
Perkins 900 Series

Models CP and CR

WORKSHOP MANUAL

3 cylinder, naturally aspirated, and turbocharged diesel engines for agricultural and industrial use

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1

General information

Introduction

This Workshop Manual has been designed to provide assistance in the service and overhaul of Perkins 900 Series engines. For overhaul procedures the assumption is made that the engine is removed from the application.

The engine conforms with USA (EPA/CARB) stage 1 and EEC stage 1 emissions legislation for agricultural and industrial applications.

Read and remember the "Safety precautions" on page 4. They are given for your protection and must be used at all times.

Most of the general information which is included in the User's Handbook (Chapters 1 to 6) has not been repeated in this workshop manual and the two publications should be used together.

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

- Delphi - DP200 Series
- Stanadyne - 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 tools is given in Chapter 16, Special tools. Reference to the relevant special tools is also made at the beginning of each operation.

Original setscrews or studs used in holes that are open to the inside of the engine, have a sealant that is applied by the manufacturer. If the setscrew or stud is to be used again, the threads must be cleaned and a suitable sealant should be used on the threads. POWERPART recommended consumable products are listed on page 8. Reference to the relevant consumable products are made at the beginning of each operation.

Data and dimensions are included in Chapter 2, Specifications.

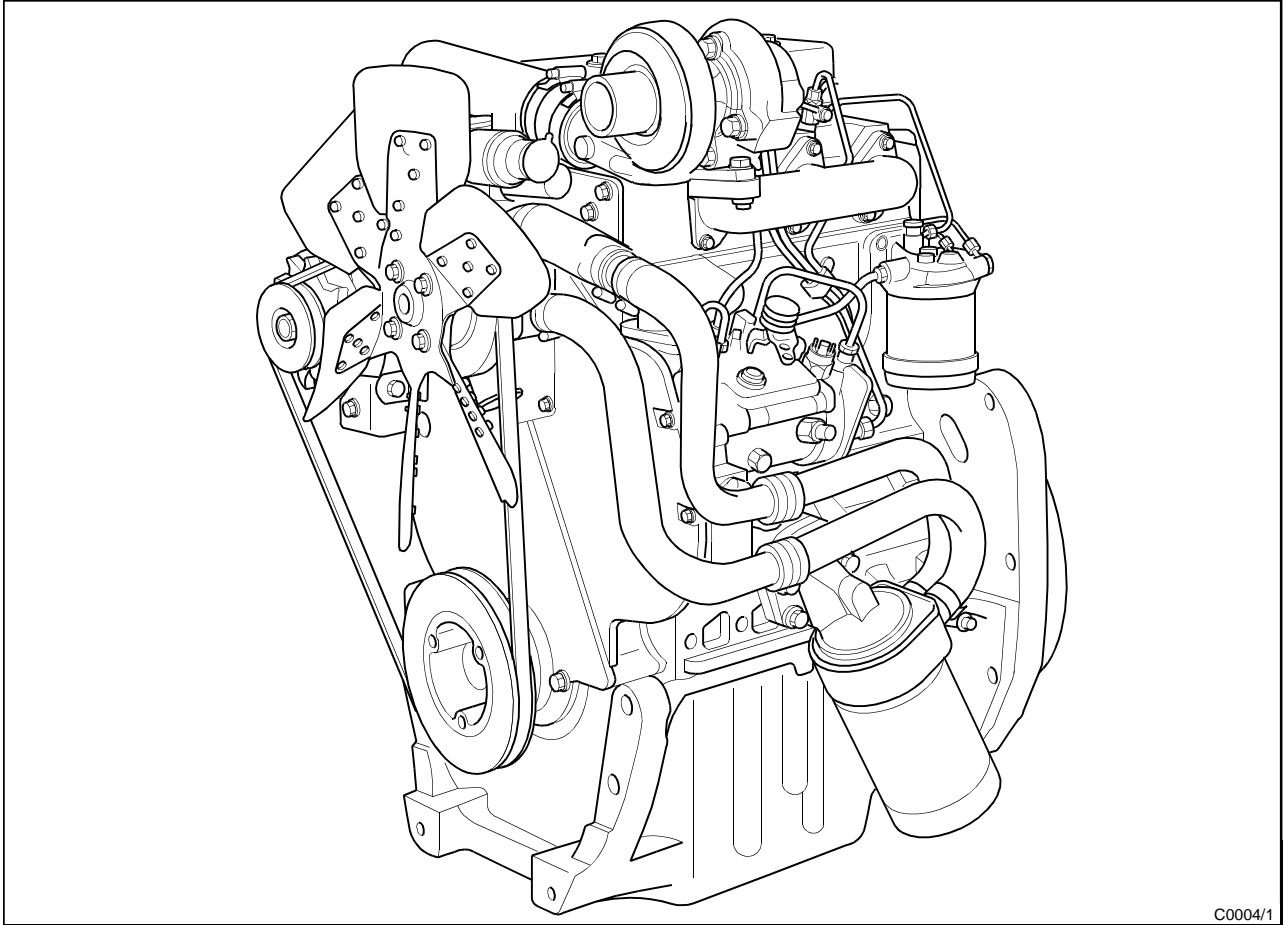
Danger is indicated in the text by two methods:

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

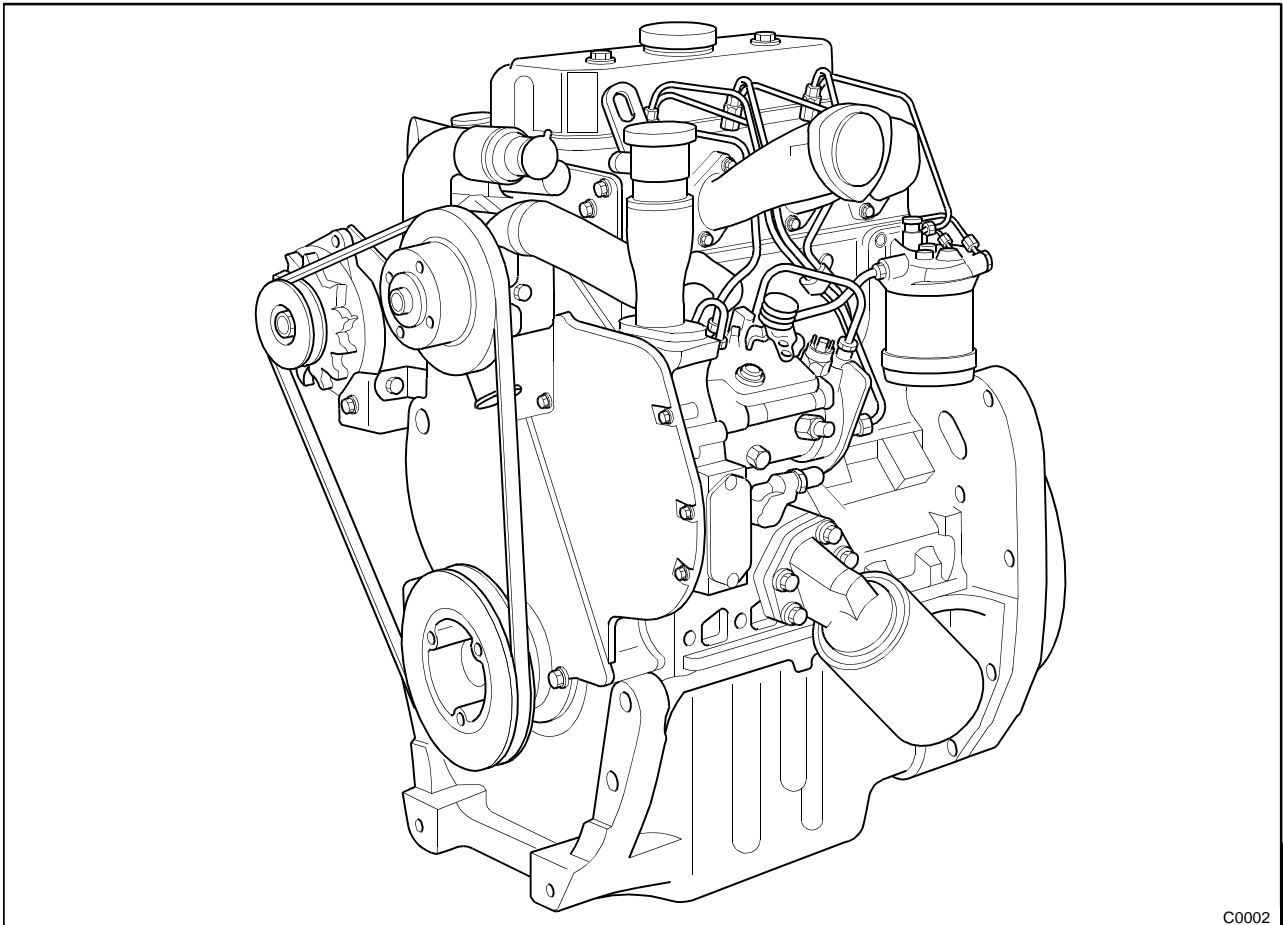
Caution: *This indicates that there is a possible danger to the engine.*

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

Engine views



C0004/1



C0002

Engine identification

The 900 Series is a 3 cylinder, water cooled, direct injection, diesel engine for industrial and agricultural applications. The complete engine family consists of both turbocharged and naturally aspirated models.

The engine number is stamped on a label (A2) fastened to the left side of the cylinder block.

The two letters at the beginning of the engine number are the code letters for the engine type.

| Code letters | Engine type |
|--------------|-------------------------------------|
| CP | Three cylinder, naturally aspirated |
| CR | Three cylinder, turbocharged |

An example of an engine number is:

CP12345U123456A

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

If you need parts, service or information for your engine, you must give the complete engine number to your Perkins distributor. If there is a number in the area of the label marked TPL No, then this number must also be given to your Perkins distributor.

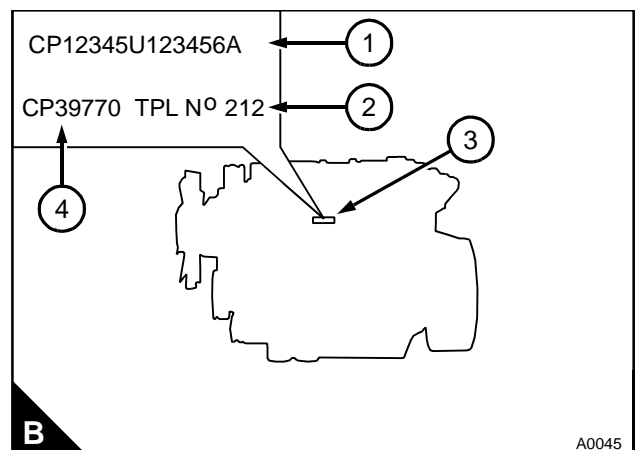
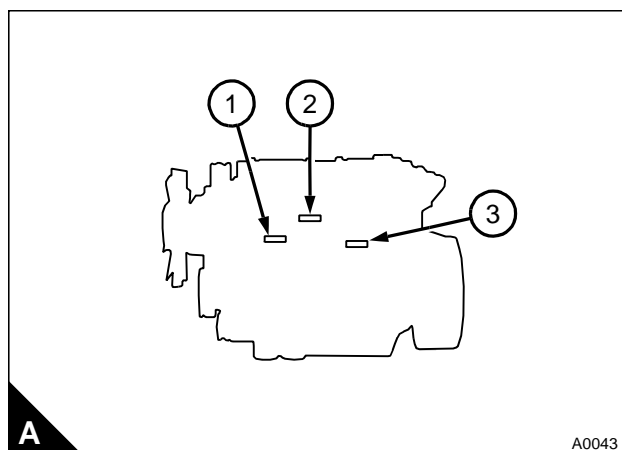
Other identification labels fitted to the engine include:

- An emissions legislation label (A3) fitted to the side of the cylinder block
- A label (A1), fitted to the fuel injection pump, with the fuel injection pump part number.

If a short engine has been fitted in service, two engine serial numbers and a TPL number are stamped on the engine serial number pad (B3).

Examples of the serial numbers are shown in (B).

If parts for the short engine are needed in service, use the serial number (B4). If parts that were moved from the original engine to the short engine are needed, use the serial number (B1) and the TPL number (B2).



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.

- Do not fill the engine with lubricating oil above the mark on the dipstick (see Operation 10-1/B1) or damage could occur to the engine.
- If the lubrication system has been drained, the rocker gear and the camshaft reservoir must be lubricated before the engine is started or damage could occur to the engine.
- 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.

Warning! *Keep away from moving parts during engine operation. 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 lift equipment, refer to "Engine lift equipment" on page 6.

Continued

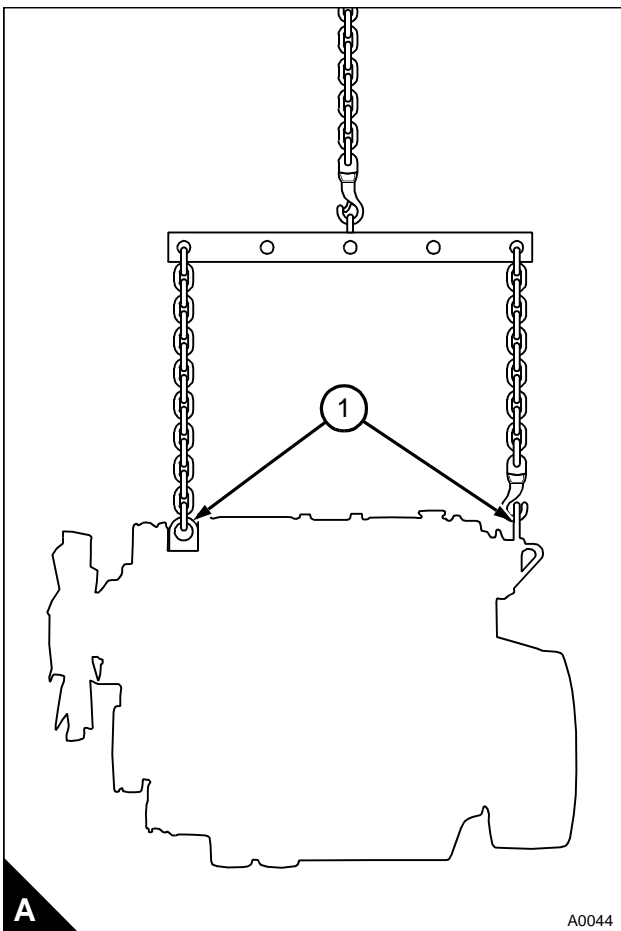
-
- Always use a safety cage to protect the operator when a component is to be pressure tested in a container of water. Fit safety wires to secure the plugs which seal the hose connections of a component which is to be pressure tested.
 - Do not allow compressed air to contact your skin. If compressed air enters your skin, obtain medical help immediately
 - Turbochargers operate at high speeds and at high temperatures. Keep fingers, tools and items away from the inlet and outlet ports of the turbocharger and prevent contact with hot surfaces.
 - Do not clean an engine while it runs. If cold cleaning fluids are applied to a hot engine, certain components on the engine may be damaged.
 - Fit only genuine Perkins parts.

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 313 Kg (690 lbs) minimum capacity is used.

Before the engine is lifted:

- Always use engine 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, flywheel housing, crankshaft and flywheel.



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:

Warnings!

- *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.**

POWERPART recommended 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 suitable for aluminium components. Part number 21820518.

POWERPART Gasket remover

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

POWERPART Griptite

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

POWERPART Hydraulic threadseal

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 plastic. 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.

POWERPART Retainer (oil tolerant)

To retain components that have an interference fit, but is in contact with oil. Part number 21820603.

POWERPART Retainer (high strength)

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

POWERPART Safety cleaner

General cleaner in an aerosol container. Part number 21820128.

Continued

POWERPART Silicone adhesive

An RTV silicone adhesive for application 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 or 21820120.

POWERPART Threadlock and nutlock

To retain small fasteners where easy removal is necessary. Part number 21820117 or 21820118.

POWERPART Universal jointing compound

Universal jointing compound which seals joints. Part number 1861117.

2

Specifications

Data and dimensions

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

Basic engine data

| | |
|---|--|
| Cycle | Four stroke |
| Number of cylinders | 3 |
| Cylinder arrangement | .In line |
| Firing order | 1, 2, 3 |
| Direction of rotation | Clockwise from the front |
| Induction system | Turbocharged / naturally aspirated |
| Cubic capacity | .2,7 litres (164.76 in ³) |
| Compression ratio | 17.25:1 |
| Combustion system | Direct injection |
| Nominal bore | 95,0 mm (3.74 in) |
| Stroke | 127 mm (5.00 in) |
| Valve tip clearances (hot or cold): | |
| - Inlet | 0,20 mm (0.008 in) |
| - Exhaust | 0,45 mm (0.018 in) |
| Lubricating oil pressure ⁽¹⁾ | 207 kPa (30 lbf/ in ²) 2,1 kgf/cm ² |
| Typical dry installed engine weight | 305 kg (672 lbs) |

(1) Minimum at maximum engine speed and normal engine temperature.

Cylinder head assembly

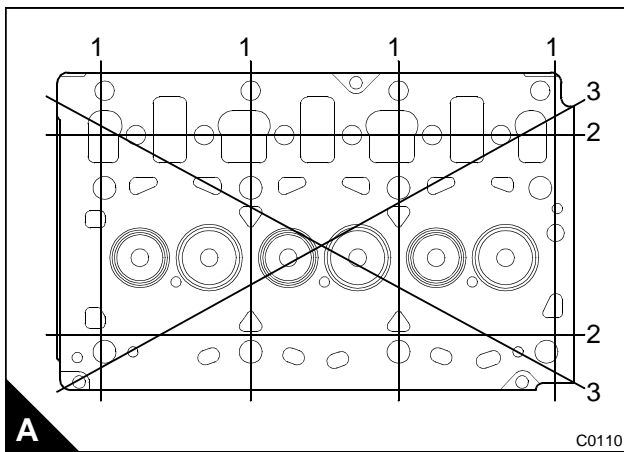
Cylinder head

Angle of valve seats:

| | |
|--|---|
| Inlet | 36° (108° included angle) |
| Exhaust | 46° (88° included angle) |
| Diameter of parent bores for valve guides | 12,000/12,027 mm (0.4724/0.4735 in) |
| Leak test pressure | 200 kPa (29 lbf/in ²) 2,0 kgf/cm ² |
| Cylinder head thickness | 87,6/88,4 mm (3.45/3.48 in) |
| Diameter of bore for tappets | 14,000/14,027 mm (0.5512/0.5522 in) |
| Finish grade of head face for cylinder head gasket | 1,1/3,20 micrometres |

Maximum permissible cylinder head distortion

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



Maximum protrusion of the atomiser nozzle

| | |
|----------------------|---------------------------------|
| Code letter KB | 1,6/2,13 mm (0.0629/0.0838 in) |
| Code letter KK | 3,49/4,01 mm (0.1374/0.1579 in) |
| Code letter KL | 3,49/4,01 mm (0.1374/0.1579 in) |
| Code letter KS | 2,36/2,88 mm (0.0929/0.1134 in) |
| Code letter PF..... | 3,45/4,01 mm (0.1358/0.1579 in) |

Valve guides

| | |
|--|---------------------------------------|
| Inside diameter | 7,027/7,052 mm (0.2767/0.2776 in) |
| Outside diameter | 12,034/12,047 mm (0.4738/0.4743 in) |
| Interference fit of guide in cylinder head | -0,007/-0,047 mm (-0.0003/-0.0019 in) |
| Length | 51,0/51,5 mm (2.00/2.03 in) |
| Protrusion above face of spring seat | 11,10/11,40 mm (0.437/0.449 in) |

Valve springs

| | |
|------------------------------|---|
| Fitted length | 38,0 mm (1.50 in) |
| Load at fitted length | 218,5/241,5 N (49.12/54.29 lbf) 22,3/24,6 kgf |
| Number of active coils | 5.0 |

Tappets

| | |
|---|-------------------------------------|
| Diameter of stem | 13,925/13,968 mm (0.5482/0.5499 in) |
| Clearance of tappet in cylinder block... | 0,075/0,102 mm (0.0030/0.0040 in) |
| Diameter of tappet bore in cylinder head. | 14,027/14,000 mm (0.5522/ 0.5519) |

Rocker shaft

| | |
|----------------------------|------------------------------------|
| Outside diameter | 9,012/19,037 mm (0.7485/0.7495 in) |
|----------------------------|------------------------------------|

Rocker levers

| | |
|---|-------------------------------------|
| Bore diameter | 19,070/19,101 mm (0.7508/0.7520 in) |
| Clearance fit on rocker shaft | 0,033/0,089 mm (0.0012/0.0035 in) |
| Maximum permissible clearance | 0,13 mm (0.005 in) |

Inlet and exhaust valves**Inlet valves**

| | |
|--|-------------------------------------|
| Diameter of valve stem | 6,980/7,000 mm (0.2748/0.2756 in) |
| Clearance fit of valve in guide | 0,027/0,072 mm (0.0011/0.0028 in) |
| Maximum permissible clearance in valve guide | 0,15 mm (0.006 in) |
| Diameter of valve head | 41,63/41,87 mm (1.639/1.648 in) |
| Angle of valve face | 35° |
| Full length, engine types CP and CR | 115,755/115,105 mm (4.557/4.532 in) |

Depth of valve head below cylinder head face:

| | |
|---|-----------------------------------|
| CP and CR engines. | 1,60/1,90 mm (0.063/0.075 in) |
| Service limit | 1,65 mm (0.065 in) |
| Seal arrangement ⁽¹⁾ | Rubber seal fitted to valve guide |

⁽¹⁾ Certain engines do not have a seal fitted to the valve guide for the inlet valve. Ensure that the full engine part number is used to order parts.

Exhaust valves

| | |
|--|-----------------------------------|
| Diameter of valve stem | 6,966/6,987 mm (0.2743/0.2751 in) |
| Clearance fit of valve in guide | 0,040/0,086 mm (0.0016/0.0034 in) |
| Maximum permissible clearance in valve guide | 0,14 mm (0.0055 in) |
| Diameter of valve head | 37,88/38,12 mm (1.491/1.501 in) |
| Angle of valve face | 45° |
| Full length, engine types CP and CR | 115,845/115,195 mm (4.56/4.53 in) |

Depth of valve head below cylinder head face:

| | |
|-----------------------------|-----------------------------------|
| CP and CR engines | 1,11/1,39 mm (0.044/0.055 in) |
| -Service limit | 1,64 mm (0.065 in) |
| Seal arrangement | Rubber seal fitted to valve guide |

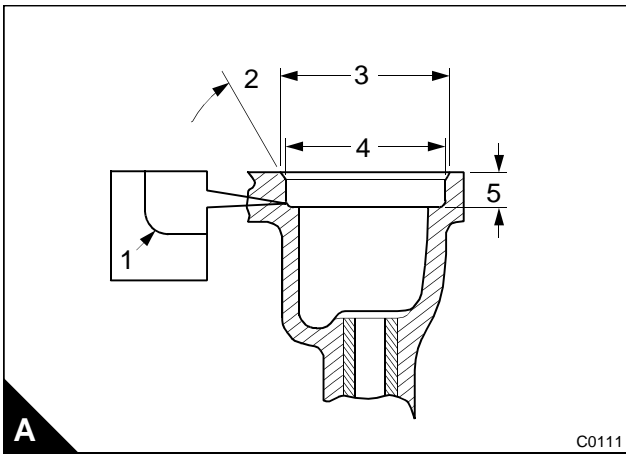
Dimensions of a recess for a valve seat insert

Exhaust valve

| | | |
|----|-------|-------------------------------------|
| A1 | ..... | Radius 0,42 mm (0.017 in) maximum |
| A2 | ..... | 45° chamfer |
| A3 | ..... | 43,1/43,3 mm (1.67/1.70 in) |
| A4 | ..... | 40,620/40,645 mm (1.5992/1.6002 in) |
| A5 | ..... | 10,06/10,19 mm (0.396/0.401 in) |

Inlet valve

| | | |
|----|-------|-----------------------------------|
| A1 | ..... | Radius 0,42 mm (0.017 in) maximum |
| A2 | ..... | 45° chamfer |
| A3 | ..... | 44,3/44,5 mm (1.74/1.75 in) |
| A4 | ..... | 41,907/41,932mm (1.6499/1.6509) |
| A5 | ..... | 9,94/10,06 mm (0.3913/0.3961) |



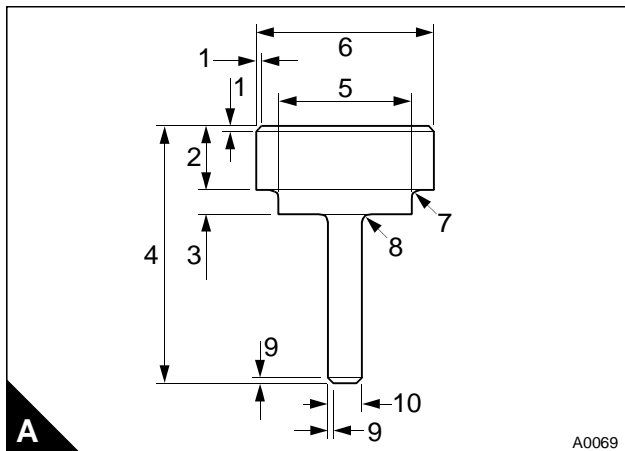
Valve seat insert tool

Inlet

| | | |
|-----|-------|---------------------------------|
| A1 | ..... | 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 | ..... | 36,10/36,15 mm (1.421/1.423 in) |
| A6 | ..... | 43,30/43,40 mm (1.705/1.709 in) |
| A7 | ..... | 0,79 mm (0.031 in) |
| A8 | ..... | 1,59 mm (0.063 in) |
| A9 | ..... | 1,59 mm (0.063 in) |
| A10 | ..... | 6,98/7,00 mm (0.275/0.276 in) |

Exhaust

| | | |
|-----|-------|---------------------------------|
| A1 | ..... | 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 | ..... | 32,30/32,40 mm (1.272/1.276 in) |
| A6 | ..... | 39,62/39,72 mm (1.560/1.564 in) |
| A7 | ..... | 0,79 mm (0.031 in) |
| A8 | ..... | 1,59 mm (0.063 in) |
| A9 | ..... | 1,59 mm (0.063 in) |
| A10 | ..... | 6,98/7,00 mm (0.275/0.276 in) |



Piston and connecting rod assembly

Pistons and connecting rods

| | |
|---|--------------------------------------|
| Type | Re-entrant bowl, off set gudgeon pin |
| Height grades | X and Y |
| Height of piston above top face of cylinder block | 0,23/0,35 mm (0.009/0.014 in) |
| Diameter of bore for gudgeon pin | 31,753/31,759 mm (1.2501/1.2504 in) |
| Width of groove for top ring (CP) | 2,560/2,580 mm (0.1008/0.1016 in) |
| Width of groove for top ring CR | 3,0mm (0.1181 in) |
| Width of groove for second ring | 2,020/2,040 mm (0.0800/0.0803 in) |
| Width of groove for third ring | 4,010/4,030 mm (0.1579/0.1587 in) |

Piston rings

| | |
|--|---|
| Top compression ring (CP) | Barrel face, molybdenum insert |
| Top compression ring (CR) | Wedge shaped, barrel face, molybdenum insert |
| Second compression ring | Taper face, cast iron, chamfer at inner bottom edge |
| Oil control ring | Coil spring loaded, chromium faced |
| Width of top ring (CP) | 2,475/2,490 mm (0.0974/0.0980 in) |
| Width of top ring (CR) | 3,0 mm (0.1181 in) |
| Width of second ring | 1,975/1,990 mm (0.0778/0.0783 in) |
| Width of third ring | 3,975/3,990 mm (0.1565/0.1571 in) |
| Clearance of top ring in groove | 0,07/0,11 mm (0.003/0.004 in) |
| Clearance of second ring in groove | 0,03/0,07 mm (0.001/0.003 in) |
| Clearance of third ring in groove | 0,02/0,06 mm (0.001/0.002 in) |
| Maximum permissible clearance in top groove | 0,20 mm (0.008 in) |
| Maximum permissible clearance in other grooves | 0,10 mm (0.004 in) |
| Gap of top ring (CP) | 0,25/0,48 mm (0.010/0.019 in) |
| Gap of top ring (CR) | 0,25/0,51 mm (0.010/0.020 in) |
| Gap of second ring | 0,40/0,73 mm (0.016/0.029 in) |
| Gap of third ring | 0,30/0,68 mm (0.012/0.027 in) |

Connecting rods

| | |
|---------------------------------------|---------------------------------------|
| Type | "H" section |
| Diameter of parent bore for big end | 60,833/60,846 mm (2.3950/2.3955 in) |
| Diameter of parent bore for small end | 34,920/34,956 mm (1.3745/1.3762 in) |
| Big end width | 39,375/39,434 mm (1.5502/1.5525 in) |
| Big end side clearance on crank pin | 0,24/0,50 mm (0.009/0.020 in) |
| Length between centres | 223,812/223,863 mm (8.8115/8.8135 in) |

Continued

Gudgeon pins

Type. Fully floating
 Outside diameter. 31,745/31,750 mm (1.2498/1.2500 in)
 Clearance fit in piston boss. 0,003/0,014 mm (0.0001/0.0006 in)

Small end bushes

Type. Steel back, lead bronze face
 Outside diameter. 35,014/35,052 mm (1.3785/1.3800 in)
 Inside diameter (reamed) 31,763/31,788 mm (1.2505/1.2515 in)
 Clearance fit on gudgeon pin... 0,013/0,043 mm (0.0005/0.0017 in)

Connecting rod bearings

Type. Steel back, aluminium tin face
 Inside diameter 57,188/57,214 mm (2.2515/2.2525 in)
 Clearance on big end .. 0,058/0,104 mm (0.0023/0.0041 in)
 Thickness at centre of bearings... 1,816/1,823 mm (0.0715/0.0718 in)
 Available undersize bearings... - 0,25 mm (0.010 in); - 0,51 mm (0.020 in); - 0,76 mm (0.030 in)

Crankshaft assembly

Crankshaft

| | |
|--|--|
| Diameter of main journal | 69,812/69,832 mm (2.7485/2.7493 in) |
| Width of second and third main journals | 30,853/31,057 mm (1.2147/1.2227 in) |
| Width of fourth main journal | 46,805/46,881 mm (1.8427/1.8457 in) |
| Fillet radii of main journal | 2,39/2,77 mm (0.094/0.109 in) |
| Fillet radii of crank pins | 3,96/4,37 mm (0.156/1.172 in) |
| Diameter of crank pins | 51,110/57,130 mm (2.2484/2.2492 in) |
| Width of crank pins | 39,67/39,75 mm (1.562/1.565 in) |
| Crankshaft end-float (CP) | 0,05/0,36 mm (0.002/0.014 in) |
| Crankshaft end-float (CR) | 0,05/0,36 mm (0.002/0.014 in) |
| Maximum permissible end-float | 0,50 mm (0.020 in) |
| Maximum permissible wear on main journals and crank pins | 0,038 mm (0.0015 in) |
| Undersize journals and crank pins | - 0,25 mm (0.010 in); - 0,51 mm (0.020 in); - 0,76 mm (0.030 in) |

Crankshaft heat treatment

| | |
|--------------------|---------------------------------|
| No heat treatment | Part number 31312734 |
| Induction hardened | Part numbers 31312733, 31312737 |
| Tufftrided | Part numbers 31312738, 31312739 |

Main bearings

| | |
|-----------------------------------|--|
| Type | Steel back, aluminium tin face |
| Width of first bearing | 32,11/32,36 mm (1.264/1.274 in) |
| Width of second and third bearing | 23,55/23,80 mm (0.927/0.937 in) |
| Width of fourth bearing | 38,91/39,17 mm (1.532/1.542 in) |
| Thickness at centre of bearing | 2,096/2,102 mm (0.0825/0.0828 in) |
| Inside diameter | 69,875/69,914 mm (2.7510/2.7525 in) |
| Bearing clearance | 0,043/0,102 mm (0.0017/0.0040 in) |
| Available undersize bearings | - 0,25 mm (0.010 in); - 0,51 mm (0.020 in); - 0,76 mm (0.030 in) |

Crankshaft thrust washers

| | |
|------------|--------------------------------|
| Type | Steel back, aluminium tin face |
| Position | Each side of rear main bearing |
| Thickness: | |
| Standard | 3,07/3,12 mm (0.121/0.123 in) |
| Oversize | 3,26/3,31 mm (0.128/0.130 in) |

Crankshaft overhaul

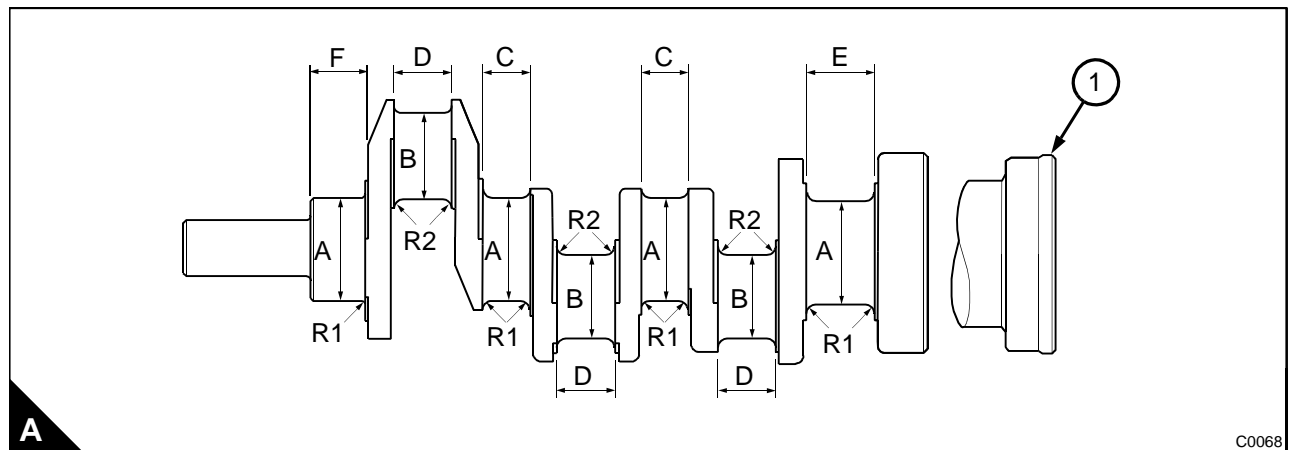
Notes:

- Induction hardened crankshafts need not be hardened after they have been machined undersize.
- Tufftrided crankshafts must be hardened again each time they are machined. If this process is not available, they can be nitrided for 20 hours. If neither process is available, a new crankshaft, or Power Exchange crankshaft, must be fitted.
- Check the crankshaft for cracks before and after it is ground.
- Demagnetise the crankshaft after it has been checked for cracks.
- After the crankshaft has been machined remove any sharp corners from the lubricating oil holes.
- Surface finish and fillet radii must be maintained.

The finished sizes for corrected crankshafts (A) are given in the table below:

| Item | 0,25 mm (0.010 in) Undersize | 0,51 mm (0.020 in) Undersize | 0,76 mm (0.030 in) Undersize |
|------|--------------------------------------|--------------------------------------|--------------------------------------|
| A | 69,56/69,58 mm (2.7385/2.7393 in) | 69,30/69,32 mm (2.7285/2.7293 in) | 69,05/69,07 mm (2.7185/2.7193 in) |
| B | 56,86/56,88 mm (2.2384/2.2392 in) | 56,60/56,62 mm (2.2284/2.2292 in) | 56,35/56,37 mm (2.2184/2.2192 in) |

- C .. 31,184 mm (1.22775 in) maximum
- D .. 40,00 mm (1.575 in) maximum
- E .. 47,27 mm (1.861 in) maximum
- F .. 35,64/36,643 mm (1.403/1.443 in)
- R1, all journals. .. 2,38/2,78 mm (0.0937/0.1093 in)
- R2, all crankpins .. 3,97/4,36 mm (0.1562/0.1718 in)
- Finished surface of journals and crankpins .. 0,40 microns (16 micro inches)
- Fillet radii, centre line average maximum .. 1.3 microns (50 micro inches)
- Crankshaft palm (A1) minimum diameter .. 133,17 mm (5.243 in)



Notes:

- The end of the crankshaft palm must not be ground. This will ensure that a spigot 4,8 mm (0.19 in) remains for location of the flywheel.
- Remove the minimum material to remove the wear marks.
- Magnetic crack detection DC Current- 2 amps, AC current - 1300 amps

Maximum taper and out of round for journals and crankpins

Taper.. 0,009 mm (0.00035 in)
 Out of round... 0,010 mm (0.00039 in)

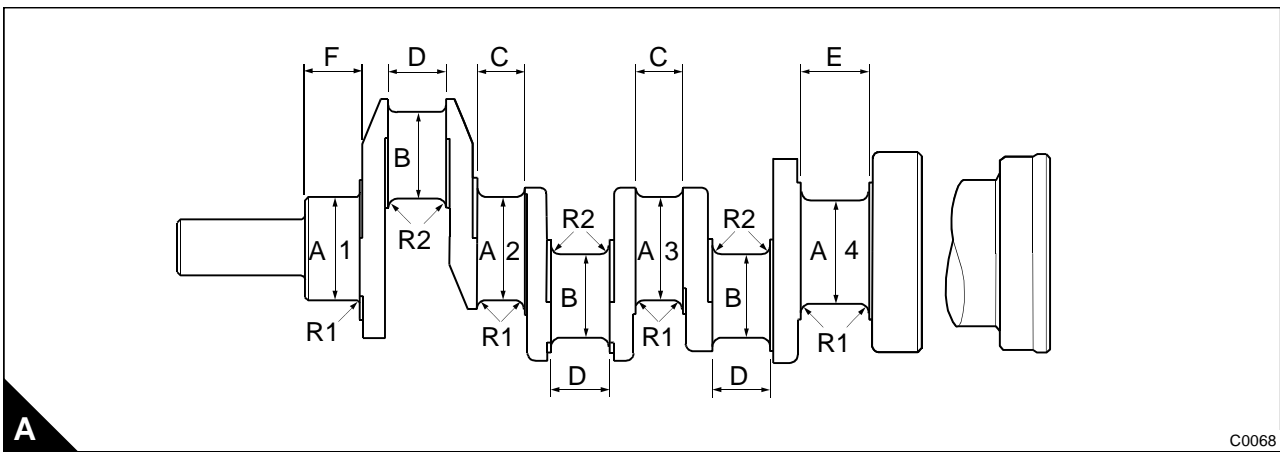
Maximum run-out with crankshaft mounted on end journals:

Crankshaft pulley diameter (total indicator reading) 0,025 mm (0.001 in)
 Rear oil seal diameter (total indicator reading) 0,025 mm (0.001 in)
 Flywheel flange diameter (total indicator reading) 0,025 mm (0.001 in)

Run-out

With the crankshaft on mountings at the front and rear journals, the maximum run-out (total indicator reading) at the journals must not be more than shown below:

A1... Mounting
 A2... 0,5 mm (0.002 in)
 A3... 0,5 mm (0.002 in)
 A4... Mounting



A

C0068

Timing case and drive assembly

Camshaft

Diameter of camshaft journals 47,450/47,475 mm (1.8681/1.8691 in)
 Clearance of journals in cylinder block 0,125/0,200 mm (0.0050/0.0080 in)

Cam lift:

- Inlet 7,63/7,73 mm (0.300/0.304 in)
 - Exhaust 7,90/8,00 mm (311/315 in)
 Spigot diameter for gear 50,76/50,79 mm (1.9985/1.9995 in)
 Maximum permissible camshaft journal wear 0,05 mm (0.002 in)
 Maximum permissible end-float 1,25 mm (0.049 in)

Camshaft gear

Number of teeth 50
 Diameter of bore 50,787/50,825 mm (1.9995/2.001 in)
 Clearance fit of gear on spigot 0,000/0,063 mm (0.0000/0.0025 in)

Fuel pump gear

Number of teeth 50
 Bore diameter 44,45/44,48 mm (1.750/1.751 in)
 Spigot diameter of pump 44,40/44,42 mm (1.748/1.749 in)
 Clearance fit of gear on spigot 0,03/0,08 mm (0.0012/0.0030 in)

Crankshaft gear

Number of teeth 25
 Diameter of bore 38,087/38,125 mm (1.4995/1.5010 in)
 Diameter of crankshaft nose 38,100/38,113 mm (1.5000/1.5005 in)
 Transition fit of gear on crankshaft -0,026/+0,025 mm (-0.0010/+0.0010 in)

Idler gear and hub

Number of teeth 90
 Diameter of bore in gear 53,98/54,02 mm (2.1250/2.1266 in)
 Diameter of hub 53,92/53,94 mm (2.1230/2.1238 in)
 Clearance of gear on hub 0,030/0,092 mm (0.0012/0.0036 in)
 Width of gear 33,465/33,592 mm (1.3175/1.3225 in)
 Width of hub 33,719/33,846 mm (1.3275/1.3325 in)
 End-float of gear 0,13/0,38 mm (0.005/0.015 in)
 Maximum permissible end-float 0,46 mm (0.018 in)
 Backlash for all gears 0,08 mm (0.003 in) minimum

Cylinder block assembly

Cylinder block

| | |
|---|--------------------------------------|
| Height between top and bottom faces | 349,01/349,09 mm (13.740/13.744 in) |
| Diameter of cylinder bore... .. | 97,012/97,037 mm (3.8193/3.8203 in) |
| Maximum permissible wear in bore | ..0,18 mm (0.007 in) |
| Diameter of parent bore for main bearing | 74,079/74,105 mm (2.9165/ 2.9175 in) |
| Diameter of bores for camshaft.. .. | 47,600/47,651 mm (1.8740/1.8760 in) |
| Diameter of bore for front journal bush | 50,80/50,83 mm (2.00/2.0012 in) |
| Maximum permissible wear in bore for camshaft... .. | ..0,05 mm (0.002 in) |

To fit a liner

| | |
|--|---|
| Diameter of parent bore for cylinder liner... .. | 97,108/97,133 mm (3.823/3.824 in) |
| Parent bore finish grade. | 1,8 micrometers maximum Ra |
| Parent bore chamfer | 0,10/0,25mm (0.004/0.010 in) at 30° to the vertical |

Cylinder liner specifications

Partially finished liner

| | |
|---|--|
| Interference fit of partially finished liner in parent bore | ..0,026/0,076mm (0.001/0.003 in) |
| Inside diameter of partially finished liner | ..94,894/94.925 mm (3.736/3.7372 in) |
| Outside diameter | 97,159/97,184 mm (3.825/3.826 in) |
| Inside diameter (finished size) | 95,012/95,037 mm (3.7406/3.7416 in) |
| Finished liner internal top chamfer. | 1,2 mm (0.00472 in) at 16° to the vertical |
| Length | 215,77/216,03 mm (8.494/8.505) |
| Relative position of top of liner to top face of cylinder block | - 0,075 / +0,050 mm (0.003/0.020 in) |

Surface finish of the preliminary bore

| | |
|---|--------------------------------------|
| Final size of liner before it is honed | ..94,894/94,925 mm (3.736/3.7372 in) |
| Grade of bore finish | 2,5 to 4,0 micrometers Ra |
| Maximum ovality and taper | 0,02 mm (0.0008 in) |

Surface finish diamond hone

| | |
|-----------------------------------|-------------------------------------|
| Hone angle (cross hatch)... .. | 35° |
| Finish size, diamond honed | 94,987/94,997 mm (3.7396/3.7400 in) |
| Grade of surface finish... .. | 2,2 to 3,0 micrometers Ra |
| Maximum ovality and taper | ..0,012 mm (0.0005 in) |

Surface finish of the Silicone carbide base hone

| | |
|---|-------------------------------------|
| Hone angle (cross hatch)... .. | 35° |
| Finish size, silicon carbide base hone | 95,012/95,032 mm (3.7406/3.7414 in) |
| Grade of bore finish | 1,5 to 2,0 micrometers Ra |
| Maximum ovality and taper | ..0,010 mm (0.0004 in) |

Silicone carbide plateau hone finish

| | |
|--|---|
| Final finish size, silicon carbide (plateau hone) | 95,012/95,037 mm (3.7406/3.7416 in) |
| Final finish grade, silicon carbide (plateau hone)... .. | 0,65/1,3 micrometers Ra |
| Chamfer | 1,2 mm (0.0472 in) at 16° to the vertical |
| Maximum permissible wear in bore | ..0,18 mm (0.007 in) |

Timing data

Delphi fuel injection pump, locked

Make Delphi DP200 Series
 Direction of rotation Clockwise from drive end
 Fuel pump code letters⁽¹⁾ AN, BN
 Fuel pump lock angle AN-88°, BN-88°
 No. 1 outlet Letter "U"

(1) Fuel pump lock angle - static timing

An example of the pump code is 2644A000AN/2/2270. The fuel pump code begins with the pump part number, followed by two letters, then a number for the governor spring position and lastly the maximum no-load speed. For identification purposes, only the two code letters are used. This information can be found on the data plate of the fuel pump.

The mark on the flange of the pump can be checked with timing tool, Part number 21825610. The lock angle is set with timing tool, Part number 21825610.

Delphi fuel injection pump, pin-timed

Make Delphi DP200 Series, pin-timed, with a locking screw
 Fuel pump code letters CN, DN, EN, FN
 Direction of rotation Clockwise from drive end

The fuel injection pump is timed to the engine with the engine set at TDC No.1 cylinder on the compression stroke.

Stanadyne fuel injection pump, pin-timed

Type. Stanadyne DB4, pin-timed, with a locking screw
 Fuel pump code letters GN
 Direction of rotation from drive end Clockwise from drive end

Lubrication system

Lubricating oil pump

| | |
|---------------------------------------|-----------------------------------|
| Type | Differential rotor, gear driven |
| Number of lobes | Inner rotor 3, outer rotor 4 |
| Clearance of outer rotor to pump body | 0,23/0,33 mm (0.009/0.013 in) |
| Inner rotor to outer rotor | 0,064/0,114 mm (0.0025/0.0045 in) |
| Inner rotor end clearance | 0,038/0,089 mm (0.0015/0.0035 in) |
| Outer rotor end clearance | 0,025/0,076 mm (0.0010/0.0030 in) |

Lubricating oil pump drive gear

| | |
|-----------------------------------|--|
| Number of teeth | 19 |
| Diameter of bore | 12,624/12,644 mm (0.4970/0.4978 in) |
| Diameter of drive shaft for pump | 12,675/12,687 mm (0.4990/0.4995 in) |
| Interference fit of gear on shaft | -0,031/ -0,063 mm (-0.0012/-0.0025 in) |

Idler gear for lubricating oil pump

| | |
|----------------------------------|---------------------------------------|
| Number of teeth | 21 |
| Diameter of bore for bush | 19,050/19,075 mm (0.7500/0.7510 in) |
| Outside diameter of bush | 19,101/19,139 mm (0.7520/0.7535 in) |
| Interference fit of bush in gear | -0,026/-0,089 mm (-0.0010/-0.0035 in) |
| Inside diameter of bush - fitted | 16,667/16,693 mm (0.6562/0.6572 in) |
| Shaft diameter for gear | 16,632/16,645 mm (0.6548/0.6553 in) |
| Clearance of gear on shaft | 0,022/0,061 mm (0.0009/0.0024 in) |
| End-float of gear | 0,20/0,58 mm (0.008/0.023 in) |

Lubricating oil relief valve

| | |
|----------------------------------|--|
| Diameter of bore in pump body | 14,237/14,288 mm (0.5605/0.5625 in) |
| Outside diameter of plunger | 14,186/14,211 mm (0.5585/0.5595 in) |
| Clearance fit of plunger in bore | 0,03/0,10 mm (0.001/0.004 in) |
| Length of spring (fitted) | 32,5 mm (1.28 in) |
| Load on spring (fitted) | 34,5/ 36,7 N (7.76/8.24 lbf) 3,5/3,7 kgf |
| Setting pressure | .345/448 kPa (50/ 65 lbf/in ²) 3,52/4,57 kgf cm ² |

Lubricating oil filter

| | |
|--------------------------------|---|
| Type | Full flow, screw-on type canister |
| Pressure to open by-pass valve | 55/ 120 kPa (8/17 lbf/in ²) 0,56/1,22 kgf/cm ² |

Fuel system

Delphi fuel injection pump, naturally aspirated engines

Make Delphi DP200 Series (locked)
 Direction of rotation Clockwise from drive end
 Fuel pump code letters ⁽¹⁾ AN, BN
 Fuel pump lock angle AN-89°, BN-88°
 No. 1 outlet Letter "U"

(1) Fuel pump lock angle - static timing

An example of the pump code is 2644A000AN/2/2270. The fuel pump code begins with the pump part number, followed by two letters, then a number for the governor spring position and lastly the maximum no-load speed. For identification purposes, only the two code letters are used. This information can be found on the data plate of the fuel pump.

The mark on the flange of the pump can be checked with timing tool, Part number 21825610. The lock angle is set with timing tool Part number 21825610.

The fuel injection pump is timed to the engine with the engine set at TDC No.1 cylinder on the compression stroke.

Delphi fuel injection pump, turbocharged and naturally aspirated engines

Make Delphi DP200 Series, (pin-timed)
 Direction of rotation Clockwise from drive end
 Fuel pump code letters ⁽¹⁾ CN, DN, EN and FN
 Fuel pump lock angle AN-89°, BN-88°
 No. 1 outlet Letter "U"

(1) Fuel pump lock angle - static timing

The fuel injection pump is timed to the engine with the engine set at TDC No.1 cylinder on the compression stroke.

Stanadyne fuel injection pump, naturally aspirated engines

Make Stanadyne DB4 (pin-timed)
 Direction of rotation Clockwise from drive end
 Fuel pump code letters GN

Fuel filter

Type. Single element canister type or Stanadyne quick release



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