workshop manual for T6.3543 diesel engines

Perkins Engines Limited
Peterborough England
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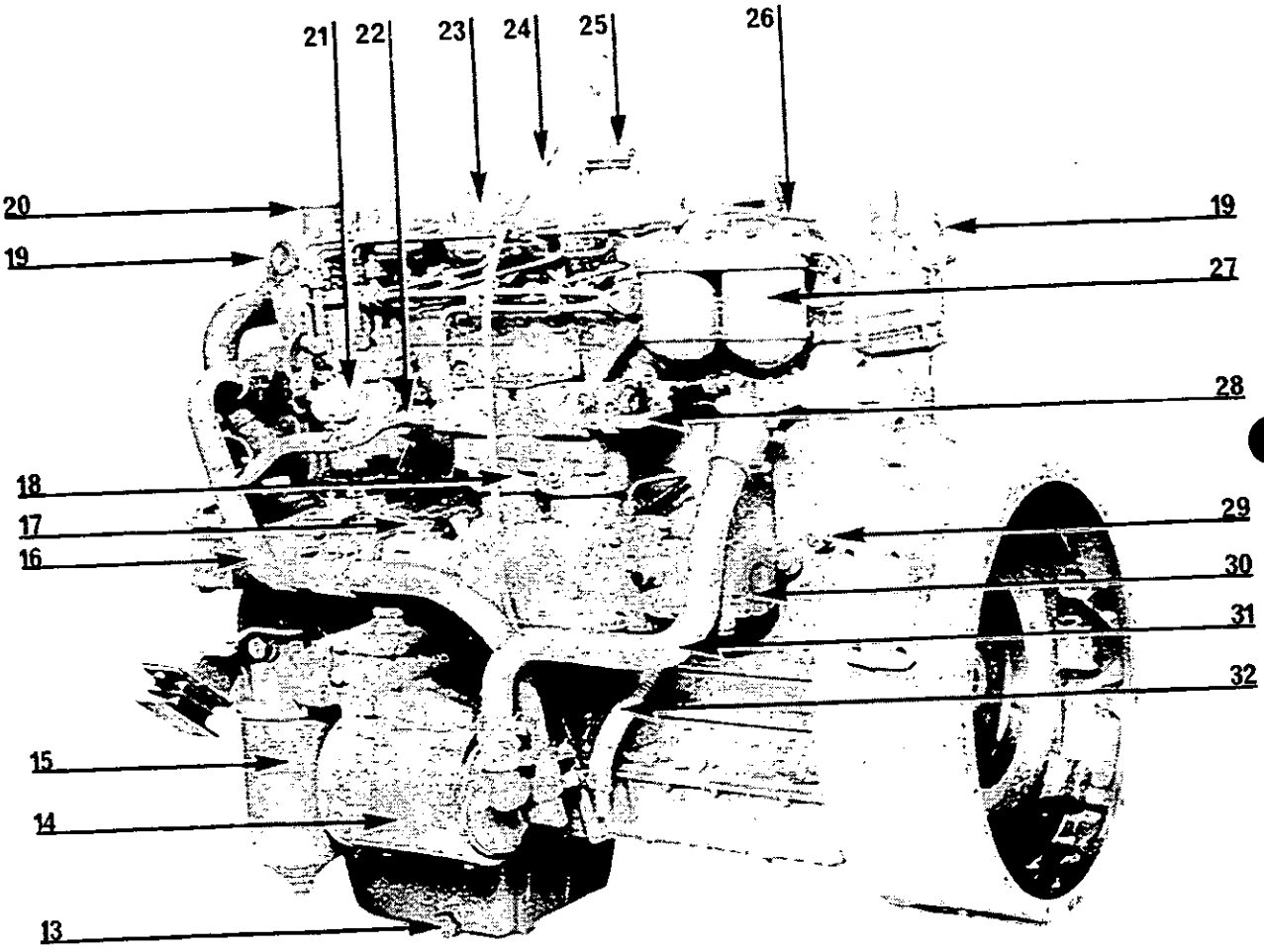


A2

VIEW OF LEFT HAND SIDE OF ENGINE

13. Sump Drain Plug
14. Lub. Oil Cooler
15. Lub. Oil Filter
16. Water Inlet Pipe to Oil Cooler
17. Compressor Coupling
18. Compressor
19. Lifting Hook
20. Water Outlet Connection
21. Fuel Injection Pump
22. Water Inlet Pipe to Compressor
23. Cylinder Head Top Cover
24. Dipstick
25. Lubricating Oil Filler
26. Atomiser
27. Twin Fuel Oil Filters
28. Water Outlet Pipe from Compressor
29. Cylinder Block Drain Tap
30. Power Steering Pump
31. Water Outlet Pipe from Oil Cooler
32. Breather Pipe

SECTION B
General Information

Engine Data

Type	Six cylinder, four stroke, direct injection
Bore	3.877/3.878 in (98,48/98,50 mm)
Stroke	5.0 in (127 mm)
Compression Ratio	16:1
Cubic Capacity	353.8 in³ (5,8 litre)
Firing Order	1, 5, 3, 6, 2, 4
Lubricating Oil Pressure	30 lbf/in² (2,1 kgf/cm²) -207 kN/m² minimum, at maximum engine speed and normal operating temperature.
Valve Tip Clearance (prior to Engine No. 3543U10342TL)	0.012 in (0,30 mm) COLD
Valve Tip Clearance (commencing Engine No. 3543U10342TL) Inlet	0.008 in (0,20 mm) COLD
Exhaust	0.018 in (0,46 mm) COLD

Rating Details

Standard Vehicle with Air Charge Cooler	
Gross Rated Output	155 b.h.p. (116 kW) at 2600 rev/min.
Maximum Torque	376 lbf ft (520 kgf m) at 1600 rev/min.
Combine Harvester with Air Charge Cooler	
Gross Rated Output	153 b.h.p. (114 kW) at 2500 rev/min.
Maximum Torque	376 lbf ft (520 kgf m) at 1600 rev/min.

The above ratings are "new engine" maximum and can vary according to application. For further details apply to the equipment manufacturer or the Service Department of Perkins Engines, Peterborough, England.

Recommended Torque Tensions

The following figures will apply with the components lightly oiled.

Component	Screw Size UNF	lbf ft	kgf m	Nm
Cylinder Head Nuts	½	95	13,1	129
Cylinder Head Setscrews	½	95	13,1	129
Cylinder Head Nuts with preformed integral washers				
Cold Torque	½	115	15,9	156
Hot Torque		105	14,5	142
Cylinder Head Setscrews with preformed integral washers				
Cold Torque	½	115	15,9	156
Hot Torque		105	14,5	142
Connecting Rod Nuts prior to Engine Number 3543U1384T	½	70	9,7	95
Connecting Rod Nuts (current)	½	75	10,4	102
Main Bearing Setscrews	⅝	180	24,9	244
Main Bearing Setscrews prior to Engine Number 3543U435T	⅝	150	20,7	203
Idler Gear Hub Nuts	⅜	36	5,0	49
Crankshaft Damper Setscrews (where fitted)	5/16	19	2,6	26
Sump to Cylinder Block, Setscrews	5/16	15	2,1	20
Flywheel Securing Setscrews	½	80	11,1	108
Camshaft Gear Retaining Setscrew	½	50	6,9	68
Crankshaft Pulley Setscrews	7/16	65	9,0	88
Piston Cooling Jet Banjo Bolt	⅜	20	2,7	27
Oil Cooler to Cylinder Block, Setscrews	7/16	50	6,9	68
Lub. Oil Filter to Oil Cooler, Setscrews	7/16	32	4,4	43
Atomiser Securing Nuts	5/16	12	1,7	16
Aux. Drive Shaft Gear to Shaft, Screws	5/16	22	3,0	30
Alternator Pulley Retaining Nut	7/16	30	4,1	41
Fuel Oil Lift Pump to Cylinder Block (to be re-torqued when hot)	5/16	20	2,7	27
Induction Manifold Setscrews (re-torque after 10 minutes see Page E.3)	⅜	24	3,3	32
High Pressure Fuel Pipe Nuts	12 x 1,5 mm	15	2,1	20
Thermostart		10	1,4	14
Thermostart Adaptor (where fitted)		10	1,4	14

Engine Weights

Bare engine, alternator, fuel and lubricating oil filters, compressor and lubricating oil cooler. Approx. dry weight = 960 lbs (435 kg)

Bare engine, alternator, fuel and lubricating oil filters, compressor, lubricating oil cooler, flywheel, flywheel housing, air charge cooler, starter motor and fan.

Not including radiator and clutch = 1180 lbs (536 kg)

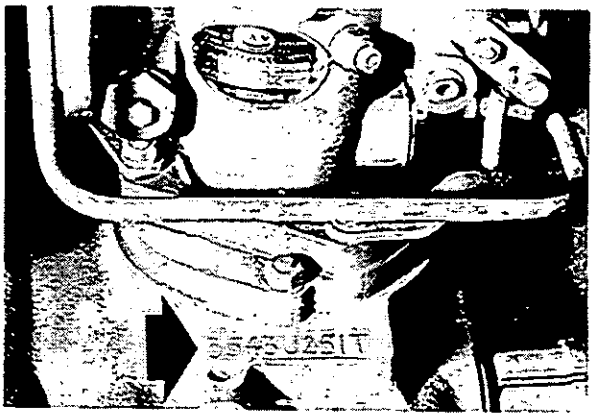
Engine Number

The engine number is stamped on top of the auxiliary drive housing, on the left hand side of the engine (see Fig. B.1).

With earlier engines, the number consisted of figures and letters e.g. 3543U251T.

A typical number for current engines is TP21531U500256C.

When requesting any service information or ordering spare parts, always quote the full combination to ensure accurate identification of the engine.



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De-rating for Altitude

Where the T6.3543 engine is required to operate at altitudes above 4,000 feet (1200 metres), it will be necessary to derate the engine because of the rarefied atmosphere. Details are available from Perkins Engines Ltd., Peterborough, England.

Any adjustments to the fuel pump for the purposes of de-rating the engine must be carried out by the accredited fuel pump dealer in the territory concerned.

Starting the Engine (See Fig. B2)

Ensure the "stop" control is in the "run" position.

Switch on the electrics by turning the switch to the "R" position.

Place the accelerator pedal or engine speed control in the maximum speed position.

Engage the starter motor by turning the switch to the "HS" position.

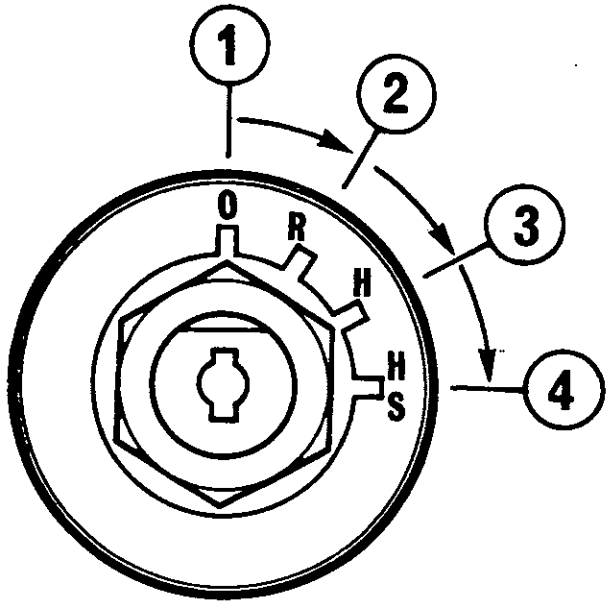
As soon as the engine starts return the switch to "R" position and check for satisfactory oil pressure 30-60 lbf/in² (2,1-4,2 kgf/cm²) -207-414 kN/m².

Do not rapidly increase and decrease engine speed immediately after starting.

If the engine fails to start at the first attempt always be sure the engine and starter motor have stopped rotating before re-engaging the starter motor.

Starting the Engine after disturbing oil feed pipe to the Turbocharger

Before starting the engine after having disturbed the oil feed pipe to the Turbocharger, release



B2

the oil feed pipe union at the Turbocharger and motor the engine over with the "STOP" control in the "STOP" position until lubricating oil issues from the union.

Tighten the union and use normal starting procedure as above.

Starting the Engine under difficult "COLD" conditions

The more common kind of starting aid is the electrically operated "Thermostart" fitted in the induction manifold and operated from the starting switch.

The "Thermostart" is supplied with fuel oil and in some applications a small reservoir is fitted and it may be necessary to turn "on" a tap between the "Thermostart" and its reservoir.

Check that the reservoir (if fitted) contains fuel oil by removing the top cover.

Turn the starter switch to the "H" position for fifteen to twenty seconds to enable the "Thermostart" to reach its operating temperature.

Adjust the engine speed control to maximum speed and turn the switch to the "HS" position to engage the starter motor.

If the engine fails to start, return the starter switch to the "H" position for a further ten seconds and then to the "HS" position again.

When the engine starts, return the starter switch to the "H" position until the engine responds to the throttle. Then return the switch to the "R" position. Check for satisfactory lubricating oil pressure and turn off the fuel supply to the "Thermostart", where applicable.

The use of alternative methods of "cold" starting aids will be found in the operator's handbook.

Stopping the Engine

A spring loaded control is located near the normal engine controls and functions by cutting off the fuel in the fuel injection pump.

To operate, pull the "stop" control and hold until the engine has completely stopped rotating. Ensure the stop control returns to its "run" position otherwise difficulty may be experienced in re-starting the engine.

Return starter switch to the "O" position.

Some engines may have a solenoid operated stop control on the fuel injection pump which is electrically operated by means of a switch.

Cold Starting Aid Failure

In the event of difficult starting, check that fuel is reaching the start aid in the induction manifold by disconnecting the fuel pipe.

If fuel is reaching the start aid satisfactorily, check that the start aid is functioning by disconnecting the piping at the induction manifold and watching the cold start aid whilst it is being used. When the switch is turned to "H" (heat) position, the element should become red hot, and on engagement of the starter motor, it should burst into flame.

The T6.3543 engine is fitted with efficient cold starting equipment and no responsibility can be accepted for any damage caused by unauthorised starting aids.

Operating the Engine—Vehicle Applications

It is essential to maintain a reasonably high engine speed when climbing a gradient owing to the power characteristics of the turbocharged T6.3543 engine.

Do not overload the engine at low engine speed.

Before the engine becomes overloaded, change gear to increase engine speed.

Running in

It is not necessary to gradually run-in a new or factory rebuilt engine and any prolonged light load running during the early life of the engine can in fact prove harmful to the bedding in of piston rings and liners.

Full load can be applied on a new or factory rebuilt engine as soon as the engine is used provided that the engine coolant is first allowed to reach a temperature of at least 140°F (60°C).

SECTION C
Preventive Maintenance

As the following preventive maintenance attentions are general in application, they should be compared with the schedules specified by the manufacturer of the application to which the engine is fitted and where necessary, the shorter periods adopted.

The periods are given in Miles, Hours and Months and the maintenance work should be carried out at the period that comes first in the normal operation of the vehicle or machine. On stop-start low mileage work, the hours run are more applicable than the mileage covered.

Every Day or 8 Hours whichever occurs first

Check coolant level in radiator.

Check lub. oil level in sump with vehicle or machine standing level.

Check oil pressures (where gauge is fitted).

Ensure alternator cooling fan and slots are clear of chaff.

*In extreme dust conditions, empty dust bowl of dry type air filter or clean oil bath type air filter.

Every 5,000 Miles (7,500Km), 250 Hours or 4 Months whichever occurs first

†Drain and renew engine lubricating oil.

Renew lubricating oil filter element or canister.

Check drive belt tension

*Empty dust bowl of dry type air filter or clean oil bath type air filter.

Clean fuel water trap (where fitted).

Check for oil, water or fuel leaks.

Check that alternator slots, fan and air spaces are clear and unobstructed.

Lubricate dynamo rear bush (where fitted).

Clean compressor air filter (where fitted).

Every 10,000 Miles (15,000Km), 500 Hours or 12 Months whichever occurs first

Clean lift pump gauze strainer.

Renew final fuel filter elements, agricultural and industrial applications only.

Check hoses and clips.

*Clean element of dry type air filter or renew unless indicated earlier.

Every 20,000 Miles (30,000Km), or 1,000 Hours whichever occurs first

Renew final fuel filter elements, vehicle applications.

Decarbonise compressor cylinder head, and delivery line.

Clean turbocharger impeller and oil drain pipe.

Every 60,000 Miles (90,000Km), or 2,500 Hours whichever occurs first

Arrange for examination and service of proprietary equipment, i.e. compressor/exhauster, starter motor, generator, turbocharger etc.

Service atomisers.

Check and adjust valve tip clearances (see Page E.4).

Operators of engines are reminded that the above preventive maintenance periods are general in application. They should be compared with the schedules specified by the manufacturer of the application to which the engine is fitted and where necessary, the shorter periods should be adopted.

Whilst we have given specific periods for preventive maintenance, you should have due regard for the local regulations concerning your vehicle or machine and ensure that the engine is operating within those regulations.

*The time limits for servicing air filters depend upon operating conditions and if dusty or similar adverse conditions prevail, the time limits given should be reduced. In extremely dusty conditions it may be necessary to service the filter more than once a day. Under such conditions, the correct maintenance will greatly assist in extending the life of the engine.

Where a *depression indicator* is fitted, this will give a positive indication that the element needs servicing and the periods given for servicing can be disregarded.

†The lubricating oil change period quoted is for this turbocharged engine using MIL-L-2104C oils. This period should be reduced if operating under dusty or adverse conditions.

Air Charge Cooler

To maintain maximum efficiency, the cooler radiator fins should be checked periodically to ensure that no foreign matter is obstructing the flow of air.

Under no circumstances should the radiator be "muffed" or "blanked-off" in an attempt to raise the temperature in the driver's cab because this will impede the flow of air through the charge cooler.

Post Delivery Checkover

After a customer has taken delivery of his Perkins Diesel engine, a general checkover of the engine must be carried out after the first 500/1000 miles (800/1600 km) or 25/50 hours in service.

The checkover should comprise the following points:—

1. Drain lubricating oil sump and refill to full mark on dipstick with new oil. Remove and clean sump strainer where possible. Change lubricating oil filter element or canister.
2. Remove cylinder head cover and set valve clearances (see Page E.4).
3. Check coolant level in radiator and inspect for leaks.
4. Check external nuts, setscrews, hose clips, mountings etc., for tightness.
5. Check belt tension.
6. Check electrical equipment and connections.
7. Check for lubricating and fuel oil leaks.
8. Check slow running speed.
9. Check general performance of engine.

Preservation of Laid-Up Engines

Where an application is to be laid up for several months it must be protected as follows:—

1. Clean all external parts.
2. Run engine until warm. Stop and drain the lubricating oil sump.
3. Throw away paper element in the lubricating oil filter, clean bowl and fit a new element or replace canister. Part fill bowl with new oil of an approved grade, a list of which appears in the Appendix.
4. Clean out breather pipe.
5. Fill lubricating oil sump to correct level with new oil of an approved grade.
6. Drain all fuel oil from fuel tanks and filters. Put into the fuel tank at least one gallon of one of the oils listed under "Recommended Oils for the Fuel System". If, because of the construction of the fuel tank, this quantity of oil is inadequate, break the fuel feed line before the first filter and connect a small capacity auxiliary tank.
7. Prime the fuel system.
8. Start engine and run it at half speed for 15 minutes when the oil will have circulated through the injection pump, pipes and injectors.
9. Seal the air vent in the tank or filler cap with waterproof adhesive tape.
10. Drain the cooling system by removing all drain plugs, including the oil cooler water drain plug. Where a fully water cooled compressor is fitted it will be necessary to drain by removing the drain plugs. To ensure complete draining check that the holes are not blocked by scale.
11. Remove the atomisers and spray into the cylinder bores ¼ pint (0,14 litre) of lubricating oil, divided between all cylinders.

    Rotate the crankshaft one complete revolution and replace atomisers.
12. Remove the air filter and any piping. Seal the air intake with water proofed adhesive tape.
13. Remove the exhaust pipe and seal the manifold port.
14. Remove fan and water pump driving belts.
15. Batteries
    (a) Remove the battery and top up the cells with distilled water.
    (b) Recharge.
    (c) Clean terminals and lightly smear with petroleum jelly.
    (d) Store in a cool, dry, dust free place. Avoid freezing risk.
    (e) Recharge once a month.
16. Starters and Generators

    Clean terminals and lightly smear with petroleum jelly. If vehicle or machine is to stand in the open, the generator, starter and control board must be protected against rain.

Recommended Oils for the Fuel System*

	Lowest Temperature during Lay-up
Esso IL815	25°F (— 4°C)
Esso IL1047	0°F (—18°C)
Shell Calibration Fluid "C" (U.K.)	0°F (—18°C)
Shell Calibration Fluid "B" (Overseas)	—70°F (—57°C)
Shell Fusus "A"	—15°F (—26°C)
Shell Fusus "A" R1476 (Old Type)	25°F (— 4°C)

No attempt should be made to restart the engine until the temperature has been at least 15°F (8°C) above that shown in the table for not less than 24 hours. Otherwise there may be difficulty in obtaining a free flow of fuel.

*The proprietary brands of oils listed may not be available in all parts of the world, but suitable oils may be obtained by reference to the oil companies. The specification should include the following:—

Viscosity: Should not be greater than 22 centistokes at the lowest ambient temperature likely to be experienced on re-starting.

Pour Point: Must be at least 15°F (8°C) lower than the lowest ambient temperature to be experienced on restarting and should be lower than the lowest temperature likely to be met during the lay-up period.

The oils selected are not necessarily suitable for calibrating or testing pumps.

Preparing the Engine for Return To Service

When the engine is to be returned to service, the following procedure must be observed:—

1. Thoroughly clean all external parts.
2. Remove adhesive tape from the fuel tank vent or filler cap.
3. Drain fuel tank to remove any remaining oil and condensed water and refill the tank with fuel oil.
4. Fit new filter element and vent the filter.
5. Vent and prime the fuel injection pump.
6. Replace the cylinder block, radiator, oil cooler water drain plugs and compressor drain plugs where necessary and fill the system with clean coolant. Check for leaks.
7. Rotate water pump pulley by hand to ensure freedom of water pump seals.
8. Refit water pump and generator driving belts.
9. Remove the rocker cover, lubricate rocker assembly with engine oil and replace cover.
10. Remove adhesive tape from the air intake, refit the air filter and any air intake pipe. Clean or renew the element of dry type air cleaner or refill the oil container with fresh oil of oil bath type air filter.
11. Remove adhesive tape from the exhaust manifold port and refit exhaust pipe.
12. Connect the battery.
13. Wipe the grease from the terminals and check that all connections are sound. If the starter is fitted with a Bendix type of drive, lubricate with a little light engine oil. Co-axial starters, except where they are fitted with dust covers, should be given the same treatment.
14. Check the level and condition of the oil in the sump. Change the oil if necessary, with new oil of an approved grade.
15. Start the engine in the normal manner, checking for oil pressure and generator charge.

Whilst the engine is reaching normal running temperature check that it is free from water and fuel leaks.

NOTE:

If the foregoing instructions are observed, the laying up and returning to service should be carried out efficiently and without adverse effect on the engine. Perkins Engines Ltd., however, cannot accept liability for direct or consequential damage that might arise following periods of laying up.

Frost Precautions

Precautions against damage by frost should be taken if the engine is to be left exposed, either by draining the water system or, where this is not convenient, an anti-freeze of reputable make and incorporating a suitable corrosion inhibitor may be used.

When draining the cooling system, ensure engine is level.

Should it be necessary to use anti-freeze it should conform to British Standard 3151, or have been approved by testing in accordance with British Standard 5117, Clause 5 to give at least as good a result as BS.3151.

The coolant solution containing 25 per cent anti-freeze manufactured to BS3151 in water in a properly maintained engine should maintain its anti-freeze and anti-corrosive properties throughout the winter season and in general, a safe life of 12 months may reasonably be expected.

After an anti-freeze solution has been used, the cooling system should be thoroughly flushed in accordance with the anti-freeze manufacturer's instructions before refilling with normal coolant.

If the foregoing action is taken, no harmful effects should be experienced, but Perkins Engines Ltd. cannot be held responsible for any frost damage or corrosion which may be incurred.

SECTION D
Fault Finding

FAULT FINDING D2

Fault Finding Chart

Fault	Possible Cause
Low cranking speed	1, 2, 3, 4.
Will not start	5, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 31, 32, 33.
Difficult starting	5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 22, 24, 29, 31, 32, 33.
Lack of power	8, 9, 10, 11, 12, 13, 14, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31, 32, 33, 60, 62, 63.
Misfiring	8, 9, 10, 12, 13, 14, 16, 18, 19, 20, 25, 26, 28, 29, 30, 32.
Excessive fuel consumption	11, 13, 14, 16, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 31, 32, 33, 63.
Black exhaust	11, 13, 14, 16, 18, 19, 20, 22, 24, 25, 27, 28, 29, 31, 32, 33, 60.
Blue/white exhaust	4, 16, 18, 19, 20, 25, 27, 31, 33, 34, 35, 45, 56, 61.
Low oil pressure	4, 36, 37, 38, 39, 40, 42, 43, 44, 58.
Knocking	9, 14, 16, 18, 19, 22, 26, 28, 29, 31, 33, 35, 36, 45, 46, 59.
Erratic running	7, 8, 9, 10, 11, 12, 13, 14, 16, 20, 21, 23, 26, 28, 29, 30, 33, 35, 45, 59.
Vibration	13, 14, 20, 23, 25, 26, 29, 30, 33, 45, 47, 48, 49.
High oil pressure	4, 38, 41.
Overheating	11, 13, 14, 16, 18, 19, 24, 25, 45, 50, 51, 52, 53, 54, 57.
Excessive crankcase pressure	25, 31, 33, 34, 45, 55.
Poor compression	11, 19, 25, 28, 29, 31, 32, 33, 34, 46, 59.
Starts and stops	10, 11, 12.

Key to Fault Finding Chart

1. Battery capacity low.
2. Bad electrical connections.
3. Faulty starter motor.
4. Incorrect grade of lubricating oil.
5. Low cranking speed.
6. Fuel tank empty.
7. Faulty stop control operation.
8. Blocked fuel feed pipe.
9. Faulty fuel lift pump.
10. **Choked fuel filter.**
11. **Restriction in air cleaner or induction system.**
12. **Air in fuel system.**
13. Faulty fuel injection pump.
14. Faulty atomisers or incorrect type.
15. Incorrect use of cold start equipment.
16. Faulty cold starting equipment.
17. Broken fuel injection pump drive.
18. Incorrect fuel pump timing.
19. Incorrect valve timing.
20. Poor compression.
21. Blocked fuel tank vent.
22. Incorrect type or grade of fuel.
23. Sticking throttle or restricted movement.
24. Exhaust pipe restriction.
25. Cylinder head gasket leaking.
26. Overheating.
27. Cold running.
28. Incorrect tappet adjustment.
29. Sticking valves.
30. Incorrect high pressure pipes.
31. **Worn cylinder bores.**
32. **Pitted valves and seats.**
33. Broken, worn or sticking piston ring/s.
34. Worn valve stems and guides.
35. Overfull air cleaner or use of incorrect grade of oil.
36. Worn or damaged bearings.
37. Insufficient oil in sump.
38. Inaccurate gauge.
39. Oil pump worn.
40. Pressure relief valve sticking open.
41. Pressure relief valve sticking closed.
42. Broken relief valve spring.
43. Faulty suction pipe.
44. Choked oil filter.
45. Piston seizure/pick up.
46. Incorrect piston height.
47. Damaged fan.
48. Faulty engine mounting (Housing).
49. Incorrect aligned flywheel housing or flywheel.
50. Faulty thermostat.
51. Restriction in water jacket.
52. Loose fan belt.
53. Choked radiator.
54. Faulty water pump.
55. Choked breather pipe.
56. Damaged valve stem oil deflectors (if fitted).
57. Coolant level too low.
58. Blocked sump strainer.
59. Broken valve spring.
60. **Damaged or dirty turbocharger impeller.**
61. **Leaking turbocharger oil seals.**
62. **Leaking boost control pipe.**
63. **Leaking induction system.**

SECTION E
Cylinder Head

To remove the Cylinder Head

The T6.3543 cylinder head is not interchangeable with any other 6.354 or T6.354 engine type cylinder heads because of different cooling passages inside the head.

Drain the cooling system.

Disconnect battery terminals.

Remove air cleaner and trunking.

Disconnect and remove all connections to the turbocharger and remove the turbocharger, see Fig. E.1.

Remove electrical connections to the cylinder head and induction manifold. Remove fuel pipe to thermostart in the manifold.

Remove the water outlet connection.

Remove the induction and exhaust manifolds.

The fuel pipe from lift pump to fuel filters should be removed, releasing the clip from the back of the cylinder head. The fuel filters may also be removed.

All high pressure pipes between fuel injection pump and the atomisers should be removed together with the atomiser leak-off pipe assembly.

Remove atomisers, see Fig. E.2.

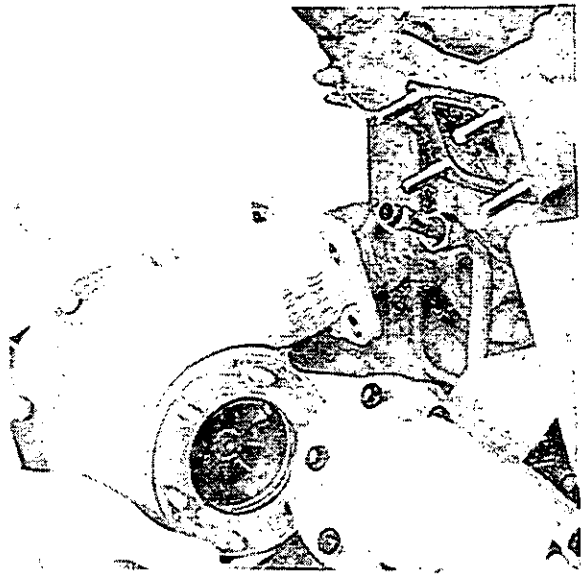
The bores in the cylinder head to accommodate atomisers are sealed with copper sleeves, see Fig. E.3. They are machine rolled and should be renewed if necessary as detailed on Page E.7.

Disconnect the breather pipe from the rocker cover and cylinder block. Remove the breather pipe.

Remove rocker cover and gasket.

Release rocker assembly bracket securing setscrews and lift off rocker assembly. Remove the push rods.

Remove cylinder head nuts and setscrews in reverse order of tightening sequence, see Fig. E.6.



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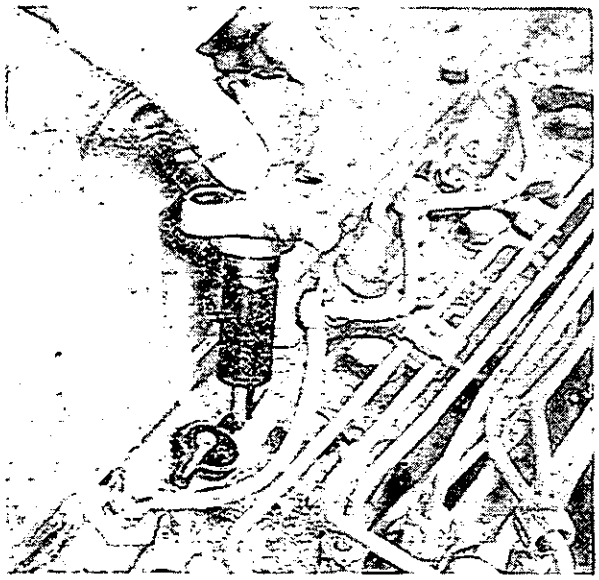

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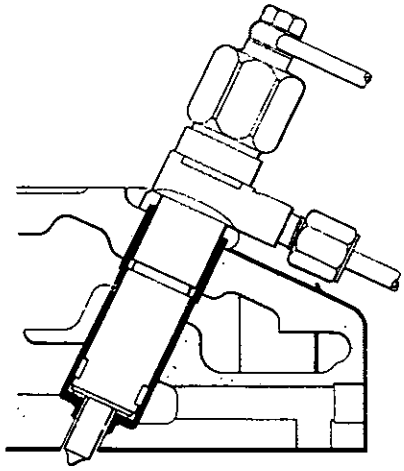

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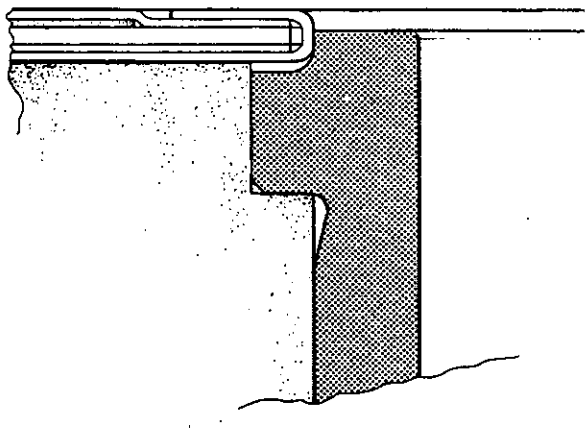

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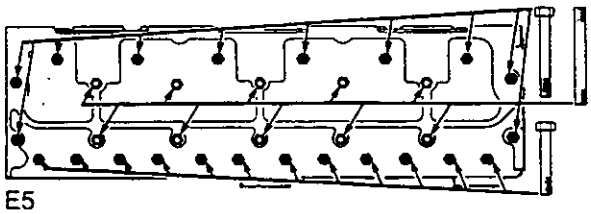

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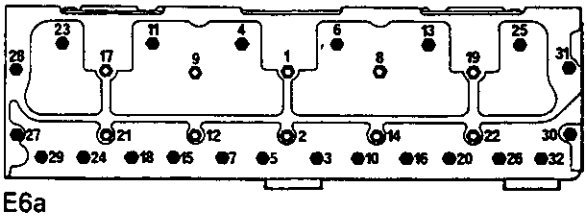
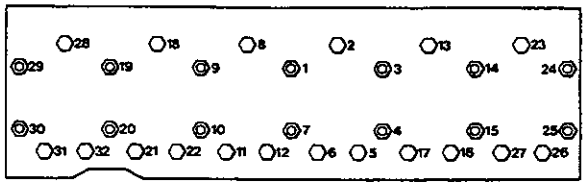


E6a



E6b

Note position of different length setscrews, see Fig. E.5.

Remove cylinder head.

To fit the Cylinder Head

Ensure the head face, cylinder block top face and bores are clean and that the rocker assembly oil feed passage in the cylinder head is clean.

Any cylinder head studs removed from the cylinder block should be refitted with "Loctite" Grade 542.

The cylinder head gasket fitted to the T6.3543 engine is not interchangeable with other 6.354 series engines. It is marked "TOP FRONT".

Using PERKINS HYLOMAR jointing compound spread evenly and thinly on both sides, fit the gasket, ensuring that the beading of the gasket is positioned in the recess around the cylinder liner, see Fig. E.4.

Lower the cylinder head in position without disturbing the gasket.

Lightly oil threads of cylinder head securing studs and setscrews.

Two types of cylinder head retaining setscrews and nuts are used.

Early engines have cylinder head setscrews and nuts with separate washers.

Later engines, from engine number ----- U610664G, have cylinder head setscrews and nuts with an integral washer face, with this, a new figure of eight sequence to tighten these nuts and screws has been introduced see Fig. E6b and an increased torque figure.

See Fig. E.5 for correct location of long and short setscrews.

Progressively tighten cylinder head securing nuts and setscrews in the order shown: for nuts and setscrews with separate washers until a torque of 95 lbf ft (131,1 kgf m) – 129 Nm see Fig. E6a;

and for nuts and setscrews with the integral washer face until a torque of 115 lbf ft (15,9 kgf m) 156 Nm (see Fig. E6b).

Replace push rods.

Renew the rocker assembly feed pipe oil seal, lightly oiling its inner and outer surfaces, and placing it in the oil feed drilling.

Examine and replace the rocker assembly, ensuring that the oil feed pipe, which has a lead in, locates correctly into the drilling, when the seal will butt against the convolution, see Fig. E.7.

The rocker assembly securing nuts should be tightened down progressively from the centre outwards to a torque of 55 lbf ft (7,60 kgf m) or 75 Nm.

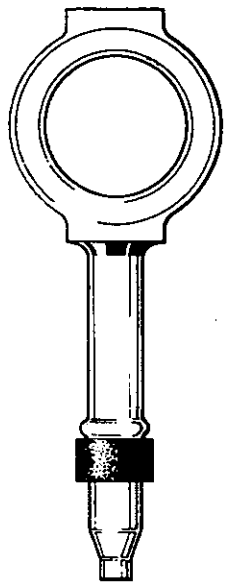
Set tappet clearances as detailed on Page E.4.

Refit atomisers with new copper sealing washers, and tighten nuts evenly to a torque of 12 lbf ft (1,7 kgf m) or 16 Nm.

Refit all high pressure fuel pipes, leak-off pipes and the fuel filters.

Refit fuel pipe from lift pump to filters, this pipe is clipped on to back of cylinder head.

Refit induction and exhaust manifolds. Two types of induction manifold joint can be found, i.e., the earlier steel/asbestos type and the later tin plated mild steel type incorporating a corrugation. Under no circumstances should either type be mixed, but fitted in complete sets. The corrugated joints are coated with lacquer and should be fitted DRY. They may be fitted either way round, but the notch (see Fig. E.8) should always be to the top. The manifold securing setscrews should be tightened to a torque of 24 lbf ft (3,3 kgf m) or 32 Nm starting from centre setscrews and working towards the ends. After at least ten minutes after fitting, re-torque the set-screws to the original figure. THIS IS IMPORTANT.



E7

Two types of exhaust manifold joint can also be found, i.e., the original steel/asbestos type and the later corrugated stainless steel type. These joints must not be mixed, but fitted in complete sets. When fitting corrugated stainless steel joints, the corrugation should be positioned so as to face the manifold.

Refit the water outlet connection.

Connect the electrical lead, fuel feed and return pipes to the thermostart unit and container.

Connect any other electrical lead (i.e. water temperature gauge).

Refit the turbocharger and all connections to it, trunking and air cleaner.

Reconnect the battery.

Refill the cooling system.

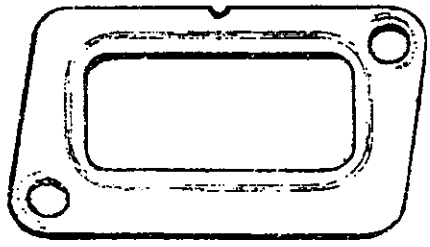
Bleed the fuel system of air as detailed on Page M.7 and start the engine.

Check the oil flow to the rocker shaft assembly and allow the engine to warm up.

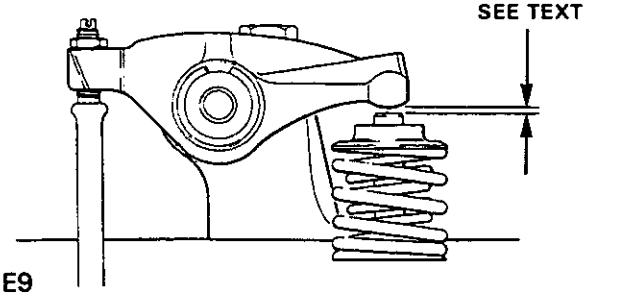
Shut the engine down, and retighten the cylinder head securing nuts and setscrews to 95lbfft (131,1kgfm) 129Nm for the nuts and setscrew with the separate washers or 105lbfft (14,5kgfm) 142Nm for the nuts and setscrew with the integral washer face, as fitted from engine number ----- U610664G.

Reset the valve clearances to 0.012in (0,30mm) cold for engines prior to Engine No. 3543U10342TL or 0.008in (0,20mm) — inlet valves and 0.018in (0,46mm) — exhaust valves — for engines commencing at Engine No. 3543U10342TL, cold.

Refit the rocker cover gasket, rocker cover and breather pipe.



E8



E9

To check or Adjust Valve Tip Clearances

For engines prior to Engine No. 3543U10342TL, the valve tip clearances should be set to 0.012in (0,30mm) by using a feeler gauge between the top of valve stem and rocker lever with the engine cold (see Fig. E.9).

NOTE: Commencing from Engine No. 3543U10342-TL, due to a change in cam profile, valve tip clearances are as follows:

Inlet .....0.008in (0,20mm) cold
Exhaust .....0.018in (0,46mm) cold

Correct valve tip clearances are important.

When setting valve clearances, the following procedure should be adopted.

With the valves rocking on No.6 cylinder (i.e. the period between opening of inlet valve and closing of exhaust valve) set the clearances on No.1 cylinder.

With valves rocking No.2—set clearances No.5.
With valves rocking No.4—set clearances No.3.
With valves rocking No.1—set clearances No.6.
With valves rocking No.5—set clearances No.2.
With valves rocking No.3—set clearances No.4.

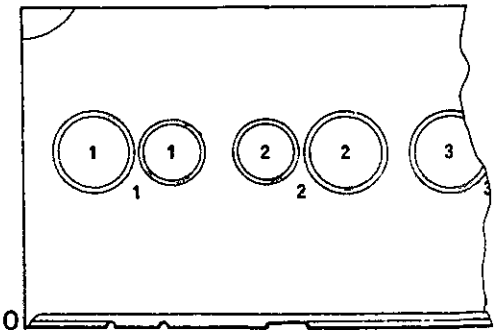
To Remove Valves

With early engines, valves were numbered 1 and 1, 2 and 2 etc., commencing at the front of the engine, with a corresponding number on the cylinder head (see Fig. E.10).

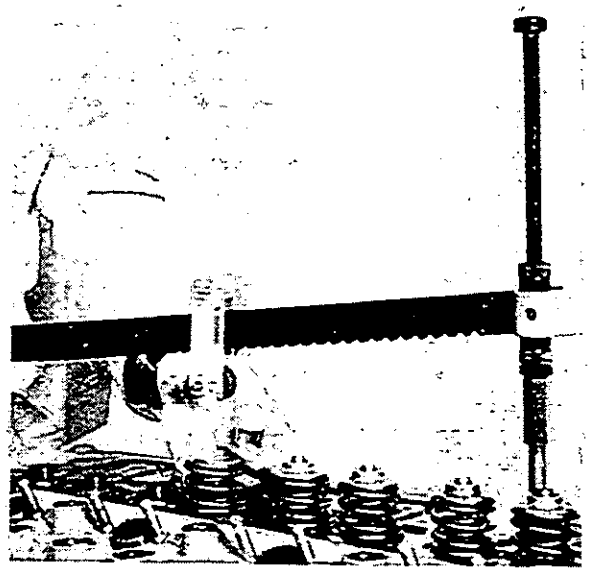
With current engines, valves are no longer marked, but if they are to be used again, they should be suitably marked to ensure they are replaced in their original positions.

Fit a suitable stud in one of the rocker assembly securing setscrew holes and using Tool No. 6118B, see Fig. E.11, depress valve springs and remove split collets.

Remove spring retaining caps, springs, oil deflectors from inlet valves and spring seating washers. Remove valves.



E10



E11

Valve Assembly

Two springs are fitted to each valve, the outer springs are left hand coiled and the inner springs right hand coiled.

A sectional view of a fitted valve assembly is shown in Fig. E.12 and E.13.

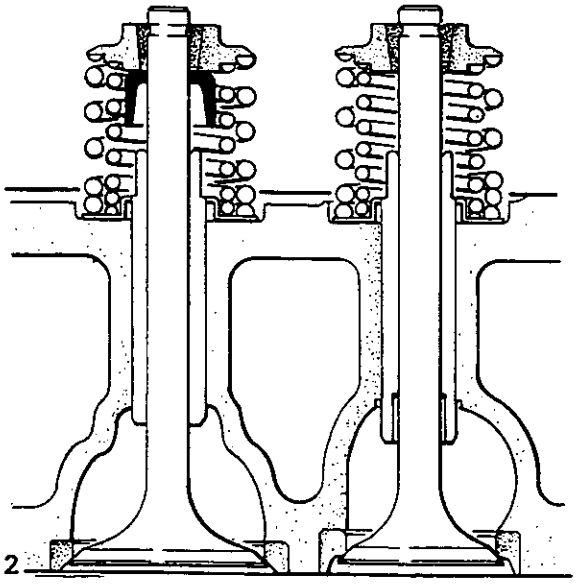
Two types of valve sealing arrangement can be found. Earlier arrangement is shown in Fig. E.12 whilst the later arrangement is shown in Fig. E.13.

To Fit Valves

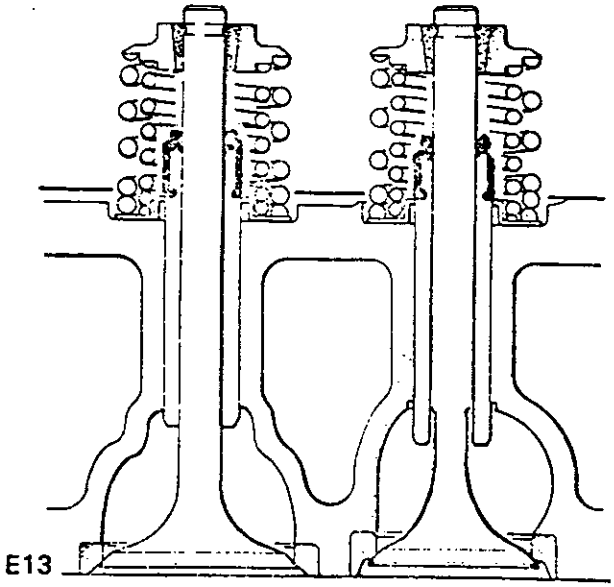
Lightly oil valve stems, and position the valves in their respective guides.

Later engines have chrome flashed valve stems with seals fitted to the valve guides. The exhaust valve guides for chrome flashed valves have no carbon brake counter bore: the carbon brake is a relief on the valve stem. Valves and guides are not individually interchangeable with the earlier types.

Position spring seating washers and fit oil deflectors onto the inlet valve stems with open end towards cylinder head.



E12



E13

Place inner and outer springs on seating washers with the damper coils towards the cylinder head, see Figs. E.12 or E.13.

Position the valve spring retaining caps and with a suitable compressor, depress the springs and fit the split collets.

Valve Guides

Examine valve guides for wear. The maximum permissible worn clearance of inlet valve stem in guide is 0.005 in (0,13 mm), and exhaust valve stem in guide is 0.006 in (0,15 mm) and if the clearance with new valve fitted exceeds this figure the guide should be replaced.

To fit new guides, press or drive out the worn guides, see Fig. E.14.

Smear the outer surface of the new guides with clean oil and using tool No. PD1C, see Fig. E.15, pull guide into the cylinder head using stop No. PD1C — 6 until 0.594in (5,08mm) of the guide is protruding from the valve spring recess.

Cylinder Head Overhaul

If water jacket of cylinder head shows sign of scale, a proprietary descaling solution should be used in accordance with the manufacturer's instructions.

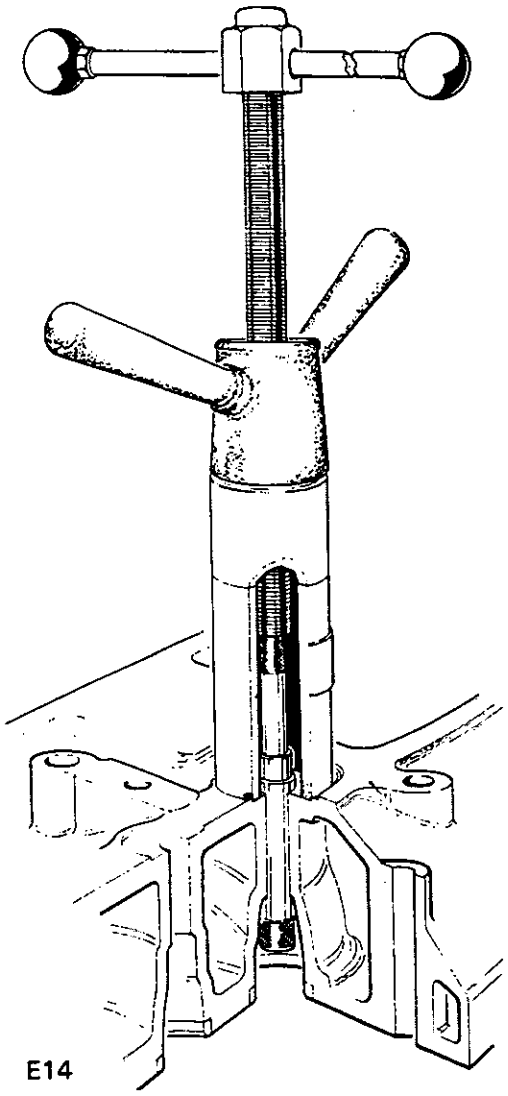
After cleaning head, check for cracks or other damage.

Maximum permissible longitudinal bow of cylinder head is 0.010 in (0,25 mm) and transverse bow is 0.005 in (0,13 mm).

The cylinder head can be skimmed by a maximum of 0.012 in (0,3 mm) provided that nozzle protrusion does not exceed 0.224in (5,69mm), see Fig. E.16. This figure must not be obtained by the use of additional atomiser sealing washers.

When grinding in valves, it is essential that no signs of pitting are left on the seatings.

Care should be taken to avoid unnecessary grinding away of the seat.



E14

After grinding, check the valve head depths relative to the cylinder head face, using tool PD41B The maximum permissible depth for both inlet and exhaust valves after servicing is 0.060 in (1.52 mm).

Where engines have to meet the smoke legislation requirement BSAU 141a: 1971, then the production limits should not be exceeded.

After any grinding or machining operation has been carried out, all parts should be washed in cleaning fluid.

Valves and Valve Seats

Examine valves for cracks. Check wear of valve stems and their fit in the valve guides.

Number all new valves to correspond with the numbering of old valves.

When fitting new valves, ensure that the depths relative to the cylinder head face are not less than that quoted on Page E.9. Correct valve head depths are important.

The valve seats in the cylinder head should be reconditioned by means of valve seat cutters as listed in approved tools at the end of this section, or specialised grinding equipment at an angle of 45°.

After reconditioning, valves and seats should be lightly ground in, keeping as narrow a seat as possible, and after grinding, the valve head depth should be checked.

Valve Seat Inserts

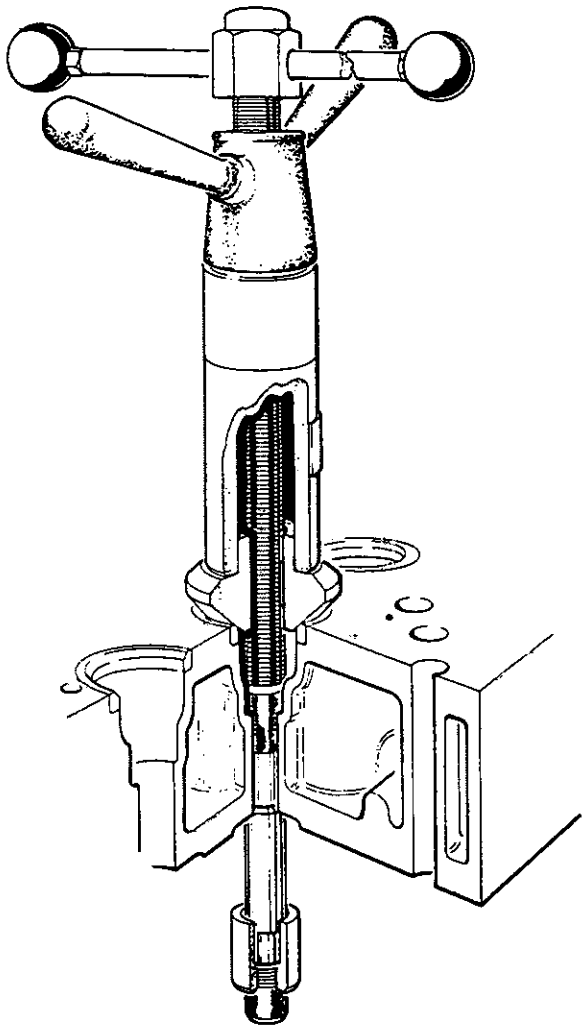
If the insert is damaged or unserviceable through wear, it must be removed and replaced with a new one.

Press out the existing valve guide and clean the guide bore.

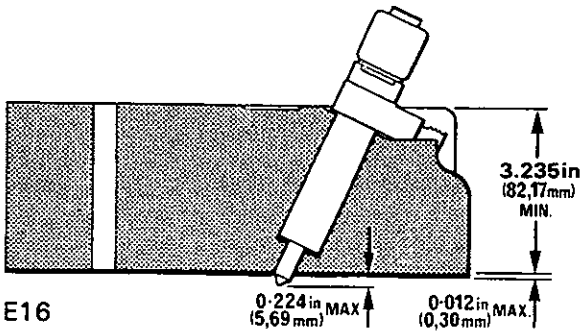
Press or machine out the old insert and remove all machining swarf and clean the insert recess.

Press in new guides as detailed on Page E.5.

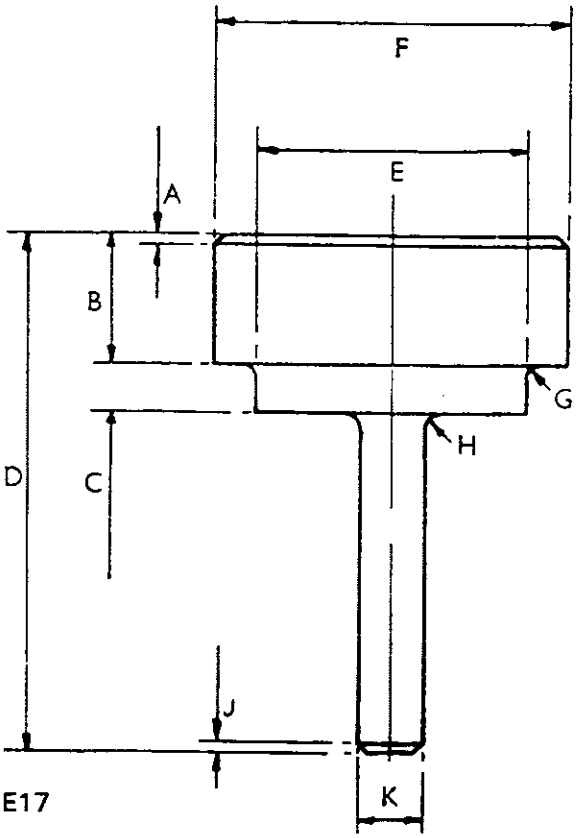
Using the valve guide bore as a pilot, press the insert home with the inserting tool, Fig. E.17. Do



E15



E16



E17

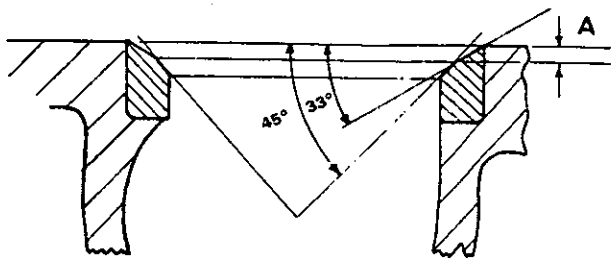
Key to Fig. E17

Inlet

A—1/16in (1,59 mm) at 45°
B—3/4in (19,05 mm)
C—0.250 in (6,35 mm)
D—3.0 in (76,20 mm)
E—1.582/1.583 in (40,18/40,21 mm)
F—2.009/2.019 in (51,03/51,28 mm)
G—1/32in (0,79 mm) radius
H—1/16in (1,59 mm) radius
J—1/16in (1,59 mm) at 45°
K—0.372/0.373 in (9,45/9,47 mm)

Exhaust

A—1/16in (1,59 mm) at 45°
B—3/4in (19,05 mm)
C—0.312 in (7,92 mm)
D—3.0 in (76,20 mm)
E—1.248/1.249 in (31,70/31,72 mm)
F—1.670/1.680 in (43,42/43,67 mm)
G—1/32in (0.79 mm) radius
H—1/16in (1,59 mm) radius
J—1/16in (1,59 mm) at 45°
K—0.372/0.373 in (9,45/9,47 mm)



E18

not hammer the insert home or use lubrication. Ensure that the insert is fully home and flush with the bottom of recess.

For inlet valve inserts using the valve guide bore as a pilot, machine the "flare" to the dimensions shown in Fig. E.18. Dimension A is 0.094/0.099in (2,39/2,52mm) for engines prior to Engine No. 3543U10342TL or 0.106/0.110in (2,69/2,79mm) for engines commencing at Engine No. 3543U10342TL.

Work as closely as possible to the minimum figure to allow for re-seating at a later date. When re-facing a valve the included angle of the contact face is 90°.

Lightly grind in valve and valve seat, keeping as narrow a seat as possible.

If the cylinder head has been skimmed, the insert will have to be surface ground on its back face so that, with insert fitted, faces of insert and cylinder head are level.

Atomiser Sleeve Renewal

The cylinder head must be removed before renewing an atomiser sleeve (see Fig. E.3).

The defective sleeve may be removed using tools 18G213A (5/8in in B.S.P. tap) and puller 18G213D.

After removing the sleeve, thoroughly clean the sleeve seating areas in the head and ensure that they are free from damage.

Annealing the new sleeve before fitment is not mandatory, but it will assist in obtaining a good seal.

Fit the new sleeve in position, gently tapping home if necessary.

The top of the sleeve should be rolled first using tool LC 173 (Fig. E.19) as follows:

(a) Lift the centre spindle and insert the body into the atomiser sleeve ensuring that the body flange abuts the rim of the sleeve and allow the centre spindle to drop.

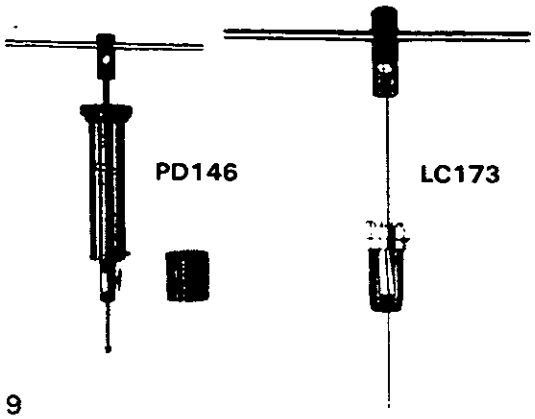
(b) Fit the tommy bar to the spindle, take up the slack and, using light pressure only, turn the spindle approximately twenty turns clockwise. The action of turning the spindle will automatically feed it downwards and expand the rollers; therefore only light pressure is needed.

(c) Unwind the spindle and remove the tool.

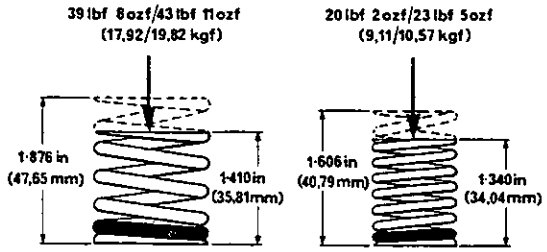
Fit the distance piece to the tool PD 146 (Fig. E.19) and roll the bottom seat using the same procedure as used for the top seat.

Pressure test the cylinder head.

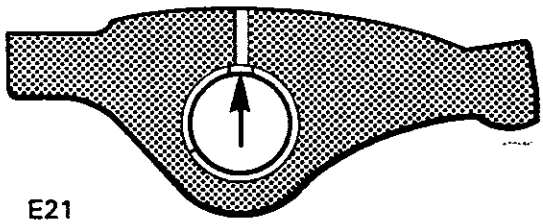
Note: Over-rolling can be detrimental to the sealing characteristics.



E19



E20



E21

Valve Springs

A new set of springs should be fitted at every major overhaul.

Examine the springs with regard to squareness of ends and pressure developed at fitted lengths, see Fig. E.20.

The inner springs require a load of 20.1/23.3 lbf (9,11/10,57 kgf) to compress them to fitted length 1.340 in (34,04 mm).

The outer springs require a load of 39.5/43.7 lbf (17,92/19,81 kgf) to compress them to fitted length 1.410 in (35,81 mm).

Rocker Shaft Assembly

To dismantle

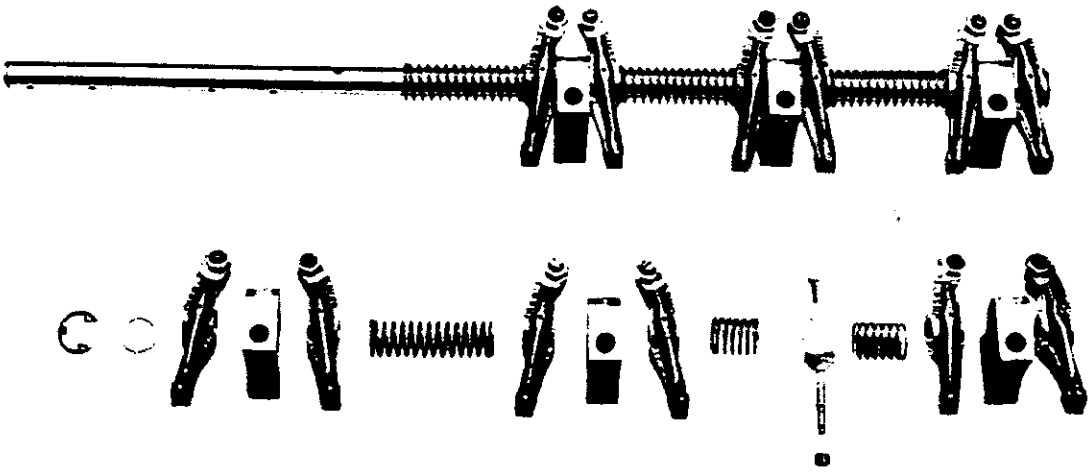
Remove circlips and washers from each end of shaft.

Withdraw rocker levers, springs and support brackets.

Remove the locating screw from the rocker oil feed connection and withdraw the connection.

Examine rocker lever bores and shaft for wear. The levers should be an easy fit on the shaft without excessive side play and there should be no indentation where the rocker taps the valve tip.

To renew the rocker lever bushes, press out the worn bushes and press in the new bushes making sure that the oil holes are in line, see Fig. E.21.



E22

Ream out to a diameter of 0.7505/0.7520 in (19,06/19,10 mm).

To assemble.

Fit oil feed connection to rocker shaft and secure with locating screw, ensuring that the screw enters the locating hole in the shaft.

Fit the support brackets, springs and rocker levers in the correct order, see Fig. E.22.

Fit securing washer and circlip to each end of the shaft.

Push Rods

Check push rods for straightness. If any are bent, fit replacements.

DATA AND DIMENSIONS FOR CYLINDER HEAD ASSEMBLY

Cylinder Head

Cylinder Head Depth	3.235/3.265 in (82,17/82,93 mm)
Leak Test Pressure	30 lbf/in² (2,11 kgf/cm²) or 207 kN/m²
Valve Seat Angle	45°
Valve Guide Parent Bore Diameter	0.6247/0.6257 in (15,87/15,89 mm)
Skimming Allowance	0.012 in (0,30 mm) Providing that nozzle protrusion does not exceed 0.224 in (5,69 mm) after skimming.

Valve Guides

Inside Diameter	0.3743/0.3757 in (9,51/9,54 mm)
Outside Diameter	0.6268/0.6273 in (15,92/15,93 mm)
Internal Diameter of Counterbore (exhaust)	0.421/0.441 in (10,69/11,20 mm)
Depth of Counterbore (exhaust)	0.39125/0.42125 in (9,94/10,70 mm)
Interference Fit of Guide in Cylinder Head	0.0011/0.0026 in (0,03/0,07 mm)
Overall length, Inlet	2.281 in (57,94 mm)
Overall length, Exhaust	2.406 in (61,12 mm)
Protrusion from Valve Spring Recess	0.594 in (15,09 mm)

Inlet Valve

Valve Stem Diameter	0.3725/0.3735 in (9,46/9,49 mm)
Clearance Fit of Valve in Guide	0.0008/0.0032 in (0,02/0,08 mm)
Maximum Permissible Worn Service Clearance of Valve in Guide	0.005 in (0,13 mm)
Valve Head Diameter	1.739/1.749 in (44,17/44,42 mm)
Valve Face Angle	45°
Production Valve Head Depth below Cylinder Head Face (prior to Engine No. 3543U10342TL).	0.027/0.036 in (0,69/0,91 mm)
Production Valve Head Depth below Cylinder Head Face (commencing Engine No. 3543U10342TL)	0.040/0.050 in (1,02/1,27 mm)
Valve Head Depth below Cylinder Head Face — Max. Permissible after Servicing	0.060 in (1,52 mm)
Overall Length	4.831/4.847 in (122,71/123,11 mm)
Sealing Arrangement	Rubber Deflector

Exhaust Valve

Valve Stem Diameter	0.372/0.373 in (9,45/9,47 mm)
Clearance Fit of Valve in Guide	0.0013/0.0037 in (0,03/0,09 mm)
Maximum Permissible Worn Service Clearance of Valve in Guide	0.006 in (0,15 mm)
Valve Head Diameter	1.467/1.477 in (37,26/37,52 mm)
Valve Face Angle	45°
Production Valve Head Depth below Cylinder Head Face (prior to Engine No. 3543U10342TL).	0.027/0.038 in (0,69/0,97 mm)
Production Valve Head Depth below Cylinder Head Face (commencing Engine No. 3543U10342TL)	0.040/0.050 in (1,02/1,27 mm)
Valve Head Depth below Cylinder Head Face — Max. Permissible after Servicing	0.060 in (1,52 mm)
Overall Length	4.846/4.862 in (123,09/123,49 mm)

Inner Valve Springs

Fitted length and Load	1.340 in (34,04 mm) at 20 lbf 2 ozf/23 lbf 5 ozf (9,11/10,57 kgf)
Number of Active Coils	4.9
Number of Damper Coils	1
Coiled	R.H.—Damper Coil to Cylinder Head

Outer Valve Springs

Fitted length and Load	1.410 in (35,81 mm) at 39 lbf 8 ozf/43 lbf 11 ozf (17,92/19,82 kgf)
Number of Active Coils	3.6
Number of Damper Coils	1
Coiled	L.H.—Damper Coil to Cylinder Head

Tappets

Overall Length	2.96875 in (75,41 mm)
Tappet Shank Diameter	0.7475/0.7485 in (18,91/19,01 mm)
Cylinder Block Tappet Bore Diameter	0.750/0.75125 in (19,05/19,08 mm)
Running Clearance of Tappet in Bore	0.0015/0.00375 in (0,04/0,09 mm)
Outside Diameter of Tappet Foot	1.1875 in (30,16 mm)

Rocker Shaft

Overall Length	26.03125 in (661,19 mm)
Outside Diameter	0.7485/0.7495 in (19,01/19,04 mm)

Rocker Levers and Bushes

Internal Bore Diameter of Rocker Lever for Bush	0.875/0.8762 in (22,22/22,26 mm)
Outside Diameter of Bush	0.877/0.8785 in (22,28/22,31 mm)
Interference Fit of Bush in Rocker Lever	0.0008/0.0035 in (0,02/0,09 mm)
Internal Diameter of Bush (after reaming in situ)	0.7505/0.7520 in (19,06/19.10 mm)
Clearance of Bush to Rocker Shaft	0.001/0.0035 in (0,25/0,09 mm)

Push Rods

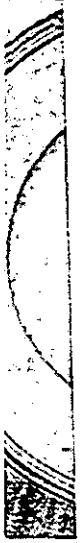
Overall Length of Push Rod	10.456/10.540 in (265,58/267,72 mm)
Shank Diameter	0.310/0.312 in (7,87/7,93 mm)

Approved Tools for Cylinder Head Assembly

Available from V.L. Churchill & Co. Ltd., Daventry, Northamptonshire, England.

Valve Spring Compressor	6118B
Adaptor for Valve Spring Compressor	PD 6118-4
Valve Guide Remover and Replacer	PD 1C
Adaptor for Valve Guide Remover	PD 1C-1
Stop for Valve Guide Replacer	PD 1C-6
Valve Seat Cutter Handle	316X
Valve Seat Cutter Pilot	316-12
Valve Seat Cutter Inlet	317-30
Valve Seat Cutter Exhaust	PD 317-22
Glaze Breaker	317G-30
Tension Wrench 50-170 lbf ft	13
Piston Height and Valve Depth Gauge	PD 41B
Atomiser Sleeve Remover	18G213D (puller) with 18G213A (tap)
Atomiser Sleeve Expander	LC 173 and PD 146

SECTION F
Pistons and Connecting Rods



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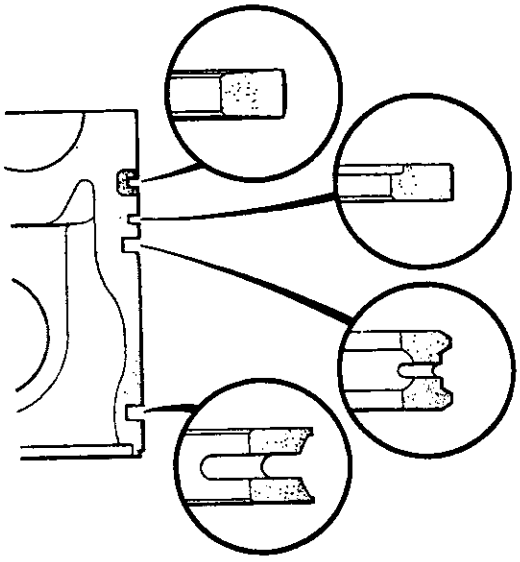


F7

To Fit Piston Rings

Piston ring layout, Fig. F.7, is as follows:-

No.1 Chrome Plated, Barrel Faced Compression
No.2 Chrome Plated, Flat Faced, Internally Stepped Compression
No.3 Chrome Faced, Spring Loaded Conformable Oil Control
No.4 Cast Iron, Slotted Oil Control

Fit rings as follows:-

Fit No.4 oil control ring.

Fit spring of No.3 oil control ring in groove, ensuring that latch pin enters both ends of spring, see Fig. F.8.

Position oil control ring over spring with spring correctly located in groove of ring and ring gap diametrically opposite to latch pin.

Fit internally stepped No.2 compression ring with "step" of ring and word "TOP" towards piston crown.

Fit barrel faced No.1 compression ring in top groove.

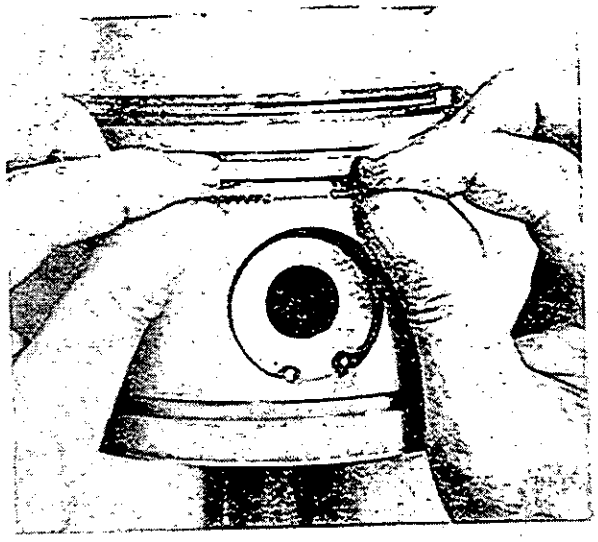
Ensure that ring gaps are equally spaced around piston and not in line.

To Fit Piston and Connecting Rod

Clean cylinder bore, piston and bearings and liberally coat with clean engine oil.

Compress piston rings with ring clamp 38U3 and enter the assemblies in the top of their respective cylinder bores, see Fig. F.9. The piston and rod number must relate to the cylinder into which it is being fitted, see Fig. F.10, and the rod identification number must be opposite to the camshaft.

When pressing the assembly through the bore, care must be taken to avoid damage to the piston



F8

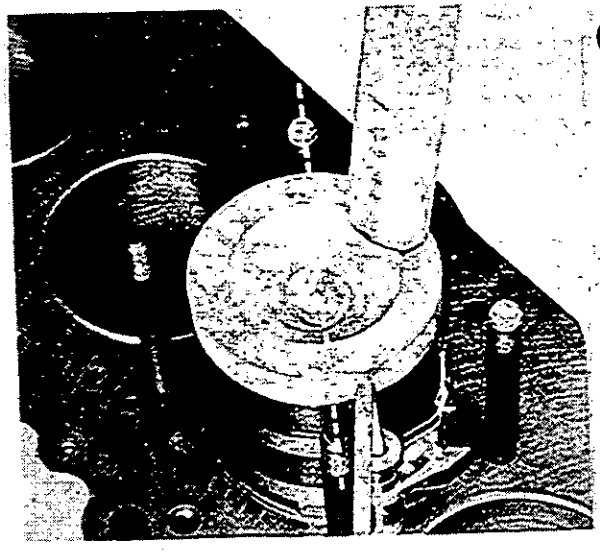
cooling jets. Fig. F.9 illustrates the piston position until the connecting rod big end has cleared the cooling jet area.

With the respective crankpin in B.D.C. position, ensure that the big end is turned to avoid contact with the piston cooling jets, see Fig. F.3.

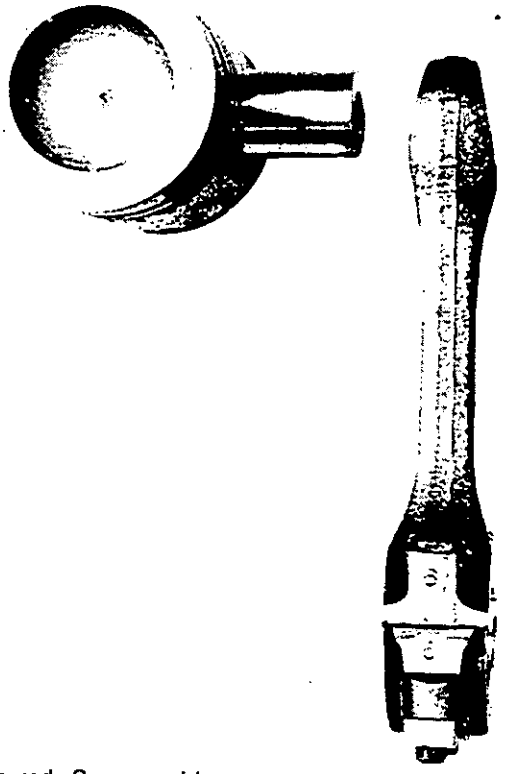
When the big end of the connecting rod has passed the piston cooling jets, turn the assembly back again to locate on the crankpin ensuring that upper half bearing is correctly located in big end and tabs fits in recess of rod, Fig. F.11. Also check that the word "FRONT" on the piston crown is towards the front of the engine.

Fit cap with lower half bearing correctly positioned and numbers of cap and rod coinciding, Fig. F.10.

Refit the two securing bolts so that the flat on the head of each bolt is located against the shoulder



F9



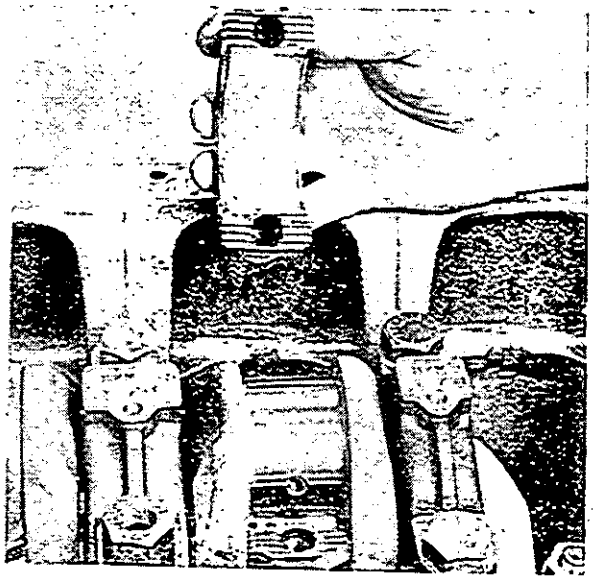
F10

of the rod. Secure with two nuts and tighten to a torque of 75lbfft (10,4kgfm-100Nm), or 70lbfft (9,7kgfm -96Nm) if prior to Engine No. 3543U1384T.

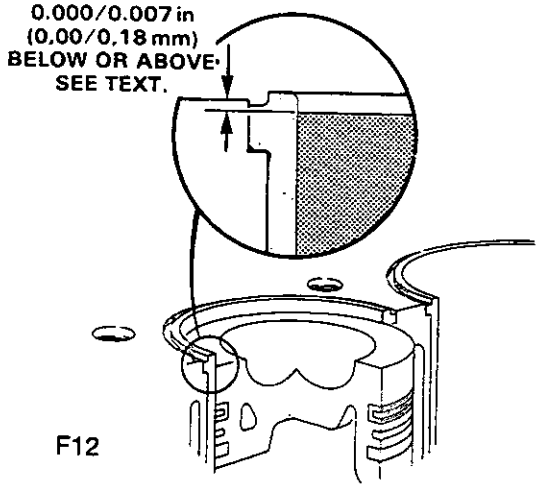
Check that, with piston in T.D.C. position and using piston height gauge PD 41B, the piston crown is 0.000/0.007in (0,00/0,18mm) **below** top face of cylinder block for engines prior to Engine No. 3543U10342TL or 0.000/0.007in (0,00/0,18mm) **above** the top face of the cylinder block for engines commencing at Engine No. 3543U10342TL, see Fig. F.12. This is important.

Where engines have to meet the smoke legislation requirements BSAU141a:1971, then production limits regarding piston heights must be maintained.

Fit the pipe from relief valve to piston cooling jet connection.



F11



F12

Fit lubricating oil suction pipe.

Refit the lubricating oil sump, Page K.3, and refill with lubricating oil to correct specification.

Refit the cylinder head, see Page E.3.

DATA AND DIMENSIONS FOR PISTONS AND CONNECTING RODS

All threads used are Unified Series. The following figures are based mainly upon those used in the factory for production.

Pistons

Type	Toroidal Cavity in Crown
Overall Height	4.2635in (108,29mm)
Piston Height in relation to Cylinder Block Top Face (prior to Engine No. 3543U10342TL)	0.000/0.007in (0,00/0,18mm) BELOW
Piston Height in relation to Cylinder Block Top Face (commencing Engine No. 3543U10342TL)	0.000/0.007in (0,00/0,18mm) ABOVE
Bore Diameter for Gudgeon Pin	1.49985/1.50005in (38,096/38,101mm)
Compression Ring Groove Width No. 1	Tapered
Compression Ring Groove Width No. 2	0.0958/0.0968in (2,43/2,46mm)
Scraper Ring Groove Width Nos. 3 and 4	0.190/0.191in (4,83/4,85mm)