PART 14
MODEL DERIVATIVES

Chapter 6

FORD 3430, 3930, 4630 AND 5030 TRACTORS (1994 UPGRADE FOR NASO ONLY)

Tractors Built After June 1st 1994

A. INTRODUCTION

A number of significant improvements have been made to the 3 cylinder Series 30 range of tractors. The improvements that require Repair Manual information are detailed in this Chapter under the headings above. There are changes to the Engine and Fuel Systems, the Electrical System, transmission lever shuttle linkage and hydraulic lift linkage. Only the changes within the different systems will be detailed and where an item has already been documented in the Repair Manual, for another model, the relevant Part, Chapter and Section will be referenced, to save duplication.

B. ENGINE SYSTEMS

Models, 3430, 3930 and 4630, (3 cylinder engines) incorporate a number of improvements to provide the following benefits:

- improved fuel efficiency
- quieter operation
- more reliable and durable performance

The Model 5030 uses a DPS injection pump and service procedures from the PowerStar Service manual #40564060 should be used.

Principal areas of change include cylinder head and valves, pistons, inlet manifolds, turbocharger (4630 model only), exhaust manifold for turbocharged model, oil pump for turbocharged model and new fuel pumps with revised fuelling and electric shut off, activated from the key start switch. The following table details the new engine specifications:

Model	Capacity	Asp.	Power (SAE)	Rated Speed	Changes
3430	192CID	Nat.	49hp	2200	+2hp and Rated Speed
3930	192CID	Nat.	53hp	2200	192CID and Rated Speed
4630	192CID	Turbo	63hp	2200	192CID + Turbo
5030	256CID	Nat.	62hp	2200	

The following sub–headings fully describe these changes.

Cylinder Head and Valves

A new cylinder head casting is used and includes the following detail:

- Larger inlet ports feature a snail shell form which swirls inducted air, Figure 1, improving the air/fuel mixing and the resultant quality of combustion. This single change contributes to a major improvement in performance and fuel efficiency.

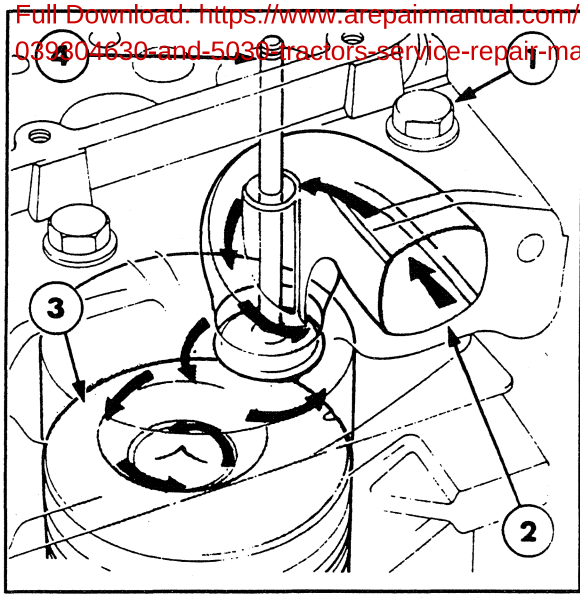

Figure 1
Cylinder Head Inlet Port

1. Head Bolt
2. Inlet Port
3. Piston
4. Inlet Valve

- The inlet valves and valve seats have a revised 29.5° face angle and a 30° seat angle respectively. The exhaust valves and valve seats are unchanged at 44.5° face angle and a 45° seat angle respectively. The inlet and exhaust valves/seats are common to both normally aspirated and turbocharged engines.

- The Turbocharged engine incorporates heavy duty rocker shafts.

Engine Cylinder Block

The engine cylinder block of the turbocharged engine has been modified to accept oil jets, Figure 2, fed from the main bearing journals, to provide under piston cooling/additional lubrication.

Manifolds

New Intake manifolds have been introduced for all engines to provide correct alignment with the new cylinder head ports. A new exhaust manifold has been introduced for the turbocharged engine.

Pistons

New piston assemblies having a different combustion bowl configuration are used in all engines. The new piston, shown in Figure 3, is described as a 'Mexican Hat' type, due to the raised section in the middle of the bowl, The normally aspirated engine piston differs from the turbo piston in that it does not have an insert in the top of the piston. The new configuration aids the swirl of the inducted air from the cylinder head, improving fuel/air mixing.

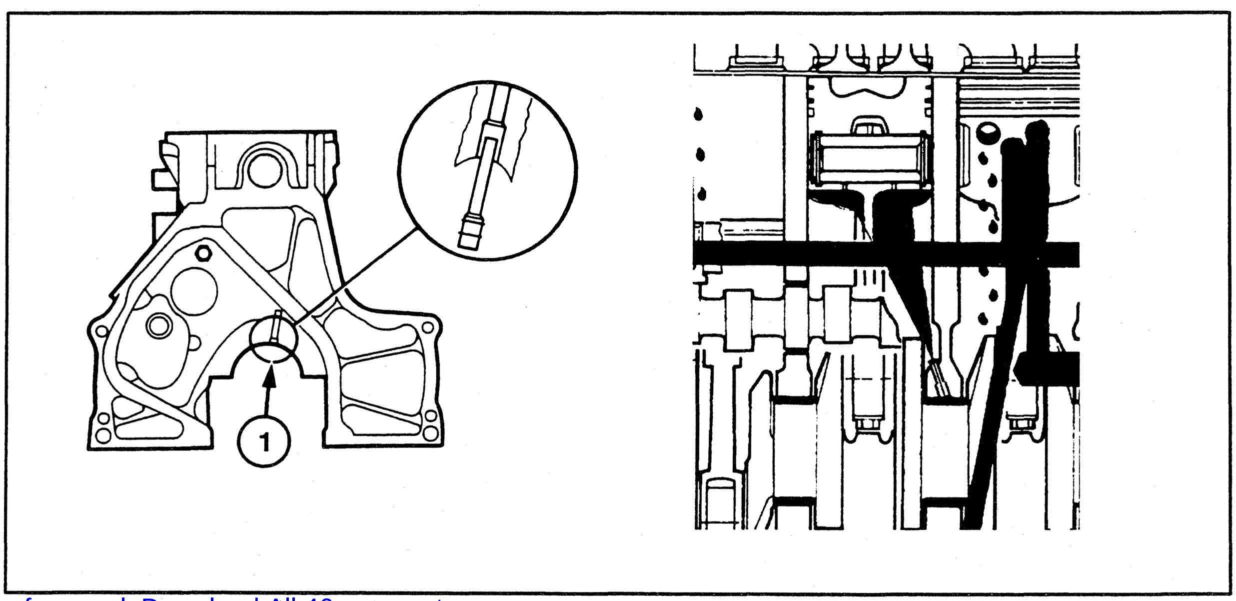

Figure 2
Piston Cooling Oil Jet

1. Replaceable oil Jet – 3 off

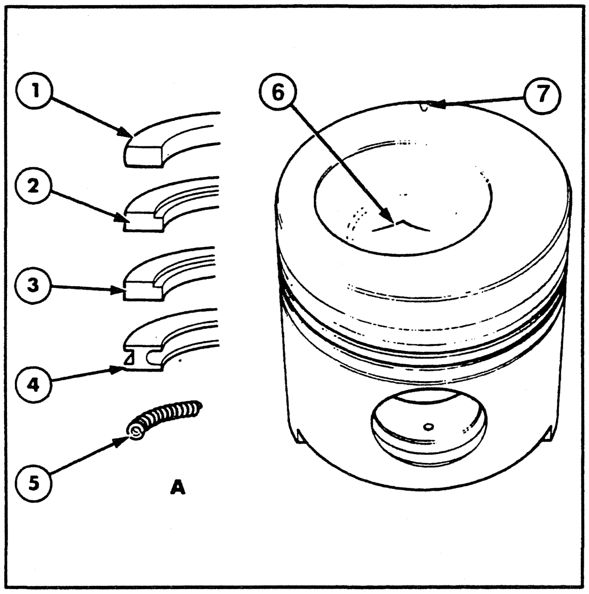

Figure 3
Piston and Ring Assembly (All models)
1. Top Compression Ring
2. 2nd Compression Ring
3. 3rd Compression Ring
4. Oil Control Ring
5. Oil Control Ring Expander
6. Raised Section in Combustion Bowl
7. Piston Identification Mark (front)

Oil Pump

The Turbocharged engine incorporates the oil pump from the 6610/7610 4 cylinder model. The overhaul procedure is the same as that for the other models and is detailed in Part 1, Chapter 1, of this manual. The normally aspirated engines retain the original pump.

C. FUEL SYSTEMS

Introduction

A new turbocharger, new injectors and new fuel injection pumps incorporating electric fuel shut–off with revised fuelling have been introduced to provide maximum engine efficiency.

The turbocharger is completely new to this model range and the overhaul procedure is fully described below.

I. TURBOCHARGER

Description And Operation

Turbochargers are used to increase power by compressing (or densifying) the air that goes into the engine combustion chambers. Therefore the Increased power comes from the additional fuel that the denser air accommodates during the combustion process.

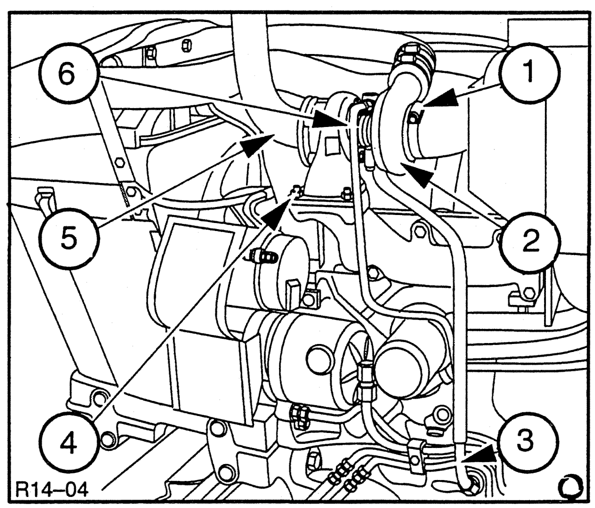

Figure 4
Turbocharger Installed
1. Air inlet Tube Clamps
2. Turbocharger Housing
3. Oil Return Tube to Block
4. Turbocharger to Manifold Bolts
5. Turbine Outlet Tube
6. Oil Intake Tube to Turbocharger

The turbocharger when fitted, is mounted on the engine exhaust manifold, situated on the left hand side of the engine underneath the top hood, Figure 4.

The turbocharger, consists of an exhaust gas driven turbine, and air compressor wheels, mounted on opposite ends of a common shaft. The wheels are enclosed by a housing, and the shaft by a centre housing, Figure 5.

The turbine is a centripetal (from outside to centre), radial inflow designed mechanism. Consisting of a cast turbine wheel shroud and a specially designed housing that encloses the wheel and directs the flow of gas through the turbine housing.

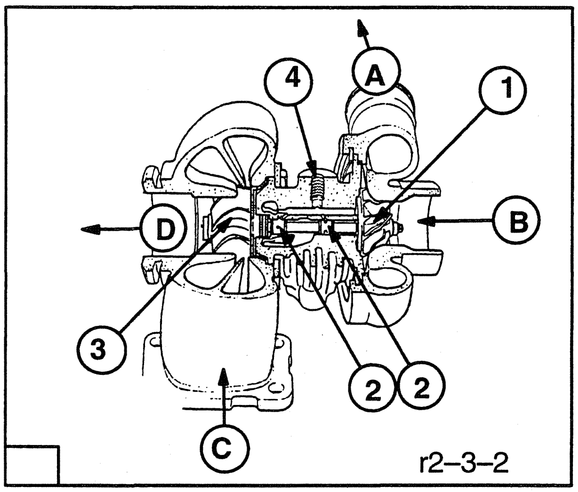

Figure 5
Turbocharger Cross Section

A To intake manifold
B From Air Cleaner
C From Exhaust Manifold
D To Exhaust Muffler
1. Compressor Wheel
2. Bearings
3. Turbine Wheel
4. Oil Supply to Bearing

The compressor is a centrifugal, radial outflow mechanism consisting of a cast compressor wheel and a specially designed housing that encloses the wheel and directs the flow of air through the compressor.

The centre housing supports the compressor and turbine wheel shaft in a pair of identical bearings which contain oil holes for directing oil to the bearing bores and shaft journals. Passages drilled in the centre housing provide for directing the oil, supplied by the engine from the inlet port to oil grooves machined in the bearing bores, which align with holes in the bearings.

Piston rings are installed at each end of the shaft, between the bearing and the adjacent turbine or compressor wheel to prevent lubricating oil from entering the turbine and the compressor area.

During operation of a turbocharged engine, exhaust gas from the engine exhaust manifold flows into the turbine. The exhaust gas pressure, and the heat energy, extracted from the gas cause the turbine wheel to rotate which, in turn, causes the compressor wheel to rotate.

The cooled and expanded exhaust gas leaving the turbine wheel, is directed by the turbine housing to the engine exhaust system, which expels it to the atmosphere.

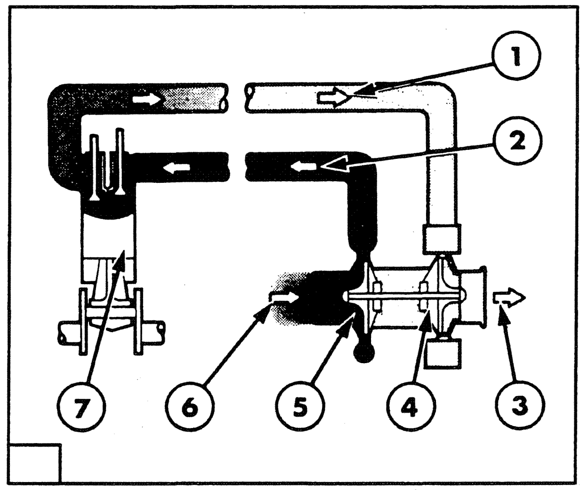

Figure 6
Turbocharger Engine Schematic

1. Engine Exhaust Gas Flow
2. Compressed Air Flow
3. Exhaust Gas Discharge
4. Turbine
5. Compressor
6. From Air Cleaner
7. Engine Cylinder

Rotation of the compressor wheel, causes ambient air from the engine air cleaner to be drawn into the compressor housing, where it is compressed and delivered to appropriate ducting which delivers it to the engine intake manifold, Figure 6.

The increased volume and density of the air thus delivered to the engine cylinders permit a corresponding increase in the volume of fuel that can be introduced into the cylinders while maintaining the air to fuel ratio required for proper combustion. Since engine power output is a function of the volume of fuel burned, the increase in the volume of fuel introduced as a result of turbocharger operation results in an increase in engine power output.

IMPORTANT: *To ensure adequate lubrication of the turbocharger, allow the engine to idle at 1000 rev/min for approximately one minute after starting the engine.*

To allow the turbocharger, and exhaust manifold, to cool down, and prevent any possible distortion of components, idle the engine at 1000 rev/min for approximately one minute, before stopping the engine.

II. FAULT FINDING

It is important when fault finding a suspected turbocharger malfunction, to keep in mind that a turbocharger cannot compensate for incorrect engine operating procedures.

Deficiencies of the engine air intake, fuel, or exhaust systems, or for damaged engine components, such as valves, pistons, rings , liners, etc. Replacing a good turbocharger with another will not correct engine deficiencies.

Consequently, systematic fault finding of a suspected turbocharger failure is essential for two very good reasons.

1, it must be determined what, if anything is wrong with the turbocharger so that it can be repaired.

2, it must be determined what action will prevent a recurrence of the failure.

In many cases the evidence required to determine the cause of a malfunction is destroyed in the process of removing the turbocharger from the engine.

For example if a turbocharger failed as the result of a faulty installation (such as loose duct connections that permitted ingestion of dirt by the compressor) this would not be evident once the turbocharger was removed from the engine.

Furthermore failure to take appropriate steps to assure correct installation (such as repairing or replacing defective clamps or ducting could cause the replacement unit to fail in a similar manner.

The following Fault Finding chart contains information pertaining to probable failure modes of turbocharged engines, possible causes for such failures and the maintenance action required to remedy each possible cause.

It is not represented that this information is all inclusive, but should be considered as representative of the methods or techniques that should be used during fault finding

In general fault finding procedures that can be performed with the least effort and least amount of time should be performed first. No removal or disassembly procedures should be performed until all visual inspections and sensory tests (sight and feel) that can be accomplished with the turbocharger have been performed.

The possible causes and procedures are generally arranged in order of ease accomplishment.

SYMPTOMS	POSSIBLE CAUSES
Engine lacks power, or emits black smoke	1. Dirty Air Cleaner 2. Loose Compressor to intake manifold connections 3. Leak at engine intake at turbocharger mounting flange 4. Turbocharger rotating assembly binding 5. Air cleaner to turbocharger duct restricted 6. Compressor to intake manifold duct restricted 7. Engine exhaust system restricted 8. Engine malfunction (rings, pistons, valves
Seal leaks at compressor end of turbocharger	1. Dirty air cleaner 2. Restricted duct between air cleaner and turbocharger 3. Loose compressor to intake manifold dust connections 4. Leaks at engine intake manifold 5. Restricted turbocharger oil drain line 6. Plugged engine crankcase breather 7. Worn or damaged compressor wheel (worn bearings, bores or journals) 8. Excessive piston blowby or high internal crankcase pressure
Seal leaks at turbine end of turbocharger	1. Excessive pre oiling 2. Plugged engine crankcase breather 3. Restricted turbocharger oil drain line 4. Sludged or coked centre housing 5. Worn turbocharger bearings, bearing bores, or shaft journals

SYMPTOMS	POSSIBLE CAUSES
Engine exhaust emits blue smoke	1. Dirty air cleaner 2. Loose compressor to intake manifold connections 3. Leak at engine intake manifold 4. Plugged engine oil filter 5. Restricted duct between air cleaner and turbocharger compressor 6. Seal leak at compressor end of turbocharger 7. Engine malfunction (rings, pistons, valves, etc
Worn turbocharger bearings, bores or journals	1. Inadequate pre oiling following turbocharger installation or engine lubrication servicing 2. Contaminated or improper grade of engine oil used in engine 3. Insufficient oil supplied to turbocharger due to oil lag 4. Restricted turbocharger oil feed line 5. Plugged engine oil filter 6. Abrasive wear due to coked material in turbocharger
Excessive engine oil consumption	1. Wrong type or viscosity of engine lubricating oil 2. Seal leaks at compressor end of turbocharger (indicated by oil in housing or on wheel) 3. Oil in engine exhaust manifold (caused by malfunction of rings, pistons, valves, etc)
Noisy turbocharger	1. Dirty air cleaner 2. Foreign material or object in compressor to intake manifold duct 3. Foreign object in engine exhaust system 4. Carbon build up in turbine housing

SYMPTOMS	POSSIBLE CAUSES
Noisy turbocharger (continued)	5. Turbocharger rotating assembly binding or dragging 6. Insufficient lubrication oil, due to malfunction of oil pump
Turbocharger rotating assembly binding or dragging	1. Damaged compressor wheel 2. Damaged turbine wheel 3. Compressor or turbine wheel rubbing on housing due to worn bearings, shaft journals, or bearing bores 4. Excessive dirt build up in compressor (housing or wheel) 5. Excessive carbon build up behind turbine wheel 6. Slugged or coked centre housing (check engine lubrication system

III. OVERHAUL

Removal

1. Remove the exhaust muffler.

2. Remove the engine hood panels.

3. Disconnect the air cleaner to the turbocharger tube, and the turbocharger to intake manifold tube, by loosening the tube hose clamps, Figure 7.

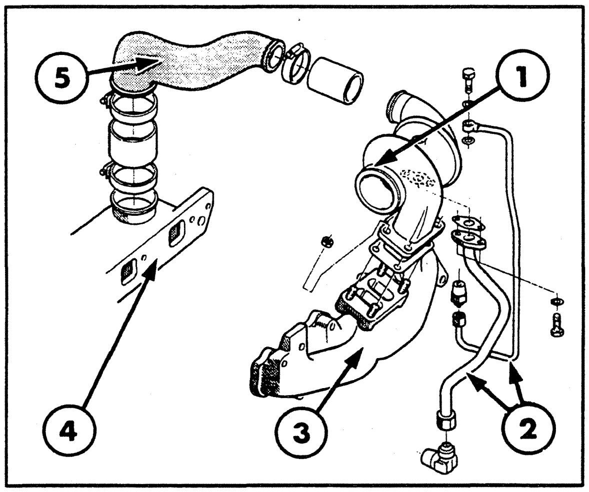

Figure 7
Turbocharger Assembly

1. Turbocharger Housing
2. Oil feed and Return Pipes
3. Exhaust Manifold
4. Inlet Manifold
5. Inlet Hoses and Tubes

4. Disconnect the oil supply and return tubes from the turbocharger. Cap the ends of the tubes and the oil ports of the turbocharger to prevent entry of foreign material therefore preventing future bearing failures.

NOTE: *Before removing and cleaning the unit look for signs of oil, and or gas leakage, also wheel damage, which may not be evident after cleaning.*

5. Remove the turbocharger and gasket from the exhaust manifold. Cover the opening in the exhaust manifold, to prevent the entry of dirt, which could cause damage to the turbine wheel blades, after installation and start up.

Disassembly

1. Clean the exterior of the turbocharger using a non caustic cleaning solvent to remove accumulated surface matter before disassembly.

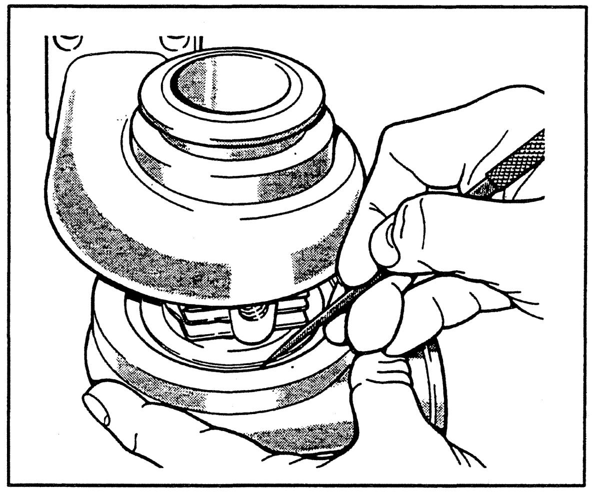

Figure 8
Scribing of Turbocharger Housing

2. Mark the compressor housing, turbine housing, and centre housing with a punch, or scribe, to facilitate correct positioning of the housings during reassembly, Figure 8.

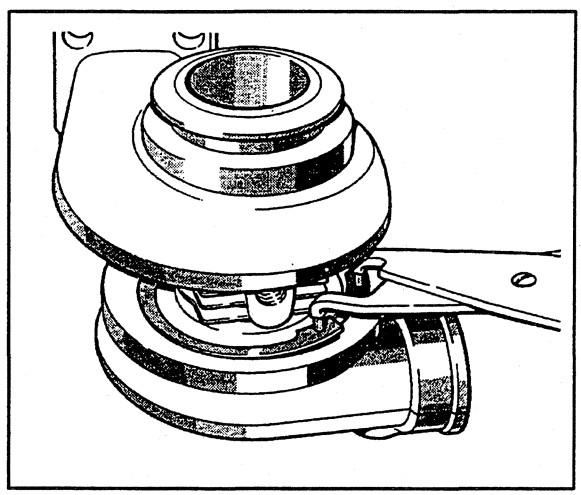

Figure 9
Removal of Compressor Housing

3. Remove compressor housing 'C' clip from centre housing intake side, Figure 9.

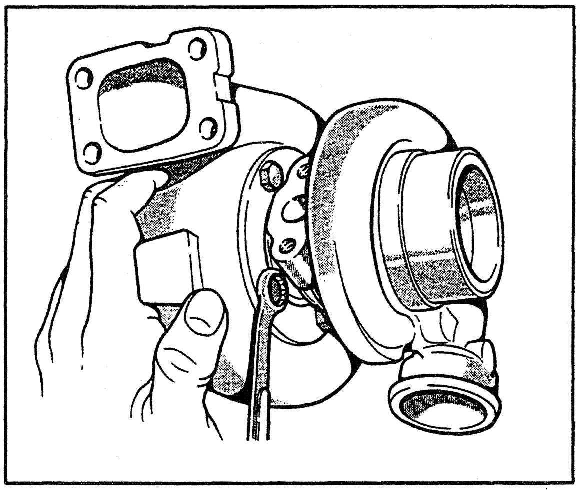

Figure 10
Removal of Turbine Housing

4. Loosen and remove bolts from turbine housing exhaust side, and lockplates, Figure 10.

NOTE: *Exercise care when removing the compressor housing to avoid damaging the compressor wheel blades.*
Tap the turbine housing with a soft faced hammer if force is needed to remove.

Cleaning

Before cleaning inspect all parts for burning, rubbing, or impact damage that may not be evident after cleaning. Clean all parts in a non caustic solution, using a soft bristle brush, a plastic blade scraper, and dry compressed air to remove residue.

DO NOT– use abrasive cleaning methods which might damage or destroy machined surfaces.
DO NOT– immerse CHRA in solvent.
DO NOT– blow under compressor wheel with compressed air.
DO NOT– permit wheel/shaft assembly to spin when blowing off solvent and residue.

Inspection

1. Inspect the compressor housing assembly for the following defects,

Wheel rub damage in the contour area that cannot be polished out with 80 grit silicon carbide abrasive cloth.

Worn, broken, or corroded snap ring grooves

Nicks, dents, or distortion that could prevent proper sealing between the compressor housing and the CHRA.

NOTE: *Replace the compressor housing if any of the above defects are found.*

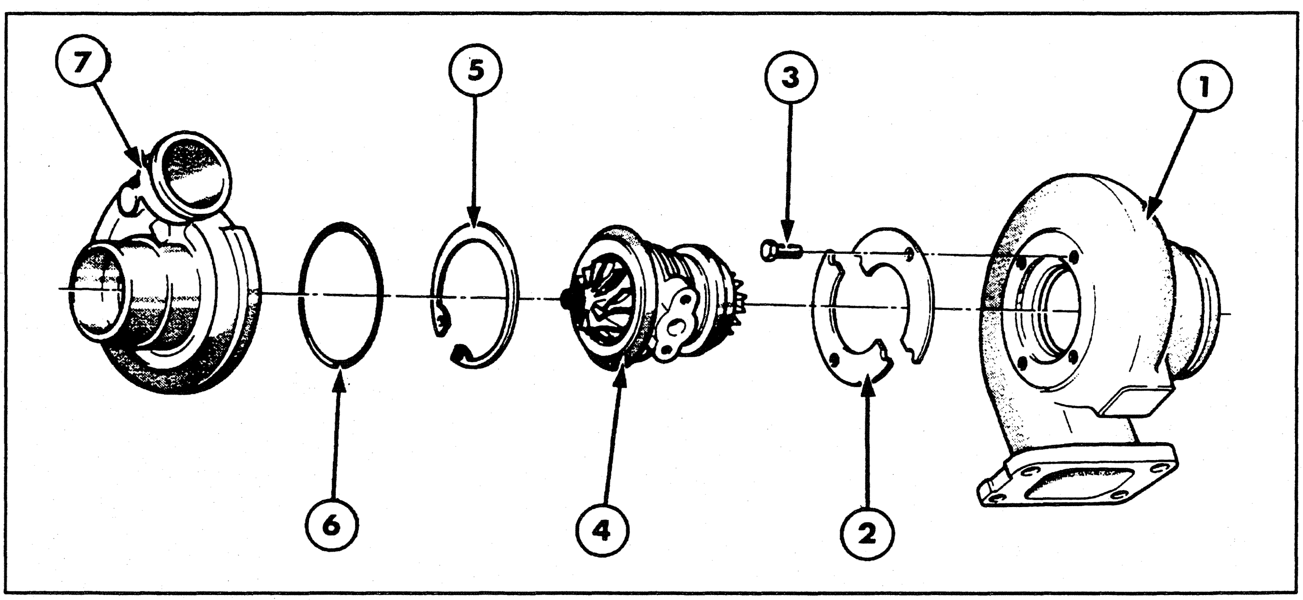

Figure 11
Exploded View of Turbocharger

1. Turbine Housing
2. Retainer Plates
3. Retainer Bolts
4. Turbine Housing
5. 'C' Clip
6. 'O' Ring
7. Compressor Housing

2. Inspect the turbine housing assembly for the following defects,

Wheel rub damage in the contour area that cannot be polished out with 60 grit silicon carbide abrasive cloth.

Worn, broken, or corroded snap ring grooves (snap ring turbine housing models).

Nicks, dents, or warpage that could prevent proper sealing between the turbine housing and the CHRA.

NOTE: *If there is any compressor or turbine wheel blade damage, the CHRA must be replaced. Operating a turbocharger with damaged blades will result in further damage to component parts or the engine.*
Blades cannot be straightened in service.

CENTRE HOUSING and ROTATING ASSEMBLY (CHRA)

IMPORTANT: *The CHRA as an assembly, has been balanced at the factory, under precision conditions. As such it must not be disassembled in any way. If disassembled the balance will be destroyed, and a new CHRA must be fitted.*

Centre Shaft Radial Check

Check the journal bearing radial clearance, whenever there is reason to suspect that the bearings are worn enough to allow either the compressor wheel, or the turbine wheel, to rub on its housing. This may be heard as a high pitched whine.

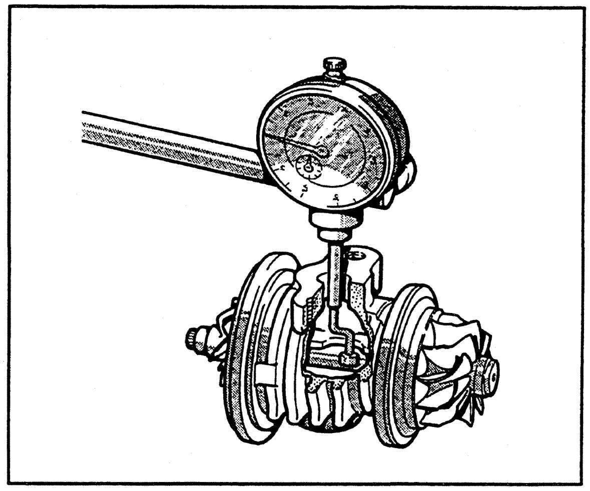

Figure 12
Checking Radial Clearance

1. With the turbocharger removed attach an indicator with a dog leg probe, Figure 12, to the centre housing. The indicator plunger should extend through the oil outlet port, and contact the shaft of the turbine wheel assembly.

2. Manually apply equal and simultaneous pressure, to the compressor and turbine wheels to move the shaft as far as it will go away from the dial indicator probe.

3. Set the dial indicator to zero.

4. Manually apply equal and simultaneous pressure to the wheels to move the shaft as far as it will go toward the plunger. Make a note of the shaft movement shown on the indicator dial.

NOTE: *To make sure the reading indicated is the maximum possible, roll the wheels slightly in both directions while applying pressure.*

5. Manually apply equal, and simultaneous pressure to the compressor, and turbine wheels, to move the shaft away from the plunger again. Note that the indicator pointer returns exactly to zero.

6. Repeat the steps 2 to 5 several times, to ensure that maximum radial clearance is indicated by maximum shaft movement, has been measured.

7. If the maximum clearance is less than 0.0022 in (0.056mm), or greater than 0.0050 in (0.127mm), replace the CHRA.

Trouble shoot the engine to find the cause of the bearing failure, and correct the problem before resuming operations.

Axle Clearance Check

Check the thrust bearing axial clearance as follows,

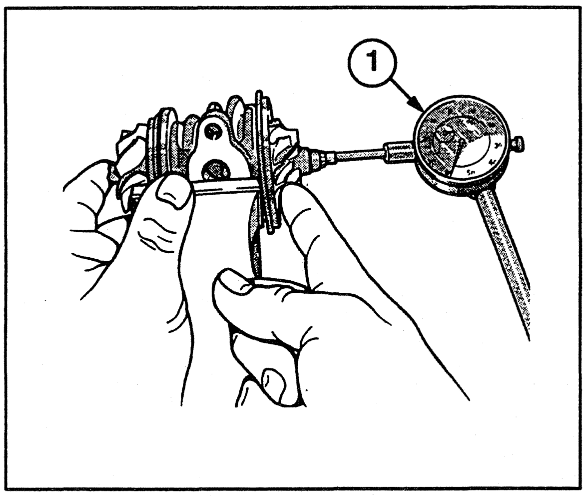

Figure 13
Axial Clearance Check

1. Dial Indicator

1. Place a dial indicator with the probe on the compressor end of the turbocharger shaft assembly, Figure 13.
2. Manually move the compressor/turbine wheel assembly, as far as it will go away from the plunger.
3. Set the dial indicator at zero.
4. Manually move the compressor/turbine wheel assembly as far as it will go toward the dial indicator plunger. Make a note of the shaft movement shown on the indicator dial.
5. Manually move the compressor/turbine wheel assembly as far as it will go away from the plunger. Note that the indicator plunger returns to zero.
6. Repeat steps 2 to 5, several times to make sure that the maximum axial clearance, as indicated by maximum shaft movement, has been measured.
7. If the maximum clearance is less than 0.0010 in (0.0254mm), or greater than 0.0039 in (0.084mm), replace the CHRA

Re–Assembly

1. It is recommended replacing the following with factory authorised parts only, at each overhaul or whenever parts are removed.

Snap ring, compressor housing retainer

O–Ring seal, compressor housing

Retainer Plates, turbine housing

Bolts, turbine housing retainers

2. Parts that require changing if faulty or damaged,

CHRA, turbine assembly

Compressor Housing

Turbine Housing

3. Inspect all mating surfaces and snap ring groove, to insure that they are free of burrs, foreign matter and corrosion deposits.
4. Transfer scribe marks from old snap rings to new, and coat with a light coating of new engine oil.
5. Install oiled snap ring on compressor end of CHRA , with beveled face toward the turbine end.

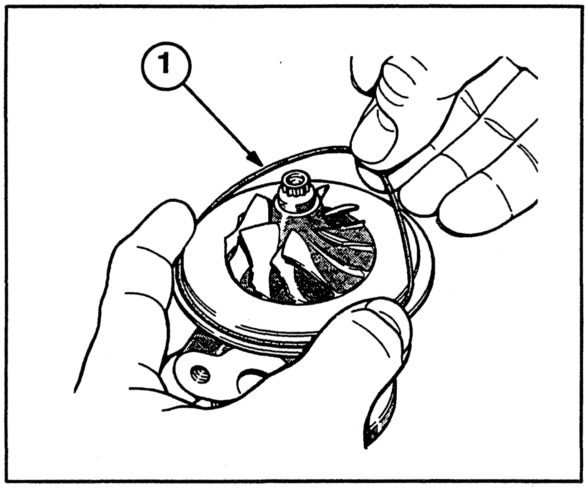

Figure 14
Compressor Assembly

1. 'O' Ring

6. Install an 'O' ring on the centre housing compressor end flange and place compressor housing assembly in position. Be careful not to damage the compressor wheel blades, Figure 14.

7. Carefully rotate the compressor housing onto the CHRA to line up scribed marks.

8. Install the oiled snap ring, lug first, into the compressor housing groove. Be sure that the beveled side faces the turbine end and the scribe marks are aligned.

9. Tap the inner circumference or lug ends of the ring with an appropriately sized drift to ensure proper seating.

NOTE: *When installing a new CHRA or turbine housing, transfer scribed alignment marks from the old, to the new parts.*

10. Position the turbine housing discharge side down, on a flat, level surface. Place the CHRA turbine wheel end into the housing, use care to avoid damaging the wheel blades. Check visually for proper alignment.

11. Carefully rotate the CHRA in the turbine housing to line up the scribed marks. Recheck for proper alignment and position the locking plates.

12. Coat the bolts in a suitable anti seize compound, and tighten to a torque of 15–18 lbf ft (20–25Nm) 2.0–2.5 kgf m.

Installation

1. Prior to installation fill the turbocharger centre housing with new clean oil, and rotate the main shaft to lubricate the bearings.

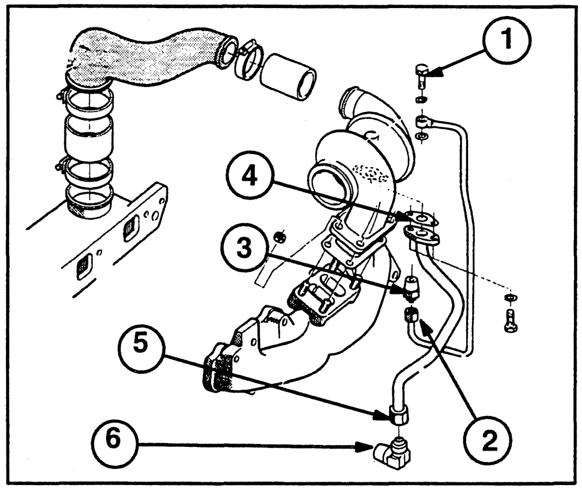

Figure 15
Turbocharger Exploded View

1. Oil Feed Tube to Turbocharger (Banjo Bolt)
2. Oil Feed Tube to Filter Head Connector
3. Connector to Filter Head
4. Oil Return Tube Bolts from Turbocharger to Block
5. Oil Return Tube to Block Connector
6. Oil Return Connector to Block

2. Installation of the turbocharger follows the removal procedure in reverse. Install a new manifold gasket, and tighten to, 30–35 lbf ft (41–47Nm) 4.1–4.7 kgf m.

3. Replace the washers and re–connect the oil Feed tube banjo bolt (1) Figure 15, and torque to 22–30 lbf ft (30–40Nm) 3.0–4.0 kgf m.

4. The oil feed tube connector, to oil filter head assembly, (3) Figure 15, if disturbed should be refitted. Apply sealer to connector "See Specifications" and torque to, 40–60 lbf ft (54–81Nm) 5.4–8.1 kgf m.

5. Apply sealer, "See Specifications", assemble the oil feed tube to the oil filter head connector (2) Figure 15, and tighten to,13–15 lbf ft (18–20Nm) 1.8–2.0 kgf m

6. Place a suitable receptacle below the oil outlet port and, **WITH THE ELECTRICAL SOLENOID WIRE DISCONNECTED AT THE FUEL INJECTION PUMP,** crank the engine until oil flows from the outlet port.

7. Reconnect the oil outlet tube (4) Figure 15, using a new gasket and tighten the retaining bolts at the turbocharger to 15–18 lbf ft (20–25Nm) 2.0–2.5 kgf m.

8. Tighten the oil return tube to cylinder block connector, (5) Figure 15 to, 45–50 lbf ft (54–81Nm) 5.4–8.1 kgf m.

9. If disturbed, Oil return tube to block connector, item (6) Figure 15, should have sealer applied, "See Specifications" and torqued to 20 lbf ft (27Nm) 2.7 kgf m.

10. Re–connect the air inlet, and outlet tubes, with the hose clamps, and torque to 15–20 lbs in (1.7–2.3Nm) , Figure 15.

11. Reconnect the fuel injection pump solenoid wire.

12. Check the engine oil level and add oil if required. Idle the engine and check all tubes and gaskets for leaks.

13. Run the engine at rated speed and listen for sounds of metallic contact from the turbocharger. If any noise is apparent, stop the engine immediately and correct the cause.

NOTE: *After the unit has obtained operating temperatures, the rotating assembly should coast freely to a stop after the engine is stopped. If the rotating assembly jerks to a sudden stop, the cause should be corrected immediately.*

IV. TURBOCHARGER SPECIFICATIONS

GENERAL TORQUES	lbf ft	Nm	kgf m
Turbine Housing Bolts	15–18	20–25	2.0–2.5
Turbocharger to Manifold	30–35	41–47	4.1–4.7
Oil Feed Tube to Turbocharger (Banjo Bolt)	22–30	30–40	3.0–4.0
Oil Feed Tube to Filter Head Connector	13–15	18–20	1.8–2.0
Connector to Filter Head	40–60	54–81	5.4–8.1
Oil Return Tube bolts from Turbocharger	15–18	20–25	2.0–2.5
Oil Return Tube to Block Connector	45–50	60–70	6.0–7.0
Oil Return Connector to Block	20	27	2.7
Inlet Hose Clamps	(15–20 lbs in)	1.7–2.3	
SEALER			
Type ESE–M4G194–B	Sealer Anaerobic Low Strength		

V. FUEL INJECTION PUMP

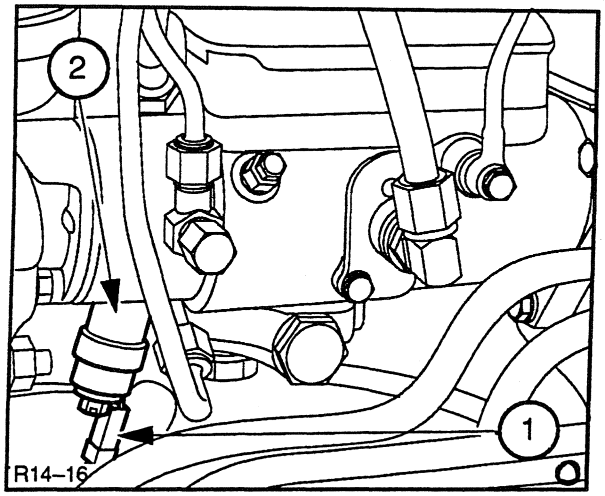

Figure 16
Fuel Pump Assembly

1. Solenoid Supply Wire
2. Electric Shut off Solenoid

All fuel pumps are installed with an electrically operated fuel shut off valve, Figure 16. The valve is screwed into the bottom of the hydraulic head, located between the transfer pump outlet and metering valve. The valve consists of a solenoid assembly which controls a spring loaded piston, Figure 17.

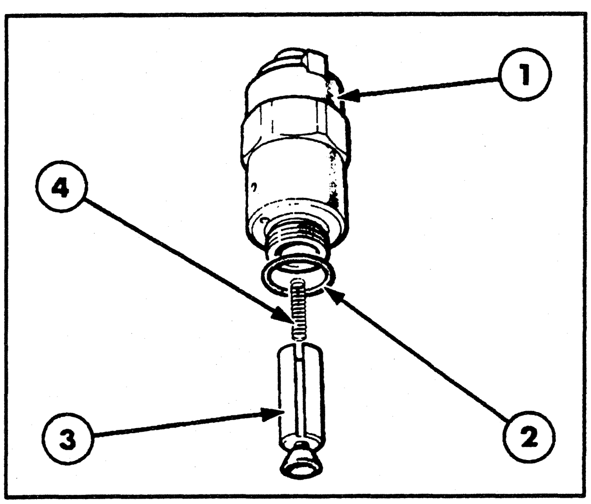

Figure 17
Solenoid Fuel Shut off Valve

1. Solenoid Valve
2. Rubber 'O' Ring
3. Piston
4. Spring

When the solenoid valve is energised on starting the engine, the solenoid lifts the piston against spring pressure and allows fuel at transfer pressure to pass to the metering valve.

When the solenoid valve is de–energised, by cutting the electrical supply, the return spring pushes the piston back against its seat and prevents the rotor from filling, thereby, stopping the engine.

INJECTORS

Coupled to the fuel injection pump are low inertia type injectors. Although used on the previous models the turbocharged engine incorporates new, '5 hole' nozzle injectors, the normally aspirated engines retaining the '4 hole' nozzles. The injector specifications have changed for all engines and the overhaul procedure for the low inertia injector is described below, as this has not been previously detailed in a Repair Manual.

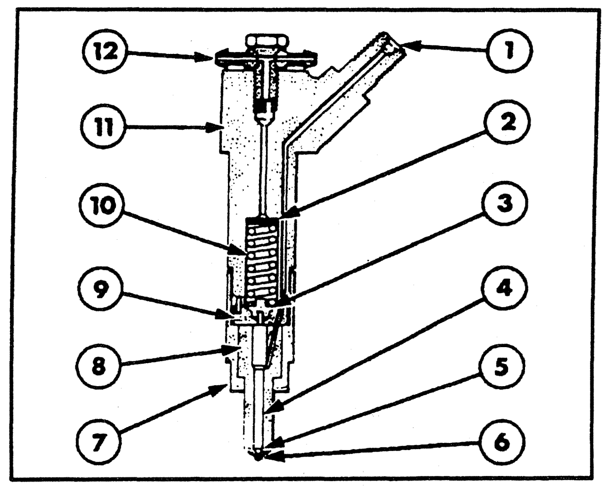

Figure 18
Fuel Injector Assembly

1. Fuel Inlet
2. Shims
3. Spring Seat
4. Nozzle Valve
5. Nozzle Valve Seat
6. Nozzle Tip
7. Nozzle Retaining Nut
8. Nozzle
9. doweled Adaptor Plate
10. Spring
11. Injector Body
12. Leak–off Line

Injector Testing

WARNING: *The spray from an injector tester can pierce human skin with serious results. When an injector is spraying, the nozzle should be turned away from the operator and any other persons.*

During the **nozzle opening pressure** and **spray pattern tests** collect the spray in a container partly filled with rags to absorb the spray.

When conducting the **nozzle seat leakage test**, release the injector tester pump pressure before touching the nozzle tip with a sheet of blotting paper.

The spray is Inflammable – ensure no naked lights are in the area of the tester and do not generate excessive vapour.

1. Fill the injector tester with a calibrating fuel oil (ISO 4113) and leave the filler cap loose to prevent a vacuum forming during testing.

2. Prime the tester until oil is emitted from the tester line then connect the injector.

3. Ensure the knob on the right hand side of the tester is screwed in to prevent the gauge being over pressurised if the injector nozzle is blocked.

4. Pump the tester and check the nozzle is free to open. Open the pressure gauge valve and commence injector testing. If the nozzle is blocked or the needle jammed, commence the disassembly procedures.

5. Nozzle opening pressure setting: Slowly pump the injector tester and observe the pressure at which the needle valve lifts and fuel is injected from the nozzle tip. The opening pressure should be 230 atm. (227 bar), if the opening pressure is incorrect, dismantle the injector and add or subtract shims as necessary to obtain the correct opening pressure (± 0.02 mm of shims equals ± 3 atm. (3 bar) approximately). When new shims are assembled and the nozzle retaining nut tightened to the correct torque, 35 lbf.ft (48 Nm), assemble to the tester, prime and recheck the opening pressure.

NOTE: *If a new spring has been fitted, the opening pressure should be set to 240 atm. (236 bar) to allow for spring settling.*

Nozzle Seat Leakage: Wipe the nozzle tip dry and apply a pressure of 220 atm. (217 bar), i.e. 10 atm. (10 bar) below the opening pressure. The nozzle tip and bottom face, must remain essentially dry and there must be no tendency for blobs of fuel to collect or drip. A slight dampness can be ignored. If there is any leakage from the nozzle seat, the nozzle assembly must be scrapped.

Nozzle Back Leakage: Apply a pressure of 220 atm. (217 bar), i.e. 10 atm. (10 bar) below the opening pressure then release the handle and the time/pressure drop should be between 150 to 100 atm. (148–99 bar) within 45 to 6 seconds, if below six seconds the nozzle assembly must be scrapped. If above 45 seconds, check for carbon on the valve and/or blocked back leak drillings.

Spray Pattern: Pump the tester rapidly (80–90 strokes per min.) and observe the spray pattern from the five holes. An atomised spray free from distortion, irregular streaks of unvaporised fuel and hosing should be observed. The tester is not regarded as providing a suitable for atomisation under working conditions but gives an approximate indication of the working of the nozzle.

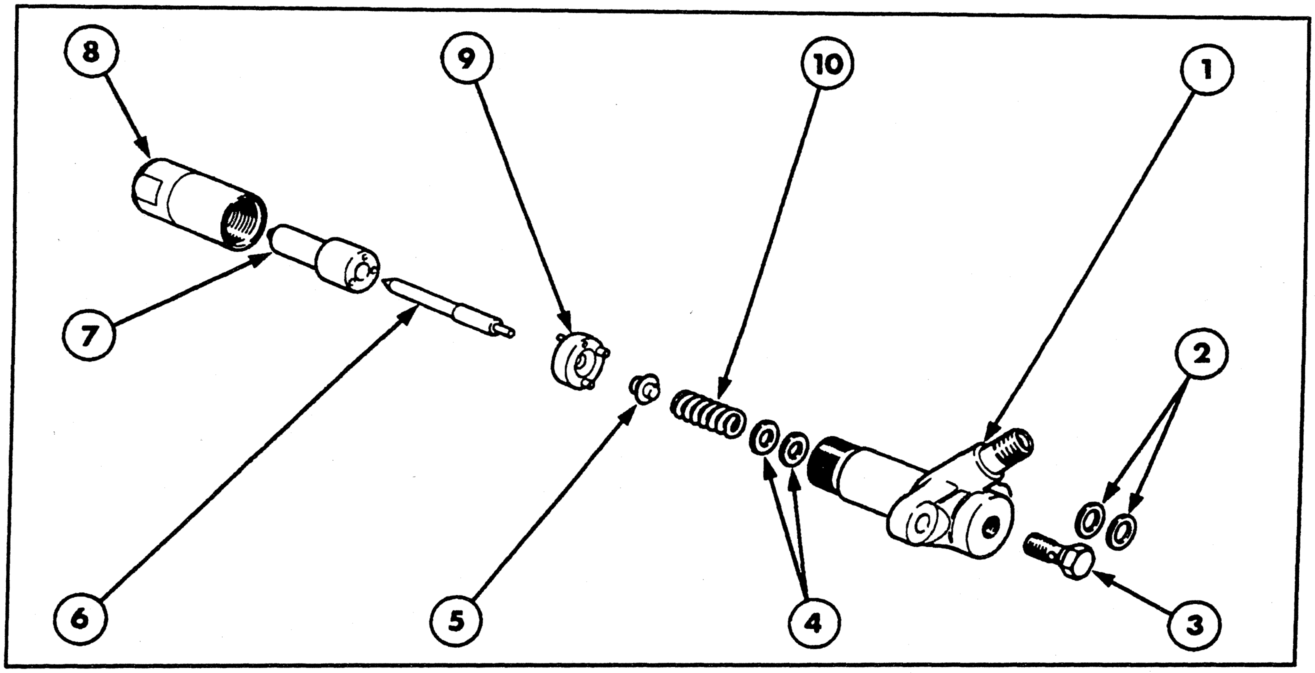

Figure 19
Injector Components

1. Injector Body
2. Copper Sealing Washers
3. Leak–off Line Connector
4. Shims
5. Spring Seat
6. Nozzle Valve
7. Nozzle
8. Nozzle Retaining Nut
9. Doweled Adaptor Plate
10. Spring

Fuel Injector Overhaul

Disassembly with reference to Figure 19.

1. Place the injector in a holding fixture with the nozzle uppermost. Do not clamp the injector body in a vice. Remove the nozzle retaining nut complete with the nozzle body, nozzle valve and the doweled adaptor plate.

2. Remove the injector body from the holding fixture, invert and carefully remove the spring seat, spring and adjustment shims. To avoid damage, place all dismantled components in suitable baths of clean fuel oil.

Inspection and Repair

NOTE: *To prevent corrosion of injector components after cleaning, rinse in clean fuel oil and place in a suitable bath of clean fuel oil.*

1. Clean the injector body by soaking in a carbon solvent and brushing with a brass wire brush. Inspect the body threads and pressure face for damage, ensuring the fuel galleries are thoroughly clean with no signs of corrosion or pitting.

2. Clean the spring and spring seat using a brass wire brush and check for scoring, pitting or corrosion.

3. Clean the doweled adaptor plate using a brass wire brush. Inspect the plate for loose or bent dowels, damaged pressure face or corrosion.

4. Clean the nozzle valve and body by soaking in a carbon solvent and brushing with a wire brush. Using the tools included in the injector nozzle cleaning kit, Tool No. 1720, available from NUDAY TOOLS. Clean the nozzle as follows:

NOTE: *If the nozzle valve is in any way damaged or blued, it must be discarded and a new matched nozzle valve and nozzle body assembly obtained. It is not possible to grind or lap the three special angles on the valve point.*

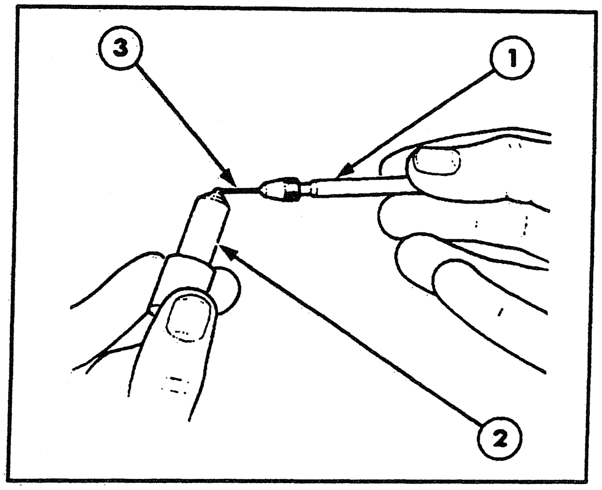

Figure 20
Cleaning Nozzle Spray Holes

1. Pin Vice
2. Nozzle
3. Nozzle Cleaning Wire (0,030 mm)

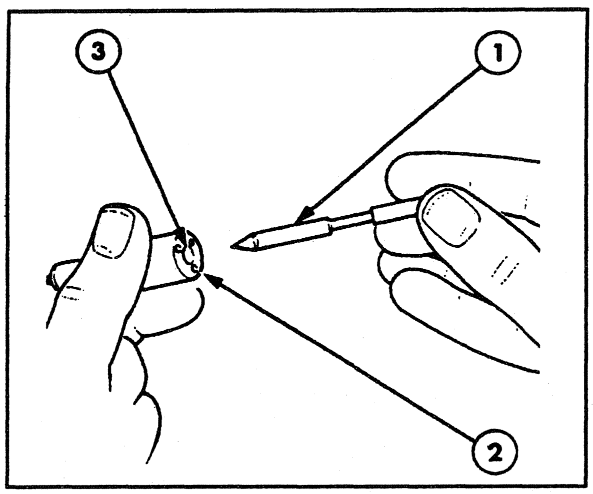

Figure 21
Cleaning Nozzle Valve Seat

1. Valve Seat Scraper
2. Nozzle
3. Nozzle Valve Bore

i) Clean the Spray holes with a 0.30 mm nozzle cleaning wire held in a pin vice so that it protrudes for only 1.5 mm, thereby giving maximum resistance to bending. Insert the wire into each hole, pushing and rotating gently until each hole is cleared, Figure 20.

ii) Clean the nozzle valve seat using the valve seat scraper by rotating and pushing the tool onto the valve seating, Figure 21.

iii) Clean the fuel gallery using the fuel gallery scraper, Figure 22. Insert the scraper into the gallery, press hard against the side of the cavity and rotate to clear all carbon deposits from this area.

5. Use a Reverse Flush Adaptor, Tool No.8124, NUDAY TOOLS, on the injector tester and reverse flush the nozzle to remove the carbon loosened during cleaning operation 4.

6. Inspect the nozzle valve and body for scoring or pitting and ensure there are no deposits of carbon or corrosion. Check that the spray holes and fuel galleries are clean and that no blueing is present. The nozzle valve must move freely within the nozzle body.

7. Clean the nozzle retaining nut using a brass wire brush and check that the threads are not damaged and are free from carbon deposits.

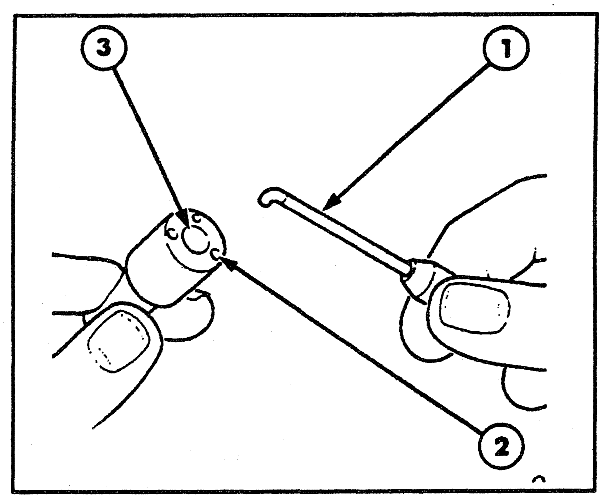

Figure 22
Cleaning Fuel Gallery

1. Carbon Scraper
2. Nozzle
3. Nozzle Valve Bore

Re–assembly

1. Ensure all parts are absolutely clean and undamaged prior to re–assembly. Rinse all parts in clean fuel oil and assemble the components whilst still wet.

2. Place the shims, spring and spring seat into the injector body bore. Place the injector body into the holding fixture.

3. Assemble the nozzle valve into the nozzle body and then position the doweled adaptor plate onto the nozzle body. Insert this assembly into the nozzle retaining nut.

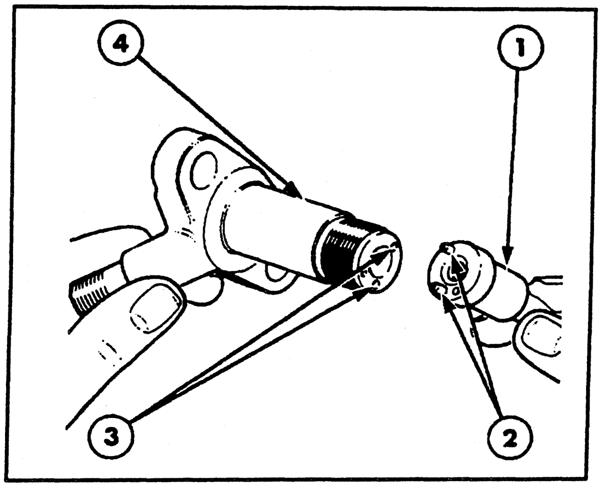

Figure 23
Assembling the Injector

1. Nozzle
2. Locating Dowels
3. Dowel Pin Holes
4. Injector Body

4. Carefully assemble the doweled adaptor plate and the nozzle retaining nut assembly onto the injector body, Figure 23, and tighten the retaining nut to 35lbf.ft (48 Nm).

FUEL INJECTION PUMP TEST PLANS

The following pages detail the fuel injection pump service test plans for the upgraded models only. Refer to Part 2, Chapter 8 for the complete ISO test conditions and explanatory notes.

BASIC PUMP SPECIFICATION

Rotation (looking on drive end) : Clockwise.
Governor type : Mechanical all – speed.
Governor link length : 54mm ± 0.3mm. (Except 5030 model)
Governor link length : 41.5mm ± 0.5mm. (5030 model only)
Governor Arm Hole No. 3
Throttle Lever Link Hole No. 1. (Except 5030 model)
Diameter and No. of plungers : 4 x 7.0mm.
Drive arrangement : Standard with supported shaft.
Advance Type : Automatic speed.(With start retard on 5030 model)
Scroll plate max. fuel adjustment, hydraulic excess fuel device (5030 model only).
Cambox pressurising valve (5030 model only).
Axial outlet head (5030 model only)
Internal venting via 'flatted' metering valve & 0.5mm orifice with loose ball connector (5030 model only)

SPECIAL FEATURES

Transfer pressure adjuster in end plate.
Solenoid shut – off device, 12 volts.

ISO TEST CONDITIONS. (IMPORTANT : READ EXPLANATORY NOTES).

These figures, for service use only, have been compiled on, and must only be used on, a test machine conforming to International Standard ISO 4008.
Test oil : ISO 4113 at temperature 40 ± 2° C.
Inlet feed pressure : 0.1 bar.
Nozzles : ISO 4010.
Nozzle opening pressure : 172 + 3 – 0 bar.
H.P. pipes : 6 x 2 x 845mm (ISO 4093.2).
H.P. outlet connections : Original.

ISO TEST PROCEDURE

- Screw transfer pressure adjuster fully out and then 2.5 turns in (Except 5030 model) or 1.5 turns in (5030 model only), before commencing test.
- Latch valve adjuster to be just below surface of locknut. (5030 model only)
- Max. fuel screw to protrude 15.0mm above surface of locknut. (5030 model only)
- Fit pressure gauge to measure cambox pressure using special bleed off connection.
- Fit auto–advance gauge and set to zero before commencing test.
- A 3.0mm shim is fitted to the piston spring cap on assembly. Additional shimming that may be added to meet test requirements may vary from 0.5 to ±1.0mm. (Except 5030 model)
- A 1.5mm shim is fitted to the piston spring cap on assembly. Additional shimming that may be added to meet test requirements may vary from 0.5 to ±1.0mm. (5030 model only)
- Where marked thus * use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking readings unless stated otherwise by the test bench manufactures instructions.

NOTE : *Critical fuel deliveries are given in mm^3/stroke. Hence the tester must determine the number of strokes applicable in accordance with the test m/c manufacturers instructions.*

TEST PLAN – FORD 3430 – 192 in3 (3147 cc) Engine

DPA DISTRIBUTOR TYPE FUEL PUMP – TYPE NUMBER DPA 3239F250

Test Operation	RPM	Requirements
1. Priming	100	Obtain delivery from all injectors and no air in backleakage
2. Transfer Pressure – Pre setting	1100	5.5± 0.35 Bar (80±5 $lbf.in^2$). Set by Transfer Pressure adjustment screw
3. Transfer Pressure	100	0.41 Bar (6$lbf.in^2$) minimum
4. Cambox Pressure	100	0.35 to 0.7 Bar (5 to 10 $lbf.in^2$)
5. Advance Setting	800	Adjust transfer pressure screw to obtain advance of 6°
6. Full Advance	1000	5.4 to 5.8mm (6.75° to 7.25°)
7. Transfer Pressure	1100	5.2 to 5.9 Bar (75 to 85 $lbf.in^2$)
8. Back Leakage	1100	30 to 60 cm^3 per 100 strokes time cycle (Flow rate 330 to 660 cm^3/min)
9. Advance Check	300	0°
10. Max. Delivery setting: see Note 1	50L850/7/2400	Set to code on nameplate +0–0.5 mm^3/stroke Spread between lines not to exceed 5 mm^3/stroke
11. Advance Check	800	4.6 to 5.0mm (5.75° to 6.25°) If adjusted, re–test as (from 5) and then recheck test (11)
12. Delivery Check	1100	Record delivery in cm3
13. Governor Setting	1200	Set throttle by max. speed adjustment screw to give 2.0 cm^3. No line to exceed 3.0 cm^3. Lock stop screw.
14. Delivery Check	1100	With throttle set as at (13), average delivery not to be less than at test (12), minus 0.4 cm^3
15. Delivery	*100	Minimum delivery to be as test (10), minus 20 mm^3/ stroke. See Note 1.
16. Delivery – Low Load	200	Maximum 1.2 cm^3. Throttle lever closed.
17. Shut–off lever	200	Average delivery not to exceed 0.5 cm3. Shut off lever closed.
18. Idle delivery	420	3.0 to 3.6 cm^3. Throttle lever closed.
19. Solenoid Shut off Check	xxx	De–energise solenoid and wait for 5 seconds before operating trip gear. average delivery not to exceed 0.5 cm^3.
19. Timing		Using outlet 'W' (55 Bar pressure) and indexing tool set to 272°, scribe line on pump housing flange.

REFER TO STATEMENT AT END OF EXPLANATORY NOTES REGARDING MAX. FUEL AND SPEED SETTING AND VARIATIONS IN ENGINE PERFORMANCE.

TEST PLAN – FORD 3930 – 192 in3 (3147 cc) Engine

DPA DISTRIBUTOR TYPE FUEL PUMP – TYPE NUMBER DPA 3239F260

Test Operation	RPM	Requirements
1. Priming	100	Obtain delivery from all injectors and no air in backleakage
2. Transfer Pressure – Pre setting	1100	5.5± 0.35 Bar (80±5 lbf.in^2). Set by Transfer Pressure adjustment screw
3. Transfer Pressure	100	0.41 Bar (6lbf.in^2) minimum
4. Cambox Pressure	100	0.35 to 0.7 Bar (5 to 10 lbf.in^2)
5. Advance Setting	700	Adjust transfer pressure screw to obtain advance of 6°
6. Full Advance	1000	5.4 to 5.8mm (6.75° to 7.25°)
7. Transfer Pressure	1100	5.2 to 5.9 Bar (75 to 85 lbf.in^2)
8. Back Leakage	1100	30 to 60 cm^3 per 100 strokes time cycle (Flow rate 330 to 660 cm^3/min)
9. Advance Check	300	0°
10. Max. Delivery setting: see Note 1	60L850/7/2400	Set to code on nameplate +0–0.5 mm^3/stroke Spread between lines not to exceed 5 mm^3/stroke
11. Advance Check	700	4.6 to 5.0mm (5.75° to 6.25°) If adjusted, re–test as (from 5) and then recheck test (11)
12. Delivery Check	1100	Record delivery in cm3
13. Governor Setting	1200	Set throttle by max. speed adjustment screw to give 2.0 cm^3. No line to exceed 3.0 cm^3. Lock stop screw.
14. Delivery Check	1100	With throttle set as at (13), average delivery not to be less than at test (12), minus 0.4 cm^3
15. Delivery	*100	Minimum delivery to be as test (10), minus 20 mm^3/ stroke. See Note 1.
16. Delivery – Low Load	200	Maximum 1.2 cm^3. Throttle lever closed.
17. Shut–off lever	200	Average delivery not to exceed 0.5 cm3. Shut off lever closed.
18. Idle delivery	420	3.0 to 3.6 cm^3. Throttle lever closed.
19. Solenoid Shut off Check	xxx	De–energise solenoid and wait for 5 seconds before operating trip gear. average delivery not to exceed 0.5 cm^3.
19. Timing		Using outlet 'W' (55 Bar pressure) and indexing tool set to 272°, scribe line on pump housing flange.

REFER TO STATEMENT AT END OF EXPLANATORY NOTES REGARDING MAX. FUEL AND SPEED SETTING AND VARIATIONS IN ENGINE PERFORMANCE.

TEST PLAN – FORD 4630 – 192 in3 (3147 cc) Engine

DPA DISTRIBUTOR TYPE FUEL PUMP – TYPE NUMBER DPA 3239F270

Test Operation	RPM	Requirements
1. Priming	100	Obtain delivery from all injectors and no air in backleakage
2. Transfer Pressure – Pre setting	1100	5.9± 0.35 Bar (85±5 $lbf.in^2$). Set by Transfer Pressure adjustment screw
3. Transfer Pressure	100	0.41 Bar (6$lbf.in^2$) minimum
4. Cambox Pressure	100	0.35 to 0.7 Bar (5 to 10 $lbf.in^2$)
5. Advance Setting	700	Adjust transfer pressure screw to obtain advance of 3°
6. Full Advance	1000	3.8 to 4.2mm (4.75° to 5.25°)
7. Transfer Pressure	1100	5.5 to 6.2 Bar (80 to 90 $lbf.in^2$)
8. Back Leakage	1100	30 to 60 cm^3 per 100 strokes time cycle (Flow rate 330 to 660 cm^3/min)
9. Advance Check	300	0°
10. Max. Delivery setting: see Note 1	68L850/7/2400	Set to code on nameplate +0–0.5 mm^3/stroke Spread between lines not to exceed 5 mm^3/stroke
11. Advance Check	700	2.2 to 2.6mm (2.75° to 3.25°) If adjusted, re–test as (from 5) and then recheck test (11)
12. Delivery Check	1100	Record delivery in cm3
13. Governor Setting	1200	Set throttle by max. speed adjustment screw to give 2.0 cm^3. No line to exceed 3.0 cm^3. Lock stop screw.
14. Delivery Check	1100	With throttle set as at (13), average delivery not to be less than at test (12), minus 0.4 cm^3
15. Delivery	*100	Minimum delivery to be as test (10), minus 20 mm^3/ stroke. See Note 1.
16. Delivery – Low Load	200	Maximum 1.2 cm^3. Throttle lever closed.
17. Shut–off lever	200	Average delivery not to exceed 0.5 cm3. Shut off lever closed.
18. Idle delivery	420	3.0 to 3.6 cm^3. Throttle lever closed.
19. Solenoid Shut off Check	xxx	De–energise solenoid and wait for 5 seconds before operating trip gear. average delivery not to exceed 0.5 cm^3.
19. Timing		Using outlet 'W' (55 Bar pressure) and indexing tool set to 273°, scribe line on pump housing flange.

REFER TO STATEMENT AT END OF EXPLANATORY NOTES REGARDING MAX. FUEL AND SPEED SETTING AND VARIATIONS IN ENGINE PERFORMANCE.