Detroit Diesel

V-71 Engines

SPECIFICATIONS

Assembly Clearances

Set Valves and Injectors

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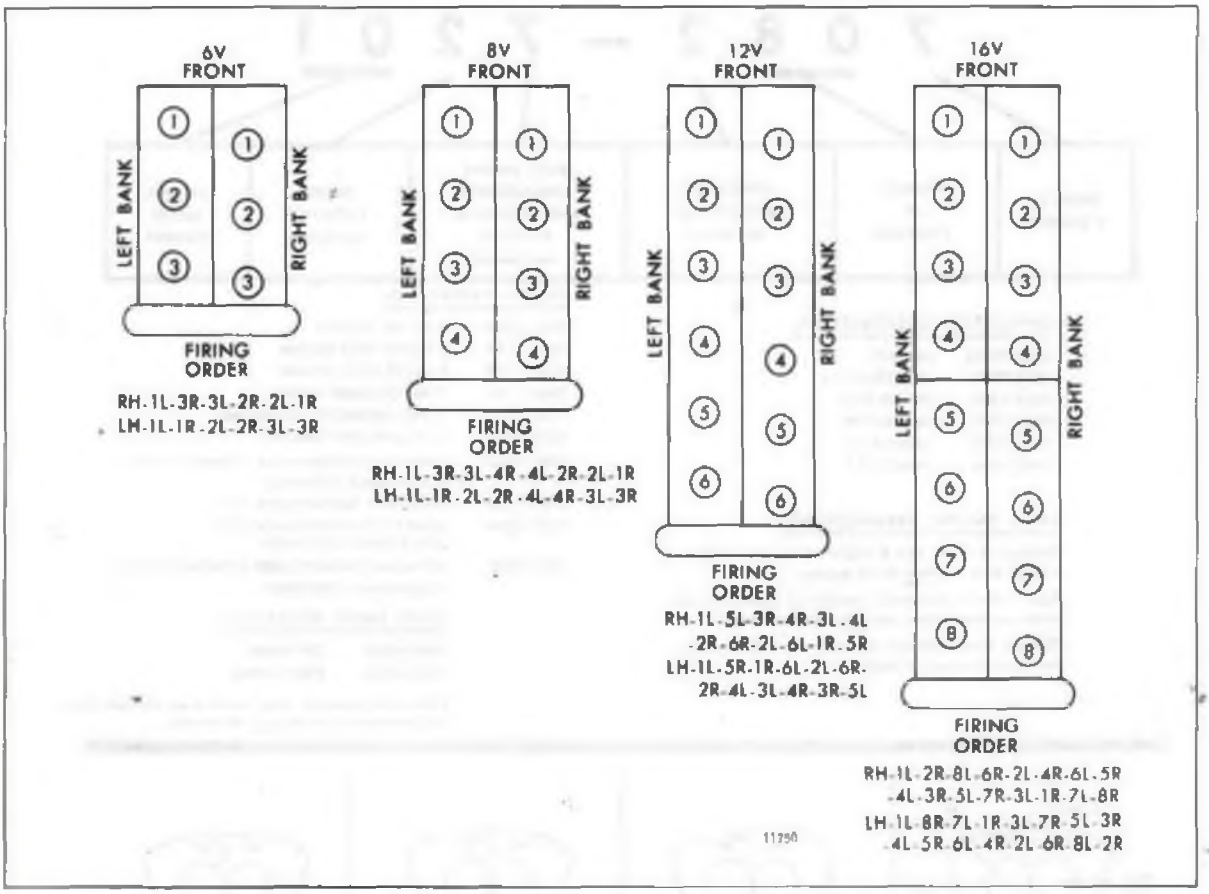


Fig. 3 – V-71 Cylinder Designation and Firing Order

GENERAL SPECIFICATIONS

	6V	8V	12V	16V
Type	2 Cycle	2 Cycle	2 Cycle	2 Cycle
Number of Cylinders	6	8	12	16
Bore (inches)	4.25	4.25	4.25	4.25
Bore (mm)	108	108	108	108
Stroke (inches)	5	5	5	5
Stroke (mm)	127	127	127	127
Compression Ratio (Normal) (Standard & Turbo.)	17 to 1	17 to 1	17 to 1	17 to 1
Compression Ratio (Normal) ("N" Engines)	18.7 to 1	18.7 to 1	18.7 to 1	18.7 to 1
Total Displacement – cubic inches	426	568	852	1136
Total Displacement – liters	6.99	9.32	13.97	18.63
Number of Main Bearings	4	5	7	10

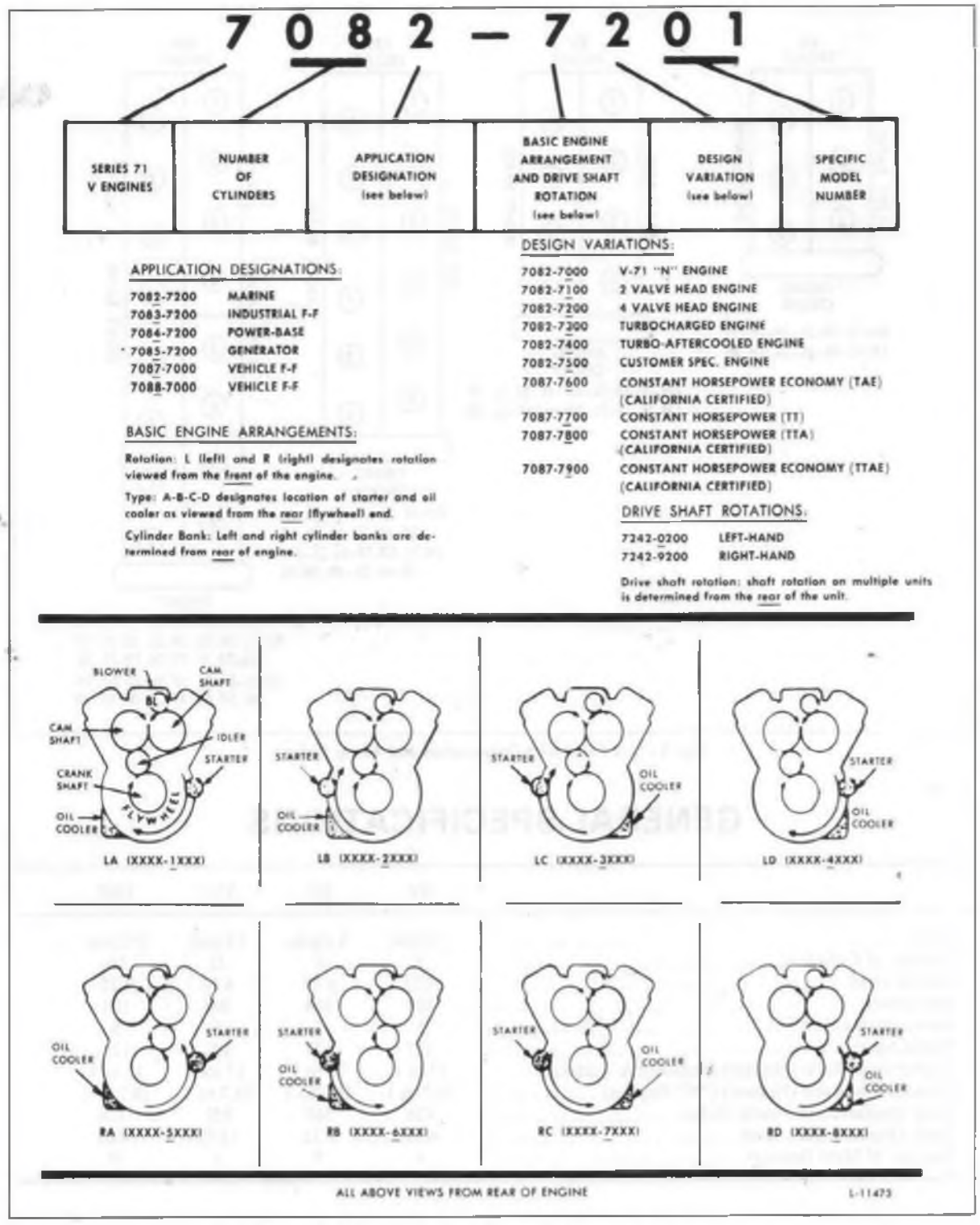


Fig. 2 – Model Numbering, Rotation and Accessory Arrangements

ENGINE MODEL, SERIAL NUMBER AND OPTION PLATE

The engine serial number and model number are stamped on the cylinder block in the following locations (as viewed from the flywheel end): The left side, upper front corner of current 6V and 8V cylinder blocks (Fig. 4) and the right side, upper rear corner of current 12V and 16V blocks and *former* 6V and 8V blocks.

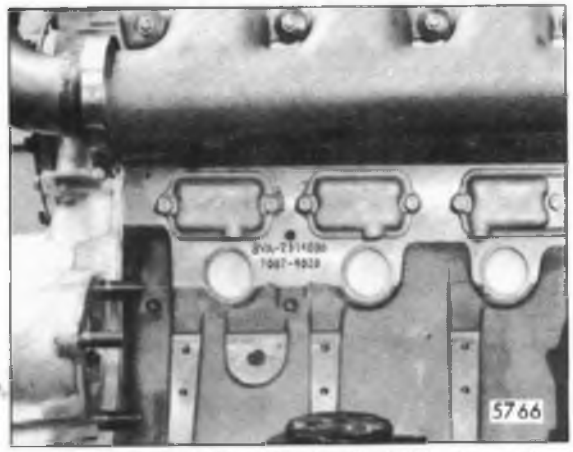


Fig. 4 – Typical 8V–71 Engine Serial Number and Model Number

Option Plate (Metal Labels)

An option plate, attached to one of the valve rocker covers, carries the engine serial number and model number and, in addition, lists any optional equipment used on the engine (Fig. 5).

On–highway vehicle engines also carry an exhaust emission certification label next to the option plate. It is separate from the option plate and is mounted permanently in the option plate retainer. The current label includes information relating to an engine family for the maximum fuel injector size and maximum speed. *Due to Federal regulations, the exhaust emission plate should not be removed from the rocker cover.* Refer to Section 14 for further information regarding emission regulations.

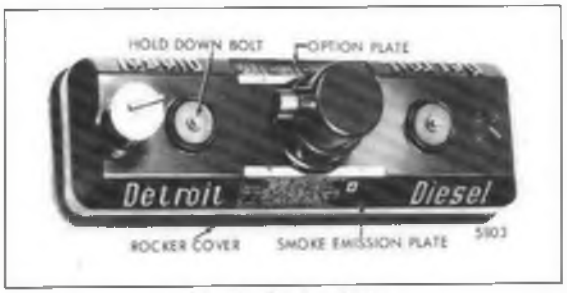


Fig. 5 – Option Plate

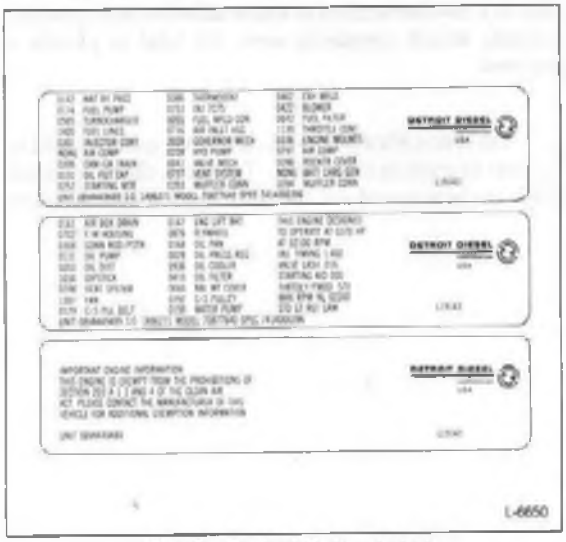


Fig. 6 – Typical Option Label

With any order for parts, the engine model number and serial number must be given. In addition, if a type number is shown on the option plate covering the equipment required, this number should also be included on the parts order.

All groups of parts used on a unit are standard for the engine model unless otherwise listed on the option plate.

Power takeoff assemblies, torque converters, marine gears, etc. may also carry name plates. The information on these name plates is also useful when ordering replacement parts for these assemblies.

• Option Plate (Paper Labels)

A new paper/laminate engine option label (Fig. 6) has replaced the metal option plate. In conjunction with the new option label, the following paper/laminate labels are also being used: **bar code labels** for engine serial number and customer specification number; **emissions label** (when applicable) and **disclaimer label**.

Distributors will provide their own label(s) in order to notify the customer of any distributor–made changes to Detrot Diesel–manufactured engines. Distributor–typed label(s) will indicate the distributor name, address and the group/type revisions that reflect their changes to engines as originally manufactured by Detroit Diesel.

Attaching Lables

Labels must be placed on rocker covers. Labels are designed to fit in the same space provided for the former stamped or current cast rocker cover option plate holder.

Replacement option labels can be placed directly over existing option labels. *Make certain the labels are applied to clean, dry, oil–free surfaces to assure adhesion and retention.* Laminate should completely cover the label to provide a good seal.

The option plate holder on cast rocker covers is held to the cover by rivets in blind holes. Therefore, the option plate holder can be removed and the labels applied directly to the rocker covers. The option plate holder on stamped rocker covers is retained by spot welding. This option plate holder should not be removed, since it can leave open holes which will allow the leakage of lube oil.

NOTICE: Extreme heat from components such as turbocharger exhaust piping can cause the labels to darken, discolor or deteriorate over a period of time. Therefore, labels should be installed at alternate rocker cover locations.

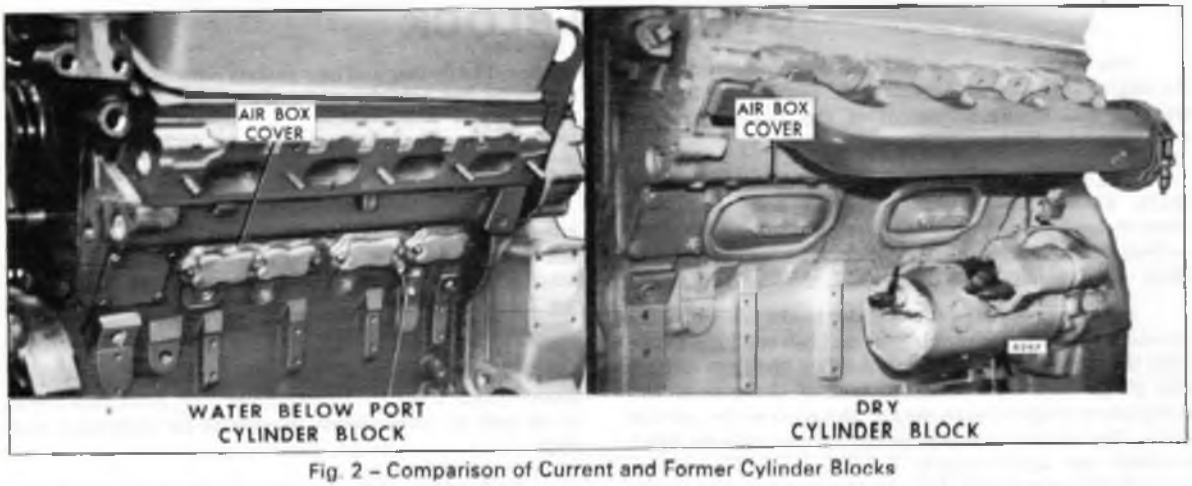
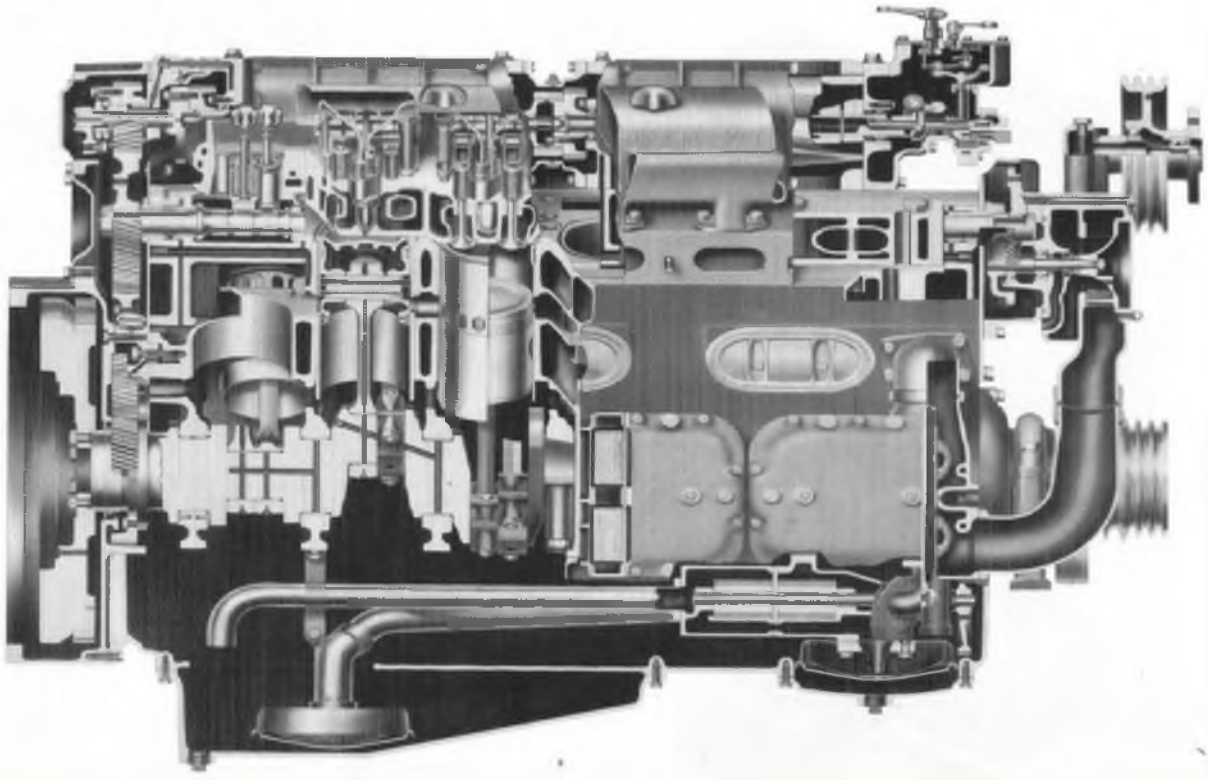


Fig. 2 – Comparison of Current and Former Cylinder Blocks



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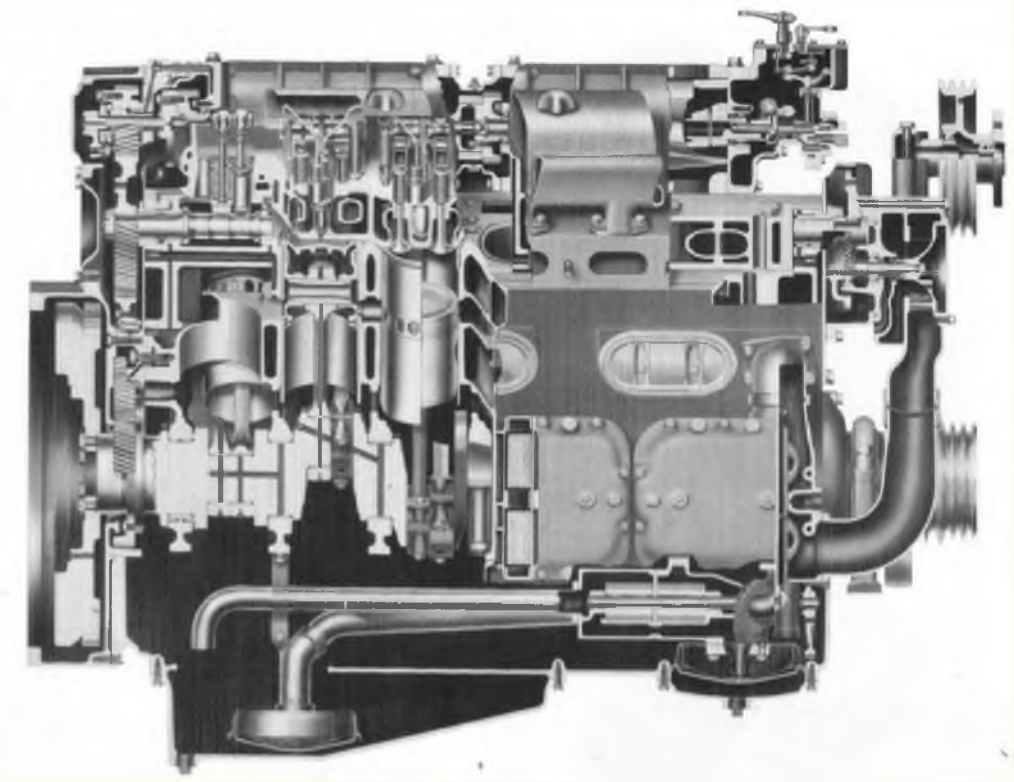
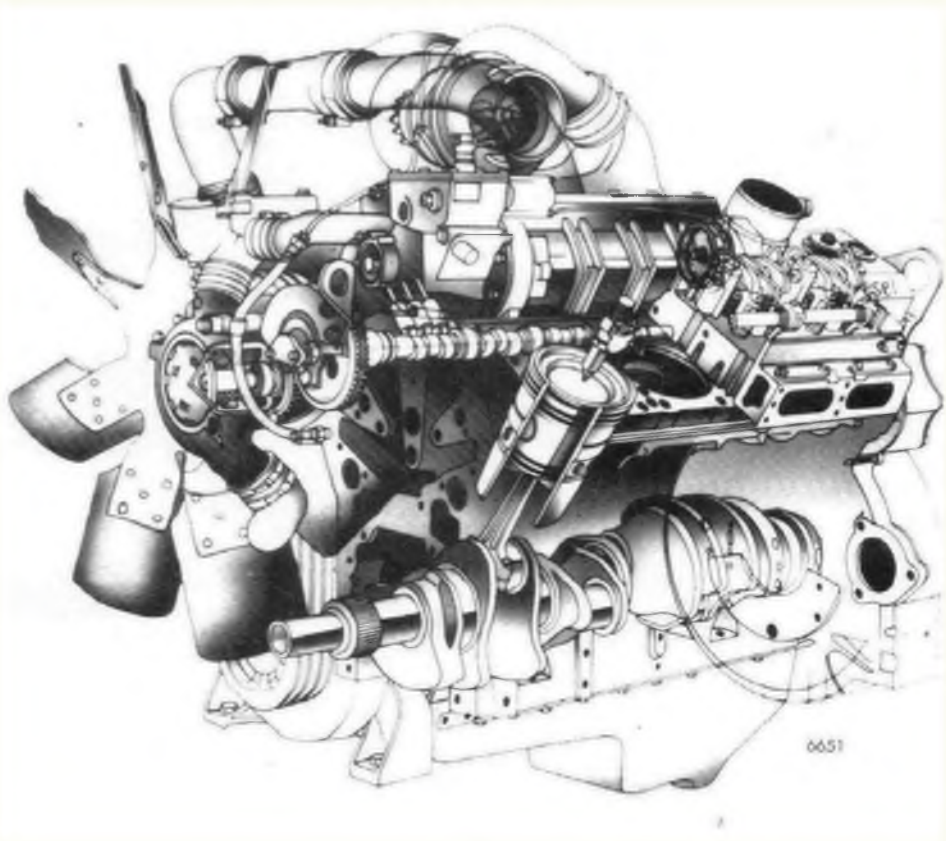
Detroit Diesel V-71 series engines





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SPECIFICATIONS

Specifications, clearances and wear limits are listed below. It should be specifically noted that the clearances apply only when all new parts are used at the point where the various specifications apply. This also applies to references within the text of the manual. The column entitled "Limits" in this chart lists the amount of wear or increase in clearance which can be tolerated in used engine parts and still ensure satisfactory performance. It should be emphasized that the figures given as "Limits" must be qualified by the judgement of personnel responsible for installing new parts. These wear limits are, in general, listed only for the parts more frequently replaced in engine overhaul work. For additional information, refer to the text.

TABLE OF SPECIFICATIONS, NEW CLEARANCES AND WEAR LIMITS

These limits also apply to oversize and undersize parts.

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
CYLINDER BLOCK			
Block bore:			
Diameter	4.6256"	4.6275"	
Out-of-round		.0010"	.0020"
Taper		.0010"	.0020"
Cylinder liner counterbore:			
Diameter	5.0460"	5.0510"	
Depth	.4770"	.4795"	
Main bearing bore:			
Inside diameter (vertical axis)	4.8120"	4.8130"	
Top surface of block:			
Centerline of main bearing bore to top of block	16.1840"	16.1890"	16.176" min.
Flatness—transverse (all)			.0030"
Flatness—longitudinal (6V)			.0060"
Flatness—longitudinal (8V or each section of 16V block)			.0070"
Flatness—longitudinal (12V)			.0090"
Depth of counterbores (top surface):			
Cylinder head seal strip groove	.0920"	.1070"	
Water holes (between cylinders)	.1090"	.1200"	
Combination water and oil holes	.0870"	.0980"	
CYLINDER HEAD			
Flatness—transverse			.0040"
Flatness—longitudinal (6V engine)			.0055"
Flatness—longitudinal (8V engine)			.0080"
Flatness—longitudinal (12V engine)			.0100"
Surface Finish (with 1mm dia. stylus)		90AA	
Distance between top deck and fire deck	3.5560"	3.5680"	3.5360"
Water nozzles	.010" Recess	.003" Protr.	
Cam follower bores	1.0620"	1.0630"	1.0650"
Exhaust Valve Insert Counterbore:			
Diameter (2 valve)	1.6260"	1.6270"	
Diameter (4 valve)	1.2600"	1.2610"	
Depth (2 valve)	.3705"	.3845"	
Depth (4 valve)	.3380"	.3520"	

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
VALVE GUIDES			
Height above cylinder head (2 valve)	1.5300"	1.5300"	
Height above cylinder head (4 valve)	.8800"	.8800"	
Height above cylinder head (4 valve–machined guide)	.6900"	.6900"	
Diameter—inside (2–valve)	.3445"	.3455"	.3465"
Diameter—inside (4–valve)	.3125"	.3135"	.3140"
Clearance—valve–to–guide (2–valve)	.0020"	.0038"	.0060"
Clearance—valve–to–guide (4 valve)	.0020"	.0035"	.0050"
VALVE BRIDGE GUIDES			
Height above cylinder head (4–valve)	2.0400"	2.0400"	
ROCKER ARMS AND SHAFTS			
Diameter—rocker shaft	.8735"	.8740"	
Diameter—inside (rocker arm bushing)	.8750"	.8760"	
Clearance—shaft–to–bushing	.0010"	.0025"	.0040"
CAM FOLLOWERS			
Diameter	1.0600"	1.0610"	
Clearance—follower–to–head	.0010"	.0030"	.0060"
Rollers and pins:			
Clearance—pin–to–bushing	.0013"	.0021"	.010" Horiz.
Side clearance—roller to follower	.0110"	.0230"	.0230"
EXHAUST VALVE SEAT INSERTS			
Outside diameter (2–valve)	1.6275"	1.6285"	
Outside diameter (4–valve)	1.2615"	1.2625"	
Seat width (2–valve)	.0625"	.0937"	.0937"
Seat width (4–valve)	.0468"	.0937"	.0937"
Valve seat runout		.0020"	.0020"
EXHAUST VALVES			
Stem diameter (2–valve)	.3417"	.3425"	.3405"
Stem diameter (4–valve)	.3100"	.3105"	.3090"
Valve head–to–cylinder head:			
30° (former 2–valve and 4–valve)	.002" recess.	.028" protr.	
30° (current 2–valve and 4–valve)	.023" recess.	.006" protr.	.038" recess.
MAIN BEARINGS			
Inside diameter (vertical axis)	4.5016"	4.5040"	
Bearing–to–journal clearance	.0014"	.0055"	.0055"
Bearing thickness 90° from parting line	.1545"	.1552"	
CRANKSHAFT			
Journal diameter—main bearing	4.4985"	4.5002"	
Journal diameter—conn. rod bearing	2.9985"	3.0002"	
Journal diameter—outboard bearing (16V engine)	4.6860"	4.6870"	
Journal out–of–round		.0005"	.0005"
Journal taper:			
Main bearing		.0006"	.0006"
Connecting rod – full length		.0008"	
Connecting rod – half length		.0004"	

DETROIT DIESEL V-71 — Specifications 1.0

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
#Runout on journals—total indicator reading:			
6V (mounted No. 1 and No. 4 journals):			
At No. 2 and No. 3 journals		.0020"	
8V (mounted No. 1 and No. 5 journals):			
At No. 2 and No. 4 journals		.0020"	
At No. 3 journal		.0040"	
12V-71 (mounted No. 1 and No. 7 journals):			
At No. 2 and No. 6 journals		.0020"	
At No. 3 and No. 5 journals		.0040"	
At No. 4 journal		.0060"	
16V-71 (mounted No. 1 and No. 10 journals):			
At No. 2 and No. 9 journals		.0020"	
At No. 3 and No. 8 journals		.0040"	
At No. 4 and No. 7 journals		.0060"	
At No. 5 and No. 6 journals		.0080"	
Thrust washer thickness	.1190"	.1220"	
End play (end thrust clearance)	.0040"	.0110"	.0180"
OUTBORAD BEARING			
Clearance—bearing-to-journal	.0059"	.0065"	.0080"
TRUNK TYPE PISTONS AND RINGS (V-71)			
Piston:			
Height (centerline of bushing to top):			
Two valve head engine	3.3880"	3.3930"	
Four valve head engine	3.5130"	3.5180"	
Diameter (above compression rings:			
Two valve head engine	4.2217"	4.2247"	
Four valve head engine (60 cmm inj.)	4.2230"	4.2260"	
Four valve head engine (70 cmm inj.)	4.2190"	4.2220"	
Diameter (at skirt):			
Two valve head engine	4.2433"	4.2455"	
Four valve head engine (60 cmm inj.)	4.2433"	4.2455"	
Four valve head engine (70 cmm inj.)	4.2428"	4.2450"	
Clearance—piston skirt-to-liner:			
Two valve head engine	.0040"	.0078"	.0120"
Four valve head engine (60 cmm inj.)	.0040"	.0078"	.0120"
Four valve head engine (70 cmm inj.)	.0045"	.0083"	.0120"
Out-of-round		.0005"	
Taper		.0005"	
Compression rings:			
Gap (top-fire ring)	.0230"	.0380"	.0600"
Gap (No. 2, 3 and 4)	.0180"	.0430"	.0600"

Runout tolerance given for guidance when regrinding crankshaft. When the runout on adjacent journals is in the opposite direction, the sum must not exceed .003" total indicator reading. When the runout on adjacent journals is in the same direction, the difference must not exceed .003" total indicator reading. When high spots of the runout on adjacent journals are at right angles to each other, the sum must not exceed .004" total indicator reading or .002" on each journal.

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
Clearance—ring-to-groove:			
No. 1 (top, fire ring)	.0040"	.0070"	.0100"
No. 2	.0095"	.0130"	.0220"
No. 3	.0075"	.0110"	.0150"
No. 4	.0055"	.0090"	.0130"
Oil control rings:			
Gap	.0080"	.0230"	.0430"
Clearance—ring-to-groove	.0015"	.0055"	.0080"
Piston:			
Height (centerline of bushing to top)	3.5430"	3.5480"	
Diameter (above compression rings)	4.2225"	4.2255"	
Diameter (at skirt)	4.2428"	4.2450"	
Clearance—piston skirt-to-liner	.0045"	.0083"	.0120"
Out-of-round		.0005"	
Taper		.0005"	
Compression rings:			
Gap (top-fire ring)	.0230"	.0380"	.0600"
Gap (No. 2, 3 and 4)	.0180"	.0430"	.0600"
Clearance—ring-to-groove:			
No. 1 (top-fire ring)	.0040"	.0070"	.0180"
No. 2	.0100"	.0130"	.0220"
No. 3 and 4	.0040"	.0070"	.0130"
Oil control rings:			
Gap	.0080"	.0230"	.0430"
Clearance .0015" .0055" .0080"			
TRUCK TYPE PISTONS AND RINGS (V-71T)			
Piston:			
Height (centerline of bushing to top)	3.5130"	3.5180"	
Diameter (above compression rings)	4.2170"	4.2200"	
Diameter (at skirt)	4.2393"	4.2415"	
Clearance—piston skirt-to-liner	.0080"	.0118"	.0140"
Out-of-round		.0005"	
Taper		.0005"	
Compression rings:			
Gap (top ring)	.0230"	.0380"	.0600"
Gap (No. 2, 3 and 4)	.0180"	.0430"	.0600"
Clearance—ring-to-groove:			
Top Ring	.0040"	.0070"	.0100"
No. 2	.0095"	.0130"	.0220"
No. 3	.0075"	.0110"	.0150"
No. 4	.0055"	.0090"	.0130"
Oil control rings:			
Gap (two rings in lower groove)	.0050"	.0140"	.0340"
Gap (one ring in upper groove)	.0050"	.0140"	.0340"
Clearance (two rings in lower groove)	.0015"	.0055"	.0080"
Clearance (one ring in upper groove)	.0010"	.0035"	.0060"

DETROIT DIESEL V-71 — Specifications 1.0

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
PISTON PINS (TRUNK PISTONS)			
Length	3.6050"	3.6200"	
Diameter	1.4996"	1.5000"	1.4980"
Clearance—pin to piston bushing	.0025"	.0034"	.0100"
Clearance—pin to conn. rod bushing	.0025"	.0034"	.0100"
Clearance—end (pin-to-retainer—retainer with lock ring)	.0160"	.0640"	.0640"
Piston bushing—inside diameter	1.5025"	1.5030"	1.5050"
CROSS-HEAD PISTONS AND RINGS (V-71N AND T)			
Piston crown:			
Saddle-to-crown distance:			
N piston (18.7:1 compr. ratio)	2.7030"	2.7100"	
T piston (17:1 compr. ratio)	2.6730"	2.6800"	
Diameter:			
At top	4.2226"	4.2256"	
Below both compression rings	4.2391"	4.2421"	
Above and below seal ring groove	3.8850"	3.8950"	
Above and below bearing saddle	3.2360"	3.2370"	
*Compression rings:			
Gap (top-fire ring)	.0230"	.0380"	.0600"
Gap (No. 2 and 3)	.0180"	.0430"	.0600"
Clearance—ring-to-groove:			
*Top (Keystone fire ring)	.0010"	.0050"	.0070"
No. 2 (rectangular section)	.0100"	.0130"	.0220"
No. 3 (rectangular section)	.0040"	.0070"	.0130"
Seal ring:			
Gap (in skirt counterbore)	.0020"	.0210"	.0270"
Clearance	.0005"	.0030"	.0040"
Piston skirt:			
+Diameter	4.2428"	4.2450"	
Clearance—skirt-to-liner	.0045"	.0083"	.0120"
Seal ring bore	3.9200"	3.9240"	3.9260"
Piston pin bore	1.5000"	1.5030"	1.5040"
Oil control rings:			
Gap (two rings in lower groove)	.0080"	.0230"	.0430"
Gap (two rings in upper groove) (V-71N)	.0080"	.0230"	.0430"
Gap (one ring in upper groove) (V-71T)	.0050"	.0140"	.0340"
Gap (two rings in upper groove) (V-71T)	.0080"	.0230"	.0430"
Clearance (two rings in each groove)	.0015"	.0055"	.0080"
Clearance (one ring in upper groove)	.0010"	.0040"	.0060"
PISTON PINS (CROSS-HEAD PISTON)			
Length	3.6150"	3.6250"	
Diameter	1.4996"	1.5000"	1.4980"
Slipper bearing (bushing):			
Thickness at center	.0870"	.0880"	.0860"
Clearance (edge of bushing to groove in piston)	.0005"	.0105"	.0120"

* Measured with Keystone fire ring flush with outside diameter of piston crown.
\+ Diameter above and below the piston pin may be 4.2414".

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
CONNECTING ROD			
Length—center-to-center of upper and lower bores	10.1240"	10.1260"	
Inside diameter (upper bushing)	1.5025"	1.5030"	1.5080"
Normal side clearance	.0080"	.0160"	
CONNECTING ROD BEARINGS			
Inside diameter (vertical axis)	3.0005"	3.0035"	
Bearing-to-journal clearance	.0008"	.0045"	.0045"
Bearing thickness 90° from parting line	.1240"	.1245"	
CYLINDER LINER			
Outside diameter	4.6250"	4.6265"	
Inside diameter	4.2489"	4.2511"	
Clearance—liner-to-block	.0000"	.0020"	.0025"
Out-of-round—inside diameter		.0020"	.0025"
Taper—inside diameter		.0010"	.0020"
Depth of flange BELOW block	.0450"	.0500"	.0500"
Variation in depth between adjacent liners		.0020"	.0020"
Insert thickness	.1795"	.1800"	
CAMSHAFT			
Diameter (at bearing journals):			
Front and rear (6V and 12V former)	1.4970"	1.4975"	
Front and rear (6V and 12V current and 8V and 16V engines)	1.4960"	1.4965"	
Center and intermediate	1.4980"	1.4985"	
Runout at center bearing (when mounted on end bearings)		.0020"	
End thrust	.0030"	.0150"	.0180"
Thrust washer thickness	.1190"	.1220"	
CAMSHAFT BEARINGS			
Inside diameter:			
Front and rear	1.5000"	1.5010"	
Center and intermediate	1.5010"	1.5030"	
Clearance—bearing-to-shaft:			
Front and rear (6V, 12V and 16V engines)	.0025"	.0040"	.0060"
Front and rear (8V engines)	.0035"	.0050"	.0060"
Center and intermediate	.0025"	.0050"	.0090"
Outside diameter:			
Front and rear	2.1875"	2.1880"	
Center and intermediate	2.1840"	2.1860"	
Diameter of cylinder block bore	2.1875"	2.1889"	
Clearance—bearings-to-block:			
Front and rear	.0005" press.	.0014" loose	
Intermediate	.0015"	.0045"	
CAMSHAFT GEARS			
Inside diameter	1.1865"	1.1875"	
Clearance—gear-to-shaft	.0015" press.	.0000"	
Backlash	.0020"	.0080"	.0100"

ENGINE PARTS (Standard Size, New)	MINIMUM	MAXIMUM	LIMITS
IDLER GEAR			
Backlash	.0020"	.0080"	.0100"
Pre-load—Variation on pull 2 lbs. 11 oz.	1/2 lb.	4 lbs.	
CRANKSHAFT TIMING GEAR			
Inside diameter	5.2490"	5.2510"	
Clearance—gear-to-shaft	.001" press.	.001" loose	
Backlash	.0020"	.000"	.0100"
BLOWER DRIVE GEAR (AND LEFT BANK ACCESSORY DRIVE GEAR)			
Backlash	.0020"	.0080"	.0100"
Inside diameter (support bushing)	1.6260"	1.6265"	
Hub diameter (at bearing)	1.6240"	1.6250"	
Hub-to-support bushing clearance	.0010"	.0025"	.0050"
Thrust washer thickness	.2350"	.2450"	
Thrust bearing thickness	.0590"	.0610"	
End thrust	.0050"	.0100"	.0120"

STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

THREAD SIZE	260M BOLTS TORQUE (lb-ft)	(N·m)	THREAD SIZE	280M OR BETTER TORQUE (lb-ft)	(N·m)
1/4-20	5-7	7-9	1/4-20	7-9	10-12
1/4-28	6-8	8-11	1/4-28	8-10	11-14
5/16-18	10-13	14-18	5/16-18	13-17	18-23
5/16-24	11-14	15-19	5/16-24	15-19	20-26
3/8-16	23-26	31-35	3/8-16	30-35	41-47
3/8-24	26-29	35-40	3/8-24	35-39	47-53
7/16-14	35-38	47-51	7/16-14	46-50	62-68
7/16-20	43-46	58-62	7/16-20	57-61	77-83
1/2-13	53-56	72-76	1/2-13	71-75	96-102
1/2-20	62-70	84-95	1/2-20	83-93	113-126
9/16-12	68-75	92-102	9/16-12	90-100	122-136
9/16-18	80-88	109-119	9/16-18	107-117	146-159
5/8-11	103-110	140-149	5/8-11	137-147	186-200
5/8-18	126-134	171-181	5/8-18	168-178	228-242
3/4-10	180-188	244-254	3/4-10	240-250	325-339
3/4-16	218-225	295-305	3/4-16	290-300	393-407
7/8-9	308-315	417-427	7/8-9	410-420	556-569
7/8-14	356-364	483-494	7/8-14	475-485	644-657
1-8	435-443	590-600	1-8	580-590	786-800
1-14	514-521	697-705	1-14	685-695	928-942

Grade identification markings are normally stamped on the heads of the bolts. To aid identification of the various bolts used in Detroit Diesel engines, refer to the following chart.

Grade Identification Marking on Bolt Head		GM Number	SAE Grade Designation	Nominal Size Diameter (inch)	Tensile Strength Min. (psi)
None		GM 255-M	1	No. 6 thru 1 1/2	60,000
None		GM 260-M	2	No. 6 thru 3/4 over 3/4 to 1 1/2	74,000 60,000
	Bolts and Screws	GM 280-M	5	No. 6 thru 1 over 1 to 1 1/2	120,000 105,000
	Hex Head Sems Only	GM 275-M	5.1	No. 6 thru 3/8	120,000
	Bolts and Screws	GM 290-M	7	1/4 thru 1 1/2	133,000
	Bolts and Screws	GM 300-M	8	1/4 thru 1 1/2	150,000
	Bolts and Screws	GM 455-M	None	No. 6 thru 1 1/2	55,000

BOLT IDENTIFICATION CHART

EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS

APPLICATION	THREAD	(lb-ft)	(lb-in)	(N·m)
Cam follower guide bolt	1/4-20	12-15		16-20
Injector control shaft bracket bolt	1/4-20	10-12		14-16
Air box cover bolt	5/16-18	8-12		11-16
Oil pan bolts (lower pan)	5/16-18	10-12		14-16
Exhaust valve bridge adjusting screw locknut	5/16-24	20-25		27-34
Idler gear bearing retainer bolts	5/16-24	24-29		33-39
Camshaft end bearing bolts	3/8-16	35-40		47-54
Engine front cover bolts (16V)	3/8-16	40-45		54-61
Flywheel housing bolts	3/8-16	25-30		34-41
Front accessory drive pulley bolt	3/8-16	25		34
Front end plate bolt (water jacket plug)	3/8-16	20-25		27-34
Idler gear hub and spacer bolts (hex head)	3/8-16	40-45		54-61
• Idler gear hub and spacer bolts (flange hex head)	3/8-16	30-35		41-47
Injector clamp bolts	3/8-16	20-25		27-34
Oil pan bolts (upper)	3/8-16	15-20		20-27
Accessory drive disc to camshaft gear bolt	3/8-24	45-50		61-68
Accessory drive hub to camshaft gear bolt	3/8-24	45-50		61-68
Blower drive support bolts and nuts	3/8-24	25-30		34-41
Balance weight-to-camshaft gear bolt	3/8-24	15-18		20-24
Balance weight-to-camshaft gear locknut	3/8-24	25-30		34-41
Balance weight-to-camshaft gear plain nut	3/8-24	18-22		24-30
Balance weight-to-camshaft gear slotted nut	3/8-24	28-32		38-43
Camshaft intermediate bearing lock screw	3/8-24	15-20		20-27
Crankshaft front cover bolts	3/8-24	25-30		34-41
Engine front cover bolts (16V-threaded into plug nuts)	3/8-24	25-30		34-41
Exhaust manifold outlet flange nuts (brass)	3/8-24	20-25		27-34
Flywheel housing bolts (threaded into plug nuts)	3/8-24	25-30		34-41
Flywheel housing cover (small cover)	3/8-24	30-35		41-47
• Fuel pipe nuts (uncoated)	3/8-24	—	160	18.3
• Fuel pipe nuts (Endurion®)	3/8-24	—	130	14.69
• Fuel pipe nuts (Jacobs brake)	3/8-24	—	120	13.6
• Fuel pipe nuts (Load limiting device)	3/8-24	—	160	18.3
Injector clamp nut	3/8-24	20-25		27-34
Left bank accessory drive support bolts and nuts	3/8-24	25-30		34-41
Water manifold cover nuts	3/8-24	20-25		27-34
Flywheel housing cover (large hole)	7/16-14	30-35		41-47
Generator drive bearing retaining bolt	7/16-14	30-35		41-47
Generator drive oil seal retaining bolt	7/16-14	30-35		41-47
Outboard main bearing support bolt (16V)	7/16-14	70-75		95-102

EXCEPTIONS TO STANDARD BOLT AND NUT TORQUE SPECIFICATIONS (CONT'D)

APPLICATION	THREAD	(lb-ft)	(lb-in)	(N·m)
Rear accessory drive pulley bolt	7/16-14	35		47
Stabilizer bolts	7/16-14	70-75		95-102
Connecting rod nut (castellated)	7/16-20	65-75		88-102
Connecting rod nut (Lubrite)	7/16-20	60-70		81-95
Cross-head piston pin to conn. rod bolt	7/16-20	55-60		75-81
Exhaust manifold nuts	7/16-20	30-35		41-47
Fuel manifold connector nuts	7/16-20	30-35		41-47
Fuel manifold connector (Nylon insert)	7/16-20	30-35		41-47
Fuel manifold connector (steel washer)	7/16-20	40-45		54-61
Fuel manifold connector (O-ring sealed, steel washer)	7/16-20	43		58
Crankshaft front cover and trunnion bolts (16V)	1/2-13	90-100		122-136
Crankshaft front cover bolts	1/2-13	80-90		108-122
Flywheel housing bolts	1/2-13	90-100		122-136
Flywheel housing cover (large hole) bolt	1/2-13	30-35		41-47
Generator drive bearing retaining bolt	1/2-13	30-35		41-47
Generator drive oil seal retaining bolt	1/2-13	30-35		41-47
Idler gear hub and dummy hub bolt	1/2-13	80-90		108-122
+Rocker shaft bolts	1/2-13	90-100		122-136
**Camshaft gear bolt (right-bank-300M)	9/16-18	180-190		244-258
**Flywheel bolts (see Section 1.4)	9/16-18			
**Vibration damper bolt-to-crankshaft	9/16-18	155-165		211-224
**Cylinder head bolts	5/8-11	170-180		231-244
**Main bearing bolts (assembly) (see Section 1.3.4)	5/8-11			
**Main bearing bolts (bolting)	5/8-11	165-175		224-238
**Cylinder head nuts	5/8-18	175-185		238-251
Accessory drive pulley nut (blower driven)	3/4-16	120-140		163-190
Accessory drive pulley nut (cam driven)	3/4-16	150-170		204-231
Crankshaft end bolt (1 5/16" hex head)	1-14	290-310		393-421
• Crankshaft end bolt (1 1/2" hex head)	1-14	450		670
Camshaft nut	1 1/8-18	300-325		407-441
Blower drive gear hub nut	1 7/16-16	50-60		68-81
Left bank accessory drive gear nut	1 7/16-16	50-60		68-81

* Stake nut after tightening.
# Lubricate before assembling to cylinder head.
+ 75-85 lb-ft (102-115 N·m) torque on the two bolts attaching load limit or power control screw bracket (if used) to the rocker arm shaft bracket.
** Lubricate at assembly with International Compound No. 2, or equivalent (refer to Parts Catalog or Microfiche, Section 12.8000A).

EXHAUST VALVE CLEARANCE ADJUSTMENT

The correct exhaust valve clearance at normal engine operating temperature is important for smooth, efficient operation of the engine.

Insufficient valve clearance can result in loss of compression, misfiring cylinders and, eventually, burned valve seats and valve seat inserts. Excessive valve clearance will result in noisy operation, increased valve face wear and valve lock damage.

Whenever the cylinder head is overhauled, the exhaust valves are reconditioned or replaced, or the valve operating mechanism is replaced or disturbed in any way, the valve clearance must be adjusted to the cold setting to allow for normal expansion of the engine parts during the engine warm-up period. This will ensure a valve setting that is close enough to the specified clearance to prevent damage to the valves when the engine is started.

All of the exhaust valves may be adjusted in firing order sequence during one full revolution of the crankshaft. Refer to the *General Specifications* at the front of the manual for the engine firing order.

ENGINES WITH TWO VALVE CYLINDER HEADS

Valve Clearance Adjustment (Cold Engine)

1. Remove the loose dirt from the valve rocker covers and remove the covers. Discard the gaskets.

2. Place the governor speed control lever in the *idle speed* position. If a stop lever is provided, secure it in the *stop* position.

3. Rotate the crankshaft, with engine barring tool J 22582 or with the starting motor, until the injector follower is fully depressed on the cylinder to be adjusted. If a wrench or barring tool is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation because the bolt could be loosened.

• CAUTION: To reduce the risk of personal injury when barring over or "bumping" the starter while performing an engine tune-up, personnel should keep their hands and clothing away from the engine as there is a remote possibility the engine could start.

4. Loosen the exhaust valve rocker arm push rod locknut.

5. Place a .012" feeler gage (J 0708-01) between the end of the exhaust valve stem and the rocker arm bridge (Fig. 1). Adjust the push rod to obtain a smooth "pull" on the feeler gage.

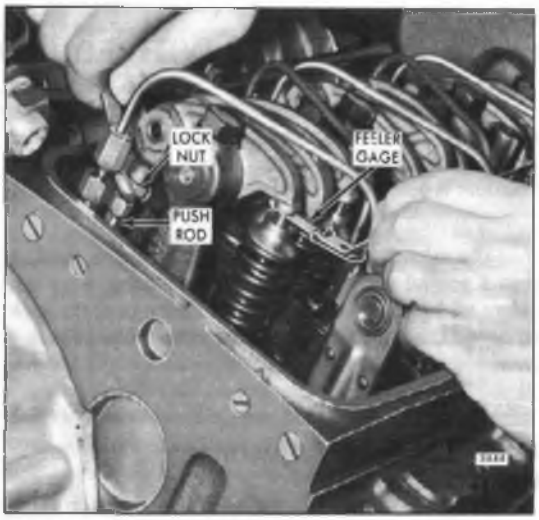


Fig. 1 – Adjusting Valve Clearance (Two Valve Head)

6. Remove the feeler gage. Hold the push rod with a 5/16" wrench and tighten the locknut with a 1/2" wrench.

7. Recheck the clearance. At this time, if the adjustment is correct, the .011" feeler gage will pass freely between the valve stem and the rocker arm, but the .013" feeler gage will not pass through. Readjust the push rod, if necessary.

8. Adjust and check the remaining exhaust valves in the same manner as above.

Valve Clearance Adjustment (Hot Engine)

It is *not* necessary to make a final hot engine exhaust valve clearance adjustment after a cold engine adjustment

has been performed. However, if a hot engine adjustment is desired, use the following procedure.

Maintaining normal engine operating temperature is particularly important when making the hot engine exhaust valve clearance adjustment. If the engine is allowed to cool before setting any of the valves, the clearance, when running at full load, may become insufficient.

NOTICE: Since these adjustments are normally made while the engine is stopped, it may be necessary to run the engine between adjustments to maintain normal operating temperature.

1. With the engine at normal operating temperature (refer to Section 13.2), set the exhaust valve clearance with feeler gage J 9708-01. At this time, if the valve clearance is correct, the .008" feeler gage will pass freely between the end of the exhaust valve stem and the rocker arm and the .010" feeler gage will not pass through. Readjust the push rod, if necessary.
2. After the exhaust valve clearance has been adjusted, check the fuel injector timing (Section 14.2).

Check Exhaust Valve Clearance Adjustment

1. With the engine at 100°F (38°C) or less, check the valve clearance.
2. If a .012" feeler gage (± .004") will pass between the end of the exhaust valve stem and the rocker arm, the valve clearance is satisfactory. If necessary, adjust the push rod.

ENGINES WITH FOUR VALVE CYLINDER HEADS

The exhaust valve bridges must be adjusted and the adjustment screws locked securely at the time the cylinder head is installed on the engine. The necessary adjustment procedure is outlined in Section 1.2.2.

The exhaust valve bridge balance should be checked when a general valve adjustment is performed. After the bridges are balanced, adjust the valve clearance at the *push rod only. Do not distrub the exhaust valve bridge adjusting screw.*

Valve Clearance Adjustment (Cold Engine)

1. Remove the loose dirt from the valve rocker covers and remove the covers. Discard the gaskets.

NOTICE: On certain 12V turbocharged engines, it is necessary to remove the air inlet housing to remove the rocker covers.

2. Place the governor speed control lever in the *idle speed* position. If a stop lever is provided, secure it in the *stop* position.
3. Rotate the crankshaft, with engine barring tool J 22582 or with the starting motor, until the injector follower is fully depressed on the particular cylinder to be adjusted. If a wrench or barring tool is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation because the bolt could be loosened.

•CAUTION: To reduce the risk of personal injury when barring over or "bumping" the starter while performing an engine tune-up, personnel should keep their hands and clothing away from the engine as there is a remote possibility the engine could start.

4. Loosen the exhaust valve rocker arm push rod locknut.
5. Place a .016" feeler gage (J 9708-01) between the end of the exhaust valve stem and the valve bridge adjusting screw (spring-loaded bridge only – Fig. 2) or between the valve bridge and the valve rocker arm pallet (unloaded bridge only – Fig 3). Adjust the push rod to obtain a smooth "pull" on the feeler gage.
6. Remove the feeler gage. Hold the push rod with a 5/16" wrench and tighten the locknut with a 1/2" wrench.

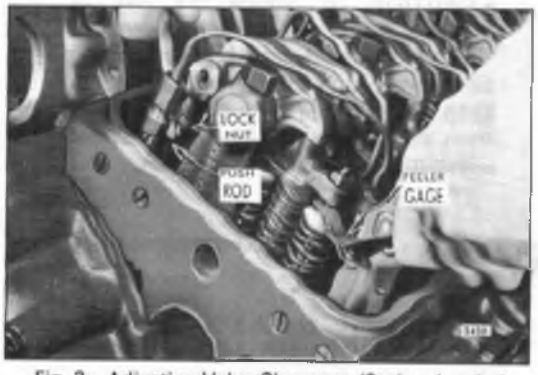


Fig. 2 – Adjusting Valve Clearance (Spring-Loaded Valve Bridge)

FUEL INJECTOR TIMING

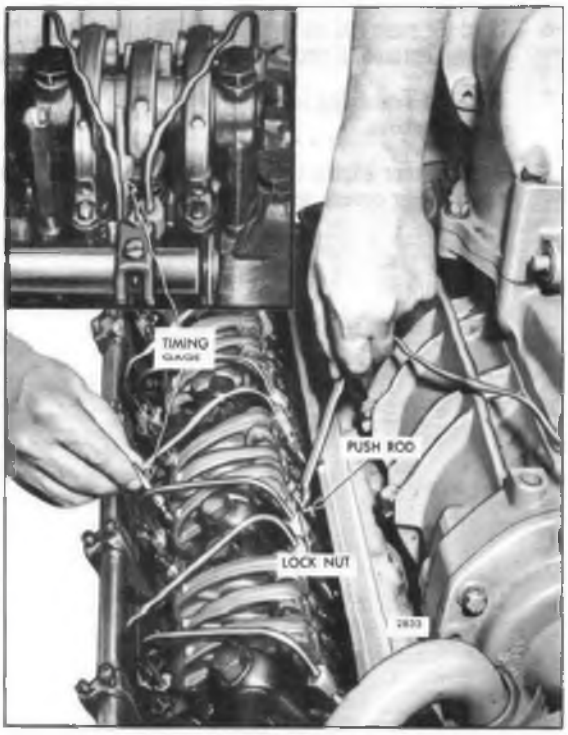


Fig. 1 – Timing Fuel Injector

To time an injector properly, the injector follower must be adjusted to a definite height in relation to the injector body.

All of the injectors can be timed in firing order sequence during one full revolution of the crankshaft. Refer to the *General Specifications* at the front of the manual for the engine firing order.

Time Fuel Injector

After the exhaust valve clearance has been adjusted (Section 14.1), time the fuel injectors as follows:

1. Place the governor speed control lever in the *idle speed* position. If a stop lever is provided, secure it in the *stop* position.
2. Rotate the crankshaft, with the starting motor or with engine barring tool J 22582, until the exhaust valves are fully depressed on the particular cylinder to be timed.

NOTICE: If a wrench or barring tool is used on the crankshaft bolt at the front of the engine, do not turn the crankshaft in a left-hand direction of rotation because the bolt could be loosened.

Injector	Timing Dimension	Timing Gage
558	1.460"	J 1853
555	1.460"	J 1853
658	1.460"	J 1853
560	1.460"	J 1853
565	1.460"	J 1853
570	1.460"	J 1853
580	1.460"	J 1853
590	1.460"	J 1853

TABLE 1 – INJECTOR TIMING GAGE CHART
(Crown Valve)

#Injector	Timing Dimension	Timing Gage	Camshaft Timing
Generator Sets			
All	1.460"	J 1853	Standard
All Other Applications			
71N5	†*1.460"	J 1853	* Standard
N55	†*1.460"	J 1853	* Standard
N60	†*1.460"	J 1853	* Standard
N60 Turbo	1.460"	J 1853	Standard
N65 (white tag)	1.460"	J 1853	Standard
N65 Turbo (brown tag)	1.484"	J 1242	Standard
N65 Non-Turbo (brown tag)	**1.484"	J 1242	** Advanced
HN65	1.460"	J 1853	Advanced
N70 Turbo	1.460"	J 1853	Standard
N70 Non-Turbo	1.460"	J 1853	Advanced
N75 Turbo	1.460"	J 1853	Standard
N80 Turbo	1.484"	J 1242	Standard
N90	1.460"	J 1853	Standard
7A50	1.466"	J 26888	Retarded
7A55	1.466"	J 26888	Retarded
7A60	1.460"	J 1853	Retarded
7A65	1.460"	J 1853	Retarded
7A70	1.460"	J 1853	Retarded
7A75	1.460"	J 1853	Retarded
7C70	1.460"	J 1853	Retarded
7C75	1.460"	J 1853	Retarded
7A15	1.460"	J 1853	®
7N65	1.484"	J 1242	®
7N95	1.520"	J 25502	®
6850	1.484"	J 1242	®
7015	1.508"	J 8909	®

† Use 1.470" timing gage (J 24236) for city coach engines.
* Use 1.484" timing gage (J 1242) when engine has advanced camshaft timing. Correct to standard camshaft timing and 1.460" injector timing at first opportunity to be consistent with current production build.
** Use 1.460" timing gage (J 1853) when engine has standard camshaft timing. Correct to advanced camshaft timing and 1.484" injector timing at first opportunity.
NOTE: Advanced camshaft timing is indicated by "ADV-GT-ADV-CAM" stamped on lower right-hand side of option plate.
For automotive applications, refer to Section 14.
® Refer to Engine Option Label.

TABLE 2 – INJECTOR TIMING GAGE CHART
(Needle Valve)

3. Place the small end of the injector timing gage in the hole provided in the top of the injector body with the flat of the gage toward the injector follower (Fig. 1). Refer to Tables 1 and 2 for the correct timing gage (for vehicle engines, refer to Section 14).

4. Loosen the injector rocker arm push rod locknut.

5. Turn the push rod and adjust the injector rocker arm until the extended part of the gage will just pass over the top of the injector follower.

6. Hold the push rod and tighten the locknut. Check the adjustment and, if necessary, readjust the push rod.

7. Time the remaining injectors in the same manner as outlined above.

8. If no further engine tune-up is required, install the valve rocker covers, using new gaskets.

GEAR TRAIN AND ENGINE TIMING

GEAR TRAIN (6V and 8V Engines)

A train of helical gears, completely enclosed between the engine end plate and the flywheel housing, is located at the rear of 6V, 8V and 12V-71 engines. The gear train consists of a crankshaft gear, an idler gear, two camshaft gears and a blower drive gear (Fig. 1)

The crankshaft gear is bolted to the flange at the rear end of the crankshaft. The idler gear is mounted on a stationary hub on either the right-hand or left-hand side of the engine (viewed from the flywheel end), depending upon engine rotation. The camshaft gears are pressed on and keyed to their respective shafts and each is secured by a nut and gear nut retainer.

The two camshaft gears mesh with each other and run at the same speed as the crankshaft gear. Since the camshaft gears must be in time with each other, and the two as a unit in time with the crankshaft gear, timing marks (Fig. 2) have been stamped on the face of the gears to facilitate correct gear train timing. When assembling the engine, it is important to line up the appropriate timing marks on the gears as each gear is installed on the engine.

The timing is advanced on certain engines by aligning the "A" on the crankshaft gear with the "L" or "R" (depending upon engine rotation) on the idler gear.

It is advisable to line up and make a sketch indicating the position of the timing marks before *removing or replacing any of the gears.*

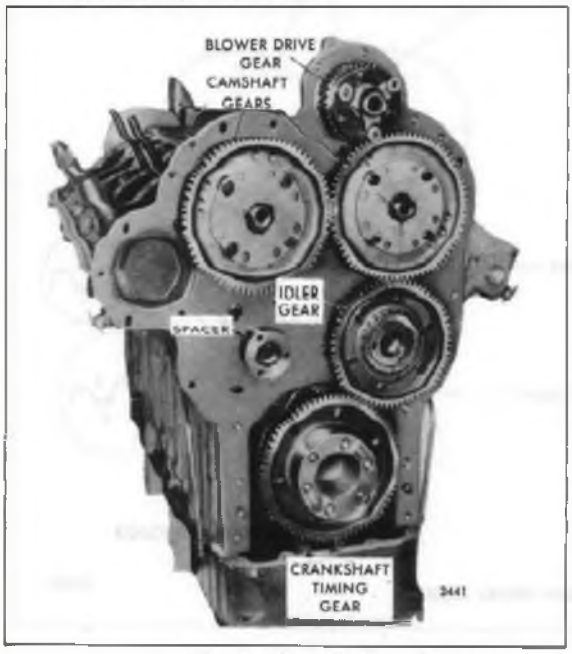


Fig. 1 - Gear Train

If it is impractical to determine the type of timing (standard or advanced) by rotating the gear train until the marks line up, refer to Table 1 as a guide.

There are not timing marks on the accessory drive gear, if used, or the blower drive gear. Therefore, it is not necessary to align these gears in any particular position during their installation.

However, as the blower drive gear and the accessory drive gear have only about half as many teeth as the camshaft gears, they turn at approximately twice the speed of the crankshaft.

STANDARD TIMING
All two-valve models.
All four-valve models with S45, S58, S50, S55, N55, 6S8, S60, N60, S65, N65 (white tag), 71C5, C55, C60 injectors.
All power generator and turbocharged models.
ADVANCED TIMING
All four-valve models with N65 (brown tag) and higher injectors; also HN65, S70, N70, N75, S80 injectors.
Except power generator and turbocharged models.

Table 1

The gear backlash between the various mating gears in the gear train should be .002" to .008" and should not exceed .010" between worn gears.

Gear train noise is usually an indication of excessive gear backlash, chipped, pitted or burred gear teeth or excessive bearing wear. Therefore, when noise develops in a gear train, the flywheel housing should be removed and the gear train and its bearings inspected. A rattling noise usually indicates excessive gear backlash whereas a whining noise indicates too little gear backlash.

Lubrication

The gear train is lubricated by the overflow of oil from the camshaft pockets spilling into the gear train compartment and by splash from the oil pan. A certain amount of oil also spills into the gear train compartment from both camshaft rear end bearings, the blower drive gear bearing and the idler gear bearing. The idler gear bearing is lubricated by oil directly from the cylinder block oil gallery to the idler gear bearing hub. The blower drive gear bearing is lubricated through an external pipe from the blower rear end plate to the blower drive support.

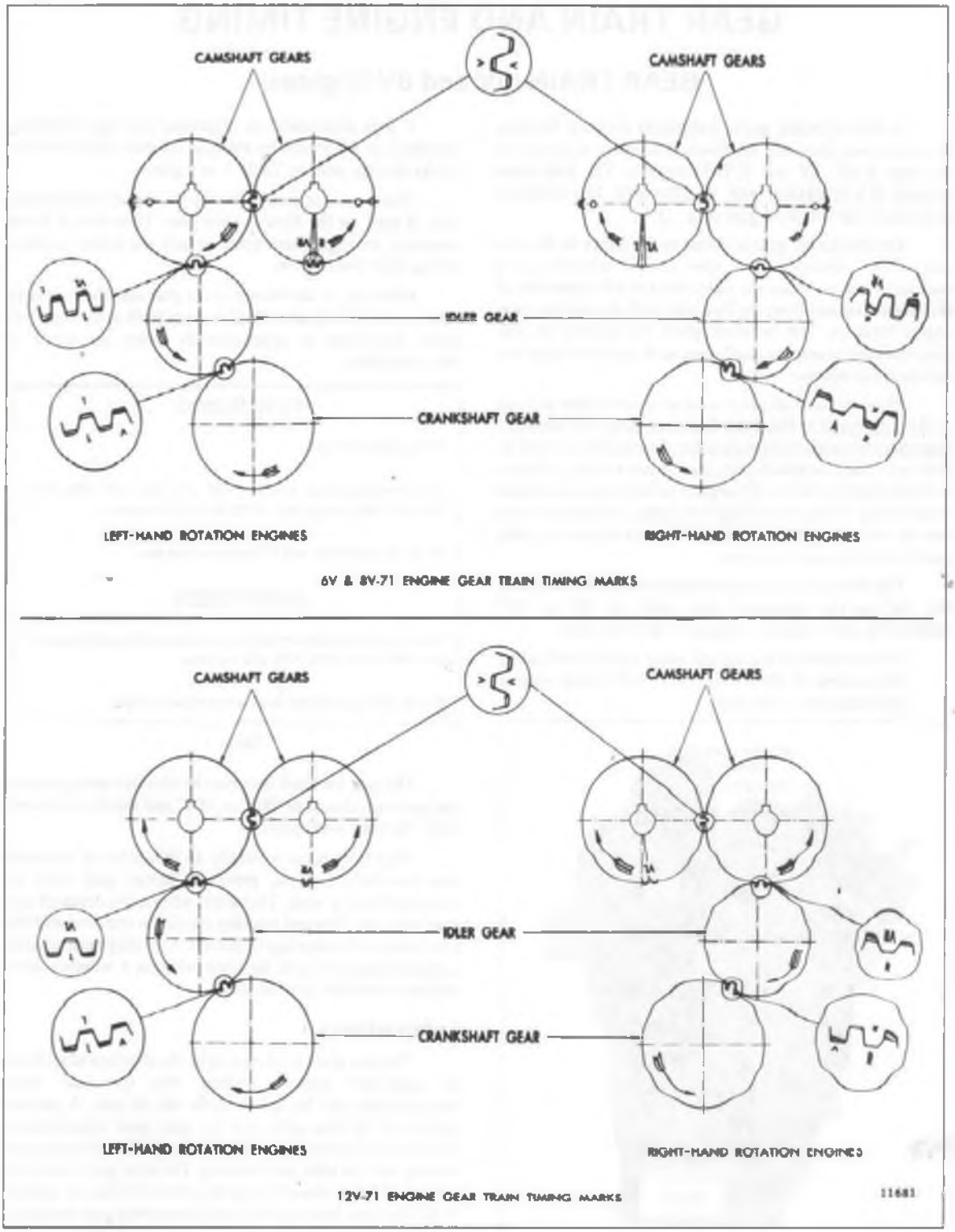


Fig. 2 – Gear Train and Timing Marks for 6V, 8V and 12V Engines

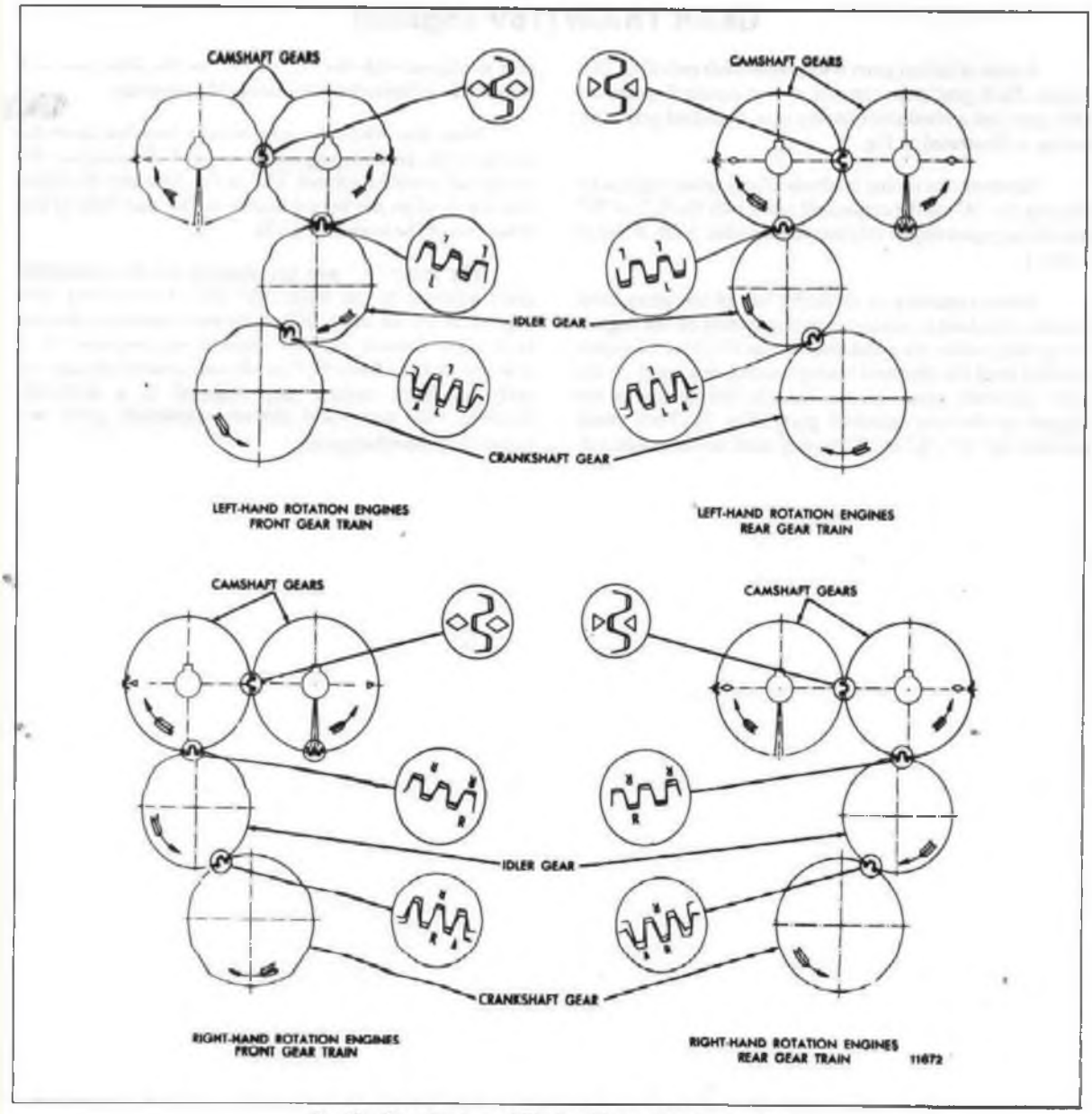


Fig. 3 – Gear Train and Timing Marks for 16V Engine

GEAR TRAIN (16V Engines)

A train of helical gears is located at each end of the 16V engine. Each gear train consists of two camshaft gears, an idler gear and a crankshaft timing gear. Standard gear train timing is illustrated in Fig. 3.

However, the timing is advanced on certain engines by aligning the "A" on the crankshaft gears with the "L" or "R" (depending upon engine rotation) on the idler gears. Refer to Table 1.

Before removing or replacing any of the gears, note whether standard or advanced timing is used on the engine. To do this, rotate the crankshaft in the direction of engine rotation until the diamond timing marks are aligned on the front camshaft gears, or the triangle timing marks are aligned on the rear camshaft gears (Fig. 3). Then check whether the "A", "L" or "R" timing mark on the crankshaft gear is aligned with the "L" or "R" on the idler gear and record this information for reassembly purposes.

Note that when the gear train is installed (and the timing marks properly aligned) at one end of the engine, the crankshaft must be rotated 180° in the direction of engine rotation to align the timing marks on the gear train at the other end of the engine (Fig. 3).

The letter "A" was not stamped on the crankshaft gears adjacent to the letter "R" and "L" on early 16V engines. Also, the letter "R" on the rear crankshaft gear on early right-handed rotation engines was enclosed in a triangle; and the letter "L" on the rear crankshaft gear on early left-hand engines was enclosed in a diamond. However, the early and current crankshaft gears are completely interchangeable.

ENGINE TIMING

The correct relationship between the crankshaft and the two camshafts must be maintained to properly control fuel injection and the opening and closing of the exhaust valves.

The crankshaft timing gear can be mounted in only one position since one attaching bolt hole is offset. The two camshaft gears can, also, be mounted in only one position due to the location of the keyway in each camshaft relative to the cams. Therefore, when the engine is properly timed, the timing marks on the various gears will match, as shown in Figs. 2 and 3.

An engine which is "out of time" may result in preignition, uneven running and a loss of power.

When an engine is suspected of being out of time due to an improperly assembled gear train, a quick check can be made without having to remove the flywheel and flywheel housing by following the procedure outlined below.

Check Engine Timing

Access to the vibration damper or crankshaft pulley, to mark the top-dead-center position of the selected piston, and to the front end of the crankshaft (or to the flywheel), for turning the crankshaft, is necessary when performing the timing check. Then proceed as follows:

1. Clean and remove one valve rocker cover.
2. Select any cylinder for the timing check — it is suggested that a cylinder adjacent to one of the rocker cover bolt or stud holes be chosen since the stud or bolt may be used to mount a dial indicator.
3. Remove the injector as outlined in Section 2.1 or 2.1.1.
4. Carefully slide a rod, approximately 12" long, through the injector tube until the end of the rod rests on top of the piston.
5. Place the throttle in the *no-fuel* position. Then turn the crankshaft slowly in the direction of engine rotation. Stop when the rod reaches the end of its upward travel. Remove the rod and turn the crankshaft, opposite the direction of rotation, between 1/16 and 1/8 of a turn.
6. Select a dial indicator with .001" graduations and a spindle movement of at least one inch. Provide an extension for the indicator spindle. The extension must be long enough to contact the piston just before it reaches the end of its upward stroke. Also select suitable mounting attachments for the indicator so it can be mounted over the injector tube in the cylinder head.
7. Mount the indicator over the injector tube. The indicator mounting may be threaded into the rocker cover stud or the tapped hole in the cylinder head. Check to be sure the indicator spindle is free in the injector tube and is free to travel at least one inch.
8. Attach a suitable pointer to the crankshaft front cover. The outer end of the pointer should extend over the top of the crankshaft pulley (or vibration damper).
9. Turn the crankshaft slowly in the direction of engine rotation until the indicator hand just stops moving. Continue turning the crankshaft until the indicator hand starts to move again.
10. Reset the dial to zero. Then turn the crankshaft until the indicator reading is .010".
11. Scribe a line on the crankshaft pulley (or vibration damper) in line with the end of the pointer.
12. Slowly turn the crankshaft opposite the direction of engine rotation until the indicator hand stops moving. Continue turning the crankshaft until the indicator hand starts to move again.
13. Reset the dial to zero. Then turn the crankshaft until the indicator reading is .010".
14. Scribe a second line on the vibration damper (or crankshaft pulley) in line with the end of the pointer.

Engine	* Indicator Reading		
	Correct	Retarded 1-Tooth	Advanced 1-Tooth
	Standard Timing		
6V, 8V, 12V 16V-71	.230"	.197"	.262"
6V-71 TA Coach	.204"	.171"	.237"
16V-71 (Front Cams)	.241"	.208"	.271"
	Advanced Timing		
6V, 8V, 12V, 16V-71	.262"	.230"	.289"
6V-71 TA Coach	.204"	.171"	.237"
16V-71 (Front Cams)	.271"	.241"	.300"
	California Engines		
†8V-71 TAE	.189"	.156"	.221"

*Indicator readings shown are nominal values. The allowable tolerance is ± .005 in.

†Beginning with 1977 engines.

TABLE 2

15. Scribe a third line half way between the first two lines. This is top dead center. Remove the indicator and rod from the engine.

    If the crankshaft pulley retaining bolt has loosened, tighten it to the specified torque (Section 1.3.7).

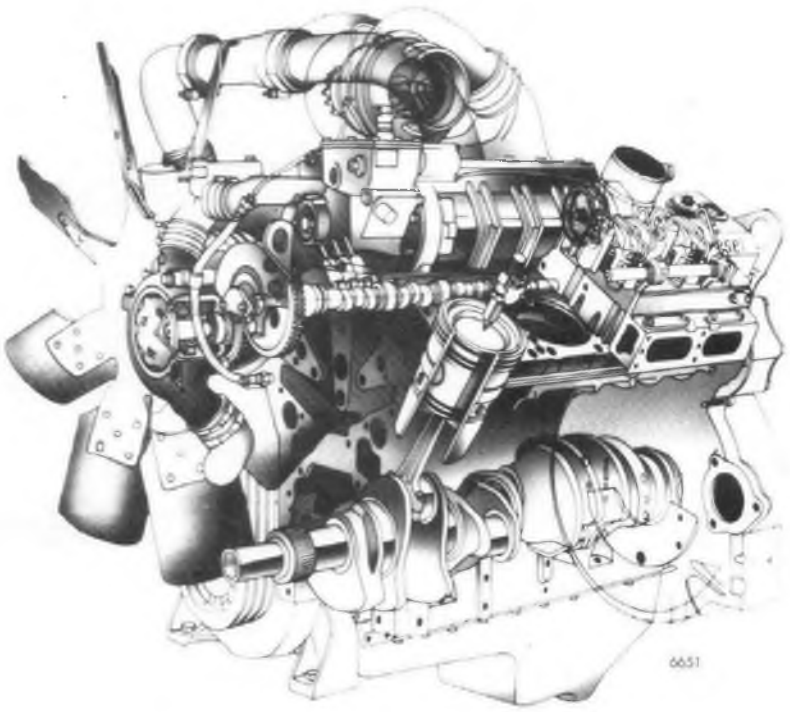
16. Install the injector as outlined in Section 2.1 or 2.1.1. Then refer to Section 14 and adjust the value clearance and time the injector.

17. Turn the crankshaft, in the direction of engine rotation, until the exhaust valves in the selected cylinder are completely open. Reinstall the dial indicator so the indicator spindle rests on top of the injector follower. Set the indicator dial on zero. Then turn the crankshaft slowly in the direction of engine rotation until the center mark on the pulley is in line with the pointer.

18. Note the indicator reading and compare it with the dimensions in Table 2.

19. After completing the timing check, remove the dial indicator. Also remove the pointer from the crankshaft front cover.

20. Install the valve rocker cover.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