TABLE OF CONTENTS

SECTION TITLE	PAGE

SECTION 01 - Engine Service - General

SUBJECT	PAGE

DESCRIPTION

Introduction

This section covers various engine tests, adjustments, service procedures and cleaning/inspection procedures. Engine assembly and service specifications appear at the end of Section 02.

For engine disassembly, assembly, installation, adjustment procedures and specifications, refer to Section 02.

Most Ford Power Product engines incorporate a closed-type crankcase ventilation system. Other than the crankcase ventilation system there are no exhaust emission controls or engine/emission control systems used with industrial versions of these engines.

To maintain the required performance level, the fuel system, ignition system and engine must be kept in good operating condition and meet recommended adjustment specifications.

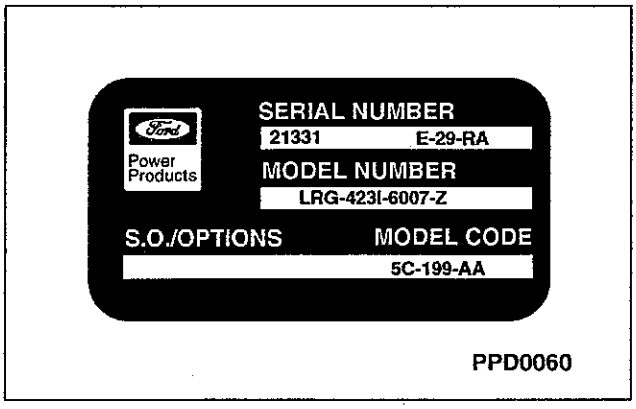
Before replacing damaged or worn engine components such as the crankshaft, cylinder head, valve guide, valves, camshaft or cylinder block, make sure part(s) is not serviceable.

WARNING: TO AVOID THE POSSIBILITY OF PERSONAL INJURY OR DAMAGE, DO NOT OPERATE THE ENGINE UNTIL THE FAN BLADE HAS FIRST BEEN EXAMINED FOR POSSIBLE CRACKS OR SEPARATION.

CAUTION: Use of abrasive grinding discs to remove gasket material from the engine sealing surfaces during repair procedures can contribute to engine damage and wear. Airborne debris and abrasive grit from the grinding disc may enter the engine through exposed cavities causing premature wear and eventual engine damage.

Ford Power Products does not recommend using abrasive grinding discs to remove engine gasket material. Use manual gasket scrapers for removing gasket material from the engine sealing surfaces.

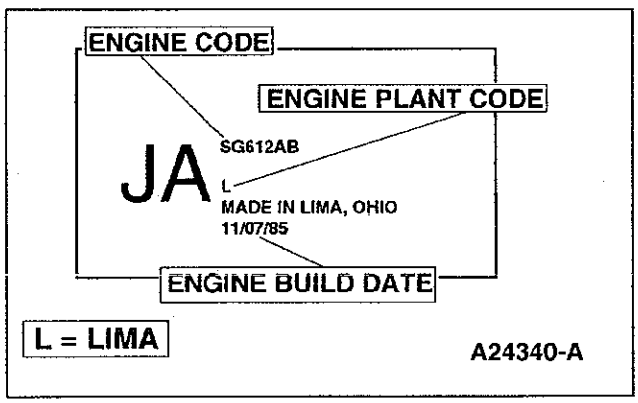
Take added care to prevent scratching or gouging aluminum sealing surfaces.



Engine Identification Nameplate

For quick engine identification, refer to the Engine Identification Nameplate. The nameplate lists engine information required for proper servicing of the engine. The Engine Identification Nameplate and identification label provide information pertaining to engine displacement, serial number, model number, S.O./Options, and model code.

An engine code decal is attached to the engine front cover. The symbol code on the decal identifies each engine for determining parts usage.



DIAGNOSIS

Inspection

Inspect to determine if any of the following mechanical concerns apply:

- Engine oil leaks.
- Damaged and/or severely worn parts.
- Loose mounting bolts, studs and nuts.

CONDITION	POSSIBLE SOURCE	ACTION
DIFFICULT STARTING	• Burnt valve. • Worn piston. • Worn piston ring(s). • Worn cylinder. • Damaged cylinder head gasket. • Malfunctioning or damaged fuel system. • Malfunctioning or damaged ignition system.	• Replace valve. • Replace piston. • Replace piston ring(s). • Service or replace cylinder block. • Replace cylinder head gasket. • Refer to section on fuel system. • Refer to section on ignition system.
POOR IDLING	• Damaged hydraulic valve tappet. • Damaged hydraulic valve tappet guide. • Improper valve to valve seat contact. • Damaged cylinder head gasket. • Malfunctioning or damaged fuel system. • Malfunctioning or damaged ignition system.	• Replace hydraulic valve tappet. • Replace hydraulic valve tappet guide. • Replace valve and/or valve seat. • Replace cylinder head gasket. • Refer to section on Fuel system. • Refer to section on ignition system.
ABNORMAL COMBUSTION	• Damaged hydraulic valve tappet. • Damaged hydraulic valve tappet bore. • Burnt or sticking valve. • Weak or broken valve spring. • Carbon accumulation in combustion chamber. • Malfunctioning or damaged fuel system. • Malfunctioning or damaged ignition system.	• Replace hydraulic valve tappet. • Replace cylinder block. • Service or replace valve. • Replace valve spring. • Eliminate carbon buildup. • Refer to section on fuel system. • Refer to section on ignition system.
EXCESSIVE OIL CONSUMPTION	• Worn piston ring groove. • Sticking piston ring(s). • Worn piston or cylinder. • Worn valve stem seal. • Worn valve stem or valve guides. • Leaking oil. • Worn piston rings. • Plugged pcv system.	• Replace piston. • Service or replace piston ring (s). • Service or replace piston or cylinder block. • Replace valve stem seal. • Replace valve stem and guide. • Service oil leak. • Replace piston rings. • Service PCV system.

CONDITION	POSSIBLE SOURCE	ACTION
ENGINE NOISE	• Excessive main bearing oil clearance.	• Adjust clearance or replace crankshaft main bearing.
	• Seized or heat damaged crankshaft main bearing.	• Replace crankshaft main bearing.
	• Excessive crankshaft end play.	• Adjust end play or replace crankshaft.
	• Excessive connecting rod bearing oil clearance.	• Adjust clearance or replace connecting rod.
	• Heat damaged connecting rod bearing.	• Replace connecting rod bearing.
	• Damaged connecting rod bushing.	• Replace connecting rod bushing.
	• Worn cylinder.	• Service or replace cylinder block.
	• Worn piston or piston pin.	• Replace piston or piston pin.
	• Damaged piston ring(s).	• Replace piston ring(s).
	• Bent connecting rod.	• Replace connecting rod.
	• Malfunctioning hydraulic valve tappet.	• Replace hydraulic valve tappet.
	• Excessive hydraulic valve tappet clearance.	• Adjust clearance or replace hydraulic valve tappet.
	• Broken valve spring.	• Replace valve spring.
	• Excessive valve guide clearance.	• Service clearance or replace valve guide/stem.
	• Malfunctioning or damaged cooling system.	• Refer to section on cooling system.
	• Malfunctioning or damaged fuel system.	• Refer to section on fuel system.
	• Leaking exhaust system.	• Service exhaust leakage.
	• Improper drive belt tension.	• Refer to section on accessory drivebelts.
	• Malfunctioning generator bearing.	• Refer to section on charging system.
	• Loose riming belt.	• Adjust or replace timing belt.
	• Damaged timing belt tensioner.	• Replace timing belt tensioner.
	• Malfunctioning water pump bearing.	• Refer to section on cooling system.
INSUFFICIENT POWER	• Malfunctioning hydraulic valve tappet.	• Replace hydraulic valve tappet.
	• Damaged hydraulic valve tappet bore.	• Replace cylinder block.
	• Seized valve stem.	• Service or replace valve, valve seat and/or cylinder head.
	• Weak or broken valve spring.	• Replace valve spring.
	• Damaged cylinder head gasket.	• Replace cylinder head gasket.
	• Cracked or distorted cylinder head.	• Replace cylinder head.
	• Damaged, worn or sticking piston ring(s).	• Service or replace piston ring(s).
	• Worn or damaged piston.	• Replace piston.
	• Malfunctioning or damaged fuel system.	• Refer to section on fuel system.
	• Malfunctioning or damaged ignition system.	• Refer to section on ignition system.

PCV System Malfunction

A malfunctioning Positive Crankcase Ventilation System (closed type) may be indicated by loping or rough engine idle. Do not attempt to compensate for this idle condition by disconnecting the crankcase ventilation system and making an air bypass or idle speed adjustment. **The removal of the crankcase ventilation system from the engine will adversely affect fuel economy and engine crankcase ventilation with resultant shortening of engine life.**

Engine Oil Leak Check

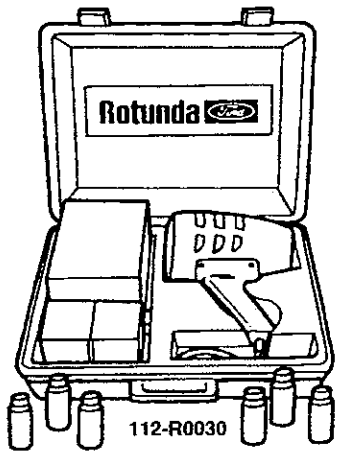
When diagnosing engine oil leaks, it is important that the source and location of the leak be positively identified prior to service.

NOTE: Due to their remote location, rear engine oil leaks may be very difficult to pinpoint. This area is also very difficult to clean. Make sure to eliminate all other possibilities before removing the engine to repair a suspected leak in this area.

There are two methods of diagnosing engine oil leaks. The following procedure has been found to be very effective and requires only a minimum of equipment. Prior to using this procedure, it is important to clean the cylinder block, cylinder heads, valve covers, oil pan and flywheel housing areas with a suitable solvent to remove all traces of oil.

Fluorescent Oil Additive Method

To perform oil leak diagnosis using Rotunda Oil Leak Detector Kit 112-R0030, or equivalent, perform the following procedure.



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1. Clean engine with a suitable solvent to remove all traces of oil.
2. Drain engine oil from crankcase and refill with recommended oil, premixed with Rotunda Fluorescent Oil Additive 112-R0015, or equivalent. Use 29.6ml (1 fluid once) of fluorescent additive. If oil is not premixed, fluorescent additive must be added to crankcase first.
3. Run engine for 15 minutes. Stop engine and inspect all seal and gasket areas for leaks using Rotunda Oil Leak Detector Y112-R0021 (part of 112-R0030 kit) Lamp or equivalent. A clear bright yellow or orange area will identify leak. For extremely small leaks, several hours may be required for the leak to appear.
4. If necessary, pressurize main oil gallery system to locate leaks due to improperly sealed, loose or cocked plugs. If flywheel bolts leak oil, look for sealer on threads.
5. Service all leaks as required.

Pressure Method

As an alternative testing procedure, the crankcase can be pressurized, not to exceed 27 kPa (4 psi), to locate oil leaks. The following materials are required to fabricate the tool to be used:

- Air supply and air hose.
- Air pressure gauge that registers pressure in increments of one psi.
- Air line shutoff valve.
- Appropriate fittings to attach the above parts to oil fill, PCV grommet holes and PCV fresh air hose tube.
- Appropriate plugs to seal any openings leading to crankcase.
- A solution of liquid detergent and water to be applied with a suitable type applicator such as a squirt bottle or brush.

Fabricate the air supply hose to include the air line shutoff valve and the appropriate adapter to permit the air to enter the engine through the rocker arm cover tube. Fabricate the air pressure gauge to a suitable adapter for installation on the engine at the oil fill opening.

CAUTION: Use extreme caution when pressurizing crankcase. Applying air pressure above specified pressure risks damage to seals, gaskets and core plugs. Under no circumstances should pressure be allowed to exceed 27 kPa (4 psi).

1. Open air supply valve until pressure gauge maintains 20 kPa (3 psi).
2. Inspect sealed and/or gasketed areas for leaks by applying a solution of liquid detergent and water over areas for formation of bubbles, which indicates leakage.
3. Examine the following areas for oil leakage:

- Rocker cover sealant or gaskets
- Intake manifold gaskets/end seals
- Cylinder head gaskets
- Oil bypass filter
- Oil level indicator (dipstick) tube connection
- Oil pressure sensor
- Cup plugs and/or pipe plugs at end of oil passages
- Oil pan gasket
- Oil pan front and rear end seals
- Oil pan front and rear end seals
- Crankshaft front seal
- Crankshaft rear oil seal
- Oil pump
- Crankshaft rear oil seal

Air leakage in area around a crankshaft rear oil seal does not necessarily indicate a rear seal leak. However, if no other cause can be found for oil leakage, it can be assumed that rear seal is the cause of the oil leakage:

- Rear main bearing cap parting line.
- Rear main bearing cap and seals.
- Flywheel mounting bolt holes.
- Rear cup plugs and/or pipe plugs at the end of oil passages.

Oil leaks at crimped seams in sheet metal parts and cracks in cast or stamped parts can be detected when pressurizing the crankcase.

Light foaming equally around rocker arm cover bolts and crankshaft seals is not detrimental and no corrections are required in such cases.

Compression Test

1. Make sure oil in crankcase is of the correct viscosity and at proper level, and battery is properly charged. Operate the engine until it is at normal operating temperature. Turn off ignition switch, then remove all spark plugs .
2. Set throttle plates in wide-open position.
3. Install a compression gauge such as Rotunda Compression Tester 059-R0009, or equivalent, in No. 1 cylinder.
4. Install an auxiliary starter switch in staring circuit. With ignition switching the OFF position, and using auxiliary starter switch, crank engine at least five compression strokes and record highest reading. Note the approximate number of compression strokes required to obtain the highest reading.
5. Repeat test on each cylinder, cranking the engine approximately the same number of compression strokes.

The indicated compression pressures are considered within specification if the lowest reading cylinder is within 75 percent of the highest (refer to chart).

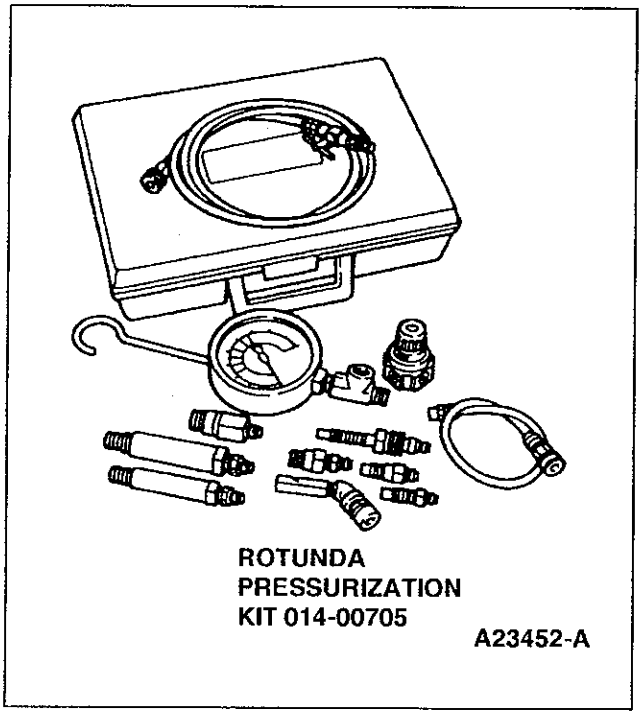
If one or more cylinders reads low, squirt approximately one tablespoon of SAE 50 weight, or equivalent, engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

1. If compression improves considerably, piston rings are at fault.
2. If compression does not improve, valves are sticking or seating poorly.
3. If two adjacent cylinders indicate low compression pressures and squirting oil on pistons does not increase compression, cause may be a cylinder head gasket leak between cylinders. Engine oil and/or coolant in cylinders could result from this problem.

Example Readings

If, after checking the compression pressures in all cylinders, it was found that the highest reading obtained was 1351 kPa (196 psi) and the lowest pressure reading was 1069 kPa (155 psi), the engine is within specification and the compression is considered satisfactory.

Compression Pressure Limit Chart (MAX - MIN)			
134 - 101	136 - 102	138 - 104	140 - 105
142 - 107	144 - 108	146 - 110	148 - 111
150 - 113	152 - 114	154 - 115	156 - 117
158 - 118	160 - 120	162 - 121	164 - 123
166 - 124	168 - 126	170 - 127	172 - 129
174 - 131	176 - 132	178 - 133	180 - 135
182 - 136	184 - 138	186 - 140	188 - 141
190 - 142	192 - 144	194 - 145	196 - 147
198 - 148	200 - 150	202 - 151	204 - 153
206 - 154	208 - 156	210 - 157	212 - 158
214 - 160	216 - 162	218 - 163	220 - 165
222 - 166	224 - 168	226 - 169	228 - 171
230 - 172	232 - 174	234 - 175	236 - 177
238 - 178	240 - 180	242 - 181	244 - 183
246 - 184	248 - 186	250 - 187	



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PRESSURIZATION
KIT 014-00705
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Cylinder Leakage Test

When a cylinder produces a low reading, the use of Rotunda Pressurization Kit 014-00705, or equivalent, will be helpful in pinpointing the exact cause.

The leakage detector is inserted in the spark plug hole, the piston is brought up to top dead center on the compression stroke, and compressed air is admitted.

Once the combustion chamber is pressurized, a special gauge will read the percentage of leakage. Leakage exceeding 20 percent is considered excessive.

While the air pressure is retained in the cylinder, listen for the hiss of escaping air. A leak by the intake valve will be audible in the carburetor. A leak by the exhaust valve can be head at the exhaust pipe. Leakage past the rings will be audible at the positive crankcase ventilation (PCV) connection. If air is passing through a blown gasket to an adjacent cylinder, the noise will be evident at the spark plug hole of the cylinder block, or gasket leakage into the cooling system may be detected by a stream of bubbles in the radiator.

Oil Leak and Valve Guide Seal Test

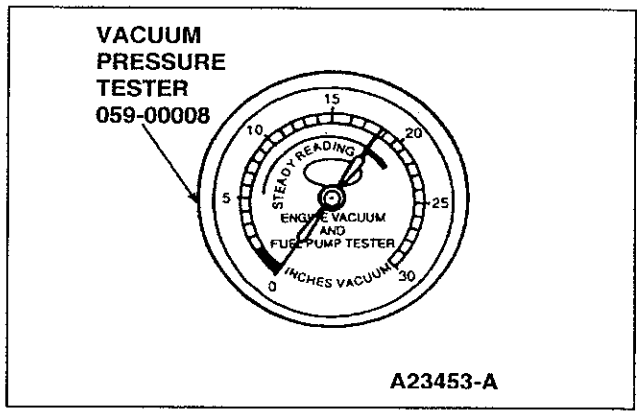
The cylinder leakage detector can be used to test for engine oil leaks and to check the valve seals for leakage.

1. Plug all crankcase openings except the one used for connecting the leakage detector.
2. Connect the detector to a crankcase opening. The oil level indicator tube is convenient. Adjust the air pressure to approximately 34 kPa (5 psi).
3. Using a solution of liquid soap and water, brush the solution along the gasket sealing surfaces and bearing seals. Look for bubbles or foam.
4. Remove the spark plugs and rotate the engine slowly with a wrench. Check for large amounts of air escaping into the cylinders as each intake and exhaust valve opens.

The spark plugs on the leaking cylinders will probably show deposits of burned oil.

Intake Manifold Vacuum Test

Bring the engine to normal operating temperature. Connect Rotunda Vacuum/Pressure Tester 059-00008, or equivalent, to the intake manifold. Run the engine at the specified idle speed.



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The vacuum gauge should read between -51 and -74 kPa (15 and 22 in-Hg) depending upon the engine condition and the altitude at which the test is performed.

Subtract 5.5 kpa from the specified reading for every 500 meters (1 in-hg for every 1,000 feet) of elevation above sea level.