

# Perkins Phaser and 1000 Series

Models AA to AH and YA to YE

## WORKSHOP MANUAL

**Phaser**      **4 and 6 cylinder diesel engines for automotive applications**

**1000 Series**      **4 and 6 cylinder diesel engines for agricultural and industrial applications**

Publication TPD 1312E, Issue 2.

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Published in February 2002 by Technical Publications.

Perkins Engines Company Limited, Peterborough PE1 5NA, England.

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# 1

## General information

### Introduction

This Workshop Manual has been written to provide assistance in the service and overhaul of Perkins Phaser and 1000 Series engines. It should be used in conjunction with normal workshop practise and information contained in current service bulletins. Mention of certain accepted practices therefore, has been purposely omitted in order to avoid repetition. For overhaul procedures the assumption is made that the engine is removed from the application.

Most of the general information which is included in the relevant User's Handbook has not been repeated in this workshop manual and the two publications should be used together.

Where the information applies only to certain engine types, this is indicated in the text.

The details of some operations will be different according to the type of fuel injection pump which is fitted. The specific pump type used can be found by reference to the manufacturer's identification plate on the pump body but, generally, the type of pump fitted is as shown below:

- Lucas/Delphi - DPA, DPS and DP200 Series
- Bosch - EPVE and MW
- Stanadyne - DB2 and DB4.

When reference is made to the "left" or "right" side of the engine, this is as seen from the flywheel end of the engine.

Special tools have been made available and a list of these is given in Chapter 16, Special tools. Reference to the relevant special tools is also made at the beginning of each operation.

Data and dimensions are included in Chapter 2, Specifications.

Read and remember the "Safety precautions" on page 5. They are given for your protection and must be used at all times.

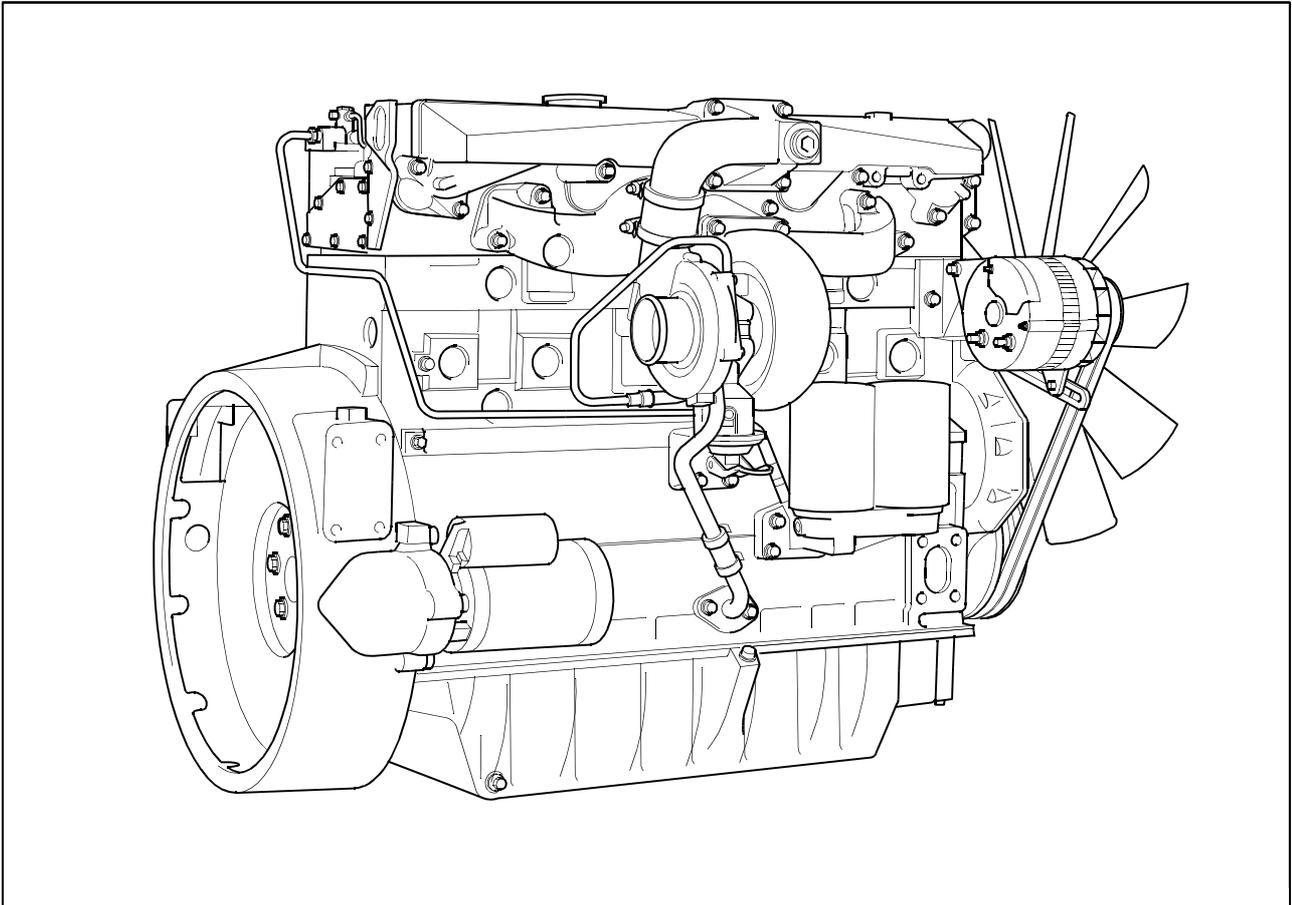
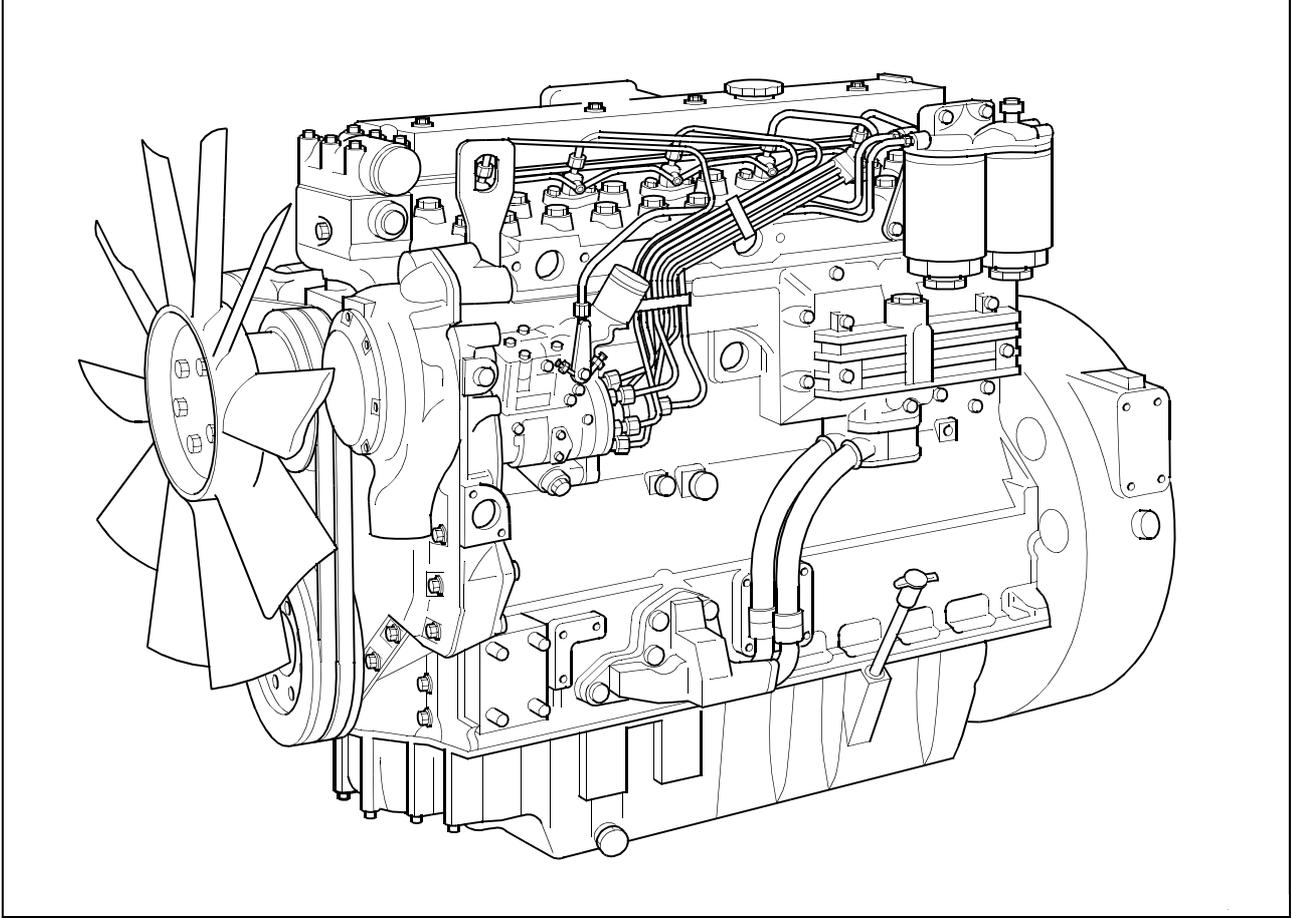
Danger is indicated in the text by two methods:

**Warning!** *This indicates that there is a possible danger to the person.*

**Caution:** *This indicates that there is a possible danger to the engine.*

**Note:** Is used where the information is important, but there is not a danger.

## Engine views



## Engine identification

The Perkins Phaser and 1000 Series engines have been designed for specific applications, as shown below:

- Phaser for automotive applications
- 1000 Series for agricultural and industrial applications.

Each series consists of both four and six cylinder engines, each of which will have four basic engine types - naturally aspirated, compensated, turbocharged and turbocharged/intercooled.

There are different models in each series.

Phaser engines are named according to their approximate power output, for example:

Phaser 110T - four cylinder engine rated at 106 bhp ("T" indicates that the engine is turbocharged).

Phaser 210Ti - six cylinder engine rated at 210 bhp ("Ti" indicates that the engine is turbocharged and intercooled).

1000 Series engines are identified by a system of numbers and letters, for example:

1006-6TW - six cylinder engine of six litres ("TW" indicates that the engine is turbocharged and intercooled).

In this Workshop Manual, the different engine types are indicated by their code letters. These are the first two letters of the engine number as indicated below:

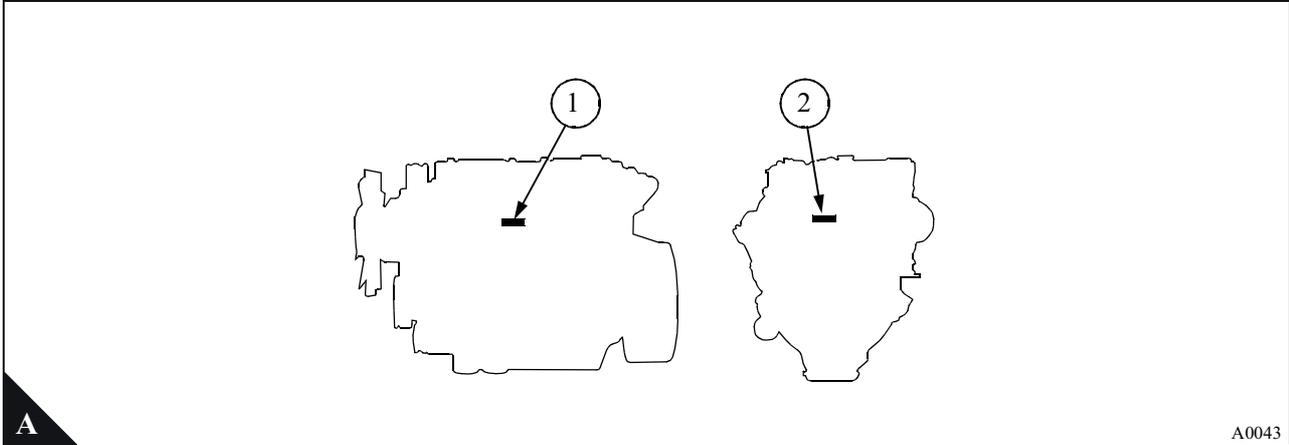
Code letters	Engine type
AA	Four cylinder, naturally aspirated
AB	Four cylinder, turbocharged
AC	Four cylinder, compensated
AD	Four cylinder, turbocharged and intercooled
AE	Four cylinder, turbocharged and intercooled designed to conform to the USA emission legislation
AG	Four cylinder, naturally aspirated with belt driven coolant pump
AH	Four cylinder, turbocharged with belt driven coolant pump
YA	Six cylinder, naturally aspirated
YB	Six cylinder, turbocharged
YC	Six cylinder, compensated
YD	Six cylinder, turbocharged and intercooled
YE	Six cylinder, turbocharged and intercooled designed to conform to the USA emission legislation

*Continued*

The engine number is stamped on a label which is fastened to the left side (A1) or rear (A2) of the cylinder block. An example of an engine number is **AB30126U510256N**.

Further information about the engine number system can be found in the relevant User's Handbook.

**Note:** If you need parts, service or information for your engine, you must give the complete engine number to your Perkins distributor.



## Safety precautions

**These safety precautions are important.** You must refer also to the local regulations in the country of use. Some items only refer to specific applications.

- Only use these engines in the type of application for which they have been designed.
- Do not change the specification of the engine.
- Do not smoke when you put fuel in the tank.
- Clean away fuel which has been spilt. Material which has been contaminated by fuel must be moved to a safe place.
- Do not put fuel in the tank while the engine runs (unless it is absolutely necessary).
- Do not clean, add lubricating oil, or adjust the engine while it runs (unless you have had the correct training; even then extreme care must be used to prevent injury).
- Do not make adjustments that you do not understand.
- Ensure that the engine does not run in a location where it can cause a concentration of toxic emissions.
- Other persons must be kept at a safe distance while the engine or auxiliary equipment is in operation.
- Do not permit loose clothing or long hair near moving parts.
- Keep away from moving parts during engine operation.

**Warning!** *Some moving parts cannot be seen clearly while the engine runs.*

- Do not operate the engine if a safety guard has been removed.
- Do not remove the filler cap of the cooling system while the engine is hot and while the coolant is under pressure, because dangerous hot coolant can be discharged.
- Do not use salt water or any other coolant which can cause corrosion in the closed circuit of the cooling system.
- Do not allow sparks or fire near the batteries (especially when the batteries are on charge) because the gases from the electrolyte are highly flammable. The battery fluid is dangerous to the skin and especially to the eyes.
- Disconnect the battery terminals before a repair is made to the electrical system.
- Only one person must control the engine.
- Ensure that the engine is operated only from the control panel or from the operators position.
- If your skin comes into contact with high-pressure fuel, obtain medical assistance immediately.
- Diesel fuel and lubricating oil (especially used lubricating oil) can damage the skin of certain persons. Protect your hands with gloves or a special solution to protect the skin.
- Do not wear clothing which is contaminated by lubricating oil. Do not put material which is contaminated with oil into the pockets of clothing.
- Discard used lubricating oil in a safe place to prevent contamination.
- Ensure that the control lever of the transmission drive is in the "out-of-drive" position before the engine is started.
- Use extreme care if emergency repairs must be made in adverse conditions.
- The combustible material of some components of the engine (for example certain seals) can become extremely dangerous if it is burned. Never allow this burnt material to come into contact with the skin or with the eyes. Refer to "Viton seals" on page 7.
- Read and use the instructions relevant to "Engine lift equipment" on page 8.

*Continued*

- Always use a safety cage to protect the operator when a component is to be pressure tested in a container of water. Fit safety wires to secure the plugs which seal the hose connections of a component which is to be pressure tested.
- Do not allow compressed air to contact your skin. If compressed air enters your skin, obtain medical help immediately.
- Turbochargers operate at high speed and at high temperatures. Keep fingers, tools and debris away from the inlet and outlet ports of the turbocharger and prevent contact with hot surfaces.
- Fit only genuine Perkins parts.

## Asbestos joints

Some joints and gaskets contain compressed asbestos fibres in a rubber compound or in a metal outer cover. The "white" asbestos (Chrysotile) which is used is a safer type of asbestos and the risk of damage to health is extremely small.

- The risk of asbestos from joints occurs at their edges or if a joint is damaged when a component is removed or if a joint is removed by abrasive action.
- To ensure that the risk is kept to a minimum, the precautions given below must be applied when an engine which has asbestos joints is dismantled or assembled.
- Work in an area with good ventilation.
- Do not smoke.
- Use a hand scraper to remove the joints - do not use a rotary wire brush.
- Ensure that the joint to be removed is wet with oil or water to contain loose particles.
- Spray all asbestos debris with water and put it in a closed container which can be sealed for safe disposal.

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## Viton seals

Some seals used in engines and in components fitted to engines are made of Viton.

Viton is used by many manufacturers and is a safe material under normal conditions of operation. If Viton is burned, a product of this burnt material is an acid which is extremely dangerous. Never allow this burnt material to come into contact with the skin or with the eyes.

If it is necessary to come into contact with components which have been burnt, ensure that the precautions which follow are used:

- Ensure that the components have cooled.
- Use Neoprene gloves and discard the gloves safely after use.
- Wash the area with calcium hydroxide solution and then with clean water.
- Disposal of components and gloves which are contaminated must be in accordance with local regulations.

If there is contamination of the skin or eyes, wash the affected area with a continuous supply of clean water or with calcium hydroxide solution for 15-60 minutes. **Obtain immediate medical attention.**

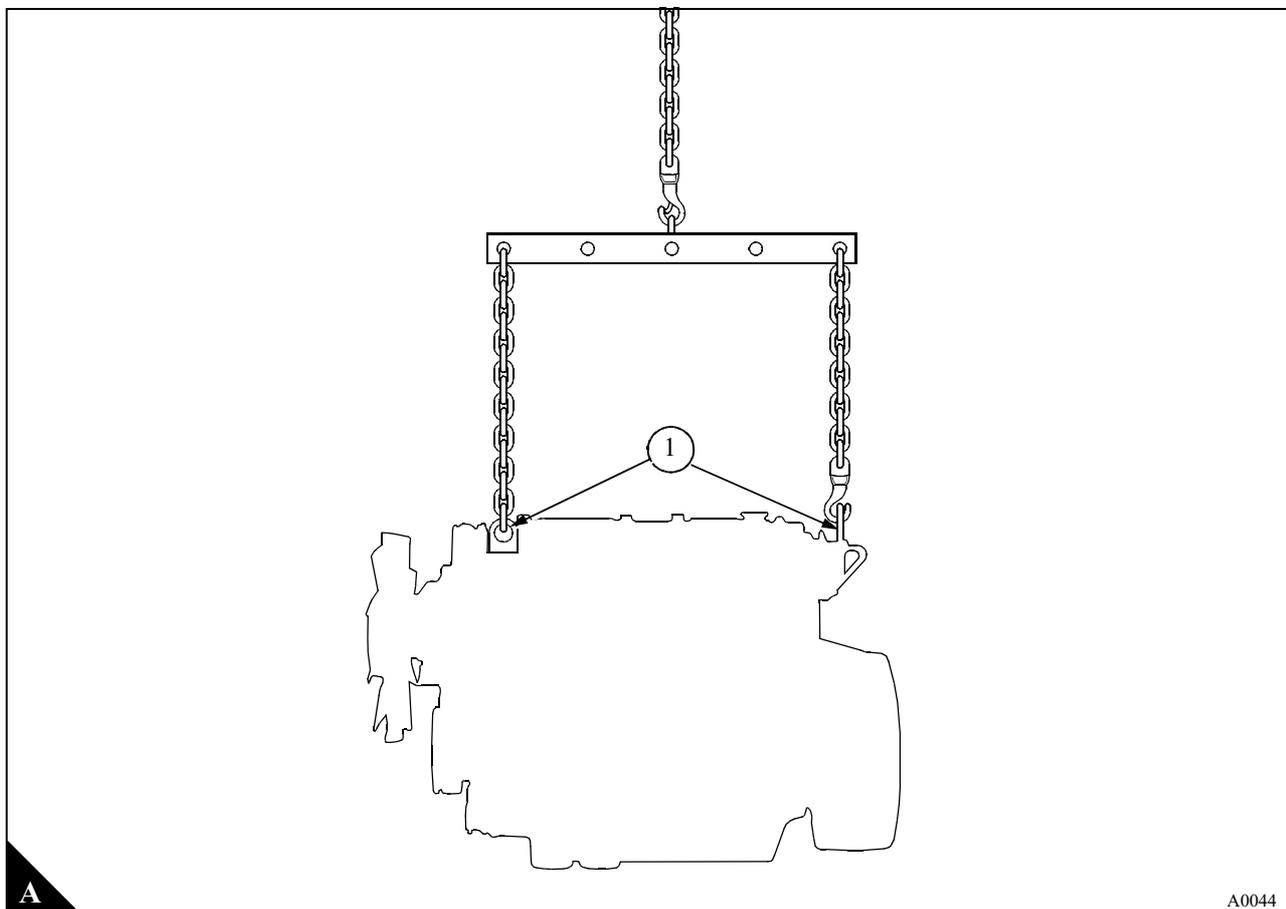
## Engine lift equipment

The maximum weight of the engine without coolant, lubricant or a gearbox fitted will vary for different applications. It is recommended that lift equipment of the minimum capacity listed below is used:

- Four cylinder engines: 500 kg (1100 lbs)
- Six cylinder engines: 600 kg (1320 lbs)

### Before the engine is lifted

- Always use lift equipment of the approved type and of the correct capacity to lift the engine. It is recommended that lift equipment of the type shown in (A) is used, to provide a vertical lift directly above the engine lift brackets (A1). Never use a single lift bracket to raise an engine.
- Check the engine lift brackets for damage and that they are secure before the engine is lifted. The torque for the setscrews for the engine lift brackets is 44 Nm (33 lbf ft) 4,5 kgf m.
- To Prevent damage to the rocker cover, ensure that there is clearance between the hooks and the rocker cover.
- Use lift equipment or obtain assistance to lift heavy engine components such as the cylinder block, cylinder head, balancer unit, flywheel housing, crankshaft and flywheel.



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**POWERPART consumable products**

Perkins have made available the products recommended below in order to assist in the correct operation, service and maintenance of your engine and your machine. The instructions for the use of each product are given on the outside of each container. These products are available from your Perkins distributor.

**POWERPART Antifreeze**

Protects the cooling system against frost and corrosion. Part number 21825166.

**POWERPART Easy Flush**

Cleans the cooling system. Part number 21825001.

**POWERPART Gasket and flange sealant**

To seal flat faces of components where no joint is used. Especially for aluminium components. Part number 21820518.

**POWERPART Gasket remover**

An aerosol for removal of sealants and adhesives. Part number 21820116.

**POWERPART Griptite**

To improve the grip of worn tools and fasteners. Part number 21820129.

**POWERPART Hydraulic threadlock**

To retain and seal pipe connections with fine threads. Especially suitable for hydraulic and pneumatic systems. Part number 21820121.

**POWERPART Industrial grade super glue**

Instant adhesive designed for metals, plastics and rubbers. Part number 21820125.

**POWERPART Lay-Up 1**

A diesel fuel additive for protection against corrosion. Part number 1772204.

**POWERPART Lay-Up 2**

Protects the inside of the engine and of other closed systems. Part number 1762811.

**POWERPART Lay-Up 3**

Protects outside metal parts. Part number 1734115.

**POWERPART Metal repair putty**

Designed for external repair of metal and plastics. Part number 21820126.

**POWERPART Pipe sealant and sealant primer**

To retain and seal pipe connections with coarse threads. Pressure systems can be used immediately. Part number 21820122.

**POWERPART Radiator stop leak**

For the repair of radiator leaks. Part number 21820127.

*Continued*

**POWERPART Retainer (high strength)**

To retain components which have an interference fit. Part number 21820638.

**POWERPART Retainer (oil tolerant)**

To retain components which have a transition fit. Part number 21820603.

**POWERPART Safety cleaner**

General cleaner in an aerosol container. Part number 21820128.

**POWERPART Silicone adhesive**

An RTV silicone adhesive for applications where low pressure tests occur before the adhesive sets. Used for sealing flange where oil resistance is needed and movement of the joint occurs. Part number 21826038.

**POWERPART Silicone RTV sealing and jointing compound**

Silicone rubber sealant which prevents leakage through gaps. Part number 1861108.

**POWERPART Stud and bearing lock**

To provide a heavy duty seal to components that have a light interference fit. Part number 21820119.

**POWERPART Threadlock and nutlock**

To retain small fasteners where easy removal is necessary. Currently Loctite 222e. Part number 21820119 or 21820120.

**POWERPART Universal jointing compound**

Universal jointing compound which seals joints. Part number 1861117.

# 2

## Specifications

### Basic engine data

Number of cylinders:

AA, AB, AC, AD, AE, AG, AH.. ..... 4

YA, YB, YC, YD, YE ..... 6

Cylinder arrangement.. ..... In-line

Cycle ..... Four stroke

Direction of rotation . ..... Clockwise from the front

Induction system:

AA, AG, YA.. ..... Naturally aspirated

AB, AH, YB.. ..... Turbocharged

AC, YC. .... Altitude compensated

AD, AE, YD, YE..... Turbocharged/intercooled

Combustion system. .... Direct injection

Nominal bore ..... 100 mm (3.937 in)

Stroke .. ..... 127 mm (5.000 in)

Compression ratio:

AA, AG, YA.. ..... 16.5:1

Certain YA engines.. ..... 17.5:1

AB, AC, AD, AH, YB, YC, YD.. ..... 16.0:1

AE, YE ..... 17.5:1

Certain AD engines . ..... 17.25:1 or 17.5:1

Cubic capacity:

- Four cylinder engines ..... .4 litres (243 in<sup>3</sup>)

- Six cylinder engines .. ..... .6 litres (365 in<sup>3</sup>)

Firing order:

- Four cylinder engines ..... 1, 3, 4, 2

- Six cylinder engines .. ..... 1, 5, 3, 6, 2, 4

Valve tip clearance (cold):

Inlet.. ..... 0,20 mm (0.008 in)

Exhaust ..... 0,45 mm (0.018 in)

Lubricating oil pressure (minimum at maximum engine speed and normal engine temperature):

Engines without piston cooling jets.. ..... .207 kpa (30 lbf/in<sup>2</sup>) 2,1 kgf/cm<sup>2</sup>

Engines with piston cooling jets... ..... .280 kpa (40 lbf/in<sup>2</sup>) 2,8 kgf/cm<sup>2</sup>

**Data and dimensions**

**Note:** This information is given as a guide for personnel engaged on engine overhauls. The dimensions which are shown are those which are mainly used in the factory. The information applies to all engines, unless an engine type code is shown.

**Cylinder head**

Angle of valve seat:

- Exhaust 46° ... .. (88° included angle)
- Inlet ... .. 46° (88° included angle) or 31° (118° included angle)
- Diameter of parent bore for valve guide. ... .. 15,87/15,89 mm (0.6247/0.6257 in)
- Leak test pressure . ... .. 200 kPa (29 lbf/in<sup>2</sup>) 2,04 kgf/cm<sup>2</sup>
- Head thickness .. ... .. 102,79/103,59 mm (4.047/4.078 in)
- Minimum permissible thickness after head face has been machined ... .. 102,48 mm (4.035 in)
- AE, YE engines.. ... .. See Operation 3-17

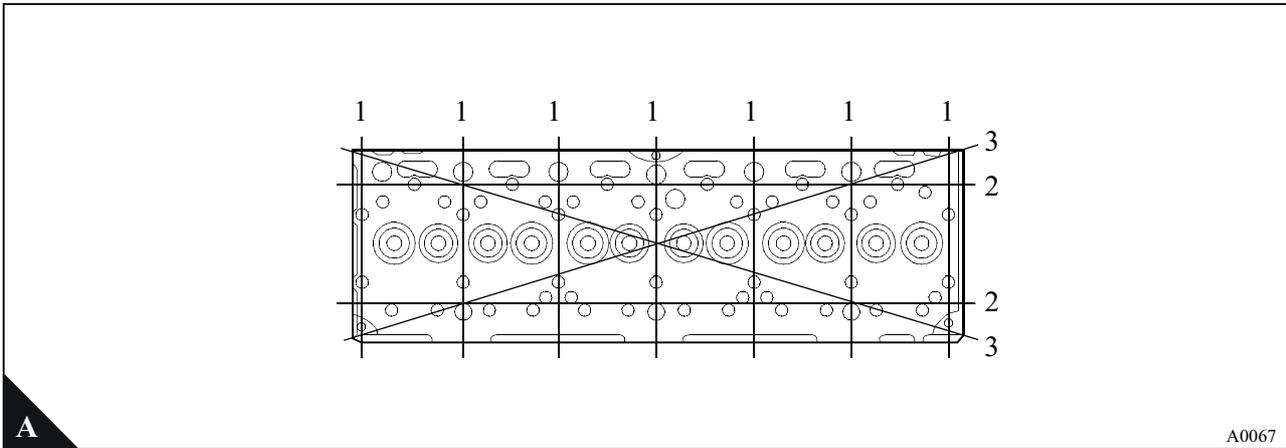
**Maximum permissible distortion of cylinder head**

**Four cylinder engines**

- A1... ..0,08 mm (0.003 in)
- A2... ..0,15 mm (0.006 in)
- A3... ..0,15 mm (0.006 in)

**Six cylinder engines**

- A1... ..0,13 mm (0.005 in)
- A2... ..0,25 mm (0.010 in)
- A3... ..0,25 mm (0.010 in)



## Inlet and exhaust valves

### Inlet valves

Diameter of valve stem	9,46/9,49 mm (0.3725/0.3735 in)
Clearance in valve guide	0,02/0,10 mm (0.0008/0.0039 in)
Maximum clearance in valve guide	0,13 mm (0.005 in)
Diameter of valve head	44,86/45,11 mm (1.766/1.776 in)
Angle of valve face	45° or 30°
Full length	122,66/123,07 mm (4.829/4.845 in)
Seal arrangement	Rubber seal fitted to valve guide

Depth of valve head below the face of cylinder head AA, AB, AC, AD, AG, AH, YA, YB, YC:

Production limits	1,27/1,60 mm (0.050/0.063 in)
Service limit	1,85 mm (0.073 in)
AD vehicle applications fitted with an intercooler	1,37/1,68 mm (0.054/0.066 in)
YA engines fitted with original valve seat inserts	1,37/1,68 mm (0.054/0.066 in)

Depth of valve head below the face of cylinder head YD:

Production limits	1,37/1,68 mm (0.054/0.066 in)
Engine build list YD 80571	1,27/1,60 mm (0.050/0.063 in)

AE, YE engines:

Production limits (for 45° valves)	1,37/1,62 mm (0.054/0.064 in)
Service limit	1,85 mm (0.073 in)
Production limits (for 30° valves)	1,27/1,76 mm (0.050/0.069 in)
Service limit (for 30° valves)	2,01 mm (0.079 in)

**Note:** The inlet valve depth for certain engine types fitted with valve seat inserts can vary. The complete engine number must be given to the distributor when parts are needed.

### Exhaust valves

Diameter of valve stem	9,43/9,46 mm (0.371/0.372 in)
Clearance in valve guide	0,05/0,13 mm (0.002/0.005 in)
Maximum clearance in valve guide	0,15 mm (0.006 in)
Diameter of valve head	37,26/37,52 mm (1.467/1.477 in)
Angle of valve face	45°
Full length	123,07/123,57 mm (4.845/4.865 in)
Seal arrangement	Rubber seal fitted to valve guide

Depth of valve head below face of cylinder head AA, AB, AC, AD, AG, AH, YA, YB, YC:

Production limits	1,28/1,60 mm (0.050/0.063 in)
Service limit	1,85 mm (0.073 in)
AD vehicle applications fitted with an intercooler	1,47/1,79 mm (0.058/0.070 in)
YA engines fitted with original valve seat inserts	1,47/1,79 mm (0.058/0.070 in)

Depth of valve head below face of cylinder head AE, YD, YE:

Production limits	1,47/1,79 mm (0.058/0.070 in)
Service limit	1,85 mm (0.073 in)
Engine build list YD 80571	1,28/1,60 mm (0.050/0.063 in)

**Note:** The exhaust valve depth for certain engine types fitted with valve seat inserts can vary. The complete engine number must be given to the distributor when parts are needed.

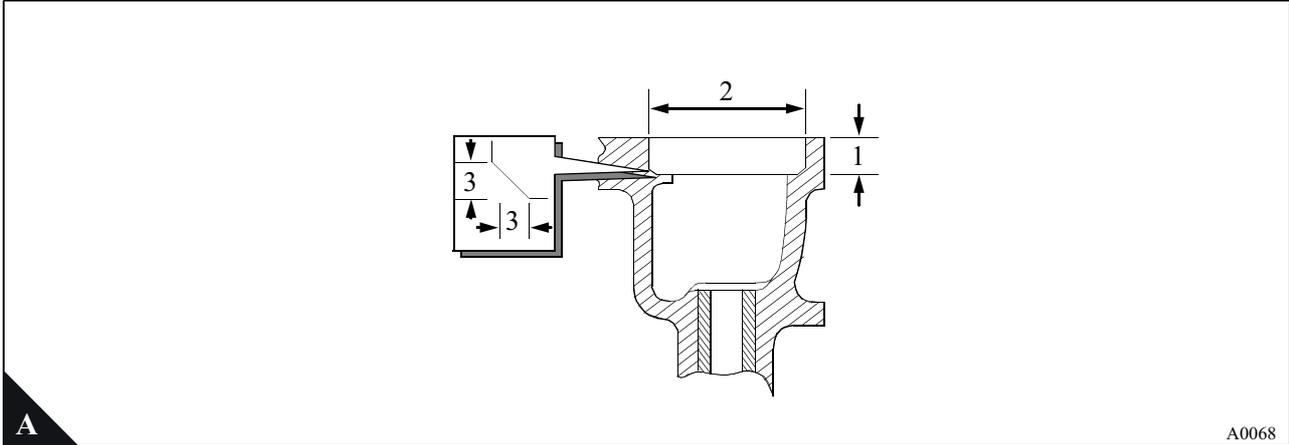
**Dimensions of recesses for valve seat inserts**

**Inlet**

- A1..... 7,19/7,32 mm (0.283/0.288 in)
- A2..... 51,22/51,24 mm (2.0165/2.0175 in)
- A3..... .Radius 0,38 mm (0.015 in) maximum

**Exhaust**

- A1..... 9,52/9,65 mm (0.375/0.380 in)
- A2..... 42,62/42,65 mm (1.6780/1.6790 in)
- A3..... .Radius 0,38 mm (0.015 in) maximum



**Valve seat insert tool**

**Inlet (for 45° valves)**

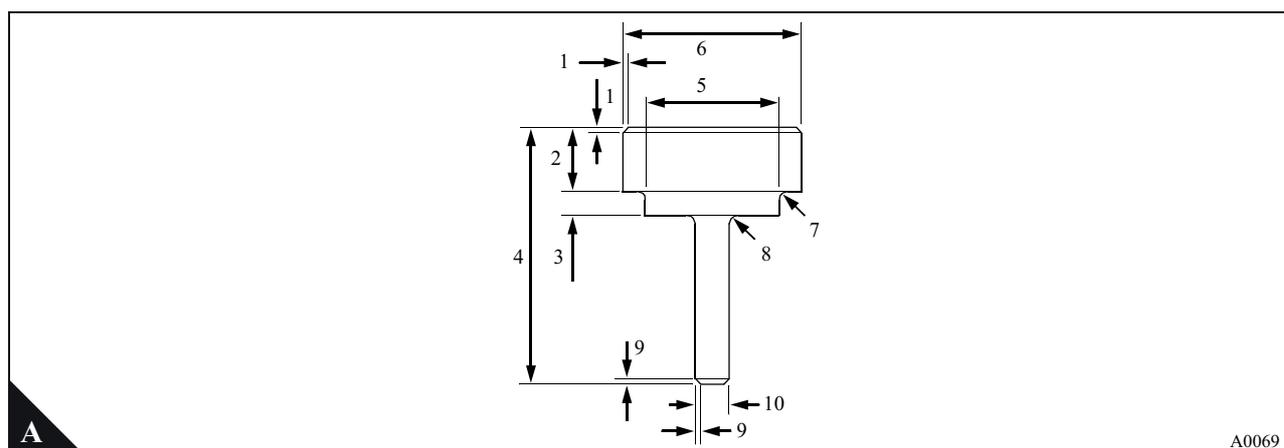
A1	.....	1,59 mm (0.063 in)
A2	.....	19,05 mm (0.750 in)
A3	.....	6,35 mm (0.250 in)
A4	.....	76,20 mm (3.00 in)
A5	.....	37,26/37,28 mm (1.467/1.468 in)
A6	.....	51,00/51,23 mm (2.008/2.017 in)
A7	.....	0,79 mm (0.031 in)
A8	.....	1,59 mm (0.063 in)
A9	.....	1,59 mm (0.063 in)
A10	.....	9,45/9,47 mm (0.372/0.373 in)

**Inlet (for 31° valves)**

A1	.....	1,59 mm (0.063 in)
A2	.....	19,05 mm (0.750 in)
A3	.....	3,00 mm (0.118 in)
A4	.....	76,20 mm (3.00 in)
A5	.....	35,30/35,60 mm (1.390/1.402 in)
A6	.....	43,94/43,99 mm (1.730/1.732 in)
A7	.....	0,79 mm (0.031 in)
A8	.....	1,59 mm (0.063 in)
A9	.....	1,59 mm (0.063 in)
A10	.....	9,45/9,47 mm (0.372/0.373 in)

**Exhaust (for 45° valves)**

A17	.....	1,59 mm (0.063 in)
A2	.....	19,05 mm (0.750 in)
A3	.....	7,92 mm (0.312 in)
A4	.....	76,20 mm (3.00 in)
A5	.....	32,58/32,84 mm (1.283/1.293 in)
A6	.....	42,39/42,62 mm (1.669/1.678 in)
A7	.....	0,79 mm (0.031 in)
A8	.....	1,59 mm (0.063 in)
A9	.....	1,59 mm (0.063 in)
A10	.....	9,45/9,47 mm (0.372/0.373 in)



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## Valve guides and valve springs

### Valve guides

Inside diameter .....	9,51/9,56 mm (0.3744/0.3764 in)
Outside diameter .....	15,90/15,91 mm (0.6260/0.6265 in)
Interference fit of valve guide in cylinder head.....	0,03/0,07 mm (0.0012/0.0027 in)

Full length:

Inlet .....	57,94 mm (2.281 in)
Exhaust.....	61,10 mm (2.406 in)
Protrusion from bottom of recess for valve spring .....	15,10 mm (0.594 in)

### Double valve springs (outer)

Fitted length .....	35,8 mm (1.41 in)
Load at fitted length .....	176/195 N (39.5/43.7 lbf) 18/20 kgf
Number of active coils .....	3.6
Number of damper coils .....	1
Direction of coils .....	Left hand - damper coil to cylinder head

### Double valve springs (inner)

Fitted length .....	34,0 mm (1.34 in)
Load at fitted length .....	89/104 N (20/23 lbf) 9/11 kgf
Number of active coils .....	4.9
Number of damper coils .....	1
Direction of coils .....	Right hand - damper coil to cylinder head

### Single valve springs

Fitted length .....	40,0 mm (1.57 in)
Load at fitted length .....	312/344 N (70.1/77.3 lbf) 31,8/35,1 kgf
Number of active coils .....	4.5
Number of damper coils .....	0
Direction of coils .....	Left hand

## Tappets, rocker shaft, rocker levers and bushes

### Tappets

Diameter of tappet stem .....	18,99/19,01 mm (0.7475/0.7485 in)
Diameter of tappet bore in cylinder block.....	19,05/19,08 mm (0.7500/0.7512 in)
Clearance of tappet in cylinder block .....	0,04/0,09 mm (0.0015/0.0037 in)

### Rocker shaft

Outside diameter .....	19,01/19,04 mm (0.7485/0.7495 in)
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### Rocker levers and bushes

Diameter of parent bore for bush .....	22,23/22,26 mm (0.8750/0.8762 in)
Outside diameter of bush.....	22,28/22,31 mm (0.8770/0.8785 in)
Interference fit of bush in rocker lever .....	0,020/0,089 mm (0.0008/0.0035 in)
Internal diameter of fitted bush when reamed .....	19,06/19,10 mm (0.7505/0.7520 in)
Clearance between rocker lever bush and rocker shaft .....	0,03/0,09 mm (0.001/0.0035 in)
Maximum permissible clearance between rocker lever bush and rocker shaft.....	0,13 mm (0.005 in)