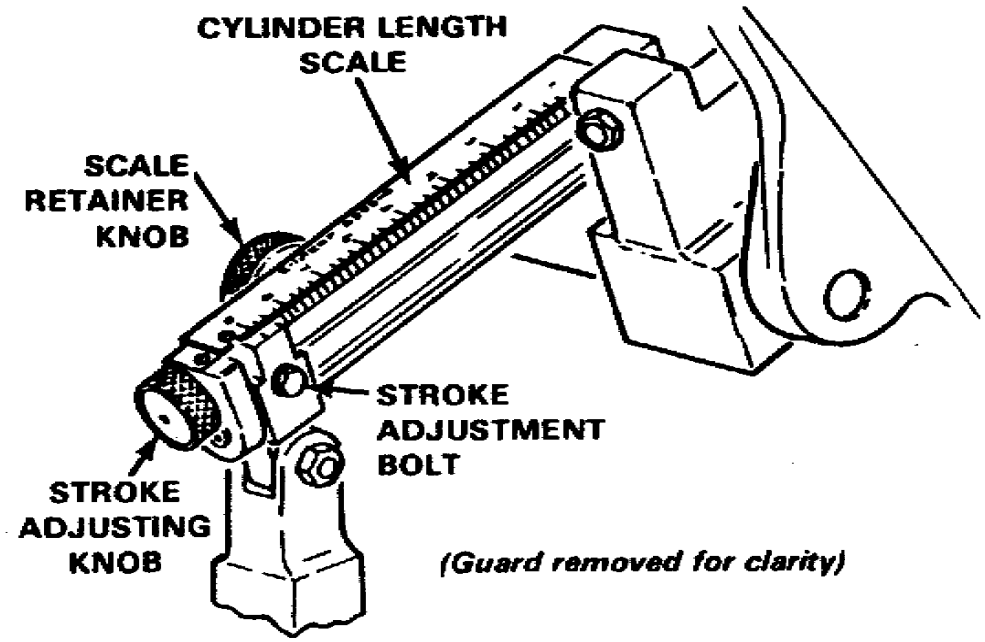


FIGURE 23

Description of Operation

Loosen stroke adjustment bolt and set stroke length at 5 3/8"

Note; to change the Stroke Scale to Metric, order PNP 1275M.

Specification

REV	Date	Revision History
1	1/7/98	Hone-4

View

Stroke Length

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	4

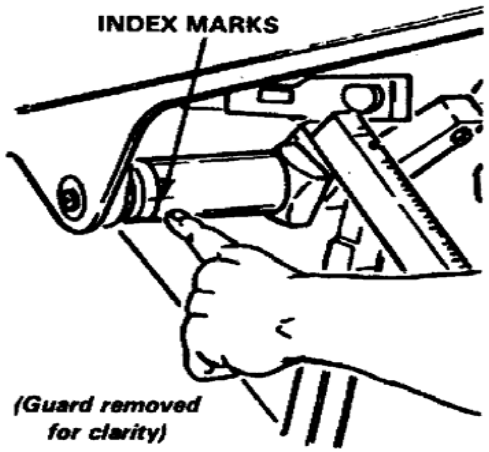


FIGURE 24

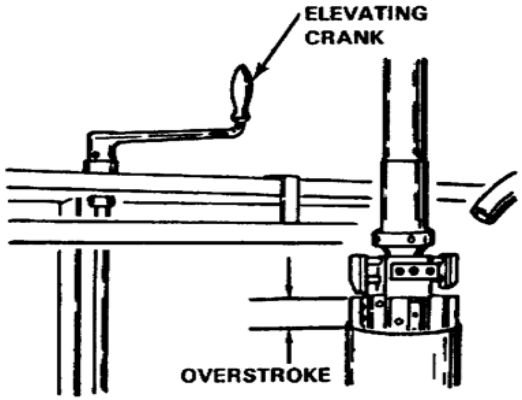


FIGURE 25

Stone Length		Top Overstroke Setting	
Inches	mm	Inches	mm
2-3/4''	70 mm	3/8''	9,5 mm
3-1/2''	89 mm	5/8''	16 mm
4-1/2''	115 mm	13/16''	21 mm
6''	152 mm	1-1/16''	27 mm

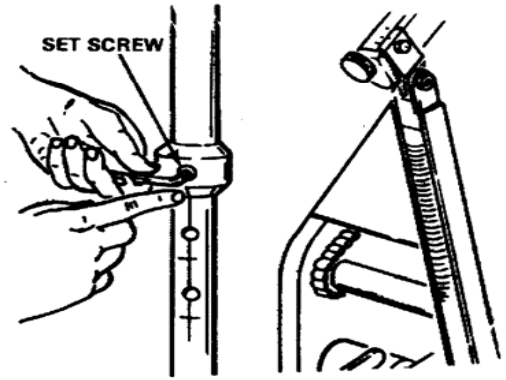


FIGURE 26

Description of Operation

With the hone head in the cylinder and the index marks lined up as shown in figure 24, use the elevating crank to adjust the overstroke length to 3/8" as indicated in figure 26 for 2 3/4" stone length.

Note: Drive tube should be set at first set of index marks.

Specification

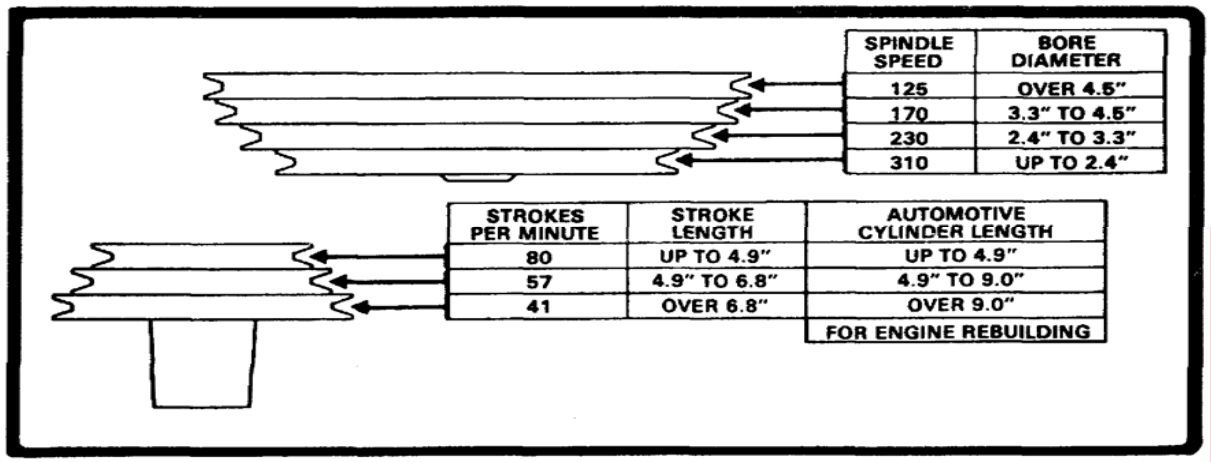
REV	Date	Revision History
1	1/7/98	Hone 4 & 5

View

Overstroke

Overstroke adjustment

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	5



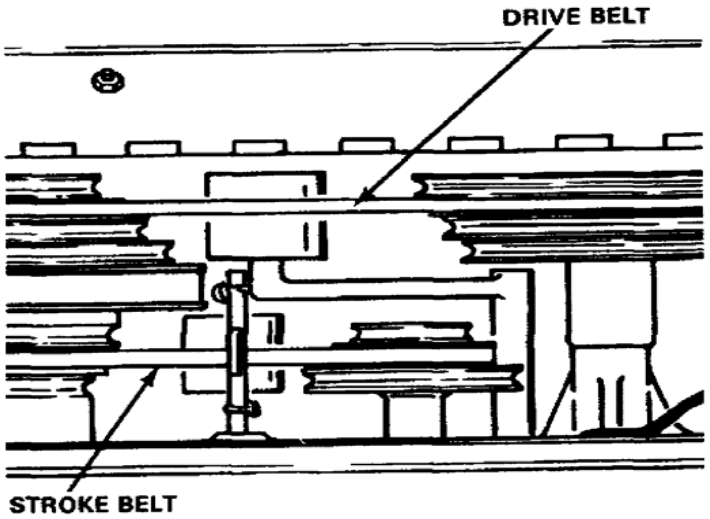


FIGURE 28

Description of Operation

Open the left side of the belt cover and set the spindle speed at 170 and the strokes per minute at 57.

Specification

REV	Date	Revision History
1	1/7/98	Hone-6

View

Speed & Stroke

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	6

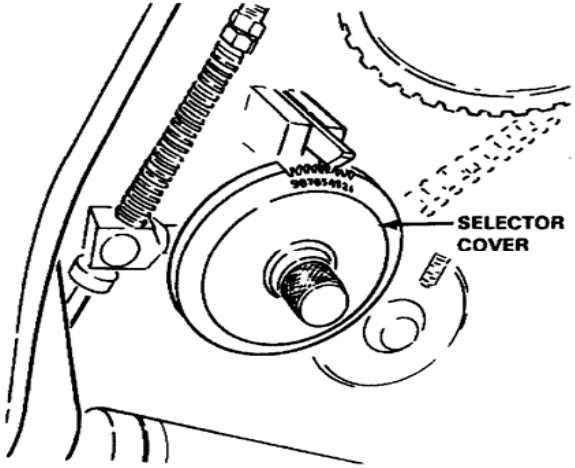


FIGURE 29

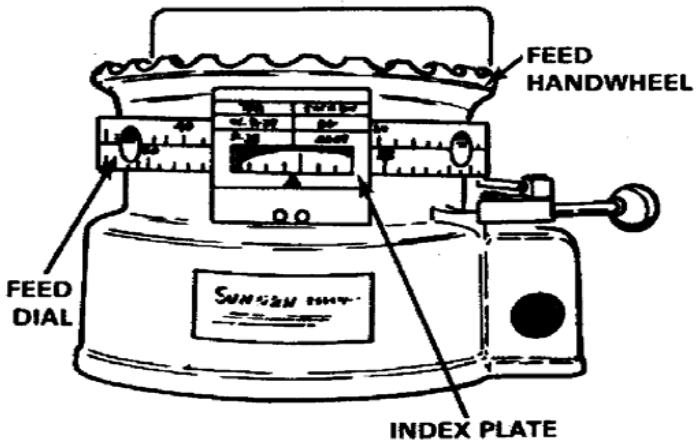


FIGURE 30

Description of Operation

Set the ratchet feed rate on the selector cover to 1 for the EHU 512 Stones. change the ratchet feed rate to 4 for the C30-PHT-731 Plateau Hone Brushes. See figure 29

Use the index plate for the lower scale identified as P28 .005 per division.

Note: to change the Hand Wheel Assembly and Stroke Plate to Metric, order CV-215MA.

Specification

REV	Date	Revision History
1	1/7/98	Hone-7
2	12/1/99	Change note from .0005 to .005
3	12/15/03	Update ratchet feed changes for stones and brushes

View

Ratchet Feed & Index Plate

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	7

Honing Operations Guide

EHU-512 Stones (**Ratchet Feed Set to 1**) **(Block must be at room temperature before honing)**

1 Insert hone head into cylinder and rotate feed handle to the left while shaking the hone head until a slight resistance is felt.
2 Adjust the feed dial to a point where it will not shut off the honer over fifteen strokes
3 Set mode switch to timed mode and set controller to 15 seconds (15 seconds = 15 strokes)
4 Start the honer and adjust the load to 15 units, maintaining 15 units load by hand during honing. Apply no more than 15 strokes per cylinder at a time. (4 strokes minimum during final sizing) Switch stone positions in the hone head between each cylinder. Do not dwell machine when cylinder is within 0.01mm of target size.

Note:1 Unit load will oscillate during normal operation. The intent is to hold 15 units as a minimum load during the honing process.

Note:2 <u>During final sizing, if less than 15 strokes are desired, set timer to desired seconds or operate in zero shut-off mode and never dwell machine or run less than 4 strokes / cylinder.</u>

5 Follow recommended honing sequence (1,5,4,-3,2,6) do not hone adjacent cylinders
6 Size cylinders, 15 strokes / cylinder maximum, switching stone positions in hone head between each cylinder. Do not chase taper (dwell machine) when cylinder size is within 0.01mm of target. Stop honing with the EHU-512 stones when cylinder size is within 0.005mm of target size. Allow block to cool for fifteen minutes to confirm final size before brush honing.

C30-PHT-731 Plateau Honing Tool (**Ratchet Feed Set to 4**)

1 Insert hone head into cylinder and rotate feed handle to the left while shaking the hone head until a slight resistance is felt.
2 Adjust feed dial so it will not shut the machine off before the control panel timer.
3 Set mode switch to timed mode and set controller to 45 seconds.
4 Start honer and increase unit load to 20 units and allow to run until system shuts off.

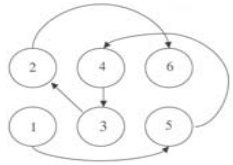
Note:3 Proper ratchet feed setting is required to establish desired cylinder surface parameters using the C30-PHT-731 Plateau Hone Tool. After setting the initial load, the ratchet feed system will increase the load during the remaining time. <u>Operaters should not release load during this operation.</u>

Description of Operation

Use LP8X-55 Chlorine free fluid set at 7L/min. flow rate. Use dual canister filtration system with honing mats CV-1100. Change filters, fluid, and mats every 15 hours of operation.

See Section 2 Sheets 10 and 11 for honer calibration and maintenance requirements.

Honing Sequence



Note: When honing first run blocks, stroke limitations due not apply until cylinder size is within 0.0254mm (0.001in) of target size.

Specification

REV	Date	Revision History
1	1/7/98	
2	12/15/03	Update honing information according to Surveillance Panel direction 12/15/03
3	6/22/06	Update honing information according to Surveillance Panel direction 6/6/06

View

Fluid and Operations Guide

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	8

Cylinder Sizing Specifications

	Metric mm	Inch
First Run Target Bore Size	96.52	3.8000
Hone with EHU-512 @ 15 units load to	96.515	3.7998
Hone with C30-PHT-731 @ 20 units load for 45 sec.	96.52	3.8000
Second run Target Bore Size	96.54	3.8008
Hone with EHU-512 @ 15 units load to	96.535	3.8006
Hone with C30-PHT-731 @ 20 units load for 45 sec.	96.54	3.8008
Third Run Target Bore Size	96.56	3.8016
Hone with EHU-512 @ 15 units load to	96.555	3.8014
Hone with C30-PHT-731 @ 20 units load for 45 sec.	96.56	3.8016
Fourth Run Target Bore Size	96.58	3.8024
Hone with EHU-512 @ 15 units load to	96.575	3.8022
Hone with C30-PHT-731 @ 20 units load for 45 sec.	96.58	3.8024
Fifth Run Target Bore Size	96.60	3.8031
Hone with EHU-512 @ 15 units load to	96.595	3.8030
Hone with C30-PHT-731 @ 20 units load for 45 sec.	96.60	3.8031
Sixth Run Target Bore Size	96.62	3.8039
Hone with EHU-512 @ 15 units load to	96.615	3.8037
Hone with C30-PHT-731 @ 20 units load for 45 sec.	96.62	3.8039

Intent is to have finished cylinders within +/- 0.005mm (0.0002in.) of target size

Do not chase taper when cylinder size is within 0.01mm (0.0004in.) of target size

Maximum allowable taper = 0.0254mm (0.001in.)

Description of Operation

Specification

REV	Date	Revision History
1	1/8/98	Cylinder sizing chart
2	12/15/03	Revised target load values, added target sizing and taper information

View

Cylinder Size

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	9

Honer Calibration

All CV-616 honers must be verified on-site by a qualified Sunnen Technician using the Hydraulic Pump and Reservoir Dynamometer. All CV-616 honers should be maintained according to the attached lubrication schedule each time the fluid and filters are changed.

Contact the Test Sponsor, ASTM Test Monitoring Center, Surveillance Panel Chairman, or Operations and Hardware Subpanel Leader for information on Sunnen calibration requirements.

Description of Operation

Specification

REV	Date	Revision History
1	1/1/98	Hone-10
2	12/15/03	Update honer calibration information
3	2/22/10	Changed "All CV-616 honers must be calibrated" to "All CV-616 honers must be verified"

View

Honer Calibration

Lubrication Point Table

1	Connecting Rod Needle Bearings	#2 Grease	2 Pumps
2	Stroke Rocker Arm (two points)	#2 Grease	2 Pumps
3	Lower Drive Arm to Carriage Connecting Strap Bearing	#2 Grease	2 Pumps
4	Upper Drive Arm to Carriage Connecting Strap Bearing	#2 Grease	Remove plug from bolt and fitting. 2 pumps, and replace plug.
5	Upper Rod-feed Universal Joint	SAE 20 Oil	Coat Universal
6	One Way Roller on Solenoid Energizer Switch	SAE 20 Oil	1 Sqirt
7	Electrical Limit Shaft Bearings	SAE 20 Oil	1 Sqirt
8	Solenoid Plunger Bushing	SAE 20 Oil	1 Sqirt
9	Top of Connecting Rod where the Stroke Release Pawl rides	#2 Grease	Brush on area
10	Connecting Rod Shaft	#2 Grease	Coat
11	Stroke Release Pawl Pivots (two points)	SAE 20 Oil	1 Sqirt
12	Stroke Release Block	#2 Grease	1 Pump
13	Gear Reducer	Gear Oil 140	Drain and refill
14	Carriage Traverse Shaft (both ends)	#2 Grease	2 Pumps each
15	Carriage Traverse Shaft (two points)	SAE 20 Oil	2 Sqirts
16	Handwheel Gears (not shown)	Lubriplate Low-Temp	Remove the handwheel and repack handwheel gears.
17	Feed Pawls	SAE 20 Oil	Fill Oiler
18	Idler Arm Shafts (three points)	#2 Grease	1 Pump each
19	Gear Reducer Pully Shaft	#2 Grease	1 Pump

Description of Operation

Use LP8X-55 Chlorine free fluid set at 7 L/min. flow rate. Use dual canister filtration system with honing mats CV-1100. Change filters, fluid, and mats every 15 hours of operation.

Perform recommended lubrication as outlined in lubrication table each time the fluid and filters are changed.

See Sheet 12 for lubrication guide.

Specification

REV	Date	Revision History
1	12/15/03	New sheet, Honer maintenance

View: Honer Maintenance

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	11

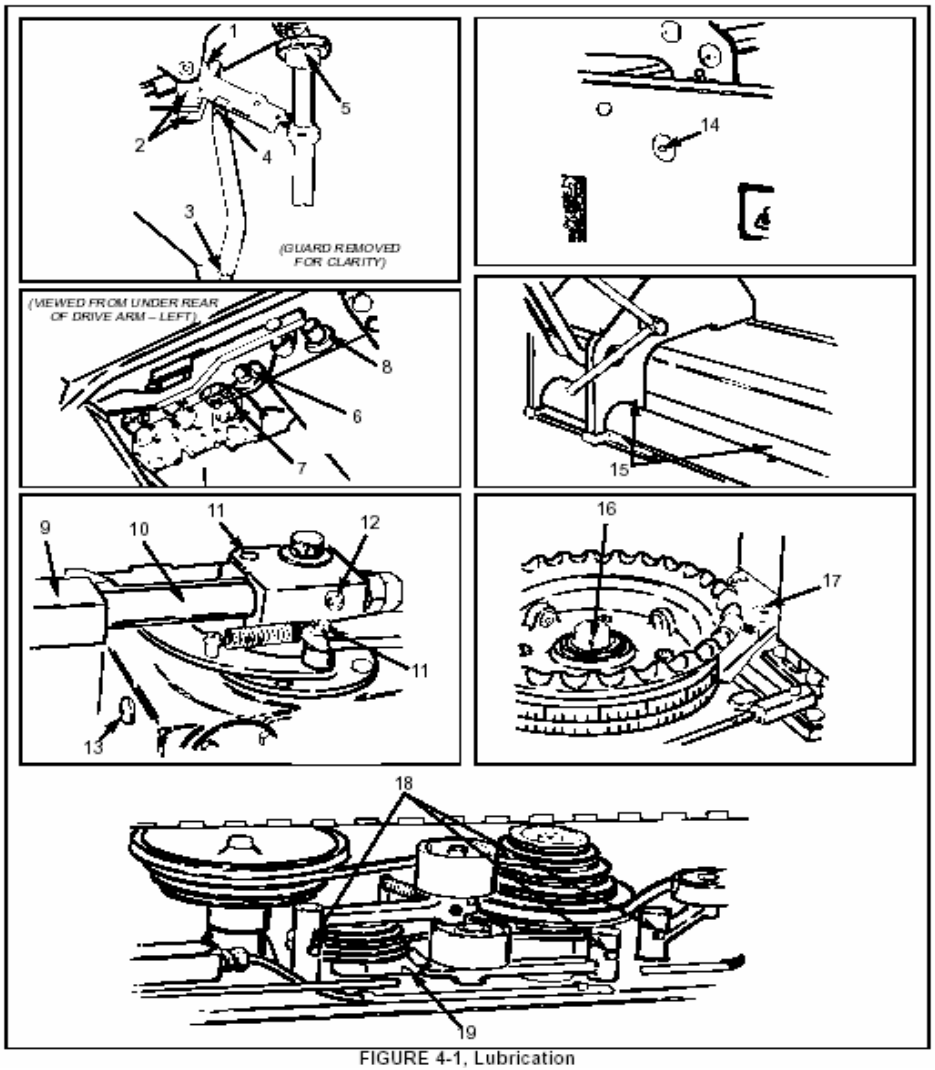


FIGURE 4-1, Lubrication

Description of Operation

Specification

View

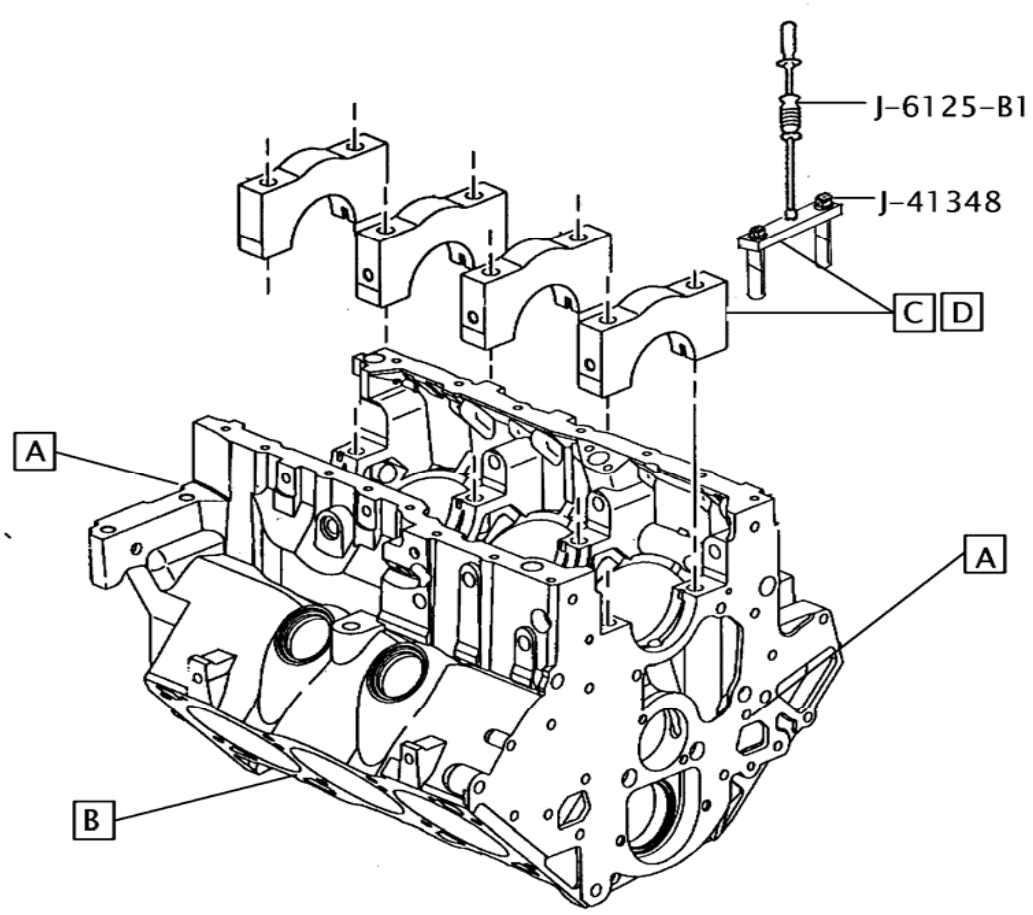
Lubrication Guide

REV	Date	Revision History
1	12/15/03	New sheet, Lubrication points, visual guide

Cylinder Honing	Sequence IIIG	Section	Sheet
		2	12

Section 3

Short Block Assembly



Description of Operation	
A	Remove all block off plates
B	Remove torque plates
C	Remove main cap side & main bolts.
D	Use Kent-Moore J-41348 main bearing cap puller & J-6125-1B slide hammer to remove main caps. Note: Main bearing caps are press fit. Do not hammer caps back and forth during removal. Damage to the caps may result in damage to engine bearings during test.

Specification

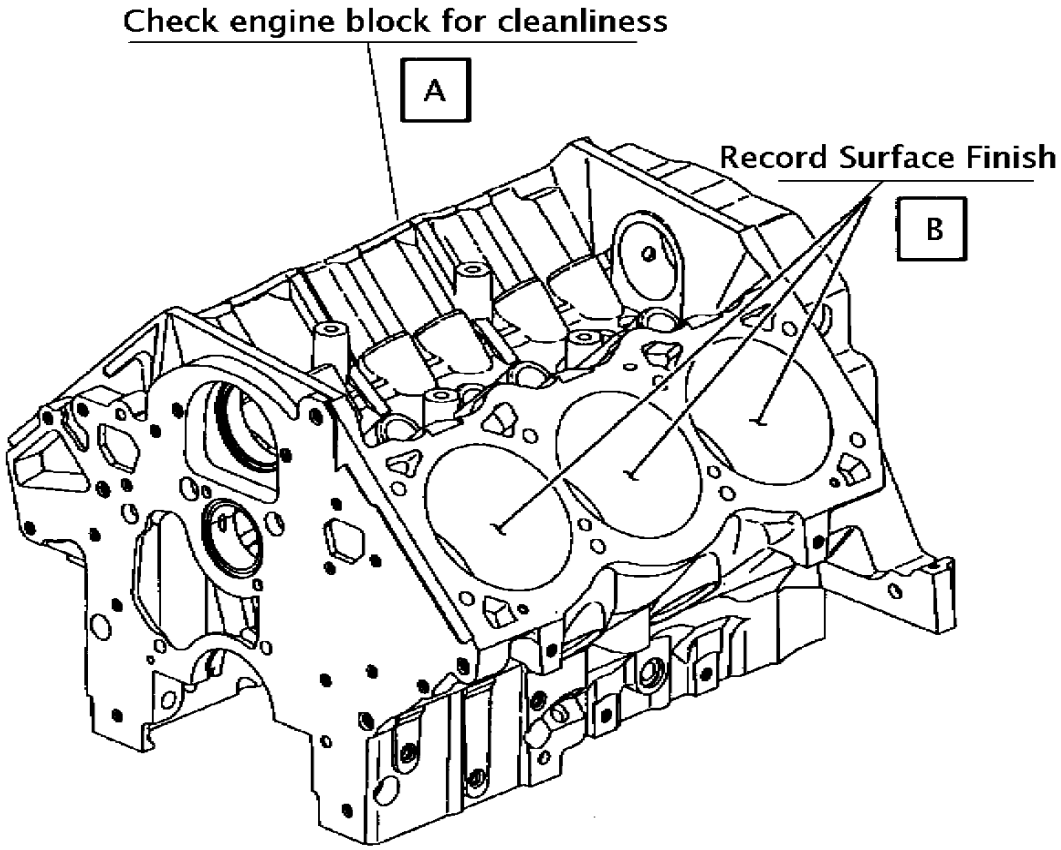
REV	Date	Revision History
1	01/01/98	Block-8

View

Short Block

Block off plate, torque plate and main cap removal

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	1



Description of Operation	
A	Check engine block, camshaft tunnel, lifter bores, oil galleries, gasket surfaces, and cylinder bores for cleanliness.
B	Check and record cylinder bore surface finish Ra and confirm bore diameters / run number.
C	Record appropriate data on form shown in Annex A.14 of IIIG test procedure.

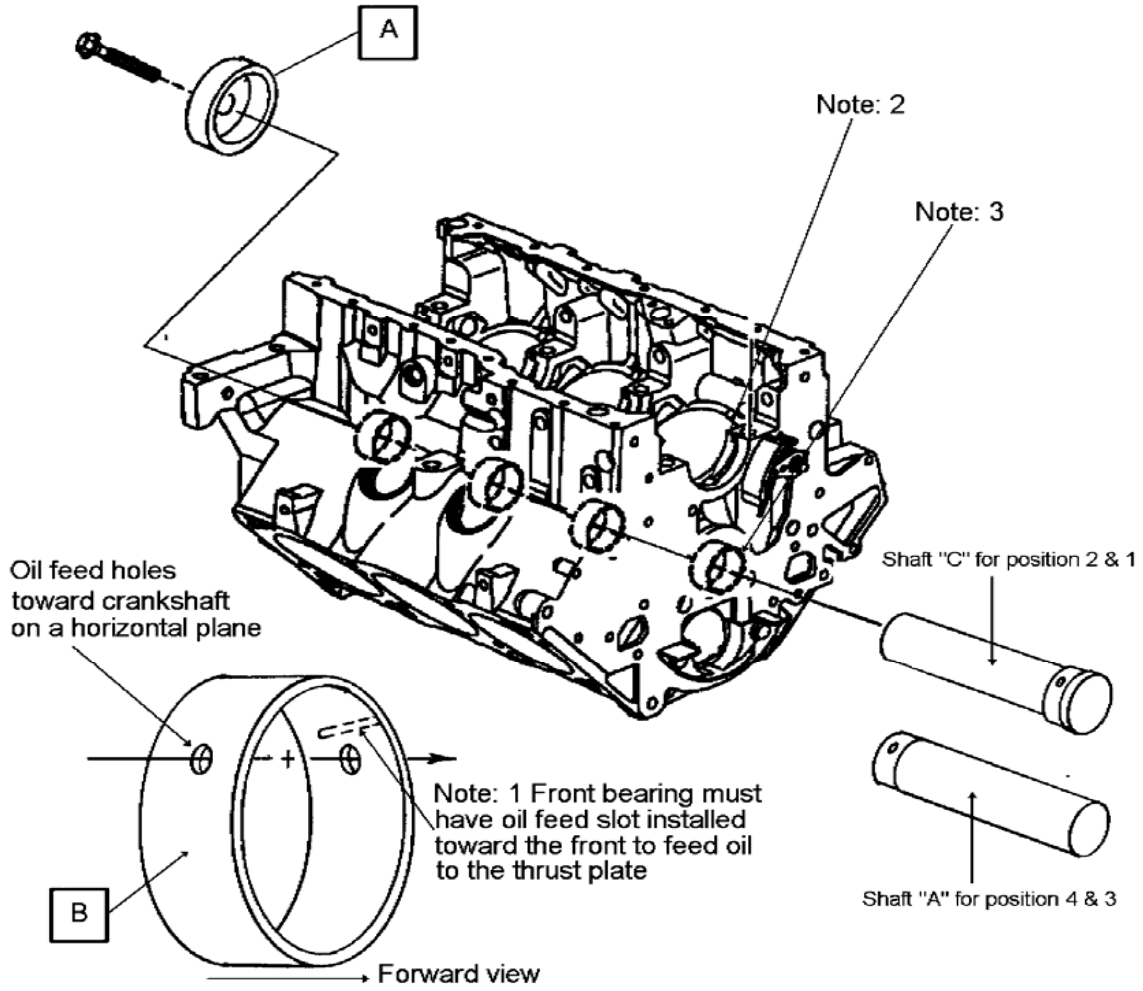
Specification

REV	Date	Revision History
1	01/02/98	Block-9
2	06/22/06	Add item "C"

View

Engine block cleanliness inspection and cylinder surface finish/size recording

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	2



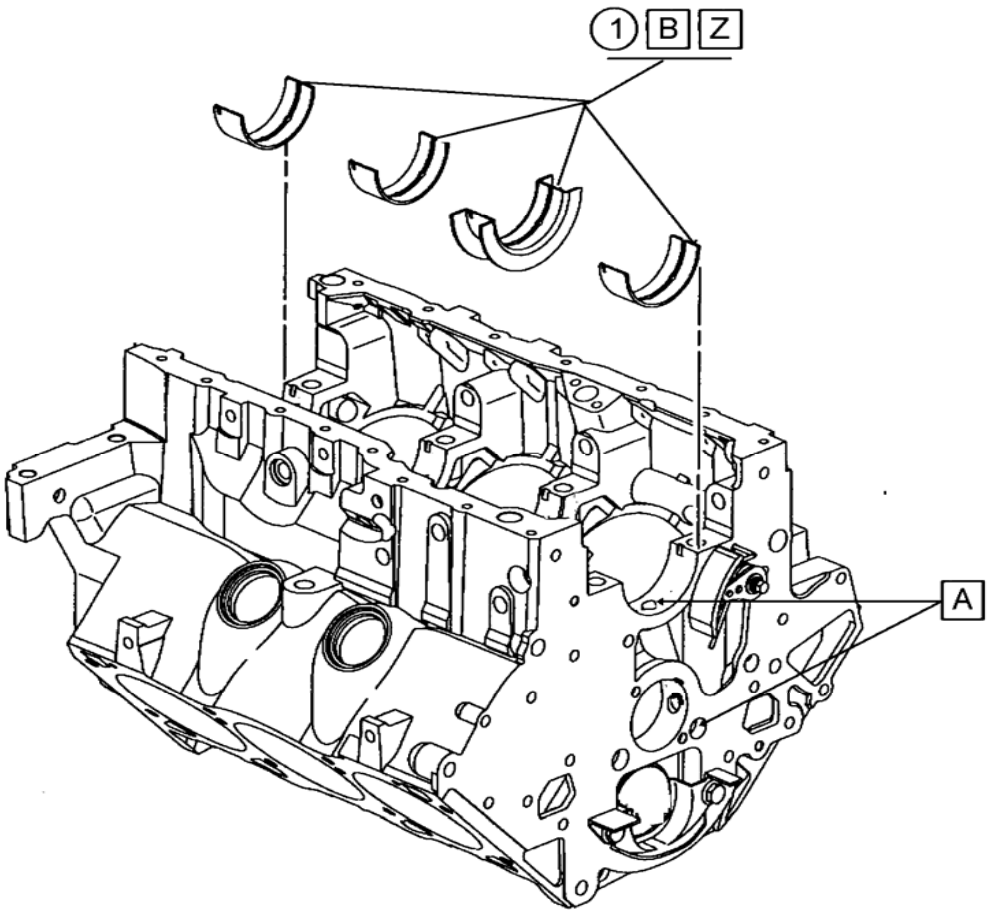
Description of Operation	
A	Install camshaft bearings using OHT3F-019-1 camshaft bearing installation tool. Sections: A for #4 rear & #3 intermediate C for #2 intermediate and #1 front
B	Lubricate bearing bore and bearing OD. with EF-411. Install bearings with the oil feed holes positioned toward the crankshaft on a horizontal plane. See view "B" and Note: 1 Note: 2 Use a pen light to check intersection of oil feed hole when viewed through main bearing oil gallery. Note: 3 Check bearing bores to remove sharp edge or burrs in leading edge and/or bore before installation. See Sec.1 Sheet 2

Specification	
1	Bearing camshaft #1 & #4 OHT3F-028-09
2	Bearing camshaft #2 & #3 OHT3F-028-10 Both bearings are included in OHT3F-042-2

REV	Date	Revision History
1	01/02/98	Block-10

View
Short Block
Camshaft bearing positioning and installation

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	3



Description of Operation	
A	Using compressed air, blow through each oil gallery feed from the main bearing support through the camshaft bearings to dislodge any babbit material that might have come off the camshaft bearings during installation. Use an inspection light to ensure proper alignment of the camshaft bearings and that all debris has been removed from the main and lifter oil galleries.
B	Check the upper main bearing bores for cleanliness and install the upper main bearings in the engine block.
Z	Lubricate with EF-411

Specification

1 OHT3F-042-2
OH-101 (1,3,4, Upper)
OH-102 (1,3, Lower)
OH-103 (4 Lower)
OH-104 (2 Lower)
OH-105 (2 Upper)

REV	Date	Revision History
1	01/03/98	Block-11

View

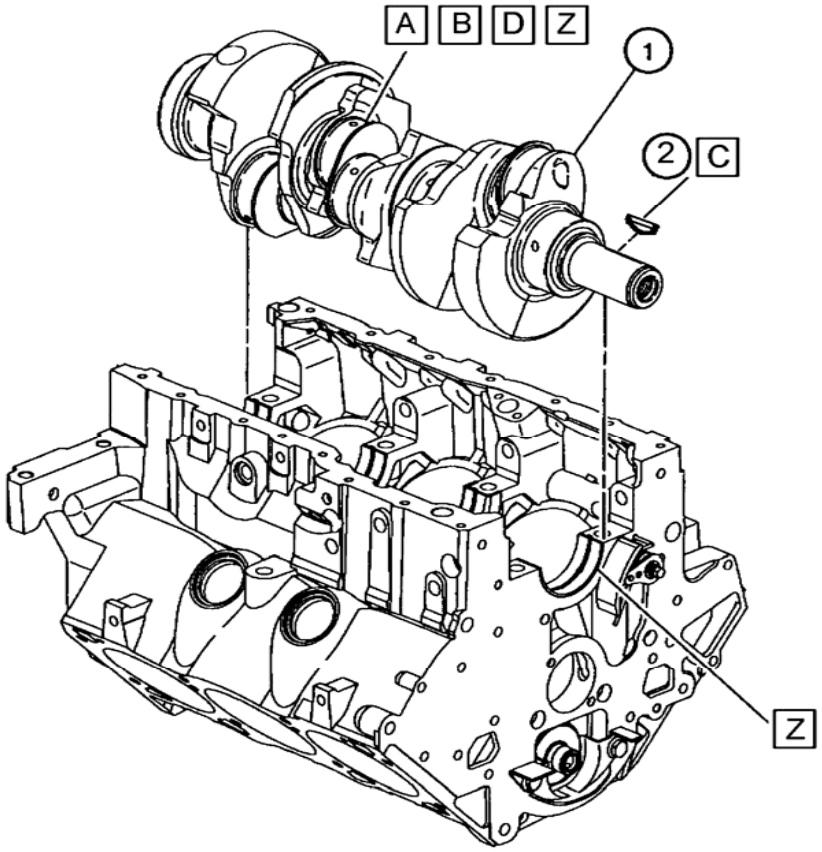
Short Block

Upper main bearing inspection and installation

Short Block Assembly

Sequence IIIG

Section	Sheet
3	4



Description of Operation	
A	Clean the crankshaft using an approved commercial cleaning agent followed by degreasing solvent and Mylar strip polishing cloth (use Mylar polishing cloth only if journals are nicked or oxidized, Do Not use to remove varnish). The final step should be degreasing solvent and nylon bristle brushing of the oil galleries. Spray crankshaft with 50/50 solution and blow excess with compressed air.
B	Check journal diameters. Mains 63.470 - 63.495mm Rods 57.1170 - 57.1475mm
C	Install key
D	Install crankshaft in engine block using care to not move the upper main bearings.
Z	Lubricate with EF-411

Specification

1 24502168 Crankshaft
2 12563282 Key
Mylar Tape
Q135 Metalite 3µ 1½ wide roll

REV	Date	Revision History
1	01/03/98	Block-12
2	12/01/04	Change to mineral spirits
3	06/22/06	Update text, add mylar tape part number, change key from (25534912 to 12563282)

View

Short Block

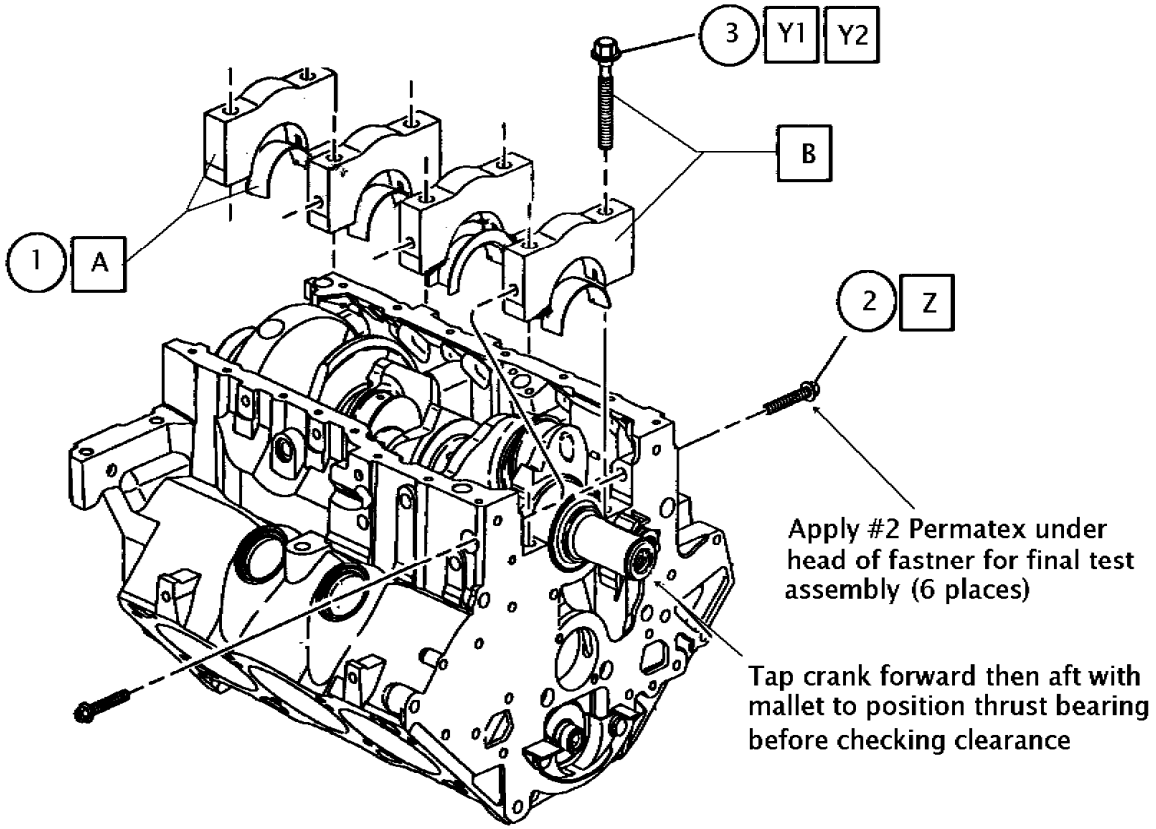
Crankshaft cleaning, inspection, and installatio

Short Block Assembly

Sequence IIIG

Section	Sheet
3	5

Use new fasteners for each test. Wire wheel sealer from under side of fastener head. Do not wire wheel threads.



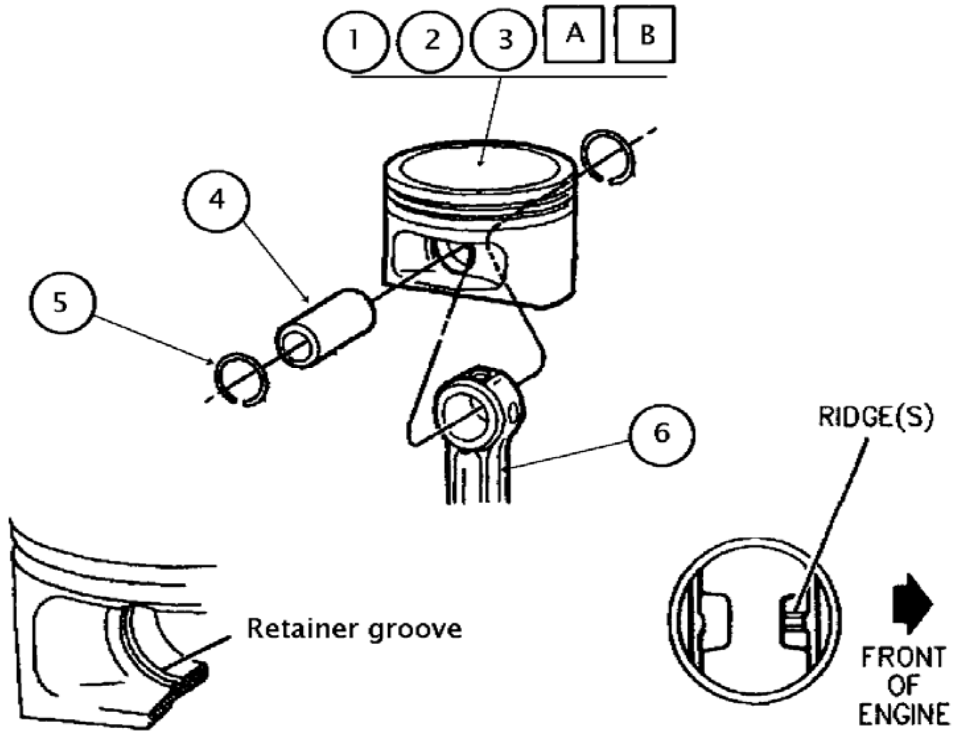
Description of Operation	
A	Install lower main bearings into main caps.
B	Install main cap with new fasteners as guides and draw into position useing very light pressure by hand with speed handle and socket in crisscross pattern.
C	Install main cap side bolts
Y1	Tighten all main bolts to 70 Nm to fully seat main caps and then loosen the bolts 360° counterclockwise. Tap crankshaft with mallet to position thrust bearing.*
Y2	Torque & Angle 20Nm then 40Nm + 35°+35°+35° (repeat 3 times from center out) Check crankshaft end play 0.076 - 0.279mm
Y3	Torque & Angle 15Nm + 45° (See note on sealer usage)

Specification	
1	OHT3F-042-2 Bearing kit
2	24505576 Bolt side (6) See note on sealer usage
3	24503056 Bolt main cap (8)

REV	Date	Revision History
1	01/10/98	Block-13
2	06/22/06	Update view, fastener usage and prep, also clearance spec.
3	02/22/10	Update view, fastener usage and prep.

View
Short Block
Lower main bearing and crankshaft final test installation

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	6



Description of Operation	
A	Confirm run number and proper grade piston selections. Clean pistons with degreasing solvent followed by air dry and wipe with lint-free cloth. Clean rods by soaking in degreasing solvent for two hours followed by spray with 50/50 EF411 and degreasing solvent.
B	Lubricate piston pin and connecting rod with EF-411. Install one piston pin retainer clip into the retaining groove. Install the con rod and piston pin. (Note: dimple on con rod is for manufacturing only) Install the second retainer clip. Make sure both retainer clips are properly seated in their grooves.

Specification	
1	OHT3F-053-1 Grade 12 test piston set
2	OHT3F-054-1 Grade 34 test piston set
3	OHT3F-055-1 Grade 56 test piston set
4	OHT3F-014-1Piston pin set
5	OHT3F-012-1 Retainer clip set
6	12574505 Rod Powdered Metal

REV	Date	Revision History
1	01/03/98	Block-14
2	11/03/04	Add part numbers for "Cast" and "Powdered Metal" Rods See "6"
3	01/31/06	Removed Cast Rod information
4	06/22/06	Update piston and rod cleaning procedure and assembly note on dimple

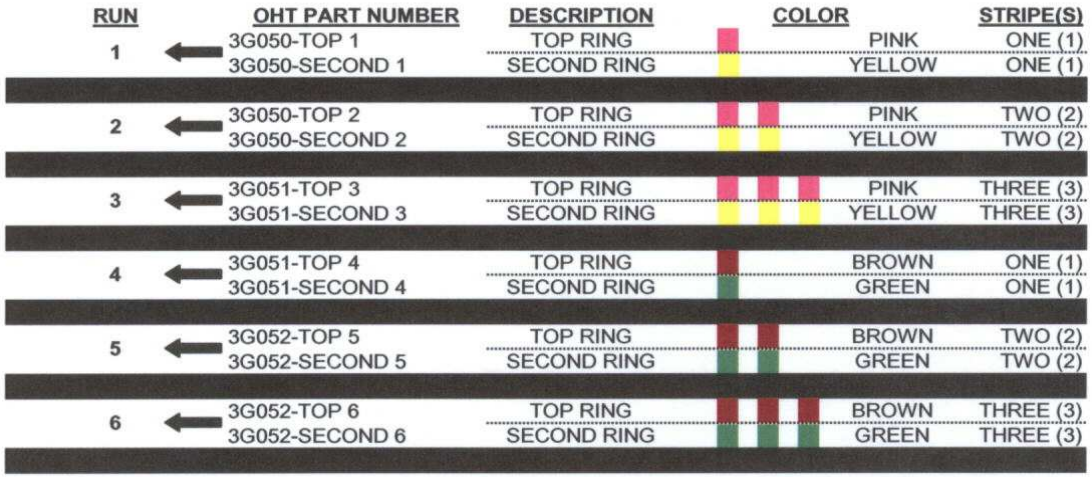
View
Piston, Pin and Connecting Rod
Piston pin and Connecting Rod assembly

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	7

Sequence IIIG
Piston, Cylinder Bore, & Ring Gap Information

Piston Grade / Run	Target Bore Size	Master Ring Gage	Target Ring Gap	Piston Size
12 / 1	96.52	96.53	Top 0.635 2nd 1.067	96.482 - 96.497
12 / 2	96.53	96.53	Top 0.635 2nd 1.067	96.482 - 96.497
34 / 3	96.56	96.57	Top 0.635 2nd 1.067	96.522 - 96.537
34 / 4	96.58	96.57	Top 0.635 2nd 1.067	96.522 - 96.537
56 / 5	96.60	96.61	Top 0.635 2nd 1.067	96.562 - 96.577
56 / 6	96.62	96.61	Top 0.635 2nd 1.067	96.562 - 96.577

All piston ring gaps to be ± 0.051mm
As measured in cylinder bore using Starrett Taper Gage #270



NOTE: PAINT IDENTIFICATION MUST BE REMOVED FROM RING PRIOR TO GAP MEASUREMENT

Description of Operation

Confirm correct ring grade and gaps for the engine run / piston grade. No piston ring gap adjustments are allowed.

To check ring gap, use Starrett Taper Gage #270 and measure the gap in the finnished cylinder bore

Specification

1 OHT3G-050 run 1
2 OHT3G-050 run 2
3 OHT3G-051 run 3
4 OHT3G-051 run 4
5 OHT3G-052 run 5
6 OHT3G-052 run 6

REV	Date	Revision History
1	06/18/02	IIIG Block-15
2	4/28/03	Update color coding
3	09/10/03	Correct top ring gap typo from 0.064 to 0.635mm
4	06/22/06	Expand drawings and add section 3 sheet 8A for additional information
4	02/22/10	Deleted OHT ring gages and allowed measurement in cylinder block

View
Piston Ring
Piston ring installation and clearance

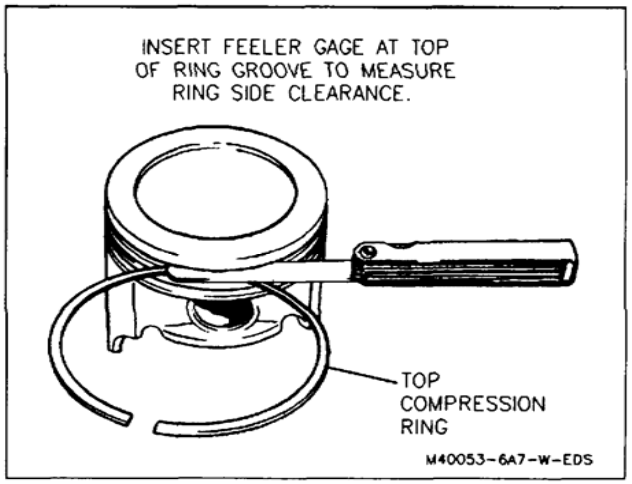


Figure 69 - Measuring Piston Ring Side Clearance

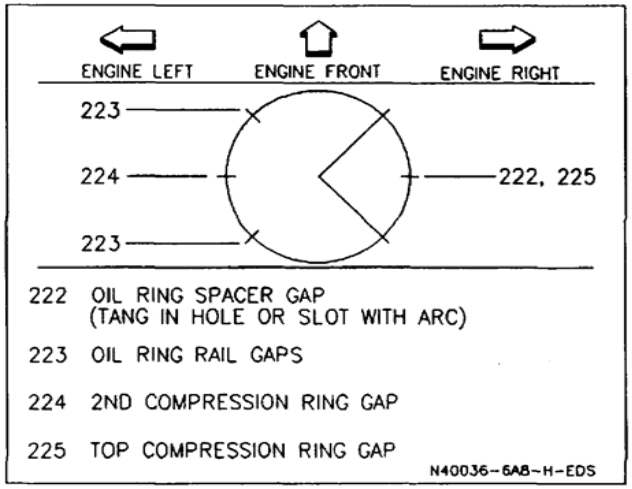
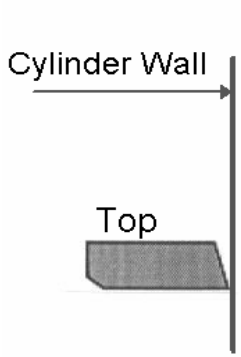


Figure 64 - Piston Ring Gap Location



Note: BC-6 second ring does not have an identification mark for top. Second ring must be installed with the sharp edge of the taper face down toward the bottom of the piston as shown in view.

Description of Operation

Check for proper ring side clearance.
Top & 2nd. 0.033 - 0.079mm
Oil control 0.023 - 0.201mm

Position rings on piston according to ring gap stagger chart. Orientation of BC-6 second ring must be taper down as shown in view. Orientation of oil control ring rails and expander are unidirectional.

Lubricate assembly with EF-411

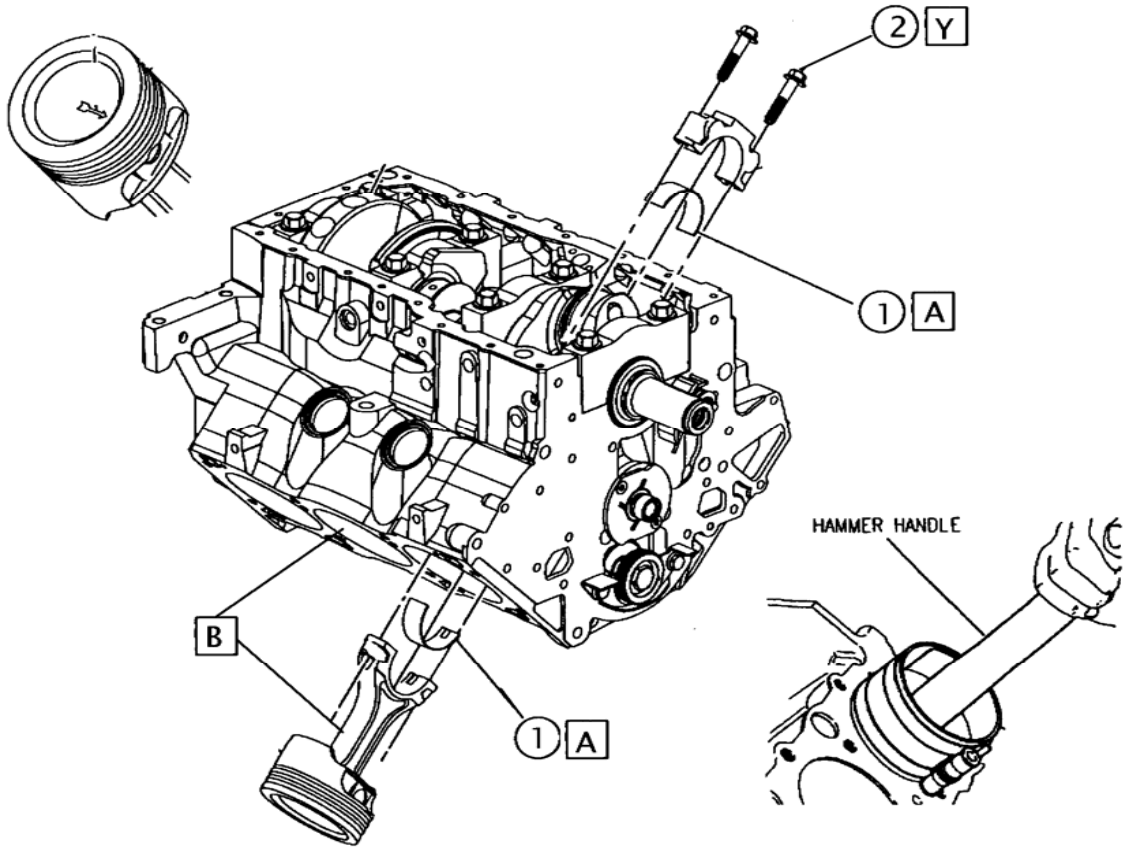
Specification

REV	Date	Revision History
1	6/22/06	Ring orientation

View

Piston ring installation, orientation, and clearance information

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	8A



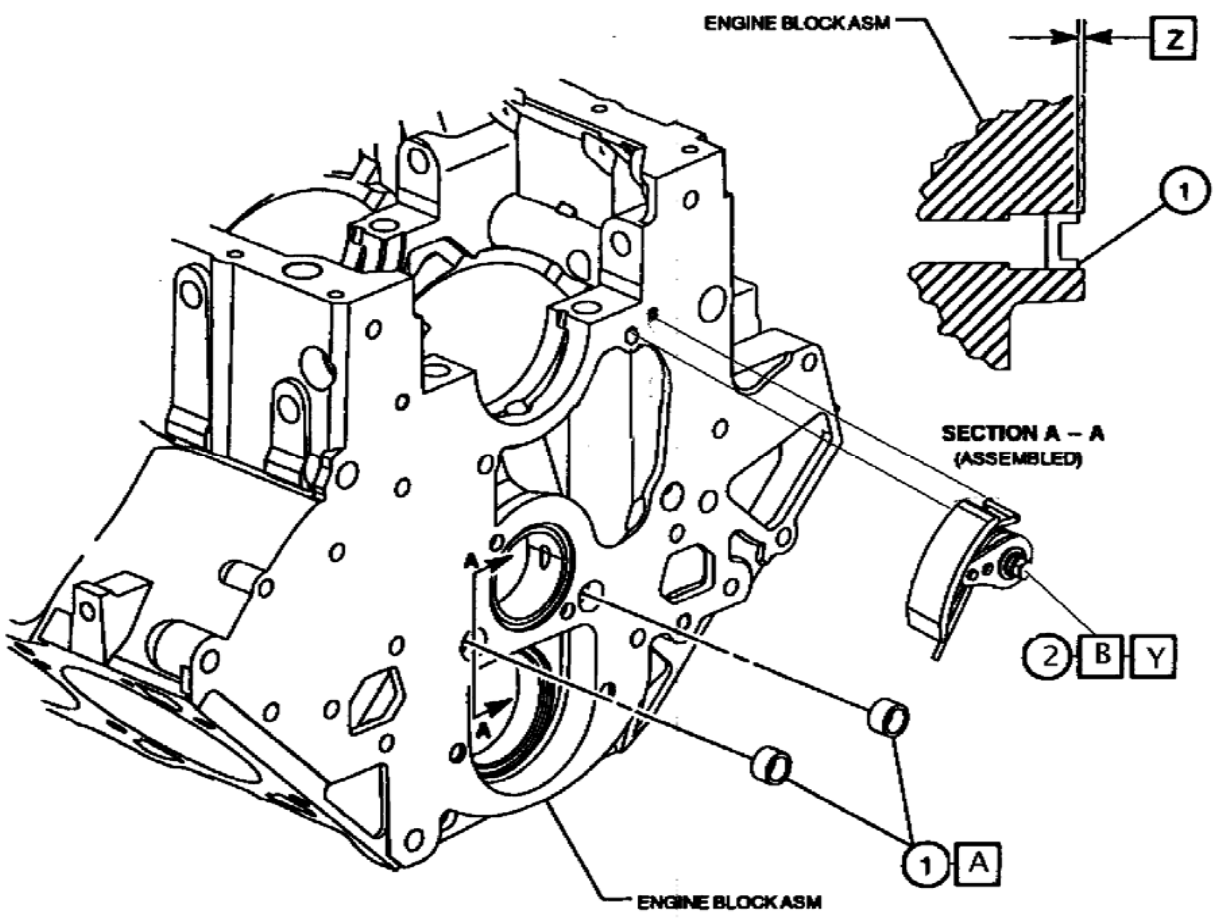
Description of Operation	
A	Install connecting rod bearings and lubricate assembly with EF-411.
B	Clean cylinder bores and lubricate with EF-411. Install piston assembly using suitable piston ring compressor and soft ended installation tool.
Y	Powdered Metal Rod (12574505) Torque & Angle 20Nm + 70°
C	Check connecting rod side clearance 0.102 - 0.508mm

Specification	
1	OHT3F-042-2 Con rod bearing OH-106
2	11589085 Bolt PM Rod

REV	Date	Revision History
1	1/3/98	Block-16
2	11/3/04	Add torque values for "Cast Rod" and "Powdered Metal Rod" See "Y" for details
3	1/31/06	Removed Cast Rod information
4	3/30/07	Update rod fastener torque from 20Nm + 75° to 20Nm + 70°

View
Short Block
Piston and rod assembly installation

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	9



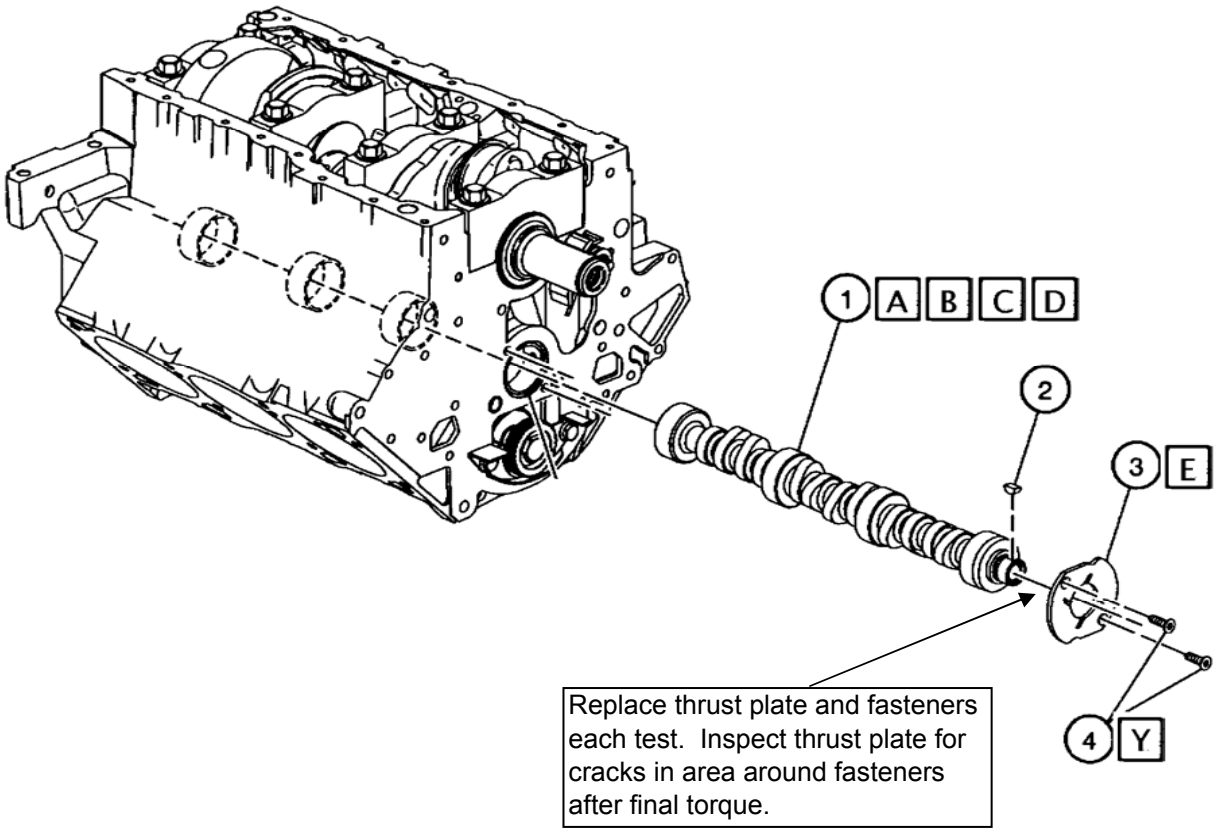
Description of Operation	
A	Install oil gallery plugs, see cross section A - A.
B	Install damper assembly
Y	Torque 22Nm
Z	Locate cup plug 1.5 +/- 0.75mm below front face of block.

Specification	
1	3835577 Plug, oil gallery
2	24503893 Damper assembly

REV	Date	Revision History
1	1/3/98	Block-17

View
Short Block
Oil gallery plugs and timing chain damper

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	10



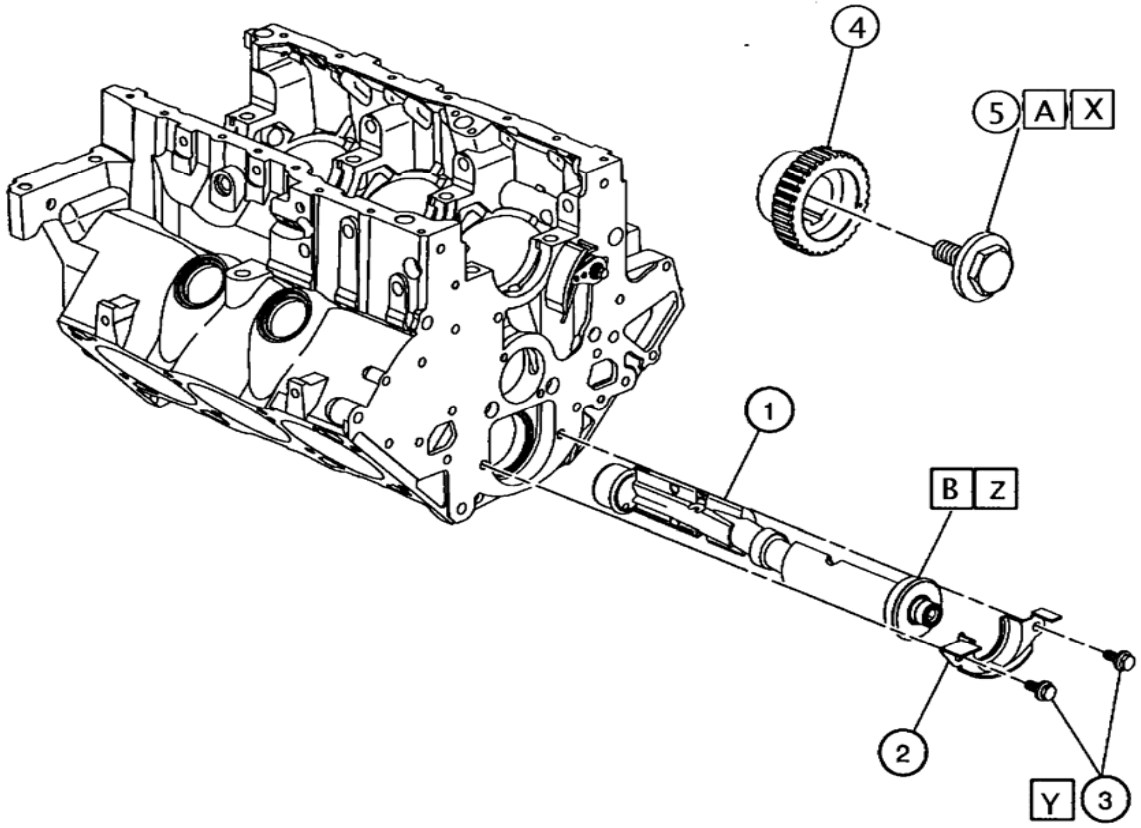
Description of Operation	
A	Check and de-burr if necessary, the front thrust surface of the camshaft.
B	Clean camshaft with degreasing solvent and very clean shop towel. Note: make sure all grinding residue is removed before continuing.
C	Make pre-test measurements at the rear side of each lobe and record to the nearest 0.001mm.
D	Lubricate the camshaft journals only (not lobes) with EF-411and install. Note: If test oil is known, lubricate journals and lobes with test oil and install
E	Lubricate thrust plate and install
Y	Torque 15Nm

Specification	
1	OHT3F-008-8 Phosphated Camshaft **(For Use in IIIG Testing Only)**
2	24500618 Key (Replace each test)
3	OHT3F-011-2 Thrust plate (0.152")
4	25519242 Bolt (Replae each test)

REV	Date	Revision History
1	1/13/98	Block-18
2	12/1/04	Change to mineral spirits
3	6/22/06	Update usage information
4	3/30/07	Update "D" pre-test lubrication directions

View
Short Block
Camshaft cleaning, measurement, and installation

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	11



Description of Operation	
A	Secure balance shaft in a smooth jawed vice and install drive gear and bolt.
B	Inspect balance shaft and roller bearing for cleanliness and install.
X	Torque & Angle 22Nm + 70°
Y	Torque 30Nm
Z	Lubricate with EF-411

Specification

1	24502388 Shaft Assembly or 24506557
2	24500374 Retainer
3	24500055 Bolt
4	24503524 Gear
5	24501367 Bolt

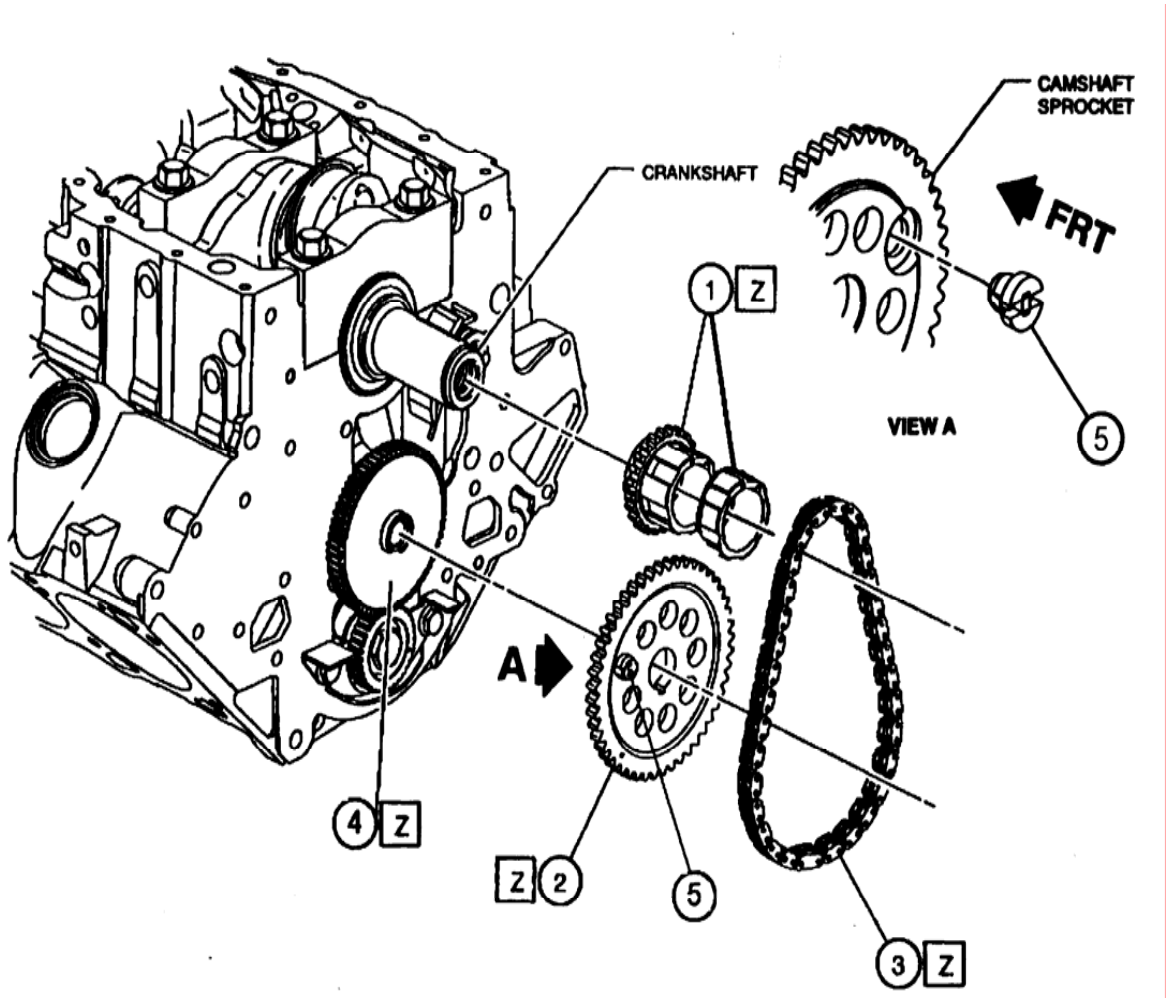
REV	Date	Revision History
1	1/5/98	Block-19
2	6/22/06	Add 24506557 shaft assembly part number

View

Short Block

Balance shaft inspect & install

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	12



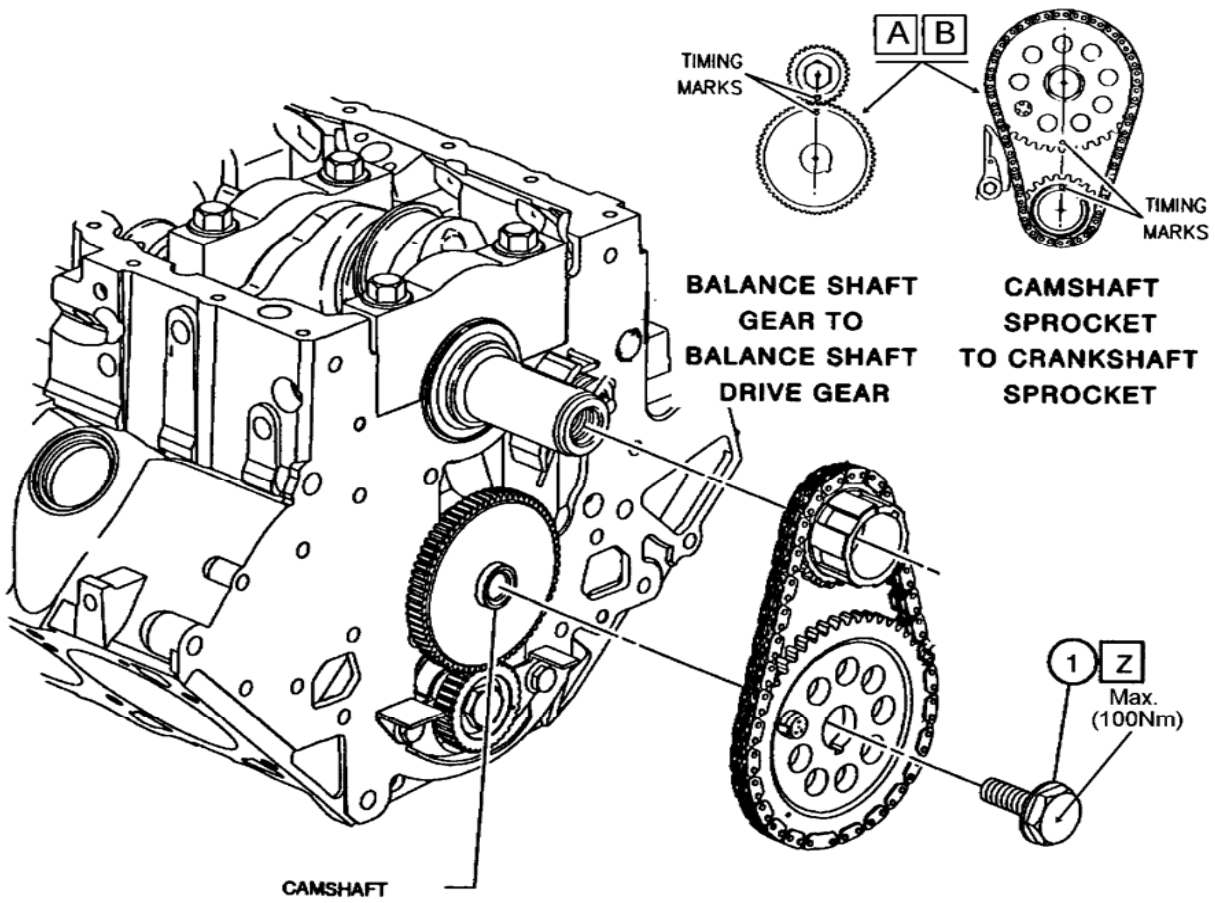
Description of Operation	
	Timing gear set. See part number information.
A	Install magnet See view "A"
Z	Lubricate with EF-411
	Note: Inspect balance shaft and gears and replace as necessary if damage to gear teeth and / or thrust surface is evident.

Specification		
1	OHT3F-036-1	Sprocket, 2pc.
2	24505306	Sprocket, camshaft
3	24504668	Chain
4	24504792	Gear
5	10456195	Magnet

REV	Date	Revision History
1	1/5/98	Block-20

View
Short Block
Timing gear set

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	13



Description of Operation	
A	Lubricate all gear sets and chain with EF-411
B	Align timing marks on balance drive and driven gears. Align timing marks on camshaft and crankshaft sprockets.
Z	Torque 100Nm + 90° **(Hold assembly by the crankshaft during torquing)**

Specification	
1	24501366 Bolt, camshaft sprocket **(Replace fastener each application)**

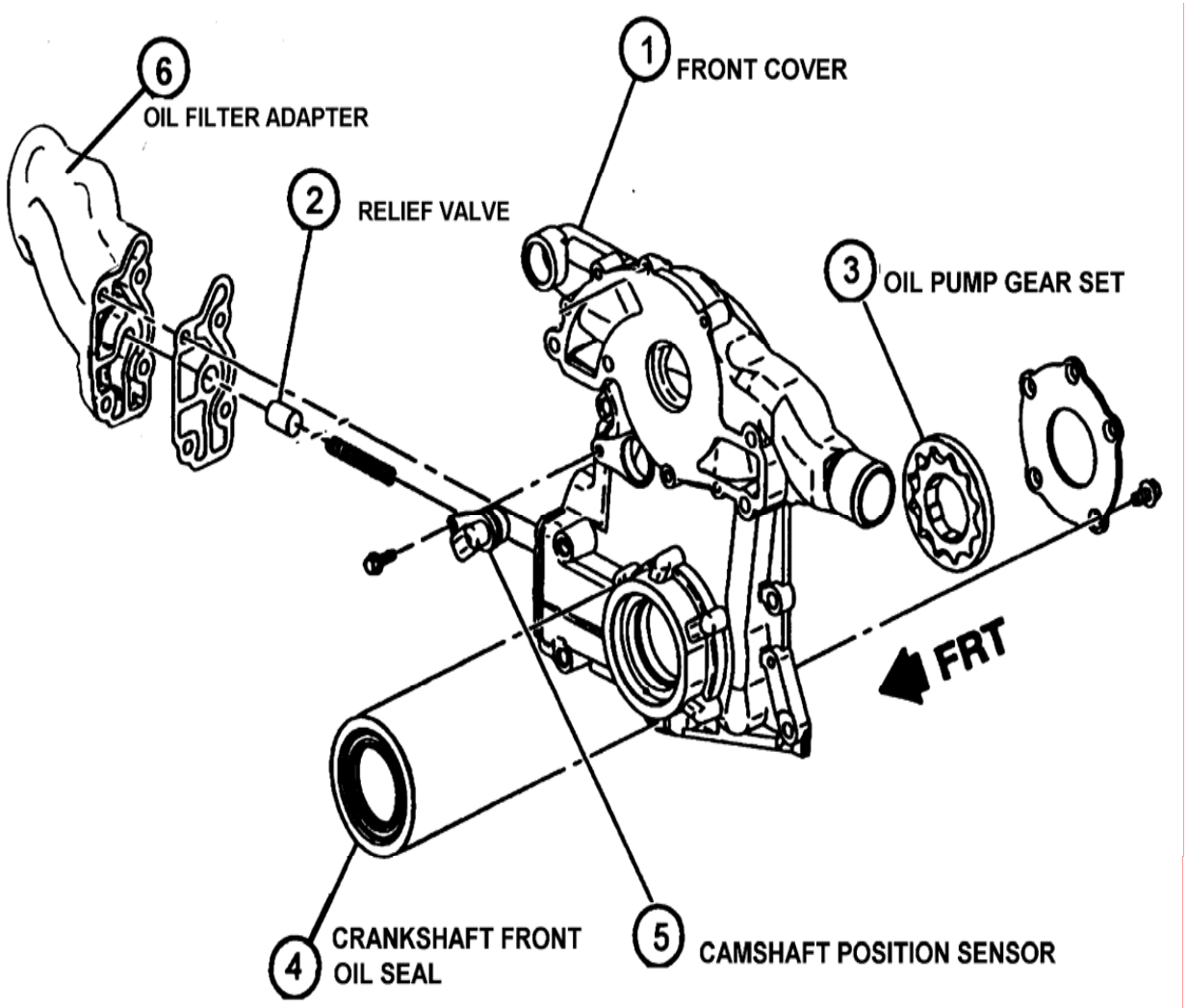
REV	Date	Revision History
1	1/5/98	Block-21

View
Short Block
Timing gear set alignment & torque

Short Block Assembly	Sequence IIIG	Section	Sheet
		3	14

Section 4

Front Cover, Rear Cover, and Sump



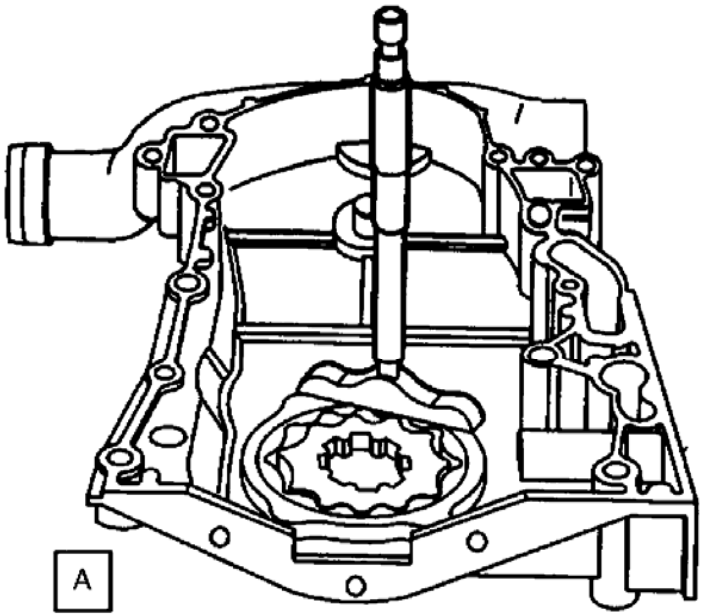
Description of Operation
Assembly view

Specification	
1	OHT3F-085-1 Front Cover
2	25530949 Valve, oil pressure relief
3	24505433 Oil pump gear set
4	OHT3G-092-1 Seal
5	10456148 Camshaft position sensor
6	OHT3F-080-1 Adapter, oil filter

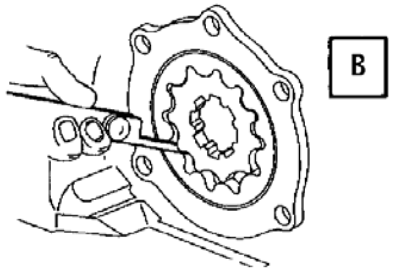
REV	Date	Revision History
1	01/05/98	Block-22
2	4/28/03	Change front cover over to OHT part number
3	11/03/04	Change front seal from 24504098 to OHT3G-092-1

View
Front Cover
Front cover assembly view

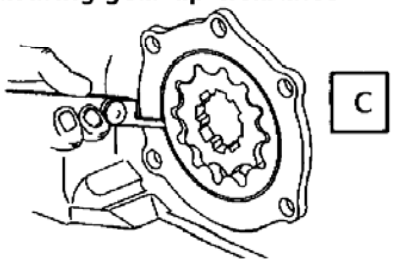
Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	1



Measuring gear end clearance drop in housing



Measuring gear tip clearance



Measuring outer gear dia. clearance

Description of Operation	
A	Measure gear drop in housing 0.025 - 0.089mm
B	Measure gear tip clearance; 0.076 - 0.127mm (0.003 - 0.007in) as measured with gear teeth in mesh with opposite side.
C	Measure outer gear diameter clearance 0.025 - 0.127mm (0.001 - 0.005in)
	Note: Inspect front cover oil gear housing for evidence of wear from previous test. Replace after six tests or as necessary if wear is evident.

Specification

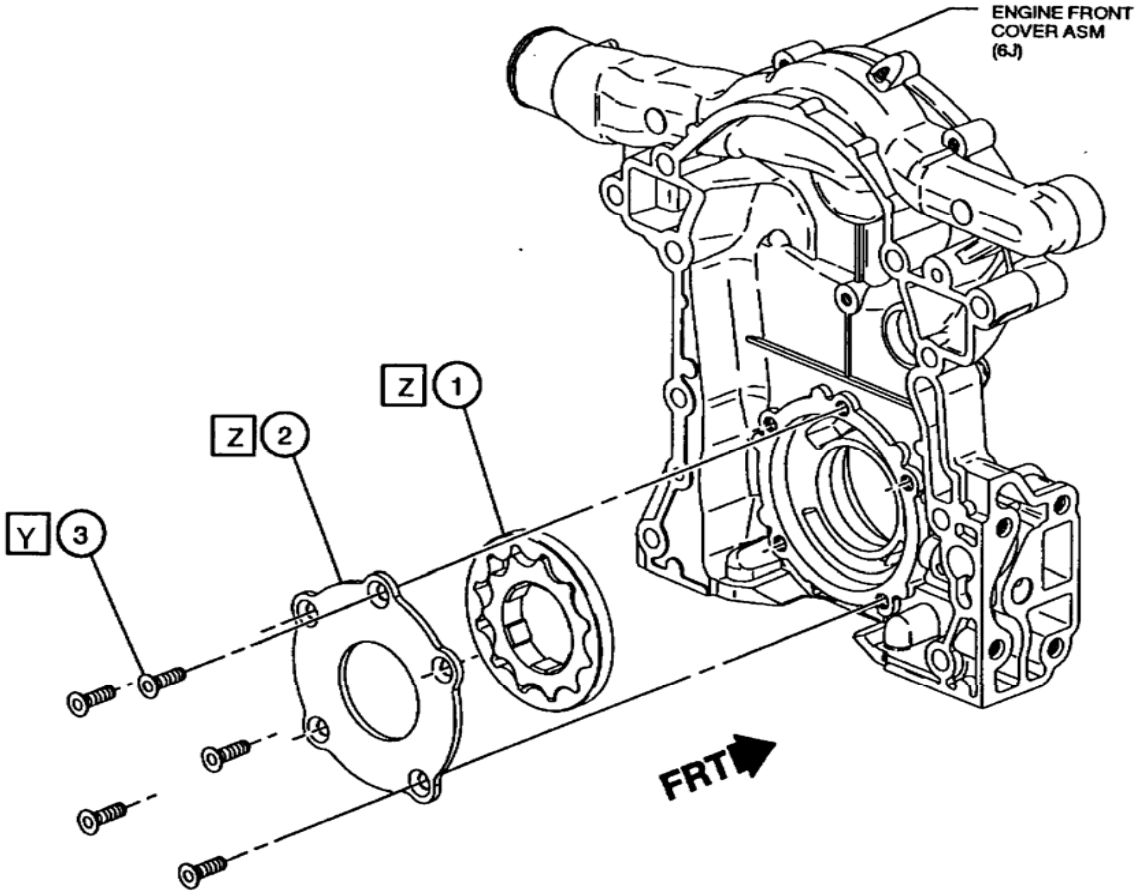
REV	Date	Revision History
1	01/05/98	Block-23
2	06/22/06	Add usage information

View

Front Cover

Oil pump gear clearance

Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	2



Description of Operation	
Y	Torque 11Nm
Z	Lubricate with EF-411

Specification	
1	24505433 Gear set
2	25521935 Cover, Gearotor
3	25519242 Bolt

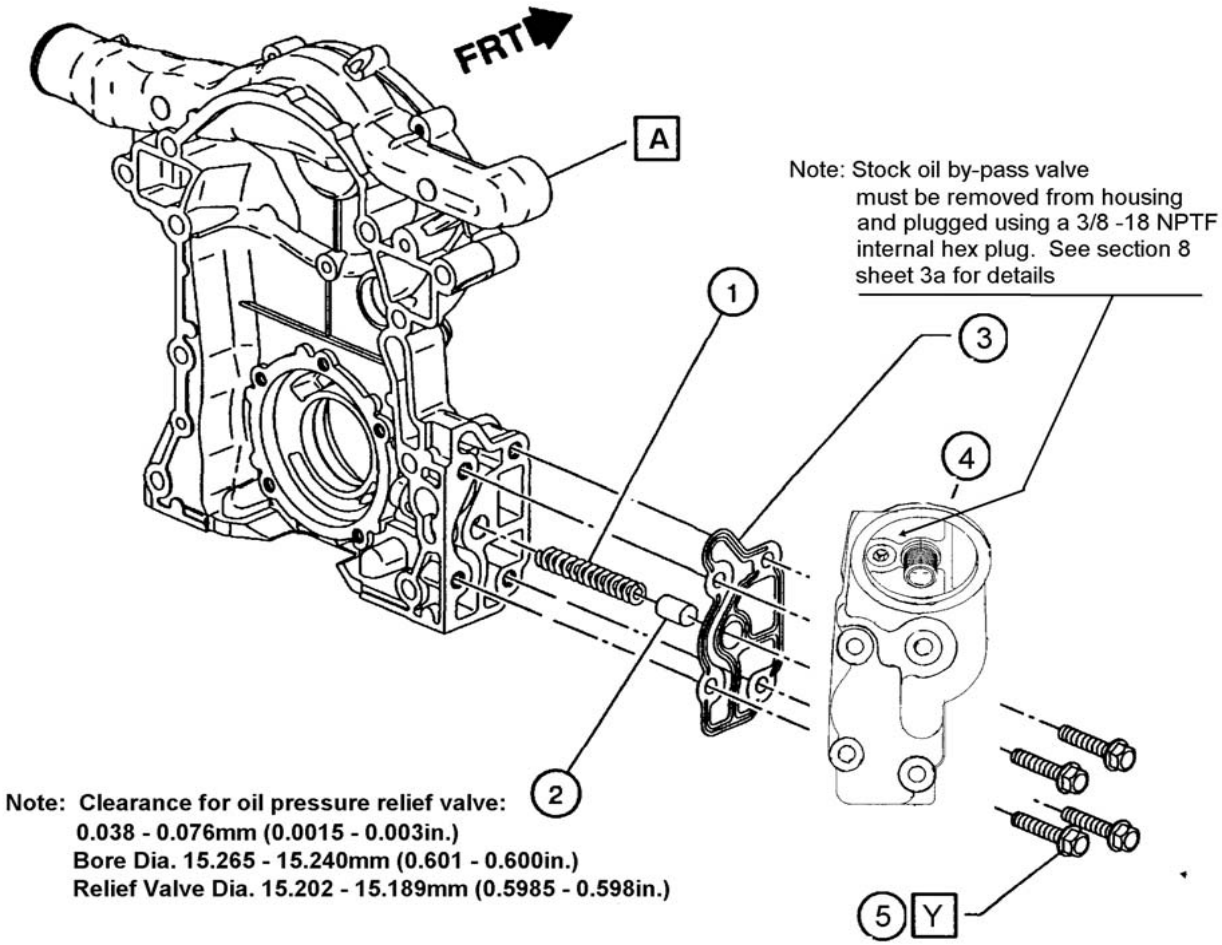
REV	Date	Revision History
1	01/05/98	Block-24

View
Front Cover
Front cover oil gear install

Front Cover, Rear Cover, & Sump

Sequence IIIG

Section	Sheet
4	3



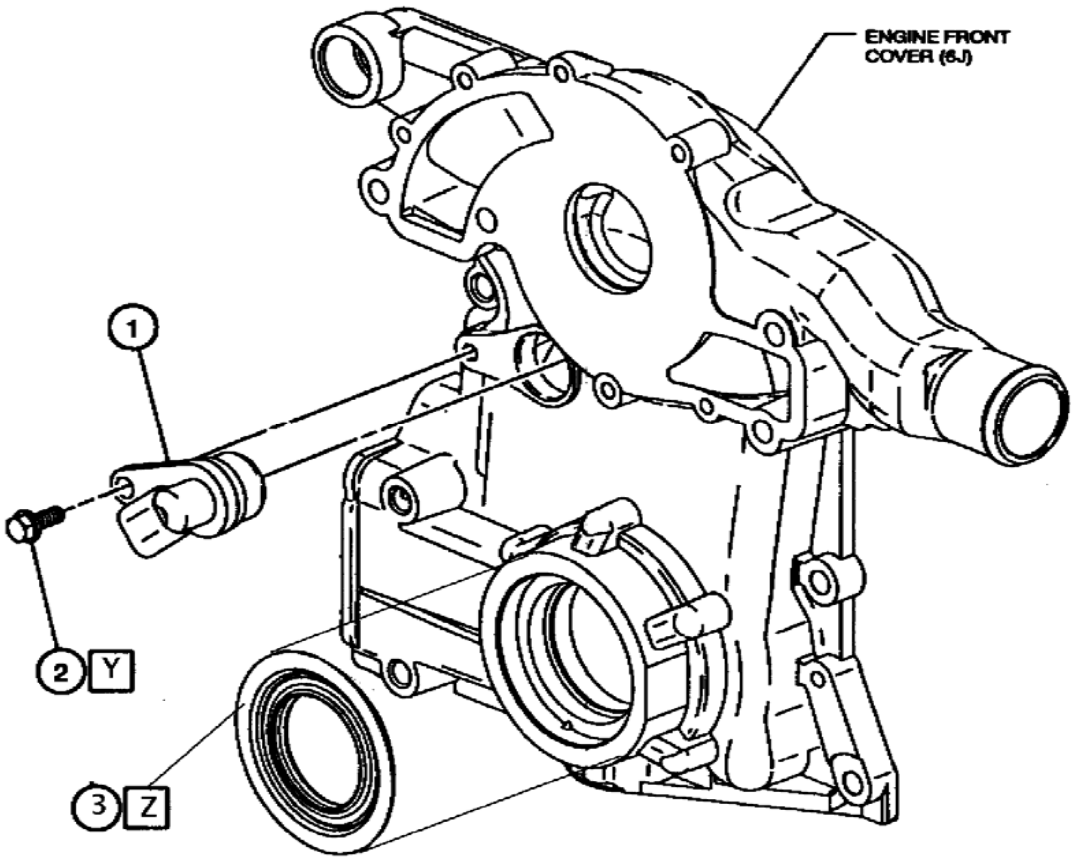
Description of Operation	
A	Front cover oil filter adapter assembly
Y	Torque 30Nm May use Permatex #2 or Perfect Seal #4 on fasteners and gasket

Specification	
1	1262505 Spring (New each test)
2	25530949 Valve
3	25534742 Gasket
4	24501300 Adapter, oil filter Modified OHT3F-080-1
5	24504713 Bolt

REV	Date	Revision History
1	01/05/98	Block-25
2	06/22/06	Update sealer usage information
3	08/04/06	Update spring usage, use new spring each test

View
Front Cover
Front cover oil filter adapter assembly

Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	4



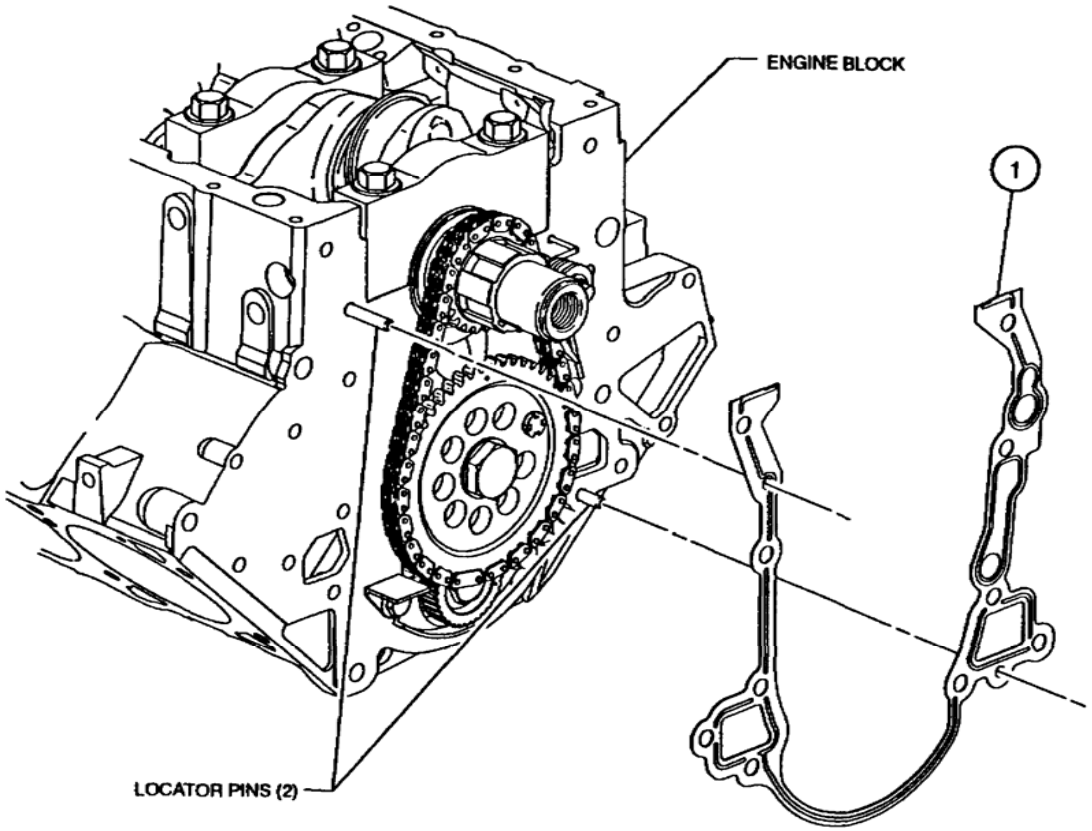
Description of Operation	
Y	Torque 30Nm
Z	Use a light application of #4 Permatex or RTV, GM part number 12346193 or Dow Corning 3154 around the rear side of the seal where it contacts the front cover.

Specification	
1	10456148 Camshaft sensor
2	25526395 Bolt
3	OHT3G-092-1 Seal

REV	Date	Revision History
1	01/05/98	Block-29
2	12/15/03	Add approved silicone sealers
3	11/03/04	Change front seal part number to OHT3G-092-1

View
Front Cover
Front cover camshaft sensor and seal install

Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	5



Description of Operation

Note:
Perfect seal #4 may be used around coolant passages on gasket.

Specification

1	12587003 Gasket

REV	Date	Revision History
1	01/05/98	Block-26
2	03/03/07	Update new gasket 12587003 old number 24502252

View

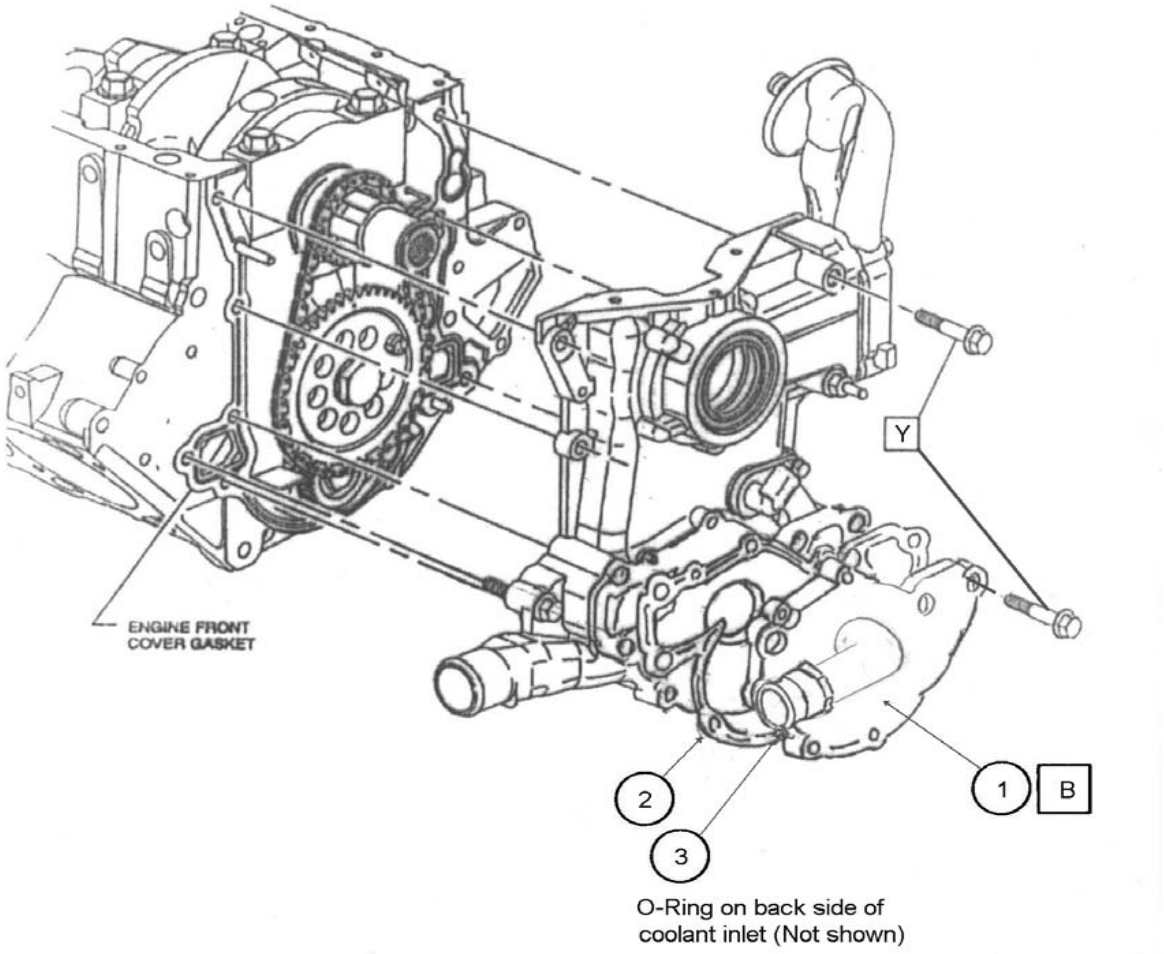
Front Cover

Front cover gasket install

Front Cover, Rear Cover, & Sump

Sequence IIIG

Section	Sheet
4	6



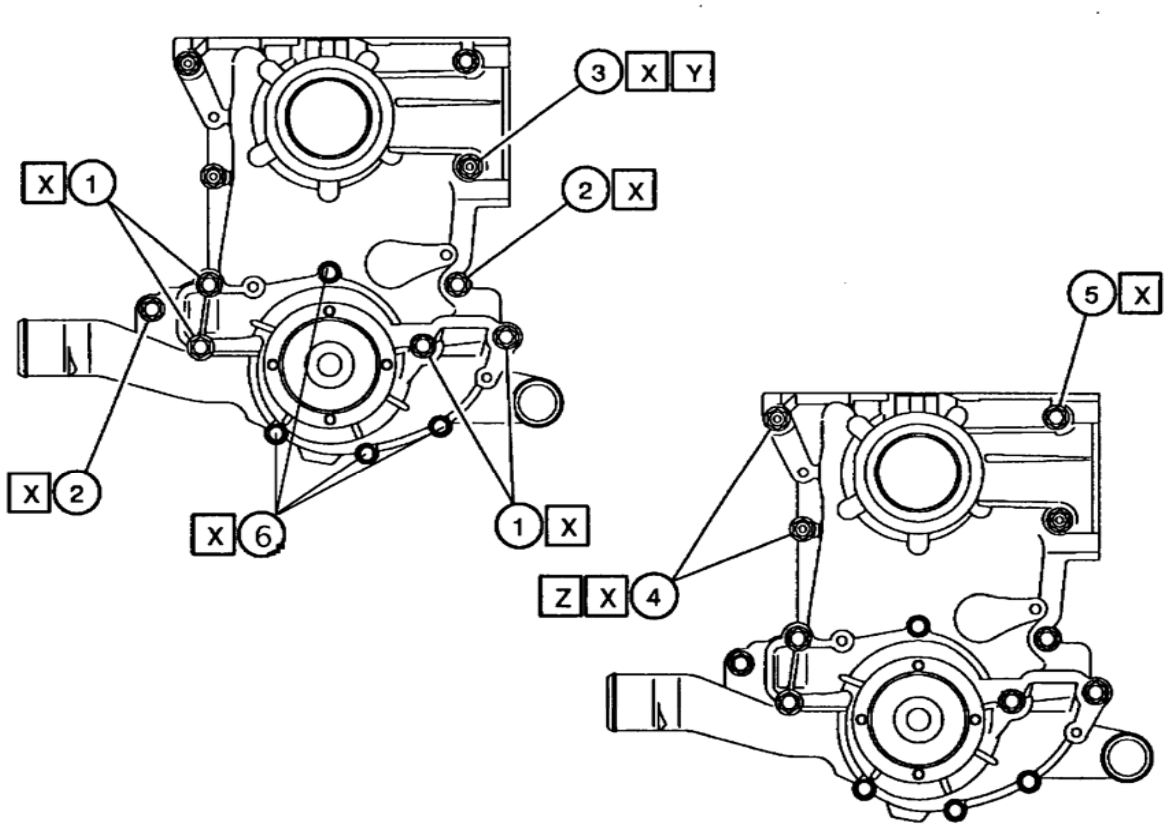
Description of Operation	
A	Front cover assembly
B	Install coolant inlet adapter with front cover
Y	Torque 30Nm
	Install thermocouple in OHT3F-031 with sensing tip centered in flow.

Specification	
1	OHT3F-031-3 Bolts included on print
2	24501565 Gasket
3	O-Ring 3F-031-2

REV	Date	Revision History
1	01/05/98	Block-30
2	12/01/99	Add thermocouple information
3	06/30/06	Update view, add gasket and O-ring part numbers

View
Front Cover
Front cover install

Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	7



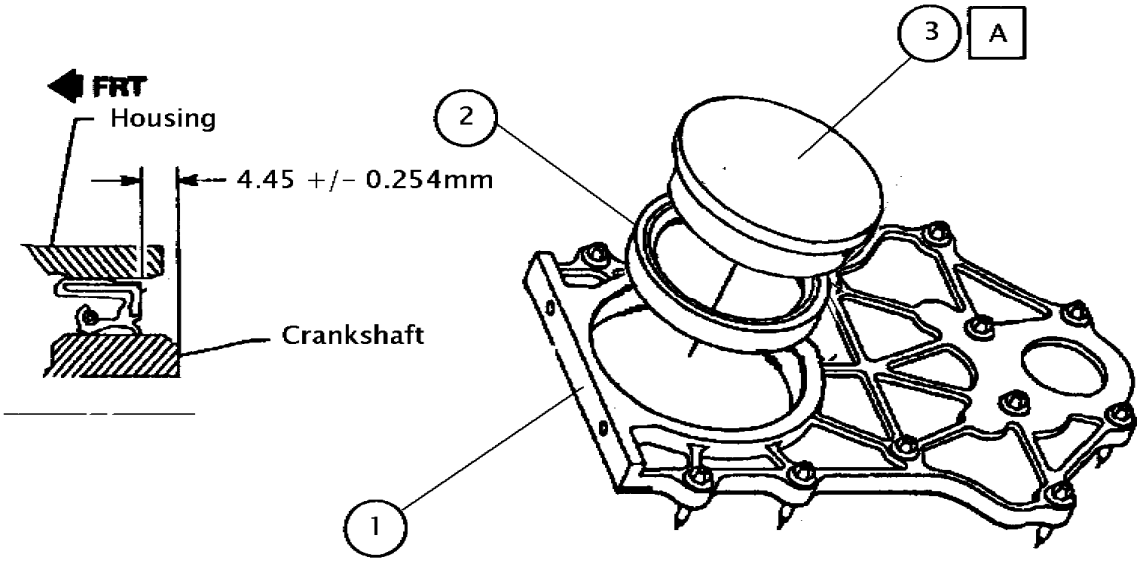
Description of Operation	
X	Torque 30Nm
Y	Stud also holds crankshaft sensor shield
Z	Studs also hold crankshaft sensor shield and sensor

Specification		
1	5/16-18x3.5 (3) plus 3F031-03 Stud (1)
2	24504713 Bolt (2)
3	24504718 Stud (2)
4	24504717 Stud (2)
5	24504712 Bolt
6	1/4-20x1.75

REV	Date	Revision History
1	01/05/98	Block-28
2	06/30/06	Update items 1 & 6 fastener information

View
Front Cover
Front cover bolt placement

Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	8



Description of Operation	
A	Install rear main lip seal using GM R&D supplied installation tool or Kentmore J38196 and a light duty bench press until seal bottoms in housing.

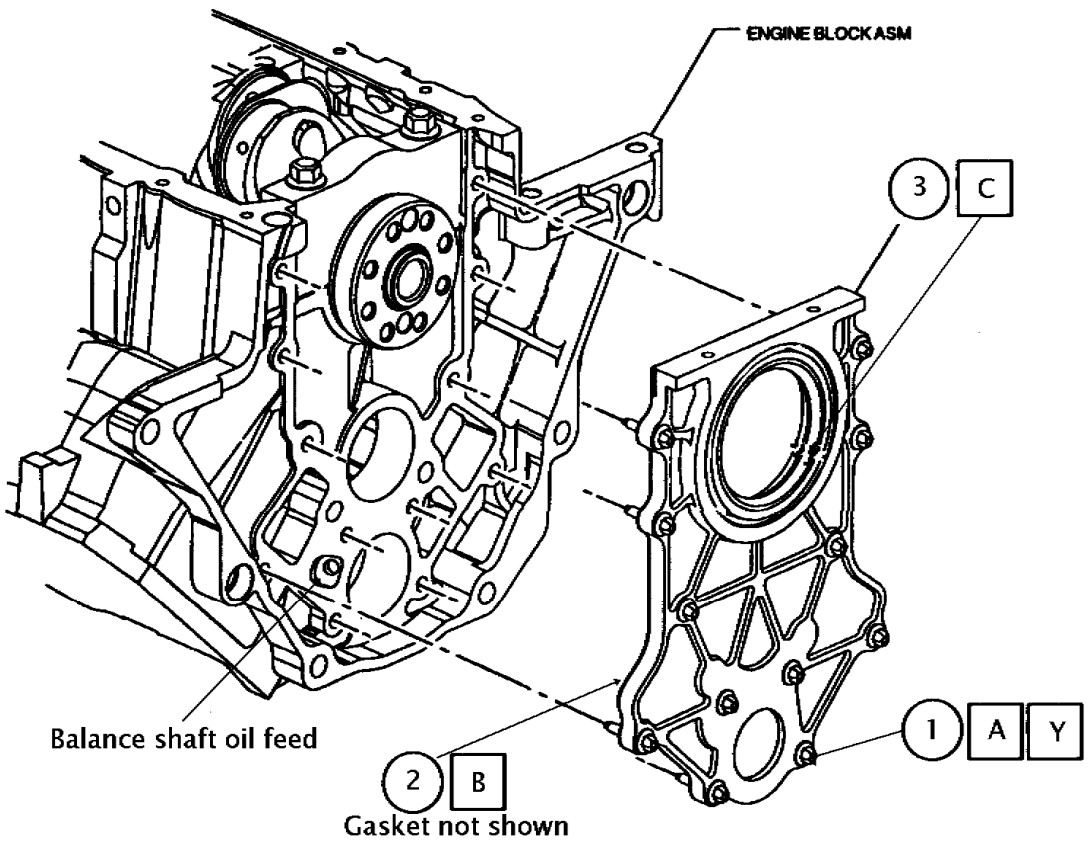
Specification	
1	24502297 Rear cover housing
2	OHT3G-091-1 Seal
3	GM R&D Seal Installation Tool or Kentmore J38196

REV	Date	Revision History
1	01/05/98	Block-31
2	11/03/04	Change rear seal part number to OHT3G-091-1
2	02/22/10	Added Kentmore J38196 tool

View
Rear Cover
Rear seal installation

Front Cover, Rear Cover, & Sump | **Sequence IIIG**

Section	Sheet
4	9



Description of Operation	
A	Bolts may be run for as long as they remain servicable.
B	Install gasket (not shown in view) **Note: Position rear cover plate gasket so that rear balance shaft oil feed is lined up with correct side of cover plate.**
C	Lubricate rear lip seal with EF-411and use extreme care not to damage rear lip seal during rear cover plate installation.
Y	Torque & Angle 15Nm + 50°
	Note: Perfect Seal #4 sealer may be used around coolant passages on gasket.

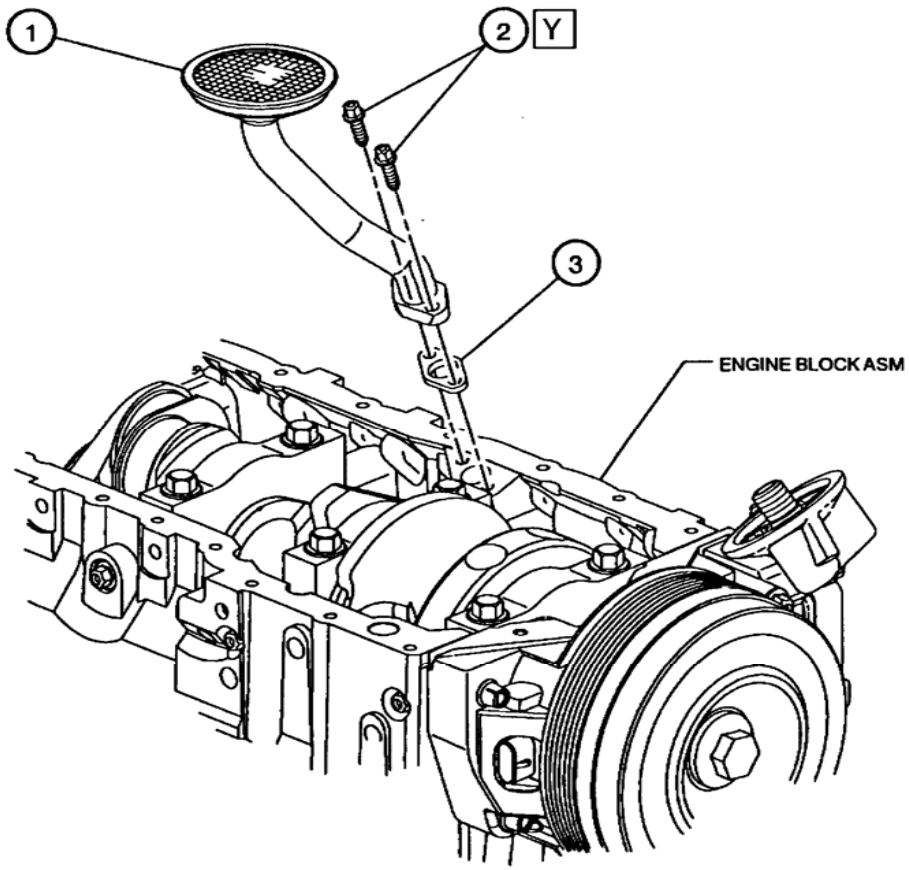
Specification	
1	24503970 Bolt
2	24507388 Gasket
3	OHT3G-88-1 Rear Cover Housing

REV	Date	Revision History
1	01/05/98	Block-32
2	12/01/99	Add Perfect seal note.
3	2/5/06	Change to OHT Rear Cover w/24507388 gasket
4	7/20/06	Update fastener usage (remove nylon collar)
5	02/22/10	Update fastener usage (allowed use for multiple tests)

View
Rear Cover
Rear cover installation

Front Cover, Rear Cover, & Sump | **Sequence IIIG**

Section	Sheet
4	10



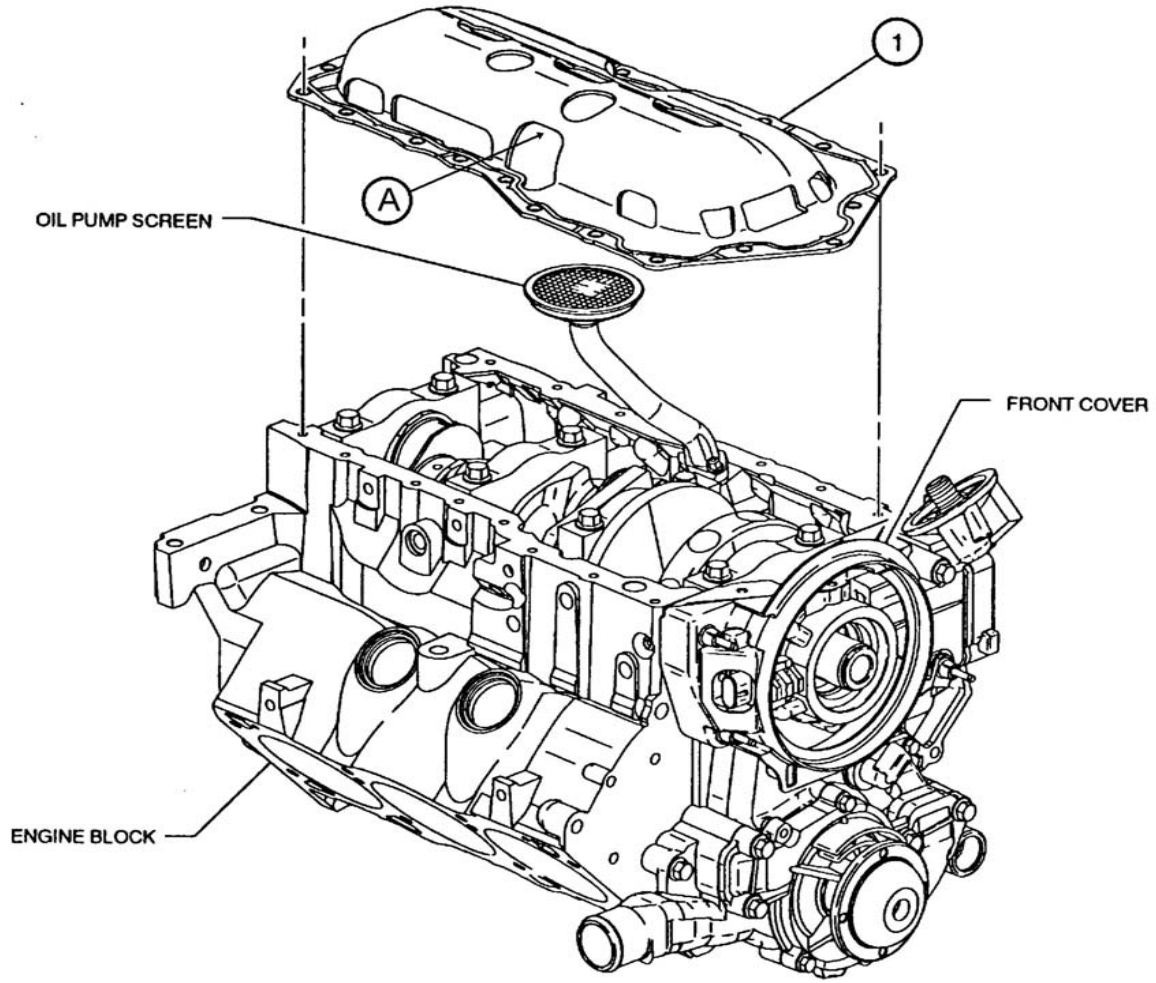
Description of Operation	
	Install oil screen assembly
Y	Torque 15Nm

Specification		
1	24505569	Screen assembly
2	24505570	Bolt
3	12581570	Gasket

REV	Date	Revision History
1	01/05/98	Block-33
2	02/01/06	Change gskt. From 24501259 to 12581570

View
Sump
Oil pickup tube

Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	11



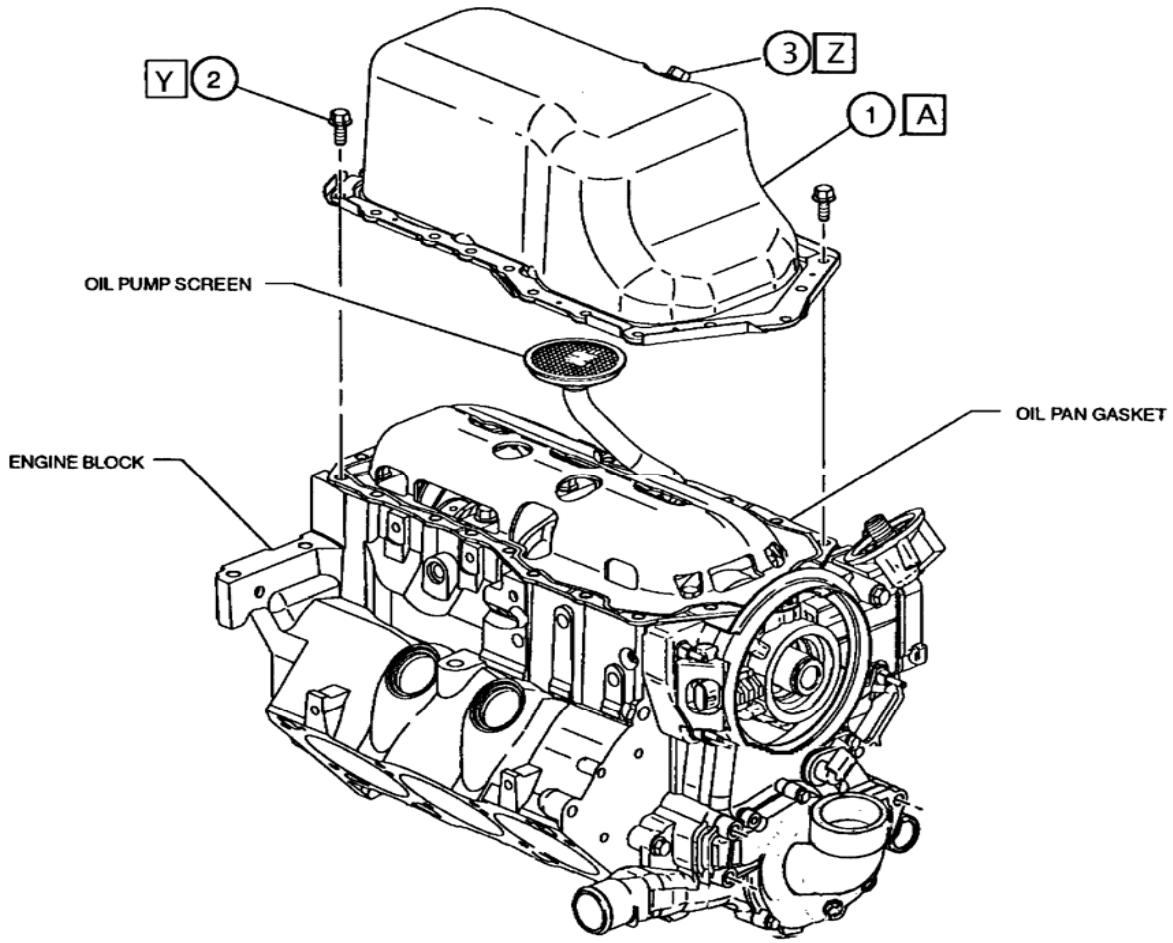
Description of Operation	
	Install oil pan gasket
A	Insure that calibrated oil level dipstick clears windage tray before final assembly
	Note: RTV, GM, (see part number info) or Dow Corning 3154 may be used at corners of front and rear covers to aid in sealing.
	GM Silicone Sealer New numbers: 12346141 Tube 12551715 Cartridge Old numbers: (Still acceptable for test) 12346192 Tube 12346193 Cartridge

Specification	
1	OHT3G-093-1 Gasket

REV	Date	Revision History
1	01/05/98	Block-34
2	4/28/03	Change part number from 24502397 to 12574776
3	12/15/03	Add approved silicone sealers
4	03/15/04	Update Sealer information
5	11/03/04	Change oil pan gasket to OHT3G-093-1

View
Sump
Oil pan gasket install

Front Cover, Rear Cover, & Sump	Sequence IIIG	Section	Sheet
		4	12



Description of Operation	
A	Install oil pan
Y	Torque 14Nm
Z	Oil drain plug to be thermocoupled

Specification	
1	Oil pan OHT3F-073-1
2	24502791 or 11610052 Bolt
3	OHT3F-063-1 Modified drain plug

REV	Date	Revision History
1	01/05/98	Block-35
2	02/05/06	Add 11610052 Bolt

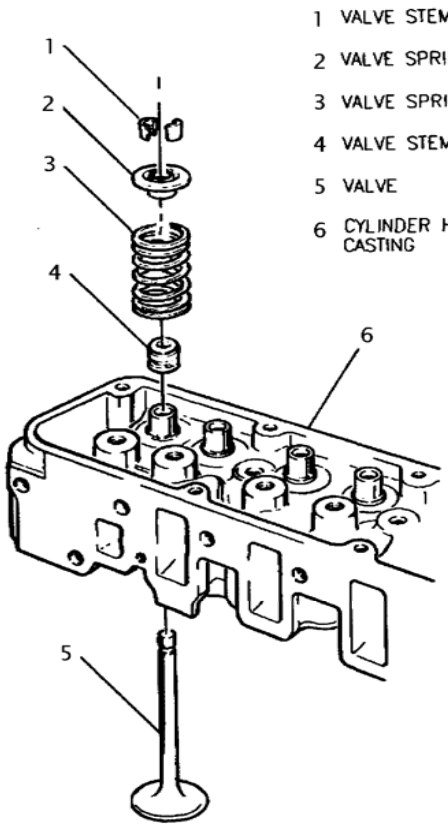
View
Sump
Oil pan installation

Front Cover, Rear Cover, & Sump | **Sequence IIIG**

Section	Sheet
4	13

Section 5

Cylinder Head and Valves



During calibration, use OHT3F-070-1 Sleeve to protect seals from being cut and OHT3F-072, 006", 010", 015", & 020" shims to assist in obtaining proper load.

Description of Operation

Clean cylinder head by automated parts washer (see section 1 sheet 5A) or with degreasing solvent and spray with 50/50 solution of EF-411 and degreasing solvent. Remove excess solution using compressed air.

Lubricate valve stems and guides with EF-411 during assembly. Ensure valve stem moves freely in guide before installing valve seal. Use a protective sheath over the valve stem that extends downward past the keeper grooves when installing the valve stem seals.

Install the valve springs, retainers, and keepers.

Calibrate the valve spring load to 912N +/- 44N @ 9.5mm (205lbf +/- 10lbf @ 0.375in.) travel.

Specification

1	10166345 Valve stem key
2	24502257 Valve spring cap
3	OHT3G-059-1 Valve spring (Pink)
4	OHT3F-060-1 Seal int.
	OHT3F-061-1 Seal exh. White stripe
5	12569550 Valve Int. (STD)
	12579949 Valve Exh.(STD)
6	24502260 Head, GM Raceshop

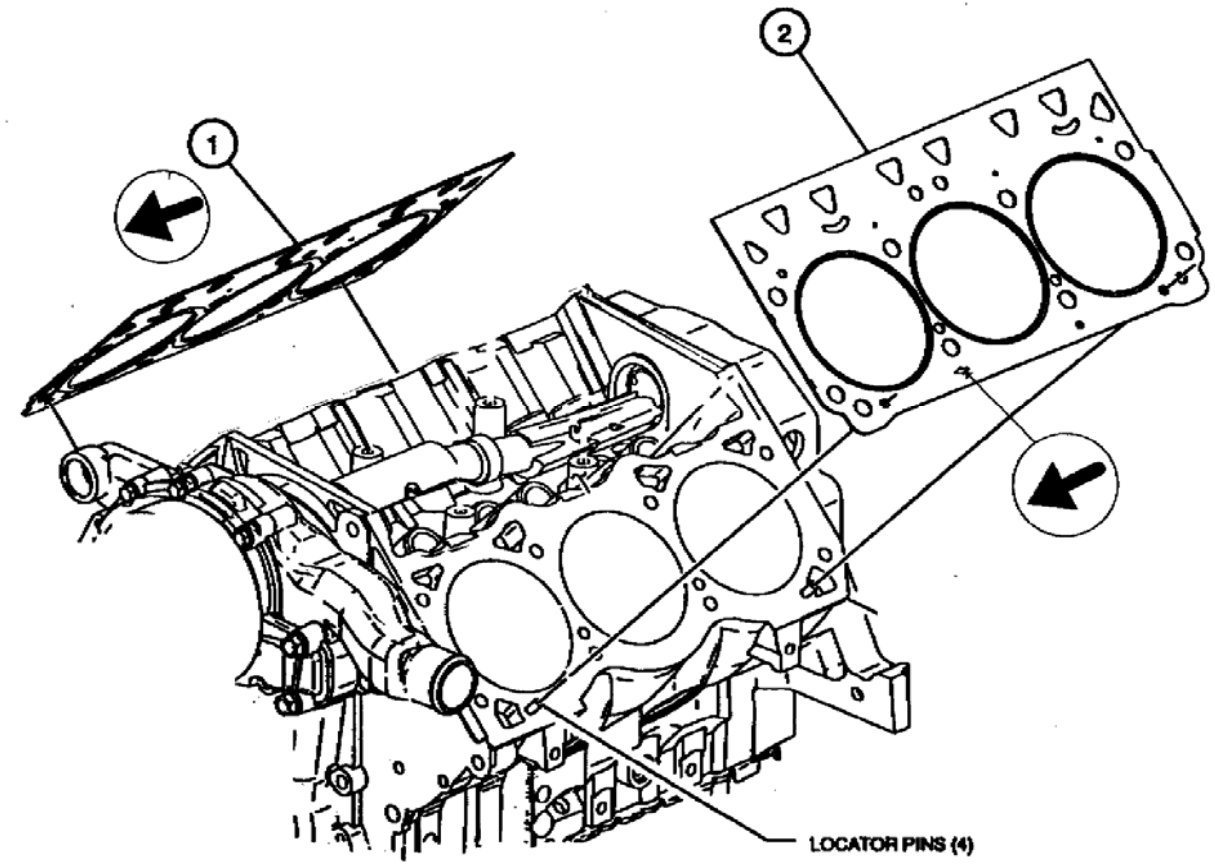
REV	Date	Revision History
1	01/06/98	Block-36
2	9/9/03	Change calibration from +/- 5lbf to +/- 10lbf
3	12/15/03	Update, change to mineral spirits
4	11/03/04	Change part number for exhaust valve from 24507423 to 12579949
5	06/30/06	Change intake part number from 24502254 to 12569550 and cleaning procedure update

View

Head Assembly

Valve & spring assembly

Head Assembly	Sequence IIIG	Section	Sheet
		5	1



Description of Operation

Head gaskets are not interchangeable. Installing the head gasket with the arrow pointing to the rear will cause gasket failure and possible engine failure.

Install the head gasket with the arrow pointing toward the front of the engine.

Do not use any sealers on the head gaskets.

Specification

1	24503801	Gasket RH
2	24503802	Gasket LH

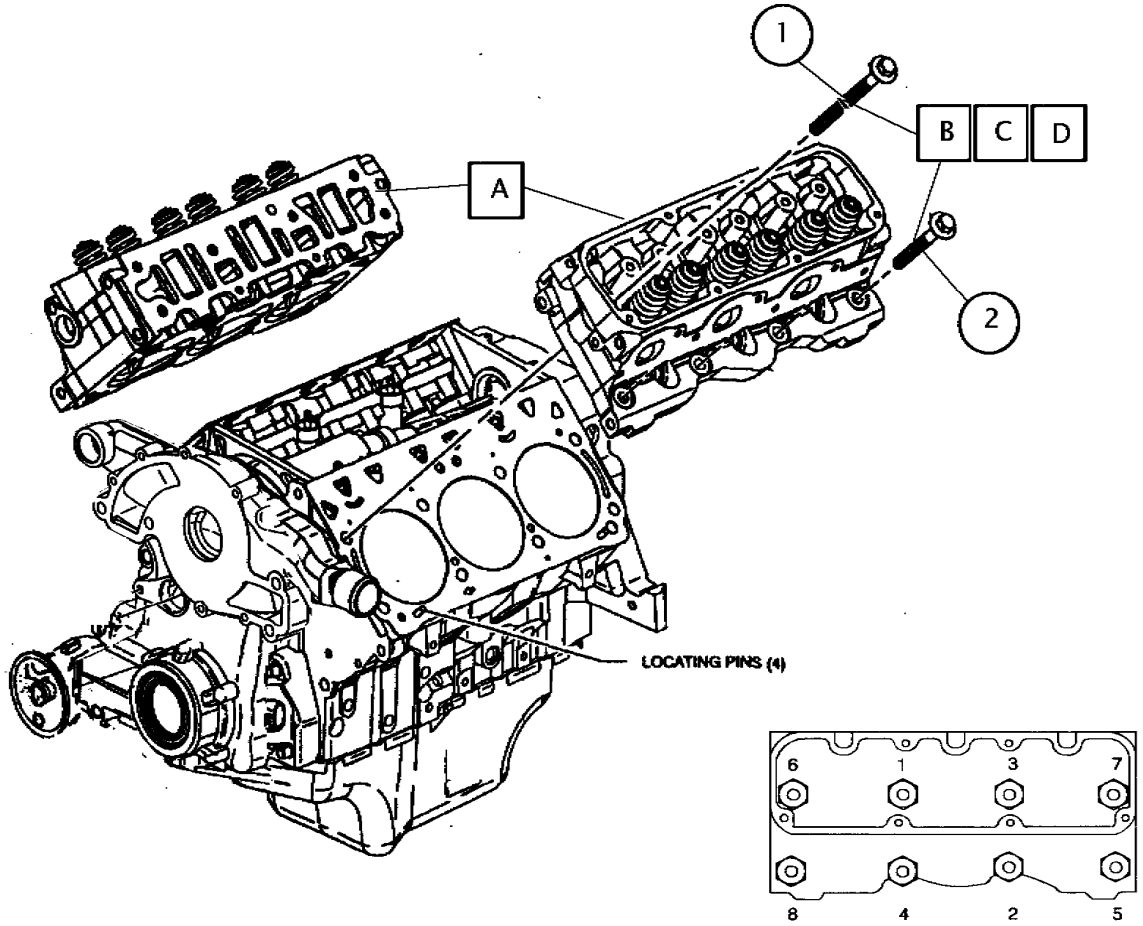
REV	Date	Revision History
1	01/06/98	Block-37

View

Head Gaskets

Head gasket install

Head Assembly	Sequence IIIG	Section	Sheet
		5	2



Description of Operation	
A	Carefully install cylinder heads.
B	Clean all sealer from new bolt threads and underside of head.
C	Install #2 Permatex on threads and underside of fastener head.
D	Torque fasteners from center out using a crisscross pattern. 30Nm-50Nm-80Nm-145±7Nm

Specification	
1	25527831 Bolt Cyl. Head (8) Long
2	88891770 Bolt Cyl. Head (8) Short 25533811K (Old)

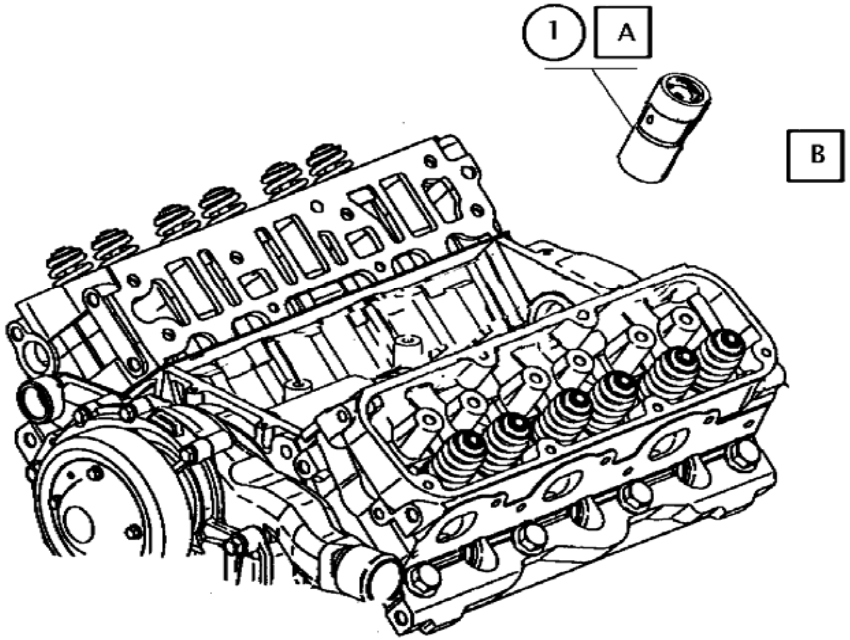
REV	Date	Revision History
1	01/06/98	Block-38 & 50
2	07/20/06	Update part number, change 25533811 to 88891770
3	03/30/07	Update fastener torque to 30Nm-50Nm-80Nm-145Nm±7Nm
4	02/22/10	Corrected short head bolt number

View
Cylinder Head
Cylinder head installation

Head Assembly	Sequence IIIG	Section	Sheet
		5	3

Section 6

Long Block Assembly



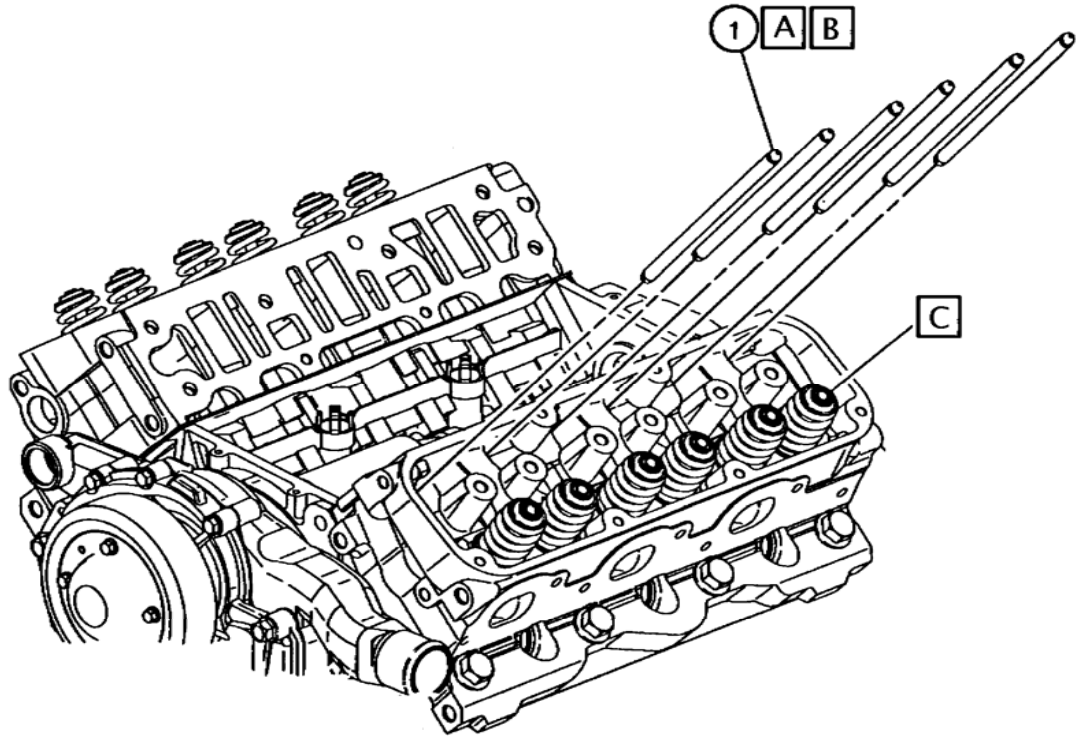
Description of Operation	
A	Measure and record pre-test lifter foot height to the nearest 0.001mm
B	Installation: 1) Clean each lifter using a lightly soaked cloth with clean (new) degreasing solvent (Do not disassemble, spray, or submerse the lifter in solvent). Dry each lifter foot using a clean dry cloth or terry towel. 2) Useig 118ml (4 oz.) of test oil, dip each lifter foot in test oil and install the lifter set less pushrods. 3) Rotate engine crankshaft 720° slowly with no load on lifters. 4) Remove each lifter, one at a time, and again dip each foot in test oil and re-install with the ground flat facing inboard. 5) With the oil pan on the engine, pour the remainder of the 118ml in the valley.

Specification	
1	OHT3f-029-3 ACI Test Lifter (with flats)

REV	Date	Revision History
1	1/6/1998	Block-39
2	12/15/03	Update, change to mineral spirits
3	7/20/06	Update operation and change to degreasing solvent

View
Lifter Installation
Lifter pre-oiling and installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	1



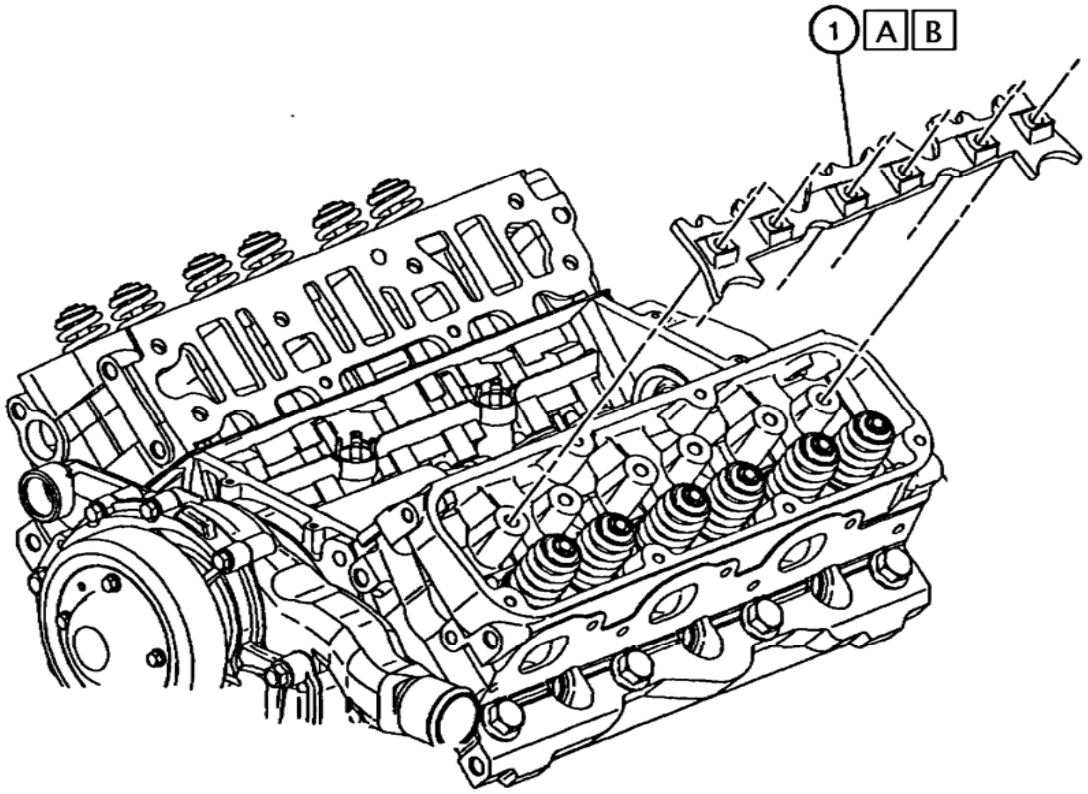
Description of Operation	
A	Clean all pushrods with clean lint free towel and degreasing solvent and spray with a 50/50 solution of EF-411 and degreasing solvent. Remove excess with compressed air. Lubricate each pushrod end, pushrod seat, and rocker arm ball socket with EF-411 prior to installation.
B	Install pushrods
C	Lubricate each valve stem seal and tip with EF-411.

Specification	
1	OHT3F-007-1 Pushrod (Special Length)

REV	Date	Revision History
1	1/6/1998	Block-40
2	12/15/03	Update, change to mineral spirits
3	7/20/06	Update change to degreasing solvent and clean towel for cleaning

View
Pushrods
Pushrod installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	2



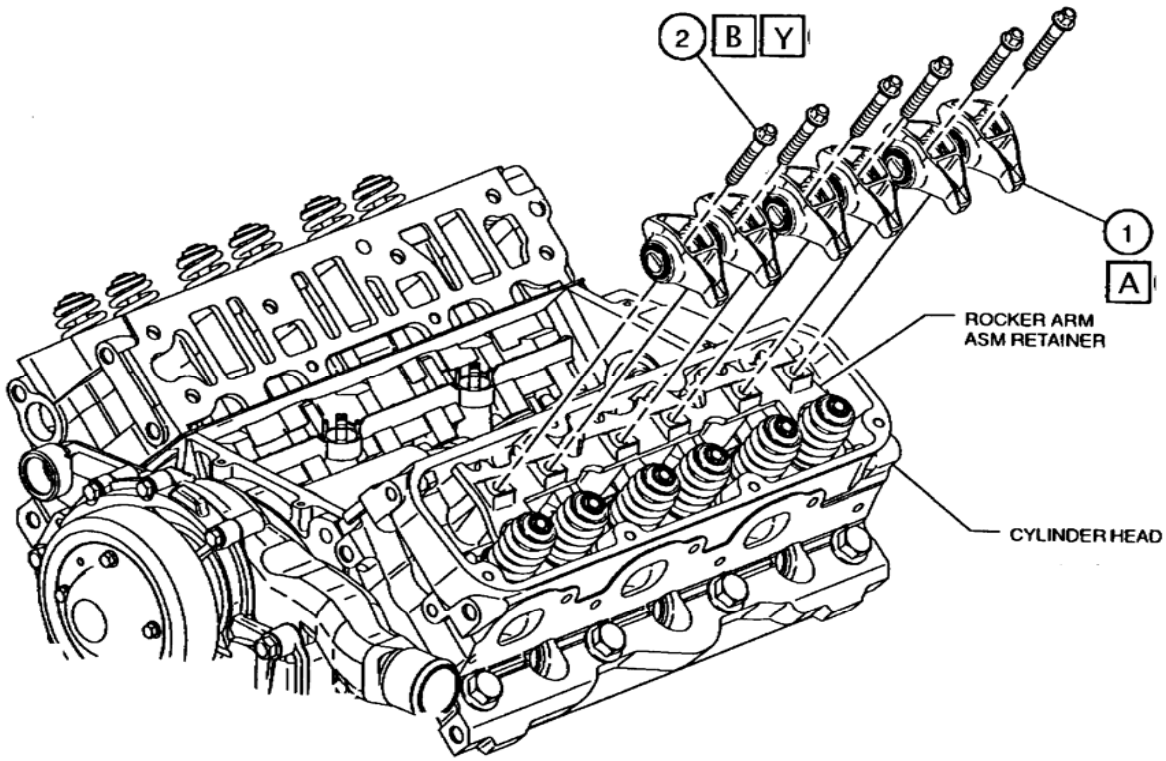
Description of Operation	
A	Clean and inspect for wear. (Replace Retainer after 6 tests)
B	Install pushrod guide / rocker bearing retainer.

Specification		
1	24502278	Retainer

REV	Date	Revision History
1	1/6/1998	Block-41
2	7/20/06	Update usage, replace after 6 tests

View
Retainer
Rocker bearing retainer installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	3



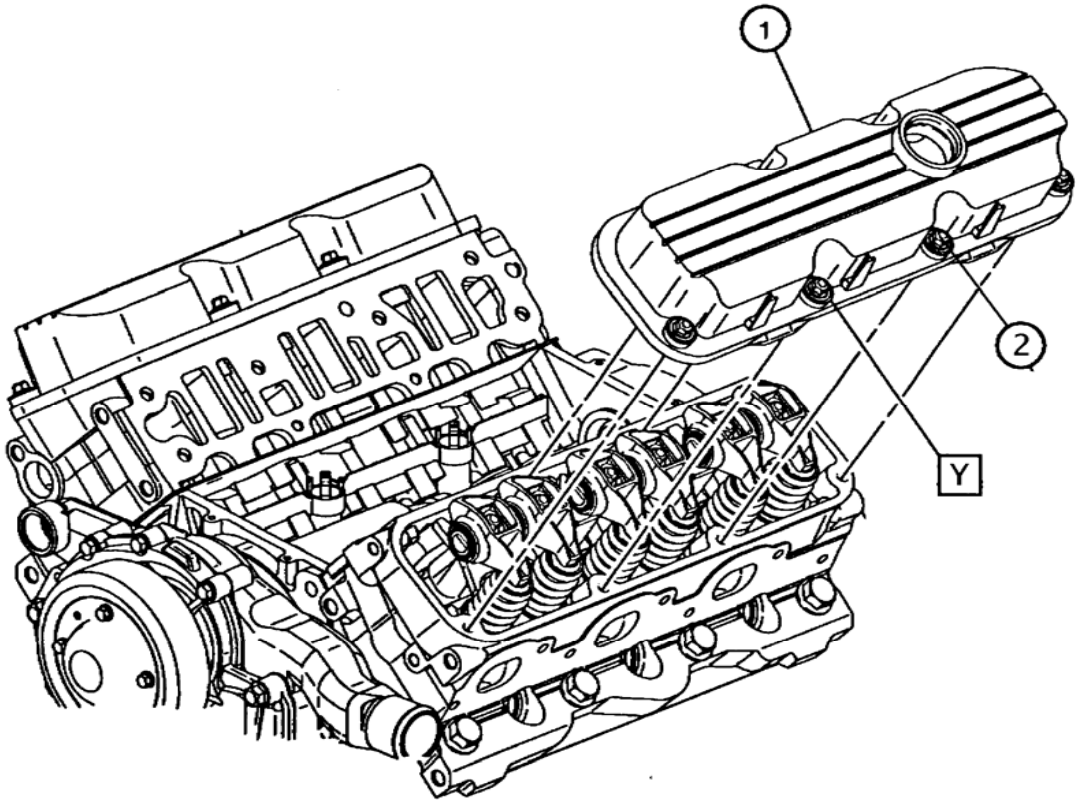
Description of Operation	
A	Lubricate rocker arms with EF-411 and install. **Note: Rocker arm assemblies are replaced every test. Do not dip or spray with degreasing solvent. Needle roller bearings will retain solvents.**
B	Lubricate bolts with EF-411 and install.
Y	Torque & Angle 25Nm + 70° Note: Do not rotate engine after final valvetrain loading.

Specification	
1	OHT3F-058-1 Rocker Arm Assembly
2	Furnished less sealers with OHT Kit

REV	Date	Revision History
1	1/6/1998	Block-42
2	12/15/03	Update, change to mineral spirits
3	7/20/06	Update, change to degreasing solvent

View
Rocker Arm
Rocker arm installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	4



Description of Operation	
	Install rocker covers
Y	Torque 10Nm

Specification

1	12590366	Cover, Valve Lt (2)
2	24502164	Bolt
	25534748	Bolt w/washer
3	25532619	Gasket (Not Shown)

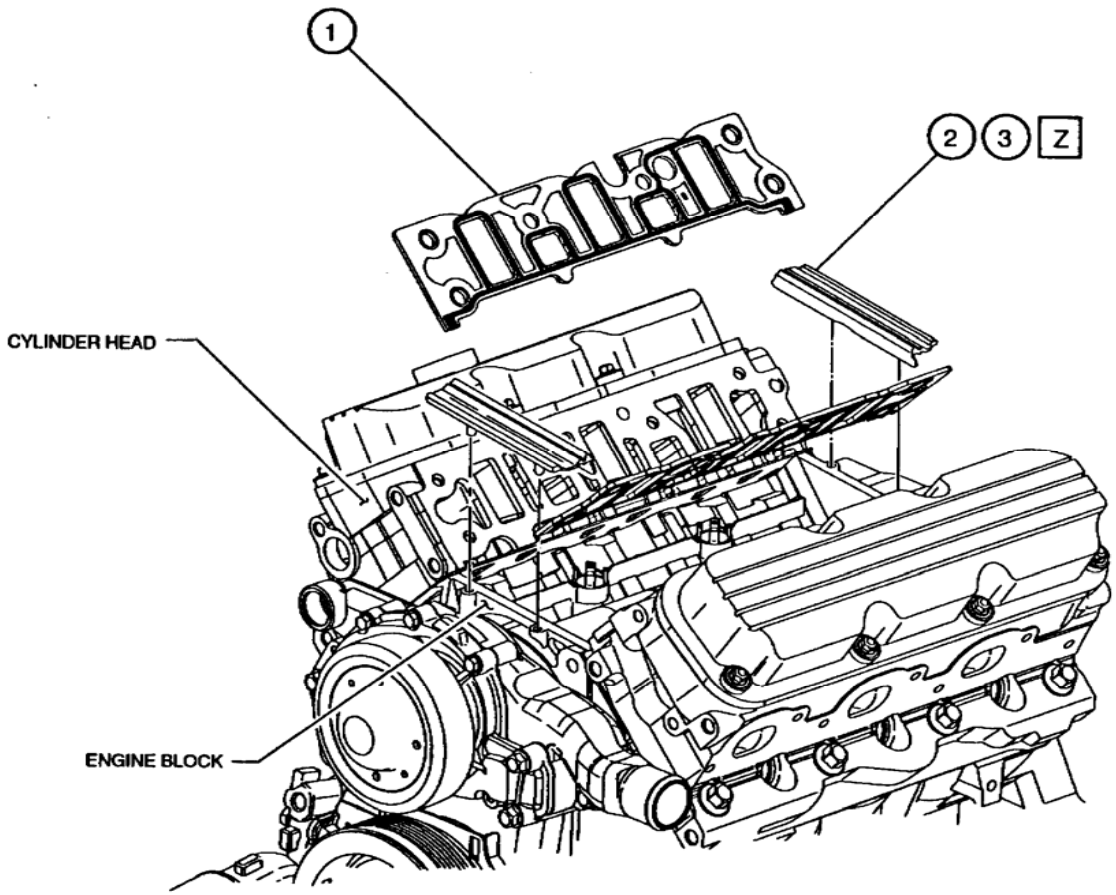
REV	Date	Revision History
1	1/6/1998	Block-43
2	3/30/07	Update Rocker Cover part number new 12590366 old 25534751

View

Rocker Cover

Rocker cover installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	5



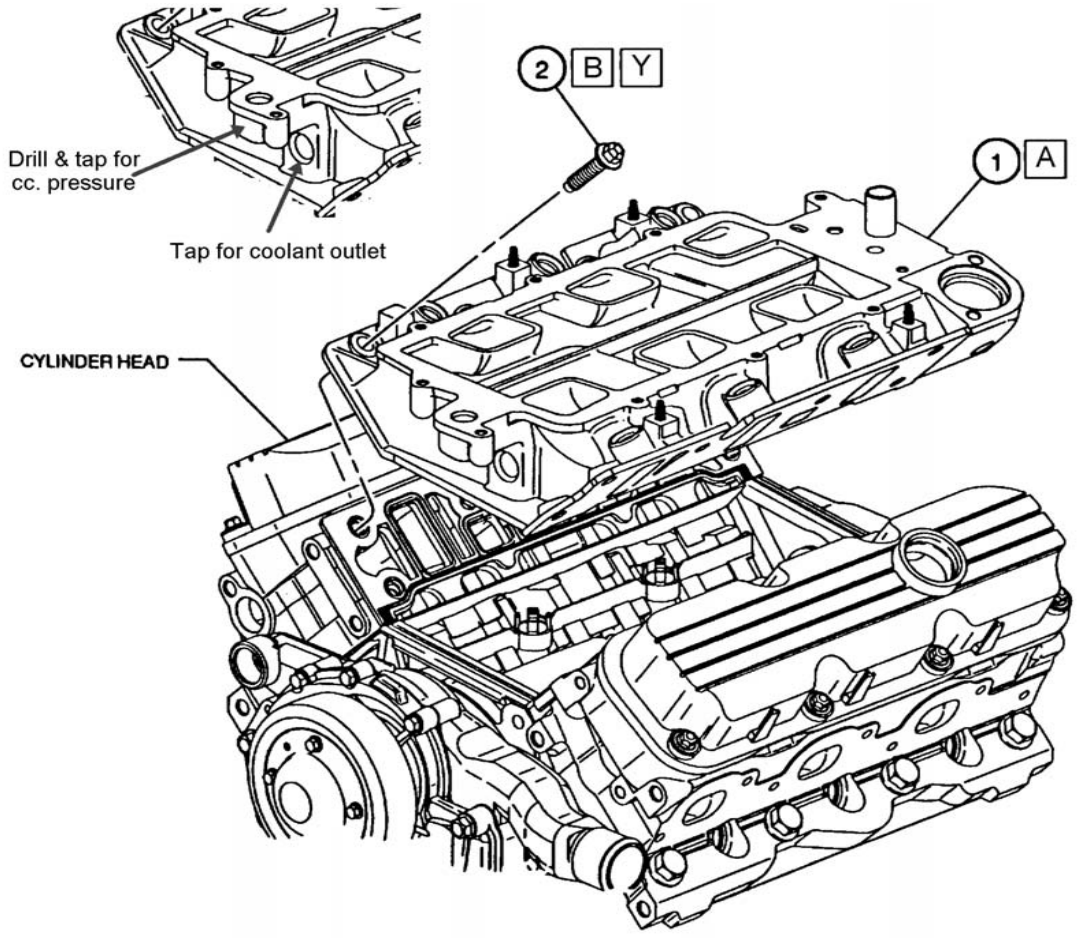
Description of Operation	
	2nd design gasket kit uses locating pins for front and rear seals
Z	Apply RTV, GM (see part number info) or Dow Corning 3154 sealer to both ends.
	GM Silicone Sealer New numbers: 12346141 Tube 12551715 Cartridge Old numbers: (Still acceptable for test) 12346192 Tube 12346193 Cartridge

Specification	
1	89017816 89017399 (Old) 12480830 (Old) All part numbers are good
2	Seal / part of kit
3	Sealant (see note Z)

REV	Date	Revision History
1	1/6/1998	Block-44
2	12/15/03	Update RTV sealer
3	3/15/04	Update Intake Gasket Part Number and Silisone Sealer Information
4	7/20/06	Update Intake Gasket Part Number

View
Intake Gaskets
Intake gasket installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	6



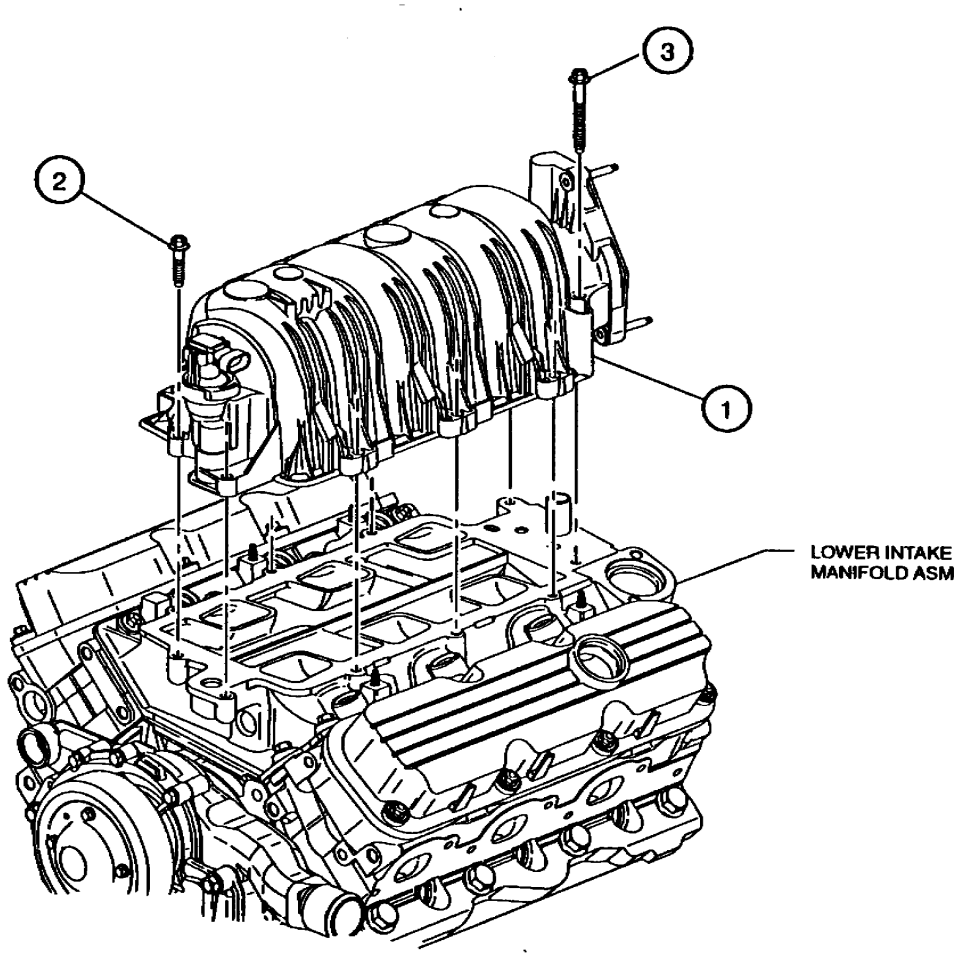
Description of Operation	
A	Install modified intake manifold
B	Clean and lubricate bolts with Permatex #2 or RTV (see sec. 6 sheet 6 for RTV information) and install.
Y	Torque 15Nm
	Drill and tap as indicated for the crankcase pressure line . Also tap coolant outlet port for coolant return line to process controller. Use a 3/4" I.D. unrestricted line for the return. Do not install shut off valves in the return line.

Specification		
1	24505728	Manifold assembly
2	24504090	Bolt (12)

REV	Date	Revision History
1	1/6/1998	Block-45

View
Lower Intake
Lower intake manifold installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	7



Description of Operation	
	Install upper intake and gasket assembly.
Y	Torque 10Nm (Max. torque)

Specification

1	17096162 Manifold assembly 89017556 Gasket Kit
2	24506498 Bolt (8)
3	24505205 Bolt (2)

See note Y for torque

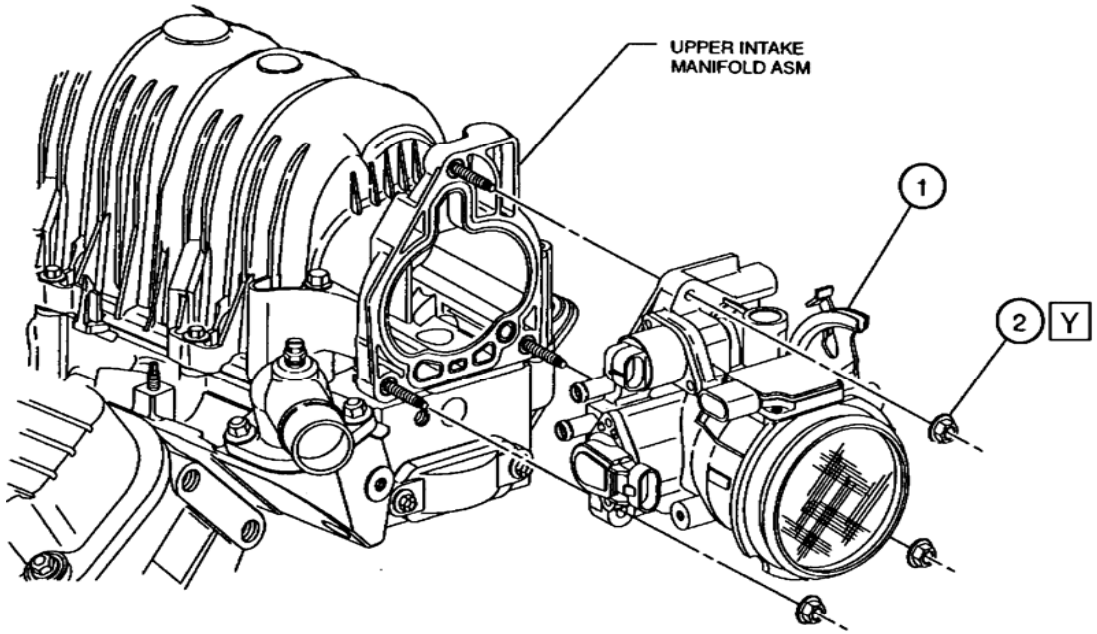
REV	Date	Revision History
1	1/6/1998	Block-46
2	3/30/07	Update upper intake gasket part number new 89017556 old 17113137
3	2/22/10	Removed stud (number 3) and renumbered 4 as 3

View

Upper Intake

Upper intake installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	8



Description of Operation	
	Install modified throttle body **Note: See section 7 sheet 5 for modifications**
Y	Torque 10Nm

Specification

1 24507235 Throttle Body
(2 bolt Mass Air Flow Sensor)
Use 12568877
May be superseded with
remanufactured part# 88961007

2 24506469 Nut

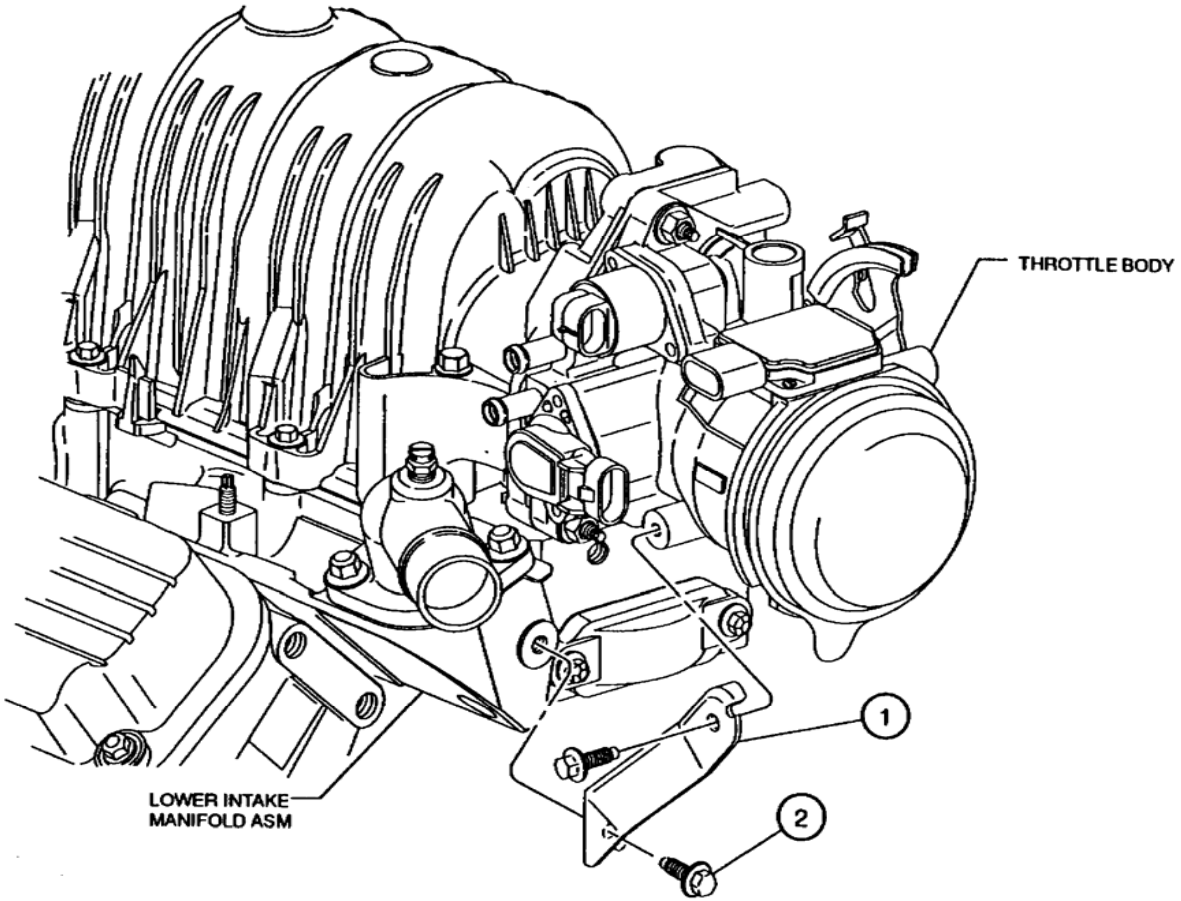
REV	Date	Revision History
1	1/6/1998	Block-47
2	4/28/03	Add new mass airflow part number 12568877
3	6/23/03	Add 88961007 remanufactured from 12568877

View

Throttle Body

Throttle body installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	9



Description of Operation	
	Install support bracket
Y	Torque 10Nm

Specification

1	24504697 Support
2	24503644 Bolt (2) See note Y for torque

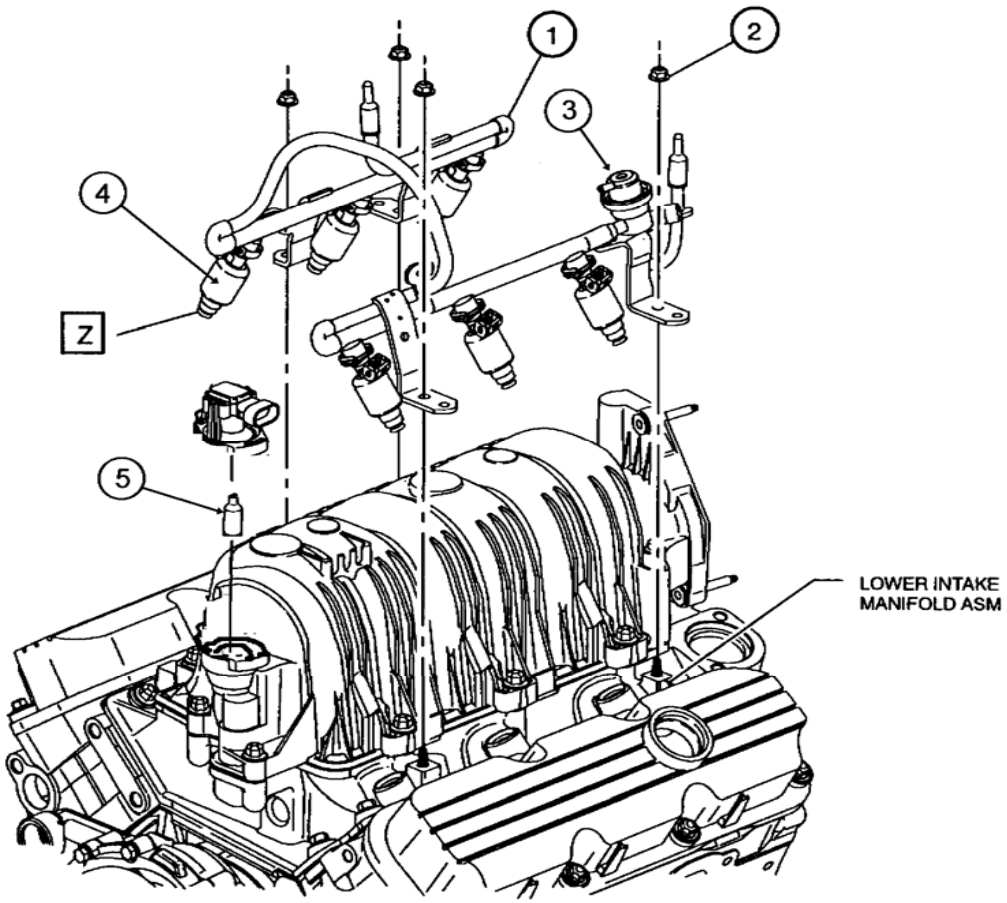
REV	Date	Revision History
1	1/6/1998	Block-48

View

Throttle Body Support

Throttle body support installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	10



Description of Operation	
	Install injector assembly (See sec. 6.14.1 of the test procedure for injector flow testing requirements).
Y	Torque 10Nm
Z	Lubricate O-ring with EF-411

Specification	
1	17098211 Fuel Rail
2	24506469 Nut
3	17113346 Regulator
4	17120601 Injector
5	OHT3F-002-1 PCV Dummy

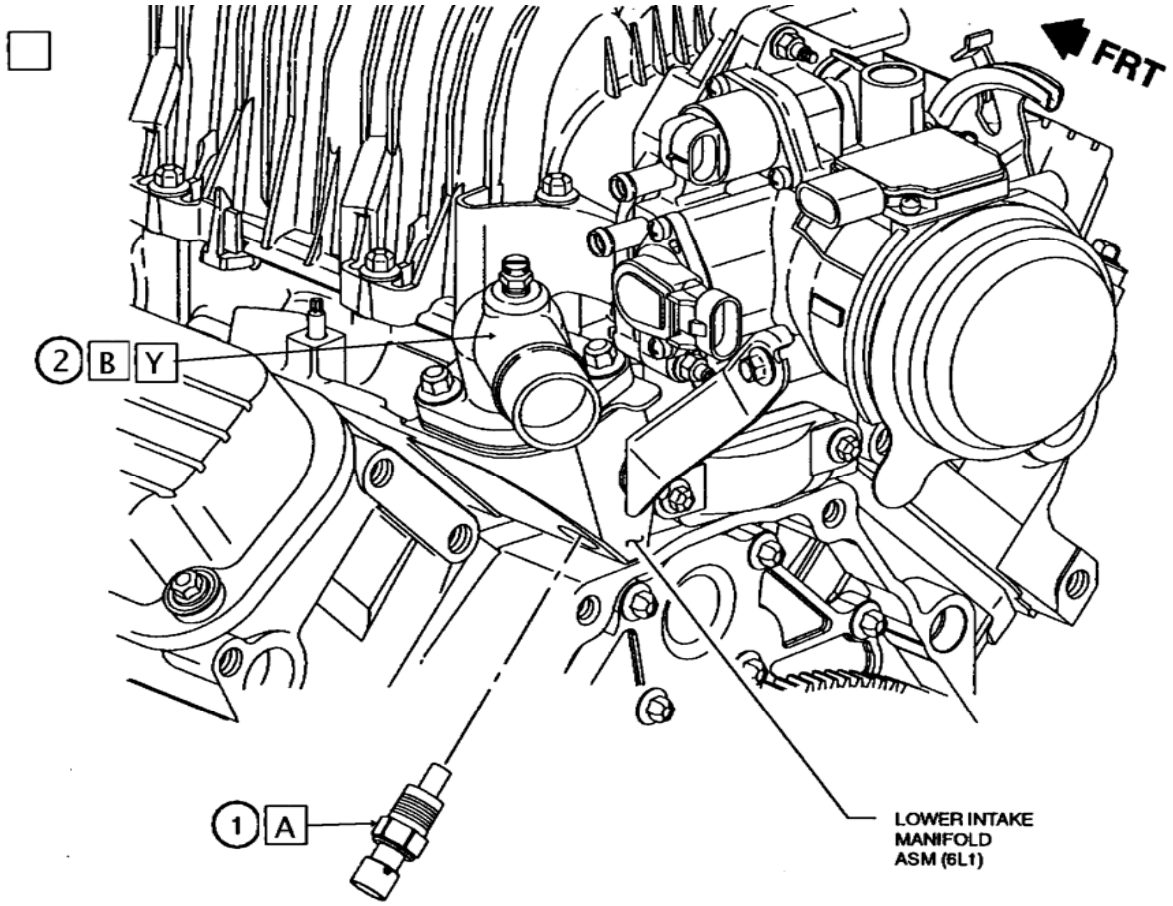
REV	Date	Revision History
1	1/6/1998	Block-49
2	12/15/03	Update text on reference to procedure for injector flow testing requirements

View
Injector Assembly
Injector assembly installation

Long Block Assembly	Sequence IIIG	Section	Sheet
		6	11

Section 7

Final Dress



Description of Operation	
A	Install production sensor as a plug only. **Do not use for connection to harness. Disable connector.**
B	Install coolant outlet
Y	Torque 27Nm

Specification

1 10096181 Sensor
(Used for plug only, disable connector)

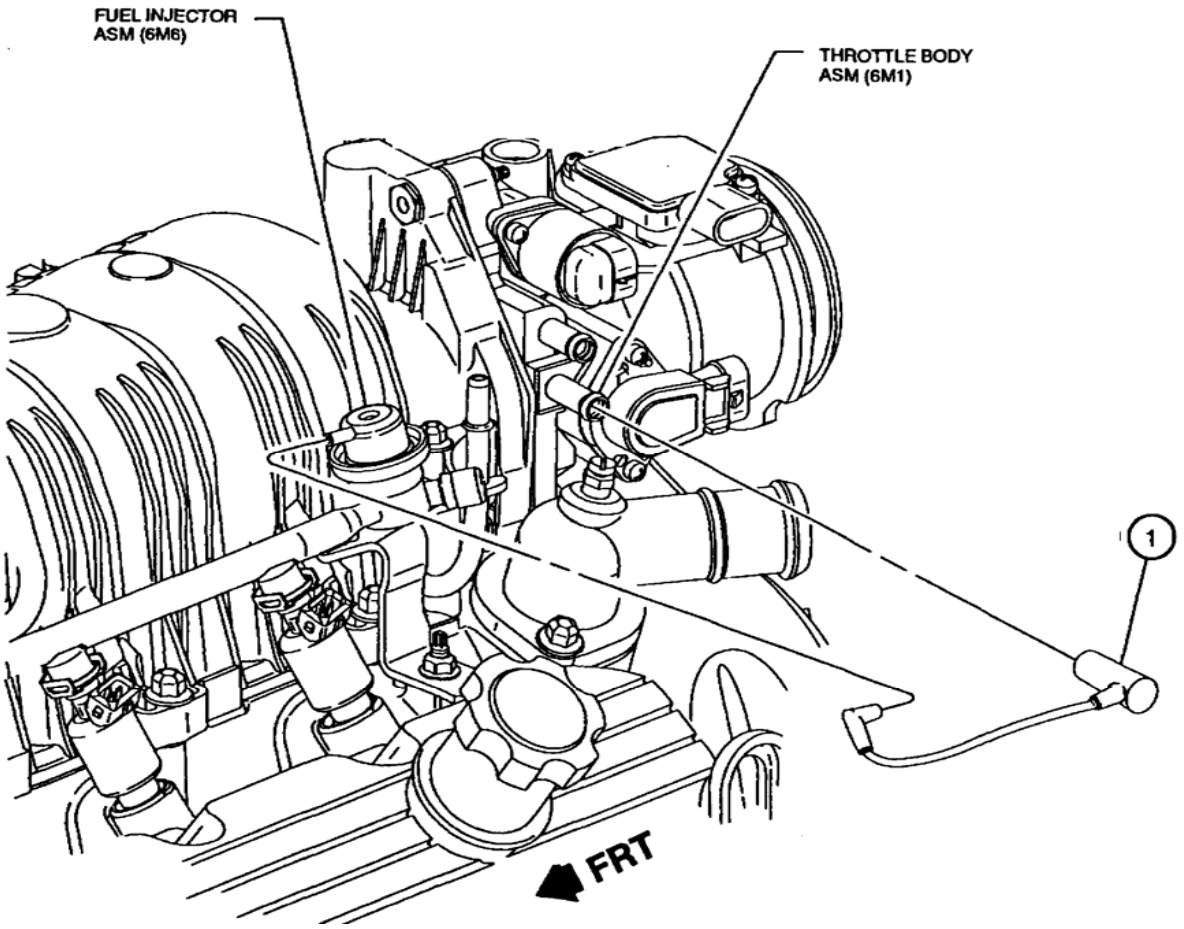
2 OHT3F-034-1 Coolant Outlet
(Not to detail on sheet)

REV	Date	Revision History
1	1/10/98	Block-51

View

Coolant Out & Sensor

Final Dress	Sequence IIIG	Section	Sheet
		7	1



Description of Operation

Specification

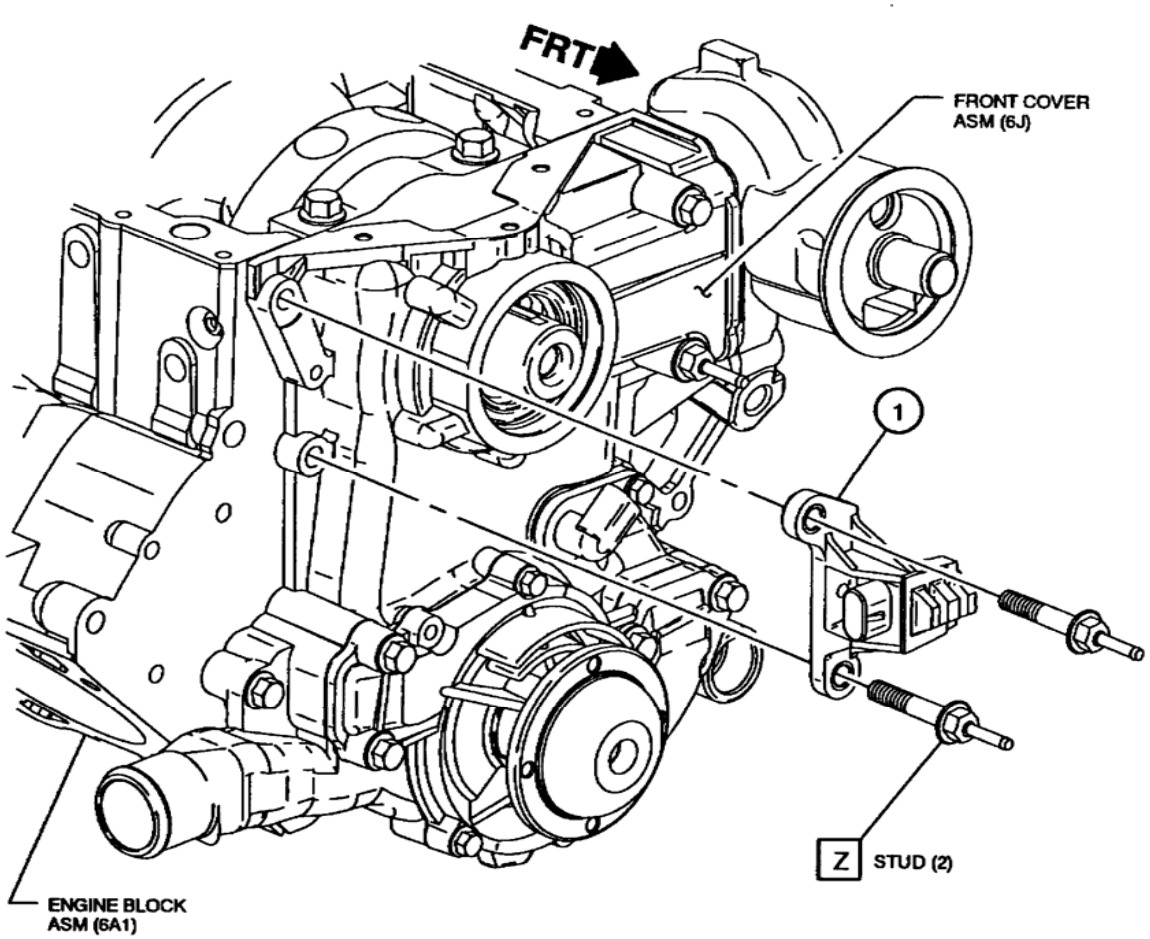
1 24505671 Tube

REV	Date	Revision History
1	1/10/98	Block-52

View

Vacuum Hose

Final Dress	Sequence IIIG	Section	Sheet
		7	2



Description of Operation	
Z	See front cover section for bolt part numbers and torque.

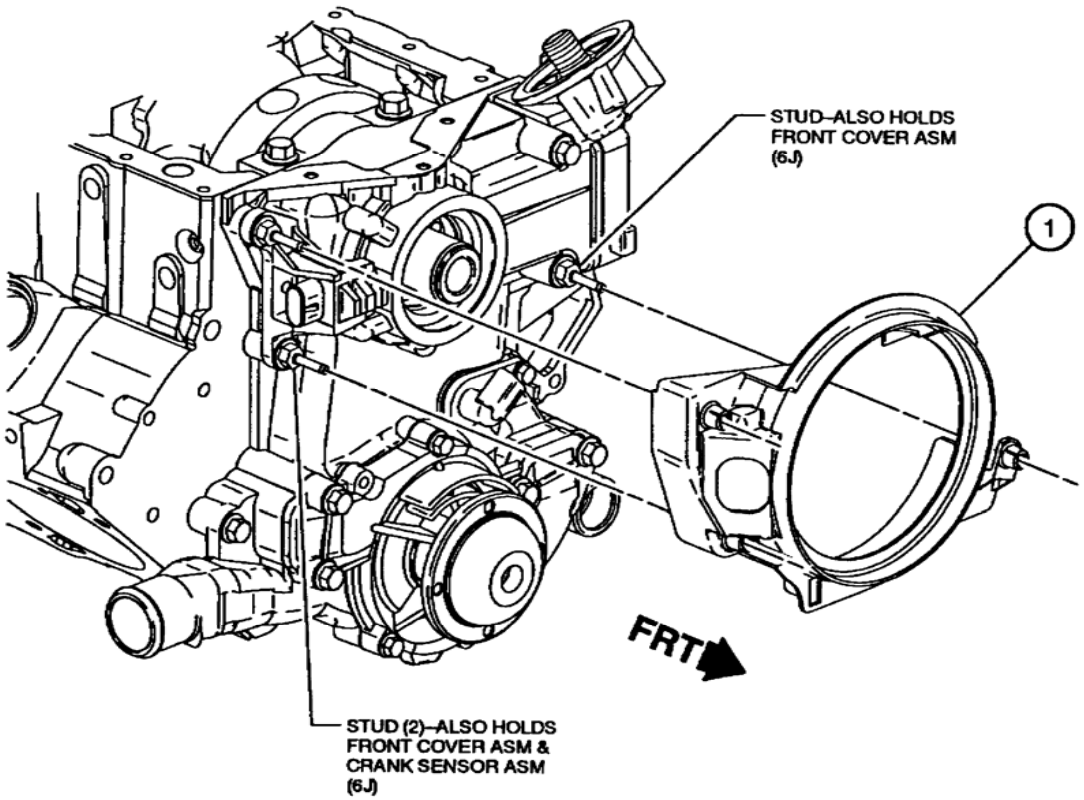
Specification		
1	10456161	Sensor

REV	Date	Revision History
1	1/10/98	Block-53

View

Crankshaft Sensor

Final Dress	Sequence IIIF	Section	Sheet
		7	3



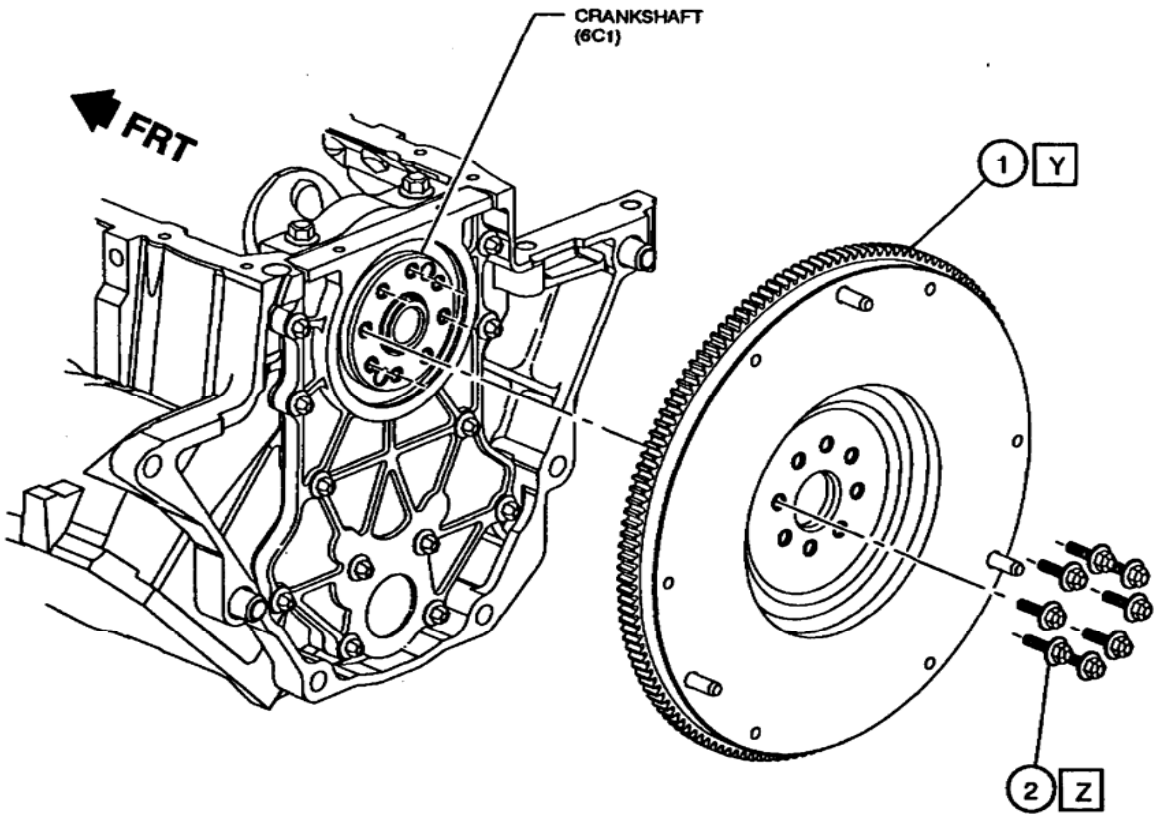
Description of Operation	

Specification	
1	24506440 or 24508586 Shield

REV	Date	Revision History
1	1/10/98	Block-54
2	12/15/03	Add 24508586

View
Crankshaft Sensor Shield

		Section	Sheet
Final Dress	**Sequence IIIG**	7	4



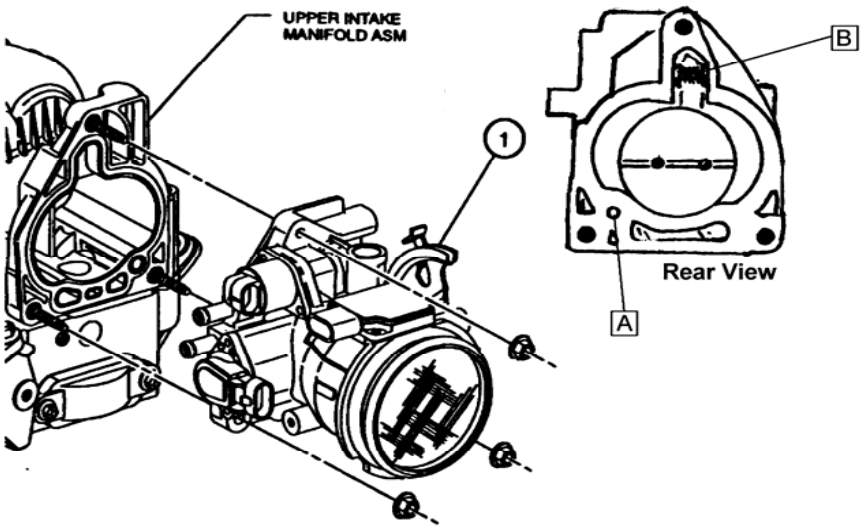
Description of Operation	
Y	OHT-020-2 modified to fit offset balance and adapter plate for Dana 1550 four bolt yoke.
Z	Torque & Angle 15Nm + 50°

Specification	
1	OHT3F-020-2 Flywheel (Modified 24503285)
2	24505092 Bolt

REV	Date	Revision History
1	1/10/98	Block-55

View
Flywheel

Final Dress	Sequence IIIG	Section	Sheet
		7	5



Description of Operation	
A	Drill and tap to receive a hex head plug
B	Use power to PCM with engine not running and throttle blade open to drive Idle Air Control motor closed. Disconnect harness connecter and adjust idle screw to obtain 800 RPM base idle. As an alternative, the IAC may be removed and both ports plugged using epoxy and welch type plugs.

Specification

1 24507235 Throttle Body
(2 bolt Mass Air Flow Sensor)
Use 12568877
or
May be superseded with
remanufactured part# 88961007

REV	Date	Revision History
1	11/13/99	Block-48
2	5/28/03	Add 12568877
3	6/23/03	Add 88961007 remanufactured from 12568877

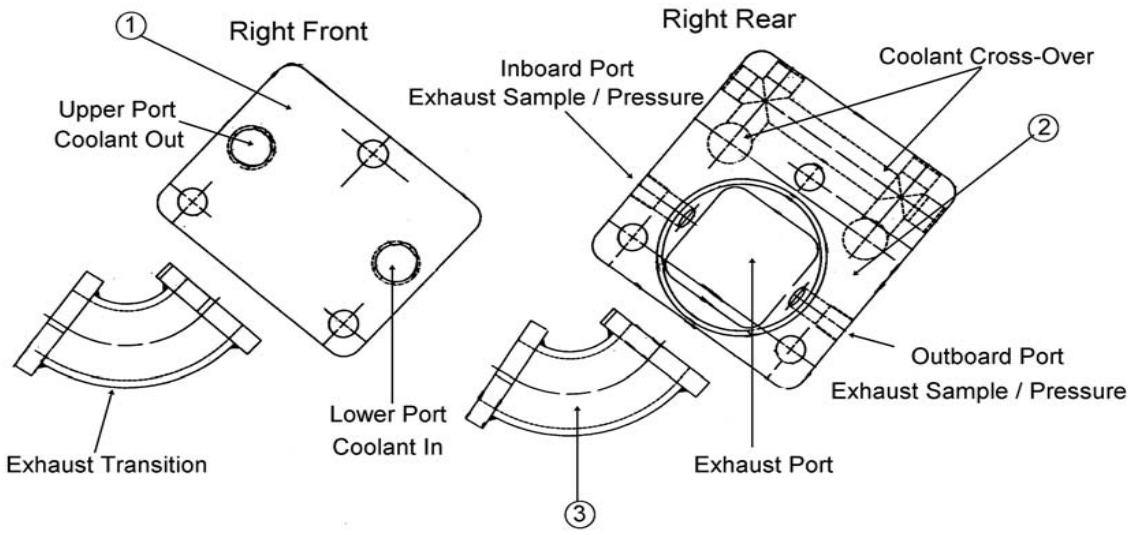
View

Throttle Body Modification

Final Dress	Sequence IIIG	Section	Sheet
		7	6

Section 8

OH Technologies Special Engine Dress



Description of Operation

Water cooled exhaust manifold end plates and exhaust manifold transitions. Note: both views are right side showing the cooling water inlet is the lower port and the outlet is the higher port. Also, the inboard exhaust sample port is typically for the gas analysis and the outboard is for the back pressure connection.

Tha transition should be connected with shilded gaskets not shown but identified by part number. Two required per side.

Thermocouples for exhaust coolant in and out should be installed in the fittings attached to the front plate and centered in the coolant flow.

Specification

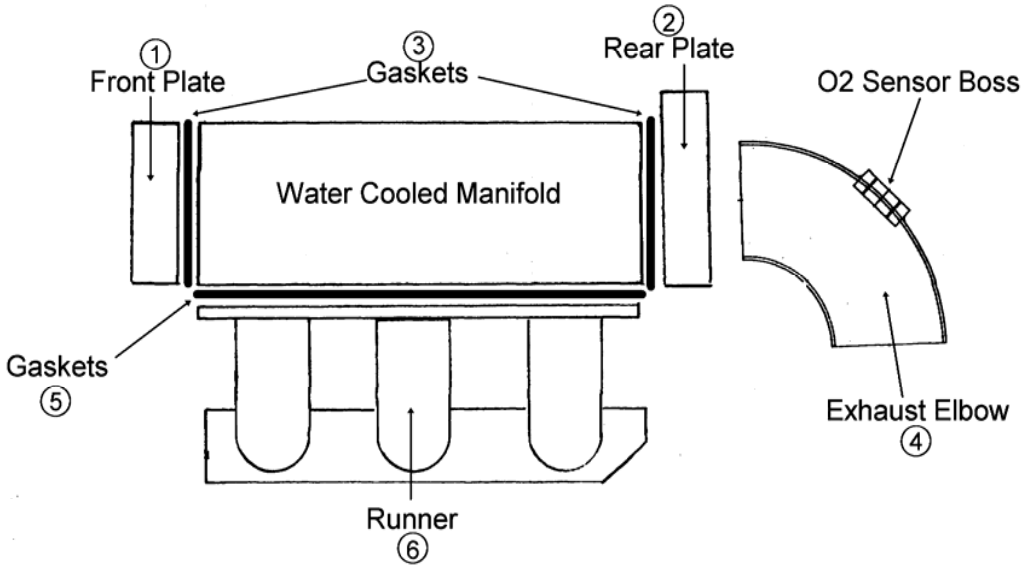
1 OHT3F-006-1 Plate, Rear Exhaust
2 OHT3F-005-1 Plate, Front Ehhaust
3 OHT3F-004-1 Runner, Exh. Man.

REV	Date	Revision History
1	11/13/99	Block-60
2	2/22/02	Update View Exhaust sample / pressure locations

View

Water Cooled Exh. Man. End Plates

OHT	Sequence IIIG	Section	Sheet
		8	1



Description of Operation

Water cooled exhaust manifold

Not to scale

Note: Do Not Use RTV Sealer on O2 sensor or other exhaust system components upstream of O2 sensor.

Specification

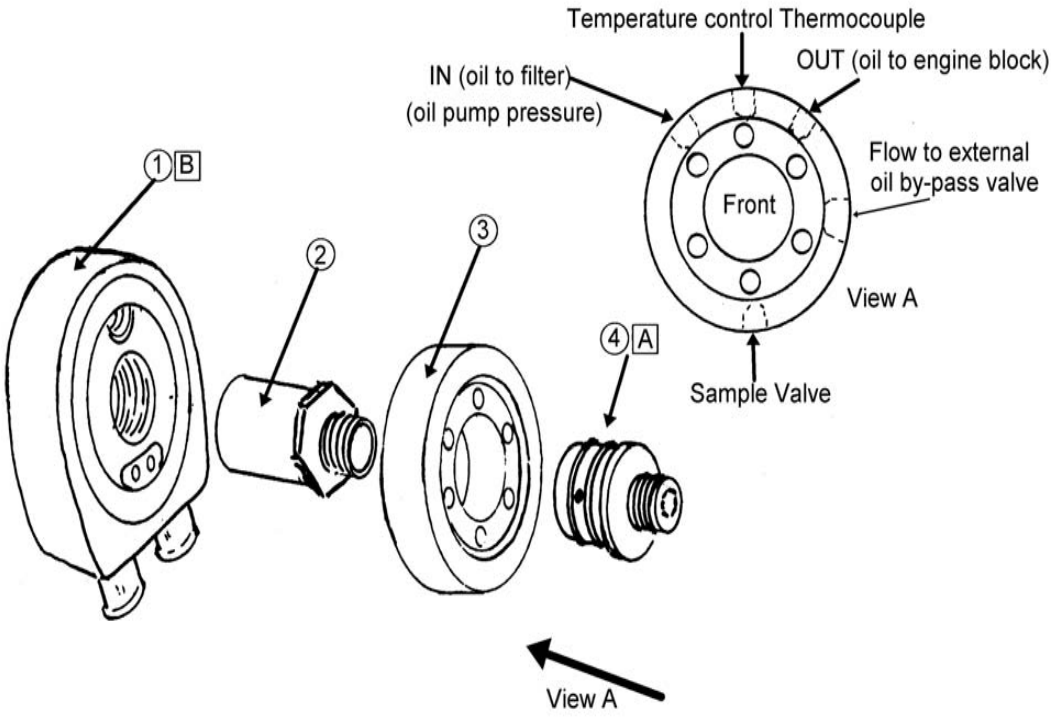
1 OHT3F-005-1 Plate, Front Ehhaust
2 OHT3F-006-1 Plate, Rear Exhaust
3 OHT3F-009-1 Gasket, End Plate
4 OHT3F-005A-1 Elbow, Exh. Modified
5 OHT3F-018-1 Gasket Flange, Metal
6 OHT3F-004-1 Runner, Exh. Man.

REV	Date	Revision History
1	11/13/99	Block-61
2	2/22/02	Update text, include warning on usage of RTV sealer

View

Water Cooled Exh. Man. & Elbow

OHT	Sequence IIIG	Section	Sheet
		8	2



Note: See section 8 sheet 3a & 3b for additional information

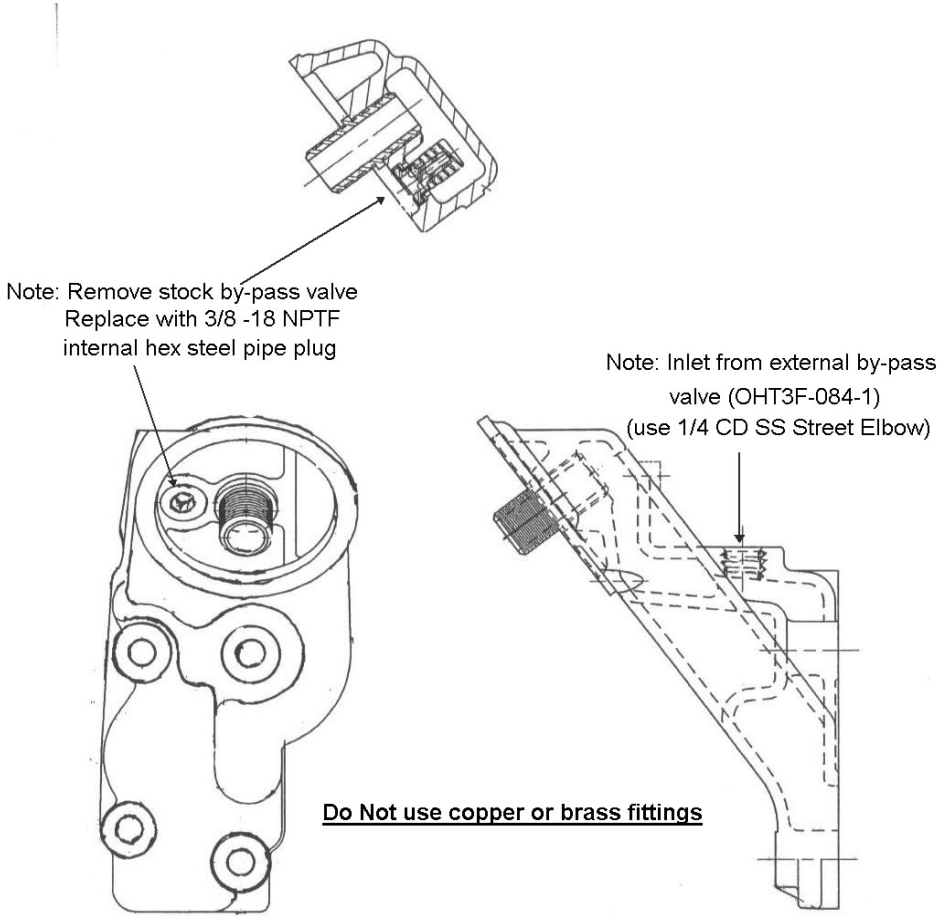
Description of Operation	
A	Replace "O"-rings every test. Note: View A Viewed from front or oil filter side, passages are, IN (oil pump pressure to filter), center port for temperature control thermocouple, OUT (oil flow out of filter in to engine block), Side outlet to external oil by-pass valve, and lower port is for oil sample valve.
B	Replace oil cooler every test

Specification
1 OHT3F-030-2 Cooler Nickel Plated
2 OHT3F-039-3 Connecter Special Cut
3 OHT3F-035-2 Adapter, Oil Filter
4 OHT3F-043-2 Fitting, Oil Filter Adapter

REV	Date	Revision History
1	11/30/99	Block 62
2	6/17/02	Add notes, new part numbers and update view. See next sheet for further details

View
Oil Cooler Assembly

OHT	Sequence IIIG	Section	Sheet
		8	3



Description of Operation

Special part modification information.

Modofied part may be purchased direct from OHT (OHT3F-080-1)

Specification

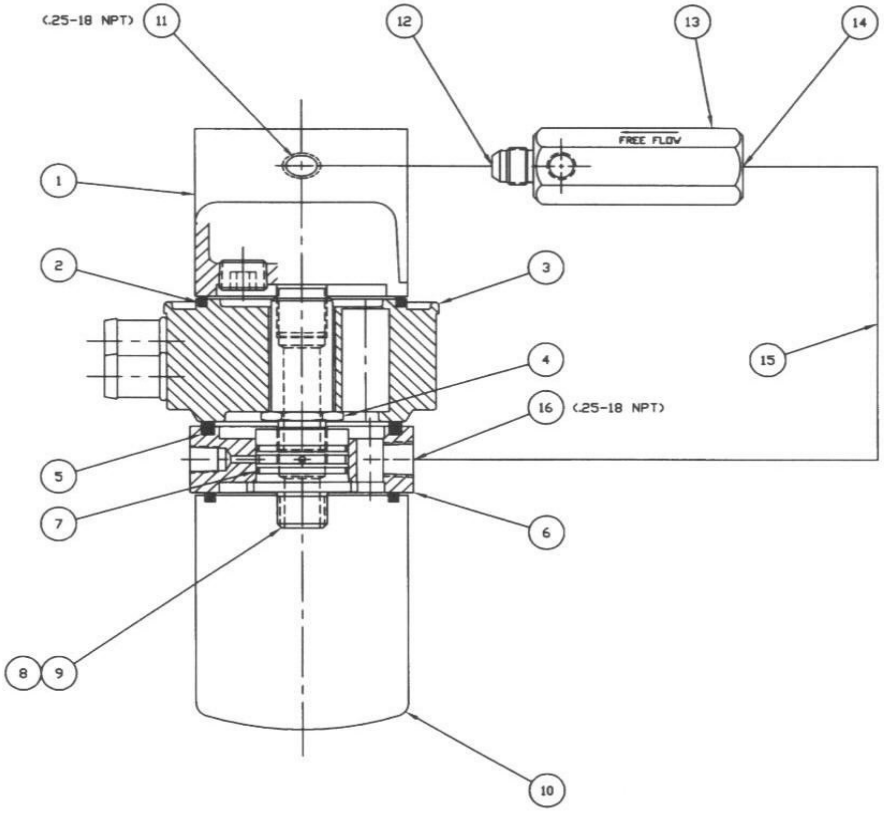
1 24501300 Adapter, oil filter
OHT3F-080-1 Modified

REV	Date	Revision History

View

Oil Filter Adapter Modification

OHT	Sequence IIIG	Section	Sheet
		8	3a



BILL OF MATERIAL		
ITEM	REQ'D	DESCRIPTION
1	1	BLOCK, OIL FILTER, MODIFIED W/BYPASS BLOCKED,
		OHT3F-080-1
2	1	SEAL, RECTANGULAR, OHT3F-074-1
3	1	COOLER, OIL, NICKEL PLATED, BYPASS CLOSED,
		OHT3F-030-2
4	1	CONNECTOR, MODIFIED, OHT3F-039-3
5	1	SEAL, RECTANGULAR, OHT3F-062-1
6	1	ADAPTER, OIL FILTER, OHT3F-035-2
7	2	SEAL, O-RING, #2-025-VITON PARKER
8	1	FITTING, OIL FILTER ADAPTER, .500" I.D.,
		OHT3F-043-2
9	1	WRENCH, SPANNER, (FOR USE W/ITEM #8),
		OHT3F-083-1
10	1	FILTER, OIL (PF-47), OHT3F-057-1
11	1	ELBOW, STREET, #1/4 CD-SS PARKER
12	1	CONNECTOR, SWIVEL, #6 F6X-SS PARKER
13	1	HOUSING, ASS'Y, BYPASS VALVE, OHT3F-084-1
14	1	CONNECTOR, MALE, #6-8FTX-SS PARKER
15	1	(.31 I.D. X 12.00 LG.) BRAIDED TEFLON HOSE ASS'Y,
		#K9190606-060606C-012.0 PARKER
16	1	CONNECTOR, MALE, #6FTX-SS PARKER

ASSEMBLE ALL SEALS WITH A LIGHT COATING OF #EF411 OIL

DIMENSIONS IN PARENTHESES ARE IN INCHES

METRIC
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS

SYM	REVISIONS	DATE

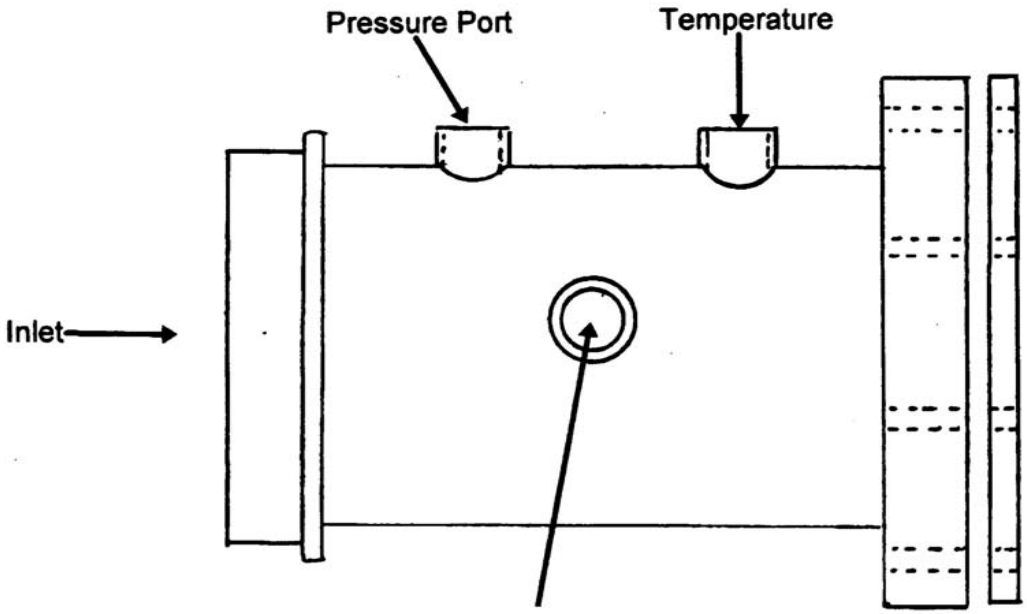
TOLERANCES UNLESS SPECIFIED
DECIMAL
X.X = ±0.3
XXX = ±0.10
ANGULAR ±1°
SURFACES 3.2

TITLE ASS'Y, OIL FILTER, COOLER & BYPASS
MATERIAL SEE B/M
SCALE FULL
DATE 6-6-02
CHECKED BY D.H.
DRAWN BY D.H.
ASSEMBLY

OH TECHNOLOGIES INC.
DWG. NO. OHT3G-XXX-1

REV	Date	Revision History	View
1	6/17/02	OHT Print	**OHT Oil Cooling & By-Pass**
			Printed by permission OH Technologies

OHT	Sequence IIIG	Section	Sheet
		8	3b



Inlet Air Temperature Sensor

"Dyno Harness"

Description of Operation

Inlte air adapter

Use pressure port for hookup to transducer, temperature for thermocouple (centered in flow), and inlet air pressure sensor port for Dyno Harness sensor.

Specification

OHT3F-001-2 Adapter, Throttle Body

REV	Date	Revision History
1	11/30/99	Block-63
2	2/22/02	Update View, Inlet Air Temp. Sensor

View

Adapter, Throttle Body

OHT	Sequence IIIG	Section	Sheet
		8	4