

A 002 – CYLINDER DESIGNATION

Section	Page
Cylinder Designation	A -11
General Specifications	A -12

Cylinder Designation

See Figure 1 for designation of engine sides and cylinders.

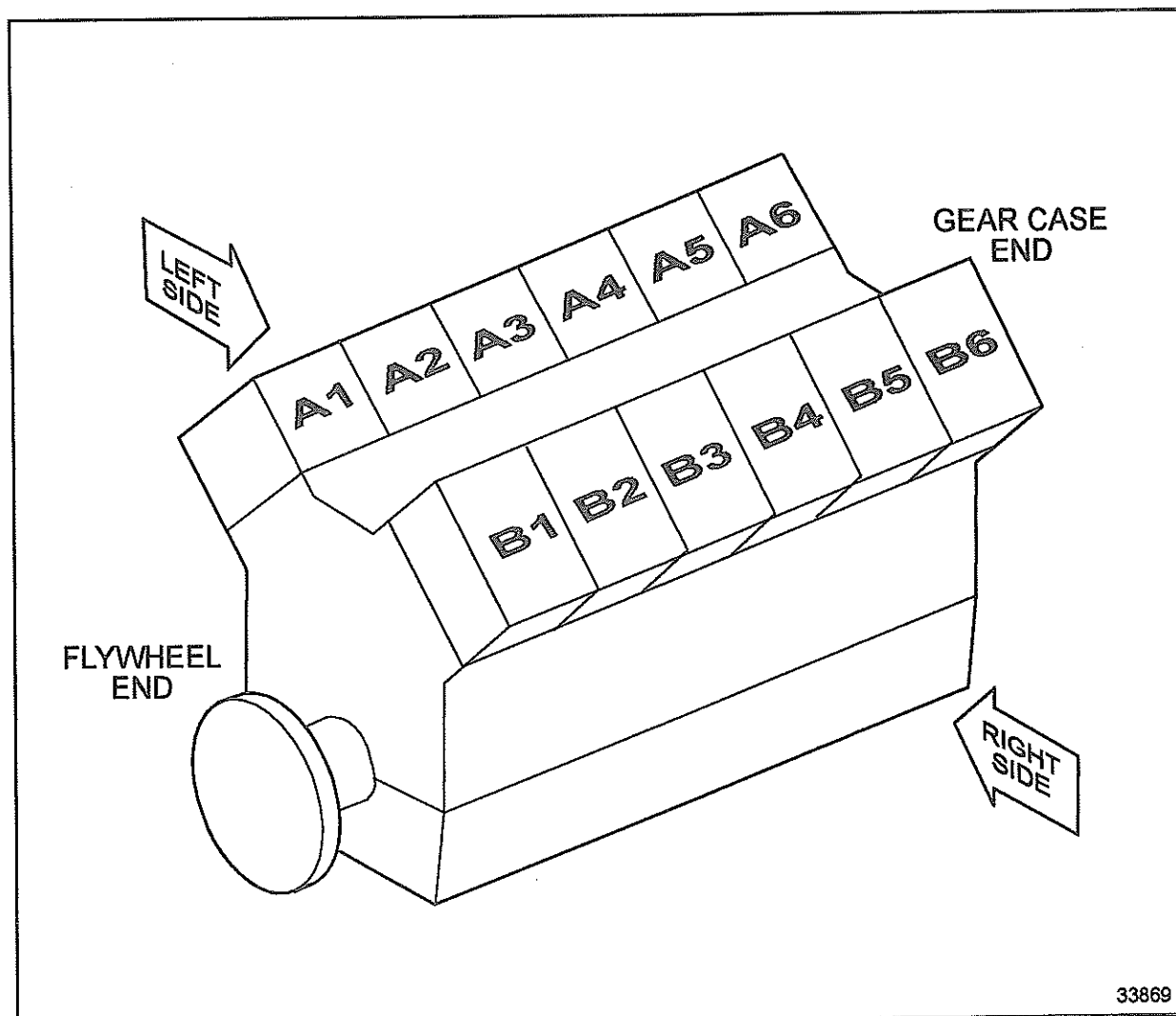


Figure 1 Cylinder Designation

- Engine side(s) are always designated as viewed from the rear (flywheel end).
- The cylinders on the left engine side are designated "A" and those of the right engine side "B" (as per DIN ISO 1204).
- Each cylinder bank is numbered consecutively from No. 1, starting at the rear of the block.
- Other components and assemblies are also numbered consecutively starting at No. 1 at the rear of the engine.

A 003 – TORQUE SPECIFICATIONS FOR BOLTS AND NUTS

Section	Page
Torque Specifications for Bolts and Nuts	A -15

Torque Specifications for Bolts and Nuts

Listed in Table 2 are the torque specifications for bolts and nuts for the cylinder block.

Description	Size	Category	Usage Description	Torque (Nm)
Bolt	—	A	ECM Strain Relief Comb	0.8-1.5
Bolt	M3	A	Injector Terminal	1.4-2.0
Bolt, Class 8.8	M6	A	Standard	9-10
Bolt, Class 8.8	M8	A	Standard	21-24
Bolt, Class 8.8	M10	A	Standard	42-47
Bolt, Class 8.8	M12	A	Standard	74-82
Bolt, Class 8.8	M14	A	Standard	115-127
Bolt, Class 8.8	M16	A	Standard	180-198
Bolt, Class 8.8	M18	A	Standard	250-275
Bolt, Class 8.8	M20	A	Standard	350-385
Bolt, Class 8.8	M22	A	Standard	480-528
Bolt, Class 9.8	M8	A	Standard	31-35
Bolt, Class 9.8	M10	A	Exhaust Outlet Mounting	42-47
Bolt, Class 10.9	M6	A	Standard	12-14
Bolt, Class 10.9	M8	A	Standard	31-35
Bolt, Class 10.9	M10	A	Standard	60-66
Bolt, Class 10.9	M10	A	Oil Pan/Block, Front 4 Bolts (Reference Category F)	60-66*
Bolt, Class 10.9	M10	A	Oil Pan/Block (Reference Category F)	30-33*
Bolt, Class 10.9	M12	A	Standard	100-110
Bolt, Class 10.9	M12	A	Standard	100-110
Bolt, Class 10.9	M12	A	Oil Pan to Gear Case (Reference Category F)	65-75*
Bolt, Class 10.9	M14	A	Standard	160-176
Bolt, Class 10.9	M16	A	Standard	250-275
Bolt, Class 10.9	M16	H	Flywheel/Flex Plate (Reference F and H)*	130 60 Degrees
Bolt, Class 10.9	M18	A	Standard	350-385
Bolt, Class 10.9	M18	A	Main Bearing Stabilizer (Reference Category F)*	80* 280*
Bolt, Class 10.9	M20	A	Standard	500-550
Bolt, Class 10.9	M20 X 1.5	H	Rod Joint (Reference Category F and H)*	240* 90 Degrees

Plug, Copper Washer in Steel/Cast Iron	M56 X 1.5	A	Standard	190-209
Plug, Copper Washer in Steel/Cast Iron	M64 X 1.5	A	Standard	205-226
Plug, Copper Washer in Aluminum	M10 X 1.0	A	Standard	15-17
Plug, Copper Washer in Aluminum	M12 X 1.5	A	Standard	25-28
Plug, Copper Washer in Aluminum	M14 X 1.5	A	Standard	25-28
Plug, Copper Washer in Aluminum	M16 X 1.5	A	Standard	30-33
Plug, Copper Washer in Aluminum	M18 X 1.5	A	Standard	35-39
Plug, Copper Washer in Aluminum	M20 X 1.5	A	Standard	45-50
Plug, Copper Washer in Aluminum	M22 X 1.5	A	Standard	50-55
Plug, Copper Washer in Aluminum	M24 X 1.5	A	Standard	60-66
Plug, Copper Washer in Aluminum	M26 X 1.5	A	Standard	70-77
Plug, Copper Washer in Aluminum	M27 X 2.0	A	Standard	70-77
Plug, Copper Washer in Aluminum	M30 X 1.5	A	Standard	90-99
Plug, Copper Washer in Aluminum	M30 X 2.0	A	Standard	85-94
Plug, Copper Washer in Aluminum	M33 x 2.0	A	Standard	110-121
Plug, Copper Washer in Aluminum	M36 X 1.5	A	Standard	115-127
Plug, Copper Washer in Aluminum	M38 X 1.5	A	Standard	120-132
Plug, Copper Washer in Aluminum	M42 X 1.5	A	Standard	130-143
Plug, Copper Washer in Aluminum	M45 X 1.5	A	Standard	140-154
Plug, Copper Washer in Aluminum	M48 X 1.5	A	Standard	145-160
Plug, Copper Washer in Aluminum	M52 X 1.5	A	Standard	150-165
Plug, Fitting, Sensor - ISO 6149	M10 X 1.0	A	Standard	10-12

Clamp	—	C	Turbo Compressor V-Band Clamp* (F)	12.4-14.7
Clamp	—	C	Turbo Turbine V-Band Clamp* (F)	
Nut - Hex Jam	1 - 14	A	Nut to Isolator Washer	603 - 617
Nut	M10	A	Turbo Mounting (Dry Exhaust)	60 - 66
Nut	M12	B	Nut, Gear Case to Block Joint	110-120*
Nut	M16 X 1.5	A	Valve Bridge and Rocker Arm Nut*	90-100
Nut	M24 X 2.0	E	Main Bearing Cap (Reference Category F and H)*	**
Stud	M10	A	Stud Installation, Turbo Oil Drain Flange	10-15
Stud	M12	A	Stud Installation, Gear Case/Block Joint	10-15
Stud	M24 X 2.0	A	Main Bearing Cap Stud	80-90
Fuel Line	M24 X 1.5	C	Nut, High-Pressure Fuel Lines (Reference Category F)*	10-110*
Fuel Line	M40 X 1.5	C	Nut, High-Pressure Fuel Lines (Reference Category F)*	100-110*
Fuel Line	M42 X 1.5	A	Fuel Rail Nut	550-605

* Additional information in assembly drawing referenced in the respective UPC group.

** Main bearing cap stud stretching detailed in assembly referenced in 6A1 Group.

Category A — Load within design capability. Process verification controlled by correct tooling. Verification — to minimum torque value.

Category B — Load required at or near yield. Process controlled by special torque equipment or process. Verification — to minimum torque value.

Category C — Load required sensitive to both low and high values. Process controlled by special torque equipment or process. Verification — to given range of torque values.

Category D — Load at yield. Process controlled by special torque equipment or process. Fasteners require lubricant 7Y2 or equivalent. Verification — to minimum torque value.

Category E — Load, both high and low critical. Process controlled by special torque equipment. Verification — to equipment capability.

Category F — Joint sensitive to torque sequence. See engine build instructions.

Category G — Gasket eliminator used as a sealant. Joint sensitive to bolt removal.

Category H — Critical joint. Torque plus angle required.

Table 2 Fastener Torque Specifications

NOTE:

Torque specification does not apply to hot engines. Re-check of torque at room temperature to be not less than 90 percent of minimum assembly values.

A 004 - SETTINGS

Section	Page
Firing Order	A -23
Direction of Rotation	A -23
Valve Clearance with Engine Cold	A -23
Valve Timing	A -24
Camshaft and Valve Lift	A -24

Firing Order

- 8V: A1-B4-A4-A2-B3-A3-B2-B1
- 12V: A1 - B2 - A5 - B4- A3 - B1 - A6 - B5 - A2 - B3 - A4 - B6
- 16V: A1 - A7 - B4 - B6 - A4 - B8 - A2 - A8 - B3 - B5 - A3 - A5 -B2 - A6 - B1 - B7

Direction of Rotation

Listed in Table 3 are the directions of rotation when viewed towards the flywheel end.

Component Description	Direction
Crankshaft	Counterclockwise
Camshaft	Clockwise
High-Pressure Fuel Pump	Counterclockwise
Oil Pump	Counterclockwise
Engine Coolant Pump	Counterclockwise
Charge Air Coolant Pump	Counterclockwise
Air Conditioner Compressor	Counterclockwise

Table 3 Direction of Rotation

Valve Clearance with Engine Cold

Listed in Table 4 are the valve clearances with engine cold, 20°C (68°F.)

Component Description	Dimension
Inlet	0.20 mm (0.008 in.)
Exhaust	0.50 mm (0.02 in.)

Table 4 Valve Clearance

A 006 – GENERAL DESCRIPTION OF SERIES 4000 OPERATION

Section	Page
General Description of Series 4000 Operation	A -41

General Description of Series 4000 Operation

The Series 4000 Diesel Engine is a four stroke, direct injected engine. The engine is available in 8V, 12V, or 16V configurations, ranging from 850 to 2700 hp (634–2013 kW). The Series 4000 is the result of a strategic partnership between MTU Motoren-und Turbinen-Union (MTU) and Detroit Diesel Corporation (DDC) to design, produce and distribute an engine for applications requiring 850–2700 hp (634–2013 kW).

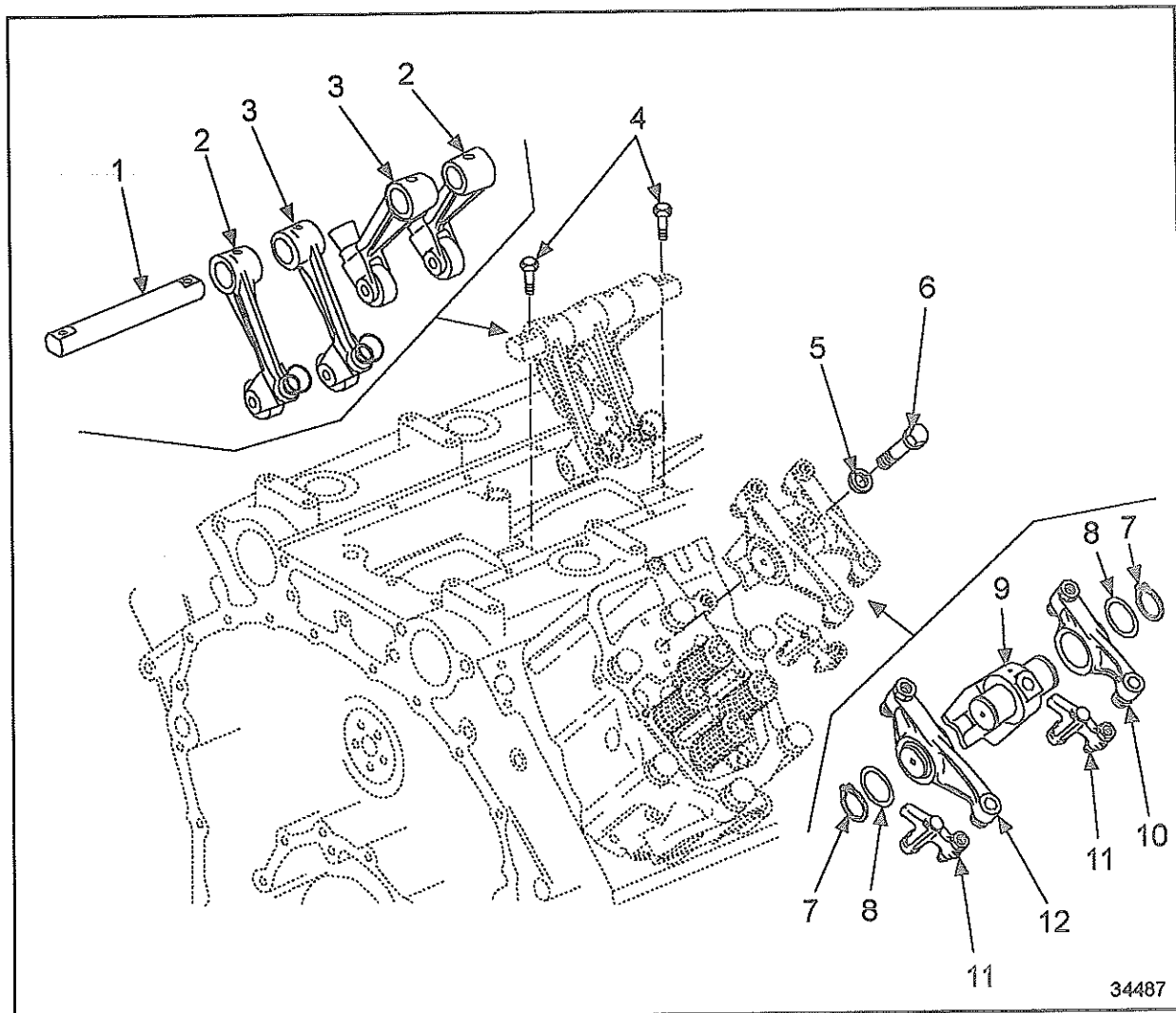
Vital features of the Series 4000 include:

- Electronic engine control through the Detroit Diesel Electronic Control (DDEC®) IV System
- A common rail fuel injection system
- A single casting cylinder block
- Individual cylinder liners
- Individual cylinder heads

The *Series 4000 Application and Installation* manual, is a compilation of the installation drawings, component sketches and technical information required for proper application and installation of the engine.

C 055.05.01 – GENERAL VIEW

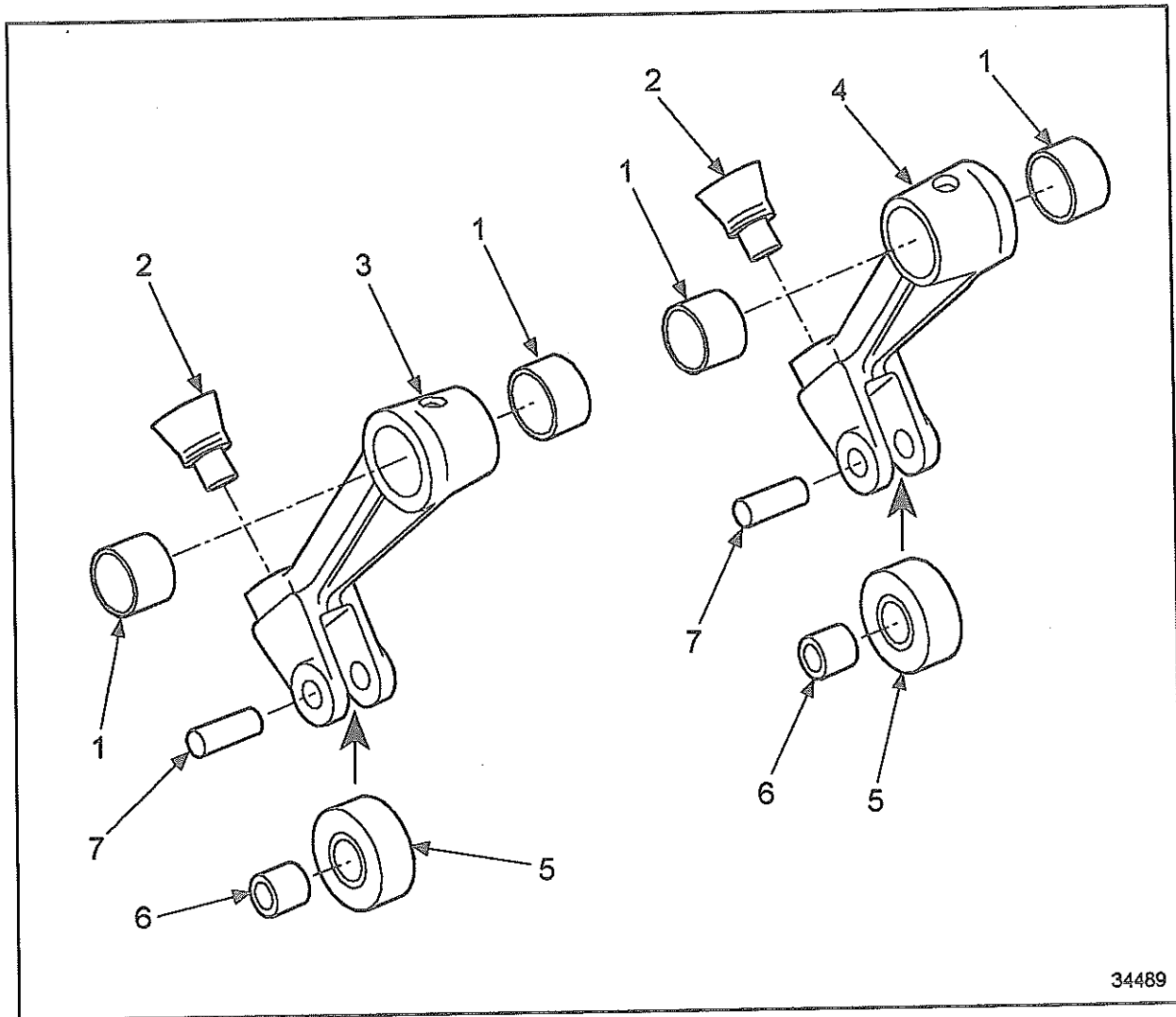
See Figure 451 for a general view of valve operating mechanism.



- | | |
|-----------------------|-------------------------|
| 1. Swing Shaft | 7. Snap Ring |
| 2. Swing Arm, Intake | 8. Adjusting Shim |
| 3. Swing Arm, Exhaust | 9. Rocker Shaft Bracket |
| 4. Hex Bolt | 10. Rocker Arm, Exhaust |
| 5. Washer | 11. Valve Bridge |
| 6. Rocker Bolt | 12. Rocker Arm, Intake |

Figure 451 Valve Operating Mechanism

See Figure 453 for a general view of swing arm.



- | | |
|------------------------|------------|
| 1. Bushing | 5. Roller |
| 2. Ball Socket | 6. Bushing |
| 3. Roller Arm, Exhaust | 7. Pin |
| 4. Roller Arm Intake | |


Figure 453 Swing Arm

C 055.05.02 – SPECIAL TOOLS

Listed in Table 48 are the special tools required for maintenance on the valve drive.

Application	Number
Valve clearance adjustment gage 0.2 mm/0.5 mm	—
Allen key, 8 A/F, for valve clearance adjustment	—
Engine barring tool	—

Table 48 Special Tools

	CAUTION:
<p>To avoid personal injury when barring the engine over, stand clear so that the crankshaft will not unexpectedly rotate and cause loss of control of barring tool.</p>	

29. Using the barring tool, set piston of cylinder to be checked to firing TDC. See Figure 482.

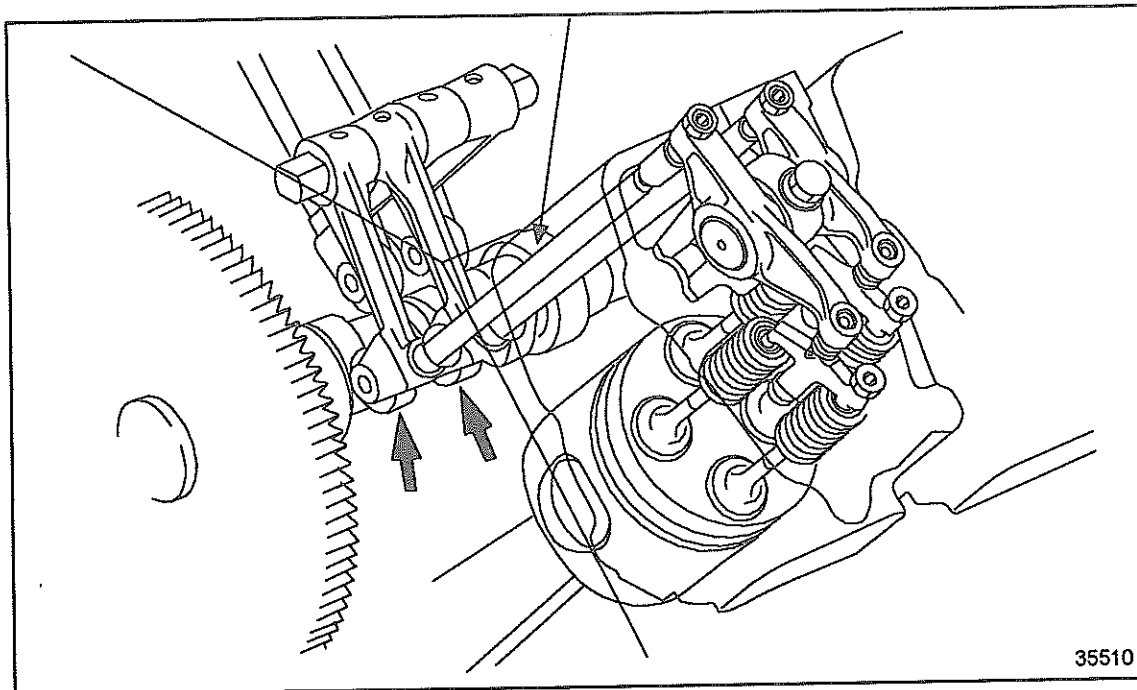


Figure 482 Position of Swing Arm Rollers at Firing TDC

NOTE:

At firing TDC, both rollers of swing arm of respective cylinder are in base circle (arrow) of camshaft.

Adjusting Valve Clearance in Two Crankshaft Positions

Perform the following steps to adjust valve clearance in two crankshaft positions:

1. If swing arms on cylinder A1 are unloaded, the piston is in firing TDC. See Figure 484.

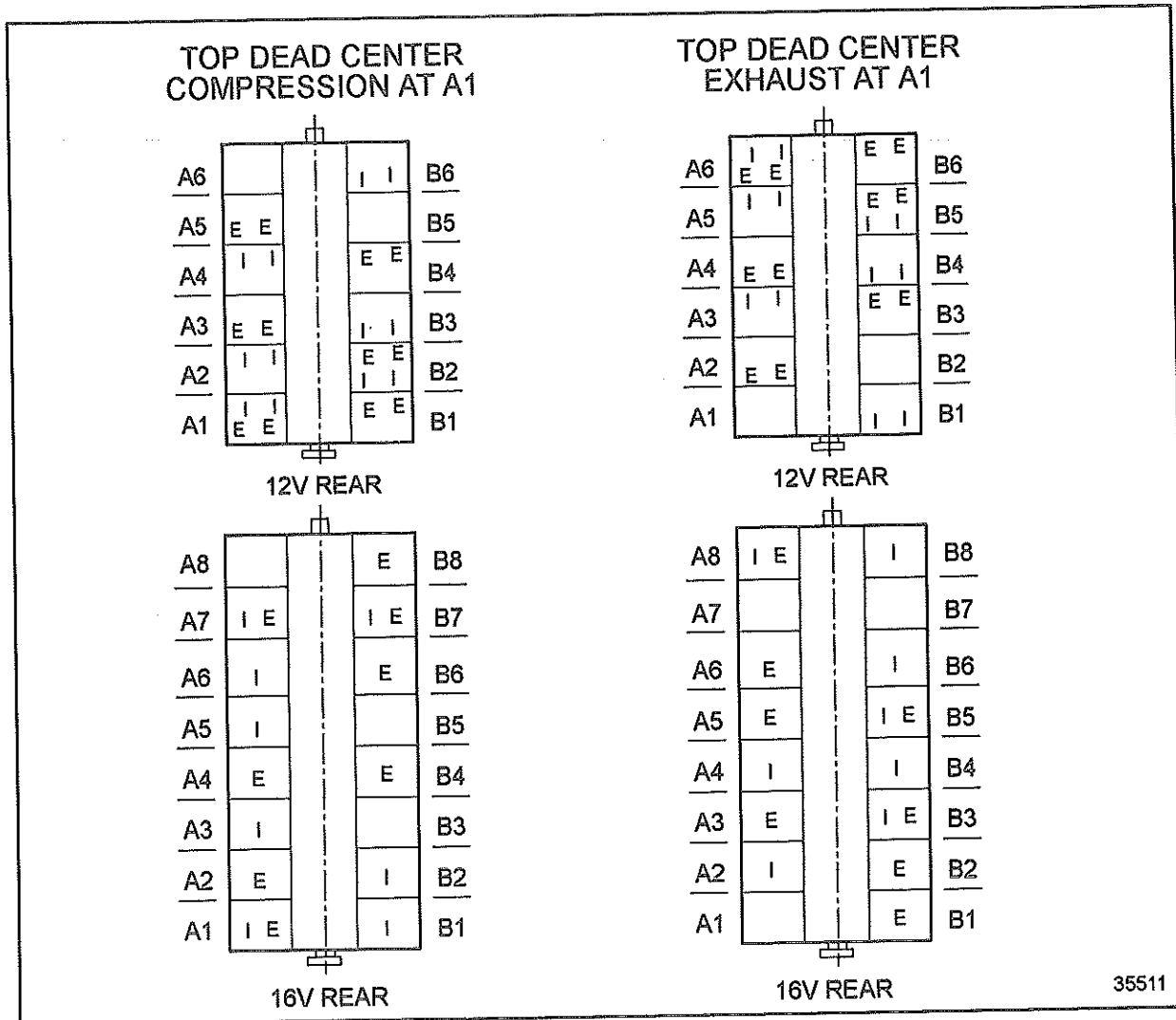


Figure 484 Adjusting Valve Clearance in Two Crankshaft Positions

2. If swing arms on cylinder A1 are loaded, the piston is in overlap TDC.
3. Check all valve clearances at two crankshaft positions (firing TDC and overlap TDC, cylinder A1) in accordance with Figure .
4. Turn crankshaft in direction of engine rotation.
5. 1 = Firing TDC at cylinder A1; 2 = Overlap TDC at cylinder A1; X = Exhaust value; 0 = Inlet valve.

Inspecting Valve Clearance in Two Positions

Perform the following steps to inspect valve clearance in two crankshaft positions:

1. If swing arms on cylinder A1 are unloaded, the piston is in firing TDC. See Figure 486.

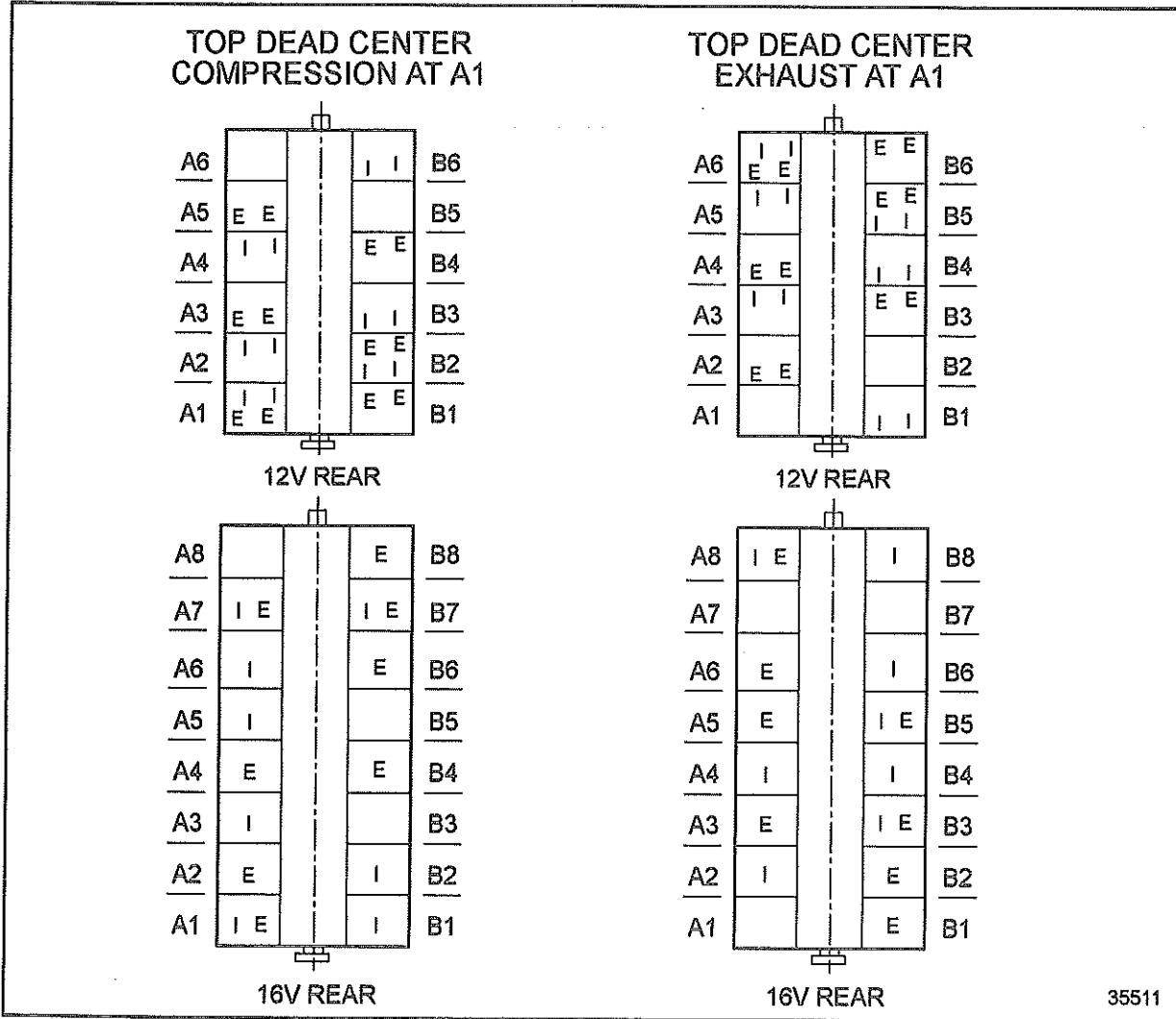
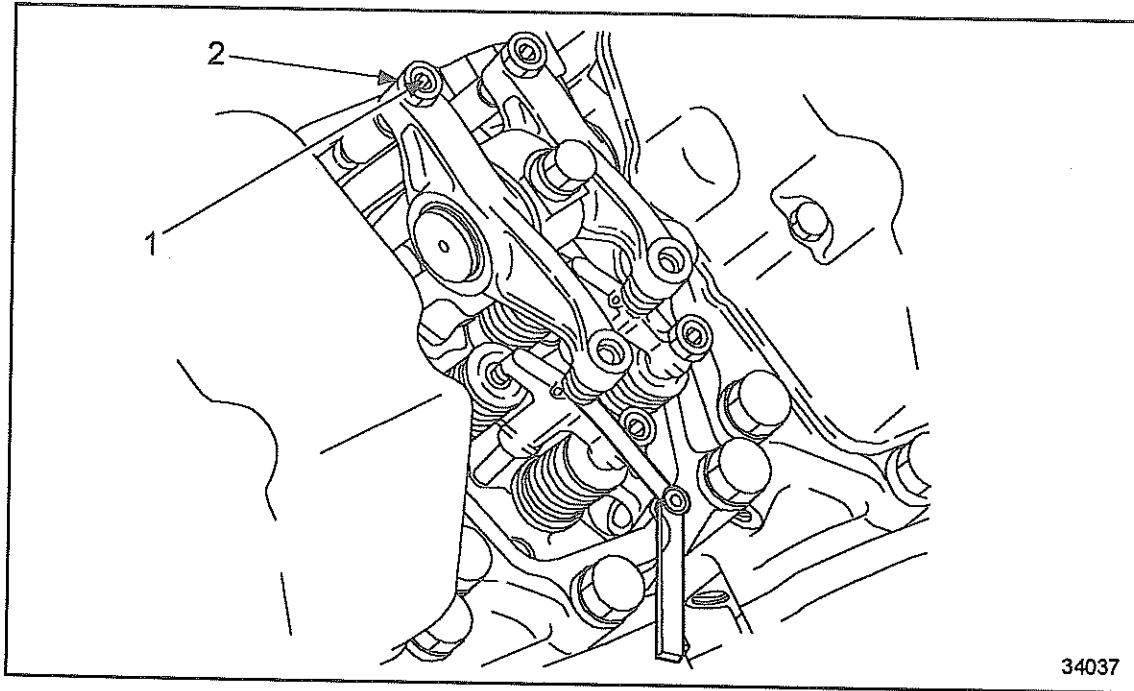


Figure 486 Inspecting Valve Clearance in Two Crankshaft Positions

9. If deviation from specified value is more than 0.1 mm, adjust valve clearance.
10. Release locknut (1) and readjust adjusting bolt (2) with Allen key until feeler gage can be pulled through. See Figure 488.



1. Locknut

2. Adjusting Bolt

Figure 488 **Readjusting Adjusting Bolt**

11. Valve clearance on inlet valve (long swing arm) = 0.2 mm (cold engine).
12. Valve clearance on exhaust valve (short swing arm) = 0.5 mm (cold engine).
13. Holding adjusting bolt firmly, again tighten locknut to specified torque.
14. For tightening torque, refer to section A 003.
15. Again check valve clearance.