FOREWORD

The 360 Series are direct injection, water-cooled four-stroke diesel engines. The cylinders are arranged in line and are positioned vertically. Depending on application 360 series engines can be fitted with a turbocharger. The engines have been designed to take advantage of the latest technology, with special emphasis on the smallest possible dimensions, a favourable power to weight ratio and low fuel consumption. ADE engines have a left hand rotation when viewed from the rear. Throughout this manual, whenever Left or Right hand side of the engine is referred to, it is the side of the engine when viewed from the flywheel end.

This publication has been written to assist all personnel engaged in the maintenance and overhaul of the ADE Diesel Engine. All necessary information contained in this manual is presented in a logical step by step format with the text supported by line illustrations, which are positioned on the right hand side of the page, together with precise instructions on the servicing and overhaul procedure. In addition each section contains a schedule of manufacturing data and dimensions which must be closely followed when overhauling any part of the engine to the Manufacturers standards. Effective maintenance can only be carried out if the personnel concerned are fully conversant with the various components of the engine. Before maintenance operations are commenced, therefore, this manual should be carefully studied, and should at all times be kept where it will be needed in the workshop. Certain operations described in this manual require the use of special tools. These tools are obtainable from Grundy-Techniform. Full details are given in the appropriate sections.

A Product Training Representative, highly skilled in the special characteristics of ADE Engines, is available to assist you with product training through your Original Equipment Manufacturer (O.E.M.).

ENGINE PARTS

Whenever parts are required for ADE Engines, it is essential that the fullest information possible is given, always quote the engine number, type of application, and where possible the part number and description. In accordance with the Preventative Maintenance Plan, your engine will require such items as fuel, oil and air filters. It is in your own interest to ensure that only genuine ADE Parts are used. Each genuine ADEPART, is backed with a six month guarantee ensuring the highest quality, and every part complies with the original specification.

RUNNING-IN PROCEDURE

It is not necessary to gradually run-in a new ADE engine, and any prolonged light load running during early life of the engine can in fact prove harmful to the bedding in of the piston rings and liners. Full load can be applied provided that the engine has reached operation temperature.

This publication is produced by the Service Department of Atlantis Diesel Engines (Pty) Ltd, and every endeavour has been made to ensure that the information contained in this manual is correct at the time of publication, however, continuous development and advancement in product design may reflect changes made to your engine which are not included in this publication.

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Technical Data

ADE 364N/C/T/TI

ENGINE DATA

<table>
<thead>
<tr>
<th></th>
<th>ADE 364N</th>
<th>ADE 364C</th>
<th>ADE 364T</th>
<th>ADE 364TI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore</td>
<td>97.5 mm</td>
<td>97.5 mm</td>
<td>97.5 mm</td>
<td>97.5 mm</td>
</tr>
<tr>
<td>Stroke</td>
<td>133 mm</td>
<td>133 mm</td>
<td>133 mm</td>
<td>133 mm</td>
</tr>
<tr>
<td>No. of cylinders</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cubic capacity</td>
<td>3,972 l</td>
<td>3,972 l</td>
<td>3,972 l</td>
<td>3,972 l</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>17.25:1</td>
<td>17:1</td>
<td>16.5:1</td>
<td>16.5:1</td>
</tr>
<tr>
<td>Compression test pressure at operating temperature (Max. difference between any two cylinders — 400 kPa)</td>
<td>Min 2000 kPa at 180-200 r/min</td>
<td>Min 2000 kPa at 180-200 r/min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firing order</td>
<td>1-3-4-2</td>
<td>1-3-4-2</td>
<td>1-3-4-2</td>
<td>1-3-4-2</td>
</tr>
<tr>
<td>Combustion system</td>
<td>Direct injection</td>
<td>Direct injection</td>
<td>Direct injection</td>
<td>Direct injection</td>
</tr>
<tr>
<td>Cycle</td>
<td>4 stroke</td>
<td>4 stroke</td>
<td>4 stroke</td>
<td>4 stroke</td>
</tr>
</tbody>
</table>

DETAIL OF RATINGS (AUTOMOTIVE) TO SABS 013-1977

<table>
<thead>
<tr>
<th></th>
<th>266 @ 1400 r/min</th>
<th>300 @ 1400 r/min</th>
<th>380 @ 1400 r/min</th>
<th>408 @ 1400 r/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Kw</td>
<td>66 @ 2800 r/min</td>
<td>70 @ 2800 r/min</td>
<td>85 @ 2600 r/min</td>
<td>100 @ 2600 r/min</td>
</tr>
</tbody>
</table>

ENGINE MASS

|                     | 335 kg | 343 kg | 343 kg | 370 kg |

ADE 366N/C/T/TI

ENGINE DATA

<table>
<thead>
<tr>
<th></th>
<th>ADE 366N</th>
<th>ADE 366C</th>
<th>ADE 366T</th>
<th>ADE 366TI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bore</td>
<td>97.5 mm</td>
<td>97.5 mm</td>
<td>97.5 mm</td>
<td>97.5 mm</td>
</tr>
<tr>
<td>Stroke</td>
<td>133 mm</td>
<td>133 mm</td>
<td>133 mm</td>
<td>133 mm</td>
</tr>
<tr>
<td>No. of cylinders</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Cubic capacity</td>
<td>5,958 l</td>
<td>5,958 l</td>
<td>5,958 l</td>
<td>5,958 l</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>17.25:1</td>
<td>17:1</td>
<td>16.5:1</td>
<td>16.5:1</td>
</tr>
<tr>
<td>Compression test pressure at operating temperature (Max. difference between any two cylinders — 400 kPa)</td>
<td>Min 2000 kPa at 180-200 r/min</td>
<td>Min 2000 kPa at 180-200 r/min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firing order</td>
<td>1-5-3-6-2-4</td>
<td>1-5-3-6-2-4</td>
<td>1-5-3-6-2-4</td>
<td>1-5-3-6-2-4</td>
</tr>
<tr>
<td>Combustion system</td>
<td>Direct injection</td>
<td>Direct injection</td>
<td>Direct injection</td>
<td>Direct injection</td>
</tr>
<tr>
<td>Cycle</td>
<td>4 stroke</td>
<td>4 stroke</td>
<td>4 stroke</td>
<td>4 stroke</td>
</tr>
</tbody>
</table>

DETAIL OF RATINGS (AUTOMOTIVE) TO SABS 013-1977

<table>
<thead>
<tr>
<th></th>
<th>402 @ 1400 r/min</th>
<th>420 @ 1400 r/min</th>
<th>560 @ 1400 r/min</th>
<th>640 @ 1400 r/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Kw</td>
<td>100 @ 2800 r/min</td>
<td>100 @ 2800 r/min</td>
<td>125 @ 2600 r/min</td>
<td>150 @ 2600 r/min</td>
</tr>
</tbody>
</table>

ENGINE MASS

|                     | 445 kg | 460 kg | 460 kg | 495 kg |

Throughout this Engine Repair Manual, S1 (International Metric System) units as approved by the South African Bureau of Standards (SABS) are used. All measurements are in mm unless otherwise indicated.
### Torque Specifications for Bolts Under Different Grade Classifications

<table>
<thead>
<tr>
<th>Quality grade</th>
<th>8.8</th>
<th>10.9</th>
<th>12.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>M6</td>
<td>8.6</td>
<td>11.8</td>
<td>14.5</td>
</tr>
<tr>
<td>M8</td>
<td>21</td>
<td>29</td>
<td>35.5</td>
</tr>
<tr>
<td>M8x1</td>
<td>23</td>
<td>32</td>
<td>38</td>
</tr>
<tr>
<td>M10</td>
<td>42</td>
<td>58</td>
<td>70</td>
</tr>
<tr>
<td>M10 x 1.5</td>
<td>46.5</td>
<td>65</td>
<td>78</td>
</tr>
<tr>
<td>M12</td>
<td>73</td>
<td>100</td>
<td>123</td>
</tr>
<tr>
<td>M12x1.5</td>
<td>76</td>
<td>105</td>
<td>128</td>
</tr>
<tr>
<td>M14</td>
<td>114</td>
<td>165</td>
<td>195</td>
</tr>
<tr>
<td>M14x1.5</td>
<td>128</td>
<td>178</td>
<td>215</td>
</tr>
<tr>
<td>M16</td>
<td>178</td>
<td>250</td>
<td>300</td>
</tr>
<tr>
<td>M16x1.5</td>
<td>190</td>
<td>270</td>
<td>320</td>
</tr>
<tr>
<td>M18</td>
<td>245</td>
<td>355</td>
<td>415</td>
</tr>
<tr>
<td>M18x1.5</td>
<td>280</td>
<td>390</td>
<td>465</td>
</tr>
<tr>
<td>M20</td>
<td>350</td>
<td>490</td>
<td>590</td>
</tr>
<tr>
<td>M20x1.5</td>
<td>390</td>
<td>550</td>
<td>660</td>
</tr>
<tr>
<td>M22</td>
<td>465</td>
<td>660</td>
<td>800</td>
</tr>
<tr>
<td>M22x1.5</td>
<td>520</td>
<td>730</td>
<td>875</td>
</tr>
<tr>
<td>M24</td>
<td>600</td>
<td>850</td>
<td>1000</td>
</tr>
<tr>
<td>M24x2</td>
<td>660</td>
<td>910</td>
<td>1100</td>
</tr>
</tbody>
</table>

**Note 1** — The bolt grading appears on the bolt head

**Note 2** — Bolt torque is subject to female thread material
IDENTIFICATION NUMBER POSITIONS

When ordering spare parts always quote the engine number in full.

ENGINE IDENTIFICATION

The engine numbering system for ADE engines consists of 16 letters and numbers.

Example

ATLANTIS DIESEL ENGINES (PTY) LTD

<table>
<thead>
<tr>
<th>ENGINE No DB</th>
<th>ADE</th>
<th>M J 01002 SA 046315 T</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGINE FAMILY</td>
<td>M J</td>
<td>300 Series</td>
</tr>
<tr>
<td>ENGINE TYPE</td>
<td>ADE</td>
<td>i.e.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G = 364N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H = 364C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>J = 366N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>K = 366T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L = 366T1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M = 364T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N = 366C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T = 366T</td>
</tr>
<tr>
<td>BUILD CODE</td>
<td></td>
<td>MADE IN RSA</td>
</tr>
<tr>
<td>COUNTRY OF ORIGIN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENGINE SERIAL NUMBER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YEAR OF MANUFACTURE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S = 1988</td>
<td>U = 1990</td>
<td>W = 1992</td>
</tr>
<tr>
<td>T = 1989</td>
<td>V = 1991</td>
<td>X = 1993</td>
</tr>
<tr>
<td></td>
<td>Y = 1994</td>
<td></td>
</tr>
</tbody>
</table>

Note:
The letter denoting the year of manufacture changes on the 1st day of January each year.
The letters I, O, Q, R and Z are not used.
The A type injection pump part number is situated on the pump body as indicated.

The MW type injection pump part number is situated on the pump body as indicated. (360T)

The governor part number is situated on the governor housing as indicated.

The alternator part number is situated on the body as indicated.

The starter motor part number is situated on the body as indicated.
OPERATING AND MAINTENANCE

Preparation before Starting
Check the radiator coolant level.
Check the engine sump oil level.
Ensure that there is fuel in the tank.
Check that the battery is fully charged and that all electrical connections are properly made and all circuits are in order.

To Stop the Engine
Remove the engine load. Decrease speed gradually to avoid heating up the coolant, then run the engine at idling speed for a short time. Shut down engine.
(a) By actuating the stopping cable.
(b) By moving the speed control lever to “stop”.
(c) By actuating the shut-off solenoid.
(d) By actuating the exhaust brake depending on the engine specification.

Points to note
Always ensure that the starter pinion has stopped rotating before re-engaging the starter, as the ring gear or pinion may be damaged.

Flame-Proofed Engines
Engines arranged to conform with flame-proofing regulations are usually fitted with non-electric starting equipment. This is supplied by the manufacturer of the application and for starting instructions reference should be made to the appropriate manufacturer’s handbook.

Preventive Maintenance
Category 1
Units operating under normal conditions, more than 100,000 km or 2,000 hours annually e.g. long haul operations.

Category 2
Units operating under normal conditions, up to 100,000 km or 2,000 hours annually e.g. medium to long haul operations.

Category 3
Units subject to severe operating conditions e.g. extremely poor road conditions, heavy dust conditions, extreme climatic conditions (temperature and humidity), very short distances in traffic or construction operation. Units operating up to 10,000 km or 200 hours annually e.g. units operating under light loads or intermittent operating conditions, such as stand-by generator sets and emergency vehicles. However, when operating less than the recommended service intervals, the oil and oil filter should be changed once or twice a year depending on the lubricating oil used. We recommend that maintenance and service be carried out according to hours of operation rather than mileage covered.

RECOMMENDED SERVICE/MAINTENANCE INTERVALS

Normal oil and filter changes/service intervals

<table>
<thead>
<tr>
<th>Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7,500 km/150 hrs</td>
<td>5,000 km/100 hrs</td>
<td>2,500 km/50 hrs</td>
</tr>
</tbody>
</table>

At least twice a year when service interval is not reached

EXTENDED oil and filter changes/service intervals

The extended maintenance and service intervals may only commence after the running in period (approximately 20,000 km).

The engine lubricating oils for extended oil change intervals, as specified in the ADE Service Bulletin on Consumables have been approved and are mandatory.

The successful application of the extended oil and filter changes/service intervals warrants careful service and maintenance of engines. As extended intervals also depend on operating conditions of the engines, it is essential to apply the 3 categories as outlined below.

<table>
<thead>
<tr>
<th>Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>15,000 km/300 hrs</td>
<td>10,000 km/200 hrs</td>
<td>5,000 km/100 hrs</td>
</tr>
</tbody>
</table>

At least once a year when service interval is not reached

Note 1:
Engines that leave the factory are filled with running-in oil. The oil must be changed during the first service at 1,500 km or 30 hours operation.

For approved engine lubricants and coolant additives, refer to ADE General Service Bulletin on Consumables.

Pre-delivery Service

1. Check general engine installation i.e. All pipes and hoses for tight sealing, condition and routing.
2. Open air cleaner and ensure element is positioned correctly and bolted down.
3. Check for fuel and oil leaks.
4. Check oil level.
5. Check coolant level.
6. Check coolant for correct mixture, i.e. anti-freeze/anti-corrosion agent and corrosion inhibitor.
7. Check V-belt tension.
8. Check electrical equipment and connections.
1. Check engine oil level and pressure upon start up (ensure machine is standing level).
2. Check coolant level in radiator.
3. Service air cleaner dust bowl, pre-filter if applicable.
4. Check air cleaner restriction indicator, service filters if required.
5. Ensure there is ample fuel in tank.
6. Ensure fuel tank cap/breather is unobstructed.
7. Check that the exterior of the sump is clean with an unrestricted air flow over the surface.
8. Ensure radiator fins have an unobstructed airflow.
9. Check oil pressure indicator.
10. Drain water from sedimentor.
11. Drain air tank (if fitted).

Note:
Injectors: Satisfactory long term functioning of injectors depends largely on the quality and purity of the fuels used. A specific service interval can therefore not be prescribed. Dealers and Fleetowners should adopt service intervals which would suit the individual operating circumstances.

Schedule A Service
1. Change engine oil, drain oil when still hot.
2. Renew oil filter.
3. Renew fuel filters.
4. Drain water from sedimentor or fuel filter drain cocks.
5. Service air cleaner dust bowls/pre-filter if applicable.
6. Check air cleaner indicator, service filters if required.
7. Service air cleaner and filter (oil bath type).
8. Check all air cleaner intake ducts, hoses and clips etc., for serviceability and tightness.
9. Check that intercooler is free from obstruction.
10. Check coolant hoses, hose clips for serviceability and tightness.
11. Pressure test cooling system.
12. Ensure that recommended corrosion inhibitor has been added to the cooling system.
13. Ensure radiator fins have an unobstructed air flow.
14. Tension all V-Belts, checking same for ageing, replacing defective V-Belts. Twin V-Belts should only be replaced in pairs. New belts must be retensioned after 10-15 minutes of operation.
15. Check exhaust system for damage or leaks.
16. Check control linkage on injection pump and exhaust brake for correct function and adjustment, lubricate all joints.
17. Check all lines and hoses for tight sealing, chafing and leaks.
18. Adjust valve clearances.
19. Retighten all visible nuts and bolts on the engine and in particular:
   - Inlet and exhaust manifolds and ducts.
   - Exhaust flange.
   - Starter motor and alternator fitting.
   - Nozzle holders.
   - Engine mount on cross member and engine support.
   - Bell housing bolts and nuts.
20. Check for fuel and oil leaks.
21. Check operation of oil pressure and temperature gauges.
22. Check battery electrolyte level. In Summer and hot regions once a week.
23. Check battery terminals for tightness and condition.
24. Check operation of Visco Fan (if fitted).

Additional items requiring servicing at 50 000 km interval listing:
1. Check carbon brushes in the starter.
2. Inspect and clean oil cooler filter element ADE 360T/TI

Schedule B Service
*1. Change engine oil and oil filter, drain when still hot.
2. Drain fuel sedimentor or fuel filter drain taps.
3. Service air cleaner dust bowl/pre-filter if applicable.
4. Check air cleaner indicator, service filters if required.
5. Check all air cleaner intake ducts, hoses and clips for serviceability and tightness.
6. Check that intercooler is free from obstruction.
7. Check coolant hoses, hose clips for serviceability and tightness.
8. Pressure test cooling system.
9. Ensure radiator fins have an unobstructed air flow.
10. Tension V-Belts checking same for ageing, replace defective V-Belts. Twin V-Belts should only be replaced in pairs. Retension new belts after 10-15 min. operation.
11. Check exhaust system for damage or leaks.
12. Check for fuel and oil leaks.
13. Check operation of oil pressure and temperature gauges.
14. Check battery electrolyte level. In Summer and hot regions once a week.
15. Check battery terminals for tightness and condition.

Additional items requiring servicing at 50,000 km intervals or to the equivalent shown on the maintenance interval listing:
1. Check the carbon brushes in the starter.
2. Clean turbocharger impeller, diffuser and oil drain pipe.
3. Inspect and clean oil cooler filter element (360T/TI)

Attention! Satisfactory long term operation of the air compressor, depends on many varying factors. Therefore a specific service interval cannot be recommended. Dealers and Fleetowners should adopt service intervals which will suit their individual operating conditions.

ENGINE COOLANT

In view of the significance of maintaining the cooling system at a specified level, it is essential to ensure that the following coolant specifications are maintained.

For the preparation of coolants, use clean water that is not too hard. Often, drinking water (tap water) will meet the desired requirements, but not always.

Sea water, salt water, industrial waste water and brackish water which includes in most cases water from dams, ponds and rivers, should be considered to be unsuitable, as these may contribute heavily to the formation of corrosion.

Specifications of fresh water

<table>
<thead>
<tr>
<th>Sum of alkaline earth</th>
<th>89.5 — 356 mg/litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH value at 20°C</td>
<td>6.5 — 8.5</td>
</tr>
<tr>
<td>Contents of chlorine ions</td>
<td>max 100 mg/litre</td>
</tr>
<tr>
<td>Total content of chlorides and sulphates</td>
<td>max 200 mg/litre</td>
</tr>
</tbody>
</table>

Full information on the quality of drinking water should be obtained from local departments of Water Affairs or local authorities. It is essential to protect your engine at all times against corrosion by the addition of Anti-corrosion/Anti-freeze additives (ethylene glycol with corrosion inhibitors) which amongst others, will meet the following demands:

- **adequate anti-corrosion and cavitation protection for all components in the cooling system**
- **lowering the freezing point**
- **raising the boiling point**

At no time should the coolant/mixture exceed 55% by volume anti-freeze/anti-corrosion agent as a higher percentage will reduce the anti-freeze protection as well as lessen the heat dissipation. As anti-corrosion inhibitors decompose during operation, as well as anti-corrosion concentration being reduced by topping up the cooling system with water, the frost protection must be checked regularly. Frost protection of —30°C corresponds with 40 to 45 percent (by volume) anti-freeze/anti-corrosion content in the coolant which may be determined by an optical or mechanical hydrometer, (+ —30°C).

The anti-corrosion oil content in the coolant i.e. 1% by volume, may be determined by a refractometer.

Only use approved products for mixture with the coolant as specified in our General Service Bulletin on Consumables and at all times strictly adhere to the mixture specifications.

ENGINE PRESERVATION

When an engine is laid-up for a prolonged period, it should be properly protected against corrosion. Preservation measures should be carried out in accordance with the different categories listed in the following sections.

1.0 General

2.0 Installed Engines
2.1 Laid up for up to 12 months
2.2 Laid up for 12 to 36 months
2.3 Laid up for more than 36 months

3.0 Non-installed Engines
3.1 Laid up for up to 12 months
3.2 Laid up for 12 to 36 months
3.3 Laid up for more than 36 months

4.0 Preparing Engine for operation

1.0 General

An engine is classified as "laid up" when it has not operated for over one month. Laid up vehicles or engines should be stored in dry, well-ventilated rooms and must always be protected against direct moisture, e.g. rain or splash water. If this is not possible, laying up conditions are classified as extreme and the treatment specified for a given period should be increased, e.g. if an engine is to be laid up for up to 12 months, it must receive treatment of an engine to be laid up for 12 to 36 months.

1.1 On any laid up engine all machined external unprotected surfaces, e.g. flywheels, V-belt pulley grooves, etc. should be coated with a preserving agent or grease.

V-belts must be slackened off and be removed from the grooves.

All openings must be sealed air tight. This includes exhaust and air inlet ducts/cleaners on installed engines.

Batteries must be disconnected in laid up vehicles and should be recharged outside the vehicle as required.

2.0 Installed Engines

These measures apply to all engines in vehicles, tractors, as well as industrial engines.

2.1 Laid up for up to 12 months

2.1.1 NEW ENGINES (distance covered up to 300 km or 6 hours of operation):

The engines must be filled to the maximum level with approved service products. Ambient temperatures must be taken into consideration when selecting SAE grades. No further preservation measures are required.

2.1.2 USED ENGINES (distance covered more than 300 km or 6 hours operation):
Run engine until warm and drain engine oil. (Running-in oil may remain in the engine). Renew oil filter cartridge. Fill with an approved running-in oil (anti-corrosion engine oil). Fill or top up cooling system with the specified coolant mixture. Run engine at medium speed for approx. 5 to 10 minutes until operating temperature is reached (coolant temperature 75-79° C). Switch off engine, fill the sump and the oil bath air filter (if fitted) to maximum level.

2.2 Laid up for 12 to 36 months

All the measures set out in Sections 1.0 “General” and 2.1 “Measures for Installed Engines Laid up for up to 12 months”, must be carried out.

In addition, the fuel system, the combustion chambers and the air compressor must be preserved in accordance with the following instructions.

Note 1: The procedure in this section should also be followed after less than 12 months in the case of sea shipments and in tropical areas.

2.2.1 Preservation of Fuel System:

Add approximately 10% running-in oil to diesel fuel and operate the engine with this mixture for approximately 5 to 10 minutes.

If a number of vehicle, tractor or industrial engines are to be preserved at the same time, the fuel and the running-in oil may be mixed in a separate container before feeding the solution into the fuel system via a three-way or four-way cock valve. This enables the concentration of oil in diesel fuel to be increased to 15-20%.

2.2.2 Preservation of Combustion Chambers:

Oil may be sprayed into the combustion chambers via the injector ports after removal of the injectors which may be immersed in oil for added protection.

For best results the metered amount of oil must be injected into the combustion chamber under pressure to ensure complete spraying of all areas. Upon completion of each cylinder (piston down), rotate the engine at least one full turn by hand.

Note 2: During the above operation the injection pump governor control must be in the shut-off position.

Oil Per Cylinder 8-10 ml

Note 3: Do not exceed above amounts as this may lead to hydraulic lock and possible engine damage.

Refit all parts removed and ensure that seals and gaskets are in place. Re-position the injection pump governor controls to the operating position.

Note 4: Engines must not be started after the combustion chamber preservation has been carried out.

2.2.3 Preservation of Air Compressors:

Air compressor preservation should be done in conjunction with the combustion chambers. A maximum of 5 cubic centimetres of running-in oil should be injected or poured into each cylinder via the compressor air intake where-after the engine must be rotated at least one half a turn.

2.3 Laid up for more than 36 months

If the laying-up period is extended for more than 36 months, preservation measures must be repeated every 3 years or 18 months in accordance with Section 2.2 in full.

3.0 NON-INSTALLED ENGINES

These measures cover new non-installed engines, as well as remanufactured engines.

3.1 Laid up for up to 12 months:

NEW ENGINES which have only been subjected to the running-in period at ADE, do not require any additional preservation measures.

Running-in oil may be left in the engines. Coolant must be completely drained. Remove the thermostat(s) and insert one Chadpack Tablet (ADE Part No 36170072) into the housing. Refit the thermostat(s) and closing cover/outlet and ensure that the joints form a good seal. All engine openings must be sealed airtight.

Note 5: Follow the instructions for sea shipments or tropical areas.

USED ENGINES must be treated in accordance with the measures set out in Items 2.1.2 and 2.2.1 before being laid up or dismantled.

Coolant must be drained completely and a Chadpack Tablet must be inserted in the thermostat housing.

REMANUFACTURED ENGINES must in all cases be preserved in accordance with Section 2.2 in full.

3.2 Laid up for 12 to 36 months:

The preservation measures set out in Section 2.2 must be carried out in full.

3.3 Laid up for more than 36 months:

If the laying-up period is extended for more than 36 months, preservation must be repeated every 36 months (3 years) or 18 months in accordance with Section 2.2 in full.

If there is oil in the engine, this may be drained off at room temperature (about 20°).

It is not necessary to renew the oil filter cartridge.

4.0 PREPARING ENGINE FOR OPERATION

4.1 Remove sealing from all openings.

4.2 Remove preserving agent or grease from the grooves of V-belt pulleys, flywheel and other unprotected surfaces.

4.3 Reposition and tension V-belts in accordance with instructions.

4.4 If not already installed, fit engine to machine.

4.5 Fill with approved lubricating and coolant service products or top up to maximum level.

ADE 360 Series
Note 6: Engines which have not received their first service must be filled with running-in oil, all others should be filled with approved operating oils.

4.6 Recharge and reconnect batteries.

4.7 Run engine to operating temperature (coolant temperature 75-79°C) while monitoring pressures and temperatures.
DUE TO CONTINUOUS DEVELOPMENT, ATLANTIS DIESEL ENGINES ARE CONSTANTLY REVISING THEIR OIL RECOMMENDATIONS.

TO OBTAIN THE LATEST OIL RECOMMENDATIONS, PLEASE REFER TO OUR SERVICE BULLETINS, OR CONSULT YOUR NEAREST OIL COMPANY FOR THEIR ADVICE.
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ENGINE TURNS OVER BUT REFUSES TO START ......................................................... 10-4
ENGINE DIFFICULT TO START ....................................................................................... 10-5
ENGINE LOCK-UP ........................................................................................................... 10-6
ENGINE CUTS OUT AFTER STARTING ......................................................................... 10-7
ENGINE OVERHEATING .................................................................................................. 10-8
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COMPLAINT

Starter motor turns engine too slowly

POSSIBLE CAUSE

- Battery undercharged
- Loose or dirty battery terminals
- Faulty engine earth connections
- Battery cables defective
- Starter motor faulty
- Incorrect grade of lubricating oil

REMEDY

- Recharge or replace battery
- Clean and tighten battery terminals
- Repair, clean or secure connections
- Perform voltage drop test. Replace
- Remove test and repair starter motor. Refer to section 18E
- Refer to section 09
COMPLAINT

Hard starting when cold

POSSIBLE CAUSE

- Starter motor turns engine too slowly
  - Refer to page 10-2

- Incorrect use of aux. starting aid
  - Instruct operator on use

- Defective cold start aid
  - Locate, defect and repair starting aid

- Incorrect Valve clearance
  - Reset Valve clearance Refer to section 12

- Low compression
  - Check and repair cause
COMPLAINT

Engine turns over but refuses to start

Faulty stop control

Check and repair
Refer to section 17

Insufficient fuel in tank

Fill tank. Bleed system

Defective injection pump

Remove and overhaul injection pump
Refer to section 17

Injection pump drive shaft broken

Remove pump and repair
Refer to section 17

NOTE: Refer also to pages:

10-2) Starter motor turns engine too slowly
10-5) Engine is difficult to start
10-3) Hard starting when cold
COMPLAINT

Engine difficult to start (hot or cold)

POSSIBLE CAUSE

- Starter motor turns engine too slowly
  - Refer to page 10-2
- Air in fuel system
  - Bleed system, check and repair air entry
- Restriction in fuel supply line or filters
  - Clean out fuel lines or replace filters
- Defective fuel lift pump
  - Check, repair or replace lift pump
- Restricted air inlet
  - Service air filter and system
- Restricted exhaust system
  - Locate and repair restriction
- Injection timing incorrectly set
  - Check injection pump timing
    Refer to section 17
- Defective injectors
  - Overhaul injectors
    Refer to section 17
- Defective injection pump
  - Repair injection pump
- Compression too low
  - Test compression, locate pressure loss
    Refer to section 12
COMPLAINT

Engine Lock-up.
Question operator as to
conditions of lock-up

POSSIBLE CAUSE

- Starter motor jammed in mesh
- Hydraulic lock-up
- Mechanical failure

REMEDY

- Remove starter. Use other means to turn engine
- Remove injectors. Turn engine. Determine cause:—
i.e. water or fuel. Repair as necessary
- Dismantle engine and rectify
COMPLAINT

Engine cuts out soon after starting

POSSIBLE CAUSE

Insufficient fuel in tank

Air in fuel system

Blocked fuel tank air vent

Blocked fuel filters. Restricted fuel return pipe from pump (Distributor pump only)

Air filter restriction

Exhaust restriction

REMEDY

Correct Fuel level

Check fuel system for air leaks. Correct as necessary. Bleed system.

Clean out air vent. Bleed system.

Replace fuel filters. Check and correct restrictions in return pipe.

Service air filtration system.

Locate and rectify restriction.
COMPLAINT

Engine Overheating

POSSIBLE CAUSE

Water level too low

Fan belt slipping

Radiator cap not seating or worn

Thermostat faulty

Exhaust restriction

Injection timing incorrectly set

Injection pump calibration

Blocked radiator

Defective water pump

REMEDY

Top-up. Check for leaks. Retest.

Inspect, adjust or replace V-belt/s. Refer to section 19

Fit new radiator cap

Test and replace thermostat. Refer to section 19

Locate and repair restriction

Reset injection timing. Refer to section 17

Recalibrate injection pump

Clean out radiator

Repair or replace water pump. Refer to section 19
COMPLAINT

Fault Finding - 10-9

Engine Running Too Cold

POSSIBLE CAUSE

- Temperature gauge faulty
- "O" ring seal above thermostat missing
- Thermostat stuck in open position
- Incorrect fan fitted
- Incorrect radiator fitted

REMEDY

- Attach Master Gauge. Verify defect and correct
- Replace seal
- Renew thermostat Refer to section 19
- Check manufacturers specs.
- Check manufacturers specs.
COMPLAINT

Engine Knocking

POSSIBLE CAUSE

- Incorrect grade of fuel
  - REMEDY: Check fuel grade. Change if necessary

- Defective injectors
  - REMEDY: Service injectors. Refer to section 17

- Injection timing incorrectly set
  - REMEDY: Reset injection timing. Refer to section 17

- Injection pump faulty
  - REMEDY: Recalibrate injection pump

- Valve clearance incorrectly set
  - REMEDY: Reset valve clearance. Refer to section 12

- Broken valve spring or sticking valve
  - REMEDY: Replace valve spring or ease off valve. Refer to section 12
COMPLAINT

Engine Vibration

POSSIBLE CAUSE

Loose accessories e.g. alternator etc.

Worn or broken engine mountings

Propshaft out of balance

Incorrect injection timing

Faulty injectors

Incorrect calibration of injection pump

Clutch or pressure plate damaged or loose

Misaligned or cracked clutch housing

Faulty vibration damper

REMEDY

Tighten up all external parts including eng mountings and exhaust system

Check and replace engine mountings

Balance or replace propshaft

Reset injection timing
Refer to section 17

Service injectors
Refer to section 17

Recalibrate injection pump

Inspect and replace as necessary

Determine run-out repair or replace clutch housing

Inspect and replace as necessary
COMPLAINT

Engine Misfires

POSSIBLE CAUSE

- Leaking or cracked high pressure pipe
- Incorrect valve clearance
- Broken valve spring
- Faulty injector
- Broken delivery valve spring (Bosch only)
- Injection pump calibration incorrect
- Compression low

REMEDIY

- Locate cause of leak and repair
- Reset valve clearance Refer to section 12
- Replace valve spring Refer to section 12
- Service injector Refer to section 17
- Replace delivery valve spring
- Recalibrate injection pump
- Locate and repair compression loss
COMPLAINTS

Loss of Power

POSSIBLE CAUSE

Stop control partly closed

Remedy

Adjust stop control

Throttle not opening fully

Check and adjust throttle linkage

Air filter restriction

Service air filtration system

Exhaust restriction

Locate and repair exhaust restriction

Valve clearance incorrectly set

Reset valve clearance
Refer to section 12

Low pressure fuel system defective

Service fuel filters, check for air leaks, and test fuel lift pump

Incorrect injection timing

Reset injection timing
Refer to section 17

Defective injectors

Service injectors
Refer to section 17

Loss of compression

Test compression
Rectify loss
Refer to section 12

Automatic timer seized

Repair or replace automatic timer

Incorrect delivery from injection pump

Test and repair injection pump

Turbocharger boost pressure low

Rectify as necessary
Refer to section 18A
COMPLAINT

Black smoke from exhaust

POSSIBLE CAUSE

Inlet system restricted

Incorrect Grade of Fuel

Incorrect valve clearance

Defective injectors

Injection pump timing incorrect or retarded

Injection pump defective

Low boost pressure from turbocharger

Incorrect valve timing/low compression

REMEDY

Service and repair inlet system

Drain and refill with correct fuel

Reset valve clearance Refer to section 12

Service injectors Refer to section 17

Check and correct injection pump timing Refer to section 17

Repair injection pump

Check as for loss of power Refer to section 18A

Check valve timing and compression Refer to section 12
COMPLAINT

Blue smoke from exhaust

POSSIBLE CAUSE

Engine oil level too high
Fuel dilution
Incorrect grade engine oil
Crankcase breathers blocked
Oil seepage past valve guides
Piston rings/piston, cylinder bores worn
Turbo-compressor/Turbine shaft to housing seals leaking

REMEDY

Correct engine oil level
Check for internal leakage
Change engine oil
Clean out crankcase breathers
Check valve seals. Check valve guides for wear. Replace as required. Refer to section 12
Dismantle, inspect repair eng. as required
Repair/Replace Turbocharger Refer to section 18A
COMPLAINT

White smoke from exhaust

POSSIBLE CAUSE

- Engine Running Too Cold
  - Check Cooling System
    - Refer to section 19

- Faulty injectors
  - Check and replace as necessary

- Injection timing too advanced
  - Check injection timing
    - Refer to section 17

- Automatic timer seized in advance position
  - Repair or replace automatic timer

- Water in fuel supply
  - Clean out fuel system

- Water entering cylinder bores
  - Check cylinder head gasket
    - Internal cracks in head and block

- Defective “thermostart” cold start system
  - Check, repair or replace system
COMPLAINT

Excessive Fuel Consumption

POSSIBLE CAUSE

External fuel leak

Internal fuel leaks

Too low operating temperature

Air filter restriction

Defective “thermostart” cold start aid

Poor engine tuning

Injection pump calibration incorrect

Automatic timer seized

Engine compression low

REMEDY

Check fuel tank, fuel lines and filters for damage

Check high pressure pipe connections, fuel return pipe connections, lift pump diaphragm leakage, injection pump shaft end seals, pump element leak-off.

Check and repair cooling system. Refer to section 19

Service system

Repair or replace

Adjust valve clearance. Service injectors. Check and correct injection pump timing Refer to sections 12 and 17

Recalibrate injection pump

Repair or replace automatic timer

Dismantle, inspect and repair engine

ADE 360 Series
COMPLAINT

Abnormal Oil Consumption

**POSSIBLE CAUSE**

- Engine overfilled
  - **REMEDY**
  - Instruct operator on oil level maintenance

- Engine oil leaks
  - **REMEDY**
  - Locate and repair oil leak

- Incorrect grade of engine oil
  - **REMEDY**
  - Refer to section 09

- Incorrect operating temperature
  - **REMEDY**
  - Check cooling system and correct
    Refer to section 19

- Valve stem seals leaking
  - **REMEDY**
  - Replace valve stem seals
    Refer to section 12

- Valve guides worn
  - **REMEDY**
  - Replace valve guides
    Refer to section 12

- Crankcase breather blocked
  - **REMEDY**
  - Locate and repair blockage

- Crankcase breather faulty
  - **REMEDY**
  - Check breather.
    Refer section 11.
    Replace if necessary.

- Piston rings worn.
  Piston and cylinders worn.
  Cylinders glazed.
  Cylinders scored.
  - **REMEDY**
  - Dismantle and inspect engine.
    Correct defects.

- Fuel dilution
  - **REMEDY**
  - Check on fuel seepage from internal injector pipes.
    Excessive leakby from pump.
    Excessive fueling.
COMPLAINT

Low engine Oil pressure

POSSIBLE CAUSE

Faulty pressure gauge

Incorrect grade of oil used

Engine oil diluted (fuel)

Engine oil diluted (water) (sludge)

Oil pickup pipe cracked or loose

Pressure relief valve stuck

Engine bearings worn

REMEDY

Verify pressure with master gauge. Correct as necessary

Change engine oil

Check for internal leakage. Check injector leak-off pipe.

Check oil cooler gasket leakage. Check cylinder head gasket leakage. Check liner seals. Check for internal cracks.

Repair or replace pickup pipe.

Ease off or replace relief valve

Dismantle, inspect and repair engine

ADE 360 Series
COMPLAINT

Oil pressure too high

POSSIBLE CAUSE

Incorrect grade of oil used

Faulty pressure gauge

Pressure relief valve stuck closed

REMEDY

Change engine oil

Test with master gauge. Repair as required.

Ease off or replace relief valve
COMPLAINT

Engine Oil Sludge

POSSIBLE CAUSE

- Incorrect grade of engine oil used
- Engine operating temp. too high or too low
- Crankcase breather blocked
- Excessive blow-by-past pistons and rings
- Oil in service for too long

REMEDY

- Flush out engine. Change filters and oil
- Check and correct cooling system
- Replace breather Refer to section 11
- Dismantle, inspect, repair engine
- Change oil and filters
SECTION 11

CYLINDER BLOCK

1 REAR MAIN OIL SEALS
2 SUMP
3 SUMP GASKETS
4 MAIN BEARING CAPS
5 GASKET
6 TIMING GEAR CASE
7 GASKET
8 TIMING COVER
9 OIL SEAL
10 COVER
11 GASKET
12 O-RING
13 SIDE COVER
14 CYLINDER LINER
15 CRANKCASE BREATHER
16 CYLINDER BLOCK
17 GASKET
18 OIL COOLER
INTRODUCTION

The cylinder block is designed to form an integral casting with the crankcase and is manufactured from high grade cast iron, alloyed with copper and chrome. Utilising the latest in engineering technology, the cylinder block is machined to very fine tolerances and is subject to a rigorous quality control inspection. Interference fit, dry cylinder liners (Sleeves), are fitted to the ADE 364T and 366T/TI. Engines fitted with cylinder liners can be identified by a "Z", stamped on the cylinder block, to one side of the push rod cover.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>CYLINDER LINER</th>
<th>Nominal diameter of cylinder</th>
<th>Cylinder bore</th>
<th>Total height of cylinder block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard (N/C/T/TI)</td>
<td>97,50</td>
<td>97,510</td>
<td>359,10 (STD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97,480</td>
<td></td>
</tr>
<tr>
<td>Rep stage 1(N) + 0,5 Re bore*</td>
<td>98,00</td>
<td>98,010</td>
<td>358,80 (- 0,3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97,990</td>
<td></td>
</tr>
<tr>
<td>Rep stage 1 (N/C/T/TI)</td>
<td>97,50</td>
<td>97,510</td>
<td>358,50 (- 0,6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97,490</td>
<td></td>
</tr>
<tr>
<td>Rep stage 2 (N/C/T/TI)</td>
<td>97,50</td>
<td>97,510</td>
<td>358,20 (- 0,9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97,490</td>
<td></td>
</tr>
<tr>
<td>Rep stage 3 (N/C/T/TI)</td>
<td>97,50</td>
<td>97,510</td>
<td>358,10 (- 1,0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97,490</td>
<td></td>
</tr>
</tbody>
</table>

*1st Rep stage for naturally aspirated optional i.e. either rebore for oversize piston or fit sleeve.

<table>
<thead>
<tr>
<th>Liner Parent Bore</th>
<th>100,435</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100,400</td>
</tr>
<tr>
<td>Liner Flange Recess — depth</td>
<td>4,8</td>
</tr>
<tr>
<td></td>
<td>4,6</td>
</tr>
<tr>
<td>— dia</td>
<td>103,626</td>
</tr>
<tr>
<td></td>
<td>103,572</td>
</tr>
<tr>
<td>Cylinder Liner O.D.</td>
<td>100,495</td>
</tr>
<tr>
<td></td>
<td>103,572</td>
</tr>
<tr>
<td>Cylinder Liner Flange O.D.</td>
<td>103,428</td>
</tr>
<tr>
<td></td>
<td>103,375</td>
</tr>
</tbody>
</table>

NOTE 1:
Stamped numbers appear on the side of the cylinder block for each cylinder. The numbers are for grading purposes during production only.
NOTE 2:
It is essential to machine to a piston clearance depth of at least 250 mm when reboring the 360 Series Naturally aspirated engine to next repair stage or for liner fitment. (See item B illustration below.)

Dimension A = 98.0 – 98.3 mm
Dimension B = 251 – 252 mm
Dimension C = 224 – 225 mm
Dimension h1 = Block Height from centre of main bearing bore to joint face of cylinder head.

(Refer to columns, cylinder block and cylinder liner for standard and repair stages for blockheight)

---

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ovality of cylinder bore</td>
<td>0.01</td>
</tr>
<tr>
<td>Taper of cylinder bore</td>
<td>0.01</td>
</tr>
<tr>
<td>Vertical deviation of cylinder bores within a distance of 200 mm in relation to crankshaft axis</td>
<td>0.04</td>
</tr>
<tr>
<td>Roughness of bore after honing</td>
<td>R3Z 3.5 μm R max. 6-11 μm</td>
</tr>
<tr>
<td>Leakage test pressure with cylinder block submerged in water at 70°C</td>
<td>200 kPa</td>
</tr>
<tr>
<td>Distortion limit — Length</td>
<td>Not to exceed 0.015 mm over a distance of 150 mm</td>
</tr>
<tr>
<td>Piston protrusion/recession to upper cylinder block surface</td>
<td>+ 0.30</td>
</tr>
<tr>
<td>Wear limit of bore</td>
<td>top piston ring upper return position 0.12</td>
</tr>
<tr>
<td>Camshaft bearing basic bore</td>
<td>60.030</td>
</tr>
<tr>
<td>Main bearing basic bore new</td>
<td>93.022</td>
</tr>
<tr>
<td>Main bearing basic bore limit for repair</td>
<td>93.040</td>
</tr>
<tr>
<td>Roughness upper joint face of cylinder block</td>
<td>8-16 μm</td>
</tr>
</tbody>
</table>

---

TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Component</th>
<th>Screw Type</th>
<th>Torque Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil gallery plugs (front and rear)</td>
<td>M18 x 1.5</td>
<td>40-45 N.m</td>
</tr>
<tr>
<td>M18 x 1.5</td>
<td>70-90 N.m</td>
<td></td>
</tr>
<tr>
<td>M20 x 1.5</td>
<td>90-110 N.m</td>
<td></td>
</tr>
<tr>
<td>Connection plug for tachometer</td>
<td>M26 x 1.5</td>
<td>60 N.m</td>
</tr>
<tr>
<td>Pushrod cover to cylinder block</td>
<td>M8</td>
<td>15 N.m</td>
</tr>
<tr>
<td>Engine mounting bracket to crankcase</td>
<td>M14 x 1.5</td>
<td>150-190 N.m</td>
</tr>
<tr>
<td>Piston cooling nozzels</td>
<td>M10 x 1</td>
<td>25 N.m</td>
</tr>
<tr>
<td>Blanking plugs (for piston cooling nozzels)</td>
<td>M10 x 1</td>
<td>10 N.m</td>
</tr>
<tr>
<td>Sidecover (water jacket) to cylinder</td>
<td>M8</td>
<td>25 N.m</td>
</tr>
</tbody>
</table>

ADE 360 Series
CHECKING CYLINDER BORES FOR WEAR

In the event of Excessive Oil Consumption and in addition to a visual check, measurements of the cylinder bores will be necessary. Before attempting to measure the cylinder bores they should be thoroughly cleaned and free from oil and carbon deposits.

1. Using compressed air, clean the top of the cylinder block, (fig. 11-1).

2. Wipe cylinder bores using clean rag, (fig. 11-2).

3. Check cylinder block top face for localised distortion using a suitable straight edge, (fig. 11-3).

4. Set internal measuring instrument, (fig. 11-4).
5. Insert measuring instrument into cylinder bores. (fig. 11-5).

6. Check cylinder bores at points 1, 2 and 3. The checks should be made in direction A = Centre line and B = 90° from centre line, (fig. 11-6).
When pistons are not removed, the measuring point 3 is just above the piston at BDC.

REBORING CYLINDER BLOCK FOR OVER-SIZE PISTONS OR FITMENT OF LINERS
1. After the cylinder block has been thoroughly cleaned it should be securely mounted under the boring bar, (fig. 11-7).

2. Align and centre the boring bar above the cylinder to be machined.

3. Insert tool into boring bar head and adjust to the required dimension, (fig. 11-8).

Attention!
If more than one cylinder requires boring for liner fitment the following sequence should be followed:
Bore cylinders 1-3-5-2-4-6 — (6 cylinder),
2-4-1-3 — (4 cylinder).
When using this sequence of boring excessive thermal stress will be avoided.

ADE 360 Series
4. Bore cylinder to 0.05 mm below the final cylinder bore dimension, (fig. 11-9).

**Attention!**
Machine or surface grind cylinder block top face by 0.3 mm to next block height repair stage, i.e. for oversized pistons or liner fitment (see specifications) and ensure correct repair stage pistons are used.

5. Securely mount cylinder block under honing machine. Hone cylinder liners to final dimensions, (see specifications), (fig. 11-10).

6. Before assembling the engine thoroughly clean the cylinder block and crankcase inside and out. Blow out oil galleries ensuring that no residue from the machining process is left.

**REMOVING CYLINDER LINERS**

1. Securely mount crankcase under boring machine, (fig. 11-11).

2. Align and centre boring bar above the cylinder to be machined.

**Attention!**
If more than one cylinder requires boring, the following sequence should be followed:
Bore cylinders 1-3-5-2-4-6 — (6 cylinder),
  2-4-1-3 — (4 cylinder).
When using this sequence of boring excessive thermal stress will be avoided.

3. Insert tool into boring bar head and adjust so that the cylinder liner will be bored out to approximately half its former thickness, (fig. 11-12).
4. Re-set tool in boring bar head and machine cylinder liner to 0.2 mm below outer diameter of cylinder liner (Standard Size). Bore cylinder liner and remove flange, (fig. 11-13).

Attention! At this setting the flange of the liner will become detached from the sleeve.

5. Insert boring bar head into cylinder bore, with cutting tool stationary and in contact with cylinder liner. Move cutting tool vertically up and down cylinder bore, allowing cutting tool to break through wall of cylinder liner. Remove cylinder liner from cylinder block, (fig. 11-14).

REPLACING CYLINDER LINERS

1. Thoroughly clean bore for cylinder liner and flange seat, (fig. 11-15).
2. Mount cylinder block under press and align cylinder bore.
3. Apply a light coating of grease to bore in cylinder block.
4. Locate cylinder liner over bore in cylinder block and align, using a set square, (fig. 11-16).
5. Fit a suitably stepped steel plate between press head and cylinder liner. Press cylinder liner into cylinder block until it protrudes approximately 20 mm, (fig. 11-17).


7. Press cylinder liner fully home, relieve pressure for a short period and press once again, retaining pressure for 5 seconds.

8. Machine or surface grind cylinder block top face by 0.3 mm to next block height repair stage (including protruding cylinder liner) see specifications for required surface finish, (fig. 11-19).

   **Attention!**
   Before machining observe cylinder block height and repair stage and ensure correct repair stage pistons are used. Refer piston compression height and block height specifications.

9. After machining/surface grinding, check cylinder block face with a straight edge, (fig. 11-20).
10. After the cylinder block has been thoroughly cleaned it should be securely mounted under the boring bar, (fig. 11-21).

11. Align and centre the boring bar above the cylinder to be machined.

12. Insert tool into boring bar head and adjust to the required dimension, (fig. 11-22).

13. Bore cylinder liner in several stages to 0,050 mm below the required bore dimension, (fig. 11-23).

Attention!
If more than one cylinder required boring, the following sequence should be followed:
Bore cylinders 1-3-5-2-4-6 (6 cylinder),
  2-4-1-3     (4 cylinder).
When using this sequence of boring, excessive thermal stress will be avoided.

14. Remove cylinder block from boring machine.
15. Securely mount cylinder block under honing machine. 
    Hone cylinder liners to final dimensions, (see specifications), (fig. 11-24).
16. Before assembling the engine thoroughly clean the cylinder block and crankcase inside and out. Blow out oil galleries ensuring that no residue from the machining process is left.
CRANKCASE BREATHER — OPERATION AND PROBLEM DIAGNOSIS

Introduction

Depending on application, the crankcase breather may be mounted to the rocker cover, pushrod cover or timing gear housing, (fig. 25).

The crankcase breather controls the pressure in the crankcase within a prescribed operating range. The device is open to crankcase gasses at the lower end (7) with a connection to the induction manifold (4) and a vent to atmosphere (3).

Note 1: For proper operation the area around the air vent (3) must be kept clean to prevent blockage. In addition all joints, connections and oil filter cap must form a tight seal to prevent crankcase depression losses and/or dirt entry into the engine.

Note 2: The flex point of the breather diaphragm is subject to deterioration e.g. hardening or cracking. It is therefore strongly recommended that the breather be replaced after every two years operation, as a precautionary measure.

1.0 Operation

1.1 Atmospheric pressure acts on the outer surface of the diaphragm (1) via the vent (3). Before start-up, atmospheric pressure will also be present in the crankcase and induction systems. The pressure on both sides of the diaphragm will thus be equal.

1.2 The spring (9) acts against the diaphragm and holds the valve (2) off its seat in the open position. To close the valve, sufficient depression must occur in the crankcase to allow atmospheric pressure acting on the outer surface of the diaphragm, to overcome the spring force. The operation of the breather is therefore dependent on engine operation.

1.3 At engine idle speeds, the spring force will be sufficient to hold the valve from its seat against atmospheric pressure acting on the outer surface of the diaphragm. Crankcase gasses will subsequently be drawn directly into the combustion chambers and will be burnt during the combustion process.

1.4 At normal operating speeds and loads the ever changing induction manifold depression acting within the breather, is higher than the required crankcase depression. The breather will react to the high manifold depression and control crankcase depression. e.g. Should the crankcase depression approach the upper negative limit in the operating range, the valve will move towards the closed position to reduce the effect of manifold depression within the crankcase. The valve in turn will react when crankcase depression is reduced towards the lower or positive limit and will open marginally to allow the high manifold depression access to the crankcase. In this manner the breather will continuously sense and accordingly, respond to manifold depression under various operating conditions and thereby, control crankcase depression with the desired operating range.

Fig. 25

1 — Diaphragm
2 — Valve
3 — Air Vent
4 — To Inlet Manifold
5 — Oil Drain Hole
6 — Gauze
7 — From Crankcase
8 — Perforated Plates
9 — Spring
10 — ‘O’ Ring

Fig. 26

OPERATING RANGE

SERVICE SPECIFICATION FOR ALL BREATHERS:

+10 TO -100 mm H₂O

Note: X — EXAMPLE ONLY = manometer reading - 60 mm H₂O
1.5 Crankcase gasses passing via the breather are oil bearing and most of the oil will be trapped by the gauze mesh (6). Excess oil not trapped by the gauze will return to the crankcase via a drain hole (5) provided in the breather neck. However, it is normal for a small quantity of oil, in the form of mist to be transferred to the intake air to lubricate the valves (3 — 5 g/hr). The dampness created by the oil fumes is normally evident in the inlet manifold of engines utilizing this type of breathing system and is not necessarily indicative of a problem.

2.0 Operational Test

2.1 Park the vehicle on level ground and ensure that the oil level is correct (not over-filled).

2.2 Use a water manometer (see fig. 26) and connect one end of the gauge to the engine dipstick guide tube. The other end of the tube is left open to atmospheric pressure. Before starting the engine ensure that the instrument registers a zero reading in both columns.

2.3 Start and run the engine at idle speed. A tendency towards a negative reading (—) should be noted.

2.4 Gradually increase the engine speed to approximately 1 500 r/min. The instrument should indicate a negative reading increasing within the operating range.

2.5 Further increase the engine speed to approximately 2 000 r/min. The negative reading should raise within the operating range. This would indicate that the valve is working.

Note 3: The operational characteristics of a breather will depend on the condition of the engine e.g. amount of blowby.

3.0 Evaluation of Test Results

3.1 Minimal negative reading at low r/min with little or no change at high r/min.

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Gauge connections leaking</td>
<td>— Secure connections</td>
</tr>
<tr>
<td>b) Leak in vacuum line to manifold</td>
<td>— Check and correct</td>
</tr>
<tr>
<td>c) Poor seal at breather mounting</td>
<td>— Check/replace O-ring or gasket</td>
</tr>
<tr>
<td>d) Diaphragm cracked/holed</td>
<td>— Renew breather</td>
</tr>
</tbody>
</table>

3.2 Excessively high negative reading.

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Valve not closing</td>
<td>— Check b, c, d below, or renew breather</td>
</tr>
<tr>
<td>b) Vent hole blocked</td>
<td>— Clear and retest</td>
</tr>
<tr>
<td>c) Vent hose pinched</td>
<td>— Repair hose and retest</td>
</tr>
<tr>
<td>d) Foreign particle on valve seat</td>
<td>— Remove object and retest</td>
</tr>
<tr>
<td>e) Diaphragm ruptured</td>
<td>— Renew breather</td>
</tr>
</tbody>
</table>

3.3 Excessive positive reading is indicated at all engine speeds.

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Broken collapsed spring</td>
<td>— Renew breather</td>
</tr>
<tr>
<td>b) Valve stuck in closed position</td>
<td>— Renew breather</td>
</tr>
<tr>
<td>c) Blockage of breather gauze by sludge*</td>
<td>— Wash in clean diesel if this fails, renew breather</td>
</tr>
<tr>
<td>d) Severe combustion gas blowby</td>
<td>— Repair as necessary</td>
</tr>
</tbody>
</table>

*Investigate reason for sludge and rectify.

Note 4: As a rule crankcase pressure depression should remain within the prescribed range (+ 10 to — 100 mm H₂O). If this is not the case and all possible contributing factors have been eliminated, it may be assumed that the breather is faulty.

4.0 Conclusion

A faulty crankcase breathing system could result in the following problems:

4.1 Excessive oil consumption.

4.2 Dust entry via — a) A ruptured or punctured diaphragm,
                        b) A poor seal at the “O” ring (10),
                        c) Other inlet or crankcase connections, could cause serious damage to the engine.

4.3 A high crankcase pressure could force oil past the crankshaft and turbocharger seals.

ADE 360 Series
REMOVAL AND REPLACEMENT OF BREATHER

Removal

1. Unscrew clip on pipe leading to inlet manifold, (fig. 11-27).

2. Remove pipe with clip, (fig. 11-28).

3. Unscrew clamp on crankcase end of breather pipe, (fig. 11-29).

4. Pull off breather from mounting pipe, (fig. 11-30).
5. Remove o-ring from the inside of the breather pipe, (fig. 11-31).

Replacing

1. Fit new o-ring in the breather pipe, (fig. 11-32).

2. Slide breather with o-ring into place over mounting pipe, (fig. 11-33).

3. Align breather to inlet manifold and secure clamp over inlet pipe, (fig. 11-34).
4. Replace pipe leading to the inlet manifold, (fig. 11.35).

5. Tighten clip on the pipe, (fig. 11.36).
ADE 364 and ADE 366

Workshop Manual
Section 12 - Cylinder Head
SECTION 12-1
Cylinder Head

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<td>12-11</td>
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<tr>
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<tr>
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<td>REPLACING CYLINDER HEAD</td>
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<tr>
<td>VALVE CLEARANCE ADJUSTMENT 364</td>
<td>12-23</td>
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<tr>
<td>VALVE CLEARANCE ADJUSTMENT 366</td>
<td>12-24</td>
</tr>
<tr>
<td>REPLACING ROCKER COVER</td>
<td>12-24</td>
</tr>
<tr>
<td>CHECKING COMPRESSION PRESSURE</td>
<td>12-25</td>
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<tr>
<td>SPECIAL SERVICE TOOLS</td>
<td>12-27</td>
</tr>
</tbody>
</table>
INTRODUCTION

Utilising the latest in automotive engineering technology, the ADE 360 series cylinder head is of advanced design common for all cylinders and is manufactured from high grade grey cast iron alloyed with copper and chrome, and machined to a very high tolerance. The fuel injectors are mounted within the cylinder head and enclosed by a light alloy rocker cover. Separate inlet and exhaust manifolds are fitted, providing enhanced gas flow and improved fuel efficiency.

SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall height of cylinder head (new)</td>
<td>92,1</td>
</tr>
<tr>
<td>Minimum height after machining*</td>
<td>90,9</td>
</tr>
<tr>
<td>Peak to valley finish of mating surface in (microns)</td>
<td>8,16 μm</td>
</tr>
<tr>
<td>Distortion limit over Length of head</td>
<td>0,150</td>
</tr>
<tr>
<td>Distortion limit over distance of 150 mm</td>
<td>0,040</td>
</tr>
<tr>
<td>Max parallel deviation between upper and lower surface</td>
<td>0,1</td>
</tr>
<tr>
<td>Injector nozzle protrusion</td>
<td>1,6-2,6</td>
</tr>
<tr>
<td>Leakage test pressure with cylinder head submerged in water at 70°C</td>
<td>200 kPa</td>
</tr>
</tbody>
</table>

*Check nozzle protrusion after each machining stage of cylinder head mating surface and correct with nozzle shims if required. When minimum height is reached fit 1 mm spacer under rocker pedestals.

VALVE SEAT INSERTS

<table>
<thead>
<tr>
<th></th>
<th>Inlet valve seat insert</th>
<th>Exhaust valve seat insert</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD “D” of valve seat insert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43,88</td>
<td>44,18</td>
<td>44,36</td>
</tr>
<tr>
<td>43,87</td>
<td>44,17</td>
<td>44,37</td>
</tr>
<tr>
<td>Basic bore “D 1” in cylinder head for valve seat insert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43,825</td>
<td>44,125</td>
<td>44,325</td>
</tr>
<tr>
<td>43,800</td>
<td>44,100</td>
<td>44,300</td>
</tr>
<tr>
<td>Interference fit of seat insert in cylinder head</td>
<td>0,045-0,080</td>
<td>0,045-0,080</td>
</tr>
<tr>
<td>Depth “t” of bore in cylinder head</td>
<td>11,2</td>
<td>11,0</td>
</tr>
<tr>
<td>Height “H” of valve seat insert</td>
<td>7,4</td>
<td>7,3</td>
</tr>
<tr>
<td>Distance “t11” between mating surface of cylinder head and face of valve seat insert</td>
<td>3,6-3,9</td>
<td>2,9-3,2</td>
</tr>
</tbody>
</table>
VALVE SEATS

<table>
<thead>
<tr>
<th></th>
<th>Exhaust</th>
<th>Inlet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve seat angle</td>
<td>45°</td>
<td>30°</td>
</tr>
<tr>
<td>Diameter &quot;A&quot; of valve seat with new valve seat inserts after machining</td>
<td>35,3</td>
<td>41,3</td>
</tr>
<tr>
<td>Width &quot;B&quot;</td>
<td>1,8-3,0</td>
<td>1,3-2,4</td>
</tr>
<tr>
<td>Size &quot;C&quot; Inspection size</td>
<td>2,9-3,2</td>
<td>3,6-3,9</td>
</tr>
<tr>
<td>Valve recession*</td>
<td>0,7-1,1</td>
<td></td>
</tr>
</tbody>
</table>

*If the valve recession is exceeded after machining the valve seat inserts, new inserts must be fitted.

VALVE SPRINGS

<table>
<thead>
<tr>
<th>ID</th>
<th>Wire dia.</th>
<th>Unloaded length</th>
<th>Preloaded Length (1)</th>
<th>Load (N)</th>
<th>Final Load Length (2)</th>
<th>Load (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25,0 - 25,4</td>
<td>4,25</td>
<td>60,5</td>
<td>46,7</td>
<td>285 - 315</td>
<td>35,18</td>
<td>570 - 630</td>
</tr>
</tbody>
</table>

1) In installed condition. Corresponds to length with valve closed.
2) In installed condition. Corresponds to length with valve opened.
## VALVE GUIDES

<table>
<thead>
<tr>
<th>Stages</th>
<th>OD</th>
<th>Valve guide ID</th>
<th>Valve guide length</th>
<th>Bore in cylinder head</th>
<th>Interference in cylinder head</th>
<th>Clearance of valve stem in valve guide</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inlet</td>
<td>Exhaust</td>
<td>Inlet</td>
<td>Exhaust</td>
<td>Inlet</td>
</tr>
<tr>
<td>Standard</td>
<td>15.046</td>
<td>15.028</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rep. stage 1</td>
<td>15.146</td>
<td>15.128</td>
<td>9,022*</td>
<td>10,022**</td>
<td>(&quot;B&quot;) (&quot;C&quot;)</td>
<td>0.010</td>
</tr>
<tr>
<td>Rep. stage 2</td>
<td>15.246</td>
<td>15.228</td>
<td>9,000</td>
<td>10,000</td>
<td>72</td>
<td>0.046</td>
</tr>
<tr>
<td>Rep. stage 3</td>
<td>15.546</td>
<td>15.528</td>
<td></td>
<td></td>
<td></td>
<td>15.518</td>
</tr>
</tbody>
</table>

* Wear limit 9.050
**Wear limit 10.050

Maximum off centre of valve seat to valve guide

<table>
<thead>
<tr>
<th>Maximum cylindrical deviation of valve seat to valve guide at</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 mm dia for inlet</td>
</tr>
<tr>
<td>34 mm dia for exhaust</td>
</tr>
</tbody>
</table>

| 0.01 |
| 0.04 |

"A" — Replacement Valve guide installation height

Valve stem/guide clearance

<table>
<thead>
<tr>
<th>Inlet valve — reading not to exceed</th>
<th>Exhaust valve — reading not to exceed</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 mm</td>
<td>0.3 mm</td>
</tr>
</tbody>
</table>

**NOTE:** Replacement valve guides must be used together with valve stem seals.
## CYLINDER HEAD — 12-6

### VALVES

<table>
<thead>
<tr>
<th>Dimen­ sions (mm)</th>
<th>&quot;A&quot; Seat Angles</th>
<th>&quot;B&quot; Dia Seat Centre</th>
<th>&quot;C&quot; Valve Head Dia</th>
<th>&quot;D&quot; Height New Min</th>
<th>&quot;E&quot; Width</th>
<th>&quot;F&quot; Stem Dia</th>
<th>Stem Hardness</th>
<th>Valve Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet</td>
<td>30°</td>
<td>40</td>
<td>42,9</td>
<td>2,8</td>
<td>2,1</td>
<td>4,3</td>
<td>8,950</td>
<td>60 HRC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>42,7</td>
<td>2,6</td>
<td>3,3</td>
<td>8,935</td>
<td>54</td>
<td>140,3</td>
</tr>
<tr>
<td>Exhaust</td>
<td>45°</td>
<td>34</td>
<td>36,10</td>
<td>2,8</td>
<td>2,1</td>
<td>4,2</td>
<td>9,940</td>
<td>60 HRC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>35,90</td>
<td>2,5</td>
<td>3,5</td>
<td>9,925</td>
<td>54</td>
<td>14,03</td>
</tr>
</tbody>
</table>

- Runout between valve seat and stem: 0.03
- Runout between valve head and stem: 0.20
- Ovality of valve seat: 0.01

### VALVE ADJUSTMENT

Valve clearance (temperature max, 50°C)

<table>
<thead>
<tr>
<th></th>
<th>360 Series N</th>
<th>360 Series C/TTI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Exhaust</td>
<td>0.60</td>
<td>0.60</td>
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</tbody>
</table>

### VALVE TIMING

<table>
<thead>
<tr>
<th></th>
<th>Inlet</th>
<th>Exhaust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>BTDC</td>
<td>BBDC</td>
</tr>
<tr>
<td>Close</td>
<td>ABDC</td>
<td>ATDC</td>
</tr>
<tr>
<td></td>
<td>15°</td>
<td>67°</td>
</tr>
<tr>
<td></td>
<td>15°</td>
<td>68°</td>
</tr>
<tr>
<td></td>
<td>45°</td>
<td>13°</td>
</tr>
<tr>
<td></td>
<td>25°</td>
<td>12°</td>
</tr>
</tbody>
</table>

### ROCKERSHAFT/ROCKER ARM

<table>
<thead>
<tr>
<th></th>
<th>22,052</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic bore rocker arm</td>
<td>22,000</td>
</tr>
<tr>
<td>Rocker arm bush</td>
<td>22,130</td>
</tr>
<tr>
<td>Outer dia.</td>
<td>22,100</td>
</tr>
<tr>
<td>Inner dia.</td>
<td>20,021</td>
</tr>
<tr>
<td></td>
<td>20,000</td>
</tr>
<tr>
<td>Rocker shaft dia</td>
<td>19,980</td>
</tr>
<tr>
<td></td>
<td>19,967</td>
</tr>
<tr>
<td>Clearance shaft/bore</td>
<td>0.020-0.054</td>
</tr>
</tbody>
</table>

### TORQUE SPECIFICATIONS

The following torque specifications will apply with the components lightly oiled.

- Cylinder head bolts ................................. 1st Stage: 60 N.m
- (Maximum stretch length 113mm) 2nd Stage: 90 N.m
- 3rd Stage: 120 - 130 N.m
- 4th Stage: 90°-100°
- Screw plugs to cylinder head ..................... M24 x 1,5 ... 70-150 N.m
- M30 x 1,5 ... 100-200 N.m
- Injector protection sleeve to cylinder head .... M14 x 1,5 ... 50 N.m
- Injector securing nut to cylinder head ........ M34 x 1,5 ... 70 N.m
- Rocker cover to cylinder head .................... M8 ... 25 N.m
- Valve adjusting screw lock nut .................... M12 x 1 ... 40 N.m
- Rocker shaft pedestal to cylinder head ........... M12 ... 100 N.m
- Rocker shaft lock screw to pedestal ............. M6 ... 5 N.m
- Exhaust manifold to cylinder head ............... M10 ... 60 N.m + 90°
- Inlet manifold to cylinder head ................. M8 x 1 ... 30 N.m
- (Check at every service)
- Turbocharger to exhaust manifold 366C/T/TTI .......... M10 .... 50 N.m
- 364C/T .... M10 .... 30 N.m
- Exhaust flange to turbocharger .................. M8 .... 30 N.m
- Pressure duct to turbocharger (V-clamp) ......... 6 N.m
REMOVAL OF ROCKER COVER

1. Unscrew and remove bolts retaining rocker cover, (fig. 12-1).

2. Lift off rocker cover, (fig. 12-2).

3. Remove gasket from cylinder head, (fig. 12-3).

REMOVING CYLINDER HEAD

Preparation

Clean the entire upper half of the engine, to prevent dirt entering the cylinder bores and tappet chamber.

1. Drain coolant from radiator and cylinder block.
2. Remove fuel filters and if fitted, power steering pump (fig. 12-4).
3. Disconnect radiator hoses and dipstick guide tube.
4. Disconnect and remove thermostat housing.
5. Remove rocker cover, see page 12-7.

6. Unscrew and remove clamps retaining injector pipes, (fig. 12-5).

7. Disconnect outer injector pipe connections on cylinder head, (fig. 12-6).

8. Using special tool part number 40200705, unscrew and remove injector pipes, (fig. 12-7).

9. Unscrew and remove fuel leak off pipe, (fig. 12-8).
10. Remove injector pipes from cylinder head.
11. Unscrew bolts retaining rocker assembly, (fig. 12-9).
12. Remove rocker assembly (and connecting niple 6 cylinder only).

13. Lift out pushrods. The pushrods should be numbered to ensure replacement in the original positions, (fig. 12-10).

14. Remove injector securing nuts, using special tool part number 40200873, (fig. 12-11).

15. Remove injectors from cylinder head, using impact puller part number 40201076, (fig. 12-12).
Attention!
16. Should the injectors not move using impact puller, use special tool part number 40201063, (fig. 12-13).
17. Disconnect exhaust down pipe.

18. Unscrew bolts and remove exhaust manifold, (if fitted with a turbocharger, disconnect turbocharger oil feed and drain pipes first), (fig. 12-14).

19. Unscrew bolts and remove inlet manifold, (fig. 12-15).

21. Screw lifting handles, part number 40200747 into cylinder head and lift off from cylinder block. Remove lifting handles from cylinder head, (fig. 12-17).

22. Remove cylinder head gasket, and clean top of cylinder block, (fig. 12-18).

CHECKING VALVE RECESSION

1. Place special tool part number 40201351 onto the cylinder head with the probe of the dial gauge resting on a valve head. Note reading on dial gauge and check the remainder of the valves in this manner, ensure that readings correspond with the specifications, (fig. 12-19).

REMOVING VALVES as follows:

2. Attach valve spring compressor, Part No. 40200679, to exhaust manifold stud, (fig. 12-20).
3. Press down lever of valve spring compressor and remove collets, (fig. 12-21).

4. Remove valve spring cap, valve, spring and valve spring seating washer, (fig. 12-22).

5. Turn over cylinder head and remove valves.

Attention! Before removing valves, ensure they are numbered in the correct replacement sequence (fig. 12-23). Do not pin punch or stamp number on the valves as this may weaken the valve head.

CHECKING VALVE STEM/GUIDE CLEARANCE

6. Insert valves so that the valve heads protrude by 10 mm. Using a magnetic based dial gauge, place the probe against the outer diameter of the valve head. Zero the gauge whilst the valve is pushed against the probe. After zeroing the gauge, push the valve away from the probe and note the reading (fig. 12-24). This procedure must be carried out on all valves. Check readings against specifications.
VALVE FACING

1. Remove carbon deposits from valves.

2. Check to see if valves can be re-used. Valve ends must have no surface damage. Valve collet grooves must not be worn and chromium plating on valve stems must be without flaws. Burnt valves must always be replaced.

3. Using V-blocks and a dial gauge, check run out of valve stems. Do not attempt to straighten bent valves, (fig. 12-25).

4. If no V-blocks and dial gauge is available, a quick check can be made using a suitable straight edge, (fig. 12-26).

5. Minor variations in tolerance can be corrected by refacing on a valve grinder.

6. Adjust grinding angle to 30° for inlet and 45° for exhaust, insert valve and clamp directly behind valve head to avoid vibration (fig. 12-27).

7. Using a low feed rate grind until valve face is cleanly cut all round.

8. The valve stem face can be lightly ground, by locating the valve stem in the special attachment mounted on the valve grinding machine, (fig. 12-28).

Fig. 12-25

Fig. 12-26

Fig. 12-27

Fig. 12-28
Cylinder Head — 12-14

Valve Seat Facing
1. Place cylinder head on wooden blocks.
2. Insert valve seat facing tool and re-cut seat to 30° for inlet and 45° for exhaust, (fig. 12-29).

Caution: Do not cut valve seat diameter above their maximum limits, see specifications.

Note: As the replacement of valve seats requires the use of certain specialised equipment, we suggest that this operation is carried out by an ADE approved engine reconditioner. If valve guides need to be replaced new guides must be fitted before valve seat re-facing.

Removing Valves Guides
1. Place cylinder head under a hydraulic press.
2. Using suitable mandrel press out valve guides from cylinder head, (fig. 12-30).

3. If necessary, ream valve guide parent-bore in cylinder head to next repair stage using special tool Part No. 40200750, (fig. 12-31).

Replacing Valve Guides
1. Coat new valve guide with graphited oil and position in cylinder head, (fig. 12-32).
2. Fit 17 – 17,5 mm spacer from special tool Part No. 40200556 over valve guide, (fig. 12-33).

3. Using mandrel of special tool Part No. 40200556, press valve guide into cylinder head to the specified installation height, (fig. 12-34) i.e. until flush with spacer.

4. Finish inner diameter of valve guide, using special reamer part number 40200828 (exhaust), 40209591 (inlet), (fig. 12-35).

5. Using a spring tension tester, check valve springs and ensure they conform to specification, (fig. 12-36).
CHECKING CYLINDER HEAD

1. Using a straight edge, check surface of cylinder head for distortion along its length, (fig. 12-37).

2. And across the cylinder head (fig. 12-38). If the cylinder head is found to be distorted, it must be refaced to the required surface specification and height.

Note: Observe fuel injector protrusion when refacing cylinder head. Refer to procedure on page 12-19.

REPLACING VALVES

1. Insert valve stem oil seal item 3 (fig. 12-42) into special tool part number 40202253, (fig. 12-39).

2. Place oil seal onto top of valve guide and press down as far as possible, (fig. 12-40).
3. Liberally oil valve stems item 1 (fig. 12-42) and insert valves into cylinder head. Ensure that the valves are inserted in their original positions, (fig. 12-41).

4. Fit valve spring seating washer (2), valve spring (4) and valve spring cap (5), (fig. 12-42).

5. Attach valve spring compressor part number 40200679, to exhaust manifold stud, (fig. 12-43).

6. Press down lever of valve spring compressor and insert valve collets, items 6, (fig. 12-42). Release lever and ensure that the collets are seated correctly. The gap between the collets should be identical, (fig. 12-44).
INJECTOR PROTECTION SLEEVES

When overhauling the cylinder head it is essential that all the injector protection sleeves are removed and examined for corrosion.

Removing

1. Using special tool part number 4020 0624, unscrew and remove all injector protection sleeves, (Fig. 12-45).
2. Examine outer surface of protection sleeves for corrosion. Badly corroded sleeves must be replaced.
3. Remove all injector protection sleeve O-ring seals from the cylinder head. **DO NOT RE-USE**, (Fig. 12-46).

Replacing

1. Apply silicon grease to new O-ring seals and insert into cylinder head, (Fig. 12-47).
2. Lightly coat bottom surface of protection sleeves with a silicon sealing compound, (Fig. 12-48).
3. Insert sleeves and tighten to the specified torque, using special tool part number 4020 0624, (Fig. 12-49).

CHECKING FUEL INJECTOR PROTRUSION

4. Attach a dial gauge with a magnetic base, to the cylinder head with the probe of the dial gauge resting on the tip of the injector nozzle.

Attention: Note reading on dial gauge and check the remainder of the injection nozzles in this manner, ensuring that measurements correspond with the specifications. The depth of the injectors can be altered by fitting a thicker or thinner sealing washer, (Fig. 12-50).

REPLACING CYLINDER HEAD

Ensure cylinder head and block faces are clean.

1. Using compressed air, blow out bolt holes in top of cylinder block, (Fig. 12-51).

2. Place new cylinder head gasket in position, (Fig. 12-52)
3. Screw lifting handles, part number 4020 0747, onto cylinder head, and lift into position. (Fig. 12-53).

4. Unscrew and remove lifting handles. Lubricate threads and grip area of the cylinder head bolts, (Fig. 12-54: 12-55) insert bolts and screw down.

5. Tighten cylinder head bolts in four stages (see specifications) by referring to sequence diagram below. (Fig. 12-56).
6. Insert pushrods, ensuring they are placed in their original positions, (Fig. 12-57).

7. Replace rocker shafts, insert bolts but DO NOT tighten, (Fig. 12-58).

8. Using special tool part number 4020 2185, insert connecting nipple between rocker shafts, (Fig. 12-59). Not required on ADE 364.

9. Tighten rocker shaft bolts to the specified torque, (Fig. 12-60).
10. Replace the fuel injectors and tighten securing nuts to the specified torque, using special tool part number 4020 0873, (Fig. 12-61).


Note: Seal outer connections with hylomar or suitable sealant. Tighten all connections to the specified torque, using special tool part number 4020 0718, (Fig. 12-62).

12. Tighten all fuel leak-off bolts to the specified torque, (Fig. 12-63).

13. Replace inlet manifold fitted new gaskets, and tighten bolts to the specified torque, (Fig. 12-64).

Note: Inlet manifold must be fitted before exhaust manifold.
14. Replace exhaust manifold with new gasket, and turbocharger if fitted. Tighten all bolts from the middle outwards, to the specified torque. (Fig. 12-65).

15. Using a new gasket, attach exhaust down pipe to manifold, insert bolts and tighten to the specified torque.

16. Fit radiator hoses and tighten clips, attach dipstick guide tube.

17. Replace fuel filters, and if fitted, power steering pump. Re-tension V-belt. (Fig. 12-65).

**VALVE CLEARANCE ADJUSTMENT ADE 364**

1. Insert feeler gauge between valve stem and rocker arm. Valve clearance is correct when the feeler gauge slides through with a slight resistance, (Fig. 12-67).

2. If the valve clearance requires adjustment, release the lock nut, adjust valve clearance and tighten the lock nut while holding the adjusting screw.

<table>
<thead>
<tr>
<th>Description</th>
<th>ADE 364</th>
<th>ADE 366</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Crankshaft</td>
<td>Intake valves to be adjusted</td>
<td>Exh. valves to be adjusted</td>
</tr>
<tr>
<td>position of cylinder No.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>364</td>
<td>No.1 valve rocking 3,4</td>
<td>2,4</td>
</tr>
<tr>
<td></td>
<td>No.1 valve closed 1,2</td>
<td>1,3</td>
</tr>
</tbody>
</table>

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**VALVE CLEARANCE ADJUSTMENT ADE 366**

1. Insert feeler gauge between valve stem and rocker arm. Valve clearance is correct when the feeler gauge slides through with a slight resistance.

2. If the valve clearance requires adjustment, release lock nut and adjust the valve clearance. Tighten lock nut while holding the adjusting screw, (Fig. 12-69).

**Description**

<table>
<thead>
<tr>
<th>Description</th>
<th>ADE 364</th>
<th>ADE 366</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine</td>
<td>Crankshaft Intake valves Exh. valves position of to be adjusted to be adjusted cylinder No.1</td>
<td></td>
</tr>
<tr>
<td>366</td>
<td>No.1 valve rocking</td>
<td>3,5,6</td>
</tr>
<tr>
<td></td>
<td>No.1 valve closed</td>
<td>1,2,4</td>
</tr>
</tbody>
</table>

**REPLACING ROCKER COVER**

1. Check surface of rocker cover for damage, (Fig. 12-71).

2. Fit new rocker cover gasket to cylinder head, (Fig. 12-72).
3. Place rocker cover in position, insert bolts and tighten to the specified torque, (Fig. 12-73).

4. Replace thermostat housing and tighten bolts to the

5. Fill radiator with coolant, start engine and run to opera-

CHECKING COMPRESSION

1. Remove rocker cover.

2. Check valve clearance, (see page 12-23).

3. Replace rocker cover.

4. Run engine until operating temperature is reached (70-95).

5. Ensure that the battery is in a good condition.

6. Remove rocker cover, injectors and sealing washers.

7. Set injection pump control to stop position.

Testing

1. Insert injector sealing washer, (Fig. 12-74).

2. Insert adaptor for the compression tester (part number 4020 0789) in the cylinder head and tighten with injector securing nut, (Fig. 12-75).

3. Attach compression tester extension to adaptor, (Fig. 12-76).

4. Check compression at an engine speed of approximately 180-200 r/min (starter speed) with the throttle in the closed position. Turn the engine until the test indicator stops rising. Repeat this procedure for all cylinders.

5. Remove compression tester and adapter.

6. Replace sealing washers, injectors and leak off pipes, tighten to the specified torque.
7. Replace rocker cover and tighten bolts to the specified torque. (Fig. 12-77).
# SPECIAL TOOLS FOR THIS SECTION

**OBTAINABLE FROM:** GRUNDY-TECHNIFORM, BURMAN ROAD, DEAL PARTY ESTATE, PORT ELIZABETH 6001

<table>
<thead>
<tr>
<th>Tool Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Split ring spanner for injector pipes. (see fig. 12-7)</td>
<td>40200705</td>
</tr>
<tr>
<td>Socket for injector securing nuts (see fig. 12-11, 12-61)</td>
<td>40200873</td>
</tr>
<tr>
<td>Fuel injector impact extractor (see fig. 12-12)</td>
<td>40201076</td>
</tr>
<tr>
<td>Extractor for injectors (see fig. 12-13)</td>
<td>40201063</td>
</tr>
<tr>
<td>Lifting handles cylinder head (see fig. 12-17, 12-53)</td>
<td>40200747</td>
</tr>
<tr>
<td>VALVE DEPTH GAUGE (see fig. 12-19)</td>
<td>40201351</td>
</tr>
</tbody>
</table>
Valve spring compressor
(see fig. 12-43)
Part Number 40200679
  40200682

Reamer for valve guide
parent bore in cyl./head
13.5 x 15.5 mm
(see fig. 12-31)
Part Number 40200750

Valve guide replacement
mandrel
(see fig. 12-33, 12-34)
Part Number 40200556

Reamer for exhaust valve guides
(see fig. 12-35)
Part Number 40200828

Reamer for inlet valve guides
(see fig. 12-35)
Part Number 40209591

Valve stem seal
replacing tool
(see fig. 12-40)
Part Number 40202253

Removing/Replacing tool for
injector protection sleeves
(see fig. 12-45, 12-49)
Part Number 40200624

Pliers rocker shaft
coupling bush
(see fig. 12-59)
Part Number 40202185
ADE 366N/C/T/TI only
Crowfoot ring spanner Remover
Replacement of injector pipes
(see fig. 12-62)
Part Number 40200718

Adaptor for compression tester,
(see fig. 12-75)
Part Number 40200789

Attention!
As we recommend that the removal and replacement of valve seats should only be carried out by an ADE Approved engine rebuilders, the use of these three special tools is not illustrated in the text. These special tools are however obtainable from Grundy-Techniform.

| Puller | Extractor for valve seats 38-46 mm | Valve seat replacing tool for 352 C/T
| Part Number 40200585 | Part Number 40200572 | Engine No. SA 037892P & UP
|        |                                  | Part Number 40202347 |
Piston and Connecting Rods 13-2

1. SMALL END BUSH
2. CONNECTING ROD
3. CONNECTING ROD BOLTS
4. BEARING SHELLS
5. CIRCLIPS
6. COMPRESSION RING
7. COMPRESSION RING
8. OIL SCRAPER RING
9. PISTON
10. GUDGEON PIN
INTRODUCTION

The light alloy pistons used have the combustion chamber cast in the piston crown. Two compression and one oil control ring are fitted to the pistons with the top compression ring retained in an Al-fin bonded insert. Gudgeon pins are tubular to reduce weight and are located in the pistons by circlips. Cooling nozzles are fitted to assist with piston cooling of turbocharged engines.

Forged steel connecting rods are used with serrated mating surfaces between the connecting rod and the cap to provide increased rigidity and to extend bearing life. The big-end bearing shells are steel backed and lined with aluminium/tin. The small-end bush is manufactured from a high quality phosphor bronze and seats in an interference fit in the connecting rod.

With the cylinder head and sump removed, the pistons can easily be withdrawn from the top of the cylinder block.

PISTONS AND CONNECTING RODS

<table>
<thead>
<tr>
<th>Repair stages</th>
<th>Nominal Piston diameter</th>
<th>Compression height **</th>
<th>Block height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard N/C/T/TI</td>
<td>97.5</td>
<td>62.80 to 62.86</td>
<td>358.82 to 359.07 (STD)</td>
</tr>
<tr>
<td>Rep 1 N + 0.5 Rebore</td>
<td>98.00</td>
<td>62.50 to 62.56</td>
<td>358.52 to 358.77 (-0.3)</td>
</tr>
<tr>
<td>Rep 1 N/C/T/TI</td>
<td>97.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rep stage 2 N/C/T/TI</td>
<td>97.5</td>
<td>62.20 to 62.26</td>
<td>358.22 to 358.47 (-0.6)</td>
</tr>
<tr>
<td>Rep stage 3 N/C/T/TI</td>
<td>97.5</td>
<td>61.90 to 61.96</td>
<td>357.92 to 358.17 (-0.9)</td>
</tr>
</tbody>
</table>

* 1st repair stage for naturally aspirated optional, i.e. either rebore for oversize piston or fit sleeve.

** measurement from gudgeon pin centre to piston top.

Max weight variation between pistons 20g

Gudgeon pin diameter 35.995 to 36.000

Gudgeon pin bore diameter 36.002 to 36.007

Gudgeon pin to piston bore clearance 0.002 to 0.012

Piston protrusion at TDC to block surface 0.170 to 0.580

Note: The codes BA09 or BC01 appear on the piston crowns. These are grading codes for production only.

PISTON RINGS

<table>
<thead>
<tr>
<th>360N/C/T/TI</th>
<th>Type</th>
<th>Side Clearance</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Keystone</td>
<td>0.042 to 0.097</td>
<td>0.20 to 0.35</td>
</tr>
<tr>
<td>2</td>
<td>Tapered face compression</td>
<td>0.060 to 0.095</td>
<td>0.20 to 0.35</td>
</tr>
<tr>
<td>3</td>
<td>Oil control (spring expander)</td>
<td>0.030 to 0.065</td>
<td>0.25 to 0.40</td>
</tr>
</tbody>
</table>

Attention: Gap and side clearance are equal to above in all bore repair stages.

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### CONNECTING ROD

<table>
<thead>
<tr>
<th>Repair size</th>
<th>Connecting rod bearing diameter installed</th>
<th>Connecting rod width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Big end</td>
</tr>
<tr>
<td>Standard</td>
<td>60,056 to 60,095</td>
<td>37,730 to 37,830</td>
</tr>
<tr>
<td>Standard 1 (-0.1)</td>
<td>59,956 to 59,995</td>
<td></td>
</tr>
<tr>
<td>Standard 2 (-0.25)</td>
<td>59,806 to 59,845</td>
<td></td>
</tr>
<tr>
<td>Rep 1 (-0.5)</td>
<td>59,556 to 59,595</td>
<td></td>
</tr>
<tr>
<td>Rep 2 (-0.75)</td>
<td>59,306 to 59,345</td>
<td></td>
</tr>
<tr>
<td>Rep 3 (-1.0)</td>
<td>59,056 to 59,095</td>
<td></td>
</tr>
</tbody>
</table>

- Connecting rod big end basic bore: 65,000 to 65,019
- Taper of big end basic bore: 0.005
- Big end bearing clearance:
  - radial: 0.041 to 0.100
  - axial: 0.10 to 0.40
- Length of connecting rod between centres of big end and small end: 230.00 to 230.05
- Weight variation between connecting rods for repair: 40g
- Max. parallel deviation between centre line of big end and small end: 0.010
- Big end bearing crush: 0.04 to 0.07

### SMALL END

<table>
<thead>
<tr>
<th>Small end basic bore in connecting rod</th>
<th>standard</th>
<th>Rep 1 (+0.2)</th>
<th>Rep 2 (+0.5)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>39,000 to 39,025</td>
<td>39,200 to 39,225</td>
<td>39,500 to 39,525</td>
</tr>
</tbody>
</table>

- Small end bush:
  - Inner diameter installed: 36,030 to 36,040
  - Taper/ovality tolerance: 0.002
  - Interference fit: 0.020 to 0.075
  - Clearance to gudgeon pin: 0.030 to 0.045

### TORQUE SPECIFICATIONS

- Connecting rod bolts:
  - 1st stage: 40-50 Nm
  - Final: +90⁰-100⁰
  - Stretch limit: 56.8 mm (M12)

- Piston cooling nozzles - up to engine no. SA 070900V:
  - M10 x 1: 25 Nm
  - from engine no. SA 070901V:
    - M10 x 1: 15-18 Nm

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Removing

1. Using a suitable scraper, remove carbon deposits from top of cylinder bores, (Fig. 13-1).

2. Unscrew retaining bolts and remove piston cooling nozzles, 360C/T/Ti, (Fig. 13-2).
   360N engines have closing plugs in place of nozzles.

3. Unscrew connecting rod bolts and remove bearing caps, (Fig. 13-3).
   **Attention!** Bearing caps and connecting rods are marked as matched pairs (note numbers before assembly).

4. Remove pistons and connecting rods from top of cylinder block, (Fig. 13-4).
5. Remove bearing shells from cap and connecting rods, if the old bearing shells are to be used again, mark shells to ensure replacement in the original position, (Fig. 13-5).

Removal of Piston Rings/Piston from Connecting Rods.

1. Clamp connecting rod and piston assembly in a vice, fitted with protective jaws, (Fig. 13-6).

2. Turn adjusting screw of ring expander, part number 4020 0307, to approx. 98 mm, (Fig. 13-7).

3. Remove piston rings at this setting, (Fig. 13-8).
4. Remove circlips from piston, push out gudgeon pin and remove piston from connecting rod, (Fig 13-9).

Checking Big End Bearings

1. Clean connecting rod and bearing cap surface, (Fig. 13-10).

2. Fit big end bearing cap and insert bolts, (cap and connecting rod numbers aligned), (Fig. 13-11).

3. Tighten connecting rod bolts to the specified torque, (Fig. 13-12).
4. Using an internal measuring instrument check big end parent bore in three places, (Fig. 13-13).

5. Using an internal measuring instrument check bore of the small end bush, (Fig. 13-14).

Attention! If the small end bush inner diameter does not meet the specification, the bush must be pressed out and replaced. With the small end bush removed, check the parent bore and, if necessary, machine to the 1st repair stage. Standard and oversize outside diameter small end bushes have an unfinished inner diameter which must be reamed to the specified size after installation. When fitting a new small end bush to the conrod, a lubricating hole must be drilled after the bush is fitted. Reaming of the bush can now be carried out.

6. Mount the connecting rod in an alignment gauge and check for bending, (Fig. 13-15).

7. Check for twisting, (Fig. 13-16).

WARNING! Under no circumstances should any attempt be made to straighten a bent connecting rod. Connecting rods that do not conform to specifications must always be replaced.
8. Unscrew connecting rod bolts and remove bearing caps. (Fig. 13-17).

9. Fit bearing shells into connecting rod and bearing cap. Ensure that the locating tabs are fitted correctly. (Fig. 13-18).

10. Fit bearing cap to the connecting rod, (numbers on the bearing cap and connecting rod aligned). Clamp connecting rod in a vice fitted with protective jaws. (Fig. 13-19).

11. Insert bolts and tighten to the specified torque. (Fig. 13-20).
12. Using an internal measuring instrument check big end bearing bore in three places, (Fig. 13-21).

Checking the Bearing Crush

13. Mount the connecting rod in a vice fitted with soft jaws. Fit the bearing shells into bearing cap and connecting rod. Insert bolts and tighten to the specified torque. Attach a dial gauge with a magnetic base to the vice, with the probe resting on the underside of the bearing cap, and set the gauge to “0”. Loosen the big end bolt nearest to the dial gauge, note the reading on the gauge. The figure will represent the bearing crush and should be compared with the specification, (Fig. 13-22).

14. Unscrew the connecting rod bolts and using a vernier gauge, check bolts for stretch, refer to specifications, (Fig. 13-23).

15. Connecting rods and bearing shells should be marked to ensure replacement in the original position, (Fig. 13-24). Check remainder of connecting rods as above.
CHECKING PISTONS AND PISTON RINGS

Before checking pistons, piston rings and gudgeon pins, ensure that the piston and piston ring grooves are clean and free of carbon deposits. Care should be taken to ensure that the piston ring grooves are not damaged during cleaning.

Attention! In all cases pistons and their associated gudgeon pins are considered to be matched pairs. When dismantling, these items must be marked, so that during assembly the markings correspond, and the parts are returned to their original position.

1. Pistons and rings should be removed as detailed on page 13-8.

2. When clean, check pistons carefully before re-use.

3. Using an internal measuring instrument, check the gudgeon pin bore in the piston, (Fig. 13-25) and

4. Using a micrometer, check the outer diameter of the gudgeon pin, (Fig. 13-26).

5. Insert a piston ring into the cylinder bore and using a piston, push the ring squarely down into the cylinder bore to a depth of approximately 30 mm from the top, (Fig. 13-27).
6. Measure the end gap of the piston ring and repeat this procedure with the remaining rings. Ring gaps must be within the specified limits. (Fig. 13-28).

Note: With the pistons removed a careful examination should be made of the cylinder bore for wear and localised seizure.

7. Re-fit pistons to connecting rods, clean carbon and oil deposits from piston ring grooves. Ensure that the grooves are not damaged, (Fig. 13-29).

8. Replace all piston rings using ring expander, part number 4020 0307, (Fig. 13-30).

9. Check clearance of piston rings in the grooves, replace piston and/or rings that do not conform to specifications, (Fig. 13-31).
REPLACING PISTONS, PISTON RINGS AND CONNECTING RODS

1. Clamp connecting rod in a vice fitted with protective jaws, with the elongated side to the right (injection pump side) as indicated by arrows. Place piston on connecting rod, with the arrow on the piston crown facing forward as indicated, (Fig. 13-32).

2. Insert gudgeon pin and secure with circlips, (Fig. 13-33).

3. Replace piston rings, using ring expander part number 4020 0307, stagger piston rings, which must rotate freely in the groove, 180° each side of the gudgeon pin, (Fig. 13-34).

4. Lubricate piston rings with engine oil, (Fig. 13-35).
5. Position ring squeezer over piston rings and compress so that the sleeve will just move (Fig. 13-36).

6. Lubricate big end bearings and crankshaft journal with engine oil, (Fig. 13-37).

7. Insert connecting rod and piston into cylinder bore, with arrow on piston crown pointing towards the front of the engine, (Fig. 13-38).

8. Push piston down into cylinder bore and guide the connecting rod until the big end bearing contacts the crankshaft journal, (Fig. 13-39).
9. Lubricate big end bearing cap with engine oil, (Fig. 13-40).

10. Fit matched big end bearing cap to connecting rod and insert bolts (Fig. 13-41).

11. Tighten big end bearing bolts to the specified torque, (Fig. 13-42).

12. Insert piston cooling nozzles ensuring that locating pin on nozzle body aligns with drilling in oil gallery, (ADE 360C/T/TI only), (Fig. 13-43), insert bolts and tighten to specified torque. (In 360N engines fit plugs and torque to specification).
Piston and Connecting Rods  13-16

SPECIAL TOOLS FOR SECTION 13

OBTAINABLE FROM GRUNDY TECHNIFORM, BURMAN ROAD, DEAL PARTY ESTATE, PORT ELIZABETH 6001

Piston ring pliers
(see fig. 13-7)
Part Number 40200307
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Crankshaft and Main Bearings 14-2

CRANKSHAFT ASSEMBLY

1 BEARING RETAINER
2 SPIGOT BEARING
3 BOLT
4 FLYWHEEL
5 BOLT
6 BALANCE WEIGHT
7 CRANKSHAFT
8 WOODRUFF KEY
9 CRANKSHAFT GEAR
10 SPACER
11 VIBRATION DAMPER
12 CENTERING RING
13 PULLEY
14 BOLT
15 CRANKSHAFT MAIN BEARINGS

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INTRODUCTION

The crankshaft is precision forged, induction hardened and supported by seven three-layer bearing shells on ADE 360 and five on ADE 364. A thrust bearing is fitted to the number 4 main bearing. Separate and detachable balance weights are bolted to the crankshaft.

SPECIFICATIONS

CRANKSHAFT

<table>
<thead>
<tr>
<th>Repair size (diameter)</th>
<th>Main bearing journal dia.</th>
<th>Width for thrust bearing</th>
<th>Conrod bearing journal diameter</th>
<th>Width</th>
<th>Dia for rear rope seal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>87.99 to 88.01</td>
<td>32,000 to 32,062</td>
<td>59,995 to 60,015</td>
<td>37.93</td>
<td>90.874 to 90.928</td>
</tr>
<tr>
<td>Standard 1 (-0.1)</td>
<td>87.89 to 87.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard 2 (-0.25)</td>
<td>87.74 to 87.76</td>
<td>32,300 to 32,362 (+0.3)</td>
<td>59,745 to 59,765</td>
<td>38.13</td>
<td>90.554 to 90.608</td>
</tr>
<tr>
<td>Repair 1 (-0.5)</td>
<td>87.49 to 87.51</td>
<td>32,500 to 32,562 (+0.5)</td>
<td>59,245 to 59,265</td>
<td></td>
<td>90.234 to 90.288</td>
</tr>
<tr>
<td>Repair 2 (-0.75)</td>
<td>87.24 to 87.26</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair 3 (-1.0)</td>
<td>86.99 to 87.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Main and big end journal hardness

| HRC | 56 ± 3 |

Min journal hardness on at least 2/3 of circumference (for repair only)

| HRC | 46 |

Max. main and big end journal taper

| 0.005 |

Max. main and big end journal ovality

| 0.01 |

Max. crankshaft run out with crankshaft turning on outer journals

| 4 cylinder journal 3 | 0.11 |
| 6 cylinder journal 4 | 0.15 |

Parallelism of big end journals to main journals

| 0.01 |

Lateral run out at thrust faces

| 0.02 |

Max. run out of flywheel flange with crankshaft turning on outer journals

| Lateral | 0.03 |
| Radial  | 0.03 |

Radii on thrust bearing journal

| Minimum | 3.75 |

Main bearing clearance

| End float (thrust bearing) | 0.190-0.290 |
| Radial (thrust bearing)    | 0.050-0.108  |
| Radial (other mains)       | 0.042-0.108  |

Torque to turn crankshaft with new seals and bearings fitted

| 12 Nm |

Rear crankshaft seal (rope type) protrusion after installation

| 0.5 to 0.8 |

Main/Big end journal surface finish

| (lapped) Ra 0.2 μm |
| R max 2 μm |

Max. imbalance of crankshaft with counterweights (without flywheel) running on outer main bearings

| 30 cmp |
Crankshaft and Main Bearings 14-4

CRANKSHAFT MAIN BEARINGS

<table>
<thead>
<tr>
<th>Repair size (diameter)</th>
<th>Main bearing dia. installed</th>
<th>Thrust bearing width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>88.052 to 88.098</td>
<td>Std</td>
</tr>
<tr>
<td>Standard 1 (-0.1)</td>
<td>87.952 to 87.998</td>
<td>Std 1 &amp; Std 2</td>
</tr>
<tr>
<td>Standard 2 (-0.25)</td>
<td>87.802 to 87.848</td>
<td>Std 2 &amp; all</td>
</tr>
<tr>
<td>Repair 1 (-0.5)</td>
<td>87.552 to 87.598</td>
<td>(+0.3) or</td>
</tr>
<tr>
<td>Repair 2 (-0.75)</td>
<td>87.302 to 87.348</td>
<td>(+0.5)</td>
</tr>
<tr>
<td>Repair 3 (-1.0)</td>
<td>87.052 to 87.098</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>31.74 to 31.81 (std)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32.04 to 32.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>32.24 to 32.31</td>
</tr>
</tbody>
</table>

TORQUE SPECIFICATIONS

Balance weight to crankshaft ........................................... M12 x 1.5
Initial .................................................. 30-40 Nm
Final .................................................. plus 90° - 110°
Max. stretch length .................................................. 45.3 mm

Flywheel to crankshaft ............................................... M12 x 1.5
Initial .................................................. 30-40 Nm
Final .................................................. plus 90° - 110°
Max. stretch length .................................................. 26.3 mm

Pulley to crankshaft (key driven) .................................. M24 x 1.5
(shanked bolt) .................................................. 500-600 Nm
(fully threaded bolt) ........................................... 800-900 Nm
(1st stage) .................................................. 800-900 Nm
(2nd stage) .................................................. plus 45° - 55°

Main bearing cap bolts - standard hex. bolts .................... M15 x 2
Initial .................................................. 80-90 Nm
Final .................................................. plus 90° - 100°
Max. stretch length .................................................. 123 mm

Main bearing cap bolts - multi hex. bolts only .................. M15 x 2
Initial .................................................. 45-55 Nm
Final .................................................. plus 90° - 100°
Max. stretch length .................................................. 47 mm

2nd pulley to vibration damper .......................................
Initial .................................................. 47 Nm
Final .................................................. 500 Nm

Vibration damper to crankshaft ..................................... M24 x 1.5
Initial .................................................. 30-40 Nm
Final .................................................. plus 90° - 110°
Max. stretch length .................................................. 45.3 mm

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REMOVAL AND REPLACEMENT OF CRANKSHAFT VIBRATION DAMPER

Removal

1. Slacken V-belt adjuster on alternator and remove belts, (Fig. 14-1).

2. Using special tool part number 4020 0145, release and remove centre bolt from crankshaft, (Fig. 14-2).

3. Draw vibration damper from crankshaft using special tool part number 4020 0019, (Fig. 14-3).

Replacement

1. If necessary heat vibration damper to approximately 80°C in a water bath, and slide onto crankshaft. Ensure that the woodruff key engages groove in the vibration damper (arrows), (Fig. 14-4).
2. Screw centre bolt into crankshaft and tighten to the specified torque, (Fig. 14-5).

Attention! Under no circumstance should the centre bolt be tightened with an impact wrench.

REMOVAL OF CRANKSHAFT

The following items must be removed from the engine: cylinder head, sump, connecting rods, pistons, flywheel and housing, timing gear case cover and oil pump.

1. Unscrew timing gear retaining bolt from crankshaft, (Fig. 14-6).

2. Using special tool, part number 4020 0019, pull timing gear from crankshaft, (Fig. 14-7).

3. Remove lower half of timing gear case, (Fig. 14-8).
4. Unscrew main bearing cap bolts and lift off bearing caps, (Fig. 14-9).

5. Lift out crankshaft from crankcase, (Fig. 14-10).

6. Remove all main bearing shells from crankcase. If bearing shells are to be re-used, they must be marked to ensure replacement in the original position, (Fig. 14-11).

7. Clean all parts, measure crankshaft journals and compare with specifications, (Fig. 14-12).
8. Check crankshaft for misalignment, journal run out (Fig. 14-13).

9. Check all main bearing cap bolts for stretch limit, refer to specifications, (Fig. 14-14).

CRANKSHAFT GRINDING

1. Mark crankshaft balance weights and remove from crankshaft, (Fig. 14-15).

2. Remove timing gear from crankshaft, using special tool part number 4020 0022, (Fig. 14-16).

Attention! When grinding the crankshaft it is essential that the radii of the bearing journals are maintained. (See Fig. 14-34, page 14-13).
Checking Crankshaft after Grinding

1. Check and crack test crankshaft, (Fig. 14-17).

2. Check all balance weight bolts for stretch limits, refer to the specifications, (Fig. 14-18).

Attention! All crankshaft balance weight bolts that exceed the maximum stretch limit must be replaced.

3. Replace balance weights, aligning marks on weights with marks on crankshaft, (Fig. 14-19).

4. Insert balance weight bolts and tighten to the specified torque, (Fig. 14-20).
5. Using compressed air, blow out all galleries in the crankshaft to ensure that no metal particles are retained within the drillings, (Fig. 14-21).

6. Replace crankshaft timing gear using special tool, part number 4020 0190, (Fig. 14-22).

Checking Crankshaft Bearing and Parent Bores

Attention! Bearing shells are supplied ready for fitting, in standard and various repair sizes. No attempt should be made to alter the pre-determined size.

1. Thoroughly clean and visually inspect condition of all main bearing bores in crankcase and bearing caps, (Fig. 14-23).

2. Replace main bearing caps insert bolts and tighten to the specified torque, (Fig. 14-24).

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3. Adjust an internal measuring instrument, (Fig. 14-25).

4. Measure main bearing parent bores in one direction, compare measurements with the specifications, (Fig. 14-26).

5. Remove main bearing bolts and bearing caps, (Fig. 14-27).

6. Insert bearing shells into crankcase and bearing caps. Ensure that locating tabs on bearing shells are correctly inserted in cap and crankcase, (Fig. 14-28).
Crankshaft and Main Bearings 14-12

Attention! Main bearing shells have oil drillings which must line up with holes in the crankcase, (Fig. 14-29).

7. Replace main bearing caps which are marked 1 to 7 for ADE366 and 1 to 5 for ADE364, which must be fitted in the correct positions with the numbers towards the front of the engine, (Fig. 14-30).

8. Insert bearing cap bolts and tighten to the specified torque, (Fig. 14-31).

9. Adjust/set an internal measuring instrument, (Fig. 14-32).
10. Measure all main bearing inside diameters in three places, compare measurements with the specifications, (Fig. 14-33).

11. Should the crankshaft have been re-ground examine the radius (R) to ensure that the specification has been adhered to, (Fig. 14-34).

12. Remove all main bearing caps, (Fig. 14-35).

REPLACING REAR MAIN BEARING OIL SEAL

Attention! The fitment of these seals must be carried out with the bearing shells removed from crankcase and bearing cap.

1. With the oil seal removed, Thoroughly clean both halves of the bearing housing, (Fig. 14-36).
2. Using a pair of long nose pliers, remove the oil seal retaining pins from the seal housing in crankcase and bearing cap, (Fig. 14-37).

3. Using an aluminium drift, tap new oil seal retaining pin into crankcase and bearing cap seal housing, (Fig. 14-38).

Attention! Do not damage the tip of the retaining pins.

4. Fit one half of the new oil seal into special tool, part number 4020 1607, (Fig. 14-39).

5. New seal must fit exactly into special tool. Both ends of seal must touch tool holder, (Fig. 14-40).
6. Locate special tool, fitted with new oil seal on to the crankcase and drive the seal into the housing, (Fig. 14-41).

7. Insert new half seal for bearing cap into the special tool and drive into bearing cap, (Fig. 14-42).

Attention! New seal ends must protrude 0,5mm above the bearing cap and crankcase mating surfaces or 0,8 mm when the crankshaft is reground to the next repair stage. No fibres should be trapped between the bearing cap and the crankcase mating surfaces.

8. Coat the seal in the crankcase and bearing cap with a heat resistant grease, (Fig. 14-43).

9. Apply a small amount of silicone sealant to the grooves in the rear main bearing cap. The end surface of seals must not be coated with sealant, (Fig. 14-44).

Attention! If the bearing cap does not have grooves, apply sealant to the surfaces of the cap and the crankcase. Surfaces to be coated with sealant must be free of grease.
REPLACING THE CRANKSHAFT

1. Liberally coat the bearings with engine oil, (Fig. 14-45).

2. Lower the crankshaft onto the bearings, (Fig. 14-46).

3. Replace all main bearing caps marked 1 to 7 for ADE 366 or 1 to 5 for ADE 364. They must be fitted in the correct position with the numbers towards the front of the engine, (Fig. 14-47).

4. Coat the threads of the main bearing bolts with engine oil, (Fig. 14-48).
5. Insert bolts and tighten to the specified torque, (Fig. 14-49).

6. Check the torque required to turn the crankshaft, with new bearings and oil seal fitted, refer to specifications, (Fig. 14-50).

**Attention!** Should the crankshaft not turn at the required torque, remove rear main bearing cap and check correct fitting of the oil seal.

7. Refit camshaft timing gear, lining up timing marks. Insert bolts and tighten to the specified torque, (Fig. 14-51. See also pages 15-12 and 15-13.

8. Mount a dial gauge indicator on the crankcase and measure the crankshaft end float in accordance with specifications, (Fig. 14-52).
9. Replace the bottom half of the timing cover and tighten the bolts to the specified torque, (Fig. 14-53).
SPECIAL TOOLS FOR THIS SECTION

**Impact socket scanner**
(see fig. 14-2)
Part Number 40200145

**Puller for camshaft gear**
(see fig. 14-71
Part number 40200019

**Crankshaft hardness tester**
(see fig. 14-13)
Part Number 40200501

**Crankshaft gear replacer**
(see fig. 14-22)
Part Number 40200190

**Rear oil seal replacer**
(see fig. 14-39)
Part Number 40201607

**Puller for vibration damper**
(see fig. 14-3)
Part number 40200019

---

ADE 360 Series
Puller for crankshaft gear
(see fig. 14-16)
Part number 40200022
CAMSHAFT AND TIMING GEARS

1. CAMSHAFT
2. THRUST WASHER
3. FLY-WEIGHT
4. PIN
5. SPRING
6. CAMSHAFT GEAR
7. RETAINING BOLT
8. BOLT
9. ROLLER
10. INJECTION PUMP DRIVE GEAR
11. FEATHER KEY
INTRODUCTION

The camshaft is precision forged and induction hardened. It is supported by steel backed bronze bearings and gear driven from the crankshaft. Access to the timing gears can be gained by removal of the crankshaft vibration damper and timing case, which is situated at the front of the engine.

SPECIFICATIONS

Camshaft Bearings

<table>
<thead>
<tr>
<th>Bearing position</th>
<th>Standard</th>
<th>364</th>
<th>366</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Journal dia.</td>
<td>Bearing ID</td>
<td></td>
</tr>
<tr>
<td>—</td>
<td>55,941 to 55,960</td>
<td>56,000 to 56,030</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>55,691 to 55,710</td>
<td>55,740 to 55,770</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>55,441 to 55,460</td>
<td>55,490 to 55,520</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>55,191 to 55,210</td>
<td>55,240 to 55,270</td>
<td></td>
</tr>
</tbody>
</table>

Camshaft lobe and journal surface finish  
Rz 3 μm

Eccentric - Compressor drive  
Ra 0,2 μm; Rmax 2 μm

Basic bore for camshaft bearing  
60,000 to 60,030

Camshaft bearing OD  
60,150 to 60,180

Camshaft bearing clearance  
Radial 0,030 to 0,079
Axial 0,180 to 0,520

Hardness  
Journal 57 to 63 Hrc
Cam lobes 57 to 63 Hrc

Run-out of camshaft journals (camshaft supported at outer journals)  
0,025

Backlash crankshaft/camshaft gear, camshaft/injection pump gear  
0,070 to 0,180

Valve travel specifications for checking valve timing at TDC and "O" clearance

| 364N, 366N | Inlet 0,56 to 0,96 | Exhaust 0,64 to 1,04 |
| 366C/T/TI, 364C/T | 0,58 to 0,98 | 0,61 to 1,01 |

Maximum valve lift (with specified valve clearance)

| 364N/C/T, 366N | Inlet 10,56 | Exhaust 10,56 |
| 366C/T/TI | 10,16 | 10,56 |

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Camshaft, Timing Case and Drive Timing 15-4

<table>
<thead>
<tr>
<th></th>
<th>Outer shaft dia.</th>
<th>Bore in cylinder block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>27,980 to 27,990</td>
<td>28,000 to 28,033</td>
</tr>
<tr>
<td>Repair stage 1 (+0,2)</td>
<td>28,180 to 28,190</td>
<td>28,200 to 28,233</td>
</tr>
<tr>
<td>Repair stage 2 (+0,5)</td>
<td>28,480 to 28,490</td>
<td>28,500 to 28,533</td>
</tr>
<tr>
<td>Repair stage 3 (+0,75)</td>
<td>28,730 to 28,740</td>
<td>28,750 to 28,783</td>
</tr>
<tr>
<td>Clearance shaft /bore</td>
<td></td>
<td>0,010 to 0,053</td>
</tr>
</tbody>
</table>

TORQUE SPECIFICATIONS

- Timing degree pointer .......................................................... M6 ............................................ 8 Nm
- Timing device to camshaft ..................................................... M16 x 1,5 .................................. 300 Nm
- Timing segment to camgear ..................................................... M8 ............................................ 30 to 40 Nm (+90° to 100°)
- Injection pump gear 364N/C/T, 366N ....................................... M14 x 1,5 .................................. 80 Nm
  366C/T/TI ........................................................................ 105 Nm
- Camshaft thrust plate to block .................................................. M8 x 1 ..................................... 35 Nm
- Timing case to cylinder block .................................................. M10 ......................................... 65 Nm
- Timing case cover to timing case .............................................. M6 ......................................... 10 Nm*
REMOVING AND REPLACING THE CAMSHAFT

1. Remove rocker cover, (refer to page 12-7).
2. Unscrew and remove rocker shaft, (refer to page 12-9).
3. Remove pushrods and mark to ensure replacement in the original position.
4. Unscrew and remove side cover, (Fig. 15-1).

5. Lift out camfollowers, (Fig. 15-2), and number each in order to replace in the same position.

6. Drain engine oil and remove sump, (Fig. 15-3).

7. Unscrew and remove bolts retaining oil pump, lift out pump, (Fig. 15-4).
8. Slacken the V-belt adjuster on the alternator and remove the belts. (Fig. 15-5).

9. Using special tool, part number 4020 0145, unscrew and remove centre bolt retaining vibration damper, (Fig. 15-6).

10. Attach special puller, part number 4020 0019, to vibration damper and pull off, (Fig. 15-7).

11. Unscrew and remove bolts retaining the timing case cover and lift off, (Fig. 15-8).
12. Using a socket, unscrew and remove the Allen cap screw retaining the timing gear to the camshaft, (Fig. 15-9).

13. Using special tool, part number 4020 0019, pull off timing gear from camshaft, (Fig. 15-10).

14. Remove shim and feather key from the camshaft, (Fig. 15-11).

15. Unscrew bolts retaining the camshaft thrust plate and remove from the camshaft, (Fig. 15-12).
16. If the engine is fitted with a crankcase mounted compressor remove the compressor cylinder head bolts together with the gasket, (Fig. 15-13).

17. Turn the piston of the compressor to TDC and pull off the cylinder barrel, (Fig. 15-14).

18. Remove the circlips retaining the gudgeon pin, push out and remove the piston, (Fig. 15-15).

19. Unscrew the nuts retaining the bearing cap to the connecting rod, (Fig. 15-16).
20. Remove connecting rod and bearing cap, (Fig. 15-17).

21. Pull out the camshaft from the cylinder block. Do not damage the camshaft bearings, (Fig. 15-18).

REPLACING

1. Carefully insert the camshaft into the cylinder block without damage to the camshaft bearings, (Fig. 15-19).

2. Fit thrust plate to camshaft, insert retaining bolts and tighten to the specified torque, (Fig. 15-20).
3. Fit shim to camshaft, (Fig. 15-21).

4. Fit timing gear to camshaft; ensure that the marks on timing gear and crankshaft gear are aligned, (Fig. 15-22).

5. Insert feather key, locating timing gear to camshaft, (Fig. 15-23).

6. Insert Allen cap screw into camshaft, (Fig. 15-24).
7. Tighten cap screw to the specified torque, (Fig. 15-25).

8. Replace timing case cover and align using special tool 4020 2198, (Fig. 15-26).

9. Insert bolts retaining the timing cover and tighten to the specified torque, (Fig. 15-27).

10. If necessary, heat the vibration damper to approximately 80°C in a water bath before sliding onto the crankshaft. Ensure that the woodruff key locates in the groove, (Fig. 15-28).
11. Screw centre bolt into crankshaft and tighten to the specified torque, (Fig. 15-29).

Attention! The centre bolt must not be tightened with an impact wrench.

12. If the engine is fitted with a crankcase mounted compressor the crankshaft should be turned so that the lobe for the compressor connecting rod is at TDC. Replace bearing cap and connecting rod, (Fig. 15-30).

Note: When using belt driven compressors the oil supply hole in the eccentric is closed off with a jubilee clamp.

13. Tighten nuts to the specified torque, (Fig. 15-31).

14. Fit compressor piston to connecting rod, insert gudgeon pin and circlips, (Fig. 15-32).
15. Lightly apply a suitable sealing compound to the base of the cylinder barrel.

16. With the special piston ring squeezer, part number 4020 1131, compress the piston rings, insert piston into the cylinder barrel, push the barrel down over the piston rings and remove the piston ring squeezer. Push the barrel fully home, (Fig. 15-33).

17. Replace the compressor cylinder head, fitted with a new gasket, insert bolts and tighten to the specified torque, (Fig. 15-34).

18. Replace the oil pump, insert the retaining bolts and tighten to the specified torque, (Fig. 15-35).

19. Using new gaskets, replace the sump, insert bolts and tighten to the specified torque, (Fig. 15-36).
20. Insert cam followers in the same position from which they were removed, (Fig. 15-37).

21. Replace side cover, insert bolts and tighten to the specified torque, (Fig. 15-38).

22. Insert push rods in their original position, see page 12-21.

23. Replace the rocker shafts and insert the bolts but do not tighten.

24. Use special tool, part number 4020 3185 and insert the connecting nipple between the rocker shafts, see page 12-21.

25. Tighten the rocker shafts to the specified torque, see page 12-23.

26. Adjust the valve clearance, see page 12-23.

27. Replace the rocker cover with a new gasket, insert bolts and tighten to the specified torque, (Fig. 12-24).

REMOVING AND REPLACING THE TIMING COVER OIL SEAL

Timing cover removed from the engine.

Removing

1. Place the support ring of special tool, part number 4020 0200, under the front of the timing cover to prevent distortion when the oil seal is removed, (Fig. 15-39).

2. Use the adapter ring and spacer of the special tool to press the oil seal from the housing, (Fig. 15-40).
Replacing

1. Locate a new oil seal in front of the housing, (Fig. 15-41).

2. Place a 12 mm distance piece inside the timing cover, behind the oil seal housing, (Fig. 15-42).

3. Place the spacer of the special tool on top of the oil seal, (Fig. 15-43).

4. Press the seal into the timing housing until it is flush with the inside edge of the timing cover and butts onto the distance piece, (Fig. 15-44).
5. Section through timing case with the oil seal in place, (Fig. 15-45).

Note: When replacing the timing case oil seal it is essential to replace the wear ring on the crankshaft.
SPECIAL TOOLS FOR THIS SECTION

OBTAINABLE FROM: GRUNDY-TECHNIFORM. BURMAN ROAD. DEAL PARTY ESTATE. PORT ELIZABETH 6001

- Impact socket scanner
  (see fig. 15-6)
  Part Number 40200145

- Puller for camshaft gear
  (see fig. 15-10)
  Part Number 40200019

- Puller for vibration damper
  (see fig. 15-7)
  Part number 40200019

- Timing cover centralizing tool
  (see fig. 15-26)
  Part Number 40202198.

- Compressor piston ring squeezer
  use with pliers below,
  (see fig. 15-33)
  Part Number 40201131.

- Pliers for compressor piston ring squeezer
  (see fig. 15-33)
  Part Number 40201144.
Timing cover oil seal remover/replacer,
(see fig. 15-40).
Part Number 40200200.

Fabricate a 12 mm spacer x 100 mm dia., which is used as a distance piece under the timing case cover, when pressing in the seal, (see fig. 15-42).
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OIL PUMP AND FILTER ASSEMBLY

1 OIL FILTER ELEMENT
2 FILTER ELEMENT RETAINER
3 SEALING WASHER
4 WASHER
5 SEALING WASHER
6 FILTER BOWL RETAINING BOLT
7 DRAINPLUG AND WASHER
8 GEAR SHAFT
9 OIL PUMP DRIVEN GEAR
10 OIL PUMP DRIVE SHAFT
11 OIL PUMP DRIVE GEAR
12 OIL PUMP DRIVE SHAFT/TACHO DRIVE
13 WOODRUFF KEY
14 OIL PUMP COVER RETAINING BOLT
15 RELIEF VALVE
16 OIL PUMP COVER PLATE
17 STRAINER
18 STRAINER RETAINING BOLT
19 OIL PUMP RETAINING BOLT
20 OIL PUMP BODY
21 OIL PUMP GEAR
22 BY-PASS VALVE SCREW PLUG
23 WASHER
24 BY-PASS VALVE SPRING
25 BY-PASS VALVE
26 OIL FILTER HEAD
27 BANJO BOLT AND WASHER
28 GASKET
29 INJECTION PUMP OIL FEED PIPE
30 BANJO BOLT AND WASHER
31 BLANKING PLUG
32 BLANKING PLUG AND WASHER
Oil is drawn from the engine sump by a gear type pump, through a gauze strainer. The oil under pressure then flows between the oil pump body and drive shaft into a gallery, passing to the oil filter. From the oil filter, cleansed oil flows via an intersecting gallery to a plate type oil cooler. On the naturally aspirated engine, oil from the cooler enters the main oil gallery to the crankshaft, camshaft, rocker gear, etc.

The turbocharged engine oil flow differs from the naturally aspirated engine, in that the oil flowing from the main oil filter passes into an additional micro type filter, mounted on the outside of the oil cooler cover, before flowing into a large capacity fin type oil cooler, providing an increase in the cooling capacity. To assist with dissipation of the additional heat generated by the turbocharged engine, piston cooling nozzles are fitted to the main oil gallery, supplying a constant jet of cooling oil to the underside of the piston crowns. The turbocharger is fed under pressure from the main oil gallery, with a drain to the engine sump.

The ADE 364C/T/TI engine has a small finned cooler mounted integrally with the engine oil filter to assist with heat dissipation.

Note: The micro type oil filter mentioned above has since been removed on turbocharged engines built from mid 1995.
INTRODUCTION

A gear type pump supplies oil under pressure through a full flow paper type oil filter to the crankshaft, camshaft, connecting rod big end bearings, rocker shaft bearings, fuel injector pump and governor. Oil under pressure is also fed to the crankcase mounted air compressor and turbocharger (if fitted). Pressure relief and by-pass valves protect the system against overload.

SPECIFICATIONS

OIL PUMP

<table>
<thead>
<tr>
<th></th>
<th>364N/C/T</th>
<th>366C/T/Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width of pump gears</td>
<td>39,936 to 39,975</td>
<td>49,936 to 49,975</td>
</tr>
<tr>
<td>Axial play between gear face and housing</td>
<td>0,025 to 0,089</td>
<td>0,025 to 0,089</td>
</tr>
<tr>
<td>Clearance between teeth and housing</td>
<td>0,030 to 0,105</td>
<td>0,030 to 0,105</td>
</tr>
<tr>
<td>Outside dia. of pump gears</td>
<td>42,020 to 42,070</td>
<td>42,020 to 42,070</td>
</tr>
<tr>
<td>Inside dia. of pump driving gear</td>
<td>16,944 to 16,958</td>
<td>16,944 to 16,958</td>
</tr>
<tr>
<td>Inside dia. of pump driven gear</td>
<td>15,050 to 15,073</td>
<td>15,050 to 15,073</td>
</tr>
<tr>
<td>Diameter in housing for shaft of driven gear</td>
<td>15,000 to 15,018</td>
<td>15,000 to 15,018</td>
</tr>
<tr>
<td>Inside diameter of oil pump drive sprocket</td>
<td>16,944 to 16,958</td>
<td>16,944 to 16,958</td>
</tr>
</tbody>
</table>

A - Installation height between drive sprocket and pump housing flange when moving shaft in the indicated direction: 116,5 +0,5 - 0,3

B - Diameter of oil pump driving shaft: 16,976 to 16,984

C - Diameter of oil pump driven gear shaft: 15,028 to 15,039

D - Installation height of driven gear shaft: 39,2 to 39,5

E - Installation height of drive gear to drive shaft: 0,5 to 0,8

Pump speed

<table>
<thead>
<tr>
<th>Pump speed</th>
<th>364N/C/T</th>
<th>366N</th>
<th>366C/T/Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. delivery rate (l/min) with SAE 10 oil at 50°C and 400 kPa pressure</td>
<td>300 r/min</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>1 400 r/min</td>
<td>45</td>
<td>58</td>
<td></td>
</tr>
</tbody>
</table>
Lubricating System and Sump 16-5

**OIL PRESSURE RELIEF VALVE**

| Opening pressure (kPa) | 470 - 570 |

**SPRING FOR PRESSURE RELIEF VALVE**

<table>
<thead>
<tr>
<th>OD</th>
<th>Wire dia.</th>
<th>Unloaded spring length</th>
<th>Spring preload</th>
<th>Spring final load</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>N</td>
</tr>
<tr>
<td>9.3</td>
<td>1.7</td>
<td>49.4</td>
<td>45.4</td>
<td>43.9</td>
</tr>
</tbody>
</table>

**OIL FILTER BY-PASS VALVE SPRING**

<table>
<thead>
<tr>
<th>OD</th>
<th>Wire dia</th>
<th>Unloaded spring length</th>
<th>Spring preload</th>
<th>Spring final load</th>
<th>Opening pressure of by-pass valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>16.5</td>
<td>1.5</td>
<td>66</td>
<td>31</td>
<td>42 to 48</td>
<td>21.0</td>
</tr>
</tbody>
</table>

**OIL PRESSURE**

Minimum operating oil pressure (warm engine)

<table>
<thead>
<tr>
<th>600 r/min</th>
<th>2800 r/min</th>
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</thead>
<tbody>
<tr>
<td>80 kPa gauge pressure</td>
<td>280 kPa gauge pressure</td>
</tr>
</tbody>
</table>

**Warning!** Stop engine immediately when the oil pressure drops below the following values

<table>
<thead>
<tr>
<th>600 r/min</th>
<th>2800 r/min</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kPa gauge pressure</td>
<td>250 kPa gauge pressure</td>
</tr>
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</table>

**OIL CAPACITY**

Depending on application

- 364N/C/T approximately 10 litres
- 366N/C/T/TI approximately 17.5 litres

**TORQUE SPECIFICATIONS**

<table>
<thead>
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<th>Component</th>
<th>Torque Specifications</th>
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<tr>
<td>Turbocharger oil drain to crankcase/sump (364C/T/TI)</td>
<td>M16 x 1.5, 40 Nm</td>
</tr>
<tr>
<td>Turbocharger oil supply from oil cooler cover (366C/T/TI)</td>
<td>M14 x 1.5, 40 Nm</td>
</tr>
<tr>
<td>Turbocharger oil drain to sump (366C/T/TI)</td>
<td>M14 x 1.5, 70 Nm</td>
</tr>
<tr>
<td>Oil supply to turbocharger</td>
<td>M8, 35 Nm</td>
</tr>
<tr>
<td>Oil drain from turbocharger</td>
<td>M8, 35 Nm</td>
</tr>
<tr>
<td>Oil pressure gauge switch</td>
<td>M14 x 1.5, 50 Nm</td>
</tr>
<tr>
<td>Oil filter mounting</td>
<td>M10, 50 Nm</td>
</tr>
<tr>
<td>Dipstick adapter</td>
<td>M14 x 1.5, 40 Nm</td>
</tr>
<tr>
<td>Sump drain plug</td>
<td>M26 x 1.5, 80 Nm</td>
</tr>
<tr>
<td>Dipstick tube to cylinder block</td>
<td>M16 x 1.5, 25 Nm</td>
</tr>
<tr>
<td>Sump to cylinder block - Pressed steel</td>
<td>M8 (Studs), 9 Nm</td>
</tr>
<tr>
<td>- Aluminium casting</td>
<td>M8 (Studs), 25 Nm</td>
</tr>
<tr>
<td>Drain plug bush to sump</td>
<td>M8 (Bolts), 15 Nm</td>
</tr>
<tr>
<td>Relief valve cap to oil pump cover</td>
<td>M24 x 1.5, 20 Nm</td>
</tr>
<tr>
<td>By-pass valve cap on oil filter</td>
<td>M24 x 1.5, 70 Nm</td>
</tr>
<tr>
<td>Banjo bolt to oil filter head</td>
<td>M26 x 1.5, 60 Nm</td>
</tr>
<tr>
<td>Plug to oil filter head</td>
<td>M10 x 1, 20 Nm</td>
</tr>
<tr>
<td>Plug to oil filter head (Aluminium)</td>
<td>M14 x 1.5, 35 Nm</td>
</tr>
<tr>
<td>Drain plug to filter head (Aluminium)</td>
<td>M10 x 1, 20 Nm</td>
</tr>
<tr>
<td>Oil filter bowl to filter head</td>
<td>M12 x 1.5, 45 Nm</td>
</tr>
<tr>
<td>Oil supply pipe to injector pump</td>
<td>M10 x 1, 15 Nm</td>
</tr>
<tr>
<td>Oil supply pipe to filter</td>
<td>M10 x 1, 15 Nm</td>
</tr>
<tr>
<td>Suction pipe to oil pump cover</td>
<td>M8, 35 Nm</td>
</tr>
<tr>
<td>Oil pump cover to pump body</td>
<td>M8, 34 Nm</td>
</tr>
<tr>
<td>Oil pump to cylinder block</td>
<td>M8, 35 Nm</td>
</tr>
<tr>
<td>Oil cooler filter to cooler</td>
<td>M10, 40 Nm</td>
</tr>
<tr>
<td>Oil cooler cover to cylinder block</td>
<td>M8, 40 Nm</td>
</tr>
<tr>
<td>Oil cooler by-pass valve</td>
<td>M22 x 1.5, 65 Nm</td>
</tr>
<tr>
<td>Oil cooler bolts (centre) 366N</td>
<td>M8, 30 Nm</td>
</tr>
<tr>
<td>Cooler to cover 366C/T/TI</td>
<td>M8, 35 Nm</td>
</tr>
</tbody>
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April '96
REMOVING AND DISMANTLING
PLATE TYPE OIL COOLER 366N

1. Remove starter motor.

2. Unscrew bolts and remove the exhaust manifold, (Fig. 16-1).

3. Unscrew the bolts and remove the inlet manifold, (Fig. 16-2).

4. Unscrew and remove the oil pressure gauge sender unit, (Fig. 16-3).

5. Remove by-pass valve from oil cooler casing, (Fig. 16-4).
6. Unscrew and remove all bolts retaining the oil cooler to the cylinder block, (Fig. 16-5).

7. Remove the oil cooler casing from the cylinder block, (Fig. 16-6).

8. Unscrew and remove bolts joining both halves of the oil cooler, (Fig. 16-7).

9. Dismantle the oil cooler halves, (Fig. 16-8).
ASSEMBLY AND REPLACEMENT OF OIL COOLER

1. Fit new gasket between oil cooler halves, (Fig. 16-9).

2. Insert bolts joining the oil cooler halves and tighten to the specified torque, (Fig. 16-10).

3. Replace oil pressure gauge sender unit and tighten the bolts to the specified torque, (Fig. 16-11).

4. Replace the by-pass valve and tighten the bolts to the specified torque, (Fig. 16-12).
5. Fit a new gasket between oil cooler casing and cylinder block.

6. Replace the oil cooler to cylinder block. (Fig. 16-13).

7. Insert bolts securing the oil cooler to the cylinder block and tighten in cross fashion from the centre outwards, to the specified torque. (Fig. 16-14).

8. Fit new gaskets to the inlet manifold, insert bolts and tighten to the specified torque. (Fig. 16-15).

9. Fit new gaskets to the exhaust manifold, insert bolts and tighten to the specified torque. (Fig. 16-16).

10. Replace the starter motor.

11. With the engine stop control set to the "OFF" position, turn the engine with the starter motor until oil pressure is registered on the gauge.

12. Start the engine and allow to idle for several minutes; check all joints for oil leaks.
REMOVING OIL COOLER ADE 366T

1. Remove the starter motor.

2. Disconnect the oil feed and drain pipes to the turbocharger, (Fig. 16-17).

3. Unscrew bolts and remove the exhaust manifold, (Fig. 16-18).

4. Unscrew bolts and remove the inlet manifold, (Fig. 16-19).

5. Do not remove the oil cooler retainer bolts until the housing has been removed from the cylinder block, (Fig. 16-20).
6. Unscrew and remove all bolts retaining the oil cooler housing and remove from the cylinder block, (Fig. 16-21).

7. Unscrew and remove bolts retaining the oil cooler element to the housing, (Fig. 16-22).

8. Detach the oil cooler element from the housing, (Fig. 16-23).

9. Unscrew the centre bolt retaining the oil cooler filter element to the housing, (Fig. 16-24).
10. Lift off the filter cover and remove the filter element, (Fig. 16-25).

11. Unscrew and remove the oil pressure gauge sender unit, (Fig. 16-26).

12. Remove the by-pass valve from the oil cooler housing, (Fig. 16-27).

REPLACING
1. Replace the oil pressure gauge sender unit and tighten to the specified torque.

2. Replace the by-pass valve and tighten to the specified torque, (Fig. 16-28).
3. Fit a new O-ring to the oil cooler filter element cover, (Fig. 16-29).

4. Replace the oil cooler filter element.  
   Note: The wide sealing face on the filter element goes towards the sealing surface of the oil cooler housing, (Fig. 16-30).

5. Replace the filter element cover, fitted with new O-ring, insert the retaining bolt and tighten to the specified torque, (Fig. 16-31).

6. Fit new gaskets between oil cooler element and housing, replace the cooler element and insert bolts, (Fig. 16-32).
7. Tighten oil cooler retaining bolts to the specified torque, (Fig. 16-33).

8. Fit a new gasket between the cylinder block and the oil cooler housing.

9. Replace all bolts retaining the oil cooler housing to the cylinder block and tighten in cross fashion from the centre outwards to the specified torque, (Fig. 16-34).

10. Fit a new gasket to the inlet manifold, insert bolts and tighten to the specified torque, (Fig. 16-35).

11. Insert the exhaust manifold bolts and tighten to the specified torque, (Fig. 16-36).
12. Connect oil feed and drain pipe to the turbocharger, and tighten to specified torque (Fig. 16-37).

13. Replace the starter motor.

14. With the engine Stop control set to the “OFF” position turn the engine with the starter motor until oil pressure is registered on the gauge.

15. Start the engine and allow to idle for several minutes. Check all joints for oil leaks.

Removing the Oil Filter Element

1. Unscrew and remove the filter bowl drain plug and allow oil to drain (Fig. 16-38).

2. Unscrew the centre bolt retaining the filter bowl to the filter head, (Fig. 16-39).

3. Remove the oil filter bowl and the filter element, (Fig. 16-40).

4. Clean filter bowl, element retainer and centre bolt.
Replacing

1. Fit a new O-ring to the filter head, (Fig. 16-41).

2. Insert a new filter element into the filter bowl, (Fig. 16-42).

3. Position the filter bowl to the centre of the filter head, insert bolt and tighten to the specified torque, (Fig. 16-43).

4. Replace the filter drain plug and tighten to the specified torque, (Fig. 16-44).

Attention! With the engine Stop control set to the "OFF" position, turn the engine with the starter motor until oil pressure is registered on the gauge.

5. Start the engine and allow to idle for several minutes. Check all joints for oil leaks.
REMOVING AND REPLACING THE OIL FILTER HEAD

Removing

1. Drain the filter bowl.
2. Remove the filter bowl and element, (Fig. 16-45).
3. Unscrew and remove the feed pipe to injection pump, (Fig. 16-46).
4. Unscrew and remove bolts retaining the filter head to the crankcase, (Fig. 16-47).
5. Remove the filter head from the crankcase.

Note: New level oil filter elements have integrated seal rings, and therefore the loose seal ring depicted in Fig. 16-47 will no longer be required.

6. Unscrew and remove the oil filter by-pass valve from the filter head, (Fig. 16-48).
Lubricating System and Sump 16-18

7. Remove the oil filter seal and retaining spring from the filter head, (Fig. 16-49).

Note: This seal is now integral part of the oil filter assembly.

8. Thoroughly clean all parts and blow out oil drillings in the head with compressed air, (Fig. 16-50).

Replacing

1. Using a spring tester, check the by-pass valve spring tension, replace if required, see specifications, (Fig. 16-51).

2. Fit a new oil filter seal and retaining ring to the filter head, (Fig. 16-52).

Fig. 16-49

Fig. 16-50

Fig. 16-51

Fig. 16-52
3. Use a new gasket, fit the filter head to the crankcase and insert bolts, (Fig. 16-53).

4. Tighten to the specified torque, (Fig. 16-54).

5. Fit by-pass valve into the filter head and tighten the screw plug to the specified torque, (Fig. 16-55).

6. Connect the oil feed pipe to the injection pump and filter head, tighten the screw plug to the specified torque, (Fig. 16-56).

Attention! A banjo connection with a small hole is fitted to the filter head, this applies a restriction to the oil flow and should not be reversed.
7. Fit a new O-ring to the filter bowl, (Fig. 16-57).

8. Insert a new oil filter element into the filter bowl, (Fig. 16-58).

9. Fit the filter bowl and element to the filter head, insert retaining bolt and tighten to the specified torque, (Fig. 16-59).

10. Replace the filter bowl drain plug and tighten to the specified torque, (Fig. 16-60).

11. With the engine Stop control set to the "OFF" position, turn the engine with the starter motor until oil pressure is registered on the gauge.

12. Start the engine and allow to idle for several minutes. Check all joints for oil leaks.
REMOVAL, STRIPPING, ASSEMBLY AND REPLACEMENT OF OIL PUMP

Removal

1. Drain engine oil and remove the sump, (Fig. 16-61).

2. Remove oil pump retaining bolts, (Fig. 16-62).

3. Pull out oil pump from crankcase, (Fig. 16-63).

Stripping

1. Clamp the oil pump in a vice fitted with soft jaws.

2. Remove bolts retaining the strainer and pick-up pipe, (Fig. 16-64).

3. Remove the pick-up pipe and strainer from the oil pump body.
4. Remove the pressure relief valve, spring and piston from the oil pump cover, (Fig. 16-65).

5. Unscrew and remove the bolts retaining the cover plate to the oil pump body, (Fig. 16-66).

6. Lift out the oil pump gear from the oil pump body, (Fig. 16-67).

7. Press the oil pump shaft from the drive gear, (Fig. 16-68).
8. Remove the oil pump drive shaft from the body, complete with gear, (Fig. 16-69).

9. Press oil pump drive shaft from the gear, (Fig. 16-70).

10. Examine the oil pump body and gears for signs of excessive wear, scoring and localised seizure. Replace all faulty parts. Should the oil pump body or gears show signs of excessive wear the complete oil pump must be replaced.

Assembly

1. Press gear onto the oil pump drive shaft, (Fig. 16-71).

2. Check the installation height of the gear to the drive shaft, (Fig. 16-72).
3. Insert the oil pump drive shaft into the pump body, (Fig. 16-73).

4. Press the helical gear onto the shaft and by using a vernier check the distance between the gear and the pump flange; refer to specifications for the correct distance, (Fig. 16-74).

5. Insert the oil pump driven gear into the pump body, (Fig. 16-75).

6. Check the clearance between the oil pump gears and housing, (Fig. 16-76).
7. Check the clearance between cover plate and gears, (Fig. 16-77).

8. Replace the oil pump plate, insert bolts and tighten to the specified torque, (Fig. 16-78).

9. Fit oil relief valve into the oil pump cover plate and tighten to the specified torque, (Fig. 16-79).

10. Prime the oil pump with engine oil.

11. Bolt the oil suction pipe and strainer to the oil pump body and tighten to the specified torque, (Fig. 16-80).
12. Fit the strainer to the suction pipe, (Fig. 16-81).

13. Insert the oil pump into the crankcase, replace the retaining bolts and tighten to the specified torque, (Fig. 16-82).

14. Fit new sump gaskets to the crankcase, (Fig. 16-83).

15. Replace the sump, insert the bolts and tighten to the specified torque, (Fig. 16-84).

16. Fill the sump with recommended oil.

17. With the engine Stop control set to the "OFF" position, turn the engine with the starter motor until oil pressure is registered on the gauge.

18. Start the engine and allow to idle for several minutes. Check all joints for oil leaks.

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INTRODUCTION

The ADE 360 series of engines are fitted with two types of Bosch fuel injection pumps. The successful "A" type injection pump is fitted to the naturally aspirated engine, and the "MW" type fuel injection pump is used on the turbocharged engine. The "MW" fuel injection pump, being of a larger and more rigid design, enables it to provide higher pressures, allowing the turbocharged engine to develop greater power and a higher torque.

SPECIFICATIONS

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<td>366TI - up to 150 kW</td>
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<td>366TI - above 150 kW</td>
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<td>pressure</td>
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<tr>
<td>Idle speed</td>
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TORQUE SPECIFICATIONS

| Injector protection sleeve  | M14 x 1          | 50 Nm |
| Injector securing nut       | M34 x 1,5        | 70 Nm |
| Injector cap nut to nozzle  | M24 x 1,5        | 80 Nm |
| body                         |                  |      |
| Stud for injection pump      | M10              | 10 - 20 Nm |
| mounting                     |                  |      |
| Injection pump gear to pump  | M14 x 1,5        | 80 Nm |
| Injector pipe nuts to        | M12 x 1,5        | 25 Nm |
| injection pump               |                  |      |
| Injector pipe nuts to        | M14 x 1,5        | 25 Nm |
| injector                     |                  |      |
| Pressure/Return pipe         | M22 x 1,5        | 10 Nm |
| adapter to cylinder head     |                  |      |
| Supply and return pipe       | M18 x 1,5        | 10 Nm |
| connections                  |                  |      |
| Injection pump support       | M8               | 20 Nm |
| Delivery valve holder:       |                  |      |
| "A" type pump                | stage 1          | 40 Nm |
|                              | stage 2          | 40 Nm |
|                              | stage 3          | 40 Nm |
| Final torque                 |                  | 45 Nm |
| "MW" type pump               |                  |      |
| 8mm nut                      |                  | 50 - 60 Nm |
| * Loosen after 1st, 2nd and 3rd stages |      |

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REMOMING THE INJECTION PUMP

1. Detach the oil filler pipe or breather from the timing case (if fitted) or remove the blanking plug, (Fig. 17-1).

2. Remove the rocker cover, (Fig. 17-2).

3. Turn the engine in the normal direction of rotation until the No. 1 piston is on compression stroke and the mark on the vibration damper is in line with (FB) pointer on the timing case, (Fig. 17-3).

Attention! Never turn the engine in the reverse direction of rotation.

4. Disconnect the fuel filter, fuel and oil feed pipes to the injection pump, (Fig. 17-4).
5. Use special tool, part number 4020 0705, to unscrew and detach the injector pipes from the injection pump (Fig. 17-5).

6. Unscrew and remove nuts retaining the intermediate flange of the injection pump to the timing housing. Fit protective dust caps (Fig. 17-6).

7. Lift off the injection pump (Fig. 17-7).

REPLACING THE INJECTION PUMP

1. Turn the engine in the normal direction of rotation until No. 1 piston is on compression stroke. The mark on the vibration damper must be in line with the (FB) pointer on the timing case (Fig. 17-8).
Fuel System 17-6

2. Replace injection pump flange gasket, insert the pump into the timing housing and ensure that the mark on the injection pump gear tooth lines up with the arrow in the timing case. (Fig. 17-90).
(Refer fig. 17-16 on page 17-7).

3. Replace the injection pump retaining nuts and tighten to the specified torque (Fig. 17-10).

4. Set start of delivery (Refer to injection pump timing Fig. 17-14)

5. Attach injector pipes to the injection pump. Use special tool part No. 4020 0718 to tighten all connections to the specified torque. (Fig. 17-11)

6. Attach the fuel and oil feed pipes to the injection pump and tighten to the specified torque. Replace the breather pipe or plug. (Fig. 17-12)

7. Replace rocker cover.
SETTING "A" TYPE INJECTION PUMP TIMING

1. Remove rocker cover, (Fig. 17-13)

2. Turn engine in the direction of rotation until No. 1 piston is on compression stroke and the mark on the vibration damper is in line with the pointer on the timing case, (Fig. 17-14)

3. Detach the oil filler pipe or breather from the timing case (if fitted) or remove the blanking plug, (Fig. 17-15).

4. Check to ensure that the marked tooth on the injection pump gear is in line with the pointer in the timing gear cover, (Fig. 17-16).
5. Disconnect all injector pipes from the injection pump using special tool part number 4020 0705. (Fig. 17-17).

6. Attach Pressure Limiting Valves, special tools part number 4020 2376, to injection pump outlets numbers 2 to 6. (Ref Fig. 17-18)

7. **Pump Unit** (Ref fig. 17-19)
   - Item 1 Electric Motor
   - Item 2 Gear Pump
   - Item 3 Pressure Limiting Valve
   - Item 4 Fuel Tank
   - Item 5 Return Line
   - Item 6 Test Line with Sightglass
   - Item 7 12v connection cable
   - Item 8 Connection line (supply)
   - Item 9 Base plate
   - Item 10 Relay box with switch

8. Detach fuel supply line at pump and connect supply line (8) of the pump unit (Ref Fig 17-20)

9. Detach fuel return line (12) and overflow valve at the injection pump and seal bore with a dummy plug (13).

10. To the No 1 outlet of the fuel pump connect the test line with sightglass (Ref (6) Fig. 17-20).
11. Turn the crankshaft in the direction of rotation until it is approx. half a turn before T.D.C. of the No. 1 cylinder. (Ref. Fig. 17-21)

12. Lock the injection pump lever at Full load position.

Note: - Before switching on the Test Pump Unit the injection pump lever must be locked at full load and must not be moved when the pump unit is running. Switch on the Test Pump Unit only while performing measurement.

13. Switch on the Test Pump Unit then slowly rotate the crankshaft in the direction of rotation and observe the fuel jet in the sight glass. The exact start of delivery is reached when the fuel jet changes from a tapered jet stream to a chain of drops.
   
   A = Full fuel jet
   B = Fuel jet tapered - shortly before start of delivery
   C = Chain of drops = start of delivery

14. Check start of delivery marking between setting pointer on timing case and marking on vibration damper or belt pulley. (Ref. Fig. 17-23)

15. If it is necessary to correct the start of delivery of the injection pump, the crankshaft should be turned in direction of rotation exactly to the start of delivery marking of setting pointer with vibration damper or belt pulley.

16. Slacken the nuts (13) securing the injection pump. (Ref. Fig. 17-24)

Note: - The injection pump lever must be locked at full load and must not be moved when the pump unit is running. Switch on the pump unit only for performing measurement otherwise fuel may get into the combustion chamber if the nozzle is leaking.
Fuel System 17-10

17. Move the injection pump on the slotted holes far enough to achieve exact start of delivery.

8. Re-tighten the hex.nuts (13) of injection pump to specified torque.

19. Repeat testing of start of delivery operations 11 to 14 above.

20. Remove the Pressure limiting valve and the test line fitted to no. 1 cylinder and reassemble injection pipes. Ref. FIG. 17-26.

21. Replace the oil filler pipe/breather or blanking plug to the timing case. Ref. FIG. 17-27.

SETTING "MW" TYPE INJECTION PUMP TIMING

Note:
With the fitting of the "MW" injection pump to the ADE 360 series turbocharged engine the timing procedure has changed. It is no longer advisable to remove the delivery valve when carrying out the spill timing. Once the valve has been removed the valve seal could be damaged and cause a leak to develop at high pressure.

1. Remove rocker cover.

2. Turn the engine in the direction of rotation and position No. 1 cylinder on firing stroke ± 45 degrees before top dead centre. (Fig. 17-28).

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3. Remove the low pressure piping to and from the injection pump and fuel filters. Note position of gallery pressure valve No. 1 and fuel supply to gallery No. 2, (Fig. 17-29).

4. Fit the supply pipe from the pressure spill pump to the front end of the injection pump gallery. Fit a blanking plug to the rear end of the gallery.

(Spill pump part number 4020 2363 or alternatively 4020-2460)

5. Disconnect all injector pipes and the respective delivery valve unions on the injection pump. Fit pressure relief valve unions, (Fig. 17-31).

6. Connect the pressure spill pump return pipe with spill pipe to the No. 1 delivery valve union, (Fig. 17-32).

7. Move the accelerator control lever on the injection pump to the full speed position.
8. Connect the pressure spill pump to a suitable power supply; ensure that the pump pressure is approx. 2500 kPa.

9. Continue turning the engine in the normal direction of rotation until the fuel discharge in the glass bowl changes from a tapered jet stream to a chain of drops, (Fig. 17-33).

10. Check the timing marks (FB) on the timing cover and vibration damper for alignment, (Fig. 17-34).

11. If the timing is retarded loosen the injection pump securing nuts and move the top of the injection pump towards the cylinder block or away from the cylinder block to advance, (Fig. 17-35).

12. After adjustment re-check the timing by repeating operations 2 to 9.

13. Tighten the nuts retaining the injection pump to the timing gear housing, (Fig. 17-36).
14. Remove the blanking plug and high pressure pipe from the test pump. Reconnect the gallery pressure valve and the low pressure feed to the pump and tighten to the specified torque.

15. Reconnect the injector pipes and tighten the bottom unions to the specified torque, (Fig. 17-37).

16. Replace rocker cover.

REMOVAL AND REPLACEMENT OF FUEL INJECTORS

Removal

1. Remove rocker cover.

2. Use special tool, part number 4020 0705, and unscrew the pipes to the fuel injector. Push the injector pipe to one side. Do not bend the pipe, (Fig. 17-38).

3. Disconnect the fuel leak off pipe, (Fig. 17-39).

4. Remove the injector securing nut with special tool 4020 0873, (Fig. 17-40).
5. Use special tool 4020 1076 to pull the injector out of the cylinder head. (Fig. 17-41).

6. If too tight withdraw the injector with special extractor, part number 4020 1063, (Fig. 17-42).
   Keep matched washer with the respective injector.

Attention!: See section 12 for removal and replacement of injector protection sleeves.

Replacement

1. Insert a new injector sealing washer into the cylinder head. (Fig. 17-43).

Note: The new sealing washers must be the same size and thickness as the ones removed.

2. Insert injector into the cylinder head and locate the notch on the injector with the groove in the cylinder head. (Fig. 17-44).
3. Replace the injector securing nut and use a torque wrench fitted with special tool 4020 0873 to tighten to the specified torque, (Fig. 17-45)

4. Replace the fuel leak off pipe fitted with new sealing washers and tighten to the specified torque, (Fig. 17-46)

5. Replace the pressure pipe to the fuel injector and use special tool 4020 0718 to tighten to the specified torque, (Fig. 17-47)

TESTING THE INJECTOR FOR LEAKAGE

1. With specialised nozzle cleaning equipment carefully remove carbon deposits from the injector nozzle tip holes, (Fig. 17-48)
2. Attach the injector to the tester, (Fig. 17-49)

**Attention!** Only use clean testing fluid or filtered diesel fuel for testing purposes.

**Note:** Care must be taken during testing as the spray is under considerable pressure and would penetrate the skin of hands or face.

3. Slowly press down the pump tester lever until the pressure gauge shows 200 kPa below opening pressure of the injector nozzle. The injector is faulty if fuel leaks from the nozzle within 10 seconds.

4. In all cases of seizure or leakage dismantle and clean the injector. The nozzle must be replaced if careful cleaning

**TESTING NOZZLE OPENING AND INJECTION PRESSURE**

1. Attach injector to tester.

2. Slowly advance the pump test lever; note the pressure when the injector opens, (Fig. 17-50)

3. The injector pressure may be adjusted by adding or removing shims on top of the compression spring.

**JET SPRAY TEST**

1. Turn off the pressure gauge.

2. Operate the hand pump lever (several brisk strokes). The injection is correct when all four jets spray fine and even, (Fig 17-51)

**DISMANTLING AND ASSEMBLY OF FUEL INJECTORS**

1. Clamp special injector support 4020 0912 in a vice.

2. Insert the injector into the holder, (Fig. 17-52)
3. With special tool 4020 0925 unscrew the injector nozzle cap nut from the injector body and dismantle the injector assembly, (Fig. 17-53).

4. Carefully remove carbon deposits from injector holes, (Fig. 17-54)

5. Dip needle valve and nozzle body into clean diesel fuel and carry out drop test, see operation 6 below.

6. Lift needle valve by approximately one third of its length from the nozzle body. Release the needle valve so that it returns to its seat under its own weight, (Fig. 17-55)

   If the needle valve sticks before reaching the seat, replace the complete nozzle assembly.

ASSEMBLY OF THE NOZZLE

1. Insert the injector body into special holding tool 4020 0912, (Fig. 17-56)
2. Insert shim (2), spring (3), thrust pin (4), adaptor (5) into the injector body (1). Insert the needle valve (6) into the nozzle (7). Place the nozzle onto the adaptor (5), (Fig. 17-57)

3. Two guide pins are fitted on both sides of the adapter. The guide pins which locate in the corresponding holes in the nozzle holder are in different position to the two pins which locate the nozzle. Incorrect fitment of the adapter is therefore impossible. The adapter face which mates with the nozzle is chamfered at the edge, (Fig. 17-58).

4. Screw injector cap nut (8) onto the injector body (1), (Fig. 17-59).

5. Use special tool 4020 0925 to tighten the injector cap to the specified torque, (Fig. 17-60)
SPECIAL TOOLS FOR SECTION 17

OBTAINABLE FROM: GRUNDY TECHNIFORM, BURMAN ROAD, DEAL PARK, PORT ELIZABETH 6001
TEL: (041) 43-2299, FAX: (041) 43-2224

Split ring spanner for injector pipes
see fig. 17-5, 17-18
part number 4020 0705

Crowfoot ring spanner for removing/replacing injector pipes
see fig. 17-11, 17-12, 17-47
part number 4020 0718

Spill pipe
see fig. 17-20
part number 4020 0860

Fuel container for checking start of delivery
see fig. 17-21
part number 4020 0857

Socket for injector securing nuts
see fig. 17-32
part number 4020 0873

Fuel injector impact extractor
see fig. 12-12
part number 4020 1076
Fuel System 17-20

Extractor for injectors
see fig. 12-13
part number 4020 1063

Support for stripping and assembling injectors, see fig. 17-44
part number 4020 0912

Spanner for stripping and assembling injectors, 22 mm
see fig. 17-45
part number 4020 0925

Pressure relief valve (set of 5)
for blanking off the delivery valve
see fig. 17-32
part number 4020 2376

Pressure spill timing pump
see fig. 17-33
part number 4020 2363

Alternative part number 4020 2460
J. S. Barnes timing unit available from:
Pro-Hyd Import & Export (Pty) Ltd
111 Tenth Road, Kew
Johannesburg
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Turbocharger 18A-2

KKK TURBOCHARGER

1 TURBINE WHEEL AND SHAFT ASSEMBLY
2 SEALING RINGS
3 HEAT SHIELD
4 CIRCLIP
5 BEARING
6 CIRCLIP
7 BEARING HOUSING
8 CIRCLIP
9 BEARING
10 CIRCLIP
11 THRUST WASHER
12 THRUST BEARING
13 OIL DEFLECTOR
14 SPACER
15 SEAL CARRIER/THRUST WASHER
16 SEALING RINGS
17 O-RING
18 END PLATE
19 SOCKET CAP SCREW
20 COMPRESSOR ROTOR WHEEL
21 COMPRESSOR ROTOR WHEEL RETAINING LOCK NUT
Garrett AiResearch

1 COMPRESSOR ROTOR WHEEL RETAINING NUT  
2 COMPRESSOR ROTOR WHEEL  
3 END PLATE  
4 O-RING  
5 SEALING RING  
6 SEAL CARRIER/THRUST WASHER  
7 CIRCLIP  
8 BEARING  
9 CIRCLIP  
10 THRUST BEARING  
11 SPRING LOCATING PINS  
12 BEARING HOUSING  
13 CIRCLIP  
14 BEARING  
15 CIRCLIP  
16 HEAT SHIELD  
17 LOCK PLATE  
18 BOLT  
19 SEALING RING  
20 TURBINE WHEEL ASSEMBLY

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**Turbocharger 18A-4**

**SPECIFICATIONS FOR KKK TURBOCHARGER**

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**TORQUE SPECIFICATIONS**

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**SPECIFICATIONS FOR GARRETT TURBOCHARGER**

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**TORQUE SPECIFICATIONS**

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<td>Turbocharger to exhaust manifold</td>
<td>65 Nm</td>
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INTRODUCTION

Turbocharger

The Garrett/AiResearch and KKK turbochargers for internal combustion engine application comprises of a turbine and a radial compressor which utilise a common shaft. The turbine and compressor wheels are mounted at opposite ends of the shaft. The shaft is enclosed and supported by fully floating bearings in a housing. The turbine and compressor wheels are enclosed in cast housings.

After the engine is started the flow of exhaust gas from the engine passes through the turbine housing and causes the shaft assembly to rotate. The compressor wheel, mounted at the opposite end of the shaft, draws ambient air into the compressor housing, compresses the air and delivers it to the engine.

During operation the turbocharger responds to the engine load demands by reacting to the exhaust gas energy. As the power of the engine increases, the speed and output of the rotating assembly increases proportionately.

The removal and replacement procedure illustrated shows a typical installation, which may vary depending on specification.

Checking a Turbocharger in a Vehicle

Disconnect the inlet duct and turn the rotor. Ensure easy and uniform running. If necessary turn back and forth several times until the rotor is free of oil and carbon deposits.

The turbocharger has gyroscopic stabilisation and runs in floating bearings. Try to move the rotor in and out. The end play is set correctly if very little or no play can be felt. Move and turn the rotor up and down in either direction. The side play is adjusted correctly if no scraping occurs.

Turbocharger Oil Leaks

The bearing housings on all types of turbochargers used on ADE engines are sealed with oil controlling rings to provide a seal between the oil and the air/exhaust gas. The function of these seals is based on the pressure build up in the compressor housing. There could, however, be a vacuum at high engine RPM while coasting which would favour oil leakage and oil coating of the inlet port. The amount of oil lost in this way is extremely low and has no measurable influence on the engine's oil consumption.

The turbocharger should not be removed if oil covered ports are found during a service, as long as an inspection of the turbocharger did not show any defects.

Another cause for oil leaks could be a damaged (deformed) or clogged oil return pipe. The reduced cross-sectional size of the pipe would lead to an increase in resistance, causing the oil level in the turbocharger to rise and oil to leak past the seals on the turbine and compressor sides. In this case clean or replace the oil return pipe.

Fitting a Reconditioned Turbocharger

Prior to fitting the turbocharger the inlet and flanged manifold ahead of the compressor, the exhaust manifold and exhaust pipe, as well as the oil feed and return pipes must be inspected thoroughly for dirt and damage. The plugs on the turbocharger openings should only be removed just before fitting. The bearing housing must be filled with clean engine oil through the oil inlet port prior to connecting the oil feed pipe. During filling turn the moving parts by hand to coat the bearings with oil.

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Turbocharger 18A-6

REMOVAL, OVERHAUL AND REPLACEMENT

1. Disconnect the oil feed pipe to the turbocharger, (Fig. 18A-1).

2. Remove the oil feed retaining bracket, if fitted, and loosen the bottom banjo union, (Fig. 18A-2).

3. Disconnect the oil drain pipe from turbocharger to sump, (Fig. 18A-3).

4. If a heatshield is fitted, unscrew the retaining nuts and remove, (Fig. 18A-4).
5. Prior to removal mark the position of the exhaust elbow in relation to the turbocharger body. (Fig. 18A-5).

6. Remove the exhaust pipe elbow from the turbocharger. (Fig. 18A-6).

7. Unscrew the mounting nuts of the turbocharger and remove the turbocharger from the exhaust manifold, (Fig. 18A-7).

**Measuring the turbocharger shaft end play.**

1. Clamp the turbocharger, turbine end up, in a vice fitted with soft jaws.

2. Mount a dial gauge fitted with a magnetic base onto the turbocharger housing. Place the dial gauge probe at the end of the turbine shaft and set the gauge to "0", (Fig. 18A-8).

3. Push the turbine shaft against the dial gauge probe and note the reading. Ensure that the reading agrees with specifications.
**Turbocharger 18A-8**

Measuring the turbocharger shaft side play

Attention! The side play should be measured at the turbine end only.

1. Push the turbine wheel to one side and measure the gap between the blades and the housing with a feeler gauge. Note clearance. (Fig. 18A-9).

2. Push the turbine wheel in the opposite direction and measure the gap between the blades and the housing with a feeler gauge. Note clearance.

3. The sum of the two readings divided by two represents the average side play. Compare with specifications.

Attention! Measurements should be made at two different points.

**HOLDING TOOLS**

![KKK HOLDING TOOL](Fig. 18A-10)

**KKK HOLDING TOOL**

A KNURLING

Fig. 18A-10

B ADAPTED TO AVAILABLE ROTOR

![GARRETT HOLDING TOOL](Fig. 18A-11)

**GARRETT HOLDING TOOL**
DISMANTLING

1. Prior to removal mark positions of the turbine and compressor housings in relation to the centre housing, (Fig. 18A-12).

2. Bend down the locking plates and unscrew the bolts holding the turbine and compressor housings to the centre housing, (Fig. 18A-13).

   **Attention!** Tight housings can be removed with a rubber or hide faced hammer.

3. Unscrew and remove the bolts and locking plates from the compressor housing, (Fig. 18A-14).

4. Remove the compressor housing from the centre housing, (Fig. 18A-15).

   **Attention!** Tight housings can be removed with a rubber faced hammer.

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5. Remove the O-ring from the compressor housing. (Garrett), (Fig 18A-16).

6. Using special holding tool made to illustration Fig. 18A-10, 18A-11, clamp the turbocharger shaft and un­螺丝 the compressor rotor wheel retaining nut, (Fig. 18A-17).

7. Remove the outer O-ring from the backing plate, (Fig. 18A-18). (KKK- turbos).

8. With a Bosch hot air blower or similar heat source, heat the compressor rotor wheel, (Fig. 18A-19).

Attention! Do not heat the compressor rotor wheel with a welding torch.
9. Lift off the compressor rotor wheel from the turbo rotor shaft. Remove retaining allen cap screws from copressor end plate, (Fig. 18A-20). Remove compressor end plate from centre housing.

Unique to KKK turbochargers:

10. Lift out the seal carrier/thrust washer from the compressor end plate, (Fig. 18A-21).

11. Remove the inner O-ring from the end plate, (Fig. 18A-22).

12. Remove the oil deflector from the centre housing, (Fig. 18A-23).
13. Remove the thrust bearing, (Fig. 18A-24).

14. Remove the spacer sleeve, (Fig. 18A-25).

15. Remove the thrust washer, (Fig. 18A-26).

**Unique to GARRETT turbochargers:**

16. Remove the O-ring from the centre housing, (Fig. 18A-27).
17. Lift out the thrust bearing and thrust washer from the centre housing, (Fig. 19-28).

18. Remove the seal carrier/thrust washer from the thrust bearing, (Fig. 18A-29)

19. Remove the sealing ring from the seal carrier/thrust washer, (Fig. 18A-30)

All Turbochargers:

20. Lift off the centre housing from the turbo rotor shaft, (Fig. 18A-31).
21. Remove the heat shield from the turbo rotor shaft, (Fig. 18A-32).

22. Remove the bottom sealing rings from the turbo rotor shaft, (Fig. 18A-33).

23. Remove the turbo-rotor shaft assembly and the holding tool clamp from the vice.

24. Remove the sealing rings from the seal carrier, (Fig. 18A-34).

25. Remove the circlips retaining the turbo rotor bearings from the centre housing, (Fig. 18A-35).
26. Lift out the bearings and remove the inner circlips, (Fig. 18A-36).

Attention! All parts should now be washed in a suitable cleaning fluid. Do not use abrasive cleaning methods which may damage or destroy machined surfaces. Thoroughly clean the turbine end oil cavity in the centre housing. Remove all carbonised oil. Check the turbine housing and rotor blades for cracks, score marks and foreign particles. Check both rotors for bent or damaged blades and seal rings for wear. Replace all worn parts. Examine mating surfaces for the seal rings in the centre housing and back plate. Examine the seal grooves in the shaft and seal carrier for wear.

ASSEMBLY

1. Place turbo rotor shaft on a suitable V-block, level with the bearing points and check the shaft for parallel running 10 mm from the end of the threads. Refer to the specifications for maximum permissible run out, (Fig. 18A-37).

2. Fit the inner circlips and bearings to the centre housing. (Fig. 18A-38).

3. Insert the outer bearing circlips in the centre housing. (Fig. 18A-39).

Attention! Always use new circlips after an overhaul.
4. Clamp the rotor shaft in a vice.
5. Fit the sealing rings to the bottom of the rotor shaft and lubricate, (Fig. 18A-40).

6. Fit the heat shield over the turbo rotor shaft, (Fig. 18A-41).

7. Fit the centre housing over the turbo rotor shaft. Do not damage the sealing rings, (Fig. 18A-42).

**Unique to KKK turbochargers:**
8. Fit the inner thrust washer, (Fig. 18A-43).
9. Replace the spacer, (Fig. 18A-44).

10. Fit the thrust bearing over the retaining pins, (Fig. 18A-45).

11. Insert the oil deflector, (Fig. 18A-46).

12. Fit a new inner O-ring to the end plate, (Fig. 18A-47).
13. Replace and lubricate the sealing rings on the seal carrier and fit into the end plate, (Fig. 18A-48).

14. Fit the end plate to the centre housing, (Fig. 18A-49).

15. Insert the cap screws retaining the end plate to the centre housing and tighten to the specified torque, (Fig. 18A-50).

Unique to GARRETT Turbochargers:

16. Lubricate and replace the sealing rings on the seal carrier/thrust washer (Fig. 18A-51).
17. Fit the thrust bearing to the seal carrier/thrust washer and slide over the turbo rotor shaft. Align the thrust bearing with the retaining pins. (Fig. 18A-52).

18. Replace the O-ring at the top of the centre housing. (Fig. 18A-53).

19. Line up the sealing ring on the seal carrier/thrust washer and fit the end plate. (Fig. 18A-54)

20. Insert the bolts fitted with the lock plates into the end plate. (Fig. 18A-55).
21. Tighten the bolts to the specified torque and secure the lock plates, (Fig. 18A-56).

22. Heat the compressor wheel with a Bosch hot air blower or alternative heat source, (Fig. 18A-57).

Attention! Do not heat the compressor wheel with a welding torch.

23. Fit the compressor wheel to the turbo rotor shaft, (Fig. 18A-58).

24. Replace the outer O-ring on the end plate, apply petroleum jelly to assist, (Fig. 18A-59).
25. Replace the compressor wheel retaining lock nut and tighten to the specified torque. Do not bend the shaft, (Fig. 18A-60).

Attention! Always use a new lock nut

26. Mount the centre housing in a vice and turn the rotor shaft by hand to check for free running, (Fig. 18A-61).

27. Fit the compressor housing to the centre housing, (note scribed assembly marks). Replace the bolts and retaining clamps and tighten to the specified torque, (Fig. 18A-62).

28. Fit the turbine housing to the centre housing (note scribed assembly marks), (Fig. 18A-63).

Note: On Garrett turbochargers ensure that a new O-ring is fitted in the compressor housing.
29. Replace the bolts and clamps, tighten to the specified torque and bend over the locking plates. (Fig. 18A-64).

Attention! Always fit new locking plates.

30. Turn the turbo rotor shaft by hand and check for free running.

31. Lubricate bearings in the centre housing with engine oil, (Fig. 18A-65).

Replacing the turbocharger

1. Mount the turbocharger onto the exhaust manifold. Ensure that the mating surfaces of flanged areas are clean and free of burrs or high spots, (Fig. 18A-66).

2. Fit the exhaust pipe elbow to the turbocharger (note scribed assembly marks), (Fig. 18A-67).
3. Mount the heat shield, if fitted, to the turbo studs and secure with new self locking nuts, (Fig. 18A-68).

4. Insert the banjo bolt connecting the turbo feed pipe to the oil pressure gallery on the cylinder block and tighten the bolt to the specified torque, (Fig. 18A-69).

5. Tighten the turbo oil feed pipe retaining bracket to the specified torque, (Fig. 18A-70).

6. Use a new gasket and replace the top oil feed pipe, insert the bolts and tighten to the specified torque, (Fig. 18A-71).
7. Fit the oil return pipe with a new gasket to the turbocharger and tighten the bolts to the specified torque. (Fig. 18A-72).
INTERCOOLER

Depending on application and/or requirement the ADE 360 series engines are built to accept a charge air cooler (intercooler), mounted between the turbocharger compressor housing and inlet manifold. The intercooler resembles a coolant radiator core (see fig 18A-118). Under load, air is compressed and forced via the intercooler into the combustion area by the turbocharger. During compression by the turbocharger the air heats up and expands, consequently becoming less dense. By directing the hot air through an intercooler some heat is removed. The expansion of the charged air is therefore reduced, which means more air will be forced into the combustion area, the increased density of the charged air (oxygen) allows for more fuel to be injected, and consequently more power will be developed.

Maintenance

1. Keep the cooler externally clean and free from obstruction which may affect the air flow.
2. Charge air leaks will result in loss of power, therefore:
   - All induction tubing and hose joints must be kept tight.
   - Ensure that all mountings are secure to prevent vibrations which may crack the intercooler tubes.
   - Periodically inspect the intercooler tubes for holes due to corrosion or impact by debris.
3. In the event of dust or foreign objects entering the induction system and/or turbocharger compressor wheel failure, clean the induction tubing/hoses to and from the intercooler. Dismantle and clean the intercooler. Sealed units that cannot be cleaned properly should be replaced.

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SECTION 18B
Power Steering Pump

ZF-ROTARY PUMP TYPE 7673

1 NUT
2 SPRING WASHER
3 DRIVE SHAFT
4 WOODRUFF KEY
5 CIRCLIP
6 BALL BEARING
7 CIRCLIP
8 SHAFT SEAL
9 NEEDLE BEARING
10 HOUSING
11 BLANKING PLUG
12 SEALING RING
13 PHILLIPS SCREW
14 IDENTIFICATION PLATE
15 FITTED PIN
16 O-RING
17 O-RING
18 FRONT PLATE, DRIVE-END
19 ROTOR
20 VANE
21 CAM RING
22 O-RING
23 FRONT PLATE COVER-END
24 SPRING
25 O-RING
26 COVER
27 HOOKED CIRCLIP
28 THROTTLE INSERT
29 VALVE PISTON COMPLETE
30 PRESSURE RING
31 SEALING RING
32 BLANKING PLUG

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INTRODUCTION

Depending on application the ADE 360 series engines can be fitted with either of two types of rotary power steering pumps, both of which operate as follows:

When the drive shaft and its rotor are turned, the vanes are guided in slots and being radially mobile, are pressed against the guide part of the cam ring by the action of centrifugal force and oil pressure. Two successive vanes are classed as a cell (a total of 10). Their lateral movement is restricted by the pressure plates. Each cell delivers the maximum effective volume twice per revolution. The suction and pressure chambers are arranged so that the hydraulic and radial forces acting on the rotor will neutralise each other. The cover end front plate and the drive end front plate are provided with four grooves so that the pressurised oil reaches the internal face of the pump vanes, which will then be supported by the centrifugal force. From the pressure chamber the oil travels through holes to the flow restricting valve, and by way of a throttle restriction to the pressure line. The reduced pressure behind the throttle restriction is transmitted via holes to the spring-loaded end of the flow restricting piston and therefore on to the relief valve.

Increasing the speed or pump delivery will produce a growing pressure drop behind the throttle restrictor and also against the spring end of the valve piston. When the hydraulic power (pressure differential times piston area) exceeds the spring force, the piston will move towards the spring and the oil delivered in excess will flow through the now exposed ejection hole into the suction duct of the pump. As a result, an almost constant oil flow for the steering gear is provided throughout the entire speed range.

TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Task</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulley to pump shaft</td>
<td>M14 x 1.5</td>
</tr>
<tr>
<td>Cover to pump housing</td>
<td>M10</td>
</tr>
<tr>
<td>Pump bracket to fuel filter bracket</td>
<td>M10</td>
</tr>
<tr>
<td>Adjusting bolt to water pump</td>
<td>M12 x 1.5</td>
</tr>
<tr>
<td>Adjusting bolt to bracket</td>
<td>M10</td>
</tr>
</tbody>
</table>

V-belt tension for 12.5 mm wide belts

<table>
<thead>
<tr>
<th>V-belt condition</th>
<th>Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>New V-belt</td>
<td>40 to 45 kg</td>
</tr>
<tr>
<td>After run-in period</td>
<td>30 to 40 kg</td>
</tr>
<tr>
<td>Used V-belt</td>
<td>30 to 40 kg</td>
</tr>
</tbody>
</table>

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## Vickers High Pressure Oil Pump VT 27

### Fault finding

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump is not delivering</td>
<td>Pump running in wrong direction</td>
<td>Change direction of rotation</td>
</tr>
<tr>
<td></td>
<td>Pump drive shaft sheared</td>
<td>Remove the pump to determine the extent of the damage and Replace damaged parts</td>
</tr>
<tr>
<td></td>
<td>V-belt slips or is torn</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow restriction, valve binds</td>
<td>Dismantle the pump and clean the valve. Re-install valve piston and check for ease of operation. Slight rough spots can be removed by lapping. Do not grind or chamfer control edges. No refinishing is permitted on valve bore. All parts must be cleaned prior to assembly. The system should be thoroughly flushed and filled with clean oil.</td>
</tr>
<tr>
<td></td>
<td>Vanes bind in rotor slots</td>
<td>Remove the pump and check the rotor slots for dirt, abrasives and swarf. Clean rotor and vanes. During assembly check the vanes for ease of operation.</td>
</tr>
<tr>
<td></td>
<td>Oil viscosity too high.</td>
<td>Use oil of correct viscosity.</td>
</tr>
<tr>
<td></td>
<td>Pump cannot suck</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inlet pipes partially blocked.</td>
<td>Drain the oil from the system. Flush all pipes. Fill the system with fresh oil in accordance with recommendations.</td>
</tr>
<tr>
<td></td>
<td>Tank vent clogged.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Inlet filter contaminated.</td>
<td>Remove tank cover and clean. Check the system filter or intake filter for clogging. If the intake filter is clogged, drain the system, flush and refill.</td>
</tr>
<tr>
<td>Excessive pump noise</td>
<td>Intake pipe partially or completely clogged. Filter clogged.</td>
<td>The pump should be able to suck without restriction to prevent cavitation. Drain the system, clean the intake pipe and filter. Fill up with recommended oil.</td>
</tr>
<tr>
<td></td>
<td>Leaking inlet pipe connections.</td>
<td>Check by pouring oil on connections. Note the change in pump noise, tighten connections.</td>
</tr>
<tr>
<td></td>
<td>Leaking shaft seals.</td>
<td>Replace in accordance with instructions</td>
</tr>
<tr>
<td></td>
<td>Misalignment of shaft coupling.</td>
<td>Inspect the shaft bearing and oil seal for possible faults, replace as necessary. Realign shaft.</td>
</tr>
<tr>
<td></td>
<td>Container seal leaking.</td>
<td>Replace the container cover seal, tighten pipe to tank connections</td>
</tr>
</tbody>
</table>

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REMOVING AND REPLACING THE STEERING PUMP

Removing the pump

1. Loosen the clamp bolt of the V-belt adjuster, (Fig. 18B-1).

2. Slacken off the V-belt adjuster from the pulley, (Fig. 18B-2).

3. Unscrew and remove the bottom pump mounting retaining bolt, (Fig. 18B-3).

4. Clamp the pump drive pulley in a vice, fitted with soft jaws, unscrew the pulley retaining nut and remove the pulley, (Fig. 18B-4)

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5. Unscrew the bolts retaining the mounting bracket to the pump and remove the bracket, (Fig. 18B-5).

DISMANTLING

Removal of Rotor and Cam Ring
ZF High Pressure Vane Pump

1. Remove the circlip from the groove in the pump housing, (Fig. 18B-6).

2. Remove the cover, spring and cover end plate from the housing, (Fig. 18B-7).

3. Tilt the pump body and remove cam ring and rotor, (Fig. 18B-8).
Removing the drive shaft

4. Remove the circlip, (Fig. 18B-9).

5. With a Rubber or plastic hammer knock the drive shaft from the housing, (Fig. 18B-10).

6. Knock the drive end face plate from the housing.

7. Remove the volume control valve.

8. With a suitable punch knock the needle bearing and drive shaft seal from the housing, (Fig. 18B-11).

9. Remove the O-rings from the housing, the hollow pin and drive end face plate.

10. After removing the circlip the bearing can be pressed from the drive shaft, (Fig. 18B-12).
Removing the Flow and Pressure Restriction Valve of the Z.F. High Pressure Vane Pump

1. Remove the screw plug from the housing, (Fig. 18B-13).

2. Remove the spring and valve piston from the housing bore

Dismantling, Inspection and Assembly of the Flow and Pressure Restriction Valve

1. Check the pressure and flow restriction valve for score marks and wear. The flow control piston should not bind in the housing bore. Check the item numbers on the housing face and the piston to ensure matching parts are used, (Fig. 18B-14).

2. Unscrew the valve seat screw from the pressure restriction valve (do not use a vice). Ensure that none of the washers, the ball, the spring guide and compression springs are lost. The thickness of the washer is critical for the response range of the pressure relief valve. New washers must be fitted to prevent the possibility of damage, (Fig. 18B-15).

3. Clean the control valve and the valve screw and blow out with compressed air. Reinsert the compression spring, guide pin and ball. Screw the valve seat screw into the control piston, together with the previously installed washers.

---

Fig. 18B-13

Fig. 18B-14

Fig. 18B-15

1 VALVE PISTON
2 COMPRESSION SPRING PRESSURE RELIEF VALVE
3 SPRING GUIDE PIN
4 VALVE BALL
5 ADJUSTING WASHERS
6 VALVE SEAT SCREW
7 SPRING VOLUME CONTROL VALVE
8 SCREW PLUG WITH SEALING WASHER

April '96
Replacement of Flow and Pressure Restriction Valve

4. Insert assembled valve piston into the bore. Check for correct tolerance, (Fig. 18B-16).

5. Slide the compression spring onto the valve piston and screw the blanking plug into the thread hole with the sealing washer placed underneath, (Fig. 18B-17).

Pre-assembly of Pump Housing

Note: Prior to assembly clean all parts, moisten slightly with ATF oil and replace all seals and O-rings.

1. With suitable mandrel press the needle bearing into the housing, (Fig. 18B-18).

The face end of the needle bearing must be 37.0 to 37.2 mm from the face end of the housing, (Fig. 18B-19).

Note: The needle bearing is installed only in pumps with V-belt drive.
2. With a mandrel press the shaft seal into the housing. Fit the seal with bearing grease between the sealing lips. (Fig. 18B-20).
3. Screw the plug into the housing and tighten.
4. Fit an O-ring into the bottom groove of the housing.
5. Insert a hollow pin into the hole provided. (Fig. 18B-21).

Assembly and Replacement of the Drive Shaft
6. Press the ball bearing on the drive shaft and replace the circlip. Fit the woodruff key. (Fig. 18B-22).
7. Insert the pre-assembled drive shaft into the housing until the ball bearing rests against the housing flange. (Fig. 18B-23).
8. Insert the circlip retaining the ball bearing, (Fig. 18B-24).

Replacement of the Drive End Face Plate

9. Insert the O-ring into the groove in the neck of the face plate.
10. Slide the drive end plate onto the hollow pin and press with the neck into the housing, (Fig. 18B-25).

Replacement of the Cam Ring and Rotor

11. Insert O-ring (1) into the groove in the housing, (Fig. 18B-26).
12. Insert the cam ring. The smaller hole locates the hollow pin. The cast half arrow indicates the driving direction of the pump, (Fig. 18B-27).
13. Fit the rotor with the smooth bore on the drive shaft, (Fig. 18B-28).

14. Insert the ten vanes with the rounded-off outer surfaces facing the cam ring into the slots of the rotor, (Fig. 18B-29).

Replacement of the End Face Plate and Cover

15. Fit the cover end onto the cam ring, as shown. The hollow pin fits in one of the smaller holes, (Fig. 18B-30).

16. Insert the O-ring, (Fig. 18B-31).
17. Insert the spring into the bore of the cover end plate. Position the cover with the recess inwards and push into the housing until the circlip can be inserted, (Fig. 18B-32).

18. Insert the flow and pressure restriction valve.

Vickers High Pressure Oil Pump VT27
Dismantling -Removal of Rotor and Cam Ring

1. Remove the screws on the pump housing to which the housing cover is connected; remove the pump housing.

2. Remove the spring from the thrust plate. Mark the thrust plate, cam ring and housing cover to ensure the parts are correctly aligned on assembly (refer to arrows), (Fig. 18B-33).

3. Remove the thrust plate from the locating pins and take off the cam ring, (Fig. 18B-34).
4. Remove rotor with pump vanes from the drive shaft splines, (Fig. 18B-35).

5. Remove O-rings items 1 & 5, (Fig. 18B-36).

6. Remove the volume control valve.

7. Clean all parts thoroughly and rinse.

**Removal and Dismantling of Volume Control and Pressure Relief Valve**

1. Knock hollow pin from the pump housing.

2. Remove the blanking cover of the volume control valve and the compression spring from the pump housing, (Fig. 18B-37).

**Note:** Caution! The compression spring may push off the blanking cover and the volume control valve after removing the hollow pin. Loosen the blanking cover with light hammer blows if it should remain in the housing. Do not damage the volume control valve.
3. Clamp the volume control valve at its unground end in a vice and unscrew the valve screw of the pressure relief valve. Ensure that no adjusting screws are lost. Remove the valve and spring from the volume control valve. (Fig. 18B-38).

4. Prior to replacement check the ground surface of the volume control valve and the bore in the pump housing for wear and damage. If the surfaces are showing score marks replace the complete oil pump. Never replace the volume control valve only.

Special Tool

To be manufactured, (Fig. 18B-39).

A INSTALLATION TOOL
B INSTALLATION TOOL
C INSTALLATION SLEEVE
Power Steering Pump 18B-16

Replacement of Drive Shaft and Sealing Ring

1. Remove the pump housing and press the drive shaft from the housing cover. Pay attention to the shell halves (item 10), (Fig. 18B-40).

2. With a screw driver lift the oil seal from the housing cover.

3. Place both shell halves on the drive shaft, then press the drive shaft into the housing cover, (Fig. 18B-41).

Note: The shell halves determine the end play of the drive shaft which is 0.7 mm max. for new high pressure oil pumps and should not be more than 1 mm for used pumps. Replace the high pressure oil pump if the end play is higher.

4. Use the installation tool to press the bush into the housing, (Fig. 18B-42)
5. Replace the assembly sleeve on the drive shaft and with the installation tool press the oil seal into the housing, (Fig. 18B-43).

Replacement of Rotor and Cam Ring

1. Moisten all parts with ATF oil.
2. Install volume control valve.
3. Place the rotor on the drive shaft so that the countersunk end of the splined bore faces the housing cover.
4. Place the cam ring on the fitted pins so that the respective markings on the housing cover and on the cam ring are aligned, (Fig. 18B-44).

Note: When a new cam ring is installed, it must be positioned so that the hydraulic oil bores are accurately located above the recesses in the housing cover, (item 4 & 5 Fig. 18B-45).

5. Insert pump vanes into slots or rotor so that the rounded ends are facing outwards toward the cam ring.
6. Position the thrust plate over the cam ring, ensuring markings are aligned.

Note: The outlet holes for the hydraulic oil should be above the hydraulic oil bores (item 5) of the cam ring.
Replacing the Pump

1. Fit the mounting bracket to the pump, insert bolts and tighten to the specified torque, (Fig. 18B-46).

2. Fit the pulley to the pump, clamp the pulley in a vice fitted with soft jaws, replace the retaining nut and tighten to the specified torque, (Fig. 18B-47).

3. Fit the pump to the mounting in the cylinder block, insert the bottom retaining bolt. Do not tighten, (Fig. 18B-48).

4. Fit the V-belt to the pulley, (Fig. 18B-49).
5. Insert the V-belt adjuster clamp bolt. Do not tighten. (Fig. 18B-50).

6. Use special tool 4020 2321 and adjust the V-belt tension to 40-50 kg (new belts), run the engine for 10-15 min. and re-check the tension, which should be 30-40 kg. Adjust to 30-40 kg if this figure is not reached. Position the tension gauge on the belt with the flange parallel against the belt edge. Gradually apply pressure to the pressure pad. When a "click" is heard or felt, stop and remove the gauge. Turn the gauge sideways and take a reading at the spot where the indicator arm intersects the scale, (Fig. 18B-51).

7. Tighten the lock nut on the V-belt adjuster, (Fig. 18B-52).

8. Tighten the clamp bolt on the V-belt adjuster, (Fig. 18B-53).

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9. Tighten the bottom pump retaining bolt. (Fig. 18B-54).

SPECIAL TOOLS FOR SECTION 18B

OBTAINABLE FROM: GRUNDY TECHNIFORM, BURMAN ROAD, DEAL PARK, PORT ELIZABETH 6001
TEL: (041) 43-2299, FAX: (041) 43-2224

V-belt tensioning gauge,
Part No. 4020 2321
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INTRODUCTION

Depending on application, some ADE 360 series engines are fitted with an exhaust brake consisting of a butterfly valve pivoting on a spindle within a separate housing, situated in the exhaust system. The butterfly valve is actuated by a pneumatically operated lever, which is secured to the butterfly valve spindle, where the spindle protrudes through the housing.

When a foot operated exhaust brake valve, located on the floor of the cab (drivers side), is pressed, compressed air flows past a valve and enters an air operated cylinder. A piston inside the cylinder attached to the valve spindle pushes the lever forward and thus closes the valve. At the same time the fuel supply to the injectors is cut off (i.e. the speed control lever moves to the stop position).

The pressure built-up in the exhaust manifold and combustion chambers exerts a braking effect via the transmission to the wheels of the vehicle.

TORQUE SPECIFICATIONS

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<th>Torque Specifications</th>
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<tr>
<td>Control lever clamp bolt</td>
<td>M6</td>
</tr>
<tr>
<td>Control lever securing bolt</td>
<td>M10</td>
</tr>
<tr>
<td>Clearance between valve and valve body</td>
<td></td>
</tr>
</tbody>
</table>
Exhaust Brake 18C-4

REMOVING AND REPLACING THE EXHAUST BRAKE VALVE, BUSHES AND SHAFT

Removing

1. Disconnect the inner and outer control linkage.

2. Disconnect and remove the exhaust brake body from the exhaust down pipe.

3. Mount the exhaust brake body in a vice fitted with soft jaws. Mark the location of the exhaust brake valve to the control lever, (Fig. 18C-1).

4. Remove the exhaust brake cylinder ball joint retaining clip and lever off the operating arm, (Fig. 18C-2).

5. Remove the clamp bolt from the operating arm, (Fig. 18C-3).

6. Remove the operating arm from the shaft, (Fig. 18C-4).
7. Remove the exhaust valve retaining bolt, (Fig. 18C-5).

8. With a hide or copper faced hammer drive out the brake valve shaft from the exhaust brake body, (Fig. 18C-6).

9. With a suitable drift drive out the bottom exhaust brake shaft bush, (Fig. 18C-7).

Replacing
1. Replace the bottom bush, insert the brake valve and shaft. Drive the shaft into the housing until the hole in the shaft lines up with the hole in the brake valve, (Fig. 18C-8).
2. Insert the bolt retaining the brake valve to the shaft and tighten to the specified torque, (Fig. 18C-9).

3. Measure the clearance between the housing and the brake valve with a feeler gauge, refer to specification. The clearance can be altered by moving the brake valve shaft in or out, (Fig. 18C-10).

4. Line up the marks and replace the control lever to the brake valve shaft, (Fig. 18C-11).

5. Insert the control lever retaining bolt and tighten to the specified torque, (Fig. 18C-12).
6. Replace the exhaust brake cylinder ball joint to the operating arm and insert the retaining clip, (Fig. 18C-13).

**Checking the Exhaust Brake Setting**

1. Disconnect the exhaust pipe from the exhaust brake body.
2. Ensure that the exhaust brake valve is in the fully open position, (Fig. 18C-14).
3. Operate the exhaust brake and ensure that the valve fully closes.

**Adjusting the Exhaust Brake Cylinder Length**

1. Remove the operating lever.
2. Adjust the exhaust brake cylinder length to 170 mm from the centre of the mounting bolt to the centre of the ball joint head, (Fig. 18C-15)
3. Open the exhaust brake valve fully and replace the operating lever. Pre-tension the cylinder by 2 to 4 mm and fit the ball joint, (Fig. 18C-16).
4. Insert the bolt into the operating lever and tighten to the specified torque.
5. Insert the locking clip to the ball joint.
6. Connect the exhaust pipe to the exhaust brake body.
ADE 364 and ADE 366

Workshop Manual
Section 18D - Flywheel

Barrington Diesel Club
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1 STARTER RING GEAR
2 FLYWHEEL
3 SPIGOT BEARING
4 BEARING RETAINER
5 FLYWHEEL RETAINING BOLT
INTRODUCTION

Manufactured from high grade grey cast iron the flywheel is precision machined and balanced to fine limits. The starter ring gear is heat treated and shrunk onto the flywheel. Eight stretch bolts retain the flywheel to the crankshaft. When removing it is not necessary to mark the relative position of the flywheel as the eight bolt holes are drilled eccentrically, making incorrect fitting impossible.

The flywheel is the storehouse of energy and is required to
a. provide energy for operating the engine between power strokes, and
b. to reduce the variation in the rotational speed of the crankshaft during the engine cycle as it transmits power to the driven machine.

SPECIFICATIONS

FLYWHEEL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Diameter for starter ring gear</td>
<td>335,390 to 335,530</td>
</tr>
<tr>
<td>Diameter for mounting crankshaft flange</td>
<td>130,000 to 130,040</td>
</tr>
<tr>
<td>Axial run-out crankshaft flange</td>
<td>0,1</td>
</tr>
<tr>
<td>Flywheel run-out mounted to crankshaft</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>radial</td>
</tr>
<tr>
<td></td>
<td>lateral</td>
</tr>
<tr>
<td>Imbalance of flywheel with ring gear</td>
<td>20 gcm</td>
</tr>
<tr>
<td>Maximum clutch surface material removal</td>
<td>2 mm</td>
</tr>
<tr>
<td>Clutch surface finish</td>
<td>Rz 16μm</td>
</tr>
</tbody>
</table>

STARTER RING GEAR

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID of ring gear</td>
<td>334,690 to 334,830</td>
</tr>
<tr>
<td>Ring gear interference fit</td>
<td>0.56 to 0.84</td>
</tr>
<tr>
<td>Lateral run-out of mounted starter ring gear</td>
<td>0.5 mm max.</td>
</tr>
<tr>
<td>Starter ring gear mounted at a temperature of</td>
<td>250° to 280°</td>
</tr>
</tbody>
</table>

TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flywheel to crankshaft M12 x 1,5.. Initial</td>
<td>30 - 40 Nm</td>
</tr>
<tr>
<td></td>
<td>Final</td>
</tr>
<tr>
<td>Bolt length 25,8 mm</td>
<td>Max. stretch length</td>
</tr>
<tr>
<td>or Bolt length 43,8 mm</td>
<td>Max. stretch length</td>
</tr>
<tr>
<td>Bell housing torque</td>
<td>110 Nm</td>
</tr>
</tbody>
</table>

April '96
REMVAL AND REPLACEMENT
OF FLYWHEEL AND HOUSING

Removal

1. Unscrew and remove the bolts retaining the flywheel, (Fig. 18D-1).

2. Lift off the flywheel, (Fig. 18D-2).

3. Unscrew the four bolts retaining the flywheel housing to the cylinder block, (Fig. 18D-3).

4. Unscrew the two outer bolts, (Fig. 18D-4).
5. Lift off the housing, (Fig. 18D-5).

Replacement

1. Fit the flywheel housing to the cylinder block. Replace and tighten the outer bolts, Fig. 18D-6).

2. Insert the four inner bolts, (Fig. 18D-7).

3. Insert the two top bolts and tighten all bolts to the specified torque, (Fig. 18D-8).
4. Replace the flywheel, insert the bolts and tighten to the specified torque, (Fig. 18D-9).

REMOVAL AND REPLACEMENT OF STARTER RING GEAR

Removal

1. Remove the flywheel, (Fig. 18D-10).

2. Punch mark the ring gear and drill two holes into the side of the gear. Do not drill through the ring gear as this will damage the flywheel, (Fig. 18D-11).

3. With a sharp chisel split the ring gear between the drilled holes and remove the gear from the flywheel, (Fig. 18D-12).

Attention! Thoroughly clean the flywheel and flange prior to replacing.
Replacing

1. Place the flywheel on a flat surface.

2. Heat the new ring gear to approximately 250°C with a welding torch or other suitable heat source. (fig. 18D-13).

3. Place the heated ring onto the flywheel. (Fig. 18D-14).

4. If necessary use a copper or aluminium hammer to fully locate the ring gear on the flywheel so that it seats against the flange shoulder. (Fig. 18D-15).

5. Replace the flywheel and tighten the bolts to the specified torque. (Fig. 18D-16).
Flywheel 18D-8

REMOVING AND REPLACING
THE SPIGOT BEARING

The flywheel spigot bearing can be extracted with the
flywheel in position or removed from the engine.

1. With special tool 4020 0381 pull the spigot bearing from
the housing, (Fig. 18D-17).

2. Insert the bearing into the housing and drive into place
with a suitable drift, (Fig. 18D-18).

Attention! The spigot bearing is sealed and does not
require greasing.

SPECIAL TOOLS FOR SECTION 18D

OBTAINABLE FROM: GRUNDY TECHNIFORM, BURMAN ROAD, DEAL PARK, PORT ELIZABETH 6001
TEL: (041) 43-2299, FAX: (041) 43-2224

Internal Extractor for spigot bearing
Part Number 4020 0381
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April '96
INTRODUCTION

Alternator

Alternators used on the 360 series engines are of the clawpole type which range from 14V-55A to 14V-90A and 28V-28A to 28V-55A. These alternators are fitted with either one or two drive pulleys, depending on application.

Starter Motor

Starter motors fitted to the 360 series engines are of the four pole, four brush earth return type with series parallel connected field coils. These starter motors range from 12V-3kW to 12V-3,5kW and 24V-4kW to 24V-4,5kW depending on application.

TORQUE SPECIFICATIONS

ALTERNATOR AND STARTER MOTOR

<table>
<thead>
<tr>
<th>Description</th>
<th>Thread</th>
<th>Torque (Nm)</th>
</tr>
</thead>
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<tr>
<td>Starter to flywheel housing</td>
<td>M10</td>
<td>60</td>
</tr>
<tr>
<td>Alternator to bracket</td>
<td>M12 x 1.5</td>
<td>60</td>
</tr>
<tr>
<td>Adjusting bolt to cylinder block</td>
<td>M10</td>
<td>40</td>
</tr>
<tr>
<td>Adjusting bolt clamp</td>
<td>M12</td>
<td>35</td>
</tr>
<tr>
<td>Pulley to alternator</td>
<td>M14 x 1.5</td>
<td>60</td>
</tr>
<tr>
<td>Pulley to alternator</td>
<td>M16 x 1.5</td>
<td>80</td>
</tr>
</tbody>
</table>

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SECTIONAL VIEW OF THE K 1 CLAW-POLE ALTERNATOR
Alternator and Starter Motor 18E-4

ALTERNATOR

Precautions

The diodes in the alternator function as one-way valves. 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 following precautions are vital to prevent them from being destroyed:

a. DO NOT disconnect the battery while the engine is running. This will cause a voltage surge in the alternator charging system which will immediately ruin the diodes or transistors.

b. DO NOT disconnect the 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 first 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 to the system without prior 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.

Maintenance

The alternator charging system will normally require very little attention, but it should be kept free from dirt and checks should be made if the alternator fails to keep the battery charged.

a. Inspect the V-belts regularly for wear and correct tension. It is important to ensure that all V-belts on a multiple drive have equal tension and are each carrying their share of the load. Slack drive belts will wear rapidly and cause slip which will not drive the alternator at the required speed. V-belts which are too tight impose severe side thrust on the alternator bearings and shorten their life. Ensure periodically that the alternator is correctly aligned to the drive.

b. Do not replace faulty V-belts individually in a multi belt system. A complete matched set of V-belts must always be used.

c. Keep the alternator clean with a cloth moistened with a suitable cleaning fluid. Ensure that ventilation slots and air spaces are clear and unobstructed.

d. Remove any dirt accumulated on the regulator/control box housing. Ensure that cooling air can pass freely over the casing.

Testing the alternator in position

First check the V-belts for condition and tension. The nominal hot outputs at 6000 r/min (alternator speed) are as follows:

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
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<tr>
<td>14V</td>
<td>35A</td>
</tr>
<tr>
<td>28V</td>
<td>28A</td>
</tr>
</tbody>
</table>

These figures may be exceeded slightly when the alternator is running cold.

A dust proofed alternator can be fitted as an option, depending on application.

Trouble Shooting

If a malfunction should develop in the current generating system it must be kept in mind that trouble sources may exist in the battery, cables or other locations besides the alternator or regulator. The most common fault symptoms are listed in the chart below with probable causes and appropriate corrective measures:

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<thead>
<tr>
<th>Problem - Cause</th>
<th>Correction</th>
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</thead>
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<tr>
<td>Battery is dead or insufficiently charged;</td>
<td>Recharge battery</td>
</tr>
<tr>
<td>1. Open circuit or contact resistance in charging circuit</td>
<td>Remove open circuit or contact resistance</td>
</tr>
<tr>
<td>2. Defective battery</td>
<td>Replace battery</td>
</tr>
<tr>
<td>3. Defective alternator</td>
<td>Have alternator repaired in authorised workshop</td>
</tr>
<tr>
<td>4. Defective regulator</td>
<td>Replace regulator</td>
</tr>
<tr>
<td>5. V-belt loose</td>
<td>Tighten V-belt</td>
</tr>
<tr>
<td>Problem - Cause</td>
<td>Correction</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Charge indicator lamp does not burn with the engine stopped and the ignition</td>
<td></td>
</tr>
<tr>
<td>1. Indicator bulb is burned out</td>
<td>Replace with a new bulb</td>
</tr>
<tr>
<td>2. Dead battery</td>
<td>Charge battery</td>
</tr>
<tr>
<td>3. Defective battery</td>
<td>Replace battery</td>
</tr>
<tr>
<td>4. Loose or damaged cables</td>
<td>Replace or tighten cables</td>
</tr>
<tr>
<td>5. Defective regulator</td>
<td>Replace regulator</td>
</tr>
<tr>
<td>6. Shorted positive diode in the alternator</td>
<td>Have alternator repaired by authorised workshop</td>
</tr>
<tr>
<td>7. Worn carbon brushes</td>
<td>Replace brushes</td>
</tr>
<tr>
<td>8. Oxide layer on slip rings or broken wire in rotor winding</td>
<td>Have alternator repaired</td>
</tr>
</tbody>
</table>

| Charge indicator lamp continues to burn brightly during higher engine speeds   |
| 1. Cable D+ /61 is shorted to ground                                           | Repair or replace cable                                                   |
| 2. Defective regulator                                                        | Replace regulator                                                         |
| 3. Over voltage protection device defective                                    | Replace over voltage protection device                                    |
| 4. Defective rectifier, dirty slip rings, short in cable “DF” or in rotor    |
|    winding                                                                     | Have alternator repaired by authorised workshop                          |

| Charge indicator lamp burns brightly with engine stopped, but only dims or     |
| glimmers with engine running:                                                |
| 1. Poor connections (contact resistance) in the charging circuit or in the    |
| cable to the charge indicator lamp                                           | Remove contact resistance                                                 |
| 2. Defective regulator                                                        | Replace regulator                                                         |
| 3. Defective alternator                                                       | Have alternator repaired                                                  |

| Charge indicator lamp flickers                                                |
| 1. Contact regulator may be incorrectly adjusted or regulating resistor is    |
| burned out                                                                    | Replace regulator                                                         |

**STARTER MOTOR**

**General**

This starter motor is a four pole, four brush earth return machine with series parallel connected field coils.

A solenoid operated pre-engaged drive assembly is carried on an extension of the armature shaft. The main features of this type of drive are as follows:

a. Positive pinion engagement preventing the pinion being thrown out of mesh while starting.

b. An overrunning clutch is incorporated in the drive assembly giving overspeed and overload protection.

c. Self-indexing pinion to ensure smooth engagement between the pinion and the ring gear teeth before the starter motor begins to rotate.

d. Armature braking system to ensure rapid return to rest when the starter button is released.

**Routine Maintenance**

a. The starter motor requires no routine maintenance beyond the occasional inspection of the electrical connections, brush gear and the commutator, which must be clean and tight.
Alternator and Starter Motor 18E-6

b. After the starter motor has been in service for some time, remove the starter motor from the engine, submit it to a thorough bench inspection.

1. Brush wear (this is a fair indication of the amount of work done), renew brushes worn to or approaching 7.9 mm length.
2. Brush spring tension: Correct tension is 0.85 - 1.13 N, renew springs if tension has dropped below 0.71N.
3. Skim commutator if it is pitted or badly worn.
4. Check bearings for excessive side play on armature shaft.
5. Check pinion movement.
6. Clean and lubricate pinion sleeve bearing.
7. Clean and lubricate drive end bracket bush.

Servicing - Testing in Position - Symptoms

Switch on the lights. If the vehicle is not equipped with lighting connect a 0/20 volt meter across the battery terminals before proceeding. Operate the starter control and watch for the following symptoms:

1. The lamps dim (or the voltmeter reading drops to about 6 volts) and the motor does not turn the engine. Check the battery (must be at least half-charged) and battery posts (clean and good earth connection).
2. Lamps do not dim, the voltmeter reading remains steady at about 12 volts, and the motor does not turn the engine. Connect voltmeter between solenoid terminal and starter yoke, then operate starter. No volts indicated.

Causes:

a. Poor post connection at battery.
b. Bad earth connection.
c. Broken starter lead, battery to starter.

Full volts, i.e. 12/14 volts indicated:

a. Faulty solenoid switch.
b. Open circuit in starter - check brushes.

cut-away view of pre engaged drive starting motor with outer-wedge roller type overrunning clutch.
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<td>BELT DRIVEN COMPRESSOR - DISASSEMBLY</td>
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<td>SPECIAL TOOLS</td>
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</table>
Compressor/Vacuum Pump 18F-2
(Camshaft driven)

Note: When belt driven compressors are used the oil hole in the lobe of the camshaft, used for driving the compressor, is closed with a Jubilee clamp. To prevent oil loss during engine re-conditioning ensure that the clamp is in position.

AIR COMPRESSOR

1 CYLINDER BARREL
2 BEARING SHELL
3 BEARING SHELL
4 CONNECTING ROD
5 CONNECTING ROD BOLT
6 NUT
7 BOLT
8 CIRCLIP
9 GUDGEON PIN
10 PISTON RING
11 SMALL END BUSH
12 PISTON
13 SCRAPER RING
14 PISTON RING
15 VALVE
16 VALVE
17 GASKET
18 SEALING WASHER
19 INLET PIPE
20 UNION
21 SEALING WASHER
22 CYLINDER HEAD
INTRODUCTION

Air compressors are used in vehicle systems to provide compressed air used for braking and the operation of ancillary air equipment. These compressors have a single reciprocating piston and are air cooled. The compressors have a one-piece cylinder head, with the inlet valve parts screwed into the head and the delivery valves retained by a locknut. The piston runs in a replaceable cylinder barrel which is mounted directly onto the engine crankcase and sealed with a gasket at the cylinder head.

During the down stroke of the piston a partial vacuum is created above the piston, which unseats the inlet valve allowing air to enter the cylinder above the piston. On the upstroke, the air pressure under the valve, plus the effort of the inlet valve spring closes the inlet valve and then opens the delivery valve, the air under compression is then discharged into a reservoir. At the start of the down stroke the delivery valve closes and the cycle is repeated. The compressor feeds air into a reservoir fitted with an unloader valve to maintain constant pressure.

The air compressor assembly can be changed to a vacuum pump by simply turning the cylinder head.

AIR COMPRESSOR/VACUUM PUMP

<table>
<thead>
<tr>
<th>Component</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder</td>
<td>1</td>
</tr>
<tr>
<td>Bore</td>
<td>94 mm</td>
</tr>
<tr>
<td>Stroke</td>
<td>30 mm</td>
</tr>
<tr>
<td>Displacement</td>
<td>208 cm³</td>
</tr>
<tr>
<td>Bore diameter</td>
<td>93.985 - 94.015 mm</td>
</tr>
<tr>
<td>Piston diameter</td>
<td>93.850 - 93.880 mm</td>
</tr>
<tr>
<td>Piston clearance</td>
<td>0.068 - 0.092 mm</td>
</tr>
<tr>
<td>Piston protrusion</td>
<td>0.250 - 0.700 mm</td>
</tr>
<tr>
<td>Gudgeon pin</td>
<td></td>
</tr>
<tr>
<td>Diameter</td>
<td>16.012 - 16.015 mm</td>
</tr>
<tr>
<td>Bore in piston</td>
<td>16.018 - 16.022 mm</td>
</tr>
<tr>
<td>Clearance in piston</td>
<td>+ 0.003 to + 0.010 mm</td>
</tr>
<tr>
<td>Clearance in small end bush</td>
<td>0.010 - 0.023 mm</td>
</tr>
<tr>
<td>Connecting rod</td>
<td></td>
</tr>
<tr>
<td>Big end basic bore</td>
<td>35.000 - 35.016 mm</td>
</tr>
<tr>
<td>Small end basic bore</td>
<td>19.000 - 19.021 mm</td>
</tr>
<tr>
<td>Small end bush outer dia.</td>
<td>19.035 - 19.048 mm</td>
</tr>
<tr>
<td>Small end bush inner dia.</td>
<td>16.025 - 16.035 mm</td>
</tr>
<tr>
<td>Small end bush interference fit</td>
<td>0.014 - 0.048 mm</td>
</tr>
<tr>
<td>Big end bearing clearance</td>
<td>radial: 0.020 - 0.066 mm</td>
</tr>
<tr>
<td></td>
<td>axial: 0.065 - 0.317 mm</td>
</tr>
<tr>
<td>Width of small end</td>
<td>27.883 - 27.935 mm</td>
</tr>
<tr>
<td>Width of big end</td>
<td>27.883 - 27.935 mm</td>
</tr>
<tr>
<td>Length of connecting rod (centre to centre)</td>
<td>96.950 - 97.000 mm</td>
</tr>
<tr>
<td>Big end bearing/small end bush, parallel within</td>
<td>0.01 mm</td>
</tr>
<tr>
<td>Piston rings (all)</td>
<td></td>
</tr>
<tr>
<td>Gap</td>
<td>0.25 - 0.40 mm</td>
</tr>
<tr>
<td>Side clearance</td>
<td>0.020 - 0.055 mm</td>
</tr>
</tbody>
</table>
Compressor/Vacuum Pump 18F-4

CONNECTING ROD BEARING AND CRANKPIN DIAMETERS

<table>
<thead>
<tr>
<th>Stages</th>
<th>Camshaft journal dia.</th>
<th>Bearing inner dia.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>31,984 to 32,000</td>
<td>32,020 to 32,050</td>
</tr>
<tr>
<td>Standard 1 (-0,1)</td>
<td>31,884 to 31,900</td>
<td>31,920 to 31,950</td>
</tr>
<tr>
<td>Repair stage 1 (-0,25)</td>
<td>31,734 to 31,750</td>
<td>31,770 to 31,800</td>
</tr>
<tr>
<td>Repair stage 2 (-0,5)</td>
<td>31,484 to 31,500</td>
<td>31,520 to 31,550</td>
</tr>
<tr>
<td>Repair stage 3 (-0,75)</td>
<td>31,234 to 31,250</td>
<td>31,270 to 31,300</td>
</tr>
</tbody>
</table>

CAPACITY

Air compressor at 2800 r/min.............................. Delivery against .................................................. 100 kPa - 140 l/min
Maximum operating pressure........................................ 810 kPa - 130 l/min

VACUUM PUMP

<table>
<thead>
<tr>
<th>Tank capacity</th>
<th>Engine speed</th>
<th>Time (sec)</th>
<th>Vacuum (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6l</td>
<td>600 r/min</td>
<td>30</td>
<td>625</td>
</tr>
<tr>
<td></td>
<td>2800 r/min</td>
<td>30</td>
<td>700</td>
</tr>
<tr>
<td>20l</td>
<td>600 r/min</td>
<td>30</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>2800 r/min</td>
<td>30</td>
<td>675</td>
</tr>
</tbody>
</table>

TORQUE SPECIFICATIONS

AIR COMPRESSOR/VACUUM PUMP

Cap to connecting rod................................................. M6 ................................................. 15 Nm
Exhaust valve to cylinder head.................................... M6 ................................................. 10 Nm
Inlet valve to cylinder head........................................ M40 x 1,5 ........................................ 180 Nm
Cylinder head barrel to crankcase................................ M8 ................................................. 35 Nm

BELT-DRIVEN COMPRESSOR

Cylinder liner to crankcase........................................ 22 Nm
Cylinder head to cylinder liner................................... 30 Nm
Pulley nut .................................................................... 100 Nm

April '96
Measuring bearing clearances

Attention! See page 15-8 for removal of the compressor from the engine

1. Clamp the connecting rod in a vice fitted with soft jaws and remove the bearing cap, (Fig. 18F-1).

2. Remove the bearing shells from the connecting rod and cap, (Fig. 18F-2).

3. Fit the bearing cap to the connecting rod, insert the bolts and tighten to the specified torque, (Fig. 18F-3).

4. Set an internal measuring instrument, (Fig. 18F-4).
5. Measure the big-end basic bore in the vertical position, (Fig. 18F-5).

6. Measure the bore of the connecting rod small end bush, (Fig. 18F-6).

7. Unscrew the bearing bolts and remove the big-end bearing cap, (Fig. 18F-7).

8. Insert the big-end bearing shells, fit the cap to the connecting rod, insert the bolts and tighten to the specified torque, (Fig. 18F-8).

April '96
9. Measure the big-end bearing inside diameter in three places, (Fig. 18F-9).

10. Remove the big-end bearing cap and connecting rod from the vice.

Measure the camshaft eccentric lobe to determine the clearance after obtaining the bearing I.D.

**Dismantling the cylinder head**

1. Remove the nut retaining the cylinder head, (Fig. 18F-10).

2. Remove and dismantle the delivery valve, (Fig. 18F-11).

3. Unscrew the inlet valve from the cylinder head, using special tool 4020 1733, (Fig. 18F-12).
Reassembly of the cylinder head

1. Mount the cylinder head in a vice, insert the delivery valve into the cylinder head and tighten the retaining nut to the specified torque, (Fig. 18F-13).

2. Turn over the cylinder head and insert the suction valve as follows: 1 valve seat, 2 valve disk, 3 spring washers, 4 suction valve nut, (Fig. 18F-14).

Note: The suction valve nuts 4A and 4B are alternate fittings requiring the use of two different special tools for removal and replacement. Refer to special tools list page 18F-9.

3. Tighten the suction valve nut to the specified torque, using special tools 4020 1733 or 4020 2334, (Fig. 18F-15).

Attention! See page 15-12 for replacement of compressor to engine

4. Insert a new gasket, replace the cylinder head, insert the retaining bolts and tighten to the specified torque, (Fig. 18F-16).

Note: 0,65 and 0,9 mm gasket depending on piston protrusion.
5. Connect the air inlet and delivery pipes, (Fig. 18F-17).

SPECIAL TOOLS

OBTAINABLE FROM: GRUNDY-TECHNIFORM, BURMAN ROAD, DEAL PARTY ESTATE, PORT ELIZABETH 6001

Socket for removal/replacement of compressor valve, (Type A). (See Fig. 18F-12, 18F-15)

Part number 4020 1733.

Socket for removal/replacement of compressor valve, (Type B). (See Fig. 18F-12, 18F-15)

Part number 4020 2334.
DISASSEMBLY

1. Loosen the pulley fastening nut. (Fig. 18F-18).

2. Pull off the pulley. (Fig 18F-19).

3. Unscrew and remove the cylinder head, (Fig. 18F-20).

4. Remove the valve plate with suction valve and delivery valve, (Fig. 18F-21).
Belt-driven Compressor 18F-12

5. Remove the cylinder liner retaining nuts and pull the liner from the piston, (Fig. 18F-22).

6. Remove the locking ring for the piston pin, (Fig. 18F-23).

7. Push out the piston and detach from the connecting rod, (Fig. 18F-24).

8. Unscrew the housing cover bolts and remove the housing cover, (Fig. 18F-25).
9. Detach the conrod from the crankshaft and remove the crankshaft, (Fig. 18F-26).

10. Remove the shaft sealing ring from the bearing cap, (Fig. 18F-27).

11. Remove the piston rings with special tool 4020 0307 (piston ring pliers), (Fig. 18-28).

ASSEMBLY

1. Insert shaft sealing ring into the bearing cap, (Fig. 18F-29).
Belt-driven Compressor 18F-14

2. Mount O-ring on bearing cap. (Fig. 18F-30).

3. Assemble connecting rod to the crankshaft and install the crankshaft, (Fig. 18F-31).

4. Mount the bearing cap, (Fig. 18F-32).
   Note: Recess in mounting boss in upward position.

5. Mount piston rings, (Fig. 18F-33). Use piston ring pliers part no. 4020 0307.
6. Position the piston with rings over the connecting rod and insert the piston pin, (Fig. 18F-34).

7. Mount the retaining rings for the piston pin, (Fig. 18F-35).

8. Mount the gasket for the cylinder liner.

9. Use the piston ring squeezer to bring the piston ring diameter to piston diameter and mount the cylinder liner, (Fig. 18F-36).

Use compressor piston ring squeezer 4020 1131 together with pliers 4020 1144.

10. Fit the cylinder liner over the mounting studs and tighten the nuts to 22 Nm, (Fig. 18F-37).
11. Place the gasket and head assembly on the cylinder liner, (Fig. 18F-38).

Note: Guide pin of the valve plate must locate into appropriate holes at the top of the cylinder liner.

12. Mount cylinder head with gasket and tighten the bolts to 30 Nm, (Fig. 18F-39).

13. Mount pulley to the compressor and tighten the nut to 100 Nm, (Fig. 18F-40).
<table>
<thead>
<tr>
<th>Tool Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston ring pliers</td>
<td>4020 0307</td>
</tr>
<tr>
<td>Compressor piston ring squeezer</td>
<td>4020 1131</td>
</tr>
<tr>
<td>Pliers for compressor piston ring squeezer</td>
<td>4020 1144</td>
</tr>
</tbody>
</table>

**SPECIAL TOOLS**

OBTAINABLE FROM: GRUNDY TECHNIFORM, BURMAN ROAD, DEAL PARK, PORT ELIZABETH 6001
TEL: (041) 43-2299, FAX: (041) 43-2224

April '96
ADE 364 and ADE 366

Workshop Manual
Section 19 - Cooling System

Barrington Diesel Club
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<td>19-21</td>
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<td>19-29</td>
</tr>
<tr>
<td>SPECIAL TOOLS</td>
<td>19-31</td>
</tr>
</tbody>
</table>
360 SERIES WATER PUMP

1. IMPELLER
2. CARBON SEAL ASSEMBLY
3. WATER PUMP HOUSING
4. SEAL
5. BEARING
6. SHAFT
7. BEARING
8. O-RING
9. SEAL
10. BEARING CARRIER
11. COUPLING FLANGE/PULLEY COUPLING FLANGE
INTRODUCTION

The water pump is of the impeller type and driven by V-belts from the crankshaft. It is a sealed unit, filled with a special high melting point grease during assembly and requires no further attention during its life time.

A thermostat housing is mounted to the cylinder block which is joined to the water pump by a connecting tube and sealed by O-rings.

SPECIFICATIONS

COOLING SYSTEM

<table>
<thead>
<tr>
<th>Thermostat</th>
<th>Standard</th>
<th>Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starts opening at</td>
<td>79 ± 2°C</td>
<td>71 ± 2°C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main valve</th>
<th>Stroke mm</th>
<th>Fully open at</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8 mm</td>
<td>8 mm</td>
</tr>
<tr>
<td></td>
<td>94°C</td>
<td>85°C</td>
</tr>
</tbody>
</table>

| Bypass valve closed at | 91°C | 82°C |
| Max. operating temperature | 95°C | 95°C |
| Coolant capacity (engine only) | 11ℓ | 11ℓ |

WATER PUMP

<table>
<thead>
<tr>
<th>Impeller shaft diameter</th>
<th>15,028 to 15,039</th>
</tr>
</thead>
<tbody>
<tr>
<td>For large bearing</td>
<td>29,996 to 30,009</td>
</tr>
<tr>
<td>For small bearing</td>
<td>16,997 to 17,008</td>
</tr>
<tr>
<td>For hub</td>
<td>29,041 to 29,054</td>
</tr>
<tr>
<td>Bore in hub dia</td>
<td>29,000 to 29,021</td>
</tr>
<tr>
<td>Hub dia. for front seal</td>
<td>41,840 to 42,000</td>
</tr>
<tr>
<td>Bore dia. in impeller</td>
<td>15,000 to 15,018</td>
</tr>
<tr>
<td>Pressing impeller on water pump shaft</td>
<td>impeller flange flush with housing Max. ± 0,1 mm</td>
</tr>
<tr>
<td>Lubrication of water pump</td>
<td>Grease approx. 80 gr</td>
</tr>
</tbody>
</table>
Cooling System 19-4

Attention: When installing an exchange engine, ensure that the spacer ring fitted between the water pump and the fan is of the same thickness as in the removed engine. If necessary replace the spacer ring so that the distance of 25 to 30 mm between the radiator and the fan is retained.

WATER PUMP

- A Water pump shaft
- B Hub
- C Bearing carrier
- D O-ring
- E Large ball bearing
- F Small ball bearing
- G Rear seal
- H Carbon seal
- J Impeller
- K Distance impeller and housing: 0,5+0,5/-0,3

TORQUE SPECIFICATION

<table>
<thead>
<tr>
<th>Component</th>
<th>Thread Size</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pump to cylinder block</td>
<td>M10</td>
<td>50 Nm</td>
</tr>
<tr>
<td>Coolant drain plug to cylinder block</td>
<td>M18 x 1,5</td>
<td>50-60 Nm</td>
</tr>
<tr>
<td>Temperature gauge probe</td>
<td>M14 x 1,5</td>
<td>20 Nm</td>
</tr>
<tr>
<td>Thermostat housing cover</td>
<td>M6</td>
<td>25 Nm</td>
</tr>
<tr>
<td>Water jacket cover to cylinder block (364N/C/T)</td>
<td>M8</td>
<td>35 Nm</td>
</tr>
<tr>
<td>Water pump bearing carrier</td>
<td>M6 x 30</td>
<td>15 Nm</td>
</tr>
<tr>
<td>Capscrew/spacer to waterpump shaft</td>
<td>M14 x 1,5</td>
<td>140 Nm</td>
</tr>
</tbody>
</table>

(Fibrate threads with engine oil)

FAN RETAINING BOLTS (DIN933) - TIGHTENING TORQUE

<table>
<thead>
<tr>
<th>Bolt dia.</th>
<th>Quality</th>
<th>Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>M8</td>
<td>8.8</td>
<td>25 Nm</td>
</tr>
<tr>
<td>M8</td>
<td>10.9</td>
<td>35 Nm</td>
</tr>
<tr>
<td>M10</td>
<td>8.8</td>
<td>50 Nm</td>
</tr>
<tr>
<td>M10</td>
<td>10.9</td>
<td>60 Nm</td>
</tr>
</tbody>
</table>
Removing the water pump

1. Drain radiator.
2. Disconnect upper radiator hose.
3. Disconnect lower radiator hose.
4. Loosen bottom alternator retaining bolt, (Fig. 19-1).
5. Slacken off adjuster and remove the V-belt.
6. Remove the thermostat housing.

7. If a power steering pump is fitted, loosen the adjuster clamping bolt, (Fig. 19-2).

8. Slacken off the adjuster and remove the V-belt, (Fig. 19-3).

9. Unscrew and remove the bolts retaining the V-belt pulley or the cap bolt retaining the fan to the water pump shaft. Remove pulley or fan, (Fig. 19-4).
10. Slacken the thermostat housing retaining bolts. Unscrew and remove the bolts retaining the water pump to the cylinder block. Remove water pump and gasket, (Fig. 19-5).

Dismantling

1. With a suitable puller remove the hub from the water pump shaft, (Fig. 19-6).

2. Unscrew the bolts retaining the front bearing carrier, (Fig. 19-7).

3. Lift off the bearing carrier, (Fig. 19-8).
4. With special tool 4020 2305 tap the old seal from the seal carrier, (Fig. 19-9)

5. Remove the O-ring from the top of the front bearing, (Fig. 19-10)

6. Remove the bolts from the front, (Fig. 19-11).

7. Remove the bolts from the back plate and detach the back plate from the pump body, (Fig. 19-12).
8. Mount the water pump body under a press and with a suitable mandrel remove the shaft complete with bearings from the water pump body, (Fig. 19-13).

9. Lift out the impeller from the rear of the water pump body, (Fig. 19-14).

10. Gently knock out the rear seal from the water pump body, (Fig. 19-15).

11. Press the large bearing from the shaft, (Fig. 19-16).
1. Thoroughly clean the water pump. Examine the body for corrosion, cracks and wear. Replace the water pump completely if any part shows excessive wear.

2. Use special tool 4020 2350 to insert the rear seal into the water pump body, (Fig. 19-18).

3. Use special tool 4020 2295 and insert the carbon seal assembly into the housing, (Fig. 19-19).

4. Pack both bearings with multi-purpose grease.

5. Press the small bearing onto the water pump shaft, (Fig. 19-20).
6. Press the large bearing onto the water pump shaft, (Fig. 19-21).

7. Use special tool 4020 2318 and replace the seal in the seal carrier, (Fig. 19-22)

8. Place the seal carrier over the water pump shaft and press the hub onto the shaft as far as it will go, (Fig. 19-23)

9. Fill the space between the bearings with multi-purpose grease, (Fig. 19-24).
10. Fit O-ring over the large bearing, (Fig. 19-25).

11. Press the water pump shaft with bearings into the water pump body, (Fig. 19-26).

12. Insert the bolts into the seal carrier and tighten to the specified torque, (Fig. 19-27).

13. Press the impeller onto the water pump shaft as far as the specified clearance between the impeller and the water pump body. Use a feeler gauge to check the clearance, (Fig. 19-28).
Cooling System 19-12

14. Replace the water pump back plate with a new gasket and insert the front and rear bolts, Fig. 19-29.

15. Tighten all bolts to the specified torque, Fig. 19-30.

16. Replace the water pump and insert the bolts retaining the pump to the cylinder block and tighten to the specified torque. Fit the thermostat housing to the cylinder block with a new gasket and tighten the bolts to the specified torque, Fig. 19-31.

17. Insert alien cap bolt into the centre hub and tighten to the specified torque. If fitted with a fan, insert the bolts retaining the fan to the hub and tighten to the specified torque, Fig. 19-32.
18. With tension gauge(special tool) 4020 2321 adjust the V-belt tension to 40-45 kg (new belts), run the engine for 10-15 minutes and re-check the tension, which should be 30-40 kg. If this is not reached adjust the tension to 30-40 kg. Position the tension gauge on the belt with the flange parallel to the belt edge. Gradually apply pressure to the pressure pad. When a click is heard or felt, stop and remove the gauge. Take an accurate reading at the spot where the indicator arm intersects the scale, (Fig. 19-33).

19. When the correct V-belt tensions have been obtained, lock the steering pump V-belt adjuster bolt (if fitted), (Fig. 19-34).

20. Tighten the alternator V-belt adjuster nuts, (Fig. 19-35).

21. Tighten the bottom alternator mounting bolt, (Fig. 19-36).
Cooling System 19-14

22. Tighten the steering pump mounting bolt, (Fig. 19-37).

23. Connect the upper and lower radiation hoses, fill the radiator with coolant to which the correct amount of approved corrosion inhibitor has been added.

24. Start the engine, allow to reach normal running temperature and check for coolant leaks.

Attention! Never force a V-belt onto the pulley by using a lever. The V-belt may be damaged and thus causing an early failure. The adjuster should be fully released and the V-belt turned onto the pulley by hand. If one belt in a set requires replacement always install a matched pair. If only one belt is replaced it will be carrying all the load, which will lead to early failure.
Cooling System - Thermostat and Housing 19-15

CAMSHAFT AND TIMING GEARS

1 BOLTS
2 COOLANT OUTLET
3 O-RING
4 THERMOSTAT
5 THERMOSTAT HOUSING
6 O-RINGS
7 CONNECTING TUBE
8 GASKET
9 WASHER
10 TEMPERATURE SENDER UNIT
REMOVING/REPLACING THERMOSTAT AND HOUSING

Removing

1. Unscrew the bolts retaining the coolant outlet to the thermostat housing, (Fig. 19-38).

2. Lift off the coolant outlet, (Fig. 19-39).

3. With a suitable screwdriver lift the thermostat from the housing.

4. Remove the O-ring from the thermostat body, (Fig. 19-41).
5. Unscrew and remove the bolts retaining the thermostat housing to the cylinder head, (Fig. 19-42).

6. Remove the thermostat housing and gasket from the cylinder head

7. Pull out the connecting tube from the thermostat housing, (Fig. 19-44).

8. Remove and discard the O-rings from the connecting tube, (Fig. 19-45).

Note: Prior to replacing the thermostat carry out the thermostat test as described on page 19-19.
Replacing

1. Fit new O-rings to the connecting tube, (Fig. 19-46).

2. Apply a light coat of silicon grease to the O-rings and insert the connecting tube into the top of the water pump housing, (Fig. 19-47).

3. Fit the thermostat housing to the connecting tube, insert a new gasket between the housing and the cylinder head and insert retaining bolts, (Fig. 19-48).

4. Tighten the retaining bolts to the specified torque, (Fig. 19-49).
5. Insert the thermostat with a new O-ring into the housing, (Fig. 19-50).

6. Replace the coolant outlet, insert bolts and tighten to the specified torque, (Fig. 19-51)

**THERMOSTAT TEST**

**Preparation**

1. Remove the thermostat from the housing, (See page 19-16).

2. Insert a length of cotton thread between the valve and the thermostat body, suitable to suspend the thermostat in the container, (Fig. 19-52).

3. Suspend the thermostat in a container filled with water and insert a thermometer. Ensure that thermostat and thermometer are suspended at the same level, (Fig. 19-53).
Cooling System - Thermostat and Housing 19-20

Check for Thermostat Opening Temperature

1. Heat the container to a temperature of 71°C. At this temperature the thermostat should drop off the cotton thread, (Fig. 19-54).

Full Open Check

2. Continue to heat the container, with the thermostat resting at the bottom, to a temperature of 82°C. The Thermostat should now be fully open, (Fig. 19-55).

Checking for Length of Travel

3. Remove the thermostat from the container. Measure the distance between the by-pass valve and the lower support bracket of the thermostat body. Allow the thermostat to cool and return to its closed position. Again measure the distance and subtract from the previously obtained dimension. The result is the length of travel, (Fig. 19-56).

Attention! If the thermostat fails to reach measurements as per specifications or any of the other checks, it must be replaced.
Cooling System - Visco Fan 19-21

BASIC VISCO FAN

1 COVER
2 GASKET
3 DISK DRIVE
4 FAN BODY
5 FLANGED SHAFT
6 SCREW
7 LOCKING DEVICE
8 SEAL
9 BEARING
10 CIRCLIP
11 SPACER
12 SPACER
13 CAPSCREW
INTRODUCTION

Depending on application 360 series engines are fitted with a thermostatically controlled viscous drive fan, which is mounted on the water pump hub and driven by V-belts from the crankshaft.

The viscous drive fan does not have a rigid connection to the water pump pulley. A drive connection, fitted to the pulley, can move within a chamber of the fan with a small clearance. On reaching a predetermined temperature the thermostat opens, allowing oil to enter the chamber. As a result of the friction created by the oil within the fan chamber, the non-driven body of the fan will turn thus driving the fan.

Checking and locking viscous drive fan

If there is an abnormal rise in coolant temperature check whether the viscous drive fan engages properly when the engine is warm. With the vehicle stationary, cover the radiator. Start the engine and allow to run at medium speed until the water temperature is 90 - 95°C. Remove the radiator cover. The thermostat is now heated by the hot air from the radiator and open, allowing silicon fluid to flow into the fan chamber, thereby driving the fan.

In the event of a failure of the viscous fan drive the device can be locked. The locking device at the rear end of the fan serves to couple the fan rigidly to the pulley.

To couple the fan unscrew the locking nut (Fig. 19-26) up to the lock stop, then turn the fan slowly by hand until the pin of the locking device is felt to snap into place aided by the spring pressure.

The viscous drive fan can be used for a limited period only in the locked condition. Extended operation in this condition is not advisable. The fan should be overhauled as soon as possible.

Note: The viscous fan drive should always be transported and stored in a vertical position (as fitted to the engine) to prevent the silicon fluid from running out. When overhauling the fan it is essential to ensure that only the recommended silicon fluid is used. Do not use mineral based oil. The fan will not operate correctly, causing overheating and serious damage to the engine.

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**VISCO FAN**

<table>
<thead>
<tr>
<th>ADE No.</th>
<th>Capacity</th>
<th>Silicon No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7620 0504</td>
<td>39 cm³</td>
<td>3808 0720</td>
</tr>
</tbody>
</table>

**Viscosity of Oil**

<table>
<thead>
<tr>
<th>Silicon No.</th>
<th>Viscosity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3808 0720</td>
<td>12.50 cSt</td>
</tr>
</tbody>
</table>

**Torques**

- Drive disc bolts: M6 .......... 10 - 13 Nm
- M8 .......... 28.5 - 33 Nm
- Thermostat cover: 10 - 13 Nm

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Fig. 19-57

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OVERHAULING THE VISCO FAN

Dismantling

Prior to dismantling the visco fan thoroughly clean the outside with a suitable cleaning fluid.

1. Secure the fan in a vice fitted with soft jaws, (Fig. 19-58).

2. Remove the thermostat cover retaining screws with a 5mm Allen key, (Fig. 19-59).

3. Insert two M8 bolts in the threaded holes in the thermostat cover, (Fig. 19-60).

4. Screw down the bolts to lift off the thermostat cover. The thermostat is pre-set and must not be dismantled.

5. Loosen and remove the drive disk retaining screws with an inhex socket, (Fig. 19-61).

Attention! These screws are secured with Loctite and may be difficult to loosen. The screws can be loosened by lightly tapping the end of the socket wrench.
6. Lift out the drive disk from the fan body, (Fig. 19-62).

7. Carefully remove the thermostat cover gasket from the fan body, (Fig. 19-63).

8. Place support (item 1 page 19-30) under the fan body and use a mandrel (item 2 page 19-30) to press out the drive shaft, (Fig. 19-64).

9. Remove the spacer ring, (Fig. 19-65).
10. Lift out the seal, (Fig. 19-66).

11. Remove the circlip, (Fig. 19-67).

12. Turn the fan body over and using a sleeve (item 4 page 19-30) press out the bearing, (Fig. 19-68).

13. Thoroughly clean the housing with a suitable cleaning fluid.

14. Inspect the fan body for any damage.

**Assembly**

1. Use the sleeve and support (items 3 and 1 page 19-29) and fit the bearings, (Fig. 19-69).

**Attention!** New bearings and fan must be used when re-assembling the fan.

2. Remove the support from under the fan and fit the drive shaft into place.

3. Using the sleeve press the drive shaft into the housing, (Fig. 19-69).
4. Secure the fan in a vice fitted with soft jaws, (Fig. 19-70).

5. Fit the circlip, (Fig. 19-71).

6. Grease the seal lips with a suitable grease and replace the seal, (Fig. 19-72).

7. With a plastic or rubber hammer replace the spacer ring, (Fig. 19-73).

Attention! Taper of spacer to point towards drive disk.
8. Carefully replace the drive disk into the fan body, (Fig. 19-74).

9. Clean the drive disk screw threads and insert the screws with Loctite, (Fig. 19-75).

10. Torque the screws using an Inhex socket, (Fig. 19-76).

11. Use a syringe filled with silicon oil (see specifications for quantity and brand) to fill the centre of the housing, (Fig. 19-77).
12. Thoroughly clean the thermostat cover with a suitable cleaning fluid, (Fig. 19-78).

13. Fit a new gasket into the fan housing, (Fig. 19-79).

14. Replace the thermostat cover with two M8 bolts in the threaded holes, (Fig. 19-80).

15. Tighten the Allen cap screws with a 5 mm Allen key socket, (Fig. 19-81).

Attention! Always store the fan in an upright position.
Cooling System - Visco Fan 19-29

Special tools for Visco Fan

These tools must be self fabricated

(Item 1)
Support for removing bearings and drive flange.

(Item 2)
Mandrel for removing flanged shaft.

(Item 3)
Sleeve for installing the drive flange.
Visco Fan 19-30

(Item 4)
Sleeve for removing the bearings.

(Item 5)
Sleeve for installing the drive flange.

(Item 6)
Support for the fan body, for installation of bearings.

(Item 7)
Support for the fan body, for installation of bearings.

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SPECIAL TOOLS FOR SECTION 19

OBTAINABLE FROM: GRUNDY TECHNIFORM, BURMAN ROAD, DEAL PARK, PORT ELIZABETH 6001
TEL: (041) 43-2299, FAX: (041) 43-2224

- Water pump front seal
  Remove mandrel,
  Part No. 4020 2305

- Water pump front seal
  replacing mandrel,
  Part No. 4020 2318

- Carbon assembly seal
  replacing tool,
  Part No. 4020 2295

- Water pump Inner lip
  type seal replacing mandrel
  Part No. 4020 2350

- V-belt tensioning gauge,
  Part No. 4020 2321
ADE 364 and ADE 366

End of

Workshop Manual