workshop manual for T6.3544, 6.3544 and 6.3724 diesel engines

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This publication is written for world wide use. In territories where legal requirements govern smoke emission, noise, safety factors, etc., then all instructions, data and dimensions given must be applied in such a way that, after servicing (preventive maintenance) or repairing an engine, it does not contravene the local regulations in use.

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This publication is published by the Technical Publications Department of Perkins Engines Limited and every endeavour is made to ensure that the information contained in this Manual is correct at the date of publication but, due to continuous developments, the manufacturers reserve the right to make alterations without notice.

USE ONLY
GENUINE
PERKINS PARTS

TO ENSURE YOU OBTAIN THE BEST RESULTS FROM YOUR ENGINE AND TO SAFEGUARD YOUR OWN GUARANTEE, FIT ONLY GENUINE PERKINS PARTS. THESE ARE READILY OBTAINABLE THROUGHOUT THE WORLD.

FOREWORD

This Workshop Manual has been compiled for use in conjunction with normal workshop practice. Mention of certain accepted practices, therefore, has been purposely omitted in order to avoid repetition.

Reference to renewing joints and cleaning off joint faces, has to a great extent been omitted from the text, it being understood that this will be carried out where applicable.

Similarly, it is understood that in re-assembly and inspection, all parts are to be thoroughly cleaned, and where present, burrs and scale are to be removed.

It follows that any open ports of high precision components, e.g. fuel injection equipment, exposed by dismantling, will be blanked off until re-assembled, to prevent the ingress of foreign matter.

When fitting setscrews or studs into holes which are tapped through into the interior of the engine, a suitable sealant should be used.

New type M.E.A.S. (micro encapsulated anaerobic sealant) fasteners are being introduced so that jointing compounds or other sealants need not be used when the fasteners are fitted in through holes into oil or waterways.

The identification of these fasteners, as supplied, is by a red, blue, or other colour sealant around the fastener threads.

With M.E.A.S. sealed studs, the sealed end must be fitted into the cylinder head/cylinder block etc.

Ensure that the threaded holes have a 1,59mm (1/16in) 45° chamfer, so that when the new fasteners are fitted the M.E.A.S. sealant is not removed.

If the fasteners have to be removed and fitted again, the threads must be cleaned and a suitable sealant used.

Throughout this manual, whenever "left" or "right" hand side of the engine is referred to, it is that side of the engine when viewed from the flywheel end.

Engine Number location

With earlier engines, the engine number was stamped on the auxiliary drive housing immediately below the fuel injection pump – see Figs. A1 and A3 (item 10). It consists of figures and letters, e.g., 3544U251T. The first three figures represent the cubic capacity, i.e., 354 in^3: the fourth figure denotes the engine model and the letter "U" signifies that the engine was built in the United Kingdom. The last group of figures comprises the engine serial number. Other letters which may follow the serial number denote specific information, i.e., a letter "T" indicates a turbocharged engine: a letter "L" indicates a lip type seal on the rear end of the crankshaft.

For current engines, the engine number consists of fifteen letters and figures, a typical number being TW30016U510256D.

In all cases, the engine number when quoted, should be **in full.**

Running in Procedure

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 is first allowed to reach a temperature of at least 140° F (60° C).**

SAFETY PRECAUTIONS

THESE SAFETY PRECAUTIONS ARE IMPORTANT. Refer also to the local and government regulations applicable in your jurisdiction.

Do not use these engines in marine applications.

Do not modify the engine.

Do not smoke when refuelling.

Always remove spilt fuel and soaked clothing to a safe place.

Do not refuel whilst the engine is running (unless absolutely necessary).

Never clean, lubricate or adjust the engine whilst it is running (unless qualified to do so, in which case, extreme care should be taken to avoid injury).

Do not attempt any adjustments you do not understand.

Ensure the engine is positioned so as to prevent a build-up of toxic emissions.

Warn persons in the area to keep well clear during engine and equipment or vehicle operation.

Do not wear loose clothing or allow long hair near moving machinery.

Keep well clear of rotating parts or machinery in operation. Note that fans are not clearly visible whilst the engine is running.

Do not run the engine with any safety guards removed.

Do not remove the radiator cap whilst the engine is hot and coolant is under pressure as scalding can result.

On no account should sea water or any other electrolytic or corrosive medium be used in the cooling system.

Keep sparks or flames away from batteries as the gases from the electrolyte (especially whilst the battery is under charge) are highly inflammable. This acid is also dangerous to the skin and especially the eyes.

Always disconnect the battery terminals before repairing or interfering with the electrical system.

Only one person should be in control of the engine.

Always operate the engine from the control panel or operator's seat.

If your skin comes into contact with high pressure fuel, seek medical attention immediately.

Diesel fuel can cause skin infection to some people. Use protective gloves or hand cream.

Do not move mobile equipment without first ensuring that the brakes are in good working order.

Ensure that the transmission drive control is in 'Out of Drive' position before starting the engine.

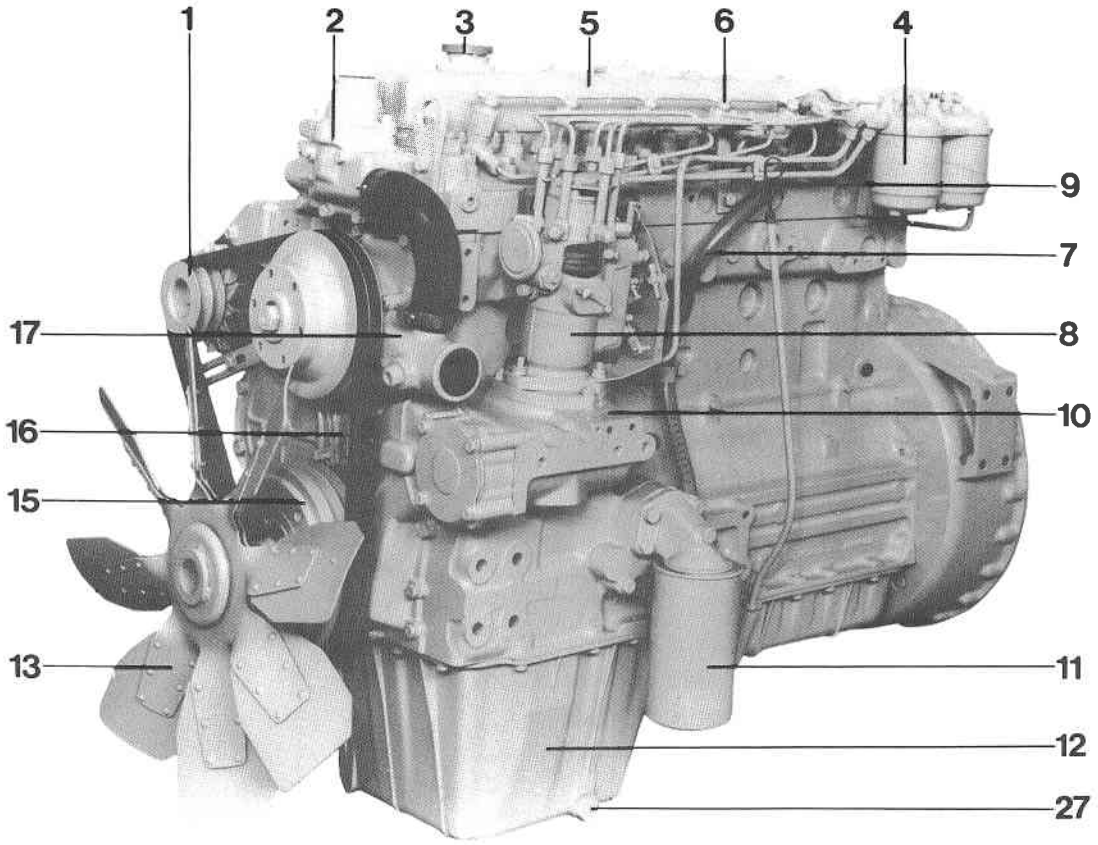
Fit only genuine Perkins Parts.

SAFETY IS SENSE. USE IT.

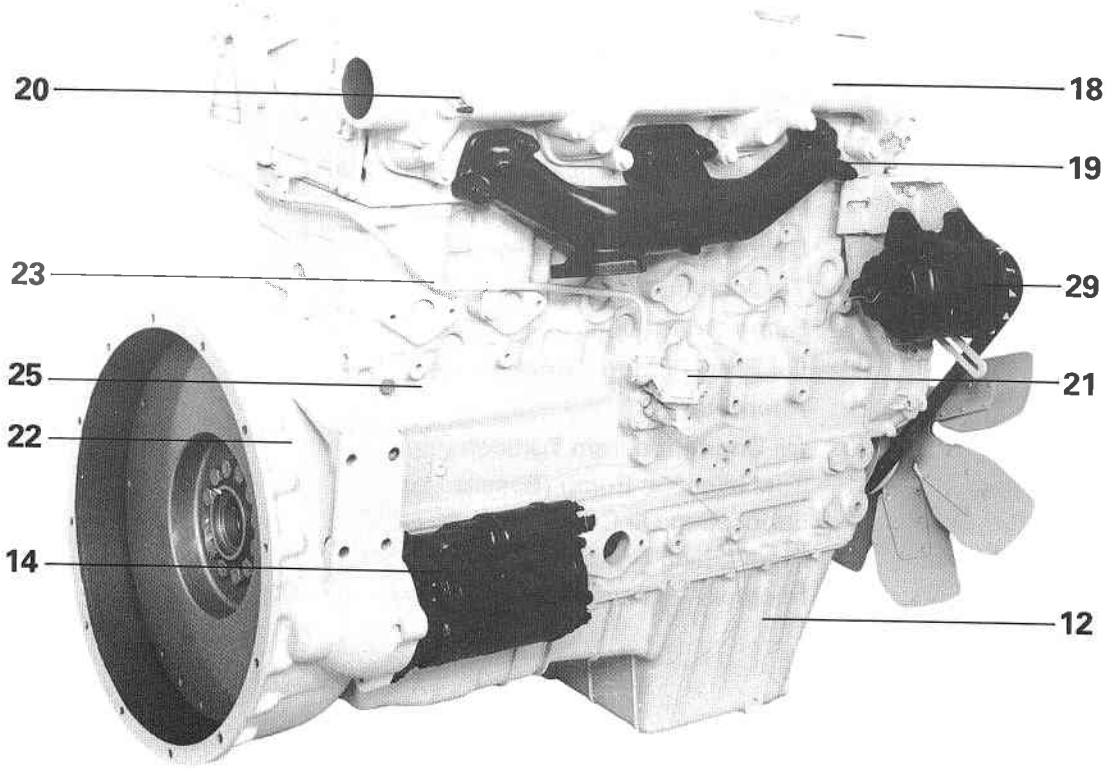
SECTION A
Engine Photographs

Perkins Engines are built to individual requirements to suit the applications for which they are intended and the following engine views do not necessarily typify any particular specification.

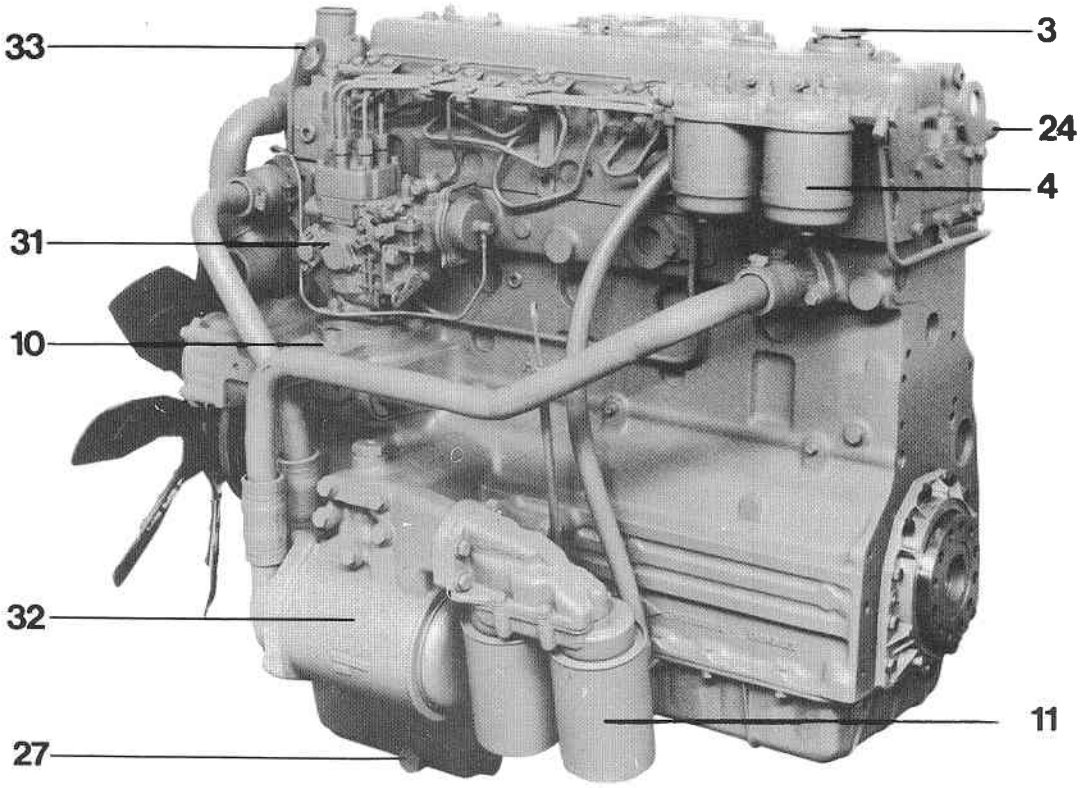
Index to Engine Photographs



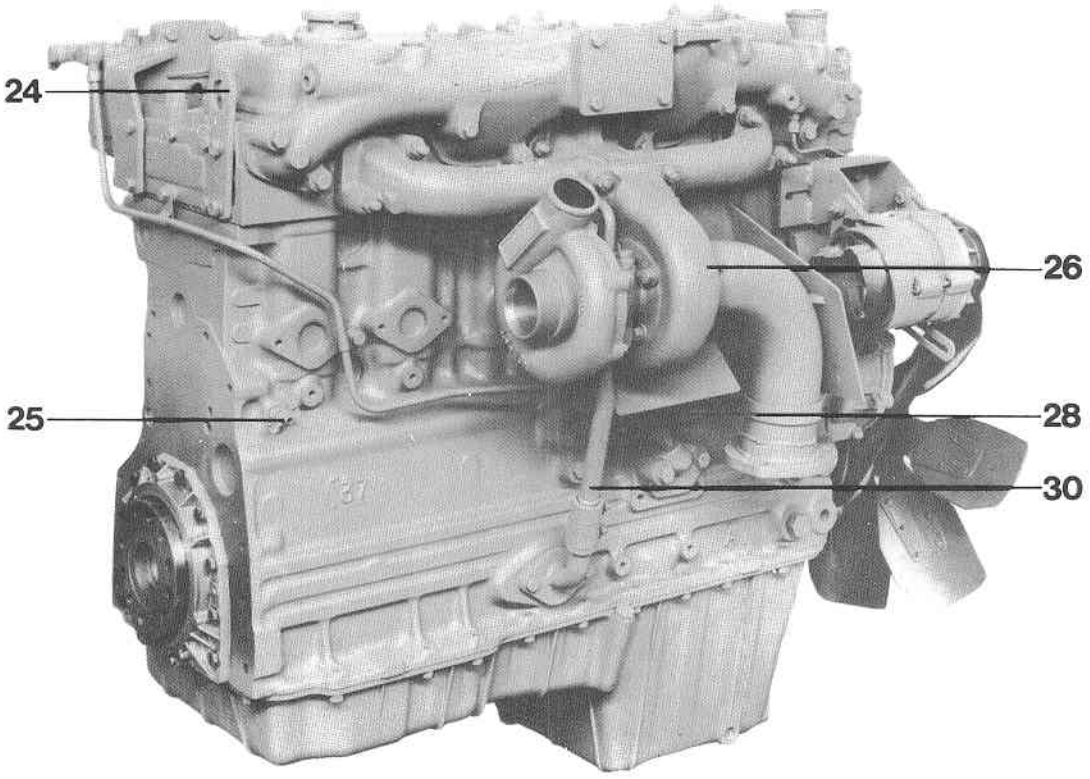
A.1 View of Fuel Pump Side of 6.3544 Engine



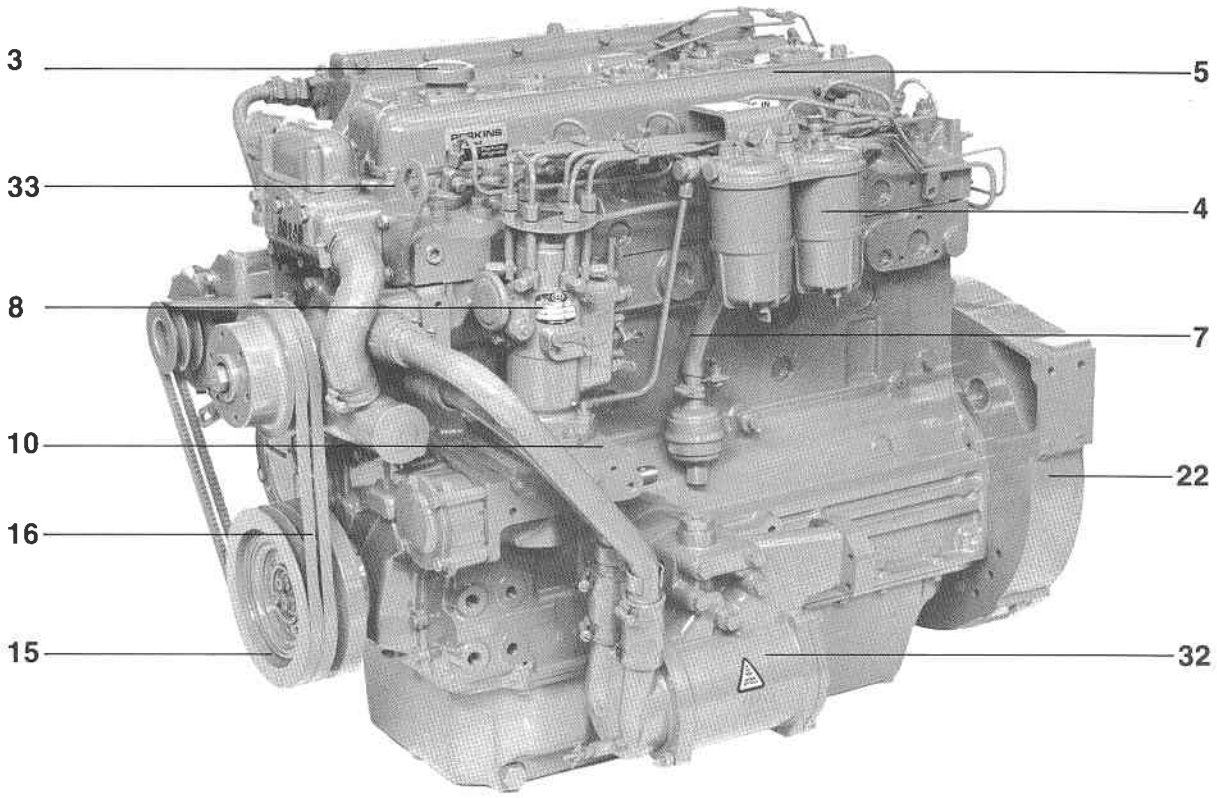
A.2 View of Camshaft Side of 6.3544 Engine



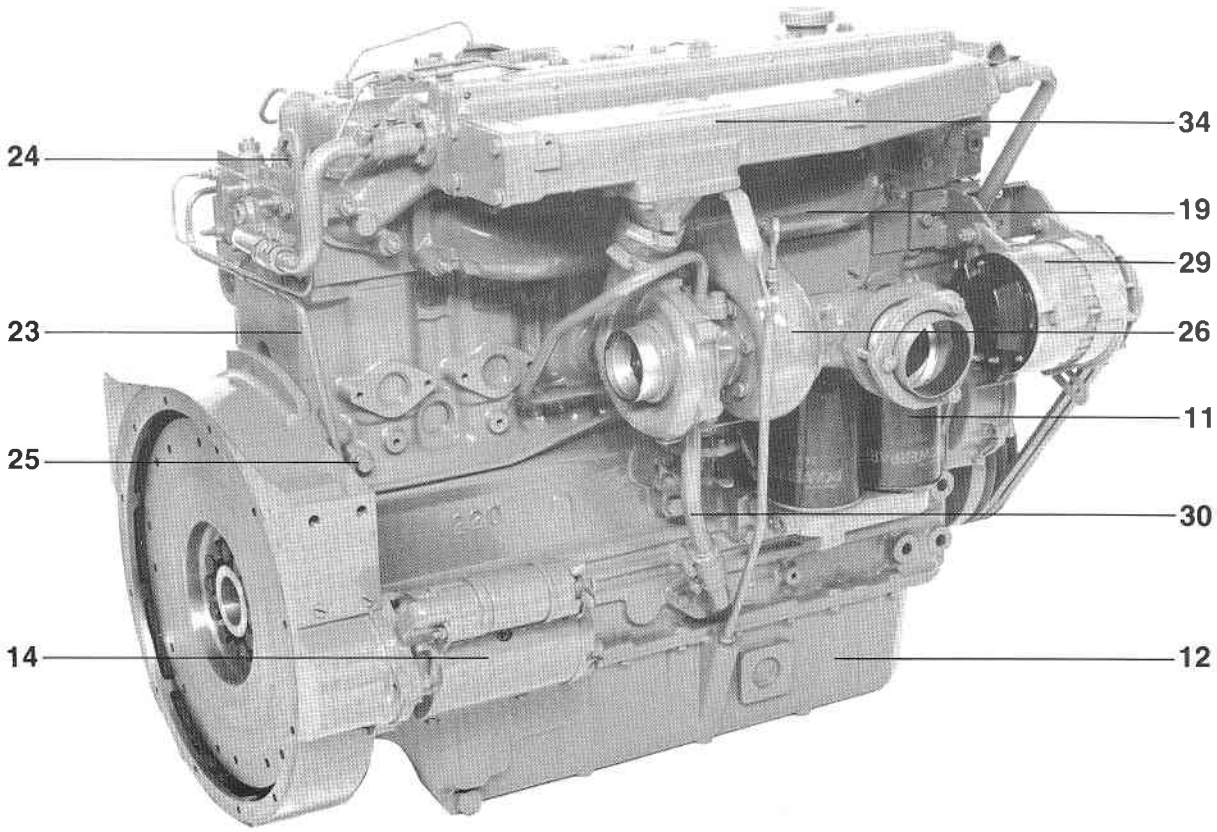
A.3 View of Fuel Pump side of T6.3544 Engine



A.4 View of Camshaft Side of T6.3544 Engine



A.5 View of Fuel Pump Side of T6.3544CC (Air Charge Cooled) Engine



A.6 View of Camshaft Side of T6.3544CC (Air Charge Cooled) Engine

SECTION B
Technical Data

Bore (T6.3544 and 6.3544 engines)	3.875 in (98,4 mm)*
Bore (6.3724 engines)	3.975 in (101 mm)*
Stroke	5 in (127 mm)
No. of cylinders	6
Cubic capacity (T6.3544 and 6.3544 engines)	354 in³ (5,8 litres)
Cubic capacity (6.3724 engines)	372 in³ (6,1 litres)
Compression ratio:	
T6.3544 engines	15.5: 1
North America vehicle T6.3544	16: 1
6.3544 engines	16: 1
6.3724 engines	16: 1
Firing order	1, 5, 3, 6, 2, 4
Combustion system	Direct injection
Cycle	4 stroke
Valve clearance (hot or cold)	
Inlet	0.008 in (0,20 mm)
Exhaust	0.018 in (0,46 mm)
Lubricating oil pressure	30 lbf/in² (2,1 kgf/cm²) or 207 kN/m² minimum at maximum working speed and normal operating temperature.
Turbocharger boost pressures (measured at induction manifold) T6.3544 engines only	11–13.5 lbf/in² (0,80–0,95 kgf/cm²) or 76–93 kN/m² These pressures will vary according to application, engine loads and speeds. They are for guidance purposes only.

*Nominal—for actual bore size see Page B.3.

Details of ratings

T6.3544CC Vehicle	119 kW (159 bhp) at 2,600 rev/min
Maximum torque	502 Nm (370 lbf ft) at 1,600 rev/min
T6.3544 Vehicle	115 kW (155 bhp) at 2,600 rev/min
Maximum torque	498 Nm (367 lbf ft) at 1,700 rev/min
T6.3544 North America vehicle	104 kW (140 bhp) at 2,600 rev/min
Maximum torque	470,5 Nm (347 lbf ft) at 1,700 rev/min
T6.3544 Agricultural and Industrial	107 kW (143 bhp) at 2,500 rev/min
Maximum torque	469 Nm (346 lbf ft) at 1,600 rev/min
6.3544 Premium Vehicle	95,5 kW (128 bhp) at 2,800 rev/min
Maximum torque	380 Nm (280 lbf ft) at 1,500 rev/min
6.3544 Agricultural and Industrial	91 kW (122 bhp) at 2,600 rev/min
Maximum torque	384 Nm (283 lbf ft) at 1,400 rev/min
6.3724 Agricultural engines	90 kW (121 bhp) at 2,500 rev/min
Maximum torque	396 Nm (292 lbf ft) at 1,450 rev/min

The above ratings are maximum and can vary according to application.

Engine weights

Typical dry weight	940 - 960 lb (425 - 435 kg)
Typical installed weight	1100 - 1170 lb (500 - 530 kg)

Recommended torque tensions

The following figures will apply with the components lightly lubricated with clean engine oil

	Screw size UNF	lbf ft	kgf m	Nm
Cylinder head nuts and setscrews (with formed washer face) — cold	½	115	15,9	156
Cylinder head nuts and setscrews (with formed washer face) — hot	½	105	14,5	142
Cylinder head nuts and setscrews (with separate washers)	½	95	13,1	129
Cylinder head setscrews	5/16	28	3,9	38
Connecting Rod Nuts (Cadmium Plated)	½	75	10,4	102
Connecting Rod Nuts (Phosphated)	½	95	13,1	129
Main bearing setscrews	⅝	200	27,7	270
Idler gear hub nuts	⅜	36	5,0	49
Fuel lift pump setscrews	5/16	20	2,8	27
Sump securing setscrews	5/16	15	2,1	20

(continued)—

Recommended torque tensions (continued)

The following figures will apply with the components lightly oiled.

Component	Screw size UNF	lbf ft	kgf m	Nm
Flywheel securing setscrews	1/2	80	11,1	108
Flywheel housing securing setscrews (standard)	3/8	36	5,0	49
Flywheel housing securing setscrews (standard)	7/16	45	6,2	61
Flywheel housing securing setscrews (Durlok*)	3/8	67	9,3	91
Flywheel housing securing setscrews (Durlok*)	7/16(UNC)	104	14,4	141
Camshaft gear setscrews	1/2	50	6,9	68
Crankshaft pulley setscrews (cadmium plated)	7/16	65	9,0	88
Crankshaft pulley setscrews (phosphated)	7/16	92	12,7	125
Piston cooling jet banjo bolt (where fitted)	3/8	20	2,8	27
Rocker shaft bracket setscrews or nuts	7/16	55	7,6	75
Oil cooler to cylinder block, setscrews (where fitted)	7/16	50	6,9	68
Lubricating oil filter setscrews	7/16	30	4,1	40
Atomiser Securing nuts/setscrews	5/16	12	1,7	16
Auxiliary drive shaft gear setscrews	5/16	22	3,0	30
High pressure fuel pipe nuts	12 x 1,5 mm	15	2,1	20
Alternator pulley nut	9/16	30	4,1	40
Thermostart unit		10	1,4	13
Thermostart insulating adaptor		10	1,4	13

*Durlok setscrews have a formed washer face with radial serrations.

649/3880/3090

The following table is given as a general guide, to be applied on a percentage basis, where specific figures for a particular engine rating are not available.

Altitude	Maximum fuel delivery de-rating*
0/2000 ft (600 metre)	No change
2000/4000 ft (1200 metre)	6%
4000/6000 ft (1800 metre)	12%
6000/8000 ft (2400 metre)	18%
8000/10000 ft (3000 metre)	24%
10000/12000 ft (3600 metre)	30%

*Measured at setting speed given on pump setting code.

It should be noted that the above information only applies to **naturally aspirated engines.** For **turbocharged engines** apply to Service Department, Perkins Engines Ltd., Peterborough or one of the Companies listed on Page 2.

MANUFACTURING DATA AND DIMENSIONS

All threads used, except perhaps on proprietary equipment are Unified Series and American Pipe Series.

The following data of clearances and tolerances are given as a guide for personnel engaged upon major overhauls and the figures are those used in the factory for production purposes.

Cylinder Block

Height between Top and Bottom Faces	17.367/17.375 in (441,12/441,32 mm)
Parent Bore Diameter for Cylinder Liner (T6.3544/6.3544)	4.0625/4.0635 in (103,19/103,21 mm)
Parent Bore Diameter for Cylinder Liner (6.3724)	4.1025/4.1035 in (104,20/104,23 mm)
Recess Depth for Cylinder Liner Flange	0.150/0.154 in (3,81/3,91 mm)
Recess Diameter for Cylinder Liner Flange (T6.3544/6.3544)	4.205/4.210 in (106,81/106,94 mm)
Recess Diameter for Cylinder Liner Flange (6.3724)	4.245/4.250 in (107,82/107,95 mm)
Main Bearing Parent Bore	3.166/3.167 in (80,42/80,44 mm)
Camshaft Bore Diameter, No. 1	2.000/2.001 in (50,80/50,83 mm)
Camshaft Bore Diameter, No. 2	1.990/1.992 in (50,55/50,60 mm)
Camshaft Bore Diameter, No. 3	1.980/1.982 in (50,29/50,34 mm)
Camshaft Bore Diameter, No. 4	1.970/1.972 in (50,04/50,09 mm)

Cylinder Liners (Cast Iron—Flanged)—T6.3544/6.3544

Type	Dry—Interference Fit—Production Dry—Transition Fit—Service
Outside Diameter of Production Liner	4.0645/4.0655 in (103,24/103,26 mm)
Interference Fit of Production Liner	0.001/0.003 in (0,03/0,08 mm)
Inside Diameter of Production Liner after Finish Honing	3.877/3.878 in (98,48/98,50 mm)
Transition Fit of Service Liner	-0.001/+0.001 in (-0.025/+0.025 mm)
Inside Diameter of Service Liner after fitting	3.877/3.8795 in (98,48/98,54 mm)
Flange Thickness	0.150/0.152 in (3.81/3.86 mm)
Height of Liner above Cylinder Block Top Face	0.026/0.037 in (0,66/0,94 mm)
Position of Liner Flange Relative to Top Face of Cylinder Block	+0.002/-0.004 in (+0,05/-0,10 mm)

Cylinder Liners (Cast Iron—Flanged)—6.3724

Type	Dry—Interference Fit—Production
Outside Diameter	4.1045/4.1055 in (104,25/104,28 mm)
Interference Fit of Liner	0.001/0.003 in (0,03/0,08 mm)
Inside Diameter of Liner after Finish Honing	3.9785/3.9795 in (101,05/101,08 mm)
Flange Thickness	0.150/0.152 in (3,81/3,86 mm)
Height of Liner above Cylinder Block Top Face	0.028/0.035 in (0,71/0,89 mm)
Position of Liner Flange relative to Cylinder Block Top Face	+0.002/-0.004 in (+0,05/-0,10 mm)

Pistons (T6.3544)

Type	Toroidal Cavity in Crown
Piston Height in Relation to Cylinder Block Top Face	0.000/0.007 in (0,00/0,18 mm) above
Bore Diameter for Gudgeon Pin	1.5000/1.5002 in (38,100/38,105 mm)
Compression Ring Groove Width, No. 1	Tapered
Compression Ring Groove Width, No. 2	0.0955/0.0963 in (2,43/2,45 mm)
Scraper Ring Groove Width, No. 3	0.1885/0.1893 in (4,79/4,81 mm)

Pistons (T6.3544 North America vehicles)

Type	Re-entrant Combustion Chamber in Crown
Piston Height in Relation to Cylinder Block Top Face	0.000/0.007 in (0,00/0,18 mm) above
Bore Diameter for Gudgeon Pin	1.5000/1.5002 in (38,100/38,105 mm)
Compression Ring Groove Width, No. 1	Tapered
Compression Ring Groove Width, No. 2	0.0959/0.0967 in (2,44/2,46 mm)
Scraper Ring Groove Width, No. 3	0.1900/0.1908 in (4,83/4,85 mm)

Pistons (6.3544)—3 Ring

Type	Toroidal Cavity in Crown
Piston Height in Relation to Cylinder Block Top Face	0.000/0.007 in (0,00/0,18 mm) above
Bore Diameter for Gudgeon Pin	1.3751/1.3754 in (34,928/34,935 mm)
Compression Ring Groove Width, No. 1	0.0959/0.0978 in (2,44/2,48 mm)
Compression Ring Groove Width, No. 2	0.0959/0.0970 in (2,44/2,46 mm)
Scraper Ring Groove Width, No. 3	0.1885/0.1893 in (4,79/4,81 mm)

Pistons (6.3544) 5 Ring

Type	Toroidal Cavity in Crown
Piston Height relative to Cylinder Block Top Face	0.000/0.007in (0,00/0,18mm) above
Bore Diameter for Gudgeon Pin	1.37485/1.37520in (34,921/34,930mm)
Compression Ring Groove Width, No. 1	0.0957/0.0967 in (2,43/2,46 mm)
Compression Ring Groove Width, No. 2	0.0957/0.0967 in (2,43/2,46 mm)
Compression Ring Groove Width, No. 3	0.0957/0.0967 in (2,43/2,46 mm)
Scraper Ring Groove Width, No. 4	0.2525/0.2535 in (6,41/6,44 mm)
Scraper Ring Groove Width, No. 5	0.2525/0.2535 in (6,41/6,44 mm)

Pistons (6.3724)

Type	Toroidal Cavity in Crown
Piston Height Relative to Cylinder Block Top Face	0.007/0.014 in (0,18/0,36 mm)
Bore Diameter for Gudgeon Pin	1.37485/1.37505 in (34,921/34,926 mm)
Compression Ring Groove Width, No. 1	0.0977/0.0987 in (2,48/2,51 mm)
Compression Ring Groove Width, No. 2	0.0957/0.0966 in (2,43/2,46 mm)
Scraper Ring Groove Width, No. 3	0.1895/0.1905 in (4,81/4,84 mm)
Scraper Ring Groove Width, No. 4	0.1895/0.1905 in (4,81/4,84 mm)

Piston Rings (T6.3544)

No. 1 Compression	Chrome or Molybdenum Faced Wedge
No. 2 Compression	Tapered Face
No. 3 Scraper	Chrome Faced Oil Control Conformable
Compression Ring Width, No. 1	Wedge
Compression Ring Width, No. 2	0.0930/0.0935in (2,36/2,37mm)
Scraper Ring Width, No. 3	0.1860/0.1875in (4,72/4,76mm)
No. 1 Clearance in Groove	Wedge
No. 2 Clearance in Groove	0.002/0.0038in (0,05/0,10mm)
No. 3 Clearance in Groove	0.0010/0.0033in (0,03/0,08mm)
Piston Ring Gap — No. 1	0.010/0.026in (0,25/0,66mm)
Piston Ring Gap — No. 2	0.012/0.030in (0,30/0,76mm)
Piston Ring Gap — No. 3	0.010/0.033in (0,25/0,84mm)

Piston Rings (T6.3544 North America vehicles)

No. 1 Compression	Chrome faced wedge
No. 2 Compression	Tapered face
No. 3 Scraper	Chrome faced oil control conformable
Compression Ring Width, No. 1	Wedge
Compression Ring Width, No. 2	0.0930/0.0935 in (2,36/2,37 mm)
Scraper Ring Width, No. 3	0.1860/0.1875 in (4,72/4,76 mm)
No. 1 Clearance in Groove	Wedge
No. 2 Clearance in Groove	0.0024/0.0037in (0,061/0,094mm)
No. 3 Clearance in Groove	0.0025/0.0048 in (0,06/0,122 mm)
Piston Ring Gap — No. 1	0.012/0.022 in (0,30/0,56 mm)
Piston Ring Gap — No. 2	0.012/0.022 in (0,30/0,56 mm)
Piston Ring Gap — No. 3	0.010/0.033 in (0,25/0,84 mm)

Piston Rings (6.3544 — 3 ring pack)

No. 1 Compression	Chrome Barrel Faced Internally Chamfered
No. 2 Compression	Chrome Taper Faced
No. 3 Scraper	Chrome Faced Oil Control Conformable
Compression Ring Width, No. 1	0.0930/0.0935 in (2,36/2,37 mm)
Compression Ring Width, No. 2	0.0930/0.0935 in (2,36/2,37 mm)
Scraper Ring Width, No. 3	0.1860/0.1875 in (4,72/4,76 mm)
No. 1 Clearance in Groove	0.0024/0.0048in (0,06/0,12mm)
No. 2 Clearance in Groove	0.0024/0.0040in (0,06/0,10mm)
No. 3 Clearance in Groove	0.0010/0.0033in (0,03/0,08mm)
Piston Ring Gap — No. 1	0.010/0.024in (0,25/0,61mm)
Piston Ring Gap — No. 2	0.016/0.034in (0,41/0,86mm)
Piston Ring Gap — No. 3	0.010/0.033in (0,25/0,84mm)

Piston Rings (6.3544—5 ring pack)

No. 1 Compression	Plain
Nos. 2 and 3 Compression	Internally Stepped
No. 4 Scraper	Chrome Faced Oil Control Conformable
No. 5 Scraper	Slotted Oil Control
Compression Ring Width, Nos. 1, 2 and 3	0.0928/0.0938in (2,36/2,38mm)
Scraper Ring Width, Nos. 4 and 5	0.249/0.250in (6,32/6,35mm)
Nos. 1, 2 and 3 Clearance in Groove	0.019/0.0039in (0,05/0,10mm)
Nos. 4 and 5 Clearance in Groove	0.0025/0.0045in (0,06/0,11mm)
Piston Ring Gaps – Cast Iron	0.012/0.030in (0,30/0,76mm)
Piston Ring Gaps – Chromed	0.016/0.034in (0,41/0,86mm)

Piston Rings (6.3724)

No. 1 Compression	Parallel Chrome Inlay
No. 2 Compression	Chrome Plated Internally Stepped or Internally Chamfered
No. 3 Scraper	Chrome Plated, Spring Expander
No. 4 Scraper	Slotted Oil Control
Compression Ring Width, Nos. 1 and 2	0.0928/0.0938 in (2,36/2,38 mm)
Scraper Ring Width Nos. 3 and 4	0.1865/0.1875 in (4,74/4,76 mm)
No. 1 Clearance in Groove	0.0039/0.0059 in (0,10/0,14 mm)
No. 2 Clearance in Groove	0.0019/0.0039 in (0,05/0,10 mm)
Nos. 3 and 4 Clearance in Groove	0.002/0.004 in (0,05/0,10 mm)
Piston Ring Gaps, Nos. 1, 2 and 3	0.016/0.034 in (0,41/0,86 mm)
Piston Ring Gap, No. 4	0.012/0.030 in (0,30/0,76 mm)

Gudgeon Pin (T6.3544)

Type	Fully Floating
Outside Diameter	1.4998/1.5000 in (38,095/38,100 mm)
Length	3.250/3.2599 in (82,55/82,80 mm)
Clearance Fit in Piston Boss	0.0000/0.0004 in (0,000/0,0010 mm)

Gudgeon Pin (6.3544 and 6.3724)

Type	Fully Floating
Outside Diameter	1.3748/1.3750 in (34,920/34,925 mm)
Length	3.297/3.312 in (83,74/84,12 mm)
Clearance Fit in Piston Boss	0.00012/0.00055 in (0,003/0,014 mm)

Small End Bush (T6.3544) (includes North America vehicle engines)

Type	Steel Backed, Lead Bronze Lined
Outside Diameter	1.65975/1.66125 in (42,16/42,20 mm)
Inside Diameter after Reaming	1.50075/1.5015 in (38,12/38,14 mm)
Clearance between Small End Bush and Gudgeon Pin	0.00075/0.0017 in (0,019/0,043 mm)

Small End Bush (6.3544 and 6.3724)

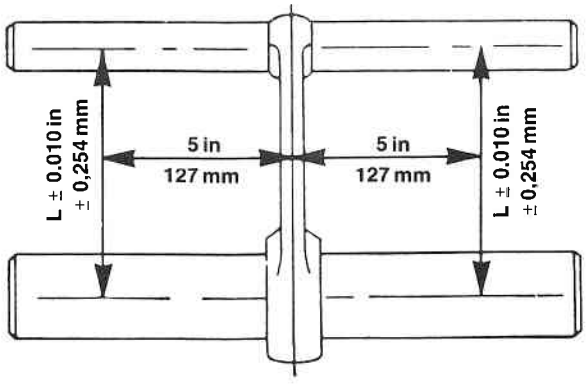
Type	Steel Backed, Lead Bronze Lined
Outside Diameter	1.535/1.5365 in (38,99/39,03 mm)
Inside Diameter after Reaming	1.3758/1.3765 in (34,94/34,96 mm)
Clearance between Small End Bush and Gudgeon Pin	0.0008/0.0017 in (0,020/0,043 mm)

Connecting Rod

Type	H Section T6.3544—Wedge Shaped Small End 6.3544—Parallel Shape Small End
Cap Location to Connecting Rod	Serrations
Big End Parent Bore Diameter	2.646/2.6465 in (67,21/67,22 mm)
Small End Parent Bore Diameter, T6.3544	1.65625/1.65725 in (42,07/42,09 mm)
6.3544 and 6.3724	1.5313/1.5323 in (38,90/38,92 mm)
Length from C/L of Big End to C/L of Small End	8.624/8.626 in (219,05/219,10 mm)

Connecting Rod Alignment

Large and small end bores must be square and parallel with each other within the limits of ± 0.010 in (0,25 mm) measured 5 in (127 mm) each side of the axis of the rod on a test mandrel as shown in Fig. B.1. With the small end bush fitted, the limit of ± 0.010 in (0,25 mm) is reduced to ± 0.0025 in (0,06 mm).



B.1

Crankshaft

Overall Length	33.844 in (859,64 mm) — nominal
Main Journal Diameter	2.9984/2.9996 in (76,16/76,19 mm)
Main Journal Length, No. 1	1.454/1.484 in (36,93/37,69 mm)
Main Journal Length, Nos. 2, 3, 5, 6 and 7	1.545/1.549 in (39,24/39,35 mm)
*Main Journal Length, No. 4	1.738/1.741 in (44,15/44,22 mm)
* Fillet Radii—Main Journals	0.145/0.156 in (3,68/3,96 mm)
Crankpin Diameter	2.4988/2.4998 in (63,47/63,49 mm)
*Crankpin Length	1.5885/1.5915 in (40,35/40,42 mm)
* Fillet Radii—Crankpins	0.145/0.156 in (3,68/3,96 mm)
Surface Finish—all pins and journals	16 micro-inches (0,4 microns)
Regrind Undersizes, Journals and Pins	−0.010, 0.020 and 0.030 in (−0,25, 0,51 and 0,76 mm)
Flange Diameter	5.247/5.249in (133,27/133,32mm)
Spigot Bearing Recess—Depth	0.579/0.609 in (14,71/15,47 mm)
Spigot Bearing Recess—Bore	2.046/2.047 in (51,97/51,99 mm)
Crankshaft End Float	0.002/0.015 in (0,05/0,38 mm)

* Fillet radii and surface finish must be maintained during crankshaft regrinding. Length of No. 4 main journal must not exceed 1.759in (44,68mm) after regrinding. Where necessary, use oversize thrust washers to suit. Length of crankpins not to exceed 1.5965 in (40,55 mm) after regrinding. For crankshaft journal run-out, see Page H.4.

IMPORTANT NOTE: See remarks on Page H.3 concerning the regrinding of 60 hour Nitrided crankshafts.

Crankshaft Thrust Washers

Type	Steel Backed, Lead Bronze Faced
Position in Engine	Centre Main Bearing
Thrust Washer Thickness—Standard	0.089/0.091in (2,26/2,31mm)
Thrust Washer Thickness—Oversize	0.0965/0.0985in (2,45/2,50mm)
Thrust Washer Outside Diameter	4.088/4.098in (103,84/104,09mm)
Thrust Washer Inside Diameter	3.42/3.43in (86,87/87,12mm)

Main Bearings

Type	Pre-finished, Steel Backed, Aluminium Silicon Faced
Shell Width, Nos. 1, 2, 3, 5, 6 and 7	1.240/1.255in (31,50/31,88mm)
Shell Width, No. 4	1.435/1.445in (36,45/36,70mm)
Outside Diameter	3.166/3.167in (80,42/80,44mm)
Inside Diameter	3.0010/3.0026in (76,225/76,266mm)
Main Bearing Running Clearance	0.0018/0.0042in (0,046/0,107mm)
Shell Thickness	0.0822/0.0825in (2,088/2,096mm)

Connecting Rod Bearings

Type	Pre-finished, Steel Backed, Aluminium Silicon or Aluminium Tin Faced
Shell Width	1.245/1.255in (31,62/31.88mm)
Outside Diameter	2.646/2.6465in (67,21/67,22mm)
Inside Diameter	2.5008/2.5019in (63,52/63,55mm)
Bearing Running Clearance	0.0012/0.0031in (0,030/0,08mm)
Shell Thickness	0.0723/0.0726in (1,836/1,844mm)

Camshaft

No. 1 Journal Length	1.085in (27,56mm)
No. 1 Journal Diameter	1.9965/1.9975in (50,71/50,74mm)
No. 1 Journal Running Clearance	0.0025/0.0045in (0,06/0,11mm)
No. 2 Journal Length	1.438in (36,53mm)
No. 2 Journal Diameter	1.9865/1.9875in (50,46/50,49mm)
No. 2 Journal Running Clearance	0.0025/0.0055in (0,06/0,14mm)
No. 3 Journal Length	1.438in (36,53mm)
No. 3 Journal Diameter	1.9765/1.9775in (50,20/50,23mm)
No. 3 Journal Running Clearance	0.0025/0.0055in (0,06/0,14mm)
No. 4 Journal Length	1.156in (29,37mm)
No. 4 Journal Diameter	1.9665/1.9675in (49,95/49,98mm)
No. 4 Journal Running Diameter	0.0025/0.0055in (0,06/0,14mm)
Cam Lift—Inlet (non-vehicle)	0.2959/0.2989in (7,516/7,592mm)
Cam Lift—Exhaust (non-vehicle)	0.3025/0.3055in (7,684/7,760mm)
Cam Lift—Inlet (vehicle only)	0.2999/0.3029in (7,617/7,694mm)
Cam Lift—Exhaust (vehicle only)	0.3036/0.3066in (7,711/7,788mm)
Camshaft End Float	0.004/0.016in (0,10/0,41mm)
Width of Spigot for Thrust Washer	0.222/0.232in (5,64/5,89mm)

Camshaft Thrust Washer

Type	360°
Outside Diameter	2.872/2.874 in (72,95/73,00 mm)
Cylinder Block Recess Diameter for Thrust Washer	2.875/2.885 in (73,03/73,28 mm)
Clearance Fit of Washer in Recess	0.001/0.013 in (0,03/0,33 mm)
Internal Diameter	1.750 in (44,45 mm)
Thickness	0.216/0.218 in (5,49/5,54 mm)
Cylinder Block Recess Depth for Thrust Washer	0.213/0.216 in (5,41/5,49 mm)
Protrusion of Thrust Washer above Cylinder Block Front Face	0.000/0.005 in (0,00/0,13 mm)

Cylinder Head

Cylinder Head Depth	3.735/3.765 in (94,87/95,63 mm)
Leak Test Pressure	30 lbf/in² (2,11 kgf/cm²) -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 0.184 in (4,67 mm) for T6.3544 engines or 0.136 in (3,45 mm) for 6.3544 and 6.3724 engines after skimming.

Valve Guides

Inside Diameter	0.3743/0.3757 in (9,51/9,54 mm)
Outside Diameter	0.626/0.6265 in (15,90/15,91 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 (61,11 mm)
Protrusion above Valve Spring Recess	0.594 in (15,09 mm)
Counter bore, Exhaust only	0.421/0.441 in (10,69/11,20 mm) dia. for length of 0.406 in (10,3 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	1.736/1.746 in (44,09/44,35 mm)
Valve Face Angle	45°
Valve Head Depth below Cylinder Head Face—Production Limits	0.040/0.050 in (1,02/1,27 mm)
Overall Length	4.831/4.847 in (122,71/123,11 mm)
Sealing Arrangement	Rubber seal fitted to valve guide

Exhaust Valve

Valve Stem Diameter	0.371/0.372 in (9,42/9,45 mm)
Clearance Fit to Valve in Guide	0.0023/0.0047 in (0,06/0,12 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°
Valve Head Depth below Cylinder Head Face—Production Limits	0.040/0.050 in (1,02/1,27 mm)
Overall Length	4.845/4.865 in (123,06/123,57 mm)
Sealing Arrangement	Rubber seal fitted to valve guide

Inner Valve Springs (short)

Fitted length and Load	1.340 in (34,04 mm) at 20.1/23.2 lbf (9,12/10,52 kgf) (89,4/103,2 N)
Number of Active Coils	4.9
Number of Damper Coils	1
Coiled	R.H.—Damper Coil to Cylinder Head

Inner Valve Springs (long)

Fitted length and Load	1.563 in (39,70 mm) at 14.63/16.67 lbf (6,64/7,56 kgf) (65,1/74,2 N)
Number of Active Coils	7
Number of Damper Coils	2
Coiled	R.H.—Damper Coils to Cylinder Head

Outer Valve Springs (short)

Fitted length and Load	1.410 in (35,81 mm) at 39.5/43.7 lbf (17,91/19,82 kgf) (175,7/194,4 N)
Number of Active Coils	3.6
Number of Damper Coils	1
Coiled	L.H.—Damper Coil to Cylinder Head

Outer Valve Springs (long)

Fitted length and Load	1.780 in (45,20 mm) at 38/43 lbf (17,25/19,52 kgf)
Number of Active Coils	5.8
Number of Damper Coils	2
Coiled	L.H. — Damper Coils 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 (0,03/0,09 mm)

Push Rods

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

Camshaft Gear

Number of Teeth	56
Bore Diameter	1.375/1.376 in (34,93/34,95 mm)
Outside Diameter of Camshaft Hub	1.3751/1.3757 in (34,93/34,94 mm)
Fit of Gear to hub	-0.0007/+0.0009 in (-0,018/+0,023 mm)

Auxiliary Drive Gear

Number of Teeth	28
Bore Diameter	1.000/1.001 in (25,4/25,43 mm)
Maximum Adjustment in Slotted Holes	10°

Crankshaft Gear

Number of Teeth	28
Bore Diameter	1.875/1.876 in (47,63/47,65 mm)
Crankshaft Diameter for Gear	1.875/1.8758 in (47,63/47,64 mm)
Fit of Gear to Crankshaft	-0.0008/+0.001 in (-0,020/+0,025 mm)

Idler Gears and Hubs

Number of Teeth	37
Bore Diameter	2.0625/2.0643 in (52,39/52,43 mm)
Outside Diameter of Bush	2.06625/2.06825 in (52,48/52,53 mm)
Inside Diameter of Bush (finished in situ)	1.8750/1.8766 in (47,63/47,67 mm)
Outside Diameter of Hub	1.8714/1.873 in (47,53/47,57 mm)
Clearance of Hub inside Bush	0.002/0.0052 in (0.05/0,13 mm)
End Float of Gears	0.002/0.012 in (0,05/0,30 mm)

Timing Gear Backlash

All Gears	0.003 in (0,08 mm) minimum

Auxiliary Drive Shaft Assembly

Drive Shaft—Overall Length	10.25 in (260,35 mm)
Number of Teeth on Worm	11
Outside Diameter of Worm	1.865/1.870 in (47,37/47,5 mm)
Diameter of Front Journal	1.9355/1.9365 in (49,16/49,19 mm)
Diameter of Rear Journal	1.248/1.249 in (31,7/31,72 mm)

Drive Shaft Bush—Front

Outside Diameter of Bush	2.1283/2.1303 in (54,06/54,11 mm)
Housing Diameter for Bush	2.125/2.1262 in (53,98/54,01 mm)

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Interference Fit in Housing	0.0021/0.0053 in (0,05/0,13 mm)
Inside Diameter of Fitted Bush	1.9375/1.9397 in (49,21/49,27 mm)
Running Clearance of Shaft in Bush	0.001/0.0042 in (0,025/0,11 mm)

Drive Shaft Bush—Rear

Outside Diameter of Bush	1.4086/1.4105 in (35,78/35,83 mm)
Housing Diameter for Bush	1.4063/1.4076 in (35,72/35,75 mm)
Interference Fit in Housing	0.001/0.0042 in (0,025/0,11 mm)
Inside Diameter of Fitted Bush	1.25/1.2519 in (31,75/31,80 mm)
Running Clearance of Shaft in Bush	0.001/0.0039 in (0.025/0,10 mm)

Auxiliary Drive Thrust Washers

Thickness	0.1875/0.1905 in (4,76/4,84 mm)
Cylinder Block Recess Depth for Thrust Washer	0.184/0.187 in (4,67/4,75 mm)
Outside Diameter	2.806/2.812 in (71,27/71,42 mm)
Inside Diameter of Cylinder Block Recess	2.8125/2.8225 in (71,44/71,69 mm)
Protrusion of Thrust Washer in Cylinder Block	0.0005/0.007 in (0,01/0,17 mm)
Groove Width on Drive Shaft	0.193/0.1965 in (4,9/4,99 mm)
Groove to Thrust Washer Clearance	0.0025/0.009 in (0,064/0,23 mm)

Hydraulically Loaded Wormwheel

Bore Diameter in Cylinder Block for Fuel Pump Adaptor Plate and Upper Thrust Collar	3.500/3.5014 in (88,90/88,94 mm)
Fuel Pump Adaptor Plate Diameter	3.4986/3.4995 in (88,86/88,89 mm)
Fit of Plate in Cylinder Block	0.0005/0.0028 in (0,01/0,07 mm)
Outer Diameter of Upper Thrust Collar	3.496/3.498 in (88,80/88,85 mm)
Clearance of Upper Thrust Collar in Cylinder Block	0.002/0.0054 in (0,05/0,14 mm)
Bore Diameter in Cylinder Block for Lower Thrust Washer	2.2491/2.2499 in (57,13/57,15 mm)
Width of Groove in Upper Thrust Collar	0.0957/0.0967 in (2,43/2,46 mm)
Upper Thrust Collar Sealing Ring Thickness	0.0928/0.0938 in (2,36/2,38 mm)
Clearance of Sealing Ring in Groove	0.0019/0.0039 in (0,05/0,10 mm)
Inner Diameter of Bush in Fuel Pump Adaptor Plate	1.875/1.8766 in (47,63/47,67 mm)
Upper Diameter of Fuel Pump Drive Shaft	1.8714/1.873 in (47,53/47,57 mm)
Clearance of Drive Shaft in Adaptor Plate Bush	0.002/0.0052 in (0,05/0,13 mm)
Inner Diameter of Upper Thrust Collar	1.886/1.89 in (47,90/48,01 mm)
Clearance of Drive Shaft in Upper Thrust Collar	0.013/0.0186 in (0,33/0.47 mm)
Current Engines:—	
Lower Thrust Collar Bore for Bush	1.7812/1.7828 in (45,24/45,28 mm)
Outer Diameter of Bush	1.7843/1.7857 in (45,32/45,36 mm)
Interference Fit of Bush in Thrust Collar	0.0015/0.0045 in (0,04/0,11 mm)
Inner Diameter of Bush (after finishing in situ)	1.6255/1.6266 in (41,29/41,32 mm)
Lower Diameter of Fuel Pump Drive Shaft	1.6214/1.6224 in (41,18/41,22 mm)
Clearance of Shaft in Bush	0.0031/0.0052 in (0,08/0,13 mm)
Early Engines:—	
Inner Diameter of Lower Thrust Collar	1.625/1.6266 in (41,28/41,32 mm)
Lower Diameter of Fuel Pump Drive Shaft	1.6214/1.6230 in (41,18/41,22 mm)
Clearance of Drive Shaft in Collar	0.002/0.0052 in (0,05/0,13 mm)

Sump

Sump Capacity (typical)	26 Imperial Pints (14,8 Litres)
Minimum to Maximum mark on Dipstick	5 Imperial Pints (2,84 Litres)
Strainer Position	Suction Pipe of Lubricating Oil Pump

Oil Pump

Type	Rotor

Oil Pump Clearance

Inner Rotor to Outer Rotor	0.003/0.005 in (0,08/0,13 mm)
Outer Rotor to Pump Body	0.006/0.013 in (0,15/0,33 mm)
Inner and Outer Rotor End Clearance	0.0005/0.0025 in (0,01/0,06 mm)

For replacement purposes, the whole pump assembly must be replaced.

Relief Valve

First Stage Pressure Setting (T6.3544 only)	30/37 lbf/in² (2,11/2,6 kgf/cm²) 207/255 kN/m²
Relief Flow Pressure Setting	50/60 lbf/in² (3,52/4,22 kgf/cm²) 348/414 kN/m²
Length of Plunger	0.9375 in (23,81 mm)
Outside Diameter of Plunger	0.7158/0.717 in (18,18/18,21 mm)
Inside Diameter of Valve Housing Bore	0.718/0.7192 in (18,24/18,27 mm)
Clearance of Plunger in Bore	0.001/0.0034 in (0,03/0,09 mm)
Free Length of Spring	2.3125 in (58,74 mm)
Spring Fitted Length and Load	2.1875 in (55,56 mm) at 3 lbf 8 ozf (1,58 kgf)

Lubricating Oil Filter

Type of Filter	Full Flow Replaceable Canister
Element Type	Paper
By-Pass Valve Setting	8/12 lbf/in² (0,56/0,84 kgf/cm²) 55/83 kN/m²

Cooling System

Type	Thermo-Syphon, Pump assisted.
Coolant Capacity	38 Imperial Pints, (21,6 litres)

Thermostat

Type	Twin Wax Capsule fitted in parallel
Opening Temperature	177/183° F (80,6/83,9° C)
Fully open at	199 - 204° F (93 - 96° C)
Valve Lift	0.374/0.500 in (9,50/12,70 mm)

Water Pump

Type	Centrifugal
Outside Diameter of Shaft for Pulley	0.8742/0.8747 in (22,20/22,22 mm)
Inside Diameter of Pulley Bore	0.8750/0.8758 in (22,23/22,25 mm)
Clearance Fit of Pulley on Shaft	0.0003/0.0016 in (0,01/0,04 mm)
Outside Diameter of Shaft for Impeller	0.5012/0.5018 in (12,73/12,75 mm)
Diameter of Impeller Bore	0.5000/0.5007 in (12,70/12,72 mm)
Interference Fit of Impeller on Shaft	0.0005/0.0018 in (0,013/0,046 mm)
Impeller Blade to Pump Body Clearance	0.011/0.035 in (0,28/0,89 mm) (including end float)

Approved Fuel Oil Specifications

United Kingdom	BS. 2869:1983	Class A1 or A2
United States	VV-F-800c	Grades DF-A, DF-1 or DF-2
	A.S.T.M./D975-81T	Grades DF-A, DF-1 or DF-2
France	AFNOR N.F.M. 15/007 (1978)	
India	1S:1460/1974	Grade HSD
Germany	DIN-51601 (1978)	————
Italy	CUNA-Gas Oil	————
	NC-630-01 (1977)	————
Sweden	SIS. 15 54 32 (1981)	————
Switzerland	SN 181 160/1	————

Fuel oils available in territories other than those listed above which are to an equivalent specification may be used.

Fuel Lift Pump

Type of Pump	A.C. Delco X D Series
Method of Drive	Eccentric on Camshaft
Delivery Pressure	6/10 lbf/in² (0,43/0,70 kgf/cm²) or 41/69 kN/m²
Diaphragm Spring Colour	Red

Fuel Filter

Type	Twin Parallel or single
Element Type	Paper

Fuel Injection Pump

Make	C.A.V.
Type	D.P.A.
Pump Rotation	Anti-clockwise
Timing Letter	"F"
No. 1 Cylinder Outlet	"X"
Make	Bosch
Type	Rotary
Pump Rotation	Anti-clockwise
No. 1 Cylinder Outlet	D

Fuel Injection Pump Static Checking Angles

The relevant timing information can be found by reference to the prefix letters or prefix letters and figures of the setting code adjacent to the word "Set" on the fuel pump identification plate and the table below. The engine checking angle is for use with timing tool MS67B and the engine set with No. 1 piston at TDC compression stroke.

Prefix Letters	Engine Checking Angle (Degrees)	Fuel Pump Marking Angle (Degrees)	Static Timing BTDC (Degrees)	Piston Displacement
T6.3544				
C.A.V. pumps				
CY	153	145	16	0.124in (3,15mm)
DY	160	144	32	0.485in (12,32mm)
JY	159	144	30	0.426in (10,82mm)
LX	159	144	30	0.426in (10,82mm)
LY	153	145	16	0.124in (3,15mm)
MY	159	144	30	0.426in (10,82mm)
TX	159	144	30	0.426in (10,82mm)
VR	159	144	30	0.426in (10,82mm)
XX	159	144	30	0.426in (10,82mm)
YX	160	144	32	0.483in (12,27mm)
ZX	159	144	30	0.426in (10,82mm)
Bosch pumps				
EY (L21-2)	135*	125½*	19	0.175in (4,45mm)
FY (L21-3)	135*	127½*	15	0.110in (2,79mm)
KY (L107)	123*	118*	10	0.049in (1,24mm)
VX (L21 or L73)	135*	127*	16	0.124in (3,15mm)
6.3544				
C.A.V. pumps				
AY	160	146	28	0.373in (9,47mm)
BY	160	146	28	0.373in (9,47mm)
EX	160	146	28	0.373in (9,47mm)
FX	160	146	28	0.373in (9,47mm)
GY	162	154	16	0.125in (3,18mm)
HY	162	154	16	0.125in (3,18mm)
MR	158	144	28	0.373in (9,47mm)
MX (except below)	160	146	28	0.373in (9,47mm)
MX/4/2640	161	146	30	0.426in (10,82mm)
MX/5/2420 from eng. no. 728207L	159	146	26	0.325in (8,26mm)
MX/5/2530	161	146	30	0.426in (10,82mm)
PX	160	146	28	0.373in (9,47mm)
SX	161	146	30	0.426in (10,82mm)
WR	160	146	28	0.373in (9,47mm)
WX	157	144	26	0.325in (8,26mm)
6.3724				
SX	161	146	30	0.426in (10,82mm)

* The settings given for the Bosch fuel pumps are with the pump set at 1 mm plunger lift. It is important that these pumps are not fitted at the static timing positions given for the CAV pumps. The code given in brackets is stamped on the side of the pump.

Atomisers

Code	Holder	Nozzle	Setting Pressure			Working Pressure		
			atm	lbf/in²	(MN/m²)	atm	lbf/in²	(MN/m²)
FL	BKBL67S5299	BDLL150S6673	215	3160	(21,8)	200	2940	(20,3)
FN	BKBL67S5299	BDLL150S6639	210	3087	(21,3)	195	2866	(19,8)
GD	BKBL67S5299 or OKLL67S2931	BDLL150S6730 or OLL150S6730	215	3160	(21,8)	200	2940	(20,3)
GG	BKBL67S5299	BDLL150S6737	210	3087	(21,3)	210	3087	(21,3)
GH	BKBL67S5299	BDLL150S6738	210	3087	(21,3)	210	3087	(21,3)
GK	KBEL62S9/13	DLLA150S741	275	4042	(27,9)	275	4042	(27,9)
GL	BKBL67S5151	BDLL150S6730	175	2572	(17,7)	170	2500	(17,2)
GX	KBEL64S21	DLLA140S827	250	3675	(25,3)	250	3675	(25,3)
HC	LRB67014* or OKLL66M2884	JB6801014 or OLL150M8575	245	3601	(24,8)	245	3600	(24,8)
HE	LRB67014*	JB6801019	230	3381	(23,3)	230	3381	(23,3)
HK	BKBL67S5299	BDLL135S6834	215	3160	(21,8)	215	3160	(21,8)
HP	LRB67014* or OKLL66M2884	JB6801014 or OLL150M8575	225	3307	(22,8)	225	3307	(22,8)
HS	BKBL67S5299 or OKLL67S2931	BDLL150S6730 or OLL150S6730	215	3160	(21,8)	200	2940	(20,3)
HT	LRB67014* or OKLL66M2884	JB6801019	200	2940	(20,3)	200	2940	(20,3)
RA	KBEL64116	DLLA140P44	250	3675	(25,3)	250	3675	(25,3)
RB	OKLL62M3136	OLL130M9027	250	3675	(25,3)	250	3675	(25,3)
VU	OKLL67S2929	OLL150S7574	250	3675	(25,3)	225	3307	(22,8)
Y	BKBL67S5151	BDLL150S6329	175	2572	(17,7)	170	2500	(17,2)

* In these atomisers the pressure is adjusted by a change of shims.

Electrical System ... ... 12 or 24 volt

Alternator

Make	Lucas						
Type	17ACR (derated)	17ACR	18ACR	A115	A133/55	25ACR	A133/65
Voltage	12V	12V	12V	12V	12V	12V	12V
Max. output (hot)	28A	35A	45A	45A	55A	65A	65A
Make	C.A.V.				Perkins		
Type	AC5 & AC5R		AC5 & AC5R		LR135		LR150
Voltage	12V		24V		12V		12V
Max. output (hot)	60A		30A		35A		50A

Starter motor

Make	Lucas		C.A.V.		Perkins
Type	M50	M127/2,8	CA45	CA45	S12-84
Voltage	12V	12V	12V	24V	12V
Starter cable resistance	0.0017Ω	0.0017Ω	0.0017Ω	0.0034Ω	0.0017Ω
No. of teeth on pinion	10	10	10	10	10

Starting Aid

Make	C.A.V. – Thermostart
Maximum Current Consumption	12.5/13.5A at 11.5V
Flow Rates through Thermostart	3,5/5,0 ml/min

SERVICE WEAR LIMITS

The following "wear limits" indicate the condition when it is recommended that the respective items should be serviced or replaced.

Cylinder Head Bow Transverse	0.005 in (0,13 mm)
Longitudinal	0.010 in (0,25 mm)
Maximum Bore Wear (when new liners are necessary)	0.008 in (0,20 mm)
Crankshaft, Main and Big End Journal, Ovality and Wear	0.0015 in (0,04 mm)
Maximum Crankshaft End Float	0.020 in (0,51 mm)
Valve Stem to Guide Bore Clearance, Inlet	0.005 in (0,13 mm)
Exhaust	0.006 in (0,15 mm)
Valve Head Depth below Cylinder Head Face	0.060 in (1,52 mm)
Rocker Clearance on Rocker Shaft	0.005 in (0,13 mm)
Camshaft Journals, Ovality and Wear	0.002 in (0,05 mm)
Camshaft End Float	0.021 in (0,53 mm)
Idler Gear End Float	0.015 in (0,38 mm)

SECTION C
Operating and Maintenance

To start the engine

There are several factors which affect engine start, for example:

The power of the batteries.
Performance of the starter motor.
Viscosity of the lubricating oil.
Installation of a cold start system.

Diesel engines need a cold starting aid when they are to operate in very cold conditions. Your vehicle will normally be fitted with the correct equipment for your area of operation.

Different systems of cold starting aids can be installed on Perkins diesel engines and they are:

Thermostart

An electrically operated device which heats the induction air. This device burns a controlled amount of diesel fuel.

Start Pilot

A hand pump discharges the cold start fluid into the induction manifold through an atomiser. The cold start fluid is held in a separate reservoir.

KBi

The cold start fluid is held in an aerosol container. It is released by a push button operated solenoid and sprayed into the induction manifold by a nozzle.

WARNING
KBi or Start Pilot equipment must not be used with heat type cold starting aids such as Thermostart.

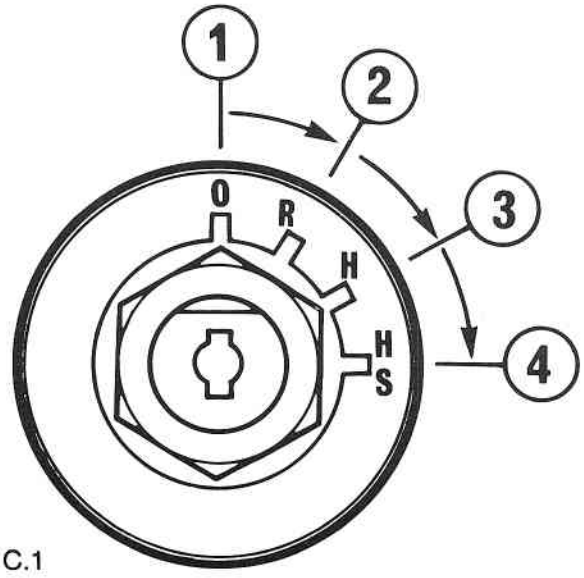
Engine start procedure, without cold starting aids.

1. Adjust the engine speed control to the maximum speed position.
2. Turn the start key to the 'S' (start) position, (see Fig. C1) to engage the starter motor.
3. As soon as the engine starts, release the start key to the 'R' (run) position.
4. Adjust the engine speed control.
5. If the engine does not start in 15 seconds, release the start key to the 'R' position. Do not engage the starter motor again until 10 to 15 seconds have passed.

Always ensure that the flywheel and starter motor have stopped their rotation before the starter motor is engaged again.

Engine start procedure with Thermostart.

1. Where a separate stop control is installed, ensure it is in the 'R' (run) position.
2. Turn the start key to the 'H' (Heat) position, (see Fig. C1) and hold it there for 20 seconds.
3. Adjust the engine speed control to the maximum speed position.



C.1

4. Turn the start key to the 'HS' (Heat/Start) position to engage the starter motor. As the engine starts, release the start key to the 'R' (run) position and adjust the engine speed control to give a smooth idle speed.
5. If the engine does not start in 15 seconds, return the start key to the 'H' position for 10 seconds and then engage the starter motor again.

Engine start procedure with Start Pilot

The Start Pilot hand pump must not be used until the starter motor is engaged.

Experience will show how much fluid is needed for each engine start.

1. Where necessary, charge the reservoir with fluid. Raise the cover of the reservoir, press the can, head down on the filler plug and hold squarely until fluid fills the bowl up to the maximum mark.
2. Adjust the engine speed control to the maximum speed position.
3. Engage the starter motor for a maximum of 30 seconds and operate the Start Pilot pump during this period. Adjust the engine speed control.
4. If the engine does not start during the first 30 seconds, disengage the starter motor for another 30 seconds and then engage the starter motor again and operate the Start Pilot hand pump.

The air filter at the outer end of the pump must be inspected from time to time and if necessary it must be washed in kerosene.

Thin lubricating oil can be applied to the pump cylinder.

The nozzle in the induction manifold can be removed and washed in kerosene, when necessary.

WARNING
Start Pilot equipment must not be used with heat type cold starting aids such as thermostart.

Engine start procedure with KBi

1. Where necessary, renew the screw type canister. A safety valve is integral with the container.
2. Adjust the engine speed control to the maximum speed position.
3. Engage the starter motor.
4. Press the KBi button for a maximum of 2 seconds. As the engine starts, adjust the engine speed control to give a smooth idle speed.
5. If the engine does not start after the first 2 seconds allow 5 seconds to pass and then press the KBi button for a maximum period of 2 seconds with the starter motor engaged.

WARNING
KBi equipment must not be used with heat type cold starting aids such as Thermostart.

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 returns to its "run" position otherwise difficulty may be experienced in re-starting the engine.

Return switch to the "O" position.

Where an engine is fitted with an electrically operated solenoid, the stop button or switch should be operated until the engine has stopped.

Thermostart 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.

Where a thermostart unit has to be replaced, care must be taken not to exceed the torque load as given on Page B.2. Excessive torque loading can crack the insulating adaptor causing an electrical short and hard starting characteristics.

To prevent thermostart damage, it is essential that the thermostart is not operated dry. After any operation which allows fuel to drain from the thermostart feed pipe, the pipe must be disconnected at the thermostart and all air bled from the pipe before the thermostart is operated.

The T6.3544 and 6.3544 engine is fitted with efficient cold starting equipment and no responsibility can be accepted for any damage caused by unauthorised starting aids.

T6.3544 ENGINES ONLY

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 T6.3544 engine.

Do not overload the engine at low engine speed.

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

PREVENTIVE MAINTENANCE

These preventive maintenance periods are general in application. Check the periods given by the manufacturer of the equipment in which the engine is installed and, where necessary, use the shorter periods. These periods and procedures must also be adapted to ensure correct operation for any local vehicle or machine regulations.

On stop/start short distance operation the hours run are more important than the distance.

It is good maintenance to check for leakage and loose fasteners at each service interval.

These maintenance periods are only for engines that are operated with fuel and lubricating oil to the specifications given in this manual.

Schedules

The schedules which follow must be done at the interval (kilometres, miles, hours or months) which occurs first.

Daily or every 8 hours

Check amount of coolant.

Check amount of lubricating oil in the sump.

Check lubricating oil pressure (where a gauge is installed).

In extreme dust conditions, clean dust bowl of air filter (where fitted).

Every 7500 km (5,000 miles), 250 hours or 4 months

Renew the lubricating oil.

Renew the lubricating oil filter canister/s.

Clean the air cleaner, or empty the dust bowl of the air filter.

Inspect the drive belt.

Check for water in the fuel pre-filter (where fitted) and drain as necessary.

Clean the compressor air filter (if fitted).

Every 15000 km (10,000 miles), 500 hours or 12 months

Clean the lift pump gauze strainer.

Clean or renew the air filter element (if not indicated earlier).

Renew element of single element final fuel filter.

Every 30000 km (20,000 miles), 1,000 hours

Renew the elements of double element final fuel filter.

Clean the turbocharger impeller and casing, and the lubricating oil drain pipe.

Every 90000 km (60,000 miles) 2,500 hours

Have the accessory equipment (starter motor, alternator, exhauster, etc.) checked.

Check and, if necessary, adjust the valve tip clearances.

Have the atomisers checked.

Renew the closed circuit breather element (naturally aspirated engines only).

Air Charge Cooler (remote)

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 Service

The service procedures given below must be done at the first 800/1600 km (500/1,000 miles), 25/50 hours of operation.

1. Run the engine until it is warm. Stop the engine and drain the lubricating oil from the sump. Fill the sump to the "full" mark on the dipstick with clean new lubricating oil to an approved grade.
2. Renew the canister of the lubricating oil filter.
3. Adjust the valve tip clearances (see page E.4).
4. Check the tension of the alternator/water pump drive belt.
5. Check that all fasteners are tight.
6. Run the engine and check for fuel, coolant and lubricating oil leakage.
7. If necessary, get a trained person to adjust the idle speed.

Protection of an Engine not in Service

The recommendations given below are to ensure that damage is prevented when an engine is removed from service for an extended period. Use these procedures immediately the engine is removed from service. The instructions for the use of POWERPART products are given on the outside of each container.

1. Thoroughly clean the outside of the engine.
2. Where a preservative fuel is to be used, drain the fuel system and fill with the preservative fuel. **POWERPART Lay-Up 1** can be added to the normal fuel to change it to a preservative fuel. If preservative fuel is not used, the system can be kept charged with normal fuel but this will have to be drained and discarded at the end of the storage period together with the fuel filter.
3. Run the engine until it is warm. Correct any fuel, lubricating oil or air leakage. Stop the engine and drain the lubricating oil sump.
4. Renew the lubricating oil filter canister.
5. Fill the sump to the full mark on the dipstick with clean new lubricating oil or with a correct preservative fluid. **POWERPART Lay-Up 2** can be added to the lubricating oil to give protection against corrosion during the period in storage. If a preservative fluid is used, this must be drained and normal lubricating oil used when the engine is returned to service.
6. Drain the cooling system, see Page C.5. To give protection against corrosion, it is better to fill the cooling system with a coolant that has a corrosion inhibitor, see 'Engine Coolant' on this page. If frost protection is needed, use an antifreeze mixture. If no frost protection is needed, use water with an approved corrosion inhibitor mixture.
7. Run the engine for a short period to send the lubricating oil and coolant around the engine.
8. Clean out the engine breather pipe and seal the end of the pipe.
9. Remove the atomisers and spray **POWERPART Lay-Up 2** into each cylinder bore. If this is not available, clean engine lubricating oil will give a degree of protection. Spray into the cylinder bores 140ml (¼ pint) of lubricating oil divided evenly between the six cylinders.
10. Slowly turn the crankshaft one revolution and then install the atomisers complete with new seat washers.
11. Remove the air filter and any pipe installed between the air filter and induction manifold. Spray **POWERPART Lay-Up 2** into the induction manifold. Seal the manifold with waterproof tape.
12. Remove the exhaust pipe. Spray **POWERPART Lay-Up 2** into the exhaust manifold. Seal the manifold with waterproof tape.
13. Remove the lubricating oil filler cap. Spray **POWERPART Lay-Up 2** around the rocker shaft assembly. Fit the filler cap.
14. Disconnect the battery and put it into safe storage in a fully charged condition. Before the battery is put into storage, give the battery terminals a protection against corrosion. **POWERPART Lay-Up 3** can be used on the terminals.
15. Seal the vent pipe of the fuel tank or the fuel filler cap with waterproof tape.
16. Remove the fan belt and put it into storage.
17. To prevent corrosion, spray the engine with **POWERPART Lay-Up 3**. Do not spray inside the alternator cooling fan area.

NOTE:

Before the engine is started after a period in storage, operate the starter motor with the engine stop control in the 'off' position until oil pressure shows on the oil pressure gauge or the oil warning light goes out. If a solenoid stop control is used, this will have to be disconnected for this operation.

If the engine protection is done correctly according to the above recommendations, no corrosion damage will normally occur. Perkins Engines Ltd. are not responsible for any damage that occurs in relation to a service storage period.

Engine Coolant

The quality of the coolant used can have a large effect on the efficiency and life of the cooling system. The recommendations given below can be of assistance in the maintenance of a good cooling system with frost and/or corrosion protection.

1. Where possible, use clean soft water.
2. Where frost protection is not necessary, it is still an advantage to use an approved antifreeze mixture (see 3 below) as this gives a protection against corrosion and also raises the boiling point of the coolant. A minimum concentration of 25% by volume of antifreeze is necessary, but it is our recommendation that 33% concentration by volume is used.

   If an antifreeze is not used, add a correct corrosion inhibitor mixture to the water. The mixture of additives given below has been found to give good results.

Sodium Benzoate	10-15 gramme/litre
Sodium Nitrite	1-2 gramme/litre
Benzotriazole	0.5 gramme/litre
pH (acid/alkaline) Control Additive	

   Change the water/corrosion inhibitor mixture every six months or check according to the inhibitor manufacturer's recommendations.

   NOTE: Some corrosion inhibitor mixtures contain soluble oil which can have an adverse effect on some types of water hose.
3. If an antifreeze mixture is used to prevent frost damage, it must have an ethylene glycol (ethanediol) base. An antifreeze that is to one of the standards given below or to an equal standard is acceptable if the pH value is kept within the range of 7.0-8.5 when diluted.

   U.K., BS3151:1959 — 'Ethanediol Antifreeze Type B with Sodium Benzoate and Sodium Nitrite Inhibitors'.

   U.S.A., ASTM D3306-74 — 'Ethylene Glycol Base Engine Coolant'.

   Australia, AS2108-1977 — 'Antifreeze Compounds and Corrosion Inhibitors for Engine Cooling Systems'.

When Perkins POWERPART Antifreeze is used, the correct mixtures of antifreeze and water are as given below. Perkins POWERPART Antifreeze fully passes the above standards.

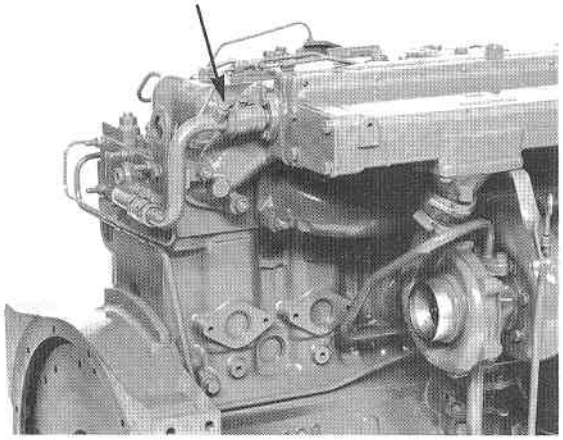
Lowest temperature of Protection Needed	% Volume of POWERPART Antifreeze	Mixture Ratio by Volume POWERPART Antifreeze: Water
−12°C (10°F)	25	1:3
−18°C (0°F)	33	1:2
−25°C (−13°F)	40	1:1.5
−37°C (−34°F)	50	1:1
−60°C (−76°F)	66	2:1

The quality of the antifreeze coolant must be checked at least once a year, for example, at the start of the cold period.

If the correct procedures are not used, Perkins Engines Ltd. cannot be held responsible for any frost or corrosion damage.

To Drain the Cooling System

1. Ensure that the vehicle or machine is on level ground.
2. Remove the radiator filler cap.
3. Remove the drain plug from the side of the cylinder block to drain the engine. Ensure that the drain hole does not have any restriction.
4. Open the tap or remove the drain plug at the bottom of the radiator to drain the radiator. If a tap or plug is not fitted to the radiator, disconnect the bottom radiator hose.
5. If an oil cooler is fitted, drain the coolant from it by removing the drain pluig from the end cap of the cooler (Section L).
6. Where necessary, flush the system with clean water.
7. Fit the drain plugs and radiator cap. Where necessary, close the radiator tap or connect the radiator hose.
8. If the engine is to be left drained during freezing conditions, remove one of the coolant hose connections at the cooler and insert 0.5 U.K. pints (250ml) of undiluted antifreeze into the cooler.



C.2

NOTE:
When draining or filling the cooling system of a T6.3544CC engine (integral induction manifold and air charge cooler) the vent plug on the outlet connection of the cooler should be removed (see Fig. C.2) and the plug replaced when the system has been filled.

SECTION D
Fault Finding

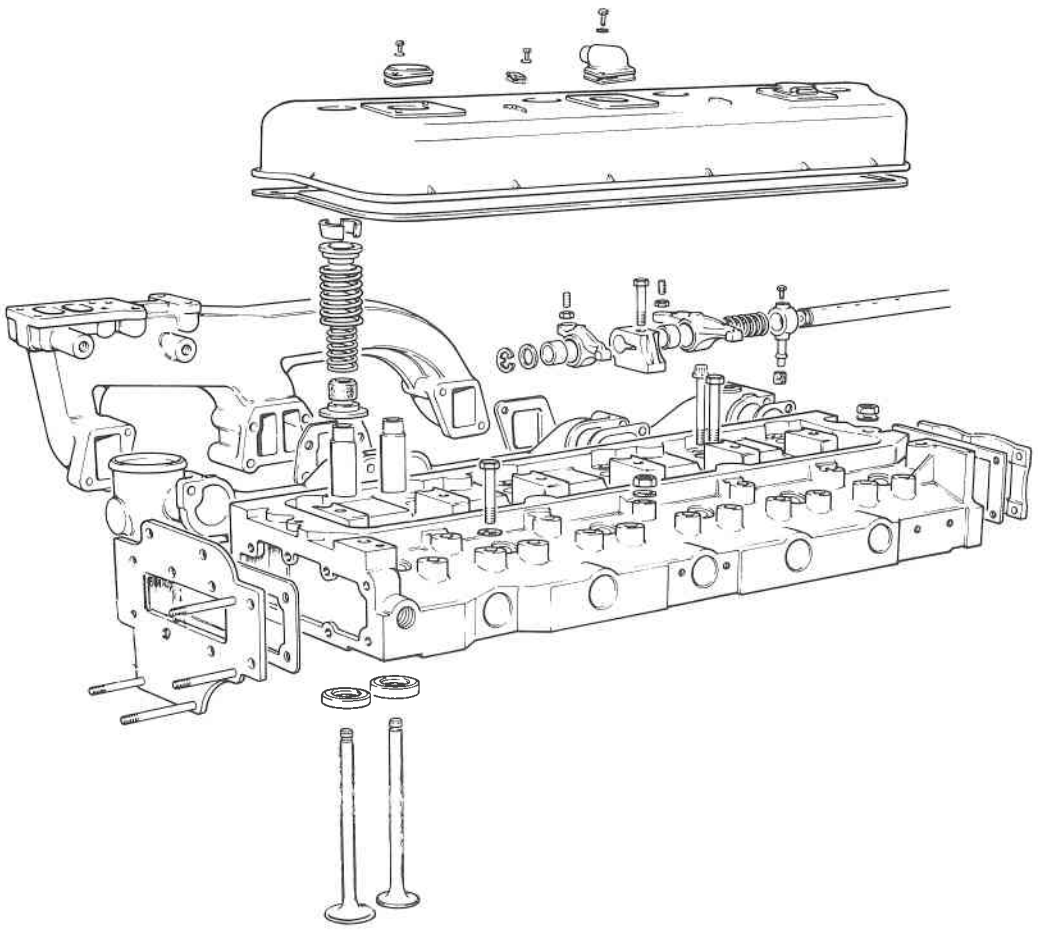
Fault Finding Chart

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, 47, 50, 51, 52, 53, 54, 57.
Excessive crankcase pressure	25, 31, 33, 34, 45, 55, 64.
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 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. Incorrectly aligned flywheel housing or flywheel.
50. Faulty thermostat.
51. Restriction in water jacket.
52. Loose water pump drive belts.
53. Choked radiator.
54. Faulty water pump.
55. Choked breather pipe/Defective breather vent valve (where fitted).
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.
64. Fault in exhauster.

SECTION E
Cylinder Head



To Remove the Cylinder Head

The T6.3544, 6.3544 or 6.3724 cylinder head is not interchangeable with any other 6.354 or T6.354 engine type cylinder heads.

Drain the cooling system.

Disconnect battery terminals.

Remove air cleaner and trunking.

Remove exhaust pipe from exhaust manifold (6.3544 engines only).

Disconnect and remove all connections to the turbocharger and remove the turbocharger, see Fig. E.1. (T6.3544 engines only).

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 atomisers leak-off pipe assembly.

Remove atomisers, see Fig. E.2.

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

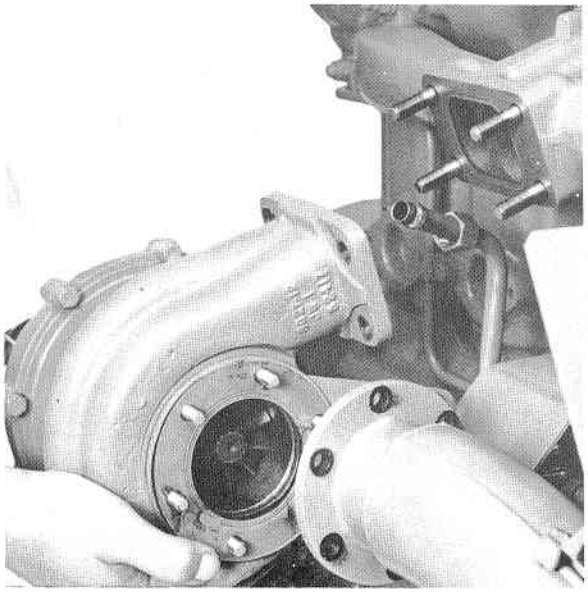
Remove rocker cover and gasket.

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

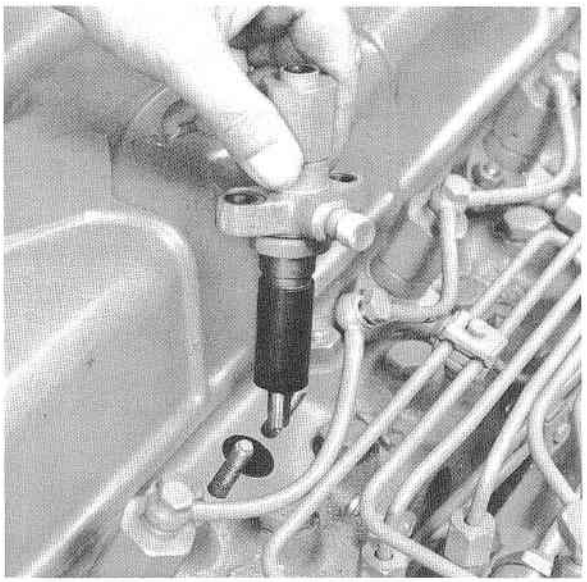
Remove cylinder head nuts and setscrews in reverse order of tightening sequence, see Fig. E.4.

Note position of different length setscrews, see Fig. E.3.

Remove cylinder head.



E.1



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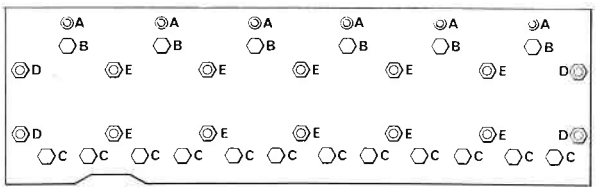

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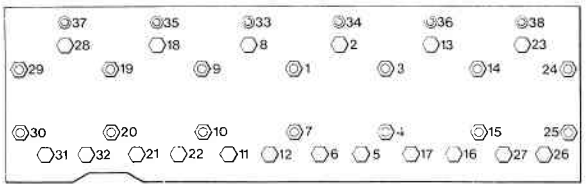


E.4

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".

The cylinder head gasket fitted to the T6.3544 and 6.3544 engine is not interchangeable with other 6.354 series engines. It is marked "TOP FRONT".

A different cylinder head gasket is used on 6.3724 engines due to the larger bore size.

The cylinder head gasket must be fitted dry. Fit the gasket ensuring it is correctly located over the two dowels.

Lower the cylinder head in position without disturbing the gasket.

Lightly oil threads of cylinder head securing studs and setscrews.

See Fig. E.3 for correct location of long and short setscrews.

Progressively tighten the cylinder head securing nuts and setscrews, numbers 1 to 32 only in the order shown in Fig. E.4 to 115 lbf ft (15,9 kgf m) 156 Nm when cold where the washer face is formed with the head of the setscrew or nut or to 95 lbf ft (13,1 kgf m) 130 Nm where separate washers are fitted. Then progressively tighten the small setscrews numbered 33 to 38 in the sequence shown in Fig. E.4 to 28 lbf ft (3,9 kgf m) 38 Nm.

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.5.

The rocker assembly securing setscrews, studs and 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 valve clearances to 0.008 in (0,20 mm) for inlet valves and 0.018 in (0,45 mm) for exhaust valves, engine hot or cold, as detailed on Page E.4.

Refit atomisers with new copper sealing washers. Ensure that a serviceable dust seal is fitted to the atomiser. Earlier dust seals consisted of a single piece rubber seal, later arrangements use a two piece dust seal which consists of a plastic or aluminium spacer and a rubber seal. The spacer must be fitted directly under the atomiser flange with the soft rubber seal up against the spacer at the nozzle end of the atomiser. Now tighten nuts/setscrews evenly to a torque of 12 lbf ft (1,7 kgf m) or 16 Nm.

Note: Different atomiser seating washers are used on naturally aspirated and turbocharged engines. The seating washers for naturally aspirated engines are 0.080 in (2,03 mm) thick and for turbocharged engines, 0.028 in (0,71 mm) thick. It is important that the correct atomiser seating washers are fitted.

For the T6.3544 North America vehicle engines the atomiser seating washer is 0.080 in (2,03 mm) thick.

Top entry atomisers which are used on some 6.3544 series engines can be fitted incorrectly with the atomiser turned 180° out of position. In this position, the nozzle holes will not spray into the combustion chamber correctly and this will cause a power loss and an increase in smoke emission.

These atomisers must be fitted with the leak off connection toward the fuel injection pump side.

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

Tighten high pressure pipe nuts to a torque of 15 lbf ft (2,1 kgf m) or 20 Nm.

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

Refit induction and exhaust manifolds.

Inlet manifolds have corrugated joints which are coated with lacquer and should always be fitted dry. The joints are not symmetrical and can be fitted incorrectly. With the earlier joints, the larger joint should be fitted with parallel edge uppermost and the smaller joint with the wider spaced hole and the word "CORROJOINT" to the bottom.

Later joints have a 1/16 in (1,63 mm) radius in the top edge and must always be fitted with this radius uppermost. The manifold securing setscrews should be tightened to a torque of 24 lbf ft (3,3 kgf m) or 32 Nm. After at least ten minutes after fitting, retorque the setscrews to the original figure. THIS IS IMPORTANT. With exhaust manifold joints, turbocharged engines have corrugated stainless steel joints, whereas naturally aspirated engines can have a set of steel asbestos or corrugated stainless steel joints fitted. Steel asbestos joints should be fitted with jointing compound, but the corrugated joints should be fitted dry and so positioned that the corrugations should face the manifold.

A one piece exhaust/induction manifold joint with an integral heat shield is fitted to some engines which have the top exhaust manifold outlet. An improved rocker assembly cover gasket is also fitted to these engines.
When the gaskets need to be renewed the same type gasket must be used.

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 (T6.3544 engines only) and all connections to it.

Refit trunking and air cleaner.

Refit exhaust pipe to exhaust manifold (6.3544 or 6.3724 engines only).

Reconnect the battery.

Refill the cooling system.

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

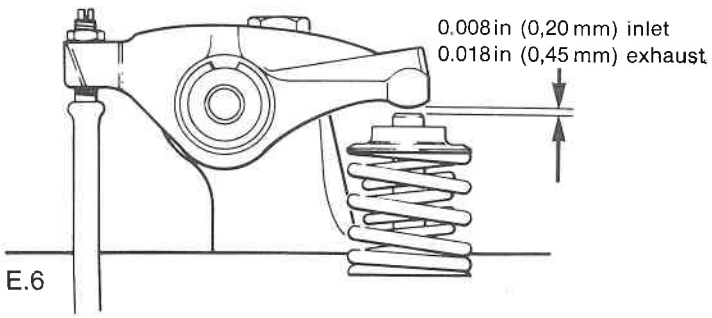
Check the oil flow to the rocker shaft assembly and allow the engine to warm up.

Shut the engine down, and retighten the cylinder head securing nuts and setscrews to the correct torques as detailed previously.

For nuts and setscrews, numbers 1 to 32 where the washer face is formed with the head of the setscrew, the correct torque when hot is 105 lbf ft (14,5 kgf m) — 142 Nm.

When retightening cylinder head nuts/setscrews, the

E.5



E.6

engine coolant temperature should not be less than 170°F (77°C).
If the nut/setscrew moves when retightening, then tighten up to the torque quoted on Page B.1.

If the nut/setscrew does not move before the correct torque is achieved, then slacken off 1/12 to 1/6 (30° to 60°) of a turn and retighten to the correct figure. After retightening all the nuts/setscrews, the first 10 positions should be rechecked without further slackening off, to ascertain they are still tightened to the correct torque.

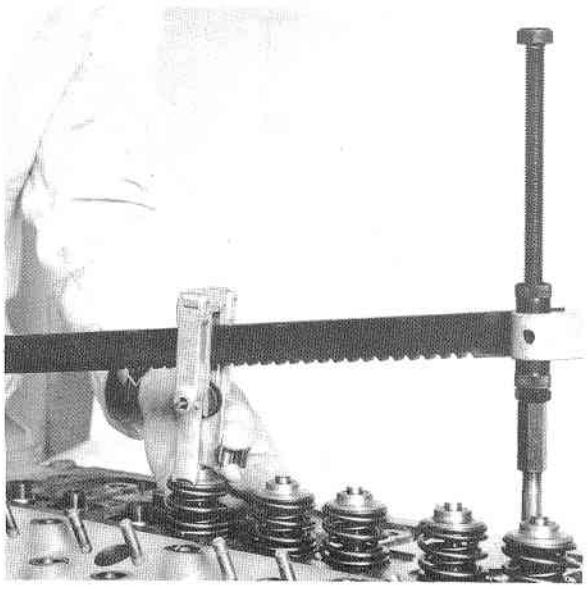
Reset the valve clearances to 0.008 in (0,20 mm) for inlet valves and 0.018 in (0,45 mm) for exhaust valves hot or cold.

Refit the rocker cover joint, rocker cover and breather pipe.
To put a rocker cover joint on correctly it must first be fitted to the rocker cover by use of a suitable Bostic type contact adhesive. The adhesive must be applied according to the manufacturer's instructions. This procedure will ensure that there is a good seal all round the cover.

When replacing the cylinder head cover, ensure that the cover retaining nuts are screwed fully home against the rocker shaft bracket retaining nuts.
Where a washer is fitted under the head of each of the rocker cover nuts, a washer is also fitted between the rocker bracket securing nut and the cover nut. Where a washer face is formed integral with the cover nut, a separate washer must not be fitted under the cover nut or between the cover nut and the rocker bracket nut.

To Check or Adjust Valve Tip Clearances

The valve tip clearances should be set to 0.008 in (0,20 mm) for inlet and 0.018 in (0,45 mm) for exhaust by using a feeler gauge between top of valve stem and rocker lever, with the engine hot or cold, see Fig. E.6.
When setting valve clearances, the following procedure should be adopted.



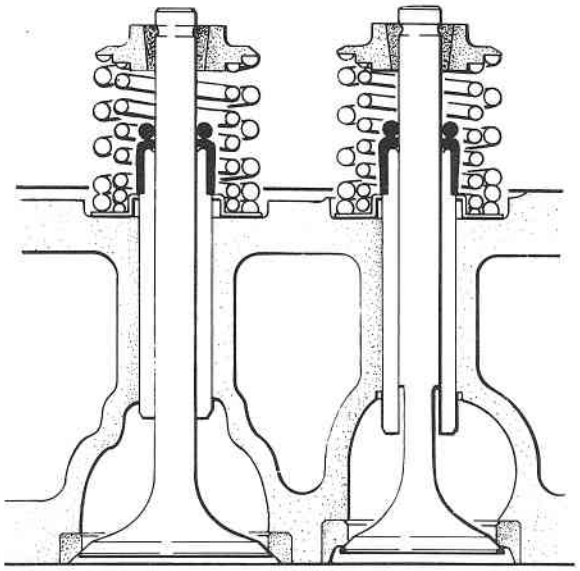
E.7

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

Fit a suitable stud in one of the rocker assembly securing setscrew holes and using Tool No. 6118B and adaptor PD.6118-4, see Fig. E.7, depress valve springs and remove split collets.



E.8

Remove spring retaining caps, springs, oil seals and spring seating washers. Remove valves.

If the valves are to be used again, they should be suitably marked to ensure they are replaced in their original positions.

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.8.

To Fit Valves

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

Position spring seating washers and fit oil seals onto valve guides.

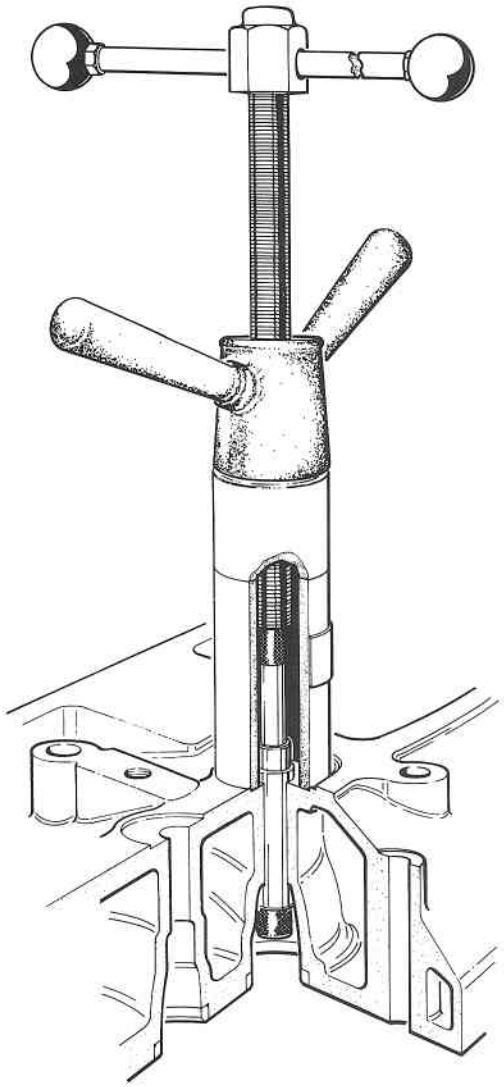
Note: Engines rated at 149kW (200bhp) or above must be fitted with exhaust valves which have "Nimonic" heads. Standard valves must not be used.

Place inner and outer springs on seating washers with the damper coils towards the cylinder head, see Fig. E.8.

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 per-



E.9

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

The exhaust valve guides are slightly longer than the inlet guides and the exhaust valve guides used on current 6.3544 and 6.3724 engines have a counterbore at the bottom of the valve bore.

To fit new guides, press or drive out the worn guides, see Fig. E.9.

Smear the outer surface of the new guides with clean oil and using tool No. PD1C, see Fig. E.10, pull guide into the cylinder head using stop No. PD1C — 6 until 0.594in (15,08mm) of the guide is protruding above 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 0.010in (0,25mm) and transverse bow is 0.005in (0,13mm).

The cylinder head can be skimmed by a maximum of 0.012in (0,3mm) provided that nozzle protrusion does not exceed 0.184in (4,67mm) for T6.3544 engines or 0.136in (3,45mm) for 6.3544 and 6.3724 engines with the atomiser seating washers in position, see Fig. E.11. This figure must not be obtained by the use of additional atomiser seating 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.

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).

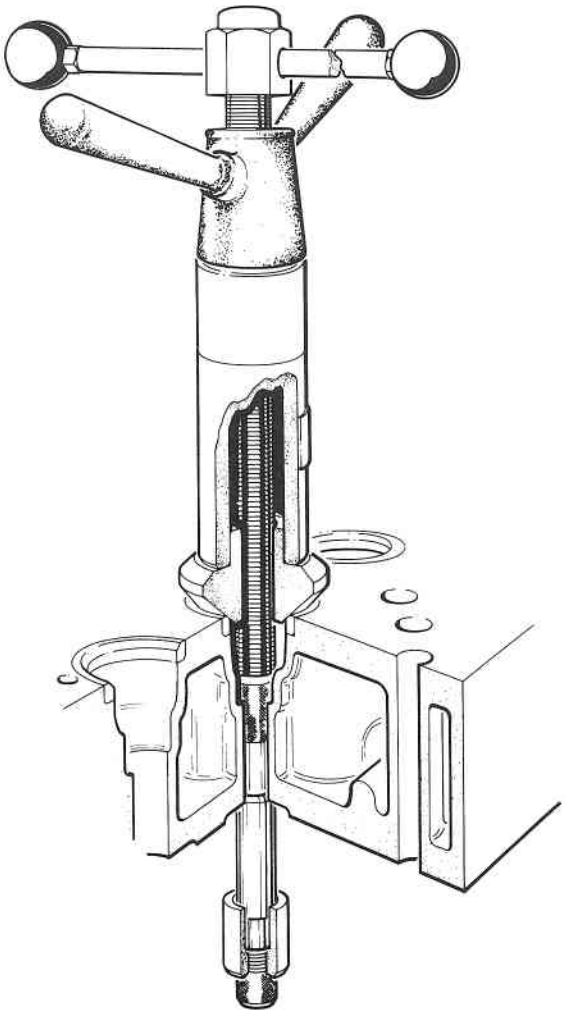
After any grinding or machining operation has been carried out, all parts should be washed in cleaning fluid.

Valves and Valve Seats

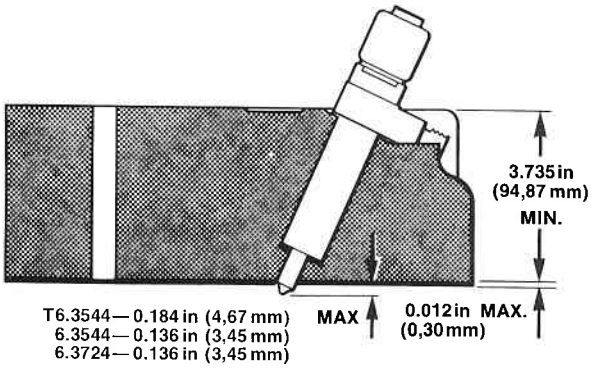
Examine valves for cracks. Check wear of valve stems and their fit in the valve guides.

When fitting new valves, valve depths relative to the cylinder head face is not less than 0.040in (1,02mm).

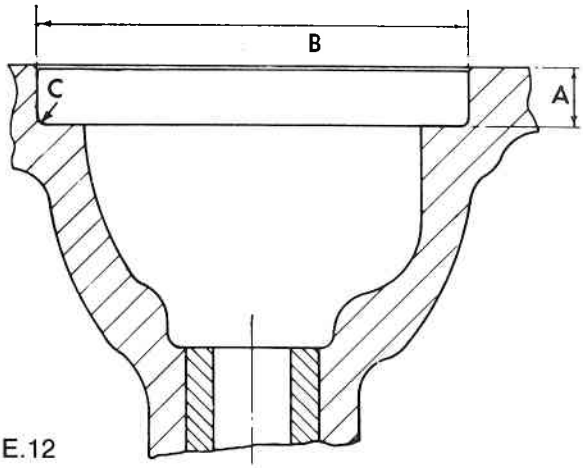
The valve seats in the cylinder head should be reconditioned by means of valve seat cutters as listed in approved tools at the end of this section, or specialised grinding equipment at an angle of 45°.



E.10



E.11



E.12

Inlet

A—0.283/0.288in (7,19/7,32mm)
B—2.0165/2.0175in (51,22/51,24mm)
C—Radius 0.015in (0,38mm) Max.

Exhaust

A—0.375/0.380in (9,53/9,65mm)
B—1.678/1.679in (42,62/42,65mm)
C—Radius 0.015in (0,38mm) Max.

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

Valve seat inserts are fitted as standard on T6.3544 engines, but are not fitted on 6.3544 or 6.3724 production engines.

If valve seats become damaged or unserviceable through wear, inserts can be fitted to 6.3544 and 6.3724 engines or the inserts replaced on T6.3544 engines.

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

Press in new guides as detailed on Page E.4.

Using the valve guide as a pilot, machine the recess in the cylinder head to the dimensions given in Fig. E.12 for 6.3544 or 6.3724 engines; or machine out the old insert for T6.3544 engines.

Remove all machining swarf and clean the insert recess.

Using the valve guide bore as a pilot, press the insert home with the inserting tool, Fig. E.13. Do not hammer the insert home or use lubrication. Ensure that the insert is fully home and flush with the bottom of recess.

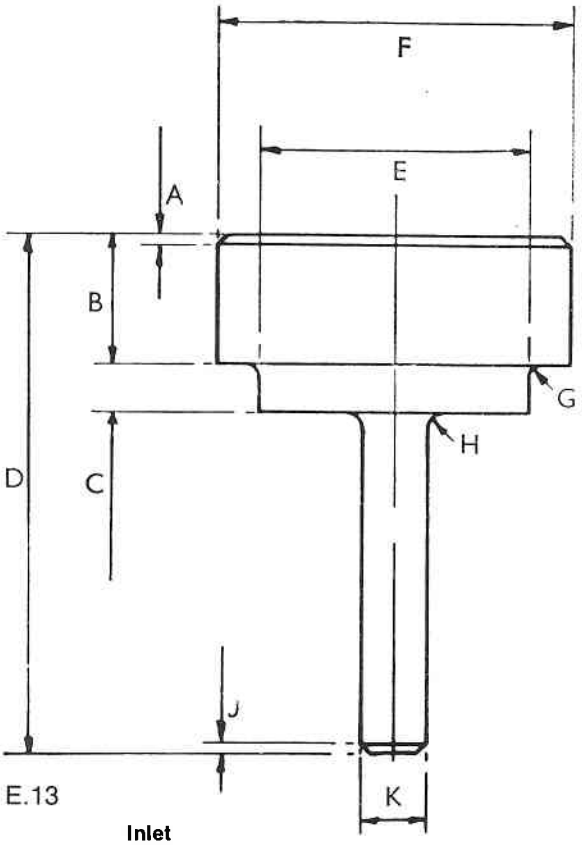
Using the valve guide bore as a pilot, machine the "flare" on inlet valve seat inserts to the dimensions shown in Fig. E.14. Dimension A is 0.106/0.110in (2,69/2,79mm).

Cut the valve seat at an included angle of 90° so that the valve head depth below the cylinder head face is within the production limits of 0.040/0.050in (1,02/1,27mm).

Work as closely as possible to the minimum figure to allow for re-seating at a later date. When refacing 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.



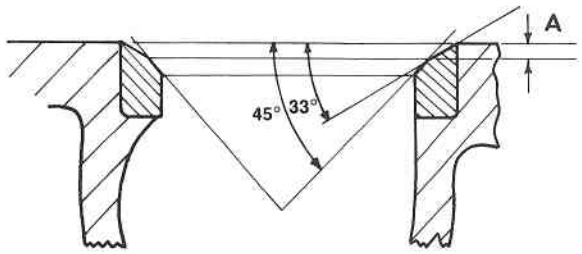
E.13

Inlet

A—1/16 in (1,59mm) at 45°
B—¾in (19,05mm)
C—0.250in (6,35mm)
D—3.0in (76,20mm)
E—1.582/1.583in (40,18/40,21mm)
F—2.009/2.019in (51,03/51,28mm)
G—1/32 in (0,79mm) radius
H—1/16 in (1,59mm) radius
J—1/16 in (1,59mm) at 45°
K—0.372/0.373in (9,45/9,47mm)

Exhaust

A—1/16 in (1,59mm) at 45°
B—¾in (19,05mm)
C—0.312in (7,92mm)
D—3.0in (76,20mm)
E—1.248/1.249in (31,70/31,72mm)
F—1.670/1.680in (42,42/42,67mm)
G—1/32 in (0,79mm) radius
H—1/16 in (1,59mm) radius
J—1/16 in (1,59mm) at 45°
K—0.372/0.373in (9,45/9,47mm)



E.14

Valve Springs

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

Examine the springs with regard to squareness of ends and pressures developed at fitted lengths.

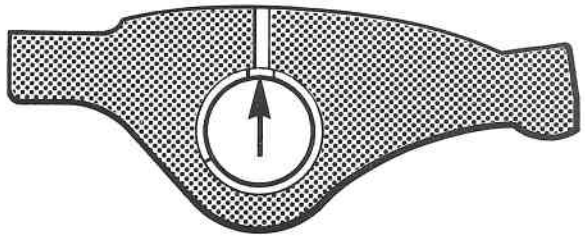
Two types of valve springs can be found according to the camshaft fitted. They are of different lengths the longer valve springs having a flat valve spring cap.

The shorter inner valve springs require a load of 20.1/23.3 lbf (9,13/10,58 kgf) to compress them to a fitted length of 1.340 in (34,04 mm).

The shorter outer valve springs require a load of 39.5/43.7 lbf (17,93/19,84 kgf) to compress them to a fitted length of 1.410 in (35,81 mm).

The longer inner valve springs require a load of 14.63/16.67 lbf (6,64/7,57 mm) to compress them to a fitted length of 1.563 in (39,70 mm).

The longer outer valve springs require a load of 38/43 lbf (17,25/19,52 kgf) to compress them to a fitted length of 1.780 in (45,20 mm).



E.15

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.15.

Ream out to a diameter of 0.7505/0.7520in (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.16.

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

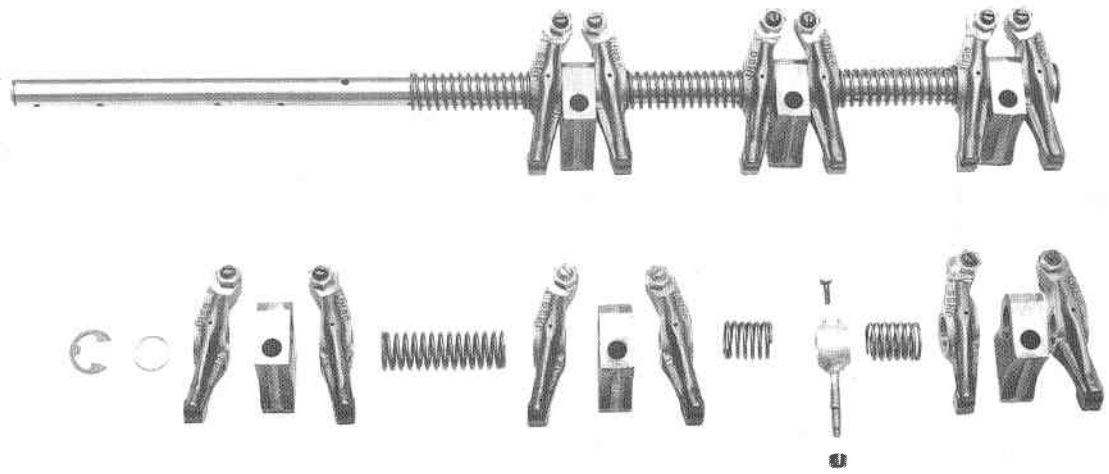
Push Rods

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

Breather Vent Valve

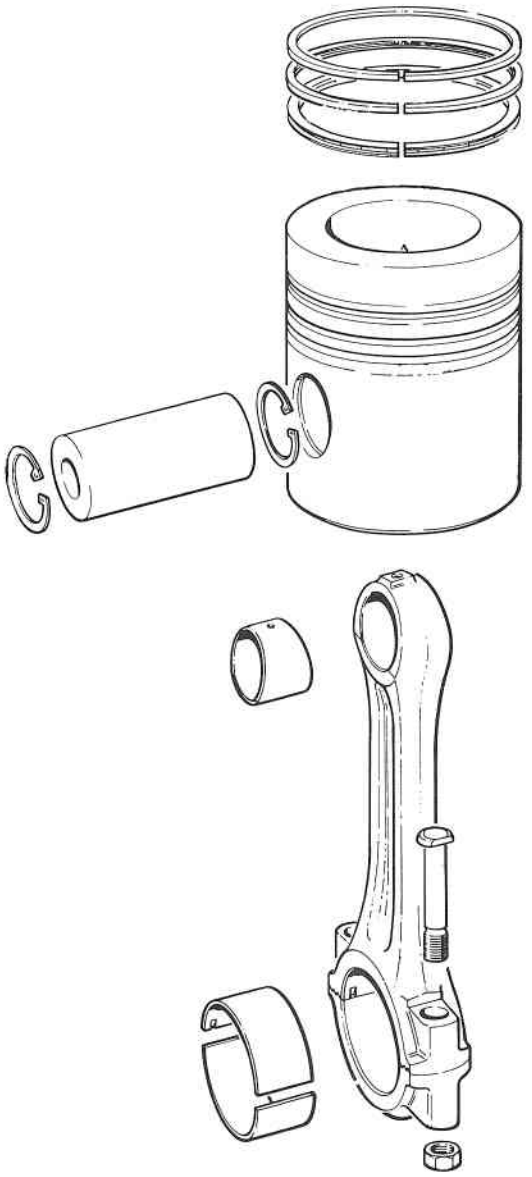
On 6.3544 engines, a vent valve is sometimes fitted between the rocker cover and the inlet manifold. This unit can be cleaned in petrol (gasoline) or paraffin (kerosene) noting the following critical points:—

1. Before cleaning, it is essential to seal off the small hole in the top cover of the unit.
2. If an air line is used to dry out the unit, this must be a low pressure air blast or irreparable damage will result.



E.16

SECTION F
Pistons and Connecting Rods



The pistons fitted to the T6.3544 and 6.3544 engine have an insert in the top ring groove and are not common to the 6.354 engine series.

Nor are T6.3544 and 6.3544 pistons interchangeable as the turbocharged piston has a larger gudgeon pin.

For T6.3544 North America vehicle engines pistons and rings see page F.6.

To remove Piston and Rod Assembly See Fig. F.1.

Remove cylinder head, Page E.2.

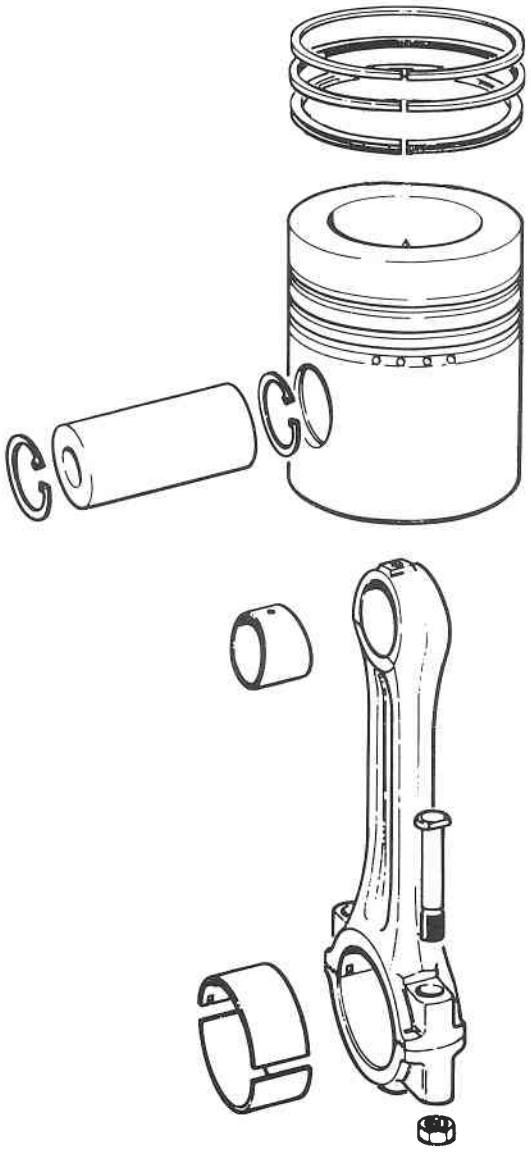
Drain lubricating oil, remove sump and lubricating oil suction pipe. Page L.3.

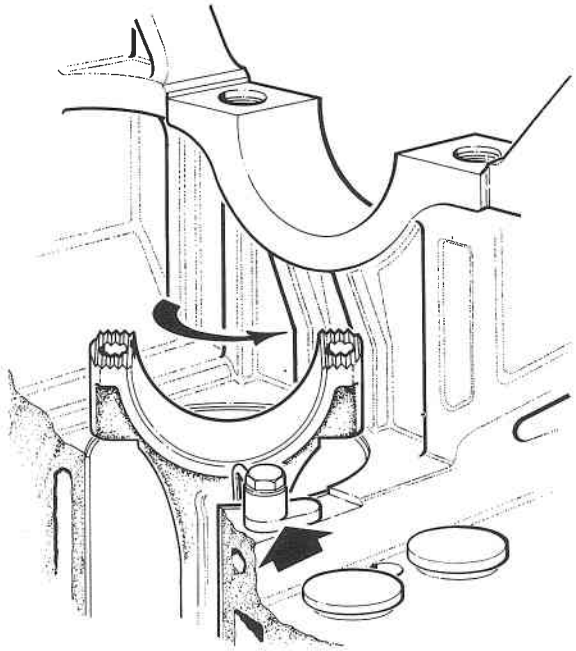
Remove pipe from the reducing valve to piston cooling feed connection (T6.3544 engines only).

When pushing the piston and rod assemblies from out of the top of the cylinders, care must be taken to avoid damage to the piston cooling jets situated in the crankcase, see Fig. F.2. (T6.3544 engines only).

Remove the nuts from the big end bolts.

Remove the big end caps, bearing shells and bolts.





F.2

Turn connecting rods in an anti-clockwise direction and press the piston assemblies from out of the top of the cylinder bores, see Fig. F.3.

The pistons, connecting rods and caps are marked with their respective cylinder number and should be kept together as an assembly with the relevant big end bearings.

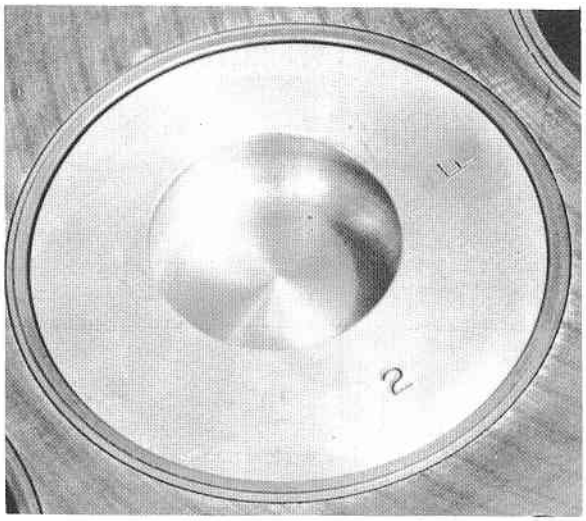
To Remove Pistons and Rings from Connecting Rods

An exploded view of a piston and connecting rod assembly is shown in Fig. F.1.

Note: The number of piston rings per piston can vary according to engine type and application (see Page F4).

Using a ring scissor tool, remove the rings from the pistons.

F.3



F.4

If the pistons are to be used again, note the markings on the piston crown, see Fig. F.4, so that on re-assembly, they can be fitted to the connecting rods in their original positions, i.e. thrust side of the piston to thrust side of the engine.

Remove the circlips and withdraw the gudgeon pin. If the pin is tight in the piston bore, heat the piston in fluid to a temperature of 100/120°F (40/50°C), then press the gudgeon pin out.

Inspection

Check pistons for scoring or other damage.

Check piston ring grooves by checking clearance of new rings fitted in grooves. If clearance is found to be excessive new pistons must be fitted.

Examine gudgeon pin and piston bores for wear and check fit of pin in small end bush.

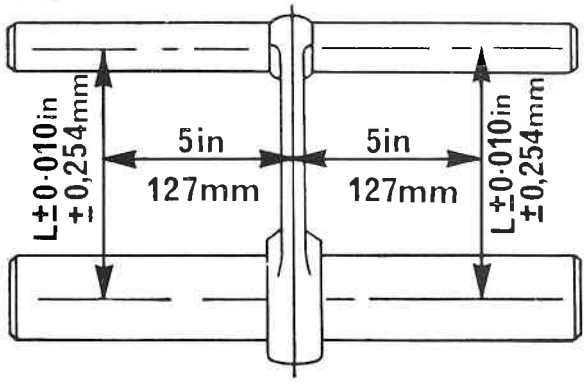
Check connecting rod alignment. The large and small end bores must be square and parallel to each other within the limits of ±0.010in (0,25mm) measured 5in (127mm) each side of axis of rod on test mandrel as shown in Fig. F.5.

With the small end bush fitted, the limit of ±0.010in (0,25mm) is reduced to ±0.0025in (0,06mm).

To Renew Small End Bush

Using suitable adaptor, press out worn bush.

Remove any sharp edges from around small end parent bore.



F.5

Press in new bush ensuring that oil hole in bush aligns with drilling in rod.

Hone out bush to finished diameter of 1.50075/1.5015in (38,12/38,14mm), for turbocharged engines or 1.3758/1.3765in (34,94/34,96 mm) for naturally aspirated engines.

With naturally aspirated engines the connecting rod small end is parallel faced and the small end bush requires no further machining.

With turbocharged engines, the small end of the connecting rod is wedge shaped and the small end bush should be machined to suit the contours of the wedge.

Remove all burrs.

Check for parallelism and twist with big end bore.

To Check Piston Ring Gaps

In a worn cylinder, piston ring gaps should be checked at extreme top of cylinder after any carbon has been removed, see Fig. F.6.

For piston ring gaps, see Page B4.

To Assemble Pistons and Connecting Rods

Assemble the piston, rod and gudgeon pin, and fit new circlips.

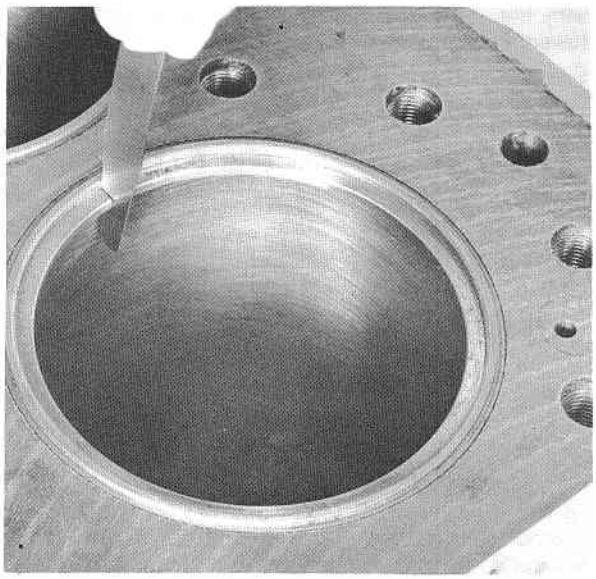
If necessary, warm the piston to 100/120°F (40/50°C) to fit the gudgeon pin.

If the old pistons are being used ensure they are assembled to the original connecting rods and in the same position as originally assembled.

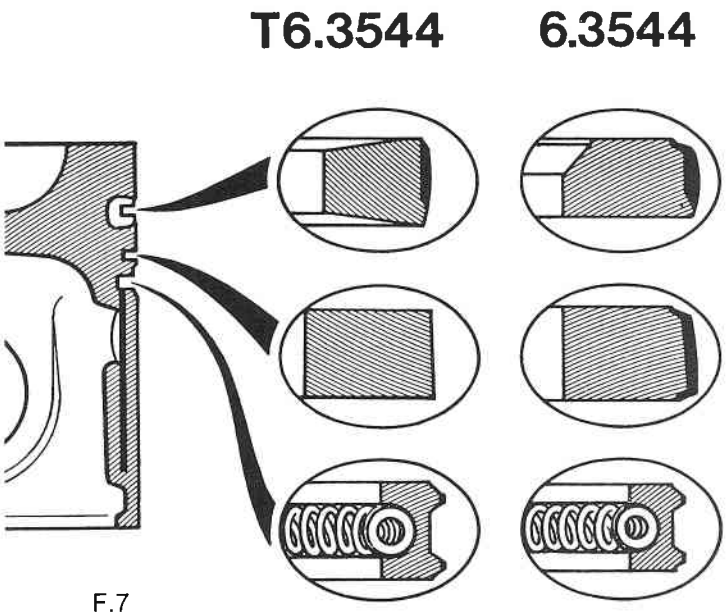
The toroidal cavity should be to the same side as the markings on the connecting rod and cap.

If new parts are being fitted, mark piston crown and adjacent faces of rod and cap with their corresponding cylinder number.

The big end bearing shell tabs are fitted on the opposite side of the rod to the rod/bearing cap numbers.
On fitment the rod/bearing cap number must be toward the fuel injection pump side of the engine.



F.6



F.7

F.8

To Fit Piston Rings

Piston ring layouts are as follows :—

T6.3544 (Fig. F.7)

No. 1 Chrome Barrel Faced Wedge Compression

No. 2 Taper Faced.

No. 3 Chrome Faced, Spring Loaded Conformable Oil Control.

Fit rings as follows :—

Fit spring of No. 3 oil control ring in groove ensuring that the latch pin enters both ends of the ring, 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 taper faced No. 2 compression ring in the second groove with the word "TOP" or the manufacturer's identification mark towards the piston crown.

Fit barrel faced No. 1 compression ring in top groove with the word "TOP" or manufacturer's identification towards piston crown.

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

6.3544 Premium Engines (Fig. F.7)

No. 1 Chrome Barrel Faced Compression, Internal Chamfer.

No. 2 Chrome Taper Faced Compression, Parallel.

No. 3 Chrome Faced, Spring Loaded Conformable Oil Control.

Fit rings as follows :—

Fit No. 3 as detailed for T6.3544 engine.

Fit taper faced No. 2 compression in the second groove with word "TOP" or manufacturer's identification mark towards piston crown.

Fit No. 1 compression ring in the top groove with the internal chamfer and the word "TOP" or the manufacturer's mark towards the piston crown.

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

6.3544 Standard Engines

No. 1 Chrome Insert Compression.

No. 2 Internally Stepped Compression.

No. 3 Internally Stepped Compression.

No. 4 Slotted Oil Control.

No. 5 Slotted Oil Control.

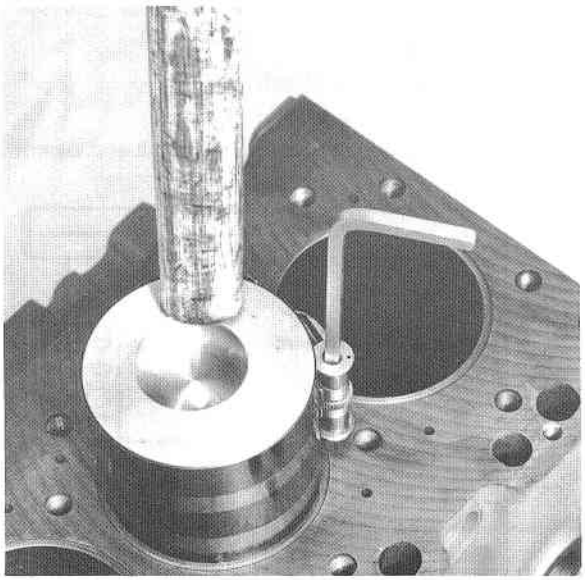
Fit rings as follows :—

Fit No. 5 ring in bottom ring groove.
Fit No. 4 ring in fourth ring groove.

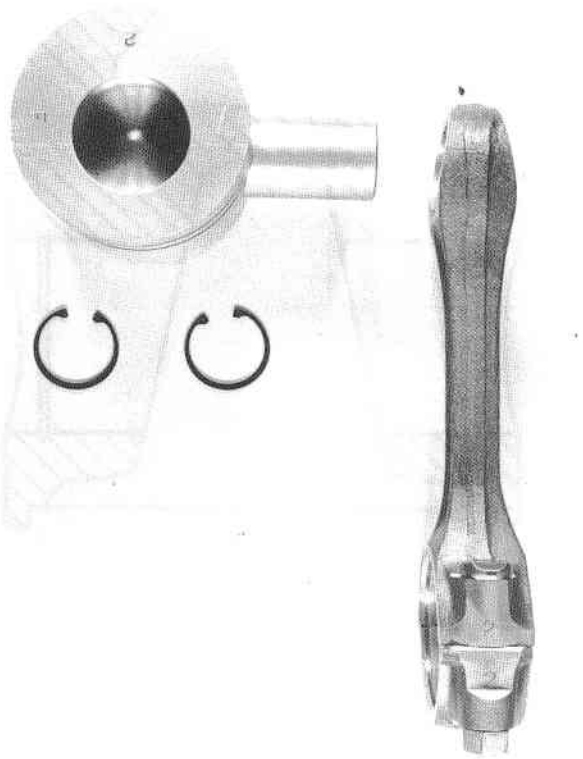
Fit Nos. 3 and 2 rings in the third and second ring grooves with the internal step and the word "TOP" or manufacturer's marks towards the piston crown.

Fit No. 1 ring in top ring groove.

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



F.9



F.10

6.3544 Combine Engines

No. 1 Chrome Insert Compression.

No. 2 Internally Stepped Compression.

No. 3 Internally Stepped Compression.

No. 4 Chrome Faced, Spring Loaded Conformable Oil Control.

No. 5 No ring fitted.

Fit rings as follows :—

Fit spring of No. 4 ring in fourth groove ensuring that the latch pin enters both ends of the ring, see Fig. F.8.

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

Fit Nos. 3 and 2 rings in third and second ring grooves with the internal step and the word "TOP" or the manufacturer's marks towards the piston crown.

Fit No. 1 ring in top ring groove.

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

6.3724 Engines

No. 1 Chrome Insert Parallel Compression.

No. 2 Chrome Faced Internally Stepped or Internally Chamfered Compression.

No. 3 Chrome Faced, Spring Loaded Conformable Oil Control.

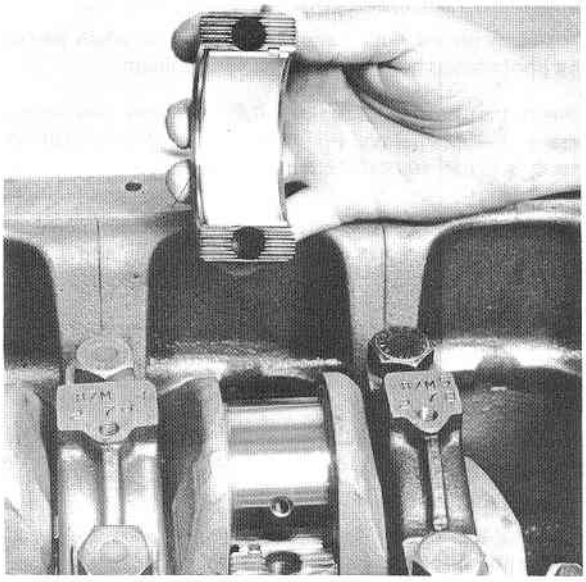
No. 4 Slotted Oil Control.

Note : With later Combine engines, the No: 4 slotted control ring is not fitted.

Fit rings as follows :—

Fit No. 4 oil control ring in bottom groove.

Fit spring of No. 3 oil control ring in third ring groove



F.11

ensuring latch pin enters both ends of ring, see Fig. F.8.

Position No. 3 oil control ring over spring correctly located in groove of ring and ring gap diametrically opposite to latch pin.

Fit No. 2 compression ring with internal step of chamfer and word "TOP" or manufacturer's mark towards crown of piston.

Fit No. 1 compression ring in top ring groove

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

To Fit Piston and Connecting Rod

If necessary, deglaze cylinder bore, see Section G.

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 toward the fuel injection pump side of the engine.

With turbocharged engines, when pressing the assembly through the bore, care must be taken to avoid damage to the piston cooling jets.

Note: Piston cooling jets are not fitted to naturally aspirated engines.

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.2.

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 fit in recess of rod, Fig. F.11. Also check that the letter "F" or arrow 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 of the rod. Secure with new nuts and tighten to a torque of 75 lbf ft (10,4 kgf m) or 102 Nm for cadmium plated nuts or

95 lbf ft (13,1 kgf m) — 129 Nm for phosphated nuts.

Cadmium plated nuts have a silver colour finish whilst the phosphated have a dull black colour finish.

Check that, with piston in T.D.C. position and using piston height gauge PD 41B, the piston crown is 0.000/0.007 in (0,00/0,18 mm) above the cylinder block top face.

The piston height for naturally aspirated engines was formerly 0.0073/0.015 in (0,19/0,38 mm) above the cylinder block face and, when checking earlier engines, either of the two heights are acceptable.

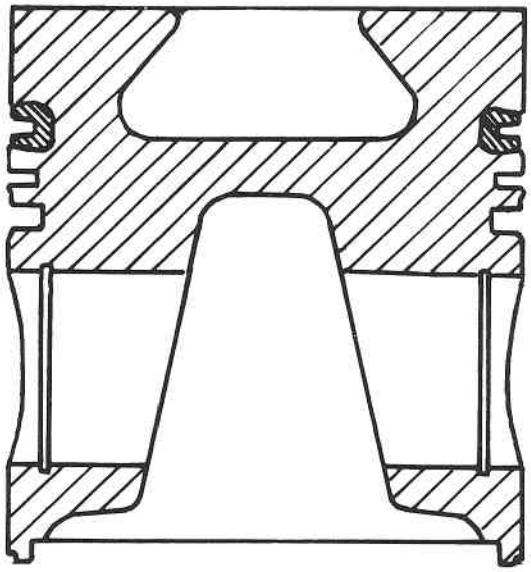
Where new production pistons are used, then these must be topped as necessary to bring them within the above limits.

Fit the pipe from relief valve to piston cooling jet connection. (T6.3544 only).

Fit lubricating oil suction pipe.

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

Refit the cylinder head, see Page E.2.



F.12

The T6.3544 North America vehicle engines are fitted with aluminium silicon alloy pistons with a re-entrant combustion chamber in the crown see Fig. F.12. A steel insert is fitted in the top ring groove and two compression and one scraper piston rings are used.

The pistons are cooled by lubricating oil pressure jets.

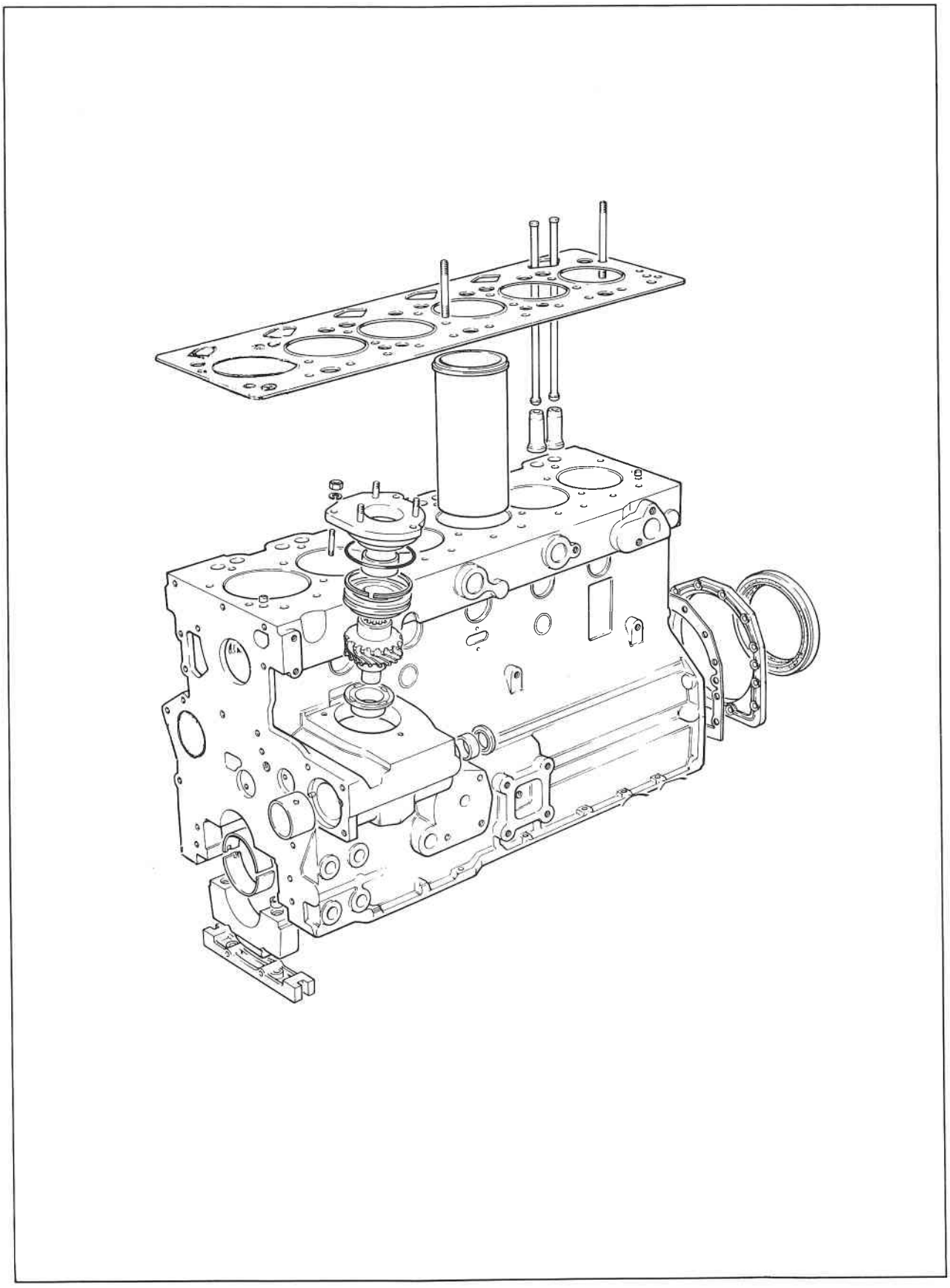
Oversize pistons are not available as the cylinder liners cannot be bored oversize.

The method used to remove and dismantle piston and ring assemblies is the same as used for other T6.3544 engines.

The height of the piston crown relative to the top face of the cylinder block is 0.000/0.007 in (0,000/0,18 mm) above the top face.

The pistons have hard anodised crowns and **must not be topped.** In production, three grades of pre-topped pistons are supplied for the high, medium and low requirements and the letters H, M and L are stamped on the piston crown. To change pistons in service, the same grade of piston **MUST** be used.

SECTION G
Cylinder Block and Liners



Cylinder Block

The top face of the cylinder block cannot be machined as this would interfere with the liner flange recess depth.

Cylinder Liners

Production liners are an interference fit, of 0.001/0.003 in (0.025/0.076mm) in the cylinder block and are bored and honed to a diameter of 3.877/3.878in (98,48/98,50mm) for T6.3544 and 6.3544 engines or 3.9785/3.9795in (101,05/101,07mm) for 6.3724 engines.

The maximum permissible worn inside diameter of a liner, in service is 3.886in (98,70mm) for T6.3544 and 6.3544 engines or 3.9875in (101,28mm) for 6.3724 engines.

An engine with perfect or little worn cylinder bores can sometimes consume an excessive amount of lubricating oil due to glazing. When fitting new piston rings to cure this problem, it is essential that the cylinder bores are first de-glazed.

A tool is available for de-glazing, marketed under the trade name of "Flex-Hone", manufactured by Brush Research Manufacturing Co. Inc., Los Angeles, California, U.S.A. under the registered trade mark U.S. Patent Nos. 3384915 and 3871139 and British Patent Nos. 1,230503 and 18450, which is ideal for this purpose as it does not remove any appreciable amount of metal and produces a good quality cross hatch pattern.

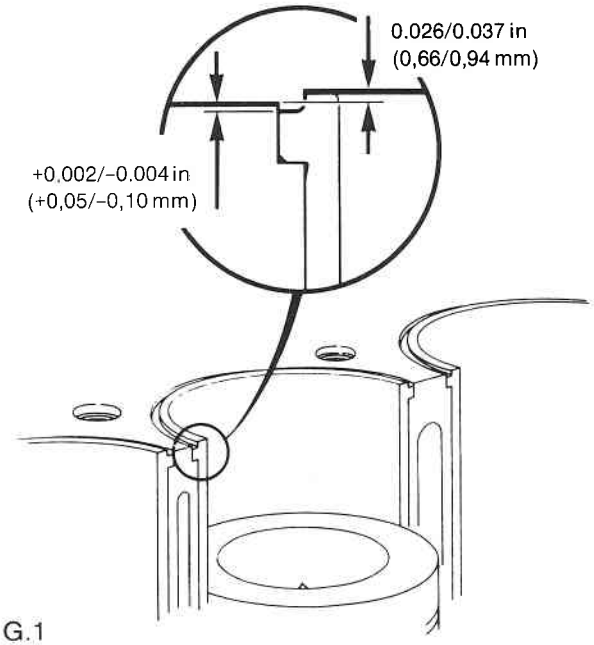
It can often be used with the engine in situ if used with a hand held electric power drill on low speed. Brand new "Flex-Hones" are to be used for one minute in a slave bore to remove all loose material and sharp edges.

1. Grade 80sc "Flex-Hone" is to be used. The "Flex-Hone" size is to be determined by measuring the bore diameter and selecting the "Flex-Hone" of the nearest size larger than the bore.
2. Remove the piston cooling jets as fitted on turbocharged engines. Guard the main journals and pins by tying clean dry rags around them. Where possible use cardboard shields to prevent debris contamination of adjacent parts of the engine.
3. Lubricate the bore with clean engine oil and also smear engine oil on the balls of the "Flex-Hone".
4. Rest the "Flex-Hone" against the cylinder block and switch on whilst pressing into the bore. Do not force the tool into the bore whilst it is not rotating.
5. Pass the tool up and down the bore once per second for 30-50 seconds and remove it whilst it is still rotating.
6. Thoroughly wash the bores to remove all the residue from the honing operation, using a coarse brush and paraffin.
7. Dry the bores using a clean rag and carefully remove the the masking. Thoroughly clean all parts of the engine that have been affected by the honing operation.
8. Refit the piston cooling jets on turbocharged engines (Section M).

This tool is equally successful in producing a good quality bedding-in finish on new cylinder bores, after boring out to finished size.

Enquiries concerning details and supply of the "Flex-Hone" in the U.K. or outside the U.S. where no Brush Research Distributor is available, should be addressed as follows:

Nicro (Leamington) Ltd.
Unit 19A, Chalford Industrial Estate,
Chalford, Nr. Stroud, Gloucestershire GL6 8NT.
Telephone: (0453) 884966
Telex: 437104



G.1

If the liners are found to be worn over the acceptable limit, they cannot be bored oversize.

For service in T6.3544 and 6.3544 engines, a pre-finished liner is available having a transition fit of +0.001/–0.001in (+0,025/–0,025mm). The fitted internal bore diameter is 3.877/3.8795in (98,48/98,54mm).

The liners can be renewed using tools PD 150 and PD 150-1B.

To Renew Service Cylinder Liners

Remove all components from the cylinder block, including the piston cooling jets. They should be carefully handled to prevent misalignment in refitting.

Piston cooling jets are not fitted to naturally aspirated engines.

The liners should be pressed out from the bottom.

Fit the new liners as follows:

It is pointed out that all pre-finished liners can be a 0.001in (0,03mm) interference fit in the parent bore, i.e. if a liner on top limit is fitted in a bottom limit parent bore.

A tight liner should never be hammered in but should be pressed or drawn into the bore using a suitable dolly and press or puller.

Generally clean the parent bore and degrease the top 2 in (50mm) and the liner flange recess using "Loctite" Safety Solvent (aerosol can) as per instructions on can.

Apply engine oil to the cylinder block parent bore except for the top 2in (50mm).

Generally clean the outside surfaces of the liner and degrease using "Loctite" Safety Solvent (aerosol can) as per instructions on can.

Locate the liner in the bore and press in to within approximately 2in (50mm) of its final position.

Further degrease the flange area of the liner using "Loctite" Safety Solvent to remove handling contamination.

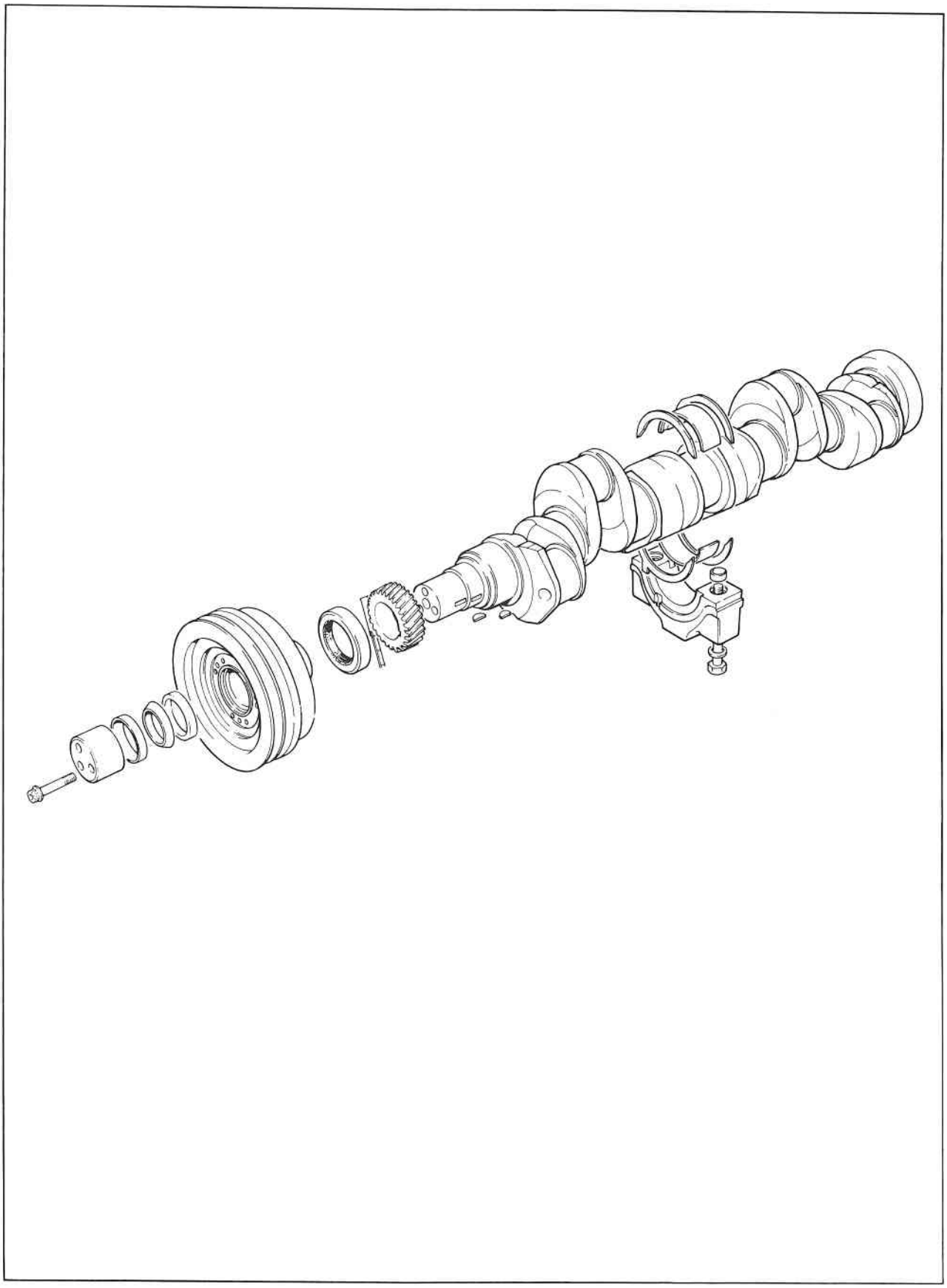
Apply a band of "Loctite" Retaining Compound, Grade 602, 1 in (25 mm) wide around the top of the liner immediately under the flange. Also liberally apply the "Loctite" to the base of the flange recess.

Press the liner into the fully fitted position and wipe the top of the cylinder block to remove any surplus "Loctite". The top of the liner should protrude 0.026/0.037 in (0,66/0,94 mm) above the top face of the cylinder block and the liner flange should be within 0.002 in (0,05 mm) above the top face of the block to 0.004 in (0,10 mm) below the top face of the block.

It is advisable to allow a settling period to elapse after fitting before checking the fitted internal bore diameter of the liner.

However, allow at least 15 minutes to elapse before commencing to fit pistons as this time lag is required to allow the "Loctite" to reach handling strength. Full cure strength is achieved after 3 hours.

SECTION H
Crankshaft and Main Bearings



The crankshaft runs in seven pre-finished replaceable shell bearings.

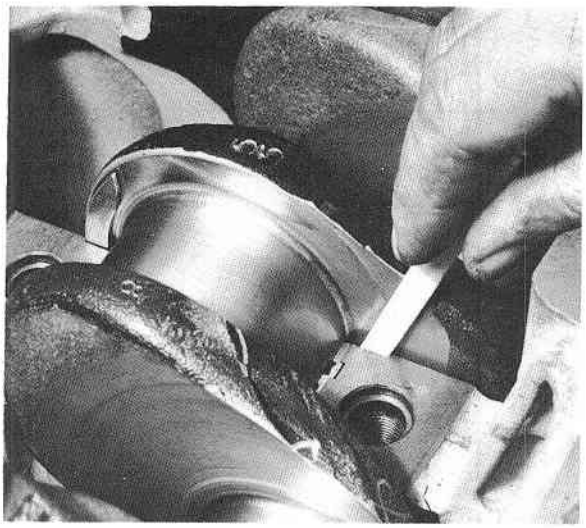
End float of the crankshaft is controlled by four thrust washers which are located on both sides of the centre main bearing housing, see Fig. H.1. 0.0075in (0,19mm) oversize thrust washers are available which may be combined with standard thrust washers to give an adjustment of 0.0075in (0.19mm) or when used on both sides of the bearing housing give an adjustment of 0.015in (0,35mm).

The maximum permissible crankshaft end float is 0.020in (0,51mm).

Crankshafts fitted to turbocharged engines are 60 hour Nitrided or Tufftrided.

Crankshafts fitted to naturally aspirated engines are induction hardened.

The crankshaft has provision for 12 bolt flywheel fixing.



H.2

To Renew Thrust Washers

Renewal of thrust washers can be carried out without the removal of crankshaft as follows:

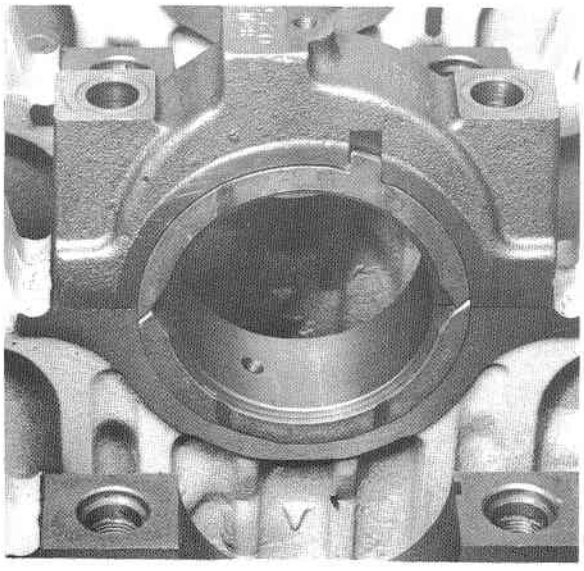
Drain the lubricating oil and remove the sump, oil suction pipe and pipe from reducing valve to cylinder block (T6.3544 engines only).

Remove the centre main bearing cap (No. 4).

Remove the two bottom half thrust washers.

Remove the two top halves of the thrust washers by sliding them round the crankshaft and out of the recesses machined in the cylinder block main bearing housing, see Fig. H.2.

Liberally oil the two upper halves and slide them into the recesses on either side of the centre main bearing housing.



H.1

Refit the two bottom halves of the thrust washers to the bearing cap.

Clean and oil crankshaft journal and place the cap in position ensuring that the block serial number stamped on the cap reads in line with other caps.

Tighten the main bearing cap setscrews to a torque of 200lbf ft (27,7kgfm), or 270Nm.

Check the crankshaft end float by using a feeler gauge between the thrust washer and crankshaft web or by using a dial test indicator on one end of the crankshaft, see Fig. H.3.

Refit suction pipe, pipe from reducing valve to cylinder block (T6.3544 only) and sump. Refill the sump with lubricating oil of an approved grade.

To Remove Crankshaft

It will be necessary to remove the engine from vehicle or machine.

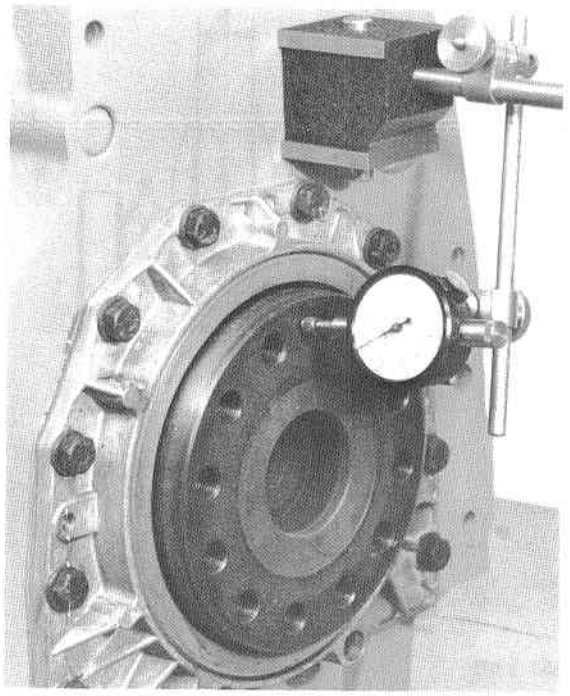
Drain and remove the sump, lubricating oil suction pipe and pipe from reducing valve to the cylinder block (T6.3544 only).

Remove the crankshaft pulley. Extractors should not be used as the pulley will probably be destroyed and the crankshaft damaged. Remove the three securing screws. If the pulley does not immediately become free the locking rings can be released by hitting the front face of the pulley inner hub, see Fig. H.4.

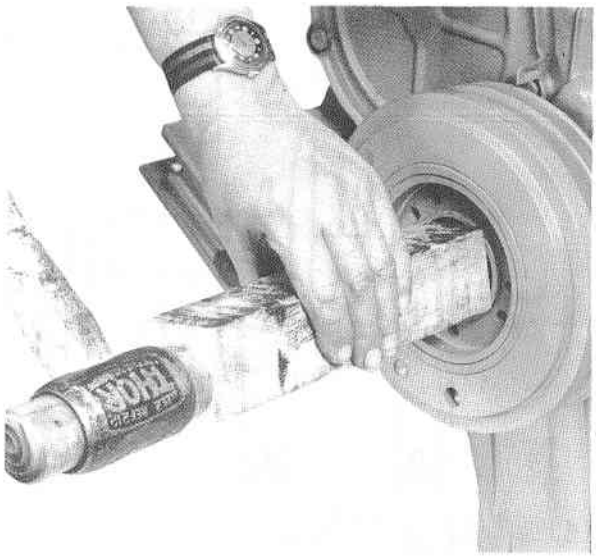
Remove camshaft gear, auxiliary drive gear and timing case, see Page J.2.

Remove flywheel and flywheel housing.

Remove rear main oil seal housing.



H.3



H.4

Remove front and rear bridge pieces from the cylinder block bottom face, with the rubber oil seals.

Remove connecting rod caps and big end bearings. Keep bearings with appropriate caps. Take care not to damage the piston cooling jets.

Remove the main bearing caps and half bearings.

Lift out the crankshaft and remove the upper half bearings, making note of fitted positions.

Crankshaft regrinding

Induction hardened crankshafts (Pt. No. 31323283, 31323288, 31323294, 3131H023, 3131H024 or 3131H025) fitted to naturally aspirated engines can be reground to –0.010in (0,25mm), 0.020in (0,51mm) or 0.030in (0,76mm) without any subsequent rehardening.

60 hour Nitrided crankshafts (Pt. No. 31323281 or 3131H021) fitted to turbocharged engines may be reground to –0.010in (0,25mm) without re-Nitriding. Subsequent regrinding to –0.020in (0,51mm) or 0.030in (0,76mm) calls for re-Nitriding for a 60 hour period after each regrinding operation.

Tufftrided crankshafts (Part No. 31323292 or 3131H022) must be re-Tufftrided after each regrinding operation.

If a 60 hour Nitrided crankshaft is found to be suitable for further service, but necessary to re-grind down to 0.020in (0,51mm) or 0.030in (0,76mm) undersize, grind down to 0.0015/0.002in (0,04/0,05mm) above finished size leaving an allowance to grind off the white compound layer formed by the 60 hour Nitriding process.

After nitriding of the crankshaft, regrinding of the fillet radii is not permissible.

When re-grinding, the operation calls for specialised equipment and great care.

Using a Prince type grinder with a Universal Grinding Wheel Company wheel to Grade WA-80 JE (or equivalent), remove the white compound layer formed by the Nitriding process to achieve finished size. The collar faces of the crankshaft should be lightly flashed but not ground at this operation and the fillet radii should be maintained at 0.145/0.156in (3,68/3,96mm). This will leave the compound layer in the radii and collars. When removing the compound layer, a grinding wheel speed of 880 rev/min and a crankshaft working speed of 16 rev/min for main journals and 8 rev/min for pins should be observed and a hand feed of approximately 0.0005in (0,01mm) per revolution of crankshaft. An adequate supply of coolant (Walker Century A305) should be used.

Where facilities for re-Nitriding are not available, then a factory replacement crankshaft should be fitted.

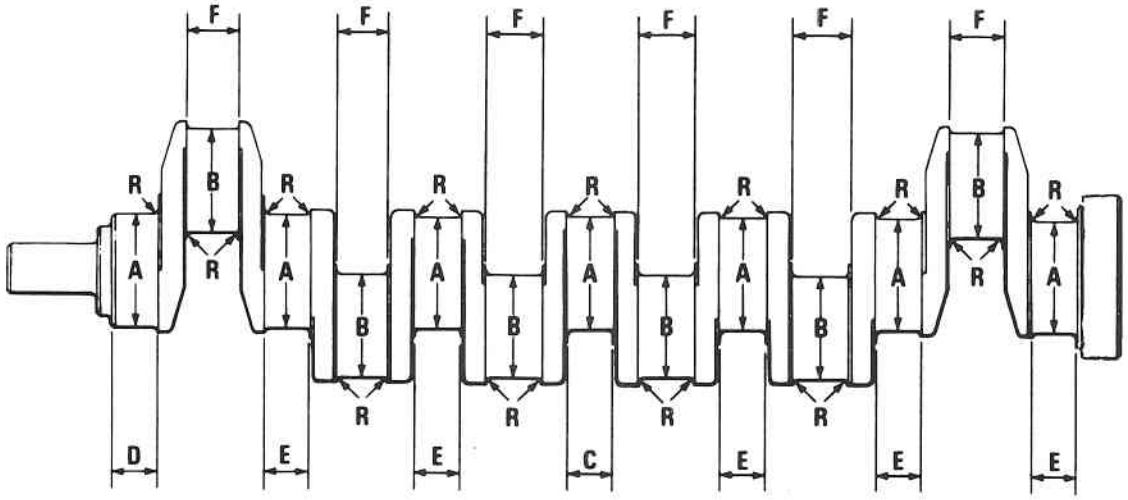
Nitrided crankshafts cannot be straightened.

Before regrinding a crankshaft, it should be crack detected. De-magnetize after crack detecting.

Data for crankshaft re-grinding is given on Page H.4.

After regrinding, the sharp corners on the oil holes should be removed and the crankshaft crack detected and de-magnetized.

Note: It is important that the radii on the main journals and crankpins are maintained.



H.5

The regrind dimensions are as follows see Fig. H.5.

	0.010 in (0,25 mm)	0.020 in (0,51 mm)	0.030 in (0,76 mm)
A	2.9884/2.9896 in (75,91/75,94 mm)	2.9784/2.9796 in (75,65/75,68 mm)	2.9684/2.9696 in (75,40/75,43 mm)
B	2.4888/2.4898 in (63,22/63,24 mm)	2.4788/2.4798 in (62,96/62,99 mm)	2.4688/2.4698 in (62,70/62,73 mm)
C	1.759 in (44,68 mm) maximum		
D	1.489 in (37,82 mm) maximum		
E	1.554 in (39,47 mm) maximum		
F	1.5965 in (40,55 mm) maximum		
R	0.145/0.156 in (3,68/3,96 mm) radius all pins and journals		

Surface finish of 16 micro inches (0,4 microns) of the crankpins and journals and 50 micro inches (1,3 microns) of the fillet radii (R) must be maintained during regrinding.

Maximum run-out with the crankshaft mounted on the end main journals.

Independent readings.

Crankshaft Pulley	Rear Oil Seal	Flywheel Flange
Diameter T.I.R.	Diameter T.I.R.	Diameter T.I.R.
0.002 in (0,05 mm)	0.002 in (0,05 mm)	0.002 in (0,05 mm)

Journals T.I.R. — Run-out must not be opposed :

Number 1	Number 2	Number 3	Number 4
Mounting	0.004 in (0,10 mm)	0.008 in (0,20 mm)	0.010 in (0,25 mm)

Number 5	Number 6	Number 7
0.008 in (0,20 mm)	0.004 in (0,10 mm)	Mounting

The difference in run-out between any two adjacent bearings must not be greater than 0.004 in (0,10 mm).

To Fit Crankshaft

Ensure that the oilways in the cylinder block and crankshaft are free from obstruction.

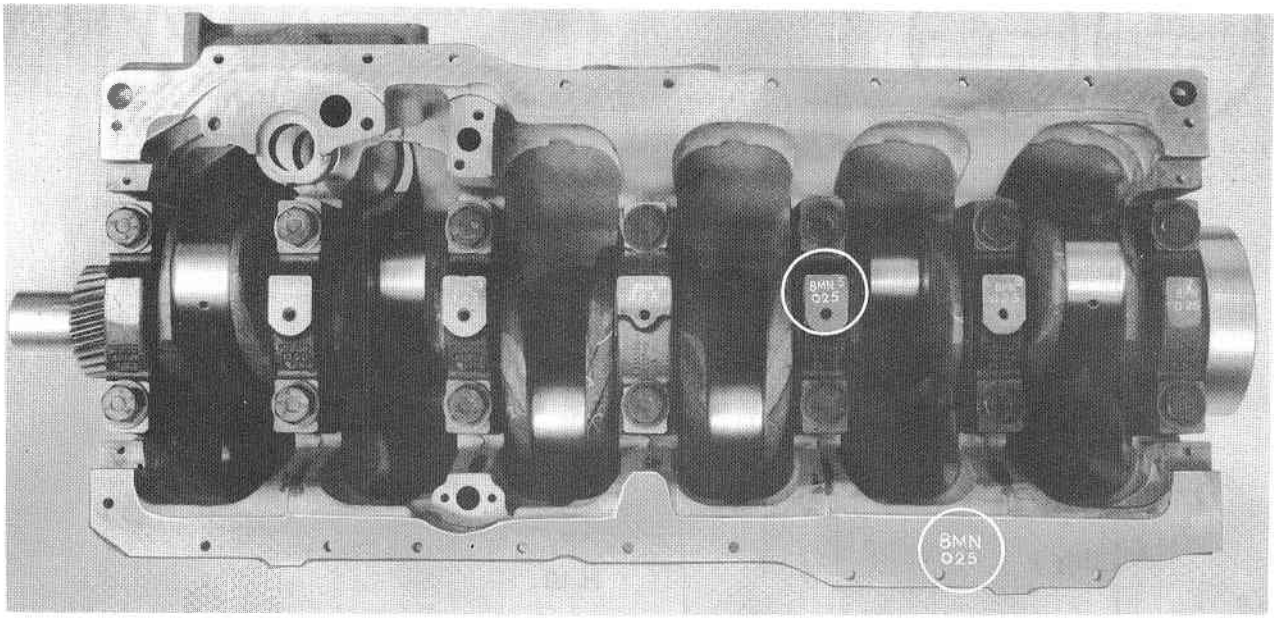
Check the main bearing setscrews for stretch or damage. If they are to be replaced, only use Perkins genuine spare parts.

Clean the bearing housings; place the top half bearings in position and liberally oil.

Position the crankshaft.

Oil the two upper thrust washers and slide into the recesses on either side of the centre main bearing housing.

Clean the main bearing caps and place the lower halves of the bearings, with the tabs correctly located, into position. Liberally oil and place the caps in position making sure that the cap to cylinder block locating



H.6

thimbles are in place and that the caps, which are numbered one to seven are fitted to the relevant main bearing housings. Care must also be taken to ensure that the caps are fitted so that the cylinder block serial number, which is stamped on the cylinder block bottom face as well as on each cap, read in line, see Fig. H.6.

Before fitting the centre main bearing cap, place the lower halves of the thrust washers into the recesses on either side of the cap.

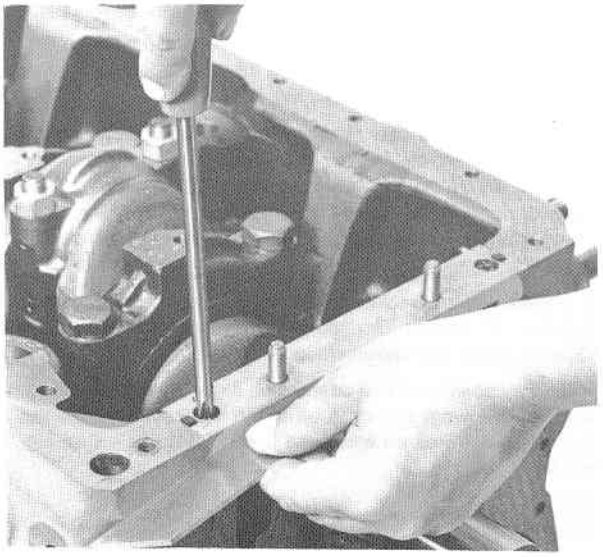
Fit a new shim washer to each main bearing cap setscrew and lightly oil.

Tighten the setscrews to a torque of 200 lbf ft (27,7 kgf m), or 270 Nm.

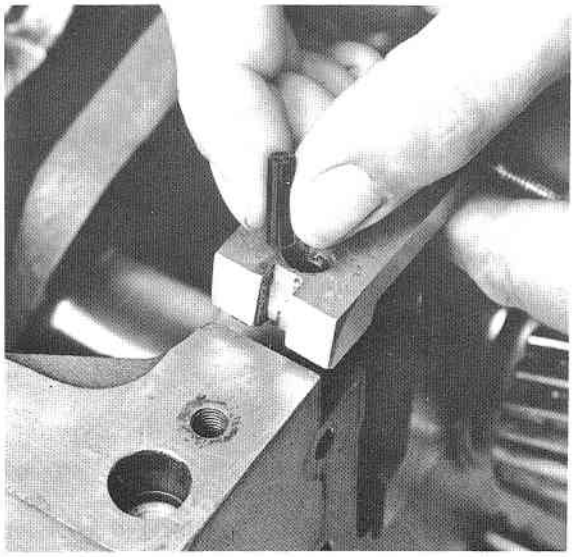
Check the crankshaft end float for a clearance of 0.002/0.015 (0,05/0,38 mm). Oversize thrust washers may be fitted.

Refit the connecting rod caps and big end bearings.

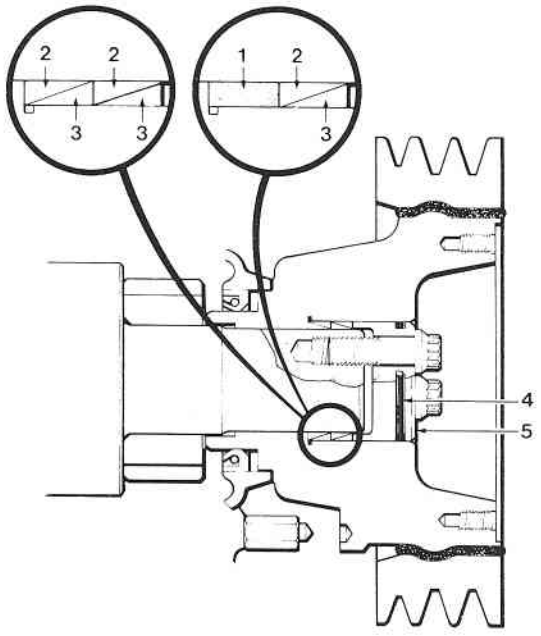
Refit the front and rear bridge pieces to the cylinder block using jointing compound between the bridge pieces and the cylinder block at the setscrew holes. Check with a straight edge to ensure that the end faces of the bridge pieces are flush with the end faces of the cylinder block, see Fig. H.7. Insert new rubber oil seals, see Fig. H.8.



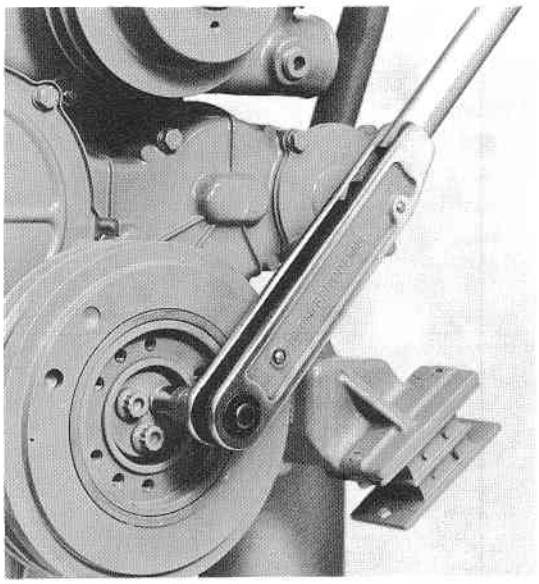
H.7



H.8



H.9



H.10

Fit new seal in the rear main oil seal housing and refit the housing.

Refit the pipe from reducing valve to cylinder block (T6.3544 only) lubricating oil suction pipe and sump.

Refit the timing case, camshaft gear and auxiliary drive gear, see Page J.2.

Refit the crankshaft pulley employing the following recommended procedure.

(a) Remove oil and grease from pulley bore, shaft, locking elements and spacer, but do not use a degreasing solution. Do not expand the rings beyond their free state.

(b) Fit pulley to shaft, lining up key and keyway.

(c) Insert the spacer (1) into the pulley bore over the shaft, followed by the inner (2) and then the outer (3) locking elements, ensuring that the slots do not coincide, see Fig. H.9.

Note: Where power take-off at the front end of the crankshaft is critical, then two pairs of locking elements are fitted — see Fig. H.9 (2) and (3).

(d) Fit the thrust block (5) with "O" ring (4) into the pulley bore.

(e) Lightly oil screw threads and underside of screw heads before fitting. Do not use molybdenum disulphide.

(f) Push pulley fully home and tighten setscrews to establish a firm connection.

(g) Tighten screws evenly and in several stages until a final torque of 65lbfft (9,0kgfm) or 88 Nm is achieved, see Fig. H.10.

Check tightening torque on each screw.

Refit and correctly align the flywheel housing and flywheel, see Page P.2.

Rebuild engine into vehicle or machine. Fill the sump to the correct dipstick level with a recommended oil. With turbocharged engines do not fire the engine until checking for lubricating oil at the turbocharger, see Page C.2.

Crankshaft Rear Oil Seal

A circular spring loaded lip seal locates on the periphery of the rear flange of the crankshaft.

This seal is easily damaged and extreme care should be taken when handling and fitting it to its housing or to the crankshaft. Any visual damage across the lip of a new seal will cause leakage and prevent bedding in of the seal.

To Fit Oil Seal in its Housing

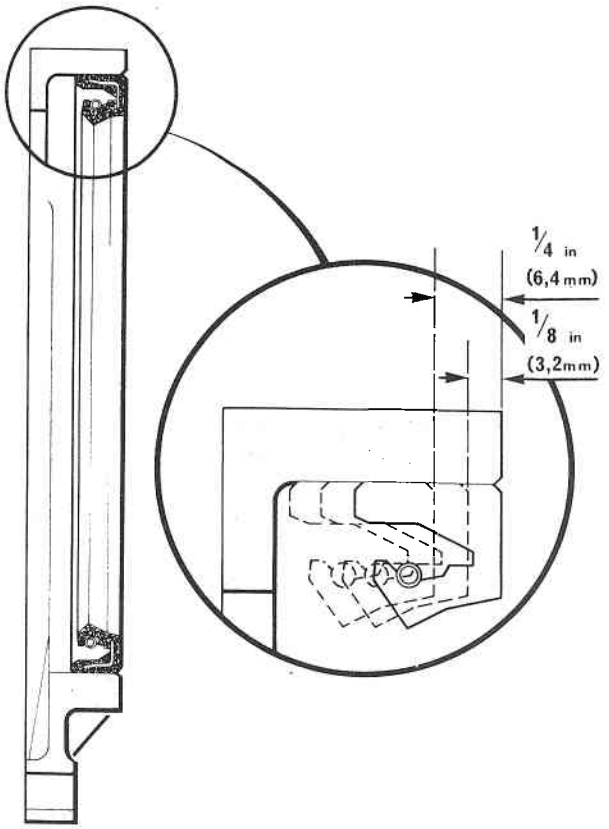
Earlier seals have a flat rear face, as shown in Fig. H.11 whereas the latest seal has a dust lip protruding from the rear face, as shown in Fig. H.12.

On production, the old type seal was fitted flush with the rear face of the housing (Fig. H.11) but the new type seal is fitted deeper into the housing at "A", Fig. H.12.

In service, when a new seal is fitted to a worn crankshaft, it should be pressed further into the housing. In the first instance it can be pressed in to ⅛in (3,2mm) for old type seals or position "B" for new type seals or, if this position has been used, to ¼in (6,4mm) for old type seals or position "C" for new type seals.

If a new type seal is used in place of an exisiting old type seal, position "C" should be used if the old seal was fitted ⅛in (3,2mm) below the housing face.

If all three positions have been used, it may be permissible to machine the worn sealing area of the crankshaft flange, but not the spigot area on which the flywheel locates – See Fig. H.13.

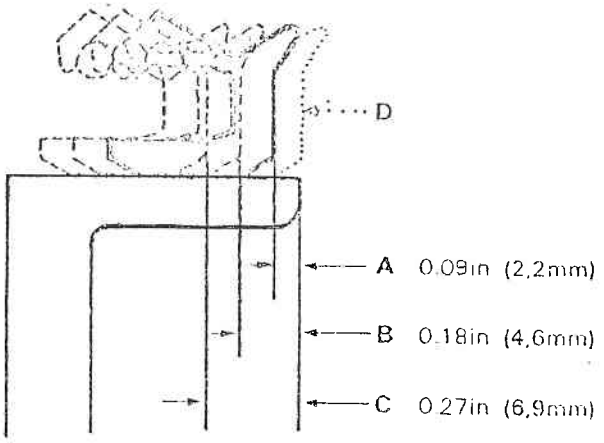


H.11

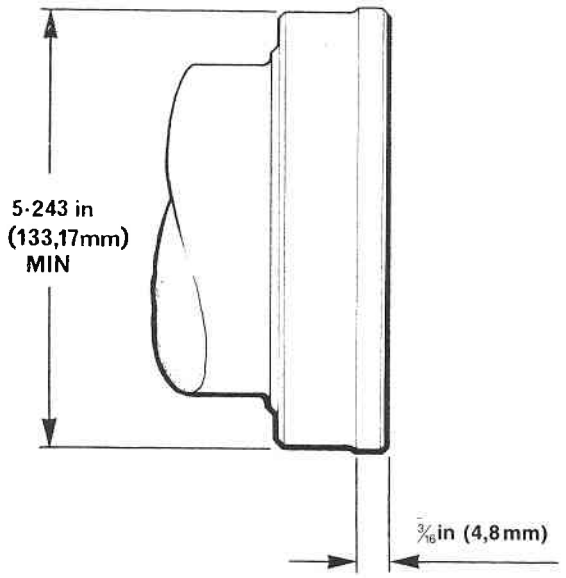
When a new seal is fitted to a new or reconditioned crankshaft in service, it should be fitted in the production position, but if the latest seal is not to be used in a wet back end application, it can be fitted flush with the housing rear face ("D", Fig. H.12).

When pressing in the latest type seal, ensure that the adaptor has a suitable recess to clear the protruding dust lip. Tool PD145C can be used with both type seals.

Before fitting the seal in the housing, carefully examine the seal for damage especially on the lip and outside diameter.



H.12



Using clean engine lubricating oil, lubricate the outside diameter of the seal and the inside diameter of the housing.

Press the seal into the housing to the required position, taking care that the seal is entered and pressed in squarely, otherwise damage to the outside diameter of the seal may occur or, if not square in the housing when fitted to the engine, it may leak.

To Fit Oil Seal and Housing

The seal and housing should be fitted, using seal guide PD145C, as follows:—

Clean the faces of the cylinder block and the oil seal housing and the outside diameter of the crankshaft flange.

Check that the seal and the outside diameter of the crankshaft flange are not damaged. Where a new seal has been fitted, check that it is in the correct position in the housing, as detailed above.

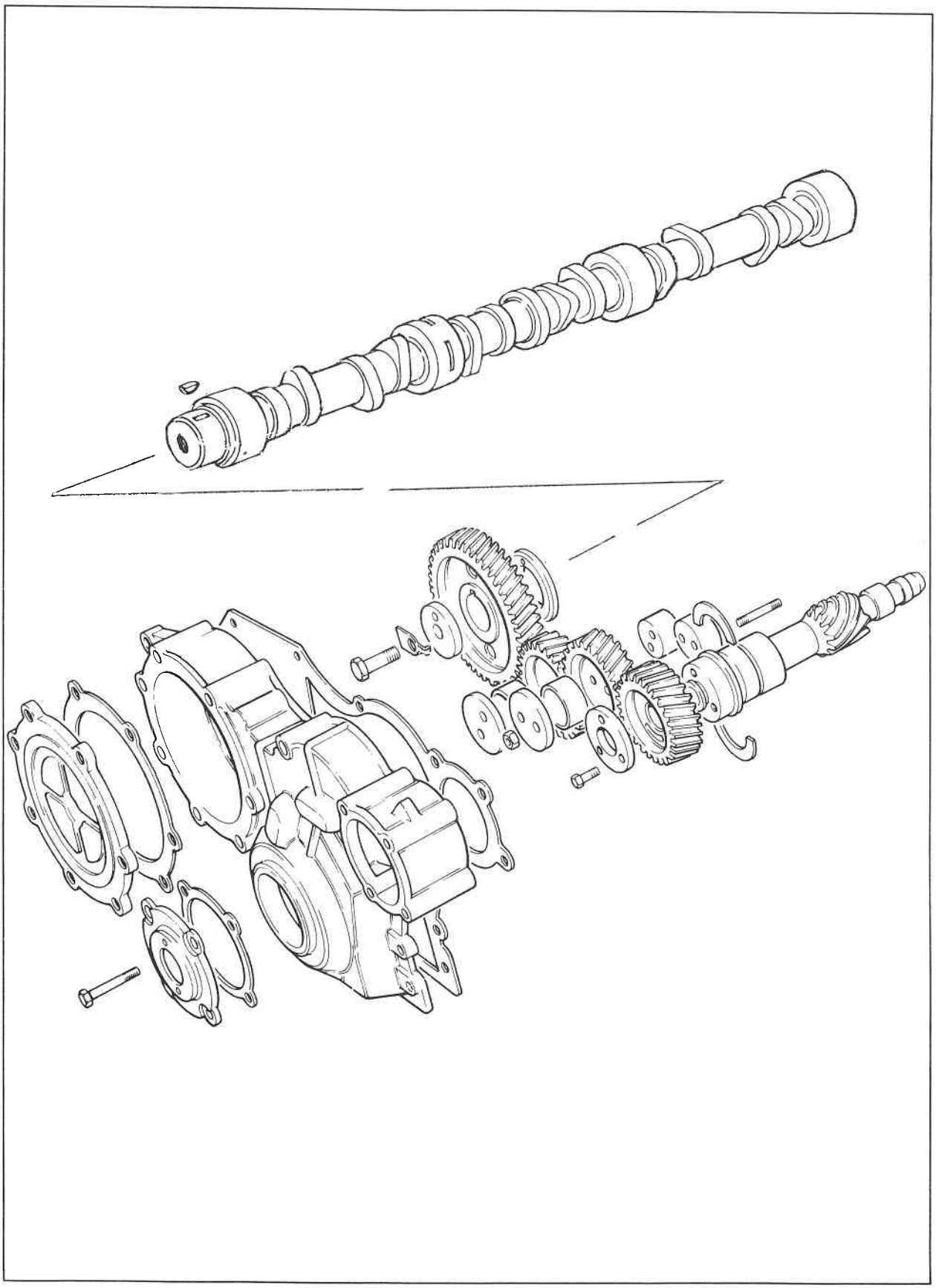
Ensure that the two dowels are fitted in the cylinder block. Coat both sides of the housing joint with Perkins (Hylomar) Jointing Compound and position the joint over the dowels in the block.

Using clean engine lubricating oil, lubricate the crankshaft flange, the seal and the seal guide. The lubrication of the seal is necessary to prevent damage that may be caused by initial dry running.

Position the seal and housing on the seal guide, locate the guide on the crankshaft flange and gently press the seal and housing into position on the flange, locating the housing on its dowels.

Withdraw the guide and secure the housing with setscrews and washers.

SECTION J
Timing Case and Drive



To Remove Timing Case, Camshaft Gear and Auxiliary Drive Gear

Slacken the generator mounting bolts and remove the drive belts.

Where necessary, remove the water pump.

Remove the crankshaft pulley, see Page H.2.

Remove the camshaft gear and auxiliary drive gear covers.

The camshaft gear securing setscrew and washers can now be removed. Extract the gear from the camshaft, see Fig. J.2.

Remove the retaining plate securing the auxiliary drive gear to the auxiliary drive shaft hub and withdraw the gear, see Fig. J.3.

The timing case securing setscrews, lower nuts and timing case can now be removed.

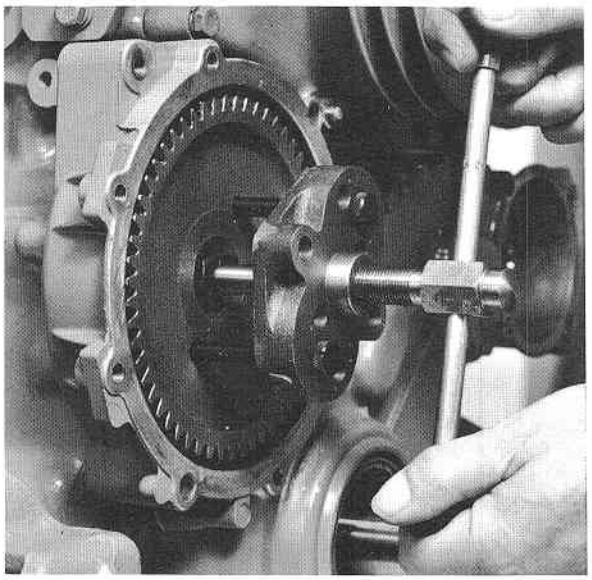
To Renew Crankshaft Front Oil Seal

Using a press, remove the oil seal from the timing case. Alternatively, the seal may be tapped out.

Early seals were black with a flat front face. Later seals were red and also had a flat front face. Current seals are black and have a protruding dust seal lip at the front. An oil thrower is fitted between the crankshaft gear and pulley with the early black seals but this is removed and a spacer or longer pulley is fitted with the later red and black seals.

If the latest seal, with a dust seal lip, is used in place of an earlier type seal, a clean locating surface for the dust lip must be provided on the pulley boss. Clean paint, etc. from the pulley for a distance of ⅜in (9mm) forward of the lip seal location.

Press the seal into position from the front until the flat front face of the seal is 0.265/0.285in (6,73/7,24mm) below the front face of the timing case, see Fig. J.4.



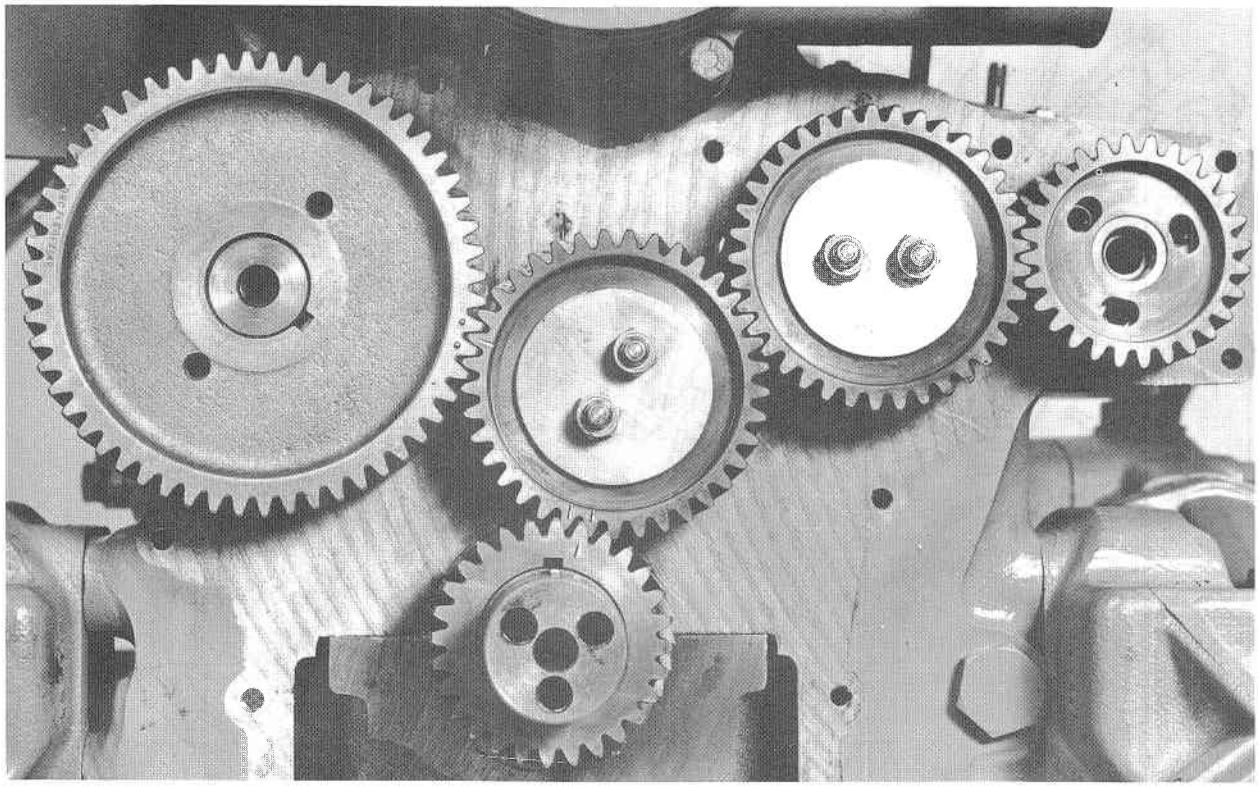
J.2

To Refit Timing Case, Camshaft Gear and Auxiliary Drive Gear

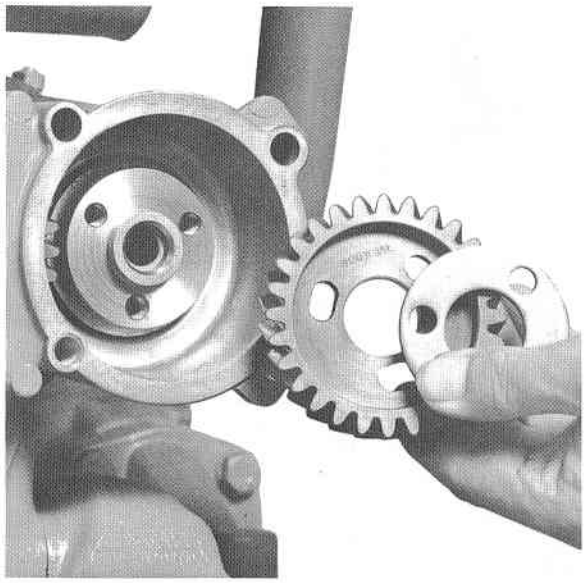
Remove the rocker cover and slacken the rocker assembly securing setscrews.

Turn the crankshaft until Nos. 1 and 6 pistons are at T.D.C. with the keyway in the crankshaft gear at T.D.C.

If the double dot on the lower idler gear is not in line with the single dot on the crankshaft gear, remove the idler gear and replace with the marks in line.



J.1



J.3

Position the timing case with a new joint on the cylinder block by means of two opposite setscrews fitted loosely. Centralise the case by locating the timing case centralising tool PD.163 on the crankshaft and in the seal housing and tighten the assembly by means of the crankshaft pulley setscrews and the washer provided. Do not overtighten. Tighten all the timing case setscrews and nuts and remove the tool. If the centralising tool is not available, the crankshaft pulley can be used to centralise the case, but, as this method utilises the inside diameter of the seal which is soft, the case may not be truly central and leaks may occur.

If the latest type of crankshaft oil seal with a protruding dust seal lip at the front is fitted, ensure that the centralising tool has a suitable recess in it to clear the dust seal lip.

Position the camshaft so that the key is aligned with the keyway in the camshaft gear and at the same time, the timing marks on the camshaft and idler gears are aligned.

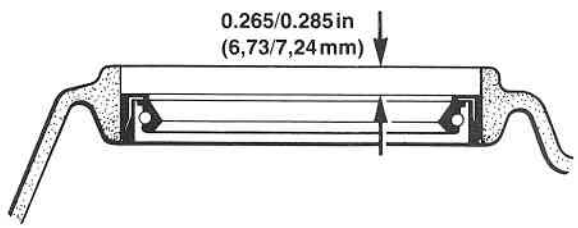
Draw the gear onto the camshaft by fitting the gear retaining washer, tabwasher, shimwasher and setscrew. Tighten the setscrew to a torque of 50 lbf ft (6,9 kgf m) or 68 Nm, and lock with the tabwasher.

Refit the camshaft gear cover plate.

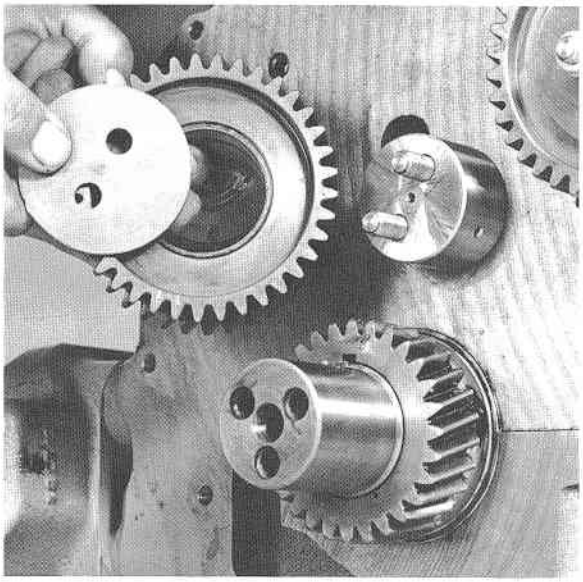
Before fitting the auxiliary drive gear, remove the fuel injection pump, see Page N.6. and turn the auxiliary drive shaft until the slot in the vertical fuel pump drive hub aligns with the slot in the fuel pump adaptor plate, see Fig. K.2.

With the engine set in this position, fit the auxiliary drive gear so that the three setscrew holes in the shaft are within the three slots of the gear.

Secure the gear with the retaining plate and setscrews.



J.4



J.5

Refit the auxiliary drive gear cover plate.

Refit the fuel injection pump, see Page N.6.

Tighten the rocker assembly and adjust the valve clearances to 0.008 in (0,20 mm) for inlet valves and 0.018 in (0,45 mm) for exhaust valves cold and replace the cover.

Refit the crankshaft pulley, see Page H.6.

Fit the drive belts and retighten the generator.

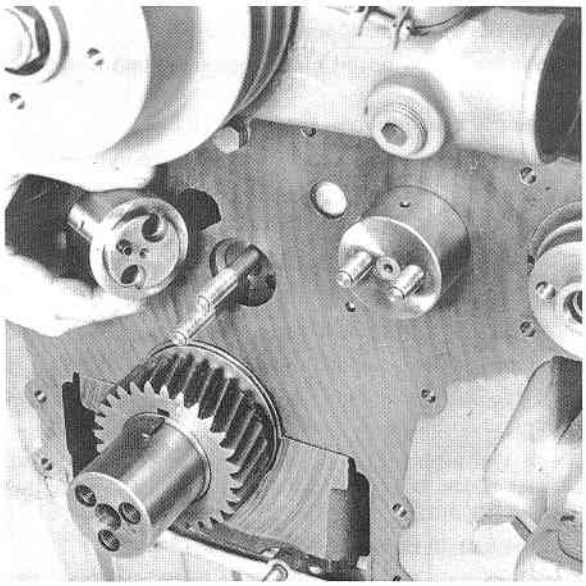
To Remove Idler Gears and Hubs

Remove the timing case, see Page J.2.

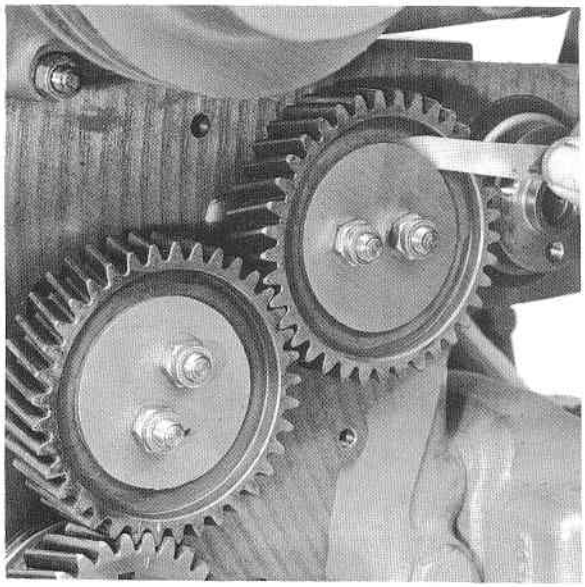
Remove the self locking nuts securing each idler gear thrust plate.

Remove the retaining plates and withdraw the gears, see Fig. J.5.

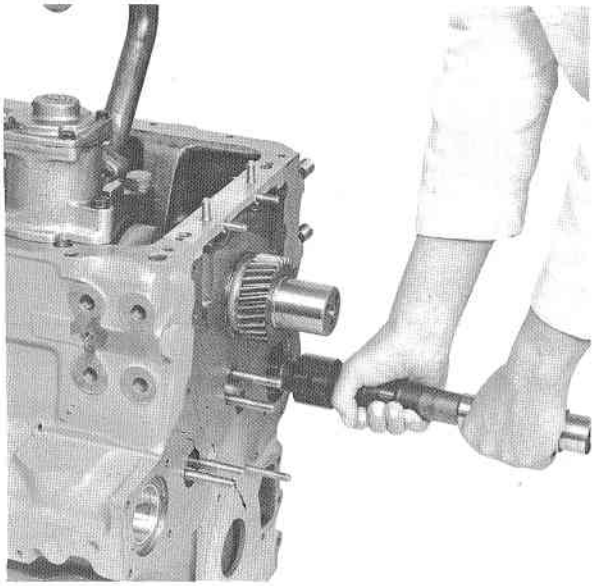
Withdraw the hubs.



J.6



J.7



J.8

To Refit Idler Gears and Hubs

Turn the crankshaft until Nos. 1 and 6 pistons are at T.D.C. with the keyway in the crankshaft gear at T.D.C.

Refit the idler gear hubs, located by dowels, see Fig. J.6. Ensure that the oilways are clear.

Refit the idler gears and retaining plates so that the timing marks on the lower idler gear align with the timing marks on the crankshaft gear.

Using new self locking nuts, tighten to a torque of 36 lbf ft (5,0 kgf m) or 49 Nm.

Refit the timing case, camshaft gear and auxiliary drive gear, see Page J.2.

Check the end float which should be 0.004/0.016 in (0,10/0,41 mm), see Fig. J.7.

To Remove Camshaft and Tappets

Remove the timing case, see Page J.2.

Remove the rocker cover, rocker assembly and withdraw the pushrods.

Remove the fuel lift pump, see Page N.5.

Turn the engine on its side and remove the sump.

Remove the camshaft thrust ring and withdraw the camshaft, see Fig. J.8.

Remove the tappets.

To Replace Camshaft and Tappets

Refit the tappets, camshaft and sump.

Fit the camshaft thrust ring so that it is correctly positioned on the dowel, see Fig. J.9.

Check the protrusion of the thrust ring beyond the cylinder block front face which should be within the limits of 0.000/0.005 in (0,00/0,13 mm).

Refit the fuel lift pump and connections.

Fit the timing case and refit the timing gears, see Page J.2.

Refit the pushrods and rocker assembly.

Adjust the valve clearances to 0.008 in (0,20 mm) for inlet valves and 0.018 in (0,45 mm) for exhaust valves cold. Refit the rocker cover.

Refill sump with lubricating oil of an approved grade.

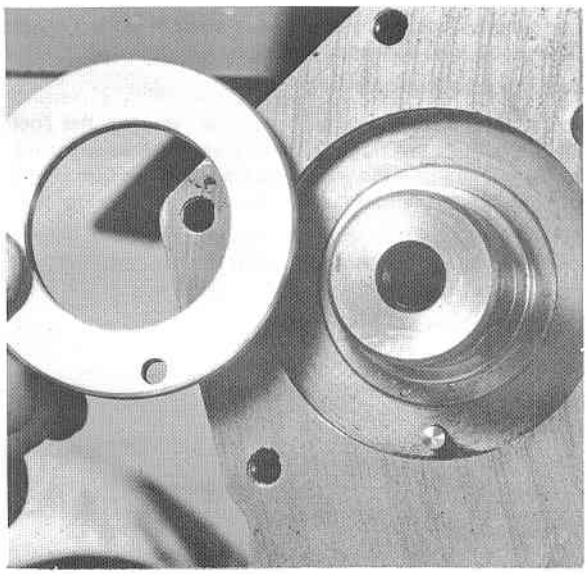
To Remove Auxiliary Drive Shaft and Fuel Pump Drive Shaft

Remove the timing case, see Page J.2.

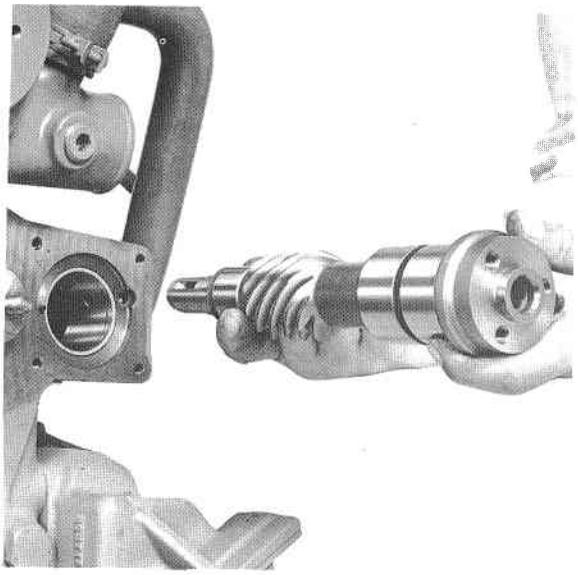
Remove the compressor and auxiliary pump (if fitted) and couplings.

Remove the fuel injection pump, see Page N.6.

With a twisting motion, withdraw the auxiliary shaft and the two 180° half thrust washers, see Fig. J.10.



J.9



J.10

Remove the fuel pump adaptor plate complete with rubber sealing ring and bush.

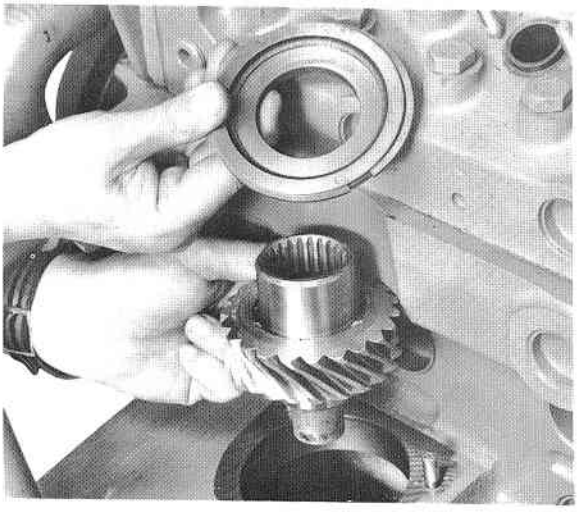
Withdraw the upper thrust collar complete with piston ring seal, see Fig. J.11.

The fuel injection pump and lubricating oil pump drive shaft complete with wormwheel can now be pulled up and removed, see Fig. J.11.

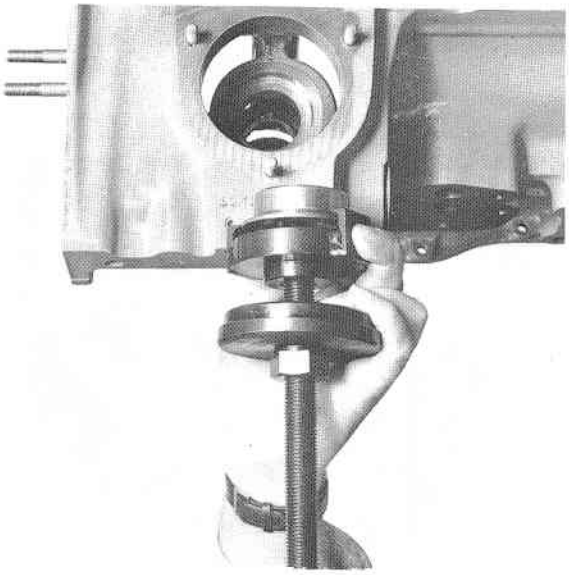
The wormwheel is shrunk on and punch peened to the drive shaft. In the event of the gear requiring renewal, the gear and shaft assembly should be replaced. The lower thrust collar and bush will remain in its location in the cylinder block and can be removed by removing the sump and lubricating oil pump.

With the use of a special tool PD 140 with adaptor 140-3 the thrust collar and bush can now be withdrawn, see Fig. J.12. Some earlier engines did not have a bush fitted.

Where necessary, renew the auxiliary drive shaft front and rear bushes in the cylinder block. It is advisable



J.11



J.12

that these be drawn into the block by means of a suitable threaded bar and adaptors.

To Refit Auxiliary Drive Shaft and Fuel Pump Drive Shaft see Fig. J.13.

Refit the lower thrust collar assembly and press into position.

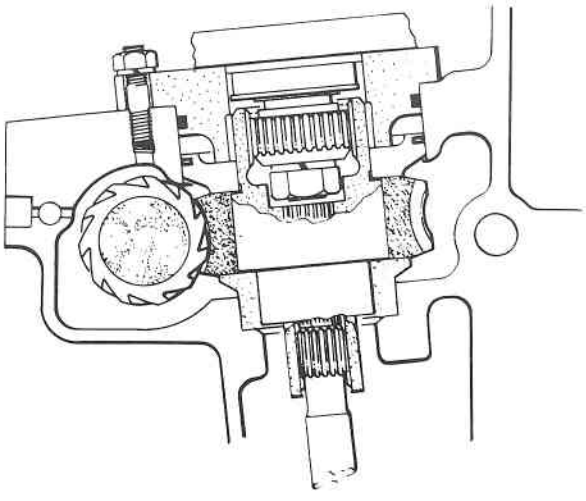
The wormwheel and fuel pump drive assembly can now be fitted.

Fit the upper thrust collar with the piston ring seal in its location.

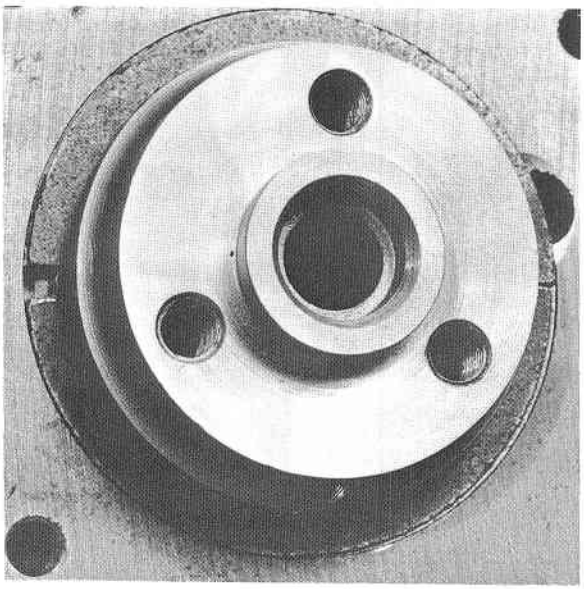
Refit the lubricating oil pump and sump, filling with oil to an approved grade.

Fit the fuel pump adaptor plate assembly, complete with bush sealing ring and joint, so that the timing mark scribed on flange is adjacent to the outside securing stud.

Where oil leaks past the adaptor plate "O" ring occur in service, the "O" ring should be renewed and a joint (Pt. No. 36822118) fitted between the adaptor plate and the cylinder block.

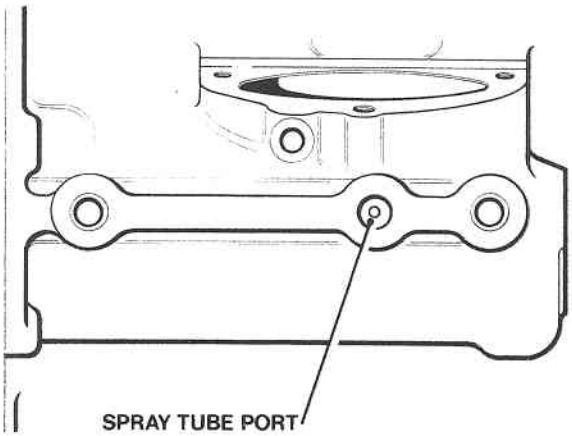


J.13



J.14

PART SIDE VIEW ON AUX. DRIVE HOUSING



J.15

Fit the auxiliary drive shaft into position with the thrust washer halves fitted around the groove in the shaft, finally locating in the cylinder block recess with two opposite butt faces located by a dowel, see Fig. J.14.

The end float of the drive shaft is controlled by the clearance between the thrust washers, (which are held in position by the timing case) and the groove of the drive shaft.

The end float is between 0.0025 in and 0.009 in (0,064 mm and 0,23 mm).

Replace the timing case, timing gears and fuel pump.

Auxiliary Drive Spray Tube

The auxiliary drive gears are lubricated by oil directed onto them by a spray tube.

The spray tube is a push fit in the auxiliary drive housing and sealed with a "D" plug.

During engine overhaul, this spray tube should be removed and cleaned.

New cylinder blocks supplied as loose parts are not fitted with this spray tube, therefore when renewing a cylinder block, ensure that the tube is transferred from the old block, or a new one fitted (see Fig. J.15).

Checking the Timing Gear Backlash

Remove the camshaft gear and auxiliary drive gear covers.

Check the backlash between the timing gears using a clock gauge or feeler gauges.

The backlash should be 0.003 in (0,08 mm) minimum.

SECTION K
Timing

Timing Marks

When the engine timing is set at the factory, markings are made on the crankshaft gear, idler and camshaft gear with the engine set with No. 1 piston at T.D.C. on its compression stroke (see Fig. K.1.).

There may be markings on the engine to establish true T.D.C. but where not, No. 1 piston at T.D.C. on its compression stroke can be ascertained by dropping a valve on to No. 1 piston crown and with the means of a clock gauge establish the maximum lift of the valve when the valves of No. 6 cylinder should be rocking.

It should be noted that Fig. K.1 has been prepared to show the markings on the timing gears. The camshaft and fuel pump gears are not normally fitted until the timing case has been replaced.

Fuel Pump Timing

When the fuel pump is removed, a machined slot will be noted in the top of the fuel pump drive shaft and a slot approximately ⅛in (3,2mm) wide in the adaptor plate will also be seen (Fig. K.2.).

With No. 1 piston set at T.D.C. on its compression stroke, these two slots should be in line.

On the mounting flange of the fuel pump is a scribed line and a further line is scribed on the fuel pump adaptor plate.

When the fuel pump is fitted, these two marks should be in alignment (see Fig. K.3).

To Reset Engine Timing

It is assumed that the timing case and all the timing gears have been removed and require replacing with the knowledge that the valve and fuel pump timing will be to the original setting.

To reset the timing to the original markings, proceed as follows:

Remove the rocker assembly, push rods and atomisers.

Turn the engine crankshaft until Nos. 1 and 6 pistons are at T.D.C.

That this has been obtained may be checked by observing that the keyway for the crankshaft gear is at T.D.C.

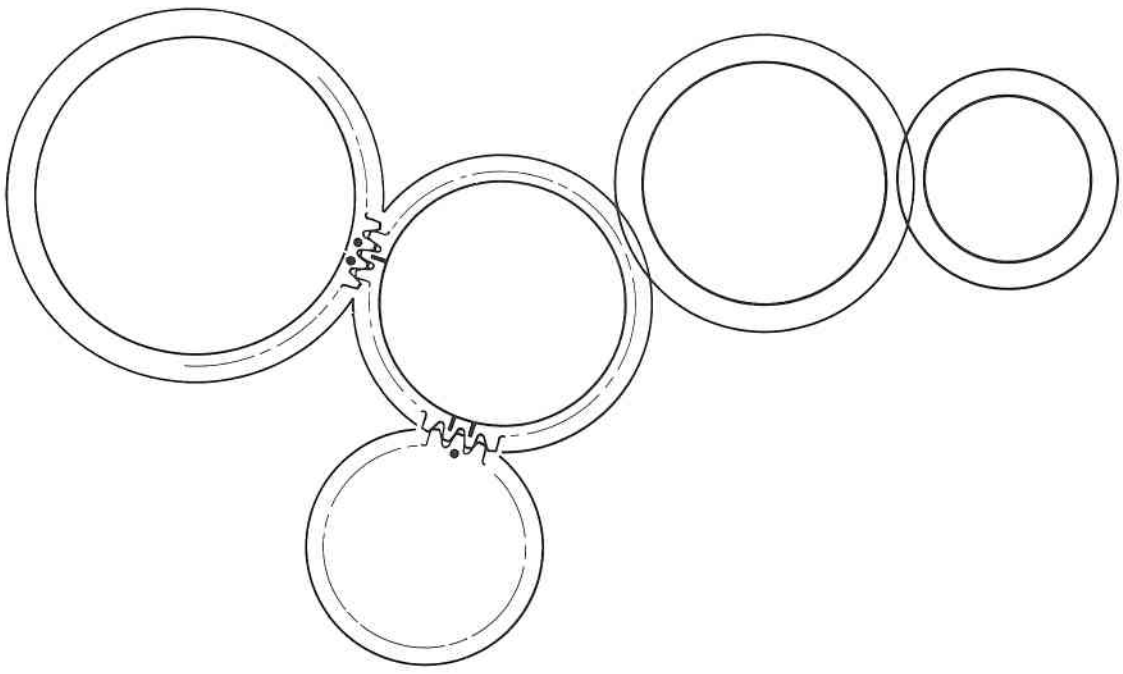
Place the two idler gears in position on their respective hubs, making sure that the double line timing mark on the left hand gear is opposite the single line timing mark on the crankshaft gear (see Fig. K.1). Then tighten the securing nuts to the correct torque (see page B.2).

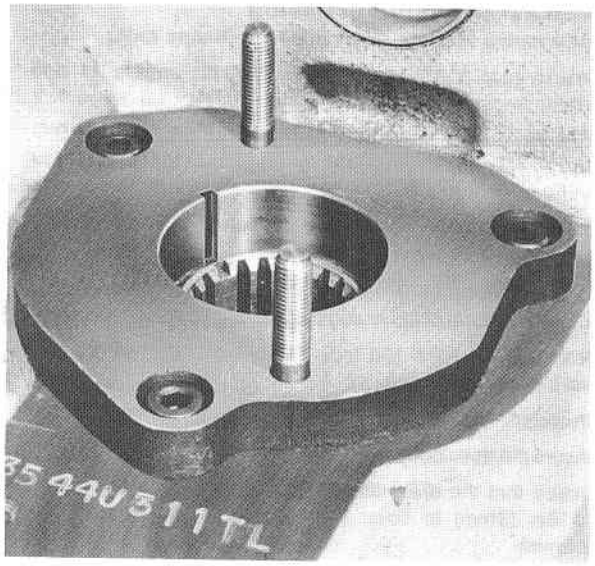
Replace the timing case and secure it to the cylinder block.

Fit crankshaft pulley as detailed on Page H.6.

With the engine still in the T.D.C. position, refit the camshaft gear with the double dot timing mark opposite the single dot timing mark on the idler gear.

Draw gear onto camshaft and fit washer, tab washer, shim washer and retaining setscrew. Tighten setscrew to the correct torque (see page B.2) and lock with tab washer.





K.2

With the engine still at T.D.C. turn the fuel pump drive shaft until the machined slot in the fuel pump driving hub is in line with the machined slot in the fuel pump adaptor plate (see Fig. K.2).

Fit the fuel pump drive gear with the part number to the front so that the three setscrew holes coincide with the holes in the fuel pump drive shaft when it is in mesh with the idler gear and secure in this position.

Ensure when fitting the gear, that the two machined slots remain in line.

Fit timing gear covers to the timing case.

Replace the fuel pump ensuring that the scribed line on its mounting flange coincides with the scribed line on the fuel pump adaptor plate (see Fig. K.3).

With later Bosch fuel pumps, this scribed line is on the top of the mounting flange.

Replace atomisers and fuel pipes.

Replace rocker assembly and adjust valve clearance.

Checking Valve Timing

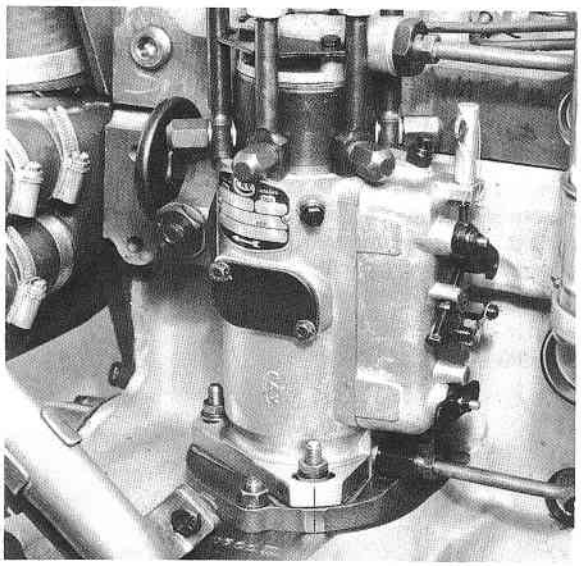
1. Turn the crankshaft until the valves on No. 6 cylinder are rocking. In this position, set the clearance on No. 1 inlet valve to one of the following clearances according to the part number which is stamped on the rear of the camshaft :

Camshaft Part No.	Clearance
31416207	0.051 in (1,30 mm)
31416222	0.026 in (0,66 mm)
31416302	0.051 in (1,30 mm)
31416303	0.047 in (1,19 mm)
31416304	0.060 in (1,52 mm)

2. Turn the crankshaft in the normal direction of rotation until the push rod of No. 1 inlet valve just tightens.
3. Check that Nos. 1 and 6 pistons are at T.D.C. The valve timing tolerance is plus or minus 2½°.
4. When the valve timing is found to be correct, reset valve clearance to 0.008 in (0,20 mm) cold.

*Includes T6.3544 North America vehicle engine.

Note: There is no adjustment provided for valve timing. If the timing is found to be incorrect, then the gears can only be one or more teeth out of correct mesh.



K.3 **(C.A.V. Pump)**

Checking Fuel Pump Timing

Ensures that No. 1 piston is at T.D.C. on compression.
The valves on No. 6 cylinder should be rocking.

Remove the fuel injection pump and ensure that the slot in the fuel pump driving hub is in alignment with the slot in the fuel pump mounting flange.

If these slots are not in line, the necessary adjustment should be made on the fuel pump drive gear, through the aperture in the timing case.

This adjustment may be effected by slackening off the three gear securing setscrews and turning the auxiliary drive shaft by means of the setscrews.

When the timing is found to be correct, refit the fuel pump ensuring the scribed line on the mounting flange coincides with the scribed line on the fuel pump adaptor plate (see Fig. K.3).

Checking Fuel Pump Timing

(Alternative Method— C.A.V. Fuel Pumps only)

There is a rotor in the pump bearing a number of scribed lines, each one having an individual letter (see Fig. K.4). A timing circlip is positioned inside the pump which has to be set so that when the appropriate scribed line on the fuel pump rotor aligns with the straight edge of the circlip, it denotes commencement of injection (static timing).

To set the timing circlip, it is necessary to remove the pump from the engine and fix the position of the cicclip by connecting No. 1 cylinder outlet connection (X) on the pump to an atomiser tester and pump up to 30 atm 440 lbf/in² or (31 kgf/cm²). Turn the pump by hand in the normal direction of rotation until it locks up. The squared end of the circlip should now be adjusted until it lines up with the letter "F" on the pump rotor.

Ensure the fuel pump is correctly fitted with the scribed line on the mounting flange coinciding with the mark on the fuel pump adaptor plate.

Position the crankshaft so that No. 1 piston is at T.D.C. on its compression stroke.

Remove the rocker cover.

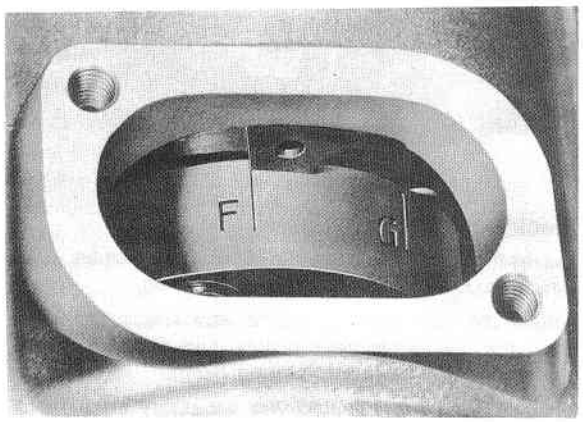
Remove the collets, spring cap and springs from No. 1 inlet valve and allow the valve to rest on top of the piston.

Reposition the valve stem seal to the collet groove to prevent the valve from dropping into the cylinder.

With the aid of a clock gauge in contact with the end of the valve now sitting on No. 1 piston, it will be necessary to position the crankshaft so that the piston will be at its static timing point (see Page B10).

To do this, turn the crankshaft in the opposite direction to normal rotation, approximately an eighth of a turn B.T.D.C. and then forward until the required position is registered on the clock gauge. This enables the backlash in the timing gears to be taken up.

Remove the flat inspection plate on the fuel pump enabling the rotor to be seen.



K.4 **(C.A.V. Pump)**

With No. 1 piston at the static timing point on its compression stroke, the scribed line on the rotor marked 'F' should align with the straight edge of the timing circlip. See Fig. K.4.

If the timing marks do not align, release the nuts securing the fuel pump and twist the pump body in the required direction until the marks align. Further adjustment can be made by turning the auxiliary drive shaft, after first releasing the auxiliary drive gear securing setscrews.

If after both these adjustments, the timing marks do not align, it could mean the auxiliary drive gear has fitted incorrectly.

Checking Fuel Pump Timing

(Alternative Method — Bosch Fuel Pumps only)

Ensure fuel pump is correctly fitted to engine as described under "To Reset Engine Timing" on Page K.2.

With the rocker cover removed, set the engine to T.D.C. No. 1 cylinder compression, i.e., the valves of No. 6 cylinder rocking.

Thoroughly clean the fuel pump around the vent plug in the hydraulic head.

Remove the central plug from the end of the pump (C, Fig. N.14) and fit one of the timing tool assemblies given below:—

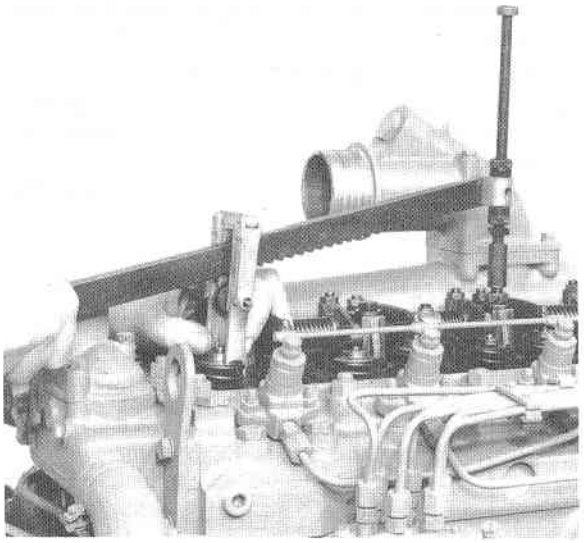
Bosch: Body 1688 130 045, Extension 1683 458 019 and Dial Indicator 1687 233 012.

Churchill: Adaptor MS107 and Dial Indicator SM991A.

Ensure dirt does not enter the pump.

Ensure that the dial indicator plunger is depressed at least 0.118in (3mm) to cover the plunger lift which is 0.110in (2,8mm).

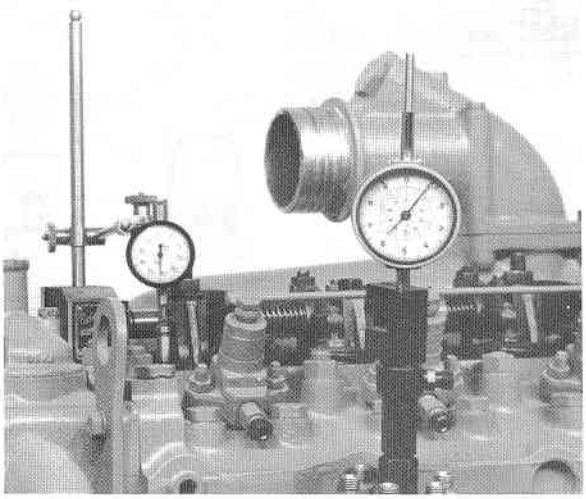
Turn the engine in each direction to obtain B.D.C. of the pump plunger and set the dial indicator to zero at this point.



K.5

Reposition the engine at T.D.C. No. 1 cylinder compression and using tool No. 6118B, remove the collets, spring cap and springs from No. 1 inlet valve (see Fig. K.5) and allow the valve to rest on the top of the piston. Reposition the valve stem seal to the collet groove to prevent the valve from dropping into the cylinder.

Position a dial indicator with the plunger resting on top of the valve stem, determine exact T.D.C. position and zero the dial indicator.



K.6

Turn the crankshaft in the opposite direction to normal rotation approximately ⅛ of a turn and then turn in the normal direction of rotation until the dial indicator indicates that the piston is 0.125 in (3,18 mm) B.T.D.C.

At this position, the dial indicator on the fuel pump should read 0.0394 in (1 mm) — see Fig. K.6.

Adjust timing as necessary by releasing the three screws securing the auxiliary drive gear to the auxiliary drive shaft.

If the plunger lift is in excess of 1 mm, turn the auxiliary drive shaft clockwise and then anti-clockwise until 1 mm lift is obtained. Secure the gear ensuring the gear backlash is taken up by holding the gear against normal direction of rotation.

If the plunger lift is less than 1 mm, turn the auxiliary drive shaft anti-clockwise until 1 mm lift is obtained. Secure the gear ensuring the gear backlash is taken up by holding the gear against the normal direction of rotation.

Recheck timing as previously detailed.

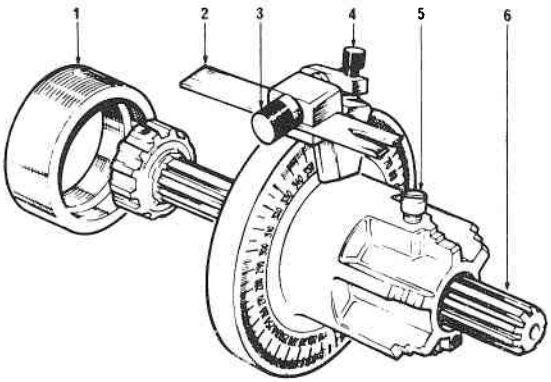
When timing is correct, turn the engine in the normal direction of rotation until No. 1 piston is at T.D.C. Refit valve stem oil seal, valve springs, spring cap and collets. Reset valve clearance to 0.008 in (0,20 mm).

Remove the special timing tool from the fuel pump and refit the plug. If the large inspection plug was removed, tighten it to 40 lbfft (54 Nm) 5,5 kgfm or if the small vent plug was removed, tighten it to 7 lbfft (10 Nm) 1,0 kgfm. If the low pressure fuel pipes have been disturbed, bleed the system as described on Page N.7.

Checking Fuel Pump Timing

(Using Churchill Tool MS.67B— See Fig. K.7)

With the engine positioned with No. 1 piston at T.D.C. compression stroke, the tool is substituted for the fuel injection pump. As the engine is at T.D.C., the pointer on the tool is set at the relevant fuel pump marking angle, plus half the static timing angle and then the timing train is set to correspond to the timing mark on the fuel injection pump adaptor plate.



K.7

To Check Engine Marking Angle

Position the engine with No. 1 piston at T.D.C. compression and using tool No. 6118B, remove the collets, spring cap and springs from No. 1 inlet valve and allow the valve to rest on the top of the piston. Reposition the inlet valve stem seal to the collet groove to prevent the valve from dropping into the cylinder. Position a dial indicator with the plunger resting on top of the valve stem, determine the exact T.D.C. position.

Remove the fuel injection pump.

Release screw (5) — Fig. K.7 — and position splined shaft (6) so that the larger splined adaptor is to the front of the tool.

Ensure that the slotted pointer (2) is positioned with the slot to the front of the tool and chamfered sides of the slot are outwards. At this stage, the slotted end of the pointer should be kept well back from the front of the body. Ensure that the flat in the washer fitted behind pointer securing screw (3) is located over pointer.

Release the bracket screw (4) and set bracket so that the chamfered edge is in line with the relevant engine checking angle. This angle can be obtained by reference to the fuel pump setting code and table given on Page B11.

Fit timing tool to the engine in the fuel pump position ensuring firstly that splined shaft with master spline is fully located in pump drive shaft and then that the register of tool is seated in fuel pump locating aperture. Lock splined shaft in tool. If pointer is 180° from timing mark, engine is probably on its wrong stroke, in which case, remove the tool and set the engine on correct stroke.

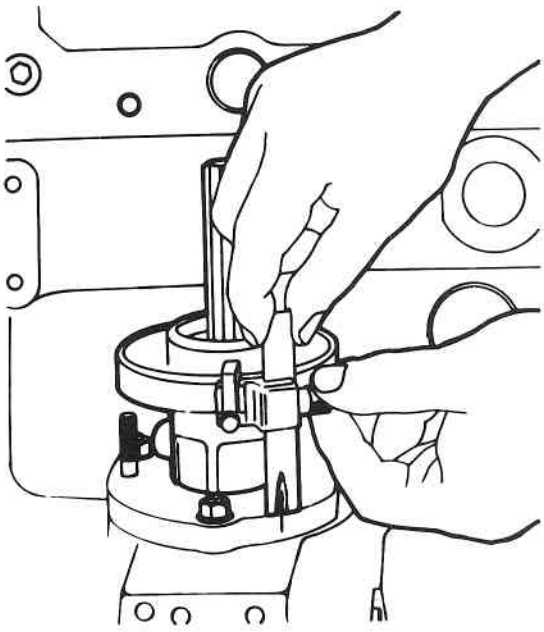
Slide the slotted pointer downwards so that the end of pointer abuts flange — see Fig. K.8.

Turn timing tool by hand in opposite direction to pump rotation (shown on pump nameplate) to take up backlash and then check that timing mark on fuel pump adaptor is in line with slot of pointer. If timing mark does not align, the position of the auxiliary drive shaft should be altered relative to its drive gear. The holes in the auxiliary drive gear are slotted to allow for adjustment.

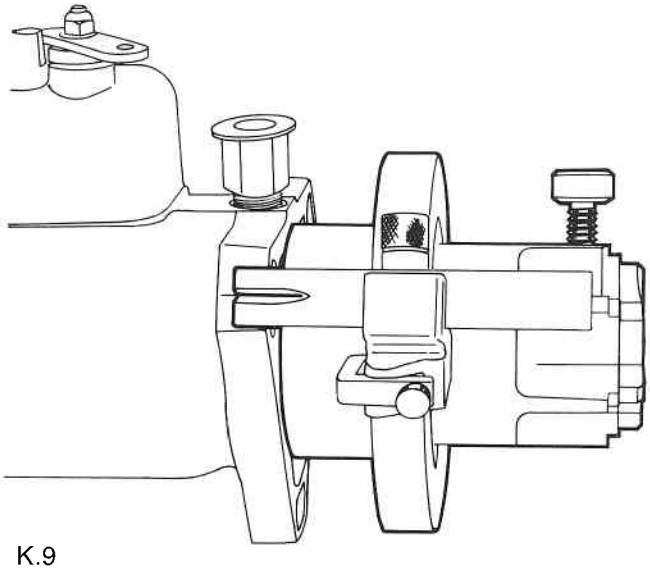
When engine timing is correct, remove the tool.

Where necessary, the fuel pump marking angle can be checked by using timing tool as described later.

Refit fuel pump to engine as given on Page N.6. Refit No. 1 inlet valve stem seal, valve springs, spring cap and collets. Then set valve clearance to 0.008 in (0,20 mm).



K.8



K.9

Checking Fuel Pump Marking Angle

Release screw (5) — Fig. K.7 — and remove splined shaft (6).

Ensure slotted pointer (2) is positioned with slot to rear of tool and chamfered side of slot outwards. At this stage, slotted end of pointer should be kept well back towards body of tool. Ensure that flat in washer fitted behind pointer securing screw (3) is located over side of pointer.

With C.A.V. pumps, connect No. 1 outlet connection of the pump (marked "X") to an atomiser tester and pump up to 30 atm 440lbf/in² or (31kgf/cm²). If a pressurising valve is fitted, this must be removed.

Release bracket screw (4) — see Fig. K.7 — and set bracket so that the chamfered edge is in line with relevant pump marking angle (see Page B.11).

Position timing tool on pump drive with master splines engaged and tool located on spigot — see Fig. K.9.

With C.A.V. pumps, turn the pump in the normal direction of rotation as shown on name plate until it "locks up".

With Bosch pumps, ensure that the keyway in the fuel pump drive shaft is in line with No. 1 outlet marked "D" on the hydraulic head.

Remove the central plug from the end of the pump (C, Fig. N.14) and fit one of the timing tool assemblies given below:—

Bosch: Body 1688 130 045, Extension 1683 458 019 and Dial Indicator 1687 233 012.

Churchill: Adaptor MS107, and Dial Indicator SM991A.

Ensure dirt does not enter the pump.

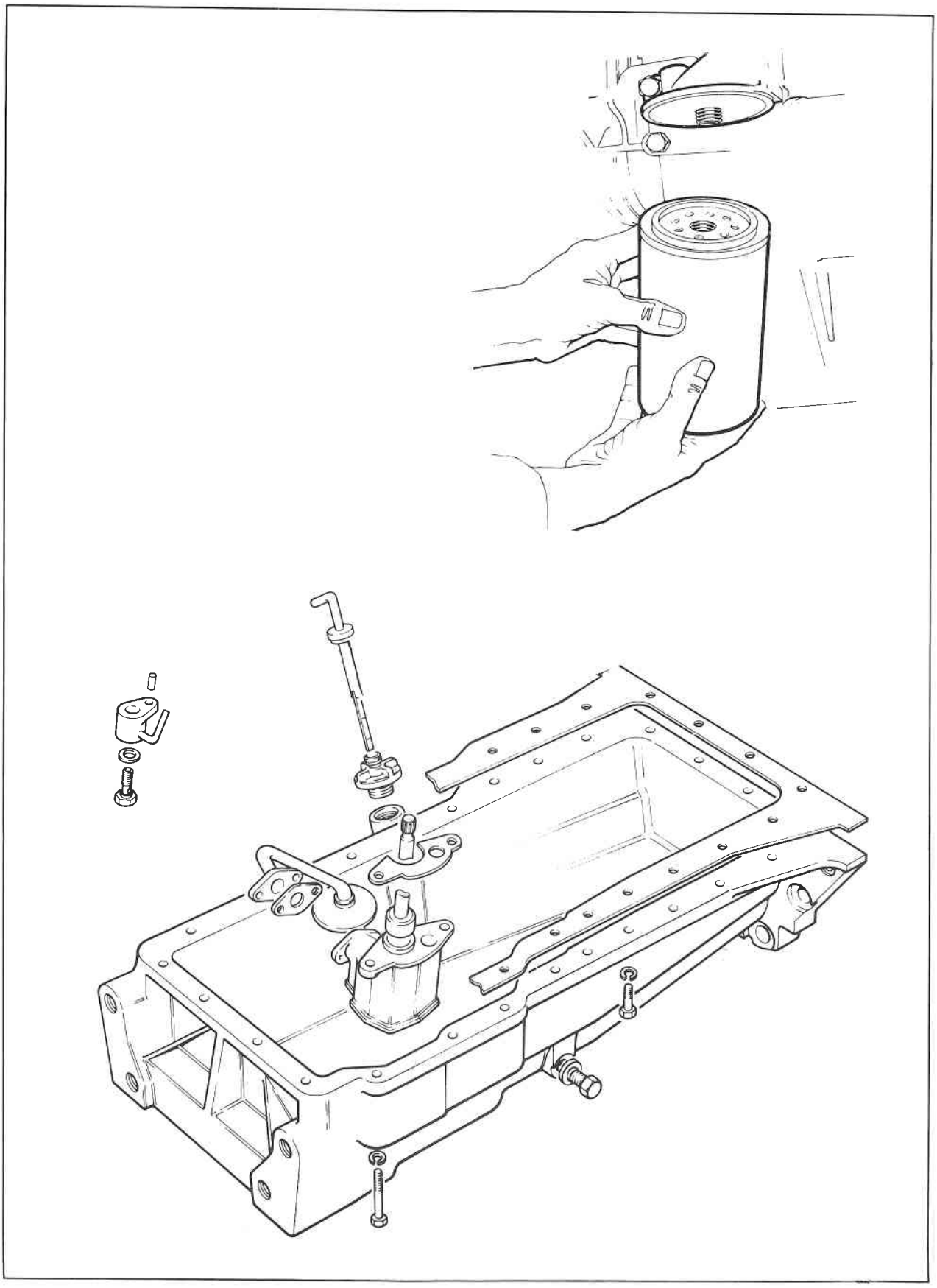
Turn the pump against the normal direction of rotation and zero the dial indicator when the plunger is at B.D.C. Then turn pump in normal direction of rotation until 0.0394in (1mm) of lift is obtained on the pump plunger.

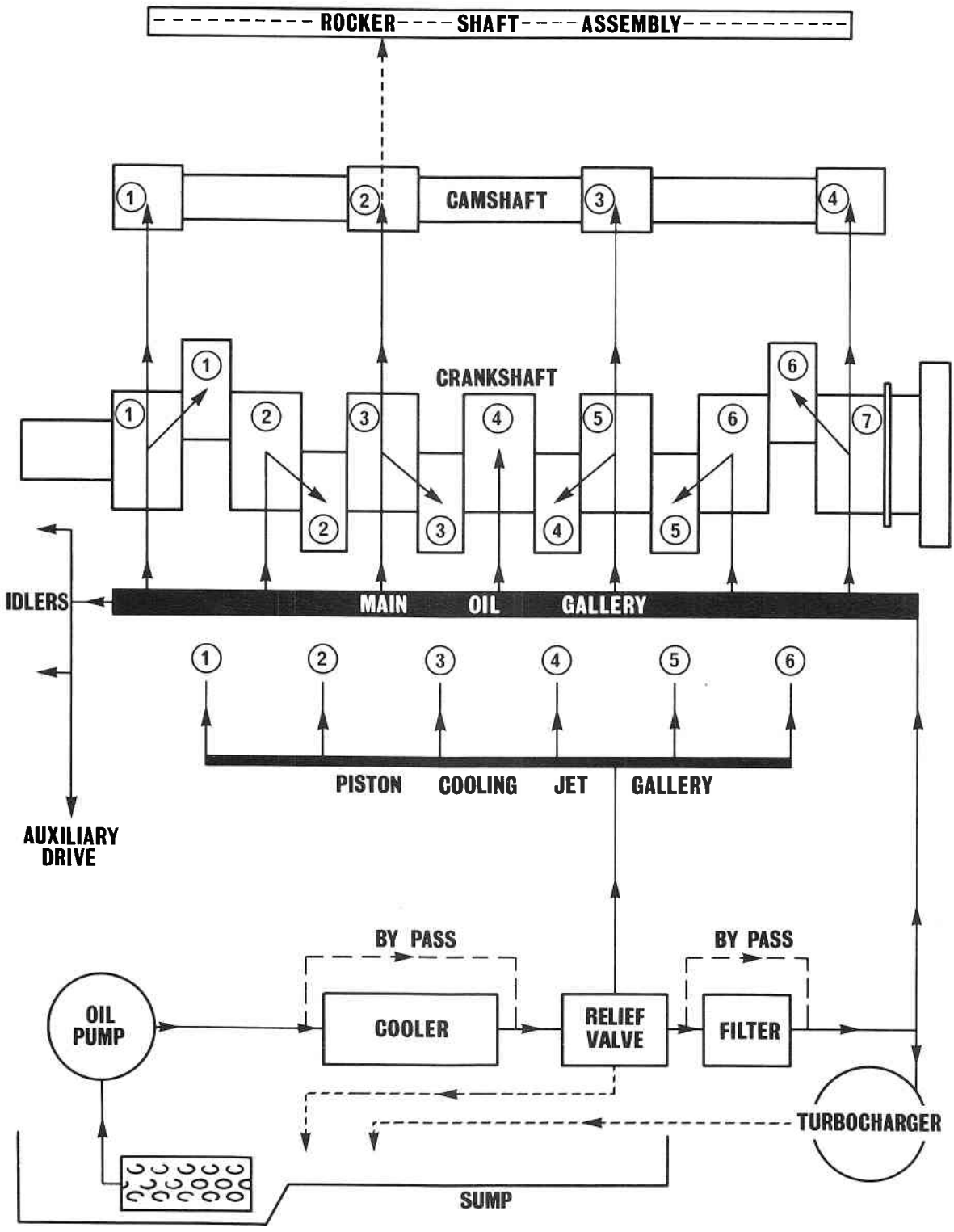
In these positions (for both C.A.V. and Bosch pumps) slide the pointer (2) of the timing tool — Fig. K.7 — forward until it is halfway over the pump flange and check that timing mark on the flange is central to the slot in the pointer — see Fig. K.9.

If necessary, remove incorrectly positioned mark and make a new mark in the correct position on the pump flange.

Remove timing tool from Bosch pumps and refit the plug. If the large inspection plus was removed, tighten it to 40lbfft (54Nm) 5,5kgfm or, if the small vent plug was removed, tighten it to 7lbfft (10Nm) 1,0kgfm).

SECTION L
Lubricating System





L.1

Note: Piston cooling is only applicable to most turbocharged engines except current T6.3544 engines fitted to generating sets and an oil cooler is not always fitted to naturally aspirated engines. By-pass valves are not incorporated in oil coolers fitted to naturally aspirated engines.

Oil Circulation

The lubricating oil pump draws oil through the suction pipe and strainer to an oil cooler, cooled by water from the engine cooling system. Oil coolers are not always fitted to naturally aspirated engines. From the oil cooler, oil passes through a full flow filter to the main pressure rail drilled the length of the cylinder block.

Drillings in the crankcase webs feed oil from the main gallery to the main bearings and drillings in the crankshaft carry oil to the big-end bearings. Through drillings in Nos. 1, 3, 5 and 7 crankcase webs, oil passes from the main bearings to lubricate the camshaft bearings.

No. 2 camshaft bearing supplies a controlled feed of oil to the rocker shaft assembly which escapes through a small bleed hole in each rocker lever to lubricate the valves and springs.

With most turbocharged engines, the pistons are cooled by lubricating oil being sprayed on their undersides by piston cooling jets.

Pistons fitted to naturally aspirated engines are not cooled and cooling jets are not fitted.

The feed for the piston cooling jets is controlled by a two stage pressure relief valve situated after the oil cooler and comes into operation at a specified pressure after oil is flowing freely to the main working parts of the engine.

Lubrication for the timing gears is taken from the oil passages connecting the pressure rail with the front main bearing and auxiliary drive.

The two idler gear hubs intersect these drillings and oil is passed through the hubs to radial drillings in the idler gears to lubricate the teeth of the gear train.

The auxiliary drive shaft bearings are lubricated by a drilling from the pressure rail to the front auxiliary drive shaft bearing. The oil then passes around a groove in the bearing journal and through a further drilling along the outer side of the auxiliary drive housing to the rear auxiliary drive shaft bearing.

Lubricant for the upper fuel pump bearing is also taken from this drilling.

Also connected with the outer drilling is a small spray tube, which directs oil onto the wormwheel and wormgear.

Oil pressure is controlled by a pressure relief valve that returns excess oil to the sump.

The filter is provided with a by-pass facility in the event of blockage.

Oil coolers fitted to naturally aspirated engines do not have by-pass valves.

To Remove Sump

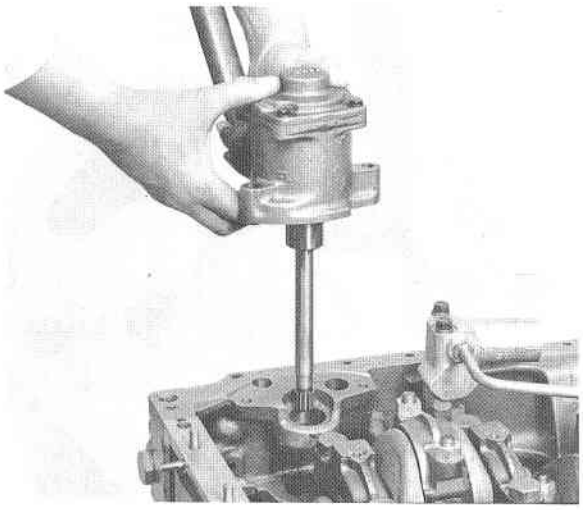
Lower the sump by releasing all flange setscrews and nuts.

To Replace Sump

Place the sump in position and secure by fastening the nuts on the four studs located in the bridge pieces.

The securing setscrews can now be inserted.

Tighten the setscrews and nuts to a torque of 15lbfft (2,1kgfm) or 20Nm.



L.2

Oil Strainer

The oil strainer is part of the oil pump suction pipe. There is no periodic servicing on this strainer but it should be cleaned whenever the sump is removed.

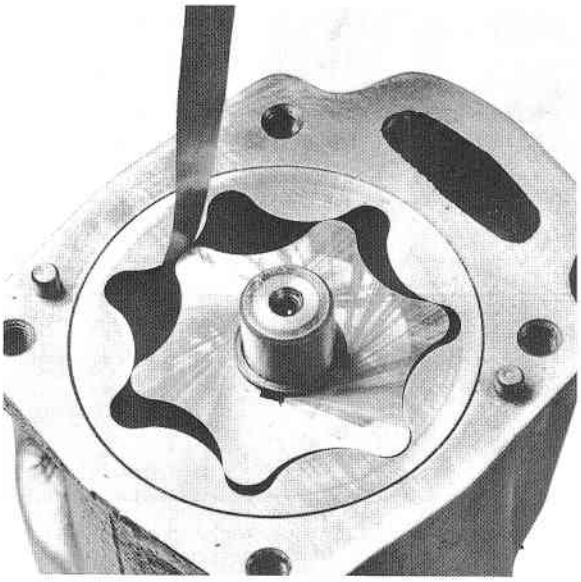
To Remove Oil Pump

Remove the sump and then the setscrews securing the oil pump to cylinder block and withdraw the oil pump, see Fig. L.2.

To Dismantle Oil Pump, see Fig. L.3

Remove the suction pipe and bottom cover of the oil pump.

L.3



L.4

The shaft, inner and outer rotors can now be removed.

Inspection of Oil Pump

The inner rotor may have 4 or 6 lobes and the outer rotor 5 or 7 lobes.

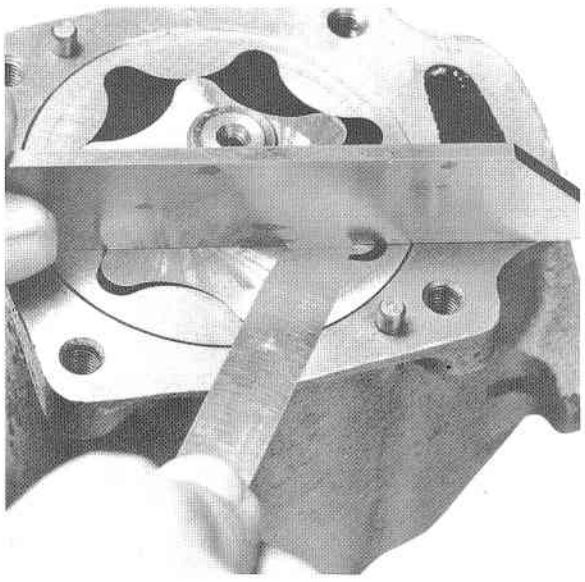
Inspect the rotors for cracks or scores.

Install the drive and driven rotors in the pump body. The two sections of the outer rotor can be fitted in any order.

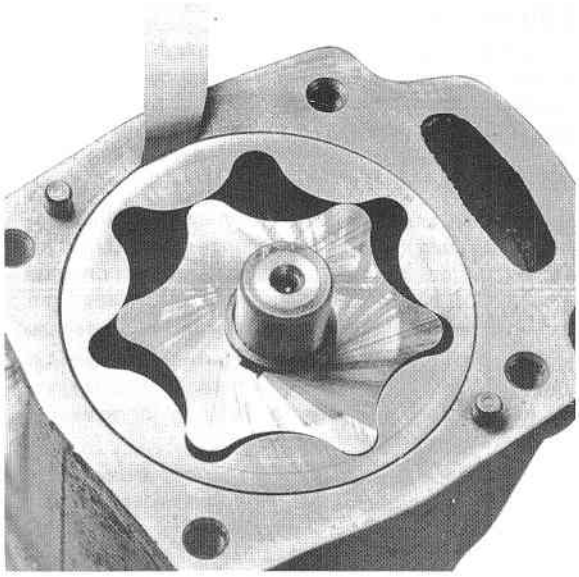
Check clearances given on Page B9, between inner and outer rotors, see Fig. L.4, rotor end float, see Fig. L.5, and clearance between outer rotor and pump body, see Fig. L.6.

These clearances are applicable to a new pump and are to be used as a guide.

If the pump is faulty, it must be replaced as a complete unit as parts are not supplied individually.



L.5



L.6

To Re-assemble and Refit Oil Pump

With the inner and outer rotors fitted into the pump body, refit the end cover with the locating dowels in position and with the joint faces smeared with a suitable jointing compound.

Prime the pump with clean lubricating oil.

The oil pump assembly and joint can now be fitted into its location in the cylinder block and secured with two setscrews and washers.

Refit the suction pipe and strainer.

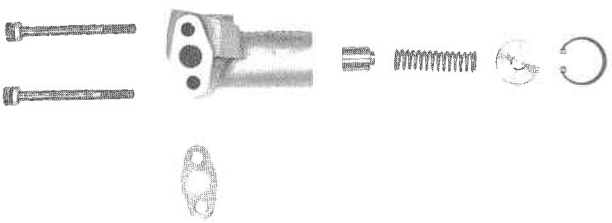
Replace the sump, and refill with oil to an approved grade.

To Remove and Dismantle the Pressure Relief Valve Assembly see Fig. L.7

Remove the sump and then the pipe from valve to the cylinder block (T6.3544 only).

Release the two securing setscrews and remove the valve.

Remove the circlip which will enable the spring seat, spring and plunger to be withdrawn from the valve bore.



L.7

To Assemble and Refit the Pressure Relief Valve Assembly

Replace the plunger, spring and spring seat in the valve bore and refit the circlip.

Using a new joint, refit the valve assembly to the cylinder block.

Refit pipe from valve to the cylinder block. (T6.3544 only).

With turbocharged engines, the first blow off stage to feed the piston cooling jets should reach a steady flow at 30/37 lbf/in² (2,11/2,60 kgf/cm²) or 207/255 kN/m², relief valve flow should commence at 50/60 lbf/in² (3,52/4,22 kgf/cm²) or 343/414 kN/m².

With naturally aspirated engines, there is only one blow off stage, when the relief valve flow should commence at 50/60 lbf/in² (3,52/4,22 kgf/cm²) or 343/414 kN/m².

Refit the sump and fill with lubricating oil to an approved grade.

Oil Coolers

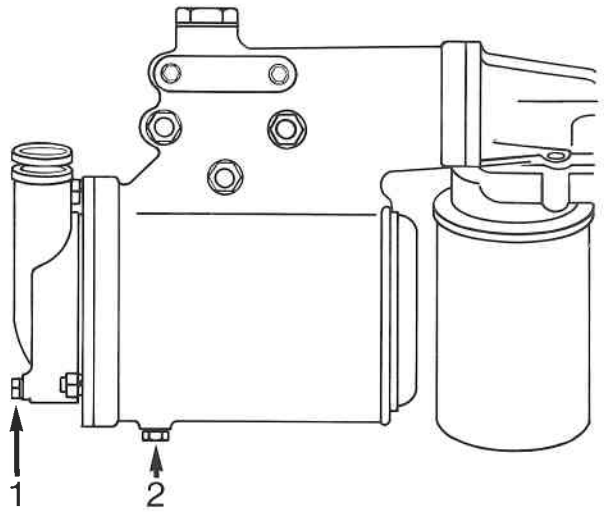
Oil coolers are filled to turbocharged engines and some naturally aspirated engines.

Four different types of cooler are utilised. For turbocharged engines having the cooler on the left hand side of the engine, see Figs. L.8 and L.9.

The oil cooler fitted to the right hand side of turbocharged engines is shown in Fig. L.10. This cooler has two filter canisters fitted on the top of the cooler and the cooler incorporates the oil pressure relief valve.

Where an oil cooler is fitted to the left hand side of naturally aspirated engines, this is shown in Fig. L.11, and where fitted to the right hand side of naturally aspirated engines, then this is shown in Fig. L.12.

Oil passes through the cooler and is cooled by water flowing through the tubes. A valve is incorporated into the headcasting which allows oil to by-pass the cooler in the event of a restriction, where the oil cooler is fitted to the left hand side of turbocharged engines. Oil coolers fitted to the right hand of turbocharged engines or either side of naturally aspirated engines do not have by-pass valves.



L.8

1. Coolant Drain Plug
2. Lubricating Oil Drain Plug

To Remove Oil Cooler

Drain the cooling system also the coolant from the cooler by removing the drain plug. Drain the lubricating oil from the cooler by removing the oil drain plug. Disconnect the cooler inlet and outlet connections.

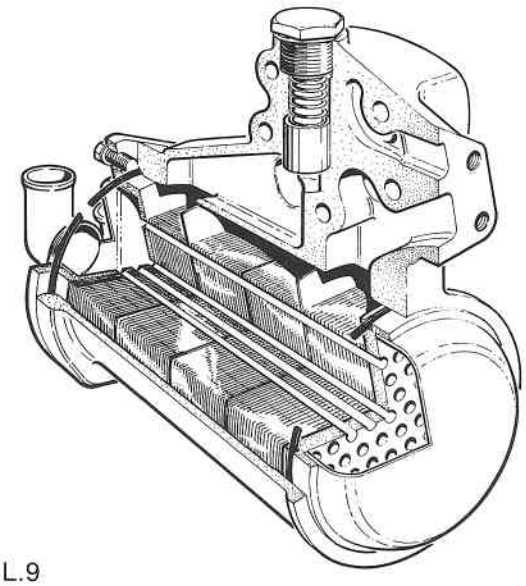
Remove the oil filter assembly (where fitted) or canisters from the cooler casting.

Release the five setscrews securing the cooler to the adaptor or cylinder block and remove the cooler.

To Dismantle Oil Cooler

Turbocharged Engines—Left Hand Mounting
(see Figs. L.8 and L.9)

Remove three nuts and washers securing the flanged tube stack to the cooler body.



L.9

Withdraw the tube stack from out of the cooler body.

Remove the "O" rings.

Remove plug and washer from the cooler bypass valve.

Withdraw spring and piston.

To Re-assemble Oil Cooler

Turbocharged Engines — Left Hand Mounting

New "O" rings must always be used.

Lightly oil the rings and their respective locations.

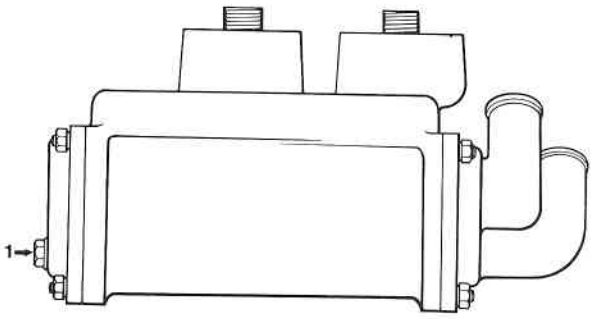
The first "O" ring should then be fitted to the flanged end of the tube stack, by placing it over the opposite end and sliding it over the full length of the stack until its location is reached.

The second "O" ring may now be fitted into the groove on the unported end of the tube stack.

Carefully insert the tube stack into the cooler body until the flange locates onto the studs and secure with spring washers and nuts.

The bypass valve assembly may now be refitted into the headcasting.

Refit the water and oil drain plugs.



L.10

1. Coolant Drain Plug

To Dismantle Oil Cooler

Turbocharged Engines— Right Hand Mounting
(see Fig. L.10)

Remove rear clamp plate.

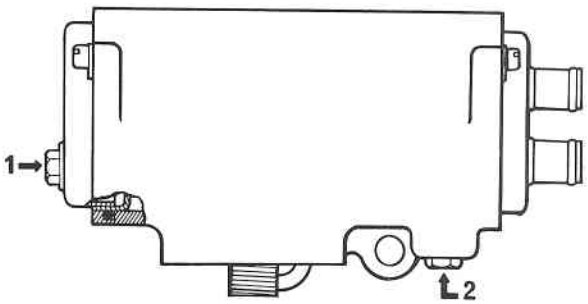
Remove rear "O" ring.

Unscrew three nuts at front of cooler and withdraw tube stack out of front of cooler body complete with front plate which is integral with tube stack.

Remove front "O" ring.

To remove oil pressure relief valve, remove end plate and pipe (which relieves oil to crankcase) and withdraw spring and plunger.

To re-assemble cooler, reverse order of dismantling. New "O" rings should be used which should be lightly oiled before fitting.



L.11

1. Coolant Drain Plug
2. Lubricating Oil Drain Plug

To Dismantle Oil Cooler

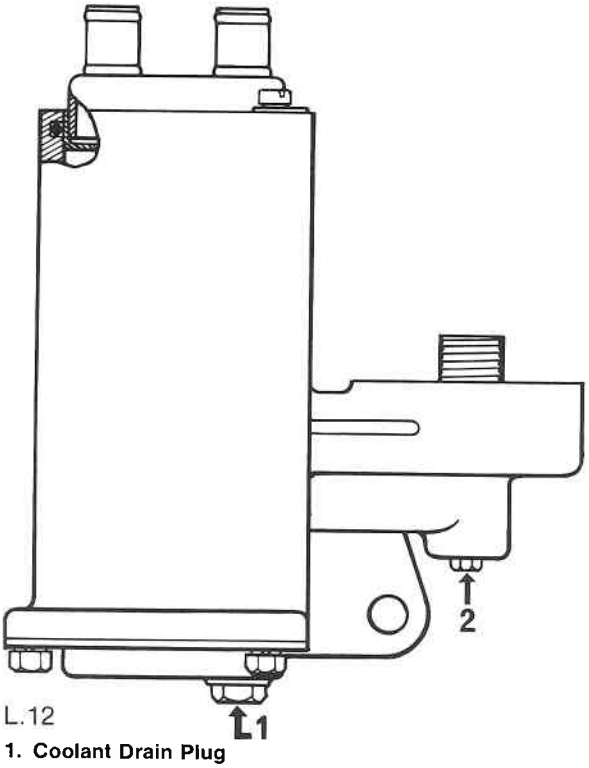
Naturally Aspirated Engines— Left Hand Mounting
(see Fig. L.11)

Remove screw complete with locking tab at each end of the cooler.

Slide the tube stack to the left and remove the right hand side "O" ring.

Remove the tube stack to the right and remove the left hand side "O" ring.

To re-assemble cooler, reverse order of dismantling. New "O" rings should be used which should be lightly oiled before fitting.



L.12

1. Coolant Drain Plug
2. Lubricating Oil Drain Plug

To Dismantle Oil Cooler

Naturally Aspirated Engines — Right Hand Mounting
(see Fig. L.12)

Remove single screw and locking tab at top of cooler.

Remove three screws at bottom of cooler and remove clamp plate.

Push tube stack down and remove top "O" ring.

Remove tube stack out of top of cooler body and remove bottom "O" ring.

To re-assemble cooler, reverse the order of dismantling. New "O" rings should be used, these being lightly oiled before fitting.

With this cooler, where the coolant feed is taken from the side of the cylinder block, if it is necessary to replace the adaptor which is a push fit in the block, then it must be fitted using Loctite Retaining Compound Grade 75.

To Test an Oil Cooler

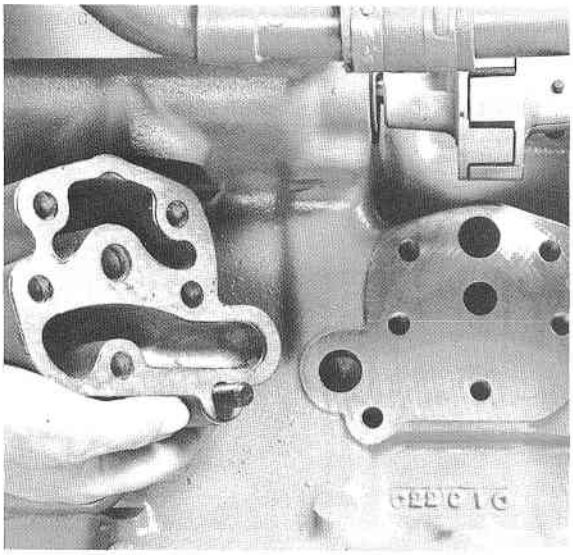
Suitable adaptors, incorporating pressure connections must be fabricated to blank off oil ports and water connections.

To test water side
Fill water side with water and immerse the unit in water, ensuring absence of trapped air.

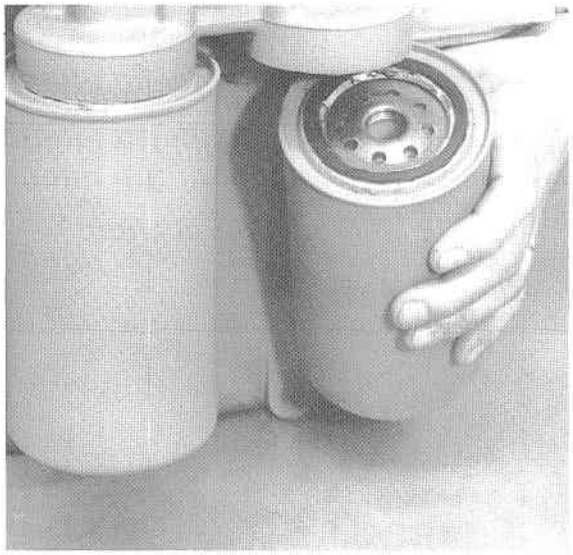
Pressurise water side with air at a pressure of 30lbf/in² (2,11kgf/cm²) or 207kN/m² and examine for leaks.

To test oil side
With water side filled with water and unit immersed in water, pressurise oil side at a pressure of 90lbf/in² (6,33kgf/cm²) or 620kN/m² for turbocharged engines or 60lbf/in² (4,22kgf/cm²) or 414kN/m² for naturally aspirated engines. Test for two minutes and examine for leaks.

The tube stack should be rejected if bubbles persist from the water inlet or outlet connections.



L.13



L.14

Adaptor — Cooler to Cylinder Block
(where fitted)

The adaptor may be released by removing the securing setscrew, see Fig. L.13.

When refitting use a new joint and suitable sealing compound and secure with setscrew, plain washer and spring washer.

To Refit Oil Cooler

The joint, lubricating oil cooler to adaptor block, must be fastened to the oil cooler flange with an approved adhesive; "Bostik" clear, "Evostik" or Dunlop SN1901.

There must not be any sealant between the joint and the adaptor block. This side of the joint must be fitted dry.

Refit the oil cooler to adaptor or cylinder block and secure with five setscrews, plain and spring washers.

Refit the oil filter with four setscrews and spring washers or refit filter canisters.

Reconnect the cooler inlet and outlet connections.

Ensuring that the water and oil drain plugs are fitted, refill the cooling system.

Start the engine, but do not speed the engine until oil pressure is achieved.

Check for oil and water leaks.

To Renew Lubricating Oil Filter Element

Unscrew filter canister from filter head casting (see Fig. L.14).

Check that threaded adaptor is secure in head casting.

Discard old canister.

Clean filter head.

Prime the new canister with lubricating oil allowing time for the oil to filter through the element.

Using clean engine oil, liberally oil the top seal of the replacement canister.

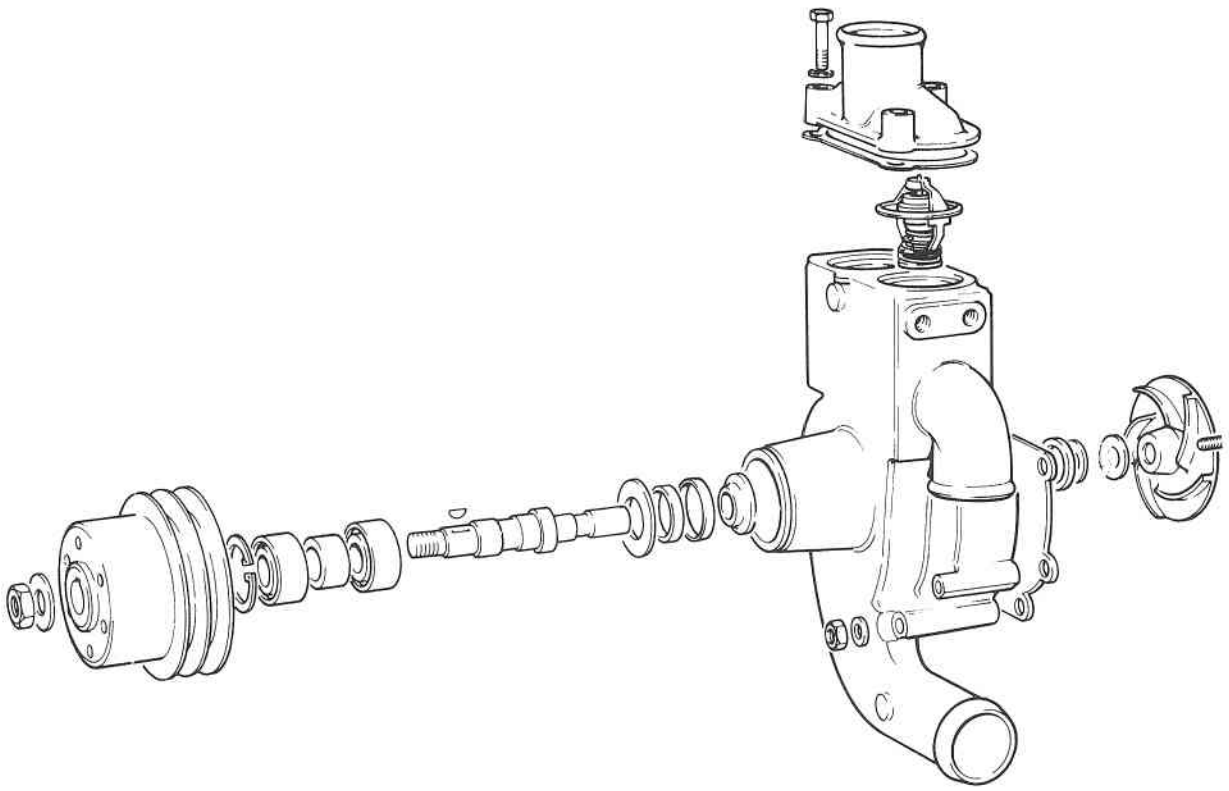
Screw replacement canister onto filter head until the seal just touches the head and then tighten by hand as per the instructions on canister. Where a tool is available, tighten to 15 lbf ft (2,07 kgf m) or 20 Nm.

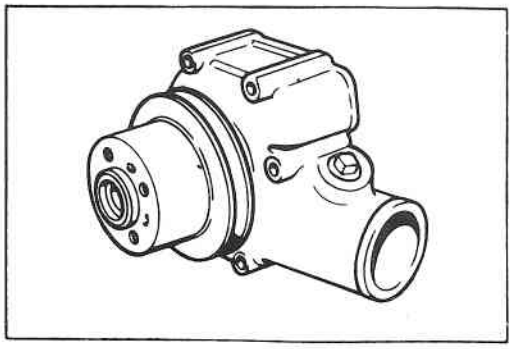
Run engine and check for leaks.

Where twin filters are fitted, both canisters should be replaced at the same time.

Note : The oil filter canisters have internal valves to prevent drain back and a special tube stack, so always ensure that the correct replacement is fitted.

SECTION M
Cooling System





Circulation of the coolant is assisted by an impeller type water pump mounted on the front of the cylinder block, driven by twin belts from the crankshaft pulley.

From the twin volute water pump, the coolant flows from one outlet into the cylinder block and up into the cylinder head. Coolant from the other outlet is piped into the oil cooler where it circulates and is then piped into the rear of the cylinder block. It then flows up into the cylinder head.

Where the oil cooler is fitted to the left hand side of naturally aspirated engines, the coolant feed is sometimes taken from the side of the cylinder block and in this case, the adaptor which is a push fit in the block must be fitted with Loctite Retaining Compound Grade 75.

Where no engine oil cooler is fitted, then all the coolant flows into the front of the cylinder block.

The coolant exits from the front of the cylinder head into a twin thermostat chamber, and when the thermostats are in the open position, allows the coolant to pass into the radiator.

Until the coolant reaches a specified temperature, however, the thermostats will be in a closed position denying access to the radiator and the coolant will flow into a by-pass and back into the water pump.

A cylinder block drain point is provided on the fuel pump side of the engine at the rear.

With T6.3544CC engines which incorporate an integral air charge cooler and induction manifold, it should be noted that the drain plug of the cooler outlet connection (see Fig. C.2) should be removed when either draining or filling the cooling system.

Fan Belts

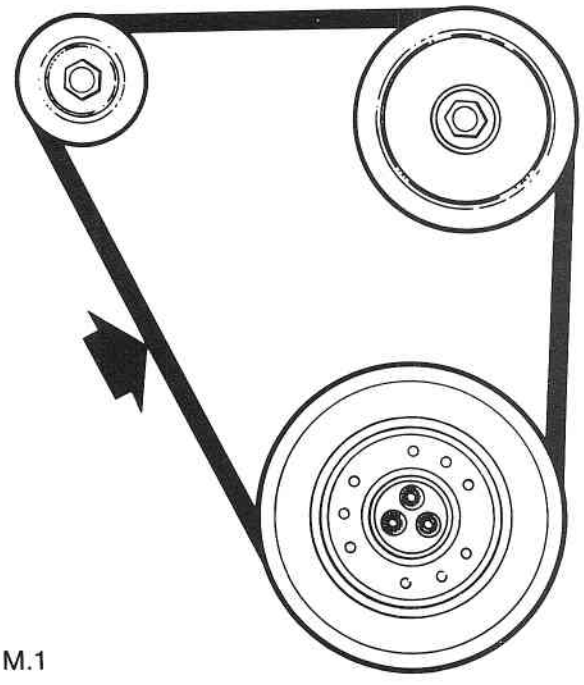
Twin belts are used to drive the generator and water pump.

The fan may be mounted on either the water pump pulley or direct to the crankshaft pulley.

New belts should be fitted in pairs and the tension checked after a short period of running to allow for the initial stretch.

Belt adjustment is obtained by loosening the generator mounting bolt and altering the position of the generator on its mounting link.

The tension should be such that a pressure applied by the thumb on the longest unsupported stretch of belt should depress it approximately ⅜in (10mm), see Fig. M.1.



M.1

To Remove and Refit Thermostats

The water outlet connection forms the top half of the thermostat housing.

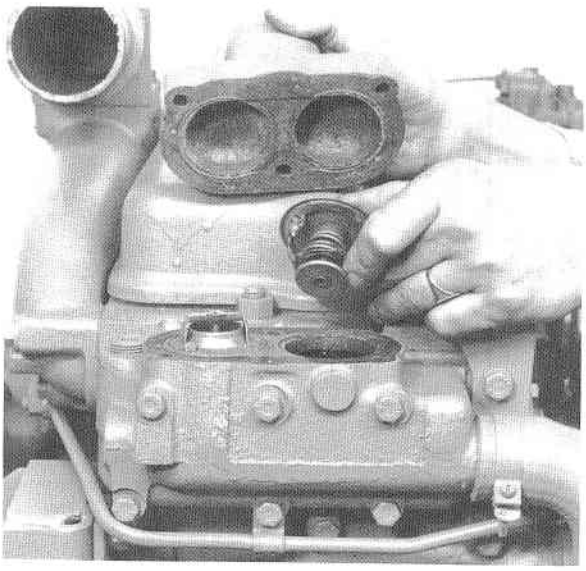
Drain the cooling system and disconnect the top radiator hose, remove three setscrews securing the water outlet connection and remove, see Fig. M.2.

The thermostats can now be withdrawn from the housing.

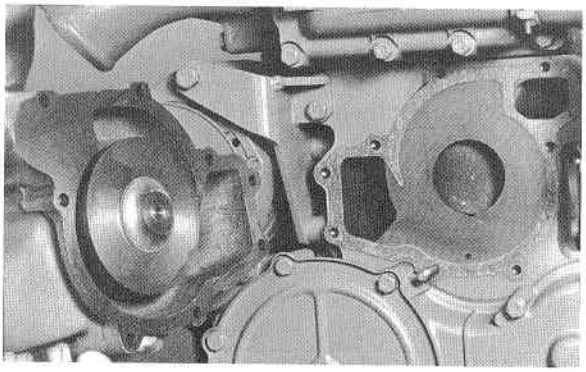
When replacing, ensure that the jiggle pins are free to move.

Ensure that only by-pass thermostats are fitted.

Refit the water outlet connection correctly placing a new joint, connect the top water hose and refill the cooling system. Check for leaks.



M.2



M.3

To Test the Thermostats

Suspend the thermostats in water and heat gradually.

With a thermometer, check that the thermostat starts to open at 177/183° F (81/84° C) and is fully open at 199/205° F (93/96° C).

The valve lift when fully open is 0.374/0.500in (9,50/12,70mm).

To Remove Water Pump

Remove the drive belts.

Drain the cooling system and disconnect the hoses.

The water pump securing setscrews and nut can now be released and the water pump removed, see Fig. M.3.

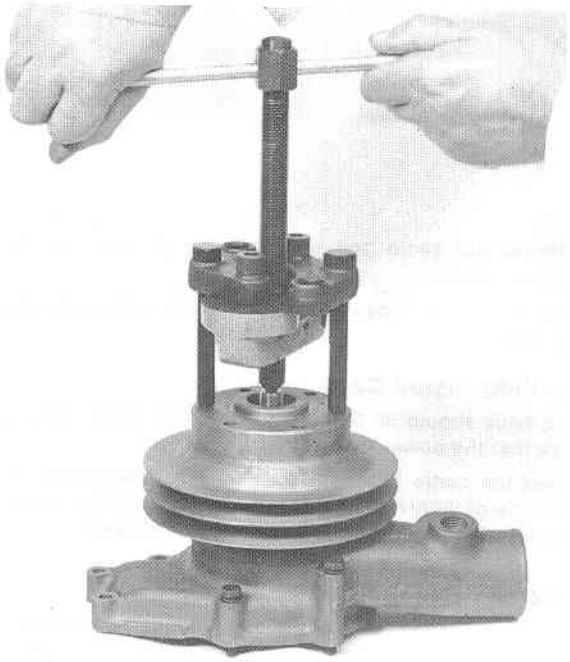
To Dismantle Water Pump

Remove the self locking nut and plain washer securing the water pump pulley and withdraw the pulley from the shaft, see Fig. M.4.

Press the shaft, complete with impeller, out of the body from the front.

Press the impeller from the shaft and remove the rear seal, counterface and flinger. Latest pumps have one-piece seals with an integral counterface and a flinger is not fitted.

Remove the bearing retaining circlip from water pump body and press out the two bearings and distance piece.



M.4

Where applicable, the flange, retainer and front seal can now be withdrawn from the body. The front felt seal assembly is not fitted to latest pumps and can be discarded provided that the latest one-piece rear seal, shaft and longer bearing distance piece are to be fitted.

To Re-assemble Water Pump, Fig. M.5

If the latest one-piece seal with an integral counterface is to be fitted to an earlier pump, the felt seal assembly and the flinger can be discarded. A new shaft and a longer bearing distance piece (to allow for the removal of the felt seal flange) will be supplied with the new seal.

Press the two bearings onto the shaft with the distance piece in between, ensuring that the shielded face of each bearing faces outwards.

Where applicable, fit the front seal assembly — retainer with felt seal inside — into its location, with felt face towards the front of the pump.

Grease the bearings and half fill the space between the two bearings with high melting point grease. Where applicable, fit the flange over the impeller end of the shaft with the dished face to the bearings and press the complete shaft and bearing assembly into the pump body from the pulley end.

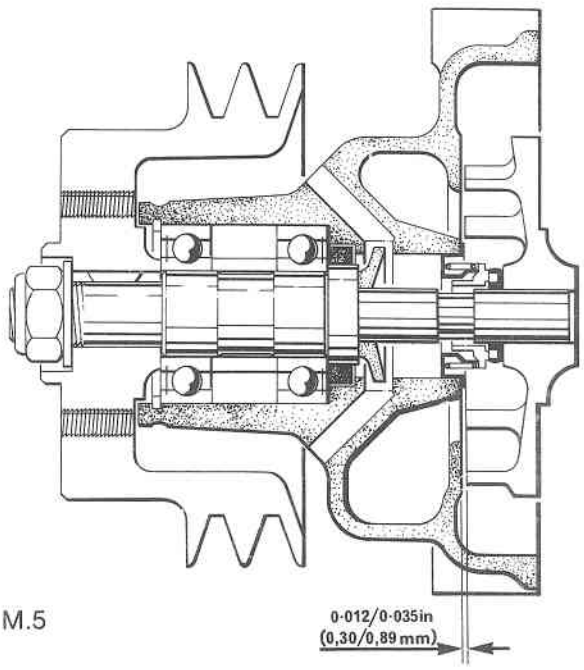
Fit the circlip into its recess in the pump body immediately forward of the front bearing.

Where applicable, slide the rubber flinger over the impeller end of the shaft until the flat face butts against the bearing retaining flange.

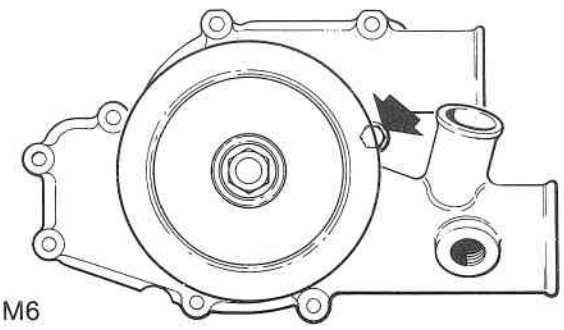
If the rear seal has a brass casing, coat its locating surface with jointing compound. Fit the rear seal over the impeller end of the shaft and press onto its flange location in the pump body with the contact face outwards.

Rotate the shaft and check for undue resistance.

Where applicable, fit the ceramic counterface ensuring that the ceramic face bears against the carbon face of the spring loaded seal.



M.5



M6

Before fitting the pulley, insert the captive setscrew and washer in its respective hole, see Fig. M.6.

Fit pulley driving key and press on pulley making sure there is no rearward movement of shaft.

Press impeller onto shaft until a clearance is obtained between impeller vanes and pump body, including end float of 0.012/0.035in (0,30/0,89mm) – see Fig. M.5.

Fit plain washer, spring washers and pulley securing nut and tighten to a torque of 60lbfft (8,30kgfm) or 82Nm. Spin the pump pulley to ensure freedom of movement.

Ceramic Seals

If an engine is run without coolant in the water pump, the heat build-up between the carbon seal and the ceramic counter face is very rapid, resulting in the cracking of the ceramic.

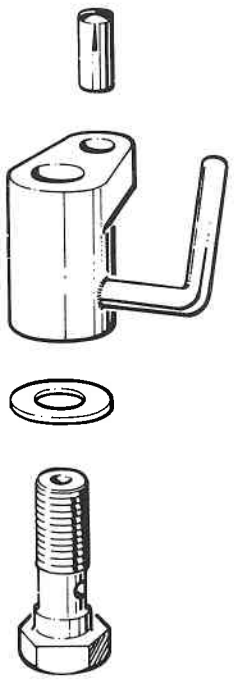
This can cause a misunderstanding that the leakage of water from the pump is due to the incorrect assembly of the sealing arrangement in the water pump.

To Refit Water Pump

Using a new joint, refit the water pump, securing with setscrews, nuts and spring washers to a torque of 20lbfft (2,77kgfm) or 27Nm.

Reconnect the hoses, fill the system with coolant.

Refit the drive belts, start the engine and check for leaks.



M.7

Piston Cooling Jets, see Fig. M.7

Piston cooling jets are fitted to most turbocharged engines only. They are not fitted to normally aspirated engines.

Cooled lubricating oil is directed, by means of spray jets situated at the base of each cylinder liner, onto the underside of each piston crown where it circulates, dispersing heat from the combustion area. The oil then drains back into the sump.

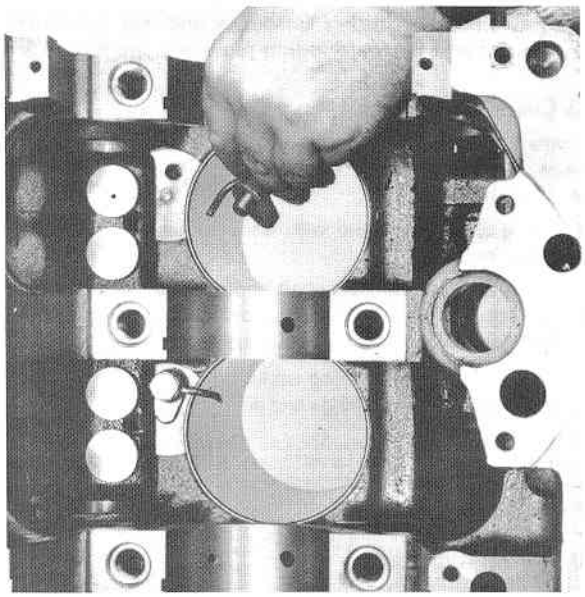
Oil is carried to the spray jets by means of a pipe from the relief valve to an oil gallery in the cylinder block which connects with an auxiliary oil pressure rail drilled the length of the cylinder block above the camshaft chamber.

This pressure rail is tapped in six places to accommodate the dowelled piston spray jet block.

The removal and refitting of the pressure relief valve is dealt with in the Lubricating Section L., on Page L.4.

To Remove Piston Cooling Jets

Drain the lubricating oil and remove sump, see Page L.3.



M.8

Remove the banjo bolt securing the jet body to the cylinder block.

The piston jet assembly can now be removed, see Fig. M.8.

To Refit Piston Cooling Jet

The body should be fitted to the cylinder block making sure that the dowel locates correctly.

Insert the banjo bolt with washer fitted and tighten to a torque of 20lbfft (2,77kgfm) or 27Nm. Refit the sump, and fill with lubricating oil of an approved grade.

Nozzle Positioning

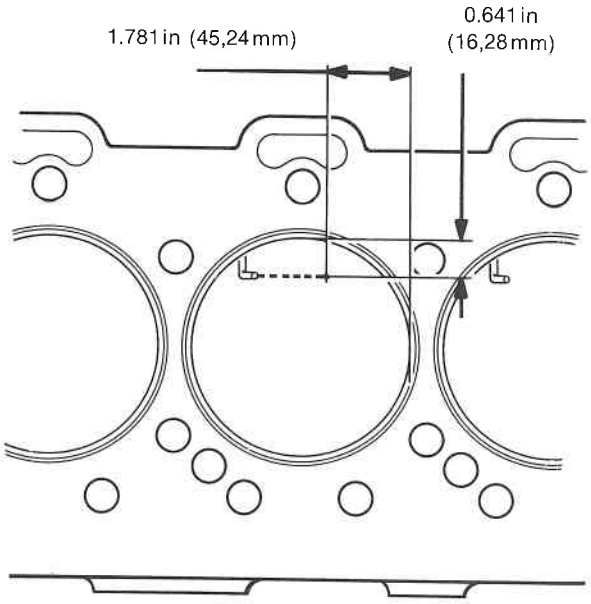
In the event of a nozzle of a piston cooling jet becoming misaligned, it is important that the condition is rectified and the illustrations in Figs. M.9 and M.10 will show how this may be accomplished.

With a piston removed, insert a piece of $\frac{3}{32}$in (2,38 mm), rod (such as welding rod) into the jet nozzle so that it protrudes above the top of the cylinder bore.

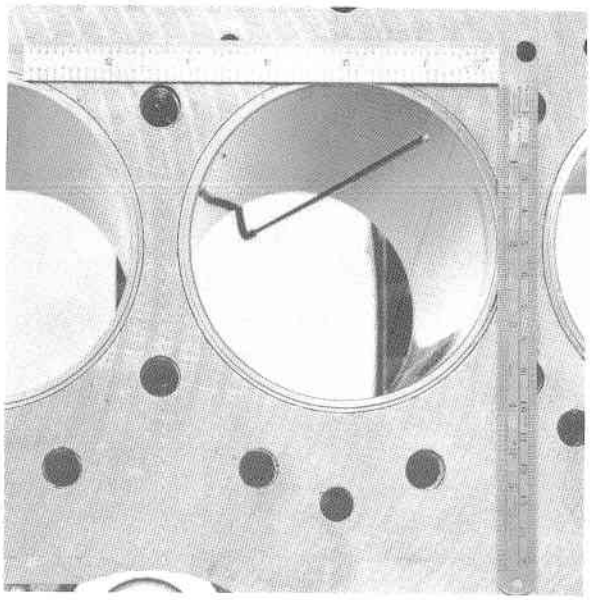
Fig. M.9 shows the dimensions taken on the top face of the cylinder block and it will be seen that the measurements of 1.781in (45,24mm) and 0.641in (16,28mm) are taken from two sides of the liner bore as illustrated.

The rod should project at a point where the lines drawn from two measurements intersect.

Fig. M.10 illustrates how the correct nozzle angle may be achieved by the use of rules.



M.9



M.10

Charge cooler (integral air/water)

No preventive maintenance is necessary on the intercooler as the air passing over the cooling fins is clean. If the turbocharger oil seals leak, this may necessitate the removal and cleaning of the intercooler. The intercooler is a sealed unit and no repairs are possible except perhaps by specialists.

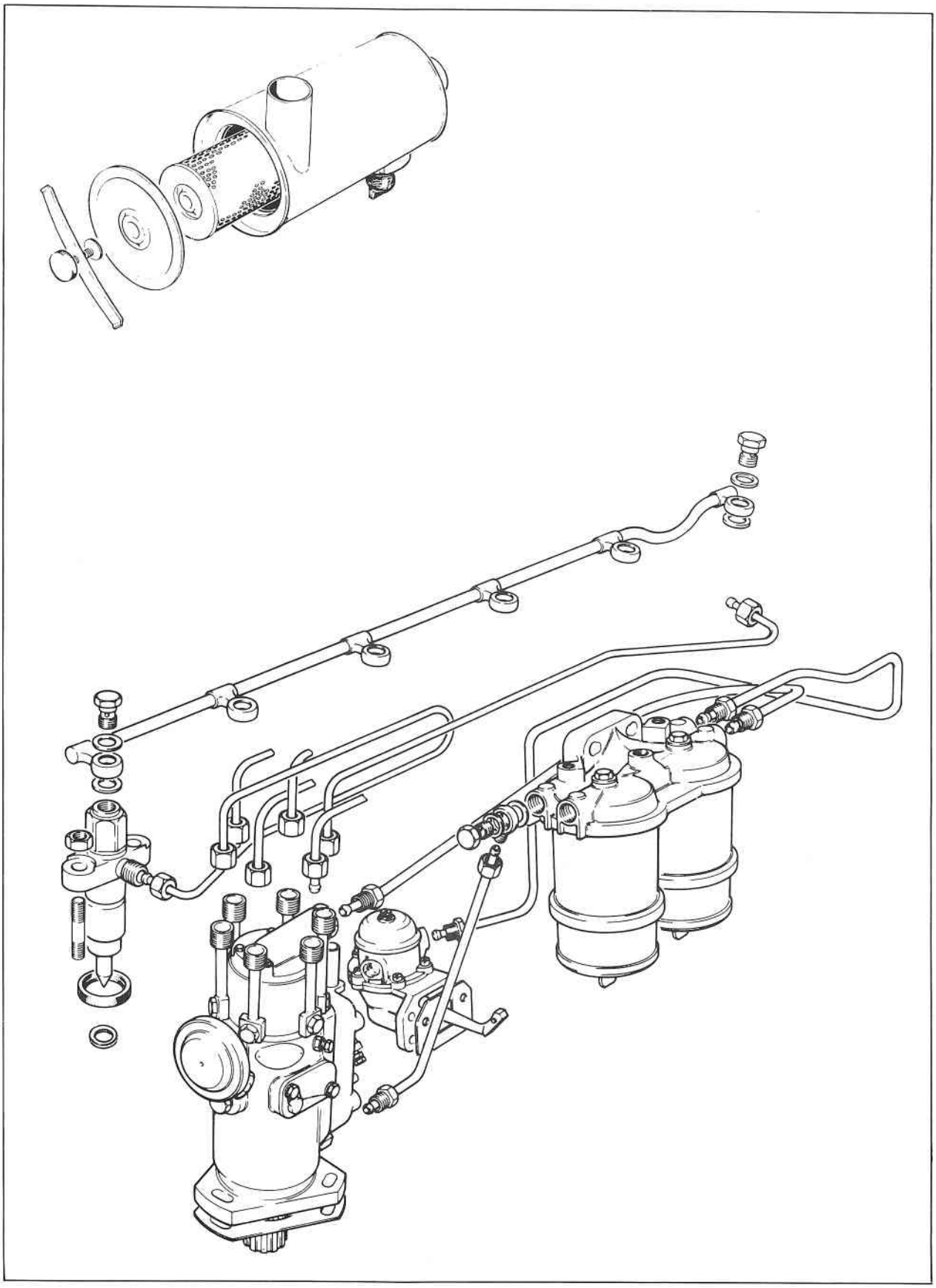
The charge cooler should be removed and fitted with the inlet manifold attached and the manifold, intercooler and top cover treated as a complete assembly. In the case of tractors this assembly will have to be removed before the exhaust manifold can be removed.

The air charge cooler can be removed and dismantled as follows:

1. Drain coolant system – remove air bleed screw on coolant outlet elbow of charge cooler to ensure that coolant drains from cooler.
2. Disconnect coolant, air and fuel pipes. Release pipe clips and support brackets.
3. Remove charge cooler/manifold assembly from engine.
4. Remove coolant pipe flanges from top cover and manifold. Note "O" ring fitted in groove in flange bore.
5. Remove setscrews securing top cover and manifold flanges.
6. Slide the top cover over the coolant pipe by lifting the opposite end of the cover to clear the intercooler.
7. Slide the intercooler out of the manifold by lifting the non-pipe end of the intercooler to clear the manifold.
8. Reassemble and refit in reverse order. Fit new joints with Hylomar. Remove air bleed screw when filling coolant system – if top of radiator is below intercooler, the system may have to be topped up after a short period of running.

The coolant flow for the charge cooler is from the water pump outlet – through the intercooler – back to the water pump inlet for tractor engines or the rear of the cylinder head for combine engines.

SECTION N
Air Filters and Fuel System



Air Charge Cooling (T6.3544 engines only)

T6.3544CC engines have an air charge cooler integral with the induction manifold (see Figs. A.5 and A.6).

Another method of cooling the air between the outlet of the compressor side of the turbocharger and the induction manifold is by pushing air through an 'air cooling radiator' usually mounted in the same air stream as the engine water cooling radiator (see Fig. N.1).

Air Cleaners

Operating conditions play an important part in deciding how frequently it is necessary to service the air cleaner. Where the cleaner has a dust bowl fitted, the amount of dust present in the bowl when removed, will show whether it is being emptied at the correct time for the prevailing conditions. If the dust bowl is allowed to become full, it will reduce the life of the element.

If an automatic dust ejector is fitted, it should be kept clean and the lips of the rubber ejector checked to see that they close, but do not adhere together.

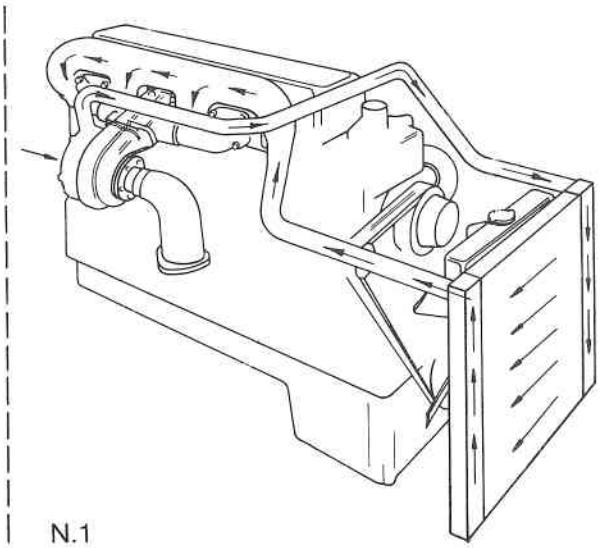
Where a restriction indicator is fitted, this will give a positive indication that the air cleaner element needs attention and eliminates haphazard servicing. If you do not have a restriction indicator fitted, then you should consider having one fitted on the trunking between the air cleaner and turbocharger/induction manifold. A 22in (559mm) water gauge indicator fitted on the cleaner outlet is suitable for the majority of cases. It should be remembered that the indicator does not show the amount of dust present in the dust bowl.

The type of air cleaner fitted to your vehicle or machine depends upon the manufacturer of your equipment. Usually, guidance for the servicing is shown on the body of the air cleaner, but the following advice may also help.

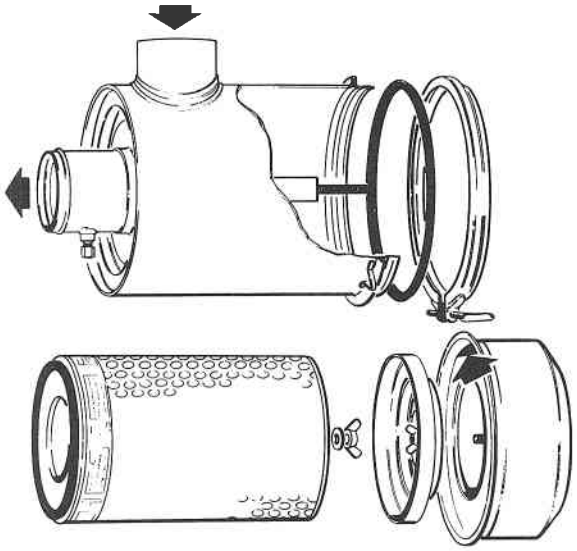
Dry Type Two Stage "Cyclopac", see Fig. N.2

Unclamp the dust bowl, remove the baffle plate and clean out the bowl.

The dust in the bowl must not be allowed to reach within ½in (13mm) of the dust entry slot in baffle. DO NOT USE PETROL (GASOLINE) for cleaning any part of air cleaners.



N.1



N.2

Release the wing nut and remove filter element.

Dry dust can be removed from the element by blowing back from the clean side of the pleats by using air pressure not exceeding 100 lbf/in² (7 kgf/cm²) or 689 kN/m².

If the element is contaminated by oil and/or soot, it can be cleaned in warm water using a suitable non-foaming detergent as recommended by the air cleaner manufacturer.

Allow, the element to soak for about ten minutes and then agitate. Spray clean water onto the "clean" side of the element rinsing thoroughly and allow to dry, do not use oven heat.

NEVER FIT a wet element as water may be inducted by the engine carrying dust with it.

Examine the element for pin holes, thin areas, or other damage by placing a bright light inside the element.

The element should be renewed after six cleanings or once a year, whichever occurs first.

Clean the inside of the filter body and fins, making sure no dirt enters the air filter outlet.

Check all hoses and joints for condition and security.

Re-assemble air cleaner unit.

If an automatic dust ejector (vacuator) is fitted, it should be kept clean and the lips of the rubber ejector checked to see that they close but do not adhere together.

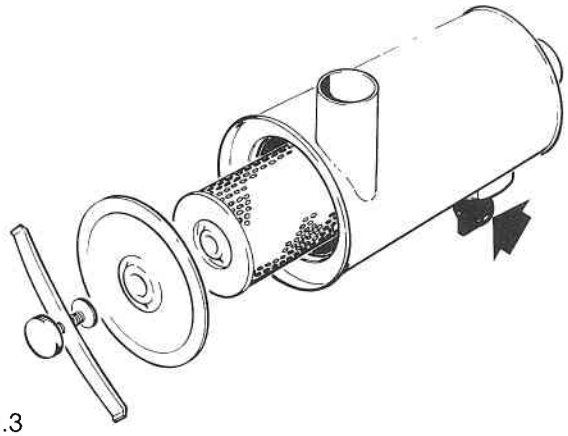
Dry Type Two Stage "Cyclone", see Fig. N.3

Unscrew the clamping screw and remove the element retaining strip. Remove the seal plate and element.

If the element is blocked by dry dust, clean by carefully hand tapping the element or by directing low pressure compressed air on to the clean side of the element.

If the element is contaminated by oil or soot, it can be partially restored by washing in a suitable non foaming detergent solution.

After washing, rinse out thoroughly by directing clean water on to the clean air side of the element and allow to dry — do not oven dry. **Never fit a wet element** to the



N.3

filter as dust may be carried through the element by water.

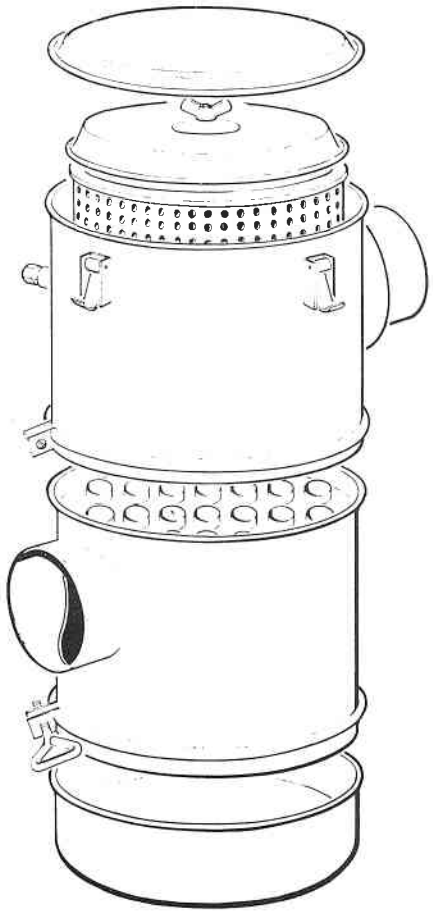
Inspect the cleaned element by placing a bright light inside and looking through the element. Any thin spots, pin holes or other damage will render the element unfit for further use.

The element should be renewed after six detergent washes or annually, whichever occurs first.

Clean the inside of the filter body and dry thoroughly — do not use petrol (gasoline) for cleaning.

Inspect the joints and hoses and renew where necessary.

Re-assemble the filter ensuring that all joints are leakproof.



N.4

Dry Type Two Stage "Duo-Dry", see Fig. N.4

Dust Bowl

Unclamp the dust bowl, empty out the dust and clean the bowl — do not use petrol (gasoline) for cleaning. The dust in the bowl must never be allowed to build up to 1 in (25 mm) of the bottom of the tubes.

Element

Clean the top of the cleaner and then unclip and remove the top cover. Unscrew the wing nut and remove the inner cover and element.

Clean and inspect the element as detailed for the "Cyclopac" cleaner, bearing in mind that the clean side of the element of the "Duo-Dry" cleaner illustrated is the outside of the element.

Clean the inside of the body — do not use petrol. If the tubes are not too dirty, they can be cleaned with a stiff fibre brush but, if heavily contaminated, the tube body should be removed and cleaned with compressed air or warm water not exceeding 150° F (65° C).

Inspect all joints and hoses and renew where necessary.

Re-assemble the cleaner ensuring that all parts are dry and all joints are leakproof.

If the tube body has been removed, tighten the clamp between it and the upper body before tightening the mounting clamp.

Dry Type, Multi-Element "Rotopamic", see Fig. N.5

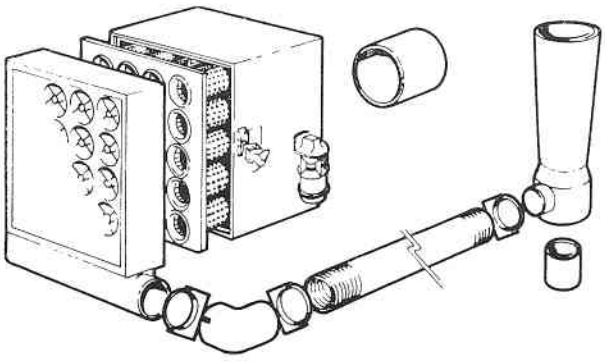
The elements of this type cleaner should not be cleaned but the complete filter cartridge should be renewed when necessary.

Release the clamps and remove the moisture eliminator or pre-cleaner panel. Clean the openings in the panel of any dust, soot, etc.

Remove the filter cartridge and clean the interior of the cleaner housing — do not use petrol (gasoline).

Fit the new cartridge in position ensuring a positive seal by pressing around the edges of the cartridge — do not press in the centre.

Refit the moisture eliminator or pre-cleaner panel and reclamp in position.



N.5

Oil Bath Air Cleaner, see Fig. N.6

To service the oil bath type cleaner, the lid should be removed and the element lifted out.

Drain the oil from out of the container and clean the dirt and sludge from the container using a suitable cleaning fluid.

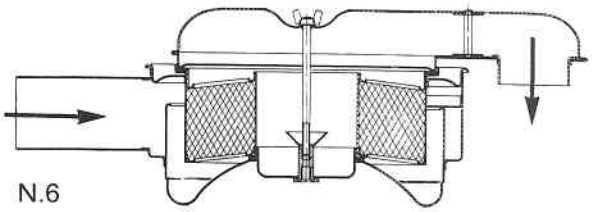
Refill the container with fresh engine lubricating oil, SAE40 grade, to the indicated level.

The element should be cleaned in a bath of Kerosene. Do not use petrol (gasoline) for cleaning purposes.

Replace the cleaned element in the container.

Refit the lid, making sure that the lid seats properly on the seal.

Do not exceed the indicated level mark when refilling the oil container, because oil could be drawn into the engine leading to uncontrolled engine speed and excessive engine wear.



N.6

FUEL FILTERS

Twin bowl, parallel flow fuel filters are situated at the rear of the engine on the left hand side, bracketed to the cylinder head, in most applications.

To Renew Fuel Filter Elements, see Fig. N.7

Thoroughly clean the exterior of the filter assembly.

Supporting the base of one of the filter bowls, unscrew the setscrew in the centre of the cover of each filter.

Lower filter base plate and discard the dirty element.

Repeat the procedure with the twin filter.

Thoroughly clean the filter heads and bases in a suitable cleaning fluid.

Inspect sealing rings and renew if damaged in any way.

Place a base squarely on bottom of new element and offer up assembly squarely to a filter head so that the top rim of the element locates centrally against the sealing rim in filter head. Hold in this position whilst securing setscrew is located and screwed home.

Repeat the procedure with the twin filter.

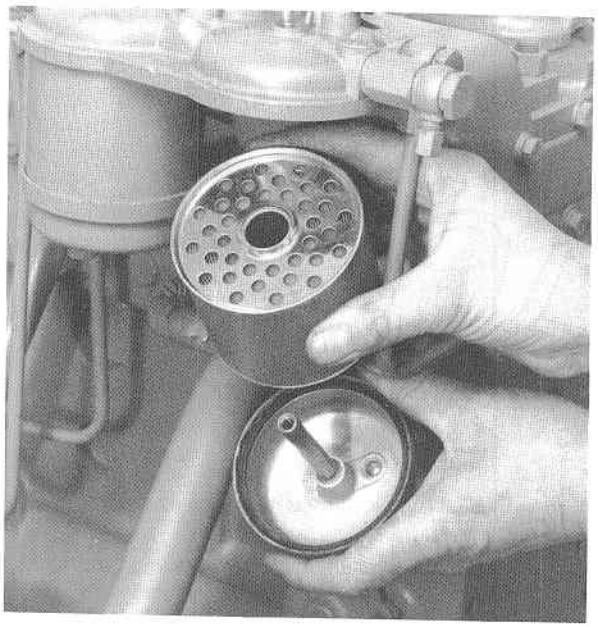
After the fuel filter has been re-assembled, the fuel system should be bled as detailed on page N.7.

Fuel Lift Pump

The mechanical diaphragm type fuel lift pump is operated by an eccentric on the camshaft and is mounted on the right hand side of the cylinder block, below the turbocharger. It is fitted with a hand priming lever.

Pressure Checking of Fuel Lift Pumps

Fit a 0–10 lbf/in² (0–0,7 kgf/cm²) or 0–70 kN/m² pressure gauge to the outlet of the pump. Ensure that there are



N.7

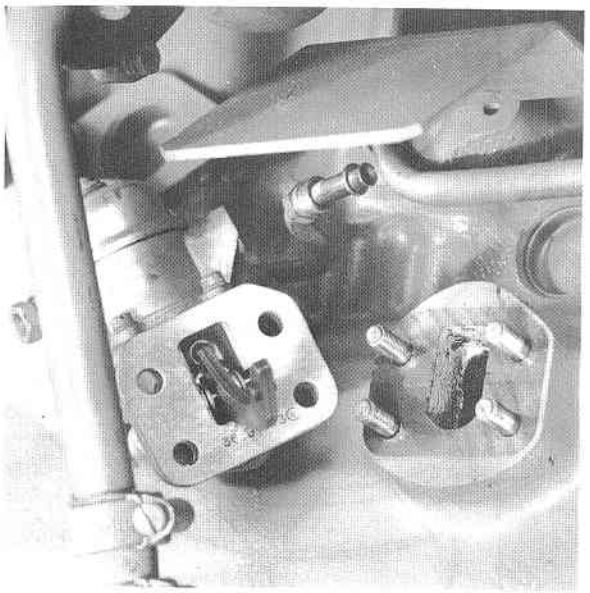
no leaks at the connections between pump and gauge. Crank the engine for 10 seconds and note the maximum pressure recorded on the gauge. If the pressure recorded is less than 75% of the minimum production static pressure shown in the table below, then rectify the pump. Also observe the rate at which the pressure drops to half the maximum figure obtained when cranking has ceased. If less than 30 seconds, rectify the pump.

Minimum Production Static Pressure

lbf/in²	kgf/cm²	kN/m²
6	0,42	41

Minimum Test Pressure (75% of Min. Production Pressure)

lbf/in²	kgf/cm²	kN/m²
4.5	0,31	31



N.8

To Remove and Fit Fuel Lift Pump, see Fig. N.8

Disconnect the inlet and outlet fuel pipes.

Remove the setscrews and retaining plates and remove the pump and joint.

If difficulty is encountered in removing the lift pump from the engine, turn the crankshaft to rotate the camshaft eccentric to a position which will enable the rocker arm to withdraw.

Fit pump using a new joint, ensuring that the mating faces are clean.

Damage can be caused to the pump operating lever if the pump is fitted to the engine with the pump driving eccentric on the camshaft in the maximum lift position. This problem is most likely if the four pump fasteners are not tightened evenly.

Therefore when the pump is fitted to an engine (especially a four bolt pump) ensure that the camshaft eccentric is on minimum lift, rotating the engine if necessary, and also that the pump fasteners are tightened evenly.

A loss of maximum engine power can occur if the lift pump is damaged during fitment.

The securing setscrews should be tightened to 20 lbf ft (2,8 kgf m) or 27 Nm and re-torqued when hot.

Re-connect pump inlet and outlet pipes.

Bleed the fuel system, Page N.7.

To Dismantle Fuel Lift Pump

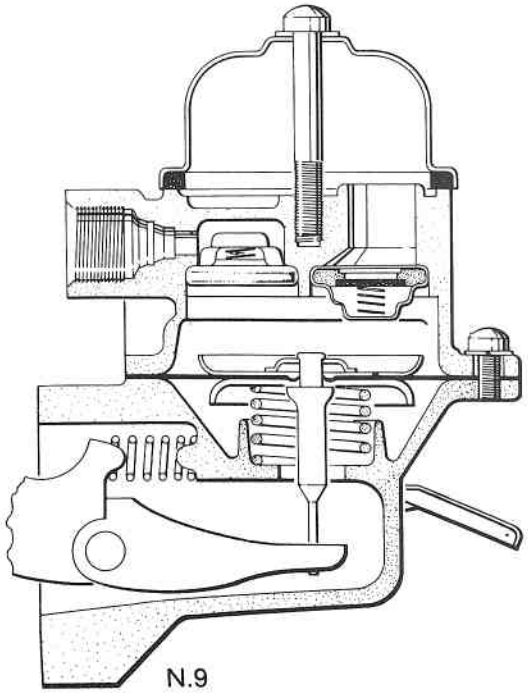
Clean exterior and file mark the flanges of top and bottom bodies for guidance in re-assembly. Remove the domed end cover and seal.

The gauze filter may now be lifted off.

Release the five setscrews securing the two halves of the pump and separate the two halves.

Turn the diaphragm assembly through 90° and lift the diaphragm and pull rod assembly from the body.

The diaphragm and pull rod assembly are serviced as an assembly and no attempt should be made to separate the layers of the diaphragm.



N.9

The valves are "staked in" and can be prised out using a screwdriver or other suitable tool. Clean the casting so that new valves can be correctly seated.

Press valves into position using a suitable "dolly". Stake the casting around the valves in six places.

The rocker arm pin can be removed by securing the rocker arm in a vice and tapping the body with a soft mallet until the retainers are dislodged.

The rocker, pin, lever and return spring can now be examined for wear.

To Re-assemble the Lift Pump, see Fig. N.9

Fit the rocker arm assembly into the bottom half of the lift pump. Fit the rocker arm return spring making sure that it seats properly.

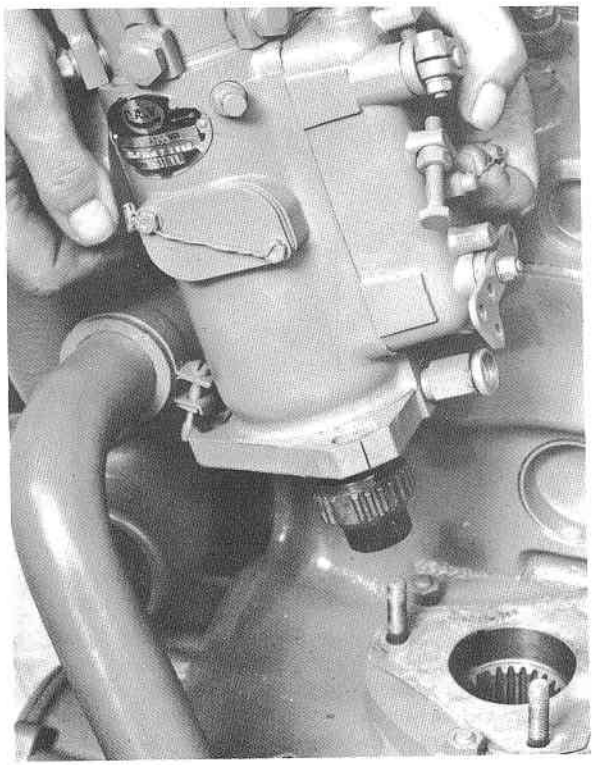
Tap new retainers into the grooves in the casting and stake over the open end of the grooves.

Fit the spring into its location and place the diaphragm and pull rod assembly over the spring with the pull rod downwards locating the top of the spring in the diaphragm protector washer.

Position the rod so that the notched blade locates into the rocker arm link.

Press downwards on the diaphragm assembly so that the notches on the pull rod align with the rocker arm link and twist it through 90° in either direction, this action will engage and retain the pull rod in the fork of the link.

When re-assembling the two pump halves, push the rocker arm towards the pump until the diaphragm is level with the body flanges. The top half can now be placed in position with the file marks aligned.



N.10 **(C.A.V. Pump)**

Maintaining the pressure on the rocker arm, fit the securing screws and washers and tighten evenly.

Refit the gauze filter.

The domed cover may now be refitted, ensuring that the rubber sealing ring is correctly located.

Fuel Injection Pump

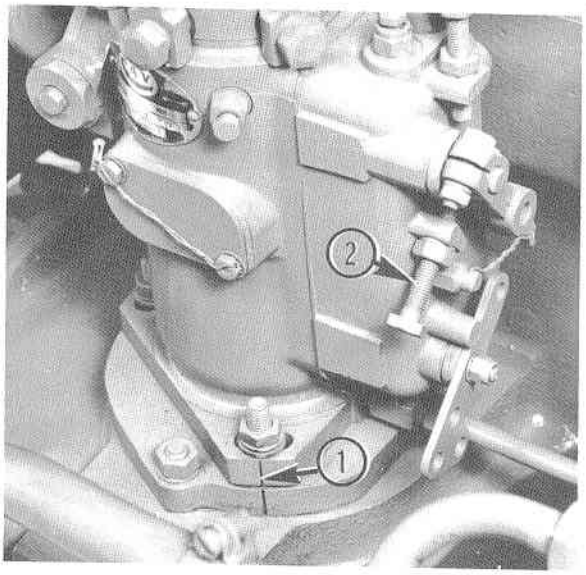
The fuel injection pump is a C.A.V., D.P.A. or Bosch distributor type, vertically mounted on the auxiliary drive housing and is spline-coupled to the auxiliary drive wormgear.

The pump is a compact, oil tight unit, lubricated throughout by fuel oil and requires no separate lubrication system.

Speed control is maintained by a mechanical governor and automatic variation of the commencement of injection is obtained with an automatic advance unit.

With Bosch fuel injection pumps, a boost control is fitted at the side of the pump. Its function is to vary the fuel into the engine depending on load. Ensure that all connections of the boost sensing pipe are in good condition.

Unless proper test equipment and the relevant Test Data for the fuel pump is available, adjustment or maintenance of the fuel pump should be referred to the Perkins Distributor or an accredited fuel pump agent.



N.11 **(C.A.V. Pump)**

To Remove the Fuel Injection Pump

Disconnect the stop and throttle controls from the pump and remove the return springs (C.A.V. pumps).

The Bosch fuel pump has a combined speed/stop control lever. Under no circumstances should the speed/stop control lever be removed when removing a Bosch fuel pump as it will upset the the settings making it necessary to put it on a test machine to reset it.

Remove the high and low pressure fuel pipes from the pump.

The fuel pump can now be withdrawn after the securing nuts and washers have been removed, see Fig. N.10.

To Fit the Fuel Injection Pump

Fit the fuel pump ensuring that the master spline on the fuel pump shaft will enter the female spline within the vertical drive shaft.

Position the fuel pump so that the scribed line on the fuel pump mounting flange aligns with the scribed line on the adaptor plate, see Fig. N.11(1). Secure the pump to the adaptor plate.

Refit the high and low pressure fuel pipes to the fuel pump.

Reconnect the throttle and stop lever controls and attach the return springs.

Bleed the fuel system as detailed on Page N.7.

If necessary, adjust the maximum and idling speeds. Details will be found on this page.

Maximum Speed Setting

The maximum speed screw is set and sealed by the manufacturers and must not be altered in any way unless factory authority is first obtained. Any adjustment should be carried out by experienced fuel pump technicians. The unauthorised removal of any seals on the pump may render the guarantee void.

When a fuel pump is supplied as a direct replacement, the maximum speed adjustment is set to a nominal figure only, and final adjustment must be made after the pump is fitted to the engine. In order to establish the correct setting which can vary according to application, reference must be made to the setting code symbol, stamped on the plate fastened to the pump body.

For the purpose of setting the maximum (no load) speed stop, the last four figures shown on the fuel pump setting code is the maximum no load engine speed. Warm the engine and run up until this figure is reached; the maximum speed stop adjustment should then be set at this figure.

Under no circumstances should the engine be allowed to operate at higher rev/min than specified or severe damage to the engine may result.

Idling Speed Setting

With C.A.V. pumps the engine idling speed is adjusted by the idling screw, see Fig. N.11 (2). With Bosch pumps, the idling speed adjusting screw is at the rear of the pump.

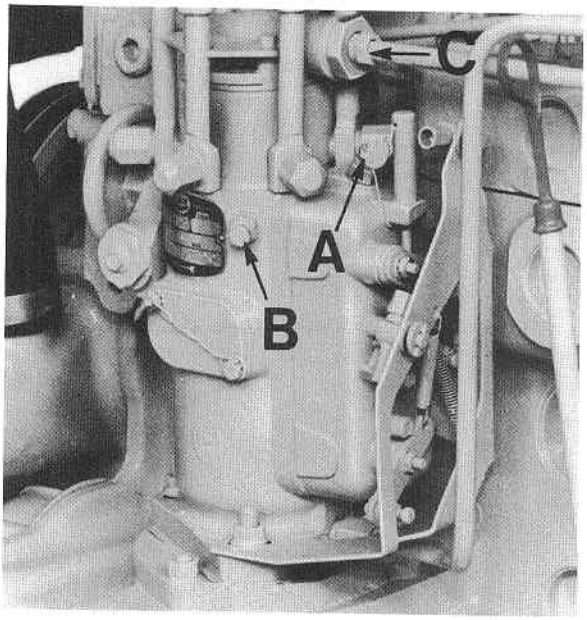
With the engine warm, turn the screw clockwise to increase the speed or anti-clockwise to decrease it.

The idling speed will vary, according to application. For details, apply to your Perkins Distributor or an accredited fuel pump Dealer, alternatively, Service Dept., Perkins Engines Ltd., Peterborough.

Atomisers

When replacing atomisers it is essential that a new, correct type copper seating washer is fitted between the nozzle cap and the cylinder head.

Note: Different atomiser seating washers are used on naturally aspirated and turbocharged engines. The seating washers for naturally aspirated engines are 0.080in (2,03mm) thick and for turbocharged engines,



N.12

0.028in (0,71mm) thick. It is important that the correct atomiser seating washers are fitted.

See page E3 for guidance on latest type of atomiser dust seal and also top entry type atomisers.

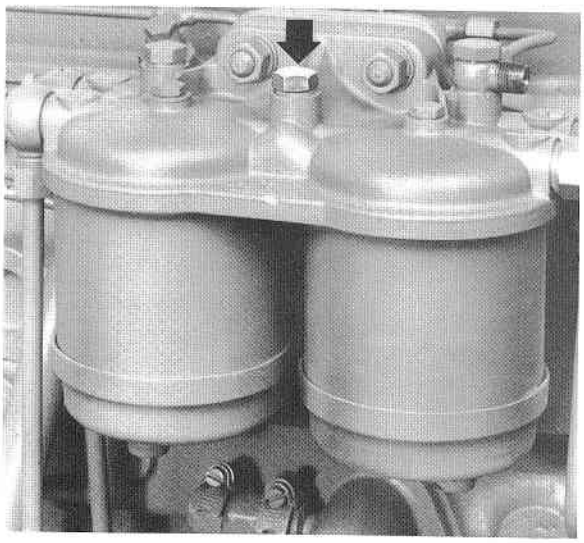
Ensure that the atomiser is seated centrally and tighten securing nuts/setscrews down evenly to a torque of 12lbfft (1,7kgfm) or 16Nm.

When fitting the high pressure pipes, tighten the unions to 15lbfft (2,1kgfm) or 20Nm.

A faulty atomiser can be determined by releasing the fuel pipe union nut of each atomiser in turn, with the engine running at a fast "tick-over". If after slackening a pipe union nut, the engine revolutions remain constant, this denotes a faulty atomiser.

No attempt should be made to service or reset the pressure of an atomiser unless the proper testing pump and pressure gauge is available.

An atomiser, when tested by pumping fuel through it gives a short "pinging" sound as the fuel emerges. After the atomiser has been in service for some time, it makes a "cracking" sound. It is not until it sounds "dead" that its condition is likely to affect the running of the engine.



N.13

Note: Do not allow the hands or face to come into contact with the atomised jet of fuel, as the working pressure will cause the fuel oil to penetrate the skin.

When changing an atomiser always remove the pipe entirely. Never bend the pipe.

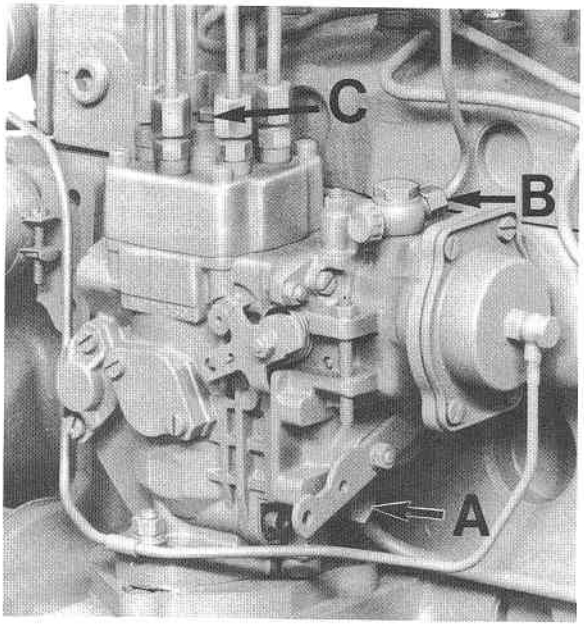
Bleeding the Fuel System

The air must be vented from the fuel system and the system primed with fuel oil whenever any disconnection in the fuel system has taken place, or when the system has been emptied of fuel.

No attempt must be made to start the engine until the injection pump has been vented and primed as serious damage can be caused by lack of lubrication.

Note: If the cam on the engine camshaft operating the fuel lift pump is on maximum lift, it will not be possible to operate the hand primer. If such a condition arises, then the engine should be turned one complete revolution.

If, after bleeding the fuel system, the engine starts and runs satisfactorily for a few moments and then stops, runs erratically, or has loss of power and when checked, the system is found to be full of air, then a leak on the suction side is indicated.



N.14

To Bleed C.A.V. Fuel Pump

1. Remove air from the fuel filter through the filter vent plug, see Figure N.13. If a filter vent plug is not fitted, the return to tank banjo connection in the top of the filter can be loosened to reduce the time needed to fill the filter with fuel.

   Operate the priming lever of the fuel lift pump until fuel, free of air, issues from the venting point.

   Tighten the plug or connection.

2. Loosen the inlet connection at the fuel pump, see Fig. N.12 item C and remove the air again by use of the lift pump.

When appropriate, tighten the connection but ensure that it is not overtightened.

3. Ensure that the stop control is in the 'run' position. If an electric solenoid stop control is used, turn the start switch to the 'R' position.
4. Loosen the vent screws in the hydraulic head locking bolt and the governor housing of the fuel injection pump, see Fig. N12, items A and B, and remove air from the pump by use of the lift pump.

   Tighten first the hydraulic head vent screw, item B and then the governor housing vent screw, item A.
5. If the fuel pipe to the Thermostart cold starting aid has been drained, loosen the union nut at the starting aid and operate the priming lever until fuel, free from air, comes from the connection. Tighten the union nut.
6. Slacken the unions at the atomiser ends of two high pressure pipes. Set the accelerator at the fully open position and ensure that the 'stop' control is in the 'run' position.

   Turn the engine until fuel oil, free of air, issues from around the threads and tighten the union nuts.

   The engine is now ready for starting.

To Bleed Bosch Fuel Pump

Slacken the vent screw on the top of the final fuel filters, see Fig. N.13.

Slacken the inlet connection on the fuel pump (A), see Fig. N.14.

Slacken the outlet connection on the fuel pump (B), see Fig. N.14. This connection is fitted with a non-return valve and must not be fitted to the inlet port.

Operate the priming lever on the fuel lift pump until fuel, free from air, issues from the final fuel filter venting point. Tighten the fuel filter vent screw and continue to operate the lift lump until fuel, free from air, issues from the inlet connection on the fuel pump (A). Tighten the inlet connection and continue to operate the lift pump until fuel, free from air, issues from the outlet connection on the fuel pump (B) and tighten the connection.

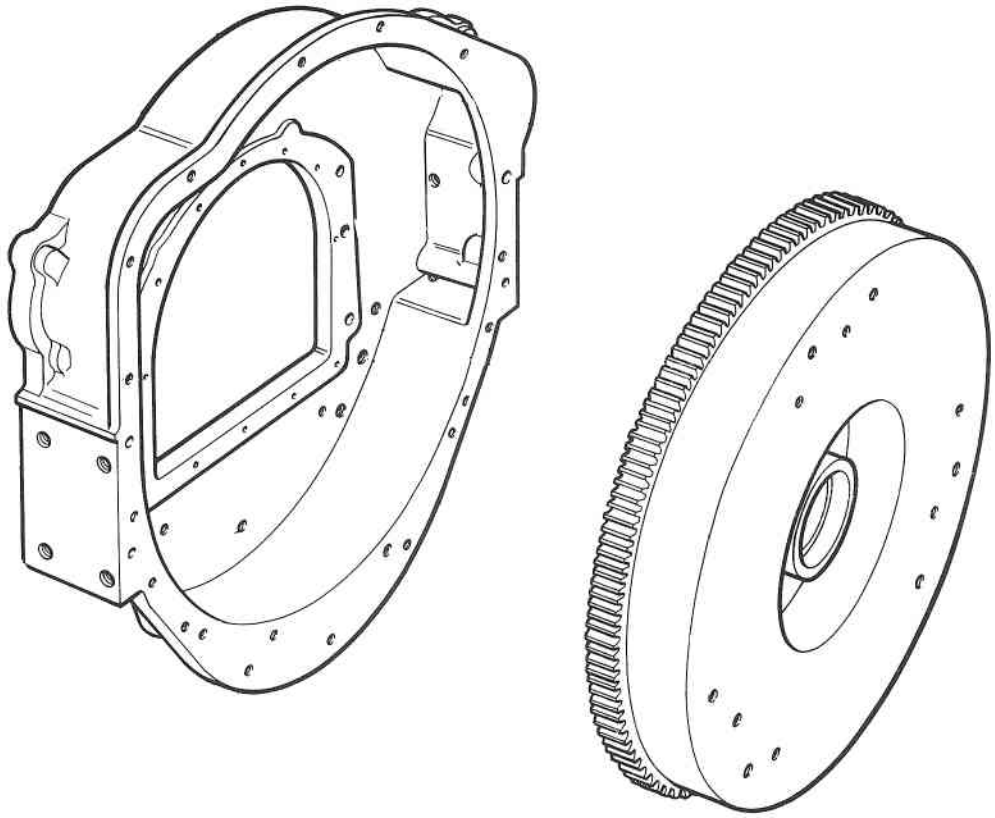
Thoroughly clean the top of the pump around the centre plug in the hydraulic head and slacken the vent plug (C). Operate the priming lever of the lift pump until fuel, free from air, issues from around the plug. Tighten the plug to 7lbfft (10Nm) 1,0kgfm.

If the fuel pipe to the Thermostart cold starting aid has been drained, loosen the union nut at the starting aid and operate the priming lever until fuel, free from air, comes from the connection. Tighten the union nut.

Slacken the nuts of two of the high pressure pipes at the atomiser end.

With the speed control in the maximum speed position, motor the engine over by means of the starter motor until fuel, free from air, issues from the connections. Tighten the connections. The engine is now ready for starting.

SECTION P
Flywheel and Flywheel Housing



To Remove the Flywheel

Remove the twelve setscrews and washers which secure the flywheel to the crankshaft flange.

It is advisable to fit suitable guide studs to prevent the flywheel from dropping as it clears the crankshaft flange.

Flywheel Ring Gear

The ring gear is shrunk on to the flywheel.

When replacing the ring gear, the applied heat to the new ring should not exceed 480° F (250° C).

Attention should be paid to the chamfered lead — in edge of the ring gear, and its relative position on the flywheel.

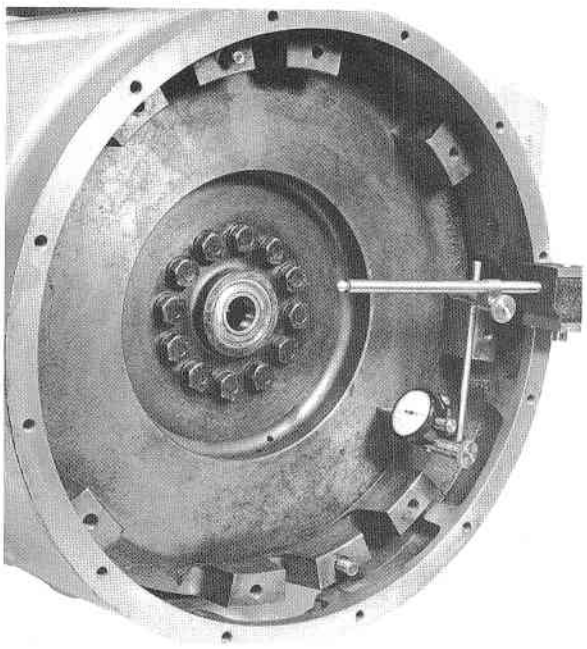
To Refit the Flywheel

Using suitable guide studs, refit the flywheel to the crankshaft flange and secure with setscrews and washers.

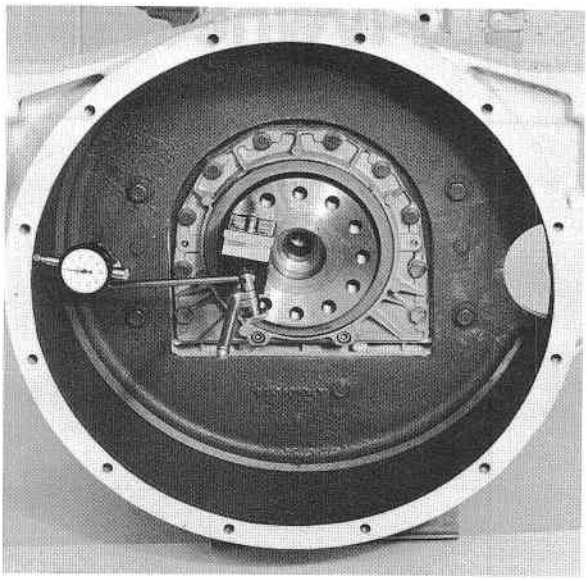
Tighten setscrews to a torque of 80lbfft (11,1kgfm) or 108Nm.

Flywheel Runout

The outside diameter of the flywheel should be concentric within 0.012in (0,30mm) total indicator reading, to the crankshaft axis.



P.1



P.2

Flywheel Alignment

The alignment of the flywheel face should be within the limit of 0.001in (0,03mm) per inch (25,4mm) of flywheel radius from the crankshaft axis to the clock gauge plunger, see Fig. P.1.

When carrying out this check, press the crankshaft one way to take up the end float whilst turning the flywheel.

To Remove the Flywheel Housing

Remove the starter motor and flywheel.

Unscrew the securing setscrews and tap the housing carefully to dislodge it from the locating dowels.

To Refit the Flywheel Housing

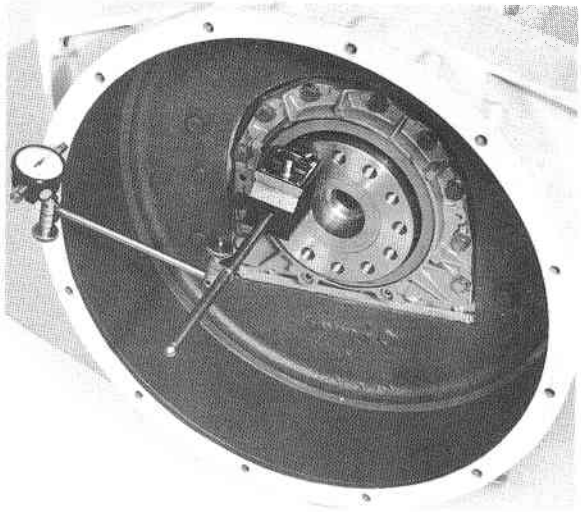
Ensure that the rear face of the cylinder block and the mating face of the housing are clean and free from burrs.

Fit new dowels, and secure housing to cylinder block to allow for adjustment, if necessary.

With a clock gauge, check that the alignment of the flywheel housing bore and face, see Figs. P.2 and P.3, are within the limits listed on Page P.3.

All adjustments to bring the housing within these limits must be carried out on the housing and not on the cylinder block.

Tighten the securing setscrews to torque given on page B.2.

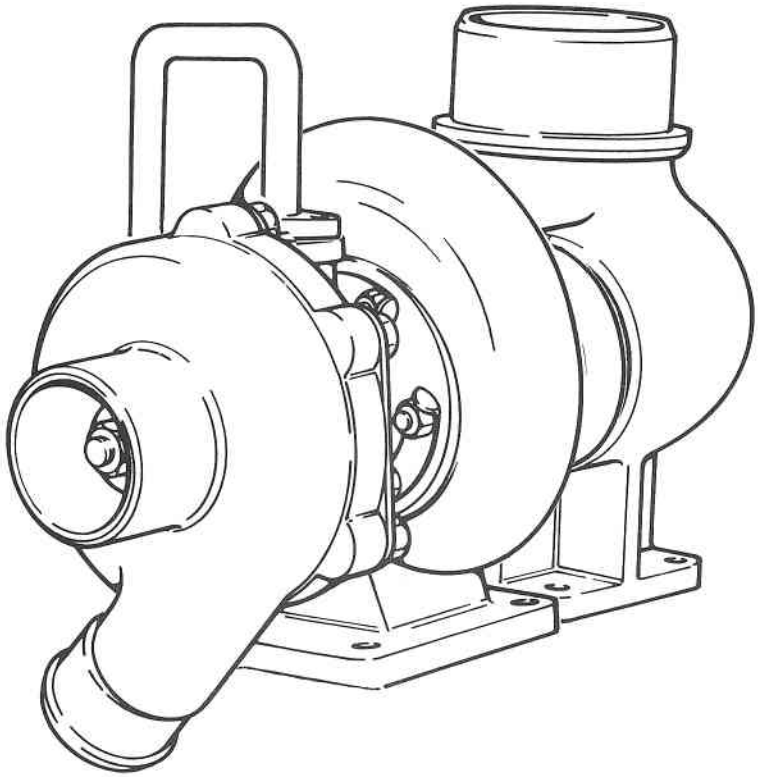


P.3

Diameter of housing Bore	Limit-Total Indicator Reading
Up to 14.25 in (362 mm)	0.006 in (0,15 mm)
14.25 to 20.125 in (362 to 511 mm)	0.008 in (0,20 mm)
20.125 to 25.5 in (511 to 648 mm)	0.010 in (0,25 mm)
25.5 to 31.0 in (648 to 787 mm)	0.012 in (0,30 mm)

All adjustments to bring the housing within these limits must be carried out on the housing and not on the cylinder block.

SECTION Q
Turbocharger



T6.3544 Engines only

The turbocharger is fitted on the exhaust manifold outlet, see Fig. A.4. It is lubricated by oil taken from the engine lubricating system. Oil pressure should never drop below 30 lbf/in^2 (2,11 kgf/cm^2) or 207 kN/m^2 at normal running speed. Check this pressure regularly.

The maximum boost pressure should be 11 – 13.5 lbf/in^2 (0,80 – 0,95 kgf/cm^2) or 76 – 93 kN/m^2 when the engine is running at maximum speed and full load.

With some engines where it is not possible to fully load the engine, the boost pressure will be somewhat lower.

No attention need be paid to the speed of the turbocharger since this varies automatically with the speed and load of the engine.

Maintenance

Every 20,000 miles (30,000 km) or 1,000 hours, clean the oil drain pipe from turbocharger to sump, also turbocharger compressor wheel and cover.

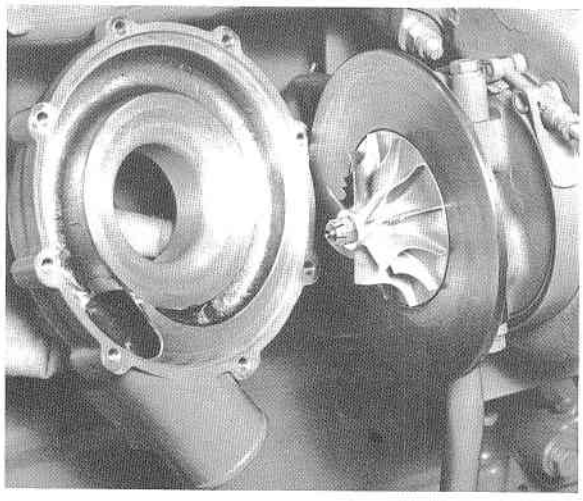
The compressor wheel and cover may be cleaned without removing the turbocharger from the engine (Fig. Q.1).

Remove the air inlet duct and compressor housing and check for dirt or dust build up.

Remove all foreign matter – determine and correct cause of build up.

Use soft brush on compressor wheel as uneven deposits can affect rotor balance and cause bearing failure.

With the compressor housing removed, push the compressor housing wheel towards the turbine wheel and turn rotating assembly by hand: check for binding and rubbing. Listen carefully for unusual noises. If binding or rubbing is evident, remove the turbocharger for dismantling and inspection.



Q.1

Fault Diagnosis

If the performance of the turbocharger is suspect, check the installation for the following faults:

Excessive air inlet depression.

Low or high air delivery pressure.

Low oil pressure and/or low oil flow.

Restricted exhaust from turbine.

Fuel pump or injection faults.

Check and rectify in accordance with the following paragraphs:

Excessive air inlet depression: The air depression at the entry to the compressor, that is in the ducting after the air filter and immediately before the compressor cover, should not exceed a 20 in (500 mm) head of water.

If the depression is excessive, the cause will be due to a restriction of inlet air by a dirty air filter.

Service the air filter.

Low or high air delivery pressure: The pressure will vary according to the engine rating, speed and load.

If the pressure is low, the probable cause is a dirty or damaged compressor, incorrect fuelling of the engine fuel pump, or leaking manifold joints.

Check that the injection pump fuelling has not been disturbed and if satisfactory, remove the turbocharger from the engine for inspection.

A higher reading may also indicate incorrect injection pump fuelling or damage to the turbine.

Action as for low pressure.

Low oil pressure and/or oil flow: The oil delivery pressure should not be less than 30 lbf/in^2 (2,1 kgf/cm^2) or 207 kN/m^2 under normal conditions of load.

If oil pressure is low, refer to Section L. Clean bores of the feed and return pipes and check the connections for obstruction.

Restricted exhaust from the turbine: A restriction of the exhaust from the turbine will affect engine performance. If the back pressure is more than 20 in (500 mm) head of water, check the exhaust system for obstruction and rectify as necessary.

Reconditioning

When a turbocharger is removed from an engine, it is imperative that all terminations of oil connections are sealed immediately, to prevent the entry of dirt.

During all stages of turbocharger dismantling, examination and rebuilding, care must be taken to ensure that no damage is caused to components.

Holset 3LD

Dismantling

Numbers in brackets refer to numbers on Sectional Drawing, Fig. Q.2.

Clamp unit upright in vice on turbine inlet flange.

Mark relative positions of turbine housing (8), bearing housing (14), compressor cover (21) and "V" clamp (7).

Remove the eight bolts (3) and associated lockwashers (2), fastening compressor cover (21) to bearing housing (14) and lift off cover (21).

Remove the "V" clamp locknut and spring "V" clamp (7) back onto bearing housing (14). Lift the core assembly clear of the turbine housing (8).

Holding the turbine wheel at the hub, remove the compressor locknut (17).

Slide compressor wheel (18) off the shaft.

Using circlip pliers, remove the large retaining ring (20) which retains compressor insert (19). Two screwdrivers should be used to lift insert (19) from bearing housing (14).

Remove "O" ring (4) from insert (19).

The individual parts of the thrust assembly can now be lifted out.

(a) Spacer sleeve (16) which can be gently pushed out of the insert (19).

(b) Oil deflector (13) positioned by two groove pins.

(c) Thrust ring (12).

(d) Thrust plate (5).

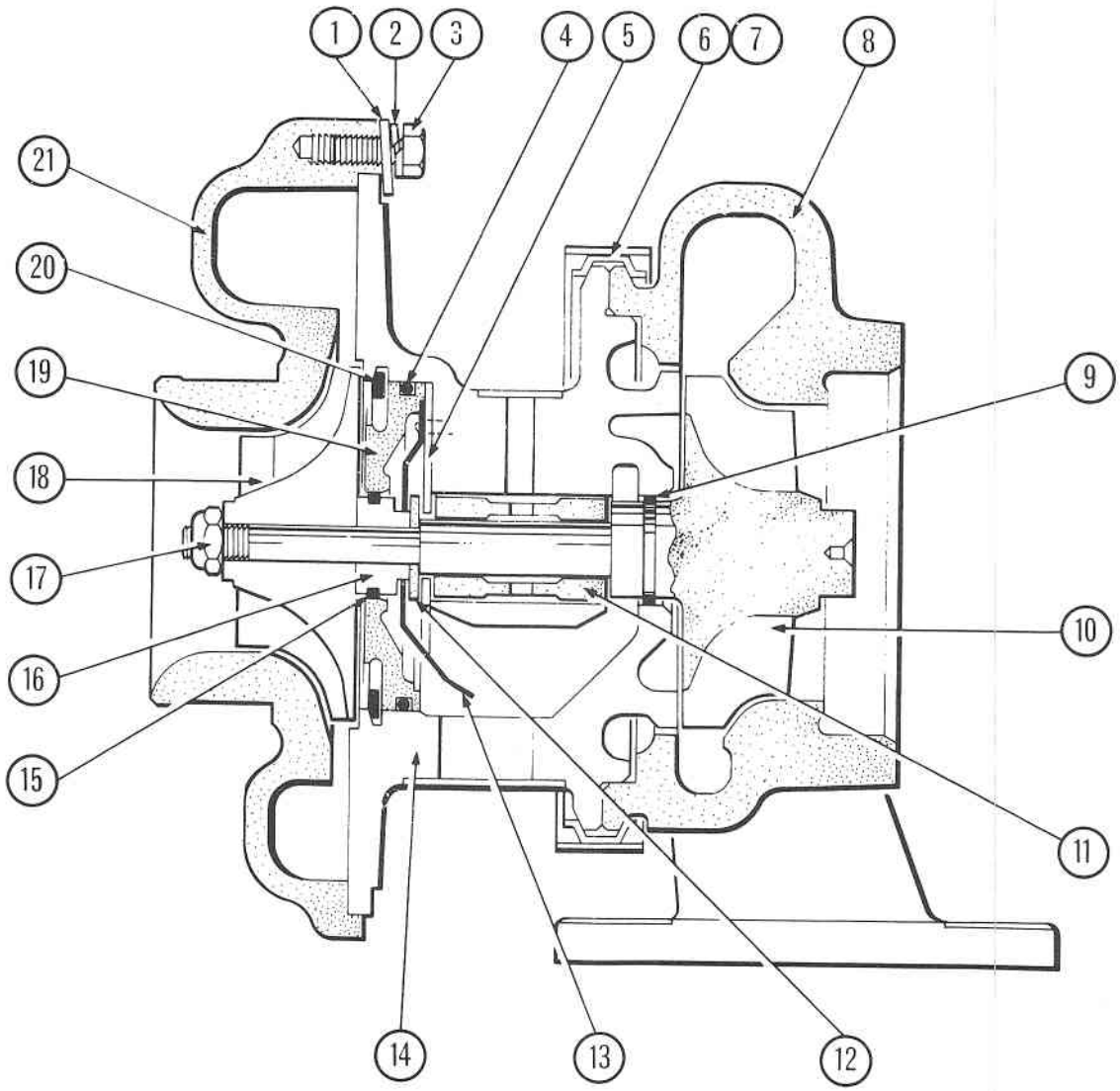
Note: The groove pins are a press fit in the bearing housing (14) and should not be removed.

Remove shaft and turbine wheel assembly (10) together with its piston rings (9) and (15).

Insert fingertip into bore of bearing (11) and remove.

Carefully expand and remove piston rings (9) and (15) from both the spacer sleeve and turbine wheel and shaft assembly.

Caution: Over expansion of piston ring will cause a permanent set or break the ring.



Q.2

Cleaning Procedure

Use a commercially approved cleaner only. Caustic solutions will damage certain parts and should not be used.

Soak parts in cleaner until all deposits have been loosened.

Use a plastic scraper or bristle type brush on aluminium parts. Vapour blast may also be used providing the shaft and other bearing surfaces are protected.

Clean all drilled passages with compressed air jet.

Make certain that surfaces adjacent to wheels on stationary housing are free of deposits and are clean and smooth.

Internal Parts Inspection

Shaft and turbine wheel assembly (10).

(a) Inspect bearing journals for excessive scratches and wear. Minor scratches may be tolerated.

(b) Inspect piston ring groove walls for scoring. Minor scratches are acceptable.

(c) Check carefully for cracked, bent or damaged blades, but **do not attempt to straighten blades.**

Bearing (11).

Replace bearings if excessively scratched or worn.

Bearing Housing (14).

Replace housing if bearing or piston ring bores are excessively scratched or worn.

Spacer Sleeve (16).

Replace if piston ring groove or spacer are damaged.

Thrust ring (12): thrust plate (5).

(a) Replace if thrust faces are damaged. Minor scratches are acceptable.

(b) Replace thrust plate (5) if faces are worn excessively, unevenly, severely scratched or otherwise damaged.

(c) The small feed grooves in the thrust plate (5) must be clean and free from obstruction.

Compressor wheel (18).

Check carefully for cracked, bent or damaged blades but **do not attempt to straighten blades.**

"O" ring (4).

Replace if section through ring has taken a permanent set; indicated by flats on the sides of the ring.

A schedule of tolerances which includes allowable dimensions after service, is given below.

Re-assembly

When the turbocharger has been thoroughly cleaned, inspected and any damaged parts replaced, assembly can commence.

Assembly of the unit is the reverse of dismantling, but the following points should be noticed.

(a) Lubricate bearings, thrust assembly, piston rings and rotor shaft, with clean engine oil.

(b) When replacing turbine wheel and shaft (10) into bearing housing (4), and spacer sleeve (16) into insert (19), do not force piston rings into bore as an off-centred ring will fracture, causing the shaft to bind.

(c) The large retaining ring (20) should have bevelled side facing outwards.

(d) Torque locknut (17) to 13lbfft (1,8kgfm) or 17Nm, bolt (3) to 5lbfft (0,7kgfm) or 7Nm and "V" clamp locknut (6) to 10lbfft (1,4kgfm) or 13Nm.

(e) On completion, spin shaft to ensure it rotates freely.

Note: If during the dismantling of the turbocharger, the lubricating oil feed and drain pipe adaptors were removed from the bearing housing, these should, on re-assembly, be torqued to 30lbfft (4,15kgfm) or 41Nm and 65lbfft (8,99kgfm) or 89Nm respectively.

The unit is now ready for fitting to the engine. If it is not intended to mount the turbocharger on the engine immediately after assembly, then the gas and oil connections must be sealed off to prevent the entry of dirt.

HOLSET 3LD
SCHEDULE OF TOLERANCES

	Manufactured Dimensions	Allowable Dimensions after Service	Remarks
Total turbine wheel clearance	0.047/0.057in (1,19/1,45mm)	0.024in (0,61mm) min.	
Back turbine wheel clearance	0.015/0.027in (0,38/0,68mm)	As Manufactured	Wheel pushed to compressor end.
Front turbine wheel clearance	0.024/0.038in (0,61/0,96mm)	0.024in (0,61mm) min.	
Total compressor wheel clearance	0.049/0.062in (1,24/1,57mm)	As Manufactured	
Back compressor wheel clearance	0.026/0.043in (0,66/1,09mm)	As Manufactured	Wheel pushed to turbine end.
Thrust clearance	0.004/0.008in (0,10/0,20mm)	As Manufactured	
Radial float at compressor wheel hub	0.015/0.021in (0,38/0,53mm)	0.024in (0,61mm) max.	
Bearing outside diameter	0.8714/0.8719in (22,13/22,14mm)	As Manufactured	
Bearing inside diameter	0.4815/0.4818in (12,23/12,24mm)	As Manufactured	
Thrust bearing width	0.105/0.107in (2,67/2,72mm)	0.104in (2,64mm) min.	
Squareness of back face of turbine wheel	0.002in T.I.R. (0,05mm T.I.R.)	As Manufactured	On Vee block at 1.375in radius.
Eccentricity of small diameter of shaft	0.0006in T.I.R. (0,01mm T.I.R.)	As Manufactured	
Piston ring grooves on shaft	0.066/0.068in (1,68/1,73mm)	0.066/0.070in (1,68/1,79mm)	
Piston ring groove on spacer sleeve	0.066/0.068in (1,68/1,73mm)	0.066/0.070in (1,68/1,79mm)	
Piston ring width at turbine end	0.062/0.063in (1,57/1,60mm)		Replace at each service.
Piston ring width at compressor end	0.062/0.063in (1,57/1,60mm)		Replace at each service.
Bearing housing bore for piston ring	0.8750/0.8755in (22,22/22,24mm)	0.877in (22,28mm) max.	
Compressor insert bore	0.875/0.876in (22,22/22,25mm)	0.877in (22,28mm) max.	
Bearing housing bore at bearing	0.8750/0.8755in (22,22/22,24mm)	As Manufactured	
Turbine wheel outside diameter	2.977/2.975in (75,62/75,56mm)	2.980in (75,69mm) max.	
Shaft diameter at bearing	0.4803/0.4800in (12,20/12,19mm)	0.4799in (12,19mm) min.	

Airesearch T-04B (see Fig. Q.3)

Dismantling

Clean the exterior with a pressure spray of a non-caustic cleaning solvent before dismantling. Dismantle only as required to make necessary inspection or repairs. As each part is removed, place in a clean container to prevent loss or damage.

Remove the bolts, clamps and lockplates which hold the compressor and turbine housings to the centre housing group. Tap the housings with a soft faced hammer if force is needed for removal.

Note: Exercise caution when removing housings to prevent damage to compressor or turbine wheel. Once damaged, they cannot be repaired. Never attempt to straighten bent compressor or turbine blades – replace the faulty component.

Place the centre housing group in a suitable holding fixture which will prevent the turbine wheel from turning.

Use a T-handled wrench when removing the compressor wheel locknut to avoid possible bending of the shaft.

Lift the compressor wheel off the shaft. Remove the shaft wheel from the centre housing keeping shaft central with bearings until clear of centre housing.

Note: The turbine wheel shroud is not retained to the centre housing and will fall free when the shaft wheel is removed.

Remove lockplates and bolts from back plate.

Tap backplate with soft mallet to remove from recess in centre housing.

Remove thrust collar and thrust bearing from centre housing.

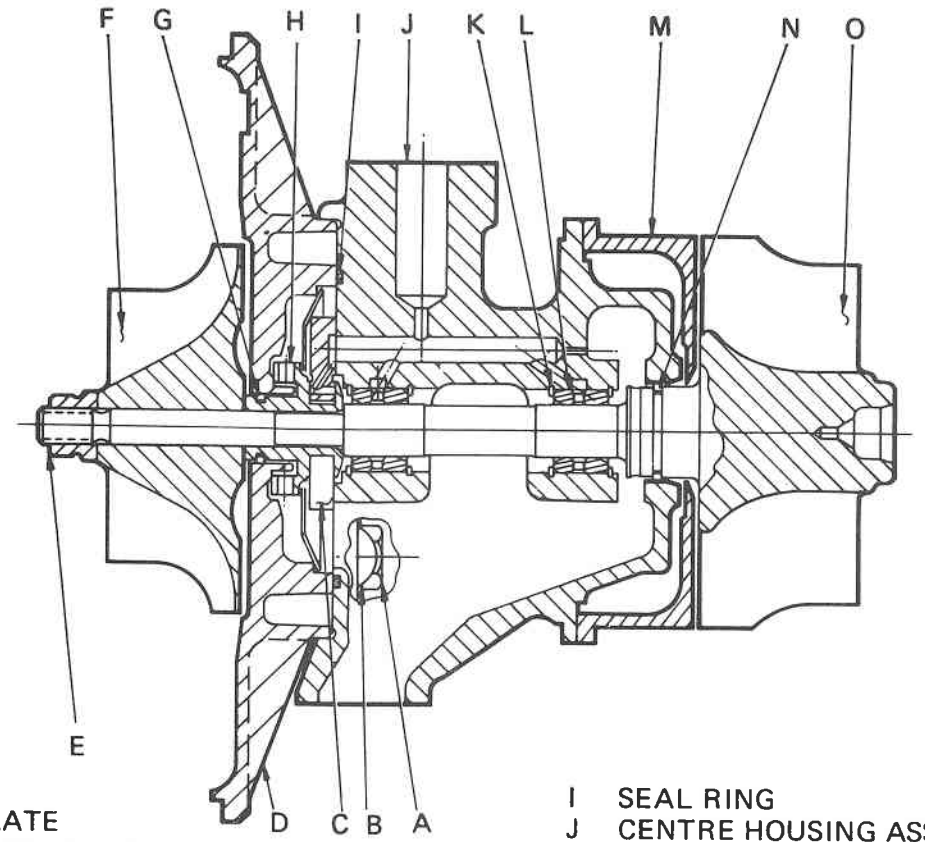
Remove bearings and retainers from centre housing. Discard rubber sealing ring.

Cleaning

Before cleaning, inspect all parts for signs of rubbing, burning or other damage which might not be evident after cleaning.

Soak all parts in clean non-caustic carbon solvent. After soaking, use a stiff bristle brush and remove all dirt particles. Dry parts thoroughly.

Note: Normally, a light accumulation of carbon deposits will not affect turbine operation.



A BOLT
B LOCK PLATE
C THRUST BEARING
D BACKPLATE ASSEMBLY
E LOCK NUT
F COMPRESSOR WHEEL
G PISTON RING' COMPRESSOR
H THRUST COLLAR
I SEAL RING
J CENTRE HOUSING ASSEMBLY
K RETAINING RING
L BEARING
M SHROUD
N PISTON RING, TURBINE
O SHAFT WHEEL ASSEMBLY

Q.3

Internal Parts Inspection

Parts must not show signs of damage, corrosion or deterioration. Threads must not be nicked, crossed or stripped.

The turbine wheel must show no signs of rubbing and vanes must not be torn or worn to a feather edge. The shaft must show little signs of scoring, scratches or seizure with the bearings.

The compressor must show no signs of rubbing or damage from foreign matter. The compressor wheel bore must not be chafed.

Seal parts must show no signs of rubbing or scoring of the running faces. Housings must show no signs of contact with rotating parts. Oil and air passages must be clean and free from obstructions.

Burnish or polish out minor surface damage. Use silicon carbide abrasive cloth for aluminium parts and crocus abrasive cloth for the steel parts. Thoroughly clean parts before re-assembly.

Replace any parts which do not meet requirements.

Replace the following parts: seal ring, lockplates, piston rings, turbine housing bolts, journal bearings, bearing retaining rings, and compressor wheel locknut.

If thrust bearing and thrust collar show signs of nicks, scores, varnish deposits or foreign matter embedments – replace. Also, a close inspection of bearing bores in the centre housing should be made and if any of the above conditions exist, replace the centre housing.

Re-assembly

Check each part prior to installation to ensure cleanliness. Exercise care to prevent entry of foreign matter during assembly.

Check thrust collar piston ring groove for nicks or burns.

Assemble in the following manner:

Install inboard bearing retainers. Lubricate bearings with clean engine oil. Fit bearings and outer bearing retainers.

Place turbine wheel upright. Gently guide shaft through shroud and centre housing bearings. Place thrust bearing over thrust collar.

Fit piston ring on thrust collar. Place thrust collar over shaft so that thrust bearing is flat against the centre housing and engages the centre housing anti-rotating pins.

Install seal ring in groove in centre housing.

Ensure that thrust spring is installed in back plate. Align mounting holes of centre housing and backplate and install over shaft and thrust collar. Use care not to break piston ring when engaging seal into back plate bore. Back plate is easily installed if open end position is engaged into back plate bore first.

Install compressor backplate bolts and lockplate. Tighten to 79lbfin (104kgfcm) or 8,93Nm and secure lockplates.

Fit compressor wheel. The larger face of the locknut and the front face of the impeller must be smooth and clean. Lightly oil threads and face of nut and tighten to 20lbfin (23kgfcm) or 2,26Nm. Then continue to tighten until length of shaft increases by 0.0055/0.0065in (0,14/0,16mm). Tighten nut by using T-handled wrench to avoid side load which may cause shaft to bend. Check axial end play for 0.001/0.004in (0,03/0,10mm) travel. If equipment is not available to measure shaft stretch, this alternative method may be used: after installing impeller nut and tightening to 20lbfin (23kgfcm) or 2,26Nm continue to tighten through an angle of 90°.

Check for clearance between wheel shroud and turbine wheel.

Orientate compressor housing to centre housing. Fit the six bolts and three lockplates. Tighten bolts to 130lbfin (150kgfcm) or 14,09Nm.

Orientate turbine housing to centre housing. Coat bolt heads with a high temperature thread lubricant. Install bolts, clamps and lockplates. Tighten bolts to 130lbfin (150kgfcm) or 14,09Nm. Bend up lockplates.

After assembly, push the rotating assembly as far as possible from the turbine end and check for binding. Repeat check, pushing from compressor end.

If the unit is to be stored, lubricate internally and install protective covers on all openings.

Note: The turbocharger does not require testing after overhaul.

Schwitzer 3LM and S.76

Dismantling

Numbers in parentheses ( ) refer to key numbers in Fig. Q.4.

Clamp the edge of turbine housing (22) mounting flange in vice. Mark the relative positions of turbine housing, bearing housing (13) and compressor cover (1).

Remove the setscrews (15), lock plates (16) and clamp plates (17). Lift the assembly from the turbine housing. Place on work bench with turbine wheel (21) up.

Remove setscrews (12) and clamp plates (11). Remove core assembly from compressor cover (1).

Invert core assembly and place in turbine housing which is clamped in vice.

Hold the end of turbine wheel with $^{11}/_{16}$in A/F socket wrench, remove the compressor nut (2). Remove the compressor wheel (3). **Use extreme care in handling the compressor wheel as the blades bend very easily.**

Remove the snap ring (8) using suitable pliers. Note the position of bevel on the outer edge of the snap ring; it must be replaced the same way on re-assembly.

Remove the insert (6) from the bearing housing, remove the thrust sleeve (4), piston ring (5) and the oil deflector (7) from the shaft.

Remove "O" ring (9) from the insert.

Remove piston ring (19) from the thrust sleeve. Both "O" ring and piston ring must be renewed on re-assembly. Separate the oil deflector from the thrust sleeve. Lift thrust bearing (10) out of bearing housing. The thrust bearing must be renewed when re-assembling.

Remove the shaft and bearing housing from the turbine housing (22).

Separate shaft and wheel assembly (21) from the bearing housing. **Care must be taken not to damage the compressor wheel or the shaft.**

Remove the bearing (14). Renew the bearing when re-assembling.

Separate the backplate (18) and gasket (20), if fitted, from the bearing housing. Where a gasket is fitted it must be renewed when re-assembling.

Remove the piston ring (19) from the shaft and wheel assembly. The piston ring must be renewed on re-assembly.

Do not remove the pins in the bearing housing.

Cleaning

Before cleaning, inspect all parts for signs of rubbing, burning or other damage.

Clean all parts in clean non-caustic carbon solvent. After soaking, use a stiff bristle brush to remove all dirt particles. Oil and air passages must be clean and free from obstructions.

Blow dry with clean jet of compressed dry air.

Following the cleaning, the parts should be examined and, if found to be in satisfactory condition, re-assembled in the reverse order of the stripping sequence.

Parts Inspection

It is suggested that all parts to be re-used should be checked and measured after the parts have been throughly cleaned.

A. Bearing Housing and Groove Pin Assembly

1. Inspect for cracks or fractures, pitting of the gasket (from corrosion or hot gas corrosion) and other machined surfaces, or distortion of turbine end flange. Renew the parts if condition is excessive.
2. Visually check the bearing bore for surface cracks. Renew if bore condition is sub-standard.

   Reference maximum bore diameters are:

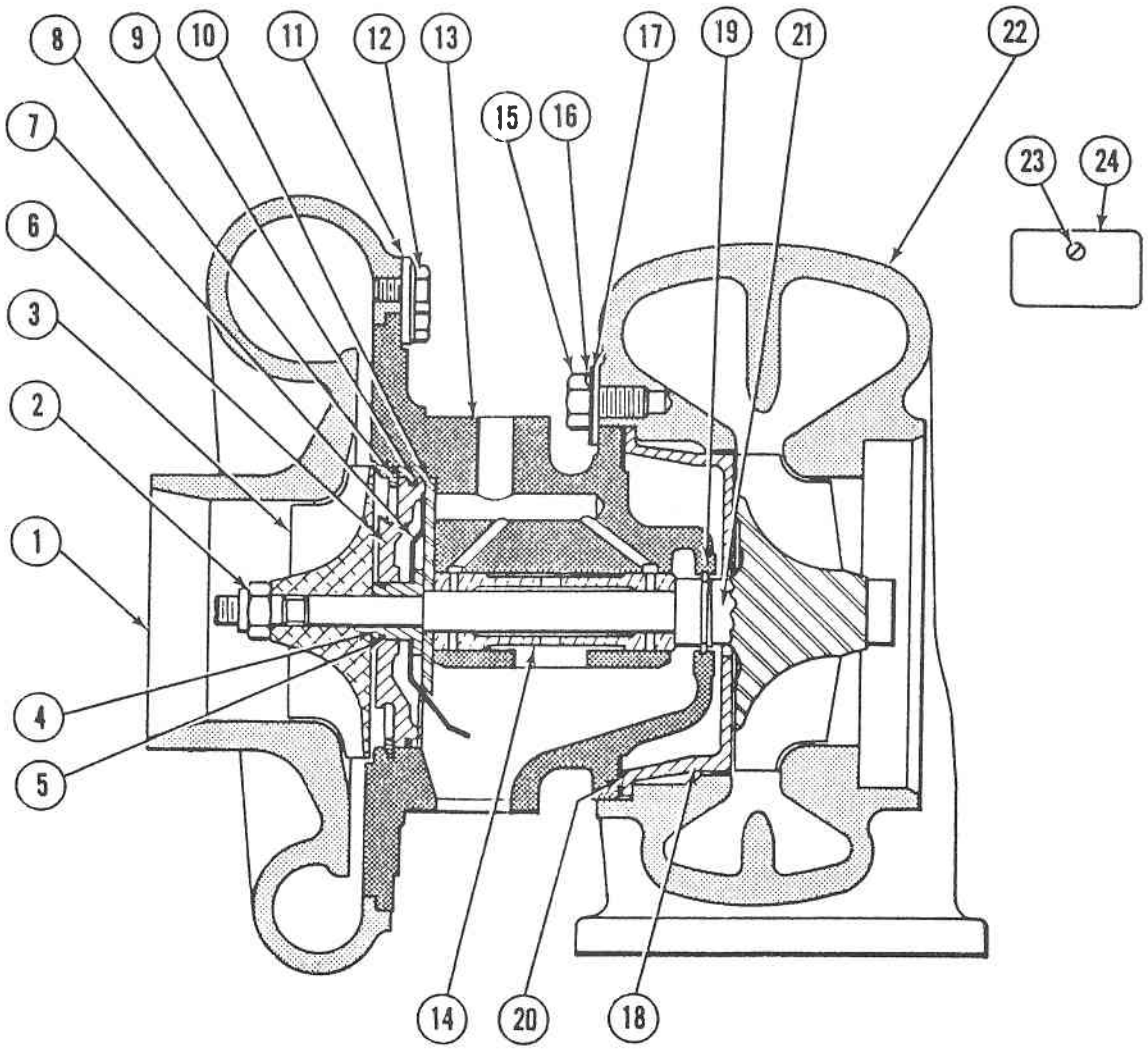
Standard	– 0.7505in (19,06mm)
.010 Oversize rebuilt	– 0.7605in (19,32mm)
.020 Oversize rebuilt	– 0.7705in (19,57mm)

   Note: The bore diameter of a rebuilt turbocharger is coded by the last digit of the serial number.

Standard	– 9
010 Over	– 0
020 Over	– 8

B. Compressor Wheel

1. Inspect for evidence of bent, burred or eroded vanes and wear marks on the back. Renew if damaged. **Do not attempt to straighten bent vanes.**



Q.4

C. Turbine Wheel and Shaft Assembly

1. Inspect the wheel for evidence of bent, burred or eroded vanes and wear marks on the back face. Renew if damaged. **Do not attempt to straighten bent vanes.**
2. Check the hub for marks (from high speed contact with the bearing housing bore) and for damage of the seal ring groove. Renew if damaged or wear is excessive.
3. Inspect the bearing journals for evidence of any damage or wear. Renew the journal if necessary.

   Minimum journal diameter 0.440in (11,18mm).
4. Measure the concentricity between the large and small shaft diameters with a dial indicator and vee block. Limit of eccentricity is 0.0006in (0,015mm) T.I.R. Renew if not within limit.

D. Compressor Cover

Check for damage from wheel contact, renew if damage is excessive. It is permissible to polish out any small nicks in the cover contour.

E. Turbine Housing and Backplate

Check for damage from wheel contact and evidence of excessive temperature damage to internal flanged surfaces, such as surface cracking and pitting or distortion. Renew if cracked. It is permissible to polish out small nicks in the contour.

F. Small Internal Parts

1. Fit new compressor seal ring in the insert bore. Check for full circle of contact and measure ring gap with feeler gauge. Gap range 0.002/0.007in (0,05/0,18mm). Renew insert if ring fit is out of the limit.
2. Inspect the thrust sleeve for evidence of wear and scratches. Renew if damage is excessive.

Re-assembly

Numbers in parentheses ( ) refer to key numbers in Fig. Q.4.

Check each part before re-assembly. The following items must be renewed when the turbocharger is rebuilt:

Compressor nut (2)	Bearing (14)
Piston ring (5)	Lock plates (16)
"O" ring (9)	Piston ring (19)
Thrust bearing (10)	Gasket (20) – where applicable

Fix the turbine housing (22) securely in vice with the four threaded holes facing upwards.

Oil piston ring (19) and fit in ring groove of shaft and wheel assembly (21), being careful not to over-expand the ring. Position the bearing housing (13) with turbine end up. Fit gasket (20), where applicable, and turbine backplate (18).

The separate backplate has no attachment to the bearing housing, its position is fixed when the bearing housing and the turbine housing are clamped together. A few models do not require a gasket (20).

Oil the piston ring area of the shaft and wheel assembly. Fit into bearing housing using care to avoid damage to piston ring.

Holding the end of the shaft to prevent the shaft wheel from falling out of the bearing housing, place sub-assembly in turbine housing wheel end down.

Oil the bearing (14) and slip bearing down over the shaft into the bearing housing bore.

Oil the thrust faces on both sides of thrust bearing (10). Place thrust bearing bronze side up over shaft and groove pins engaging pins to holes in thrust bearing. Some models have only one groove pin.

Place oil deflector (7) on thrust sleeve (4).

Oil the piston ring (5) and fit on thrust sleeve using care not to over expand the piston ring.

Oil the "O" ring and fit into groove of insert (6).

Oil the thrust sleeve and fit the small end in hole of the insert from the concave side, taking care not to damage the piston ring.

Oil the thrust cavity in bearing housing and fit insert/oil deflector/thrust sleeve sub-assembly over the shaft into the bearing housing, aligning oil deflector with oil drain cavity in bearing housing. Take care not to damage "O" ring.

Using suitable pliers, fit snap ring (8) into the groove with the flat side against the insert. Ensure the snap ring is securely in position.

Mount a dial indicator on the bearing housing with the stem of the indicator on the end of the shaft. Make sure that the turbine end of the bearing housing is correctly seated in the turbine housing. Move the shaft vertically to determine turbine wheel contour clearance. The clearance must be between 0.018in (0,46mm) and 0.049in (1,24mm). If clearance is not within these tolerances, dismantle unit to determine the cause. Look for burrs, dirt particles or incorrectly assembled parts. If after re-assembly it is still out of the permitted tolerance, do not use.

Install compressor wheel (3) on shaft.

Remove any oil from the shaft threads and apply 2 drops of "Loctite 601" (or equivalent locking agent) to the shaft threads. Using a socket wrench on the turbine wheel lug to prevent the shaft from turning, tighten the compressor nut to 13lbfft (17,6Nm).

Mount the dial indicator on the bearing housing with stem on the end of the shaft, measure the end play. The tolerance is 0.002/0.005in (0,05/0,13mm). **This is a dry (no oil) reading.** If not within tolerance, dismantle and look for burrs, dirt particles or incorrect assembly. Re-assemble and if still out of tolerance, do not use.

Place compressor cover (1) on the bench with wheel cavity upwards. Lubricate the small diameter of the shaft with grease or oil and place the turbocharger core assembly in compressor cover with the turbine wheel up.

Check turbine wheel clearance between back face of the turbine wheel and plate on opposite sides of the shaft. Clearance tolerance must be 0.017/0.049in (0,43/1,24mm). If clearance is not within the limits, dismantle and inspect as with previous components, if on re-assembly still not to tolerance, do not use.

Ensure that the location marks previously made on the compressor cover and bearing housing are in line and fit the four clamp plates (11) with setscrews and locking washer (12). Tighten setscrews to 5lbfft (6,8Nm). Use care not to overtighten screws as damage can be caused to the aluminium compressor cover.

Turn unit over and place in the turbine housing. Apply anti-seize compound to threads and setscrews (15).

Ensure that the location marks previously made on the turbine housing and bearing housing are in line.

Fit clamp plates (17), lock plates (16) and setscrews.

Tighten the setscrews to 12lbfft (16,3Nm) and lock the tabs to setscrews.

Remove completed turbocharger from the vice.

Installation Check List

Inspect the air intake system and the exhaust manifold for cleanliness and foreign matter.

Inspect the oil drain line and make sure it is not clogged.

Inspect the oil supply line for clogging, deterioration or possibility of leaking under pressure.

Inspect the turbocharger mounting pad on the manifold to make certain that all the old gasket has been removed. On some applications an adaptor is fitted between the turbocharger and exhaust manifold assembly. The adaptor is secured to the manifold by four stud nuts and washers and it should be ascertained that all traces of the old gasket have been removed from it.

Install a new gasket between the turbocharger and exhaust manifold. In cases where an adaptor is fitted, it will be necessary to install a gasket between the adaptor and the manifold assembly before placing the turbocharger gasket over the four turbocharger locating studs fitted in the adaptor. Ensuring that the gaskets do not protrude into the openings of the manifold (and adaptor where fitted). The openings in the gaskets should preferably be 0.06in (1,6mm) away from the edge of the openings in the manifold and adaptor.

Install turbocharger and tighten mounting bolts or securing nuts.

Connect the oil supply line but leave the oil drain line disconnected.

Connect the compressor inlet and outlet piping. Check all joints for possible leaks. Make certain that the piping is not exerting a strain on the compressor cover.

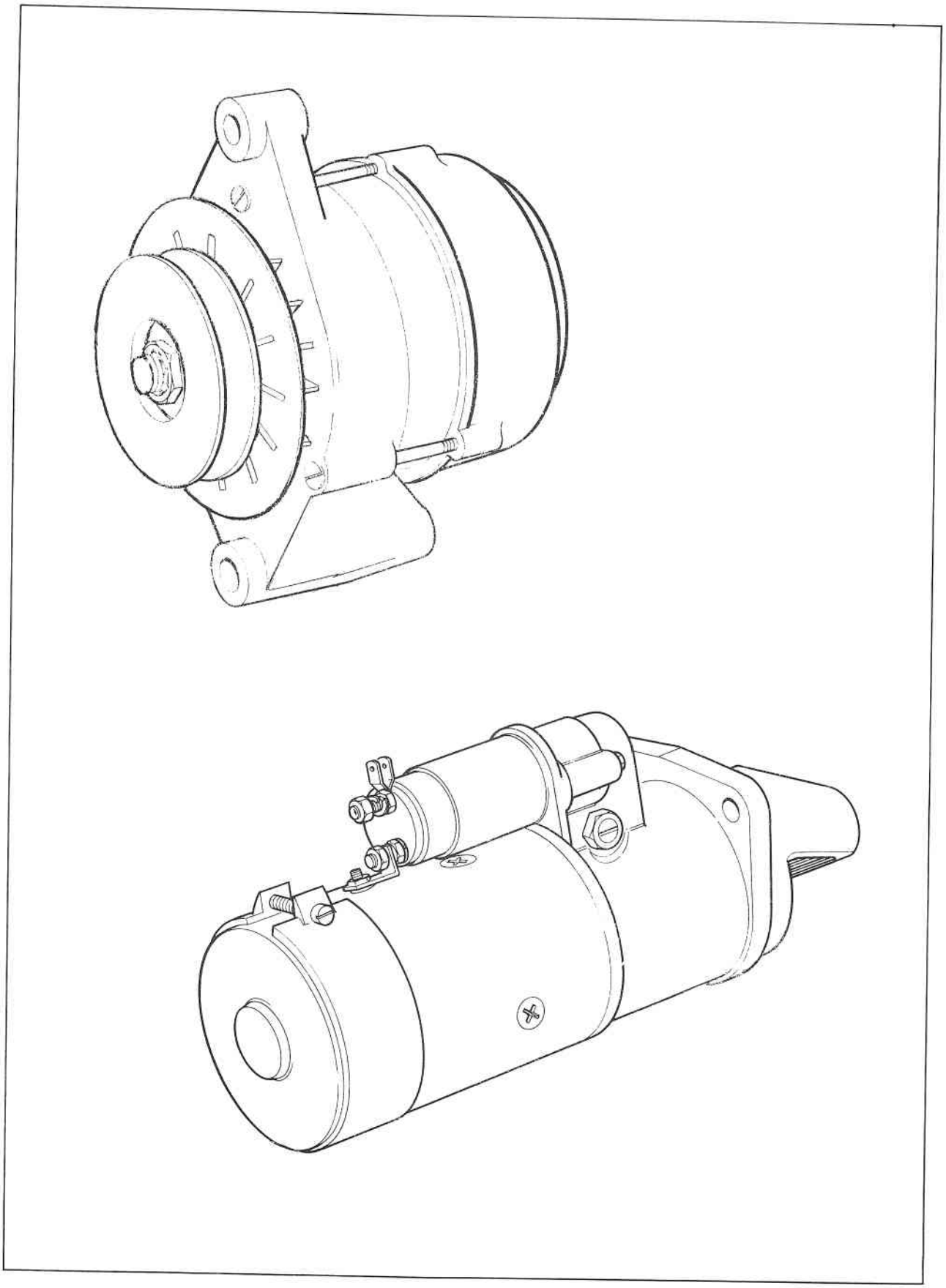
Connect exhaust pipe.

Motor the engine without firing (i.e. by operating stop control), until a steady flow of oil comes from the oil drain line.

Stop motoring and connect oil drain pipe connection.

Note: When the turbocharger is put into service, it is not advisable to run up to maximum speed or boost during the first 500 miles or 25 hours of running.

SECTION R
Alternator and Starter Motor



ALTERNATOR

Models AC5, 17ACR (derated), 17ACR, 18ACR, 25ACR or A133/65.

1. General

At the time of writing there are five types of alternator fitted to the T6.3544 and 6.3544 engine, namely the AC5, 17ACR, 18ACR, 25ACR and A133/65.

These are driven by the engine in the same manner as a DC Generator, namely, belt driven from the crankshaft pulley, but the advantage lies in their ability to provide higher maximum output at lower speeds, to cope with increased electrical load demanded by modern equipment and decreased road speeds owing to increased density of traffic, especially in built up areas. They are also much lighter in weight, output for output.

As opposed to the DC Generator in which the armature windings rotate inside a stationary field system, the alternator has a rotating field system inside a stationary generating winding. When the rotor rotates inside the stator, the output produced is alternating current (AC). This is unsuitable for charging the battery which requires direct current (DC), so it is rectified by means of diodes which convert it to uni-directional flow to the battery.

The alternator voltage output is maintained within close limits by means of a control box which is fully transistorised and functions as fast switches.

2. Precautions

As previously described the diodes in the alternator function as one-way valves and the transistors in the regulator/control box operate as fast switches. Both are accurate and sensitive.

They do not wear out and seldom require adjustment, but because they are sensitive to voltage changes and high temperature, the precautions are vital to prevent them from being destroyed.

(a) DO NOT disconnect the battery whilst the engine is running. This will cause a voltage surge in the alternator charging system that will immediately ruin the diodes or transistors.

(b) DO NOT disconnect a lead without first stopping the engine and turning all electrical switches to the off position.

(c) DO NOT cause a short circuit by connecting leads to incorrect terminals. Always identify a lead to its correct terminal. A short circuit or wrong connection giving reverse polarity will immediately and permanently ruin transistors or diodes.

(d) DO NOT connect a battery into the system without checking for correct polarity and voltage.

(e) DO NOT "flash" connections to check for current flow. No matter how brief the contact the transistors may be ruined.

3. Maintenance

The alternator charging system will normally require very little attention, but it should be kept free from build-up of dirt, and a check made if it fails to keep the battery charged.

(a) Regularly inspect the driving belts for wear and correct tension. It is important to ensure that all belts on a multiple belt drive have equal tension and are each carrying their share of the load. Slack belts will wear rapidly and cause slip which will not drive the alternator at the required speed. Drive belts which are too tight impose severe side thrust on the alternator bearings and shorten their life. Periodically ensure that the alternator is correctly aligned to the drive.

(b) Do not replace faulty belts individually in a multi-belt system. A complete matched set of drive belts must always be used.

(c) Keep the alternator clean with a cloth moistened in kerosene or cleaning fluids. Ensure that ventilation slots and air spaces are clear and unobstructed.

(d) Remove any dirt accumulated on the regulator/control box housing, and ensure that cooling air can pass freely over the casing.

4. Fault Finding on AC5

The AC5 alternator is so designed that a flow of current indicated either by the extinguishing of the warning light, or as shown on the ammeter, is sufficient evidence that the system is in proper working order. Therefore, no open circuit, voltage or current output checks should be performed on the installation UNLESS:

(a) The warning light fails to illuminate when the generator is stationary, and the switch is closed OR fails to become extinguished when the alternator is running.

(b) No charging current is shown on ammeter.

(c) The battery is flat.

(d) The battery is "boiling", indicating loss of voltage control.

If any of the above symptoms occur, the procedure indicated below should be followed:

(a) Connect a good quality moving coil voltmeter 0—50 volts range across the battery or regulator negative terminal, and one of the three positive terminals marked LO, MED, HI. If an ammeter is not part of the applications circuit, fit a good quality moving coil 0—100 amp ammeter in the alternator to battery positive line. **The battery should be in a charged condition.**

(b) Close the warning light switch (master electric switch on dashboard) when the warning lamp should light up.

(c) Switch on a 10—15 amperes load such as lights, fans, etc.

(d) Start engine and run at fast idle speed when
1. The warning light should go out.
2. The ammeter records a small charge dependent on engine speed.

(e) Increase engine speed momentarily to maximum speed, when the charging current should be about 30 amperes for 24 volts — 55 amperes for 12 volt systems.

(f) With the alternator running at approximately half speed (engine speed about 1,500 rev min), switch off electrical load. Depending on the connection selected for the positive sensing wire LO, MED, or HI, the voltage should rise to between 26 and 28 volts on 24 volt systems and 13—14 volts on 12 volt systems and then remain constant. At the same time the current reading should drop appreciably.

Any variance in the above data could indicate a fault and the following procedure should be adopted before disconnecting any components.

The regulator is a sealed unit and is non-repairable and if found to be faulty it must be replaced.

Warning Lamp does not light up when switched "On".

Check the bulb.

If no fault

Check all wiring connections at regulator, alternator and battery.

If no fault

Switch off, disconnect "F" lead at regulator and connect it to the negative terminal.

Switch on. If warning lamp lights up, the regulator is faulty. If lamp fails to light up the alternator is faulty.

Warning Lamp does not go out and Ammeter shows no output when running.

Check all regulator, alternator and battery connections.

If no fault.

Switch off, disconnect "F" lead at regulator and connect to regulator negative terminal.

Switch on, and run at fast idle.

If no output, alternator is faulty.

If output appears, regulator is faulty.

Warning Lamp does not go out when running and Ammeter shows reduced output with full output only at maximum speed or Warning Lamp goes out but Alternator delivers reduced output. Full output only at maximum speed.

Alternator faulty. Remove from installation and apply open circuit diode check.

Warning Lamp flashes intermittently and Ammeter needle oscillates when Battery is fully charged and no loads are switched in.

Check for excessive resistance in regulator negative sensing lead.

If no fault, regulator is faulty.

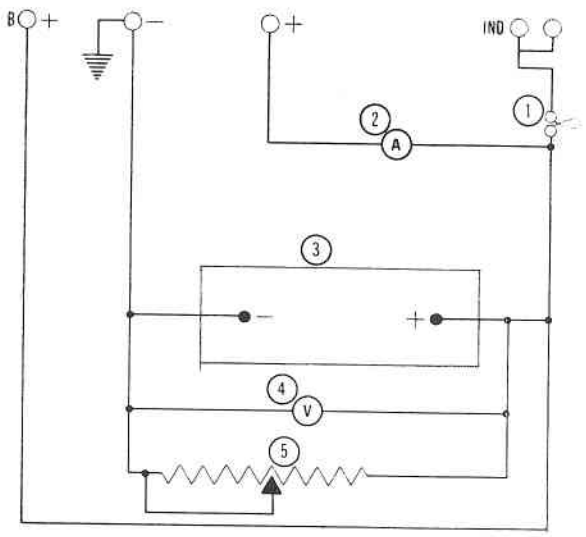
Batteries overcharging and Ammeter indicates high or full output all the time.

Check regulator positive sensing lead and its connection at regulator.

If no fault, regulator is faulty.

5. Testing the 17ACR, 18ACR, 25ACR and A133/65 in Position

First check the driving belt for condition and tension. The nominal hot outputs at 6,000 rev/min (alternator speed) are given on Page B12. These figures may be exceeded slightly when the alternator is running cold. To avoid misleading results, the following test procedure should therefore be carried out with the alternator running as near as possible to its normal operating temperature.



Test Circuit for 17ACR alternators.
Standard terminations, battery-sensed.

R.1

Alternator Output Test with Regulator Inoperative

Withdraw the cable connector(s) from the alternator, remove the moulded cover (secured by two screws) and earth the regulator green lead or connector strip to frame.

Connect an external test circuit to the alternator output terminals as shown in Fig. R.1, R.2 or R.3.

Value of components in Figs. R.1, R.2 and R.3 are as follows:

1. 12 volt 2.2 watt bulb.
2. 0—60 ammeter
3. 12 volt battery
4. 0—20 moving coil voltmeter
5. 0—15 ohm 35 amp variable resistor.

Observe carefully the polarity of battery and alternator terminals — reversed connections will damage the alternator diodes.

The variable resistor across the battery terminals must not be left connected for longer than is necessary to carry out the following test.

Start the engine. At 1,500 rev/min (alternator speed), the test circuit bulb should be extinguished. Increase engine speed until the alternator is running at 6,000 rev/min approximately, and adjust the variable resistance until the voltmeter reads 13.6 volts. The ammeter reading should then be approximately equal to the rated output (see previous heading). Any appreciable deviation from this figure will necessitate the alternator being removed from the engine for further examination.

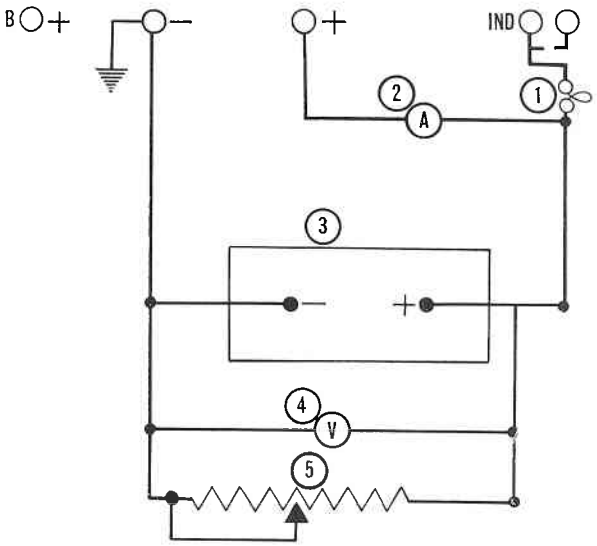
Failure of one or more of the diodes will be indicated in the above test by effect on alternator output, and also in some instances by abnormally high alternator temperature and noise level.

Regulator Test

The following test assumes the alternator to have been tested and found satisfactory.

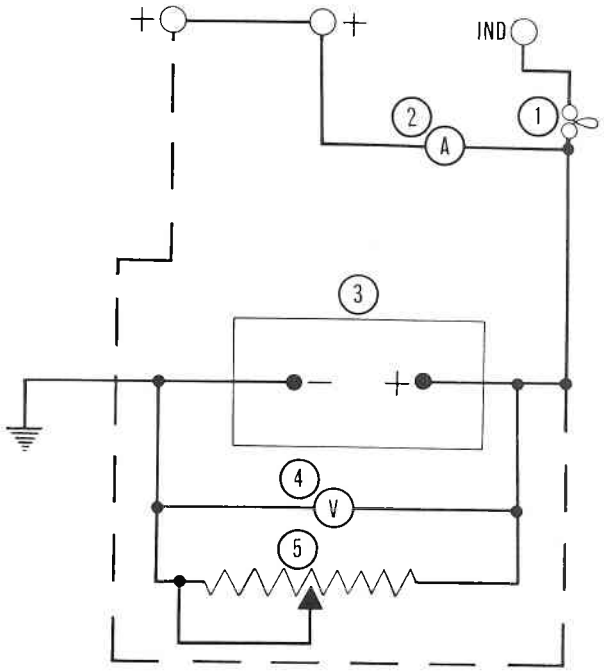
Disconnect the variable resistor and remove the earth connection from the regulator green lead or connector strip to frame.

With the remainder of the test circuit connected as for the alternator output test, start the engine and again run the alternator up to 6,000 rev/min until the ammeter shows an output current of less than 10 amperes. The voltmeter should then give a reading of 13,6 — 14,4 volts. Any appreciable deviation from this (regulating) voltage means that the regulator is not functioning properly and must be replaced.



Test Circuit for 17ACR alternators with standard terminals and two piece connection plug (machine-sensed).

R.2



Test Circuit for 17ACR, 18ACR, 25ACR and A133/65 alternators with European terminations and single 3 terminal connector plug (machine-sensed). Broken line cable connection applies to battery-sensed, in which case, the connections between the two '+' terminals will not apply and the broken line terminal will be marked "S" instead of "+".

R.3

If the foregoing tests show the alternator and regulator to be satisfactorily performing, disconnect the test circuit and reconnect the alternator terminal connector. Now connect a low range voltmeter between the positive terminal of the alternator (the moulded terminal connector is open ended to facilitate this) and the positive terminal of the battery. Switch on battery load (headlights etc.), start the engine and increase speed until the alternator runs at approximately 6,000 rev/min. Note the voltmeter reading.

Transfer the voltmeter connections to the negative terminals of the alternator and battery and again note the meter reading.

If the reading exceeds 0.5 volt on the positive side or 0.25 volt on the negative side, there is a high resistance in the charging circuit which must be traced and remedied.

STARTER MOTOR
Model M50

General Description

The model M50 starter motor is a four pole machine of 5in (127,0mm) nominal yoke diameter, and has a 21 slot armature.

The drive is of pre-engaged, solenoid operated, push screw type, incorporating a five roller clutch.

The function of the clutch is to prevent the armature being rotated at high speeds in the event of the engaged position being held after the engine has started. The solenoid incorporates a two-stage switching arrangement which ensures that the motor develops its maximum torque only when full pinion-flywheel engagement has been achieved.

Testing on the Application

Ensure that the battery is in a charged condition.

Switch on the lamps and operate the starter button. If the starter fails to function, but the lights maintain full brilliance, check the switch and battery connections to the starter and all external leads. Sluggish action of the starter can be caused by a poor or faulty connection.

Difficulty in smooth engagement between starter and engine flywheel is probably due to dirt on the starter-shaft helices preventing free pinion movement. The shaft should be thoroughly cleaned with cleaning fluid followed by the application of a small quantity of Acro Shell 6B or its equivalent.

MAINTENANCE

Brush Gear and Commutator

Inspect the brushes at intervals to ensure that they are free in their guides and that the leads are quite free for movement, by easing back the brush springs and pulling gently on the flexible connections. If a brush is inclined to stick, remove it from its holder and clean the sides with a petrol moistened cloth.

Be sure to refit the brushes in their original positions to retain the "bedding". The brushes should be well

bedded (i.e. worn to the commutator periphery) but if not, wrap a strip of very fine glass or carborundum paper firmly around the commutator with the abrasive side outwards. With the brushes in position, rotate the armature by hand in the normal working direction of rotation; until the correct brush shape is obtained. If the brushes are worn down so that the springs are no longer providing effective pressure, they should be renewed. Check the brush spring pressure by hooking a spring balance under the spring lip. The correct tension is 30/40ozf (0,85/1,13kgf).

It is essential that replacement brushes are the same grade as those originally fitted. Genuine spares should always be used. To remove the brushes, unscrew the four fixing screws, one to each brush. In re-assembling care must be taken to reconnect the field coil and inter-connector leads, held by two of the fixing screws. Before inserting brushes in their holders, it is advisable to blow through the holders with compressed air or clean them with a cloth moistened with petrol.

The commutator should be clean, entirely free from oil or dirt. Any trace of such should be removed by pressing a clean dry fluffless cloth against it, while armature is hand rotated.

If the commutator is dirty or discoloured, tilt the brushes and wrap a strip of fine glass or carborundum paper (not emery cloth) round the commutator, with the abrasive side inwards. Rotate the armature by hand until the surface is even. Clean with a petrol moistened cloth.

If repair is necessary to the commutator or switch gear etc., the starter must be exchanged or repaired by an authorised agent.

Model CA45

General Description

Designed for flange mounting, the CA45 starter motor has a uniform cylindrical shape with no surface protrusions. This is because the solenoid and main switch assemblies are housed within the drive end-shield, around (i.e., co-axially with) the armature shaft.

The essential feature of the co-axial starter is that, **the Pinion alone** moves axially to engage the engine flywheel. There is no longitudinal movement of the whole armature assembly, as in the axial types.

Smooth engagement of the pinion with the engine flywheel is constantly ensured by using two-stage operation of the solenoid and switch mechanisms. Thus the risk of damage to both pinion and flywheel, through faulty meshing, is practically eliminated.

In construction, the starter consists of three main sections, into which it can be easily dismantled.

1. The solenoid switch-gear and pinion assembly housed in the drive end-shield.
2. The armature, shaft and commutator assembly.
3. The yoke, pole-piece and field-coil assembly.

Ready access is possible therefore, to those parts most likely to require adjustment, such as the switchgear and commutator assemblies.

Testing on the Application

Ensure that the battery is in a charged condition.

Switch on the lamps and operate the starter button. If the starter fails to function, but the lights maintain full brilliance, check the switch and battery connections to the starter and all external leads. Sluggish action of the starter can be caused by a poor or faulty connection.

Difficulty in smooth engagement between starter and engine flywheel is probably due to dirt on the starter-shaft helices preventing free pinion movement. The shaft should be thoroughly cleaned with cleaning fluid followed by the application of a small quantity of Acro Shell 6B or its equivalent.

MAINTENANCE

Brush Gear and Commutator

Inspect the brushes at intervals to ensure that they are free in their guides and that the leads are quite free for movement, by easing back the brush springs and pulling gently on the flexible connections. If a brush is inclined to stick, remove it from its holder and clean the sides with a petrol moistened cloth.

Be sure to refit the brushes in their original positions to retain the "bedding". The brushes should be well bedded (i.e. worn to the commutator periphery) but if not, wrap a strip of very fine glass or carborundum paper firmly around the commutator with the abrasive side outwards. With the brushes in position, rotate the armature by hand in the normal working direction of rotation; until the correct brush shape is obtained. If the brushes are worn down so that the springs are no longer providing effective pressure, they should be renewed. Check the brush spring pressure by hooking a spring balance under the spring lip. The correct tension is 30/40ozf (0,85/1,13kgf).

It is essential that replacement brushes are the same grade as those originally fitted. Genuine spares should always be used. To remove the brushes, unscrew the four fixing screws, one to each brush. In re-assembling care must be taken to re-connect the field coil and inter-connector leads, held by two of the fixing screws. Before inserting brushes in their holders, it is advisable to blow through the holders with compressed air or clean them with a cloth moistened with petrol.

The commutator should be clean, entirely free from oil or dirt. Any trace of such should be removed by pressing a clean dry **fluffless cloth** against it, while armature is hand rotated.

If the commutator is dirty or discoloured, tilt the brushes and wrap a strip of fine glass or carborundum paper (not emery cloth) round the commutator, with the abrasive side inwards. Rotate the armature by hand until the surface is even. Clean with a petrol moistened cloth.

If repair is necessary to the commutator or switch gear etc. the starter must be exchanged or repaired by an authorised agent.

SECTION S
Compressor

The air compressor is a single or twin cylinder water cooled unit which is bracket mounted on the cylinder block and driven from the auxiliary drive.

Should it be necessary to drain the engine cooling system to prevent damage by frost, the Clayton Dewandre compressor must also be drained. Drain plugs are provided on the compressor cylinder block. With the Bendix Westinghouse compressor, only the cylinder head is water cooled and this will be automatically emptied when the engine is drained.

If leakage in the braking system is not excessive, failure of the compressor to maintain adequate air in the system, or to charge the system in a reasonable time, usually denotes loss of efficiency due to wear. This wear could be in the cylinder head (valves and seats) or cylinders (piston assemblies). Another sign of wear is excessive oil passing through to the reservoir.

Preventive Maintenance

Every 5,000 miles (7,500 km), 250 hours or 4 months (whichever occurs first).

Remove, dismantle and clean compressor air cleaner (if fitted).

Every 10,000 miles (15,000 km), 500 hours or 12 months (whichever occurs first).

Visually check all unions, pipe fittings, etc., for looseness or leakage.

Check cylinder head bolts for correct tightness.

Check end covers for oil leaks.

Check that compressor mounting is secure.

Every 20,000 miles (30,000 km) or 1,000 hours
Uncouple delivery port and check the head passages for excessive carbon deposits which, if present, must be removed by dismantling the cylinder head.

Check compressor delivery line for carbon deposits, clean or replace line as necessary.

Every 60,000 miles (90,000 km) or 2,500 hours
Dismantle compressor, thoroughly clean all parts and inspect for wear or damage. Repair or replace all worn or damaged parts or replace with Factory Reconditioned Unit.

To Remove the Compressor

Drain the engine cooling system and compressor of coolant.

Remove hydraulic pump which may be fitted to rear of compressor.

Remove steadying bracket between compressor cylinder head and engine cylinder head.

Remove all connections to and from compressor.

Unscrew compressor mounting bolts and remove compressor from engine.

To Replace Compressor

The replacement of the compressor is a reversal to removal.

When the compressor is fitted, check that the clearance between the rubber insert and the forward half-coupling is 0.020/0.025in (0,51/0,63mm).

Should the clearance be incorrect, the half-coupling can be moved on the shaft to obtain the correct clearance.

CLAYTON DEWANDRE SC6 COMPRESSOR

Dismantling

Marking before dismantling
The compressor should have the following items marked to show the correct relationship to dismantling.

1. Position of cylinder head in relation to cylinder and crankcase.
2. Position of end-cover(s) in relation to crankcase.
3. Position of crankshaft in relation to crankcase.

Removing and Dismantling Cylinder Head and Cylinder

Remove the unloader cap and copper washer and withdraw the unloader plunger assembly and spring.

Remove the delivery valve cap and copper washer, and remove delivery valve spring and seat retaining spring.

Unscrew the four nuts and washers from cylinder head studs and lift off cylinder head. Remove the joint.

Remove the delivery valve and screw out the valve seat.

Withdraw inlet valve spring guide. (A simple extractor can be made from two ¼in UNF bolts and a strip of metal formed to bridge the guide.) Remove the inlet valve spring, inlet valve and valve seat.

Withdraw cylinder and remove the joint.

Removing and Dismantling Piston and Connecting Rod Assemblies

Remove the compressor mounting bracket and joint.

Turn the crankshaft to B.D.C. position and release the tabs of the locking strap. Unscrew the two bolts and remove the connecting rod cap. Withdraw piston assembly and replace connecting rod cap.

Remove the piston rings from the piston. If the piston is to be detached from the connecting rod, release one gudgeon pin retaining circlip and press the gudgeon pin from the piston and connecting rod.

Removing Crankshaft

Remove drive key from crankshaft.

Unscrew the four setscrews or nuts together with washers securing the rear end-cover to crankcase. Withdraw the end-cover, plain bearing, thrust washer (where fitted) and joint.

Unscrew the four setscrews or nuts securing the drive end-cover, and withdraw the end-cover complete with crankshaft and joint. Tap crankshaft with bearing from drive end-cover.

Cleaning

Ensure that all carbon is removed from the cylinder head. Check that the air passages in the head and the oilways in the crankcase, where applicable, rear end-cover and crankshaft are clear and clean.

Clean inlet and discharge valves, not damaged or worn excessively, by lapping them on a sheet of crocus cloth held on a flat surface.

Inspection of Parts

Cylinder

Check cylinder bore for excessive wear, out-of-round or scoring. If scored or out-of-round more than 0.002in (0,05mm) or tapered more than 0.003in (0,08mm) cylinder should be rebored. The original cylinder bore is to the limits 2.6255/2.620in (66,69/66,71mm) and the clearance for the piston is 0.002/0.003in (0,05/0,08mm). Check for wear in cylinder bore and rectify in accordance with following table:

Wear in bore	Remedy
+0.005in (0,13mm)	Fit new standard rings.
+0.005/0.010in (0,13/0,25mm)	Bore out to +0.010in (0,25mm) and fit 0.010in (0,25mm) oversize piston rings.
+0.015in (0,38mm)	Fit new 0.010in (0,25mm) oversize rings.
+0.015/0.020in (0,38/0,51mm)	Bore out to +0.20in (0,51mm) and fit 0.020in (0,51mm) oversize piston and rings.
+0.025in (0,63mm)	Fit new 0.020in (0,51mm) oversize rings.

Piston and Connecting Rod

Inspect piston for scores, cracks or damage of any kind. Check fit of rings in ring grooves, clearance should be 0.0005/0.0025in (0,01/0,06mm). Install rings in cylinder and check that gaps are 0.003/0.007in (0,08/0,18mm). Check fit of gudgeon pin in piston and connecting rod. Gudgeon pin should be a light press fit in piston and clearance in the connecting rod bush should not exceed 0.0015in (0,04mm).

Inspect connecting rod bearing for correct fit on crankshaft journal. Clearance between rod journal and bearing must not be less than 0.001in (0,02mm) and not more than 0.003in (0,08mm). Check connecting rod for cracks or damage.

Crankshaft and Bearings

Examine ball bearings for discoloration, pitting wear and cracked races. Rotate slowly to check for roughness. Defective bearings should be removed, using a well-fitting extracting tool. Press new bearing on to crankshaft, using a suitable length of tube, until it contacts shoulder.

Inspect crankshaft for wear and check threads, shaft ends, keyways and drive keys for damage. The crank pin diameter should be within the limits 0.874/0.8735in (22,20/22,19mm).

Crankshaft and End-covers

Inspect oil seal carefully, ensuring that sealing edge is intact and sharp. If an oil leak has been observed at the crankshaft end, a new seal must be fitted. Lip of seal should face inwards.

Examine crankcase, end-cover and mounting bracket for damage and cracks. Check bearing bores for wear. The ball race should be a light press fit in end-cover and the crankshaft should be a neat sliding fit in the plain bearing. Inspect crankshaft thrust washer for wear (where fitted).

Cylinder Head

Inspect cylinder head for cracks and unloader plunger guide bush for wear. Check that unloader plunger is a neat sliding fit in the guide. If it is necessary to replace the unloader piston guide, this will be found to have an undersized bore, and will require reaming in situ to 0.3745/0.3755 in (9,51/9,54mm). Ensure that the bore is machined square to the underside of the cylinder head. The maximum finish of the guide bore should be 25 micro inches (0,6microns). A chamfer is also required at the top of the guide bore to an angle of 15° and to a depth of 0.102in (2,59mm). Make sure that the guide and chamfer angle are free from burrs. Examine unloader plunger seal ring for wear. Inspect inlet and delivery valves and seats. If valves are grooved deeper than 0.003in (0,08mm) where they contact the seat, they should be replaced. If not badly grooved they can be refaced by lapping on crocus cloth. Valve seats, if showing slight scratches, may be reclaimed by lapping with fine grinding paste. If badly pitted or scratched, use a seating reamer before lapping.

Renew delivery valve spring and check remaining springs for corrosion, fatigue or permanent set.

Re-assembly

Lubricate all internal parts with clean engine oil to prevent possible damage until the oil supply is functioning.

Install the crankshaft, complete with bearing, into the drive end-cover. Insert the crankshaft into the crankcase and secure the drive end-cover, ensuring that the joint is correctly positioned over the oil drain ports.

Position the thrust washer in the rear end-cover with the steel face towards the plain bearing and the tab located in the slot. Assemble the rear end-cover with joint and secure. Check the crankshaft to ensure free rotation and then tighten end-cover nuts or bolts. Fit the drive key to the crankshaft.

Refit the piston rings, ensuring that sides marked "Top" are uppermost, and assemble the piston to the connecting rod. Assemble the connecting rod on the crankshaft, tighten the bolts to a torque of 4lbfft (0,55kgfm) or 5,4Nm, and turn up the tabs of the locking strap. Space the piston ring gaps and assemble the cylinder, with joint, over the piston.

Assemble the cylinder head. Lightly smear the outside diameters of the inlet valve seat and spring guide with "Loctite", or equivalent, sealing compound. Insert the inlet valve seat, inlet valve and valve spring and press the spring guide into position. Screw in the delivery valve seat, using a wrench inserted in the hexagonal hole through the centre of the fitting, and tighten securely. Place the delivery valve on the seat and position the springs. Screw in the valve cap together with the copper washer. Lightly smear the unloader plunger with "Dow-Corning" grease, and insert the spring and plunger complete with the spring circlip. Screw in the unloader cap together with copper washer.

Place the joint on the cylinder and correctly position the cylinder head on the studs. Tighten nuts progressively to a torque of 10lbfft (1,38kgfm) or 13,6Nm.

Invert the compressor and apply clean engine oil over the crankshaft and on the cylinder wall. Assemble the mounting bracket and joint.

BENDIX WESTINGHOUSE TWIN 9 COMPRESSOR

To Dismantle Compressor

Remove filter assembly, filter element and adaptor plate.

Remove top cover and cylinder head/valve plate assembly.

Remove valve plate from cylinder head. Mark valves, springs and valve cages to identify position.

Remove mounting bracket and gasket.

Mark connecting rods and caps to identify position.

Release big end securing bolts and remove piston/connecting rod assembly. (Note it is important to release big end bolts before the bolts securing the end cover).

Remove gudgeon pins to release pistons from connecting rods.

Remove piston rings.

Remove end cover.

Remove plastic cover from non-drive end of compressor (if fitted).

Remove crankshaft with thrust washer.

Remove all seals, "O" rings and gaskets.

Reconditioning

All gaskets, seals and "O" rings should be renewed.

The cylinder head and associated parts, and the pistons should be cleaned of any carbon present. The valve discs, springs and valve guides should be renewed. The valve seats may be lapped with a fine grinding paste, but if there is any appreciable wear, the valve plate should be renewed.

The unloading pistons must be a neat sliding fit in the guide bushes. If wear is apparent, renew the pistons or bushes as necessary.

The maximum permissible worn diameter of the cylinder bores is 2.257in (57,33mm).

The clearance of the compression rings in the piston grooves is 0.0005/0.002in (0,012/0,051mm) and that of the scraper rings is 0.0005/0.0025in (0,012/0,063mm). The gap of the compression and scraper rings in the cylinder is 0.003/0.007in (0,08/0,18mm).

If the piston rings are being refitted and are bedded for more than the 30% of the width or if new rings are being fitted, the glaze on the cylinder bores must be broken.

The clearance of the crankshaft in the main bearings should not exceed 0.0035in (0,09mm), whilst the clearance of the crankpins in the big end bearings should not exceed 0.003in (0,08mm).

The end float of the crankshaft is 0.004/0.012in (0,10/0,30mm).

The gudgeon pin should be a light press fit in the piston and the clearance of the pin in the small end of the connecting rod should not exceed 0.0015in (0,038mm). Renew gudgeon pin circlips if necessary.

To Re-assemble Compressor

Clean all parts, remove all jointing compound and gaskets. Ensure that all oilways and water passages are clean and free from obstruction. Lightly oil all bearing surfaces, journals and thrust washer faces.

Fit oil seals to crankcase and end cover.

Fit crankshaft to crankcase ensuring that oil seal is not damaged by the edges of the slot in the crankshaft.

Fit thrust washer to crankshaft.

Coat joint face of end cover with sealing compound and fit end cover to crankcase securing with setscrews and spring washers.

Tighten setscrews to 9lbfft (1,24kgfm) or 12,2Nm.

Ensure that end float of crankshaft is correct.

Fit connecting rod to piston. Fit gudgeon pin and secure with circlip.

Fit piston rings to piston, ensuring that the ring gaps are equally spaced around the piston. The two compression rings on each piston must be fitted with the internal steps or chamfers towards the piston crown. Rings are usually marked with the word "top" or "bottom" on the appropriate face to aid correct fitting.

Lubricate piston rings and cylinder bores thoroughly with clean engine oil before fitting pistons in cylinders.

Fit piston/connecting rod assemblies in crankcase, ensuring that they are fitted with the tooling hole in the connecting rod facing inwards towards the centre line of the compressor.

Fit big end caps and secure with bolts and tabwashers. Tighten bolts to 9lbfft (1,24kgfm) or 12,2Nm and lock tabwashers.

Ensure compressor has free rotation.

Fit "O" rings to unloader pistons, lubricating assemblies with Silicone Fluid MS200. Fit unloader piston assemblies to crankshaft. Fit spring and saddle. Ensure that unloader pistons have free movement.

Fit inlet and exhaust valves, springs and valve guides to cylinder head. Fit valve plate to cylinder head with gasket and secure with countersunk screw. Tighten screw to 50lbfin (0,57kgfm) or 5,6Nm.

Ensure valves have free movement after assembly.

Fit cylinder head/valve plate assembly with gasket to crankcase. Fit cover with gasket to cylinder head. Secure with nuts and spring washers where studs are fitted and with bolts and spring washers at tapped hole

positions. Tighten nuts and bolts to 17lbfft (2,35kgfm) or 23Nm progressively.

Fit mounting bracket with gasket to base of compressor with bolts and spring washers. Tighten bolts to 17lbfft (2,35kgfm) or 23Nm progressively.

Where required, fit plastic cover to non drive end of compressor and crankshaft.

Coat joint face of filter adaptor with sealing compound and fit plate to crankcase. Secure with countersunk screws tightened to 50lbfin (0,58kgfm) or 5,6Nm.

Fit new filter element to filter body. Fit retaining plate and retain with bolts and spring washers.

Fit filter assembly to adaptor plate and secure with nuts and spring washers tightening to a torque of 9lbft (0,124kgfm) or 12,2Nm.

Fit key to drive end of crankshaft.

Finally protect all ports to prevent ingress of foreign matter.

Data and Dimensions for Bendix Westinghouse Twin 9 Compressor

Cylinder bore diameter	2.250/2.251 in (57,15/57,18 mm)
Max. permissible worn bore diameter	2.257 in (57,33 mm)
Clearance of piston skirt in bore	0.0023/0.0043 in (0,06/0,11 mm)
Clearance of compression rings in piston grooves	0.0005/0.002 in (0,012/0,051 mm)
Clearance of scraper rings in piston grooves	0.0005/0.0025 in (0,012/0,063 mm)
Compression ring gap in cylinder	0.003/0.007 in (0,08/0,18 mm)
Scraper ring gap in cylinder	0.003/0.007 in (0,08/0,18 mm)
Crankpin diameter	1.2495/1.250 in (31,74/31,75 mm)
Big end running clearance	0.005/0.0015 in (0,012/0,038 mm)
Max. permissible worn big end bearing running clearance	0.003 in (0,076 mm)
Main journal diameter	1.2482/1.2491 in (31,70/31,73 mm)
Main bearing running clearance	0.0009/0.0028 in (0,02/0,07 mm)
Max. permissible worn main bearing running clearance	0.0035 in (0,09 mm)
Crankshaft end float	0.004/0.012 in (0,10/0,30 mm)
Max. permissible end float on worn compressor	0.017 in (0,43 mm)

Recommended Torques

Cylinder head bolts/nuts	17 lbf ft (2,35 kgf m) or 23 Nm
End cover bolts	9 lbf ft (1,24 kgf m) or 12,2 Nm
Mounting bracket bolts	17 lbf ft (2,35 kgf m) or 23 Nm
Strainer mounting nuts	9lbfft (1,24kgfm) or 12,2Nm
Strainer adaptor screws	50lbfin (0,58kgfm) or 5,6Nm
Big End Bolts	9lbfft (1,24kgfm) or 12,2Nm

Drive Coupling (Holset)

With the compressor fitted to the engine and the coupling assembly in place on the auxiliary drive shaft the distance between the two halves of the coupling (see Fig. S.1 dim. C) must be adjusted to the value given in the table below. When fitting the coupling, ensure that the scribed lines on the outside of the flanges are in line.

Coupling diameter	Dimension C	Diff. between C1 and C2
3.875in (98,4mm)	0.146/0.250in (3,71/6,35mm)	0.068in (1,71mm)
3.00in (76,2mm)	0.125/0.187in (3,18/4,75mm)	0.052in (1,32mm)

The parallel alignment can be checked with a straight edge and feeler gauge to dimension B as shown in Fig. S.1.

To check the angular alignment find the difference between C1 and C2 as shown in Fig. S.1. If this difference is the same as or less than the dimension given in the chart above any angular misalignment will be 1° or less which is satisfactory.

On later engines the coupling setscrews and separate tab washers have been replaced by washer-faced setscrews only. These setscrews should be tightened to 18lbfft (24,4Nm), 2,5kgfm.

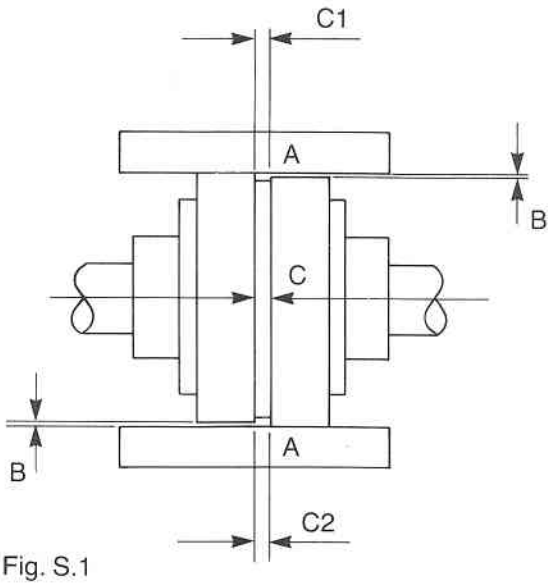


Fig. S.1

A. Straight edge
B. Max. 0.006in (0,15mm)
C. Gap between coupling halves
C1. Max. gap
C.2 Min. gap

SECTION T
Exhausters

DESCRIPTION

The A.350 type exhauster is a rotary sliding vane pump, with an eccentrically mounted rotor.

The unit is bolted directly against the side of the engine crankcase and is driven through a flexible coupling, by a shaft which is connected to the timing gears and also drives the fuel pump. The exhauster body and end covers are of cast iron, and house an aluminium rotor die-cast on to a steel shaft. The rotor has four equi-spaced slots to accommodate fibre blades. The shaft runs in sintered bronze plain bearings fitted in the end cover, which, if bored straight through, also contain seals to prevent the ingress of air and dirt and the leakage of oil from the exhauster. The drive end of the shaft is machined to accept a Woodruff key, thus ensuring non-slip drive. The intake port in the exhauster is pipe-connected to the vacuum reservoir, and the outlet port formed in the base of the exhauster aligns with an aperture in the engine crankcase.

Lubrication is by engine pressure feed, oil entering through a connection in the rear end cover to an annular groove in the bearing housing, from which it passes through a hole in the bearing to oilways in the rotor shaft, communicating with the slots in the rotor. The plain bearing fitted in the drive end cover receives oil through an extension of the main oil way in the rotor shaft, a passage in the drive end cover to the vacuum side of the pump relieving oil pressure on the seal.

OPERATION

At all speeds the rotor blades are kept in contact with the bore of the body by centrifugal force, assisted by the hydraulic action of the oil beneath the blades. When the rotor turns, the spaces between the blades vary, because of the eccentric mounting of the rotor in the exhauster body. As a blade passes the inlet port the space between it and the following blade increases and air is drawn from the vacuum reservoir. This air is then compressed and expelled with the lubricating oil through the outlet port to the engine crankcase.

SERVICING EXHAUSTER

Periodic Inspection and Preventive Maintenance

Weekly or every 5,000 miles

Examine the vacuum lines and fittings. Vacuum leakage may occur through the line or reservoir mounted non-return valve, if the valve seat is dirty or pitted. Should leakage occur, the exhauster will pressurise the engine crankcase, resulting in oil leakage at the crankshaft seals and other joints. Examine the exhauster for evidence of oil leakage, particularly at the end cover joints and at the shaft oil level. Check the oil supply line for leaks at fittings and connections.

Every 10,000 miles

Check the mounting setscrews and end cover retaining screws for tightness.

Every 60,000 miles

Remove and dismantle the exhauster, thoroughly clean all parts and inspect them for wear and damage. If the exhauster is well worn it will be advisable to return it to Perkins Engines Ltd., in exchange for a factory reconditioned unit.

To Remove the Exhauster

Disconnect the oil vacuum pipes at the exhauster and plug the open unions to prevent the entry of foreign matter. Release the driving coupling from the end of the rotor shaft. Unscrew the setscrews which secure the exhauster to the crankcase, and remove the unit from the engine.

Dismantling

Mark the end covers in relation to the body to ensure correct location on re-assembly. Unscrew the four socket-headed screws and remove the rear end cover with the rubber sealing ring. Mark the blades in relation to the rotor and withdraw the rotor complete with blades from the body. Unscrew the four socket-headed screws and remove the drive end cover with its rubber sealing ring.

CLEANING AND INSPECTION

Cleaning

Wash all the components in cleaning solvent and clear the rotor and drive end cover oil ways with compressed air.

Inspection of Parts

Examine the bushes for excessive wear. To renew them see "Overhaul" section. Inspect the rotor and shaft for cracks and damage, check the fit of the fibre blades in the rotor slots and replace any worn or damaged blades. Examine the seals carefully to see that the sealing edges are pliable, intact and sharp. Seals rendered ineffective (usually by dirty oil and grit) should be renewed as prescribed in the section headed "Overhaul". Examine the body for cracks and damage and the bore for longitudinal

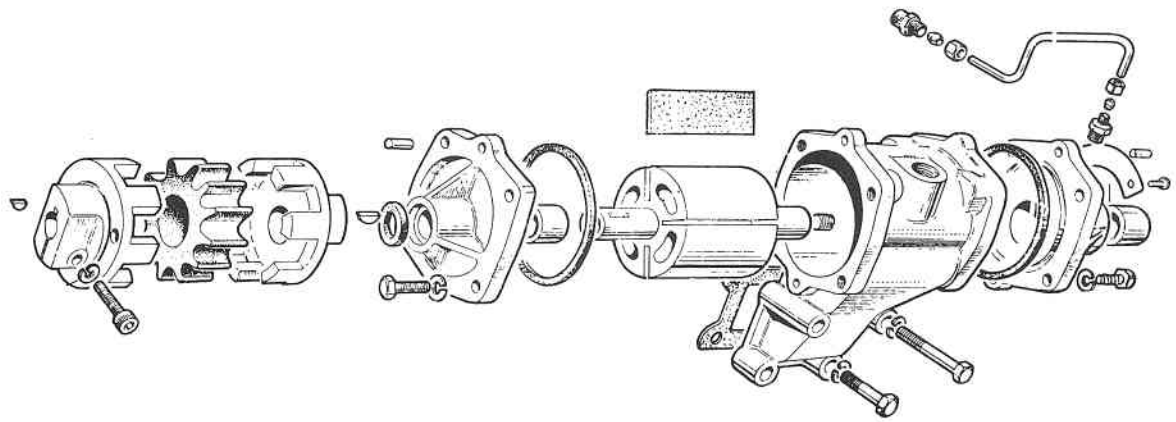


Fig. T.1. Exploded view of an Exhauster.

ripples or lines. If these are only slight the body is still serviceable, if excessive the body should be renewed. Examine the end covers, and renew them if they are cracked or scored.

OVERHAUL

To renew End Cover Bearings and Seals

Drive End Cover

Extract the seal from the drive end cover and press in the new one until the steel seal holder abuts against the shoulder in the cover. With the seal removed, press the worn plain bearing out of the cover using a bar or tube 1 1/16 in diameter. Press the new bearing into the cover until it is 1/8 in below the cover face.

Rear End Cover

Blank end covers are not fitted with seals. The bearing should be extracted or machined out taking care not to damage the housing, or in an emergency it may be removed by cutting a groove along the bearing, using a narrow half round chisel. Inspect the housing, remove any burrs and press the new bush fully into the cover. Where the rear end has been bored straight through and blanked off, the circlip should be removed followed by the blanking disc and 'O' ring, which acts as a seal. The bush may then be pressed out of the cover, using a bar or tube, 1 1/16 in diameter. When replacing these components it is advisable to fit the circlip in its groove and then refit the blanking disc followed by a new 'O' ring. The new bush should be pressed into the cover until it slightly compresses the 'O' ring against the blanking disc, the resulting reduction in internal diameter of the 'O' ring ensuring an effective seal on the shaft. The large rubber 'O' rings which seal the gaps between the exhauster body and the end covers, should be renewed if they appear to be in any way compressed or damaged.

Re-assembly

Lubricate all moving parts with clean engine oil.

Carefully insert the shaft into the drive end cover, avoiding damage to the seal.

With the large rubber 'O' ring fitted in its groove in the cover, assemble the latter to the body, locating the dowels in their respective holes.

Hold the body, drive end downwards, and replace the blades in the rotor slots, making sure that the marks made during dismantling correspond.

Install the rear end cover with its rubber 'O' ring on to the body (ensuring that the dowels locate in their respective holes) and tighten the socket-headed screws.

Turn the rotor by hand to make sure that it revolves freely.

Installation

Replace the joint and remount the exhauster securely to the engine crankcase, with the coupling halves fitted loosely on the shafts.

Where there are scribed lines on the outside of the coupling flanges, these must be in line.

Ensure that there is approximately 1/8 in (3mm) between auxiliary shaft oil seal and front half coupling.

Where Simms couplings are fitted (Fig. T.2), ensure that there is a nominal clearance of 3/64 in (1,2mm) between the rubber coupling and each half coupling. Where Holset couplings are fitted, check the parallel and angular alignment with a straight edge and feeler gauges as shown in Fig. T.3.

When the alignment is correct tighten the coupling setscrews and in the case of earlier Holset couplings lock the setscrews with the tab washers. Later Holset couplings have washer faced setscrews without tabwashers and these setscrews must be tightened to 18 lbf ft (24 Nm) 2,5 kgf m.

Reconnect the oil feed and vacuum pipes.

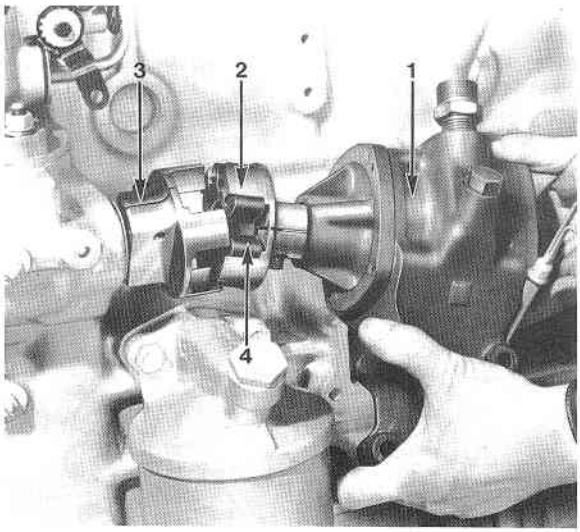


Fig. T.2. Removing Exhauster.

1. Exhauster.
2. Exhauster Coupling (Driven Half).
3. Exhauster Coupling (Drive Half).
4. Rubber Coupling.

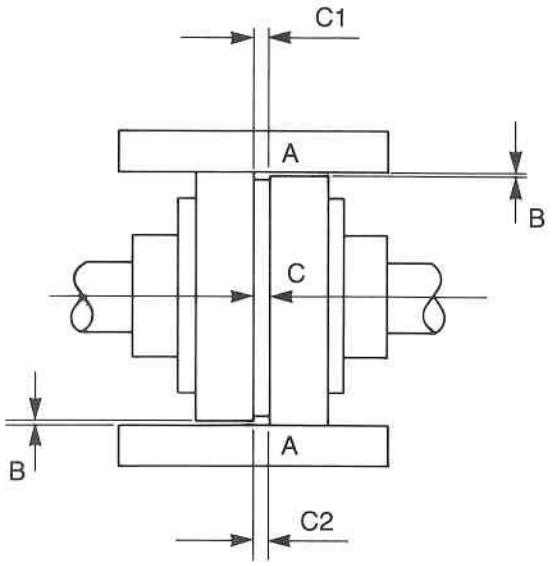


Fig. T.3

A.	Straight edge	C1. Max. gap
B.	Max. 0.006 in (0,15 mm)	C.2 Min. gap
C.	Gap 0.125/0.187 in (3,18/4,75 mm)	Max. difference C1-C2, 0.052 in (1,32 mm)

LUBRICATING OILS

Lubricating oils for naturally aspirated engines should meet the requirements of the U.S. Ordnance Specification MIL-L-46152 or MIL-L-2104C. Lubricating oils for turbocharged engines and engines installed in Heavy Duty Earthmoving Equipment should meet the U.S. Ordnance Specification MIL-L-2104C.

Some of these oils are listed below and next page. Any other oils which meet these specifications are also suitable.

MIL-L-46152 OILS

Company	Brand	S.A.E. Designation		
		0°F (–18°C) to 30°F (–1°C)	30°F (–1°C) to 80°F (27°C)	Over 80°F (27°C)
B.P. Ltd.	Vanellus M	10W	20W	30
	Vanellus M		20W/50	20W/50
Castrol Ltd.	Castrol/Deusol CRX	10W	20	30
	Castrol/Deusol CRX	10W/30	10W/30	10W/30
	Castrol/Deusol CRX		20W/50	20W/50
	Deusol RX Super		20W/40	20W/40
A. Duckham & Co. Ltd.	Fleetol HDX	10	20	30
	Q Motor Oil		20W/50	20W/50
	Fleetol Multi V		20W/50	20W/50
	Fleetol Multilite	10W/30	10W/30	10W/30
	Farmadcol HDX		20	30
Esso Petroleum Co. Ltd.	Essolube XD-3	10W	20W	30
	Essolube XD-3		15W/40	15W/40
Mobil Oil Co. Ltd.	Delvac 1200 Series	1210	1220	1230
	Delvac Special	10W/30	10W/30	10W/30
Shell	Rotella TX	10W	20W/20	30
	Rotella TX		20W/40	20W/40
	Rimula X	10W	20W/20	30
	Rimula X	10W/30	10W/30	10W/30
	Rimula X		15W/40	15W/40
	Rimula X		20W/40	20W/40
Total Oil Co. Ltd.	Total Super HD		20W/20	30
	Total HD2-M	10W/30	20W/40	20W/50
	Total HD3-C (Rubia S)	10W	20W/20	30
	Total HD3-C (Rubia TM)		15W/40	15W/40
	Total Universal Tractor Oil (Multagri)		20W/30	20W/30
	Total Super Universal Tractor Oil (Multagri TM)		20W/30	20W/30

MIL-L-2104C OILS

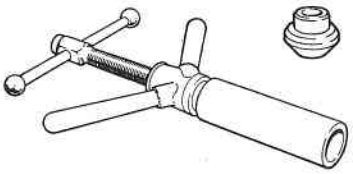
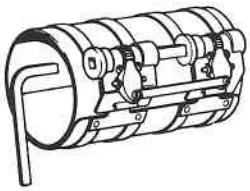
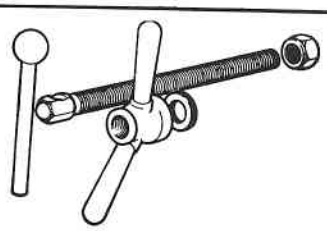
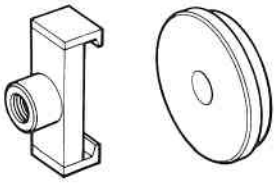
Company	Brand	S.A.E. Designation		
		0°F (–18°C) to 30°F (–1°C)	30°F (–1°C) to 80°F (27°C)	Over 80°F (27°C)
B.P. Ltd.	Vanellus C3	10W	20W/20	30
Castrol Ltd.	Castrol Deusol CRD	10W	20	30
	Deusol RX Super		20W/40	20W/40
	Agricastrol HDD	10W	20	30
	Agricastrol MP		20W/30	20W/30
	Agricastrol MP		20W/40	20W/40
A. Duckham & Co. Ltd.	Fleetol 3	3/10	3/20	3/30
	Farmadcol 3	3/10	3/20	3/30
Esso Petroleum Co. Ltd.	Essolube D-3HP	10W	20W	30
	Essolube XD-3	20W	20W	30
	Essolube XD-3		15W/40	15W/40
Mobil Oil Co. Ltd.	Delvac 1300 Series	1310	1320	1330
Shell	Rimula CT	10W	20W/20	30
	Rimula X	10W	20W/20	30
	Rimula X	10W/30	10W/30	10W/30
	Rimula X		15W/40	15W/40
	Rimula X		20W/40	20W/40
	Rotella TX	10W	20W/20	30
	Rotella TX		20W/40	20W/40
Total Oil Co. Ltd.	Total HD3-C (Rubia S)	10W	20W/20	30
	Total HD3-C (Rubia TM)		15W/40	15W/40
	Total Super Universal Tractor Oil (Multagri TM)		20W/30	20W/30

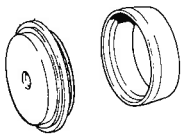
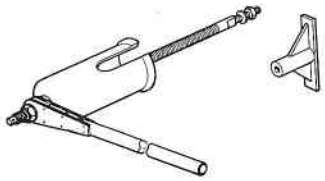
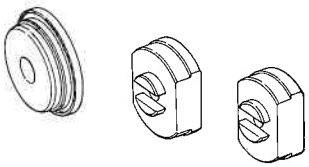
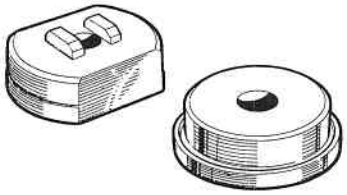
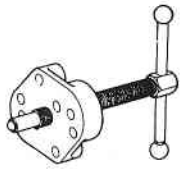
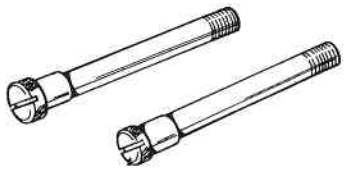
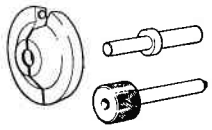
Lubricating oils for use in Perkins Diesel engines should have a minimum viscosity index of 80.

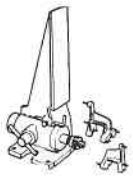
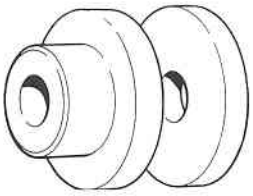
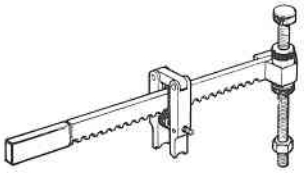
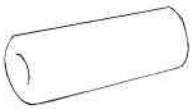
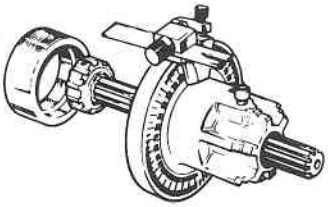
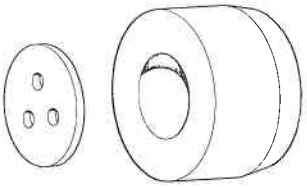
APPROVED SERVICE TOOLS

Available from V. L. Churchill & Co. Ltd., Daventry, Northamptonshire, England, NN11 4NF.

The numbers shown in brackets after the Churchill tool number are the part numbers of equivalent Perkins tools. Perkins tools are available through your Perkins Distributor.

	Tool No.	Description
	PD.1D (21825026)	VALVE GUIDE REMOVER AND REPLACER (MAIN TOOL)
	PD.1D-1A (21825027)	ADAPTOR FOR PD.1D OR 21825026 A pair of puller bars fitted with knurled nuts. Suitable for 5/16" and 3" guides. The necessary distance piece from the adaptors below should also be used.
	PD.1D-6 (21825030)	ADAPTOR FOR PD.1D OR 21825026 A 19/32" (15mm) distance piece used to replace valve guides to a set height.
	No. 8 (21825018)	PISTON RING SQUEEZER
	PD.41B (21825019)	PISTON HEIGHT AND VALVE DEPTH GAUGE A simple method of quickly checking piston height.
	PD.140	CAMSHAFT BUSH/THRUST COLLAR REMOVER
	PD.140-3	FUEL PUMP THRUST COLLAR REMOVER/REPLACER ADAPTORS

	Tool No.	Description
	PD.145	CRANKSHAFT REAR OIL SEAL REPLACER ADAPTOR (LIP TYPE SEAL)
	PD.150A (21825052)	CYLINDER LINER REMOVER/REPLACER (MAIN TOOL) For Field Service replacement of single liners. Not advised for complete overhaul. For this work use adaptors with a hydraulic ram unit.
	PD.150-1B (21825054)	ADAPTORS FOR PD.150 Suitable for cylinders of 3.6" dia. and 3.87" dia. Removal and replacement.
	PD.150-7A (21825057)	ADAPTORS FOR PD.150 Suitable for cylinders of 3.97" dia. Removal and replacement.
	155B (21825006)	BASIC PULLER The cruciform head with multiple holes at different centres is used with adaptors listed below.
	PD.155-1	ADAPTORS FOR PD.155B Used to remove water pump pulleys. Also suitable to remove Camshaft Gears.
	MF.200-26	WATER PUMP OVERHAUL KIT Used with 370 Taper Base and Press.

	Tool No.	Description
	335	CON ROD JIG & 336 MASTER ARBOR
	336-102	ARBOR ADAPTOR Used with 335
	6118B-4 (21825020)	VALVE SPRING COMPRESSOR
	6118B-4 (21825023)	ADAPTOR FOR 6118B
	MS67B	TOOL FOR CHECKING FUEL INJECTION TIMING
	PD.163 (21825042)	TIMING CASE CENTRALISING TOOL
	MS 73 (21825064)	ADJUSTABLE VALVE SEAT CUTTERS

POWERPART Consumable Products

To give assistance in the correct operation, service and maintenance of your engine and machine, Perkins Engines Ltd. have made available the products shown below.

The instructions for the use of each product are given on the outside of each container.

These products are available from your Perkins distributor.

POWERPART Antifreeze
Gives corrosion protection and also a more efficient coolant in hot conditions. See Page C.5.

POWERPART Lay-Up 1
A diesel fuel additive for protection against corrosion. See Page C.4.

POWERPART Lay-Up 2
Gives inside protection to the engine and other closed systems. See Page C.4.

POWERPART Lay-Up 3
Gives outside protection to any metal parts. See Page C.4.

POWERPART De-Icer
To remove frost.

POWERPART Silent Spray
Silicone lubrication to lubricate and prevent noise from hinges, slide doors, etc.

POWERPART Damp Displacer
To make damp electrical equipment dry and to give future protection.

POWERPART Hylomar
Universal sealing compound to seal joints.

POWERPART Hylosil
Silicone rubber sealant to prevent leakage.

POWERPART Impact Adhesive
To keep joints in position during installation and other general attachment purposes.

POWERPART Solvent
To thoroughly clean metal faces before assembly.

POWERPART Locking Agent
Used to securely install fasteners, sleeves, etc.

EXAMPLES OF SERVICE FACILITIES

Service Publications

The following Service Literature may be purchased through your local Perkins Distributor

Workshop Manuals,

Operators Handbooks,

Crankshaft Regrinding,

Fault Finding Guide,

Installation and Maintenance Guide for Static Standby Engines,

Engine Brake Testing Data,

Etcetera.

Service Instruction

PETERBOROUGH

Apply to Product Education Department for details.

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