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(PE (S) L)
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Perkins Engines

A Business of Varity Corporation VARITY

SUCCESSOR TO THE DIESEL ENGINE ® DIVISION OF ROLLS-ROYCE MOTORS

ROLLS ROYCE Diesels

FUEL, COOLANT AND LUBRICATING OIL RECOMMENDATIONS FOR EAGLE, 2000 SERIES, 'C', 'CV', 'SF65C' AND 'D' RANGE DIESEL ENGINES

1. DIESEL FUEL

A distillate fuel with at least 85% recovery by 350 deg. C. (IP 123) having a maximum sulphur content of 1% by weight (Industrial engines) or 0.5% (Automotive engines) with a Cetane Number not less than 45.

The following specifications meet these requirements:

(i) British Standards Institution B.S. 2869 : 1983 Class A1 – (0.3% Sulphur – 50 min. Cetane) or
B.S. 2869 : 1983 Class A2 – (0.5% Sulphur – 45 min. Cetane).

(ii) ASTM Diesel Fuel Classification: D.975 No. 1-D or
ASTM Diesel Fuel Classification: D.975 No. 2-D.

The use of fuels not meeting the above requirements may result in damage and/or reduced engine life and may affect the Warranty. If in doubt please consult Perkins Engines (Shrewsbury) Limited.

2. COOLANT

(i) The coolant approved for use in all diesel engines manufactured by PE(S)L is a mixture of 50% inhibited ethylene glycol **or** 50% inhibited propylene glycol and 50% clean fresh 'soft' water.

Mixtures containing methanol are **not** approved.

Anti-freeze mixtures supplied by most major Chemical and Oil companies are suitable, but the Operator is responsible for obtaining the Manufacturer's assurance that the ethylene glycol or propylene glycol products they supply have an inhibitor performance level suitable for a multi-metal cooling system.

(ii) If anti-freeze is not available, and there is no likelihood of ambient temperatures below 10 deg. C., then clean fresh 'soft' water may be used, treated with 1% by volume of PE(S)L inhibitor, in the cooling system. This proportion is the equivalent of 0.5 litre of inhibitor to 50 litres or 11 Imperial gallons of water. The inhibitor is available in bottles under PE(S)L Part Nos. OE. 45141 (0.5 litre) and OE. 45142 (1.0 litre).

Caution: The use of any other product may cause serious problems in the cooling system, and the use of insufficiently inhibited coolant mixtures may lead to erosion and/or corrosion of **aluminium** or cast iron components in the system.

(iii) If the acceptability of the available water supply is in doubt, refer to the appropriate Service Instruction, obtainable free of charge from PE(S)L Dealers and Distributors.

Engine range	Service Instruction
Eagle	E.S.I. 70
'CV'	CV.I. 14
'C' and 'SF65C'	S.I. 128
'D'	D.S.I. 48

3. LUBRICATING OIL

(i) PE(S)L recommend the use of a multi-grade oil, with a viscosity rating of S.A.E. 15W/40, for all engines operating at ambient temperatures above -15 deg. C (5 deg. F). The oil selected must **adequately** meet the requirements for high quality monograde oils, as described in specification: MIL-L-2104C/2104D: API - CD/SF.

(ii) **Eagle engines only.**
Further information on oils selection is contained in Publications TSD.3034/ESI.68 obtainable free of charge from PE(S)L and Distributors.

(iii) ***Industrial engines only.***
For continuous running engines, with infrequent starting, a monograde oil of S.A.E. 30 or S.A.E. 40 viscosity rating, may be used. Engines operating for long periods in ambient temperatures exceeding 32 deg. C. (90 deg. F.), should use a monograde oil of S.A.E. 40 viscosity rating. These oils should **adequately** meet the requirements of specification: MIL-L-2104C/2104D: API - CD/SF.

The following abbreviated list of oils are amongst those which comply with the Perkins recommendations. The onus is on the Operator to ensure that the oil used does meet the above requirements.

* *Industrial engines only (column 4).*

Manufacturer	Preferred Multi-grade oils	Acceptable Multi-grade oils	*Special Conditions see Para. 3 (iii) Mono-grade oils
Agip	Agip Sigma Turbo 15/40	Super Diesel Multi-grade 15W/40	Agip Sigma 30 and 40
BP	Vanellus C3 Extra 15W/40 Vanellus FE 15W/30	Vanellus C3 Multi-grade 15W/40	- -
Burmah Castrol	Deusol Turbomax 15W/40	Deusol RX Super 15W/40	Deusol RX Super 30 and 40
Caltex	RPM Delo 450 15W/40	RPM Delo 400 15W/40	RPM Delo 400 30 and 40
Daltons	Silkolene Turbolene 15W/40	Silkolene Ashford 15W/40	Silkolene Hardwick 30 and 40
Elf	Multi-performance 4D 15W/40	Multi-performance 3C 15W/40	Performance 3C 30 and 40
Esso	Diesel Motor Oil 500 15W/40	Essolube XD3 15W/40	Essolube XD3 30
Mobil	Delvac 1400 Super 15W/40	Delvac Super 15W/40	Delvac 1300 30 and 40
Morris's	Golden Film Ring-Free XHD 15W/40	Golden Film Ring-Free XS 15W/40	Golden Film Ring-Free XHD 30 and 40
Petrofina	Fina Kappa LDO 15W/40	Dilano HPD 15W/40	Dilano HPD 30 and 40
Shell	Myrina 20W/40	Rimula X 15W/40	Rimula 30 and 40 Rimula X 30 and 40

For information regarding engines operating in ambient temperatures below -15 deg. C., please contact the PE(S)L Service Department.

GUARANTEE

It is explicit in the PE(S)L Guarantee that an engine must be operated with approved fuel, lubricant and coolant, and maintained in accordance with the Schedule contained in the Servicing Manual.

Perkins

Engines

SERVICING MANUAL

CV12 INDUSTRIAL ENGINES

Publication T.S.D. 3138
(Third Issue)

August 1987
Printed in England

NOTES TO USERS

The purpose of this Manual is to provide Operators with all the information necessary for the correct usage and efficient maintenance of Perkins CV 12 industrial engines, between overhauls.

Service

Throughout the world, Dealers and Distributors, appointed by Perkins, can provide advice, spare parts and Factory trained staff, and the area based engineer and Service Department of Perkins Engines (Shrewsbury) limited are always available for consultation.

To assist Operators in reducing 'down time' to a minimum, Perkins Engines have instituted a Service Exchange Scheme so that Dealers and Distributors can speedily supply a 'short engine' or major component, fully reconditioned and guaranteed for six months. Units always available are listed overleaf. In certain circumstances, reconditioned complete engines can also be supplied.

Advice and assistance can be supplied more efficiently if enquiries are accompanied by the following information :

1 In all cases, the engine Number, Designation and Build Number, as stamped on the crankcase data plate, and the operating hours recorded on the control panel.

2 If a proprietary unit, e.g. injection pump, turbocharger, is involved, the details on its data plate and the number of hours run.

3 Any other information logically connected with the subject, e.g. type of fuel, lubricating oil or coolant used, details of service history, etc.

Instruction

A five day course on servicing and overhaul of CV 12 engines is available at the Factory. For details, apply to :

The Superintendent,
Customer Training Centre,
Perkins Engines (Shrewsbury) Limited,
Sentinel Works,
Shrewsbury SY1 4DP.
Shropshire,
England.
Telephone : 0743/- 52262

Technical and Parts Bulletins

Engine design is under constant review at Perkins, so that from time to time, it becomes necessary to revise manuals and associated publications to include the results of development work. Between revisions, all concerned are provided with full details of changes as they occur, the information being produced in leaflet form and sent in bulk to Dealers and Distributors for onward transmission as necessary.

1 Changes occuring in service techniques are issued as Service Instructions for inclusion in Servicing Manuals held by Distributors and Operators.

2 Engine design changes are published, usually as modifications, in Service Bulletins for the information of Dealers and Distributors.

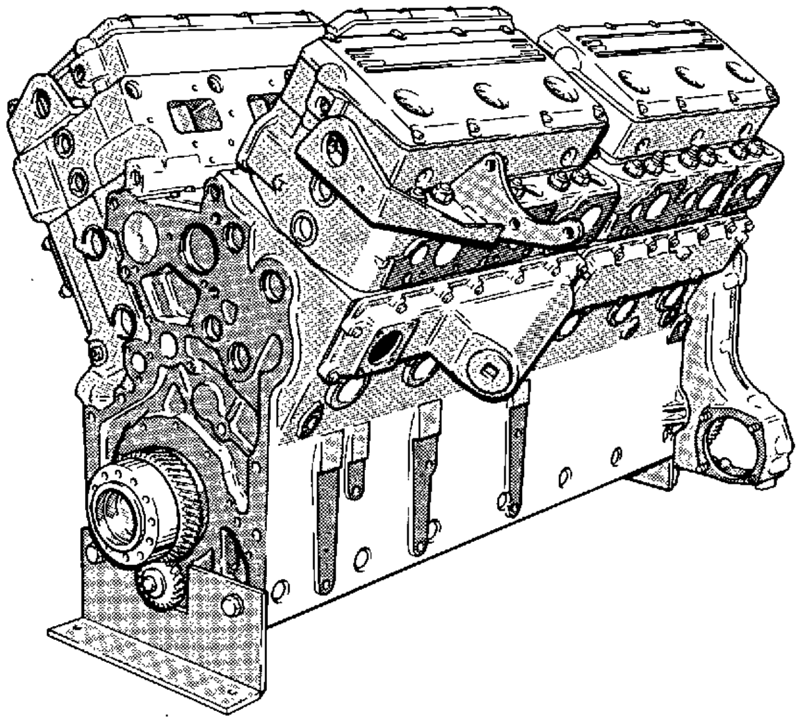
Associated publications for CV 12 range of engines

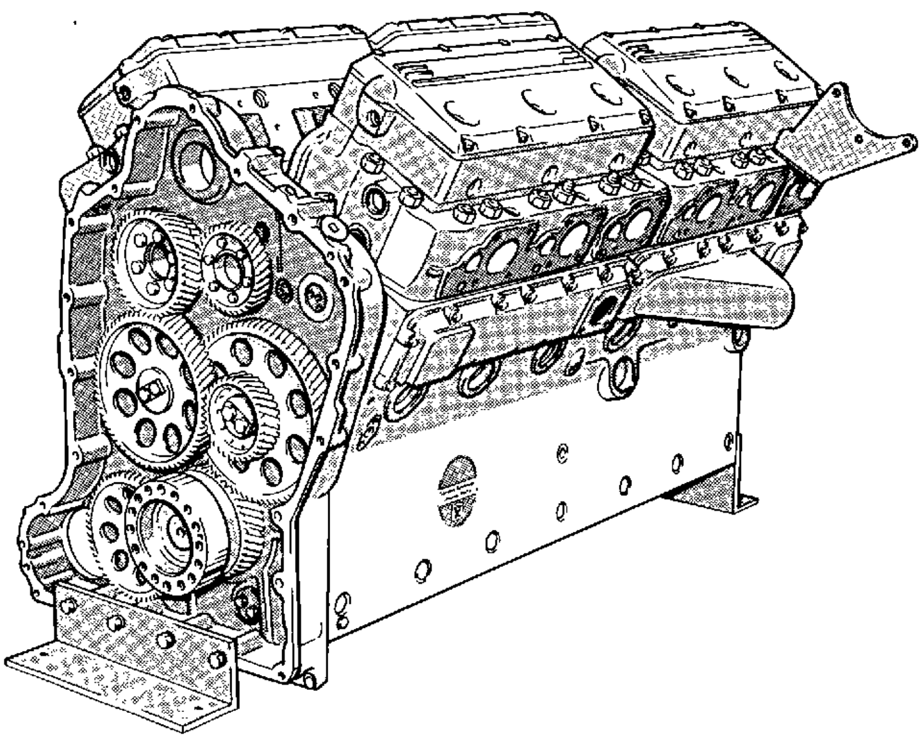
T.S.D. 3085 Fuel, oil and coolant recommendations (see rear cover pocket)
T.S.D. 3128 Service Instructions
T.S.D. 3129 Service Bulletins
T.S.D. 3146 Operator's Guide
T.S.D. 3148 Essential Information for Operator's (supplied with engine)
T.S.D. 3153 Wall chart - Servicing Schedules
T.S.D. 3154 Wall chart - Torque loadings
T.S.D. 3156 Wall charts - Fuel, oil and coolant flow diagrams
T.S.D. 3169 Workshop Manual

SERVICE EXCHANGE UNITS

The following units are available.
For further details, apply to Perkins Dealers and Distributors.

Alternators	Fuel injection pumps
Coolant pumps	Oil pumps
Crankshafts	Short engines
Cylinder heads	Starters
Fuel injectors	Turbochargers

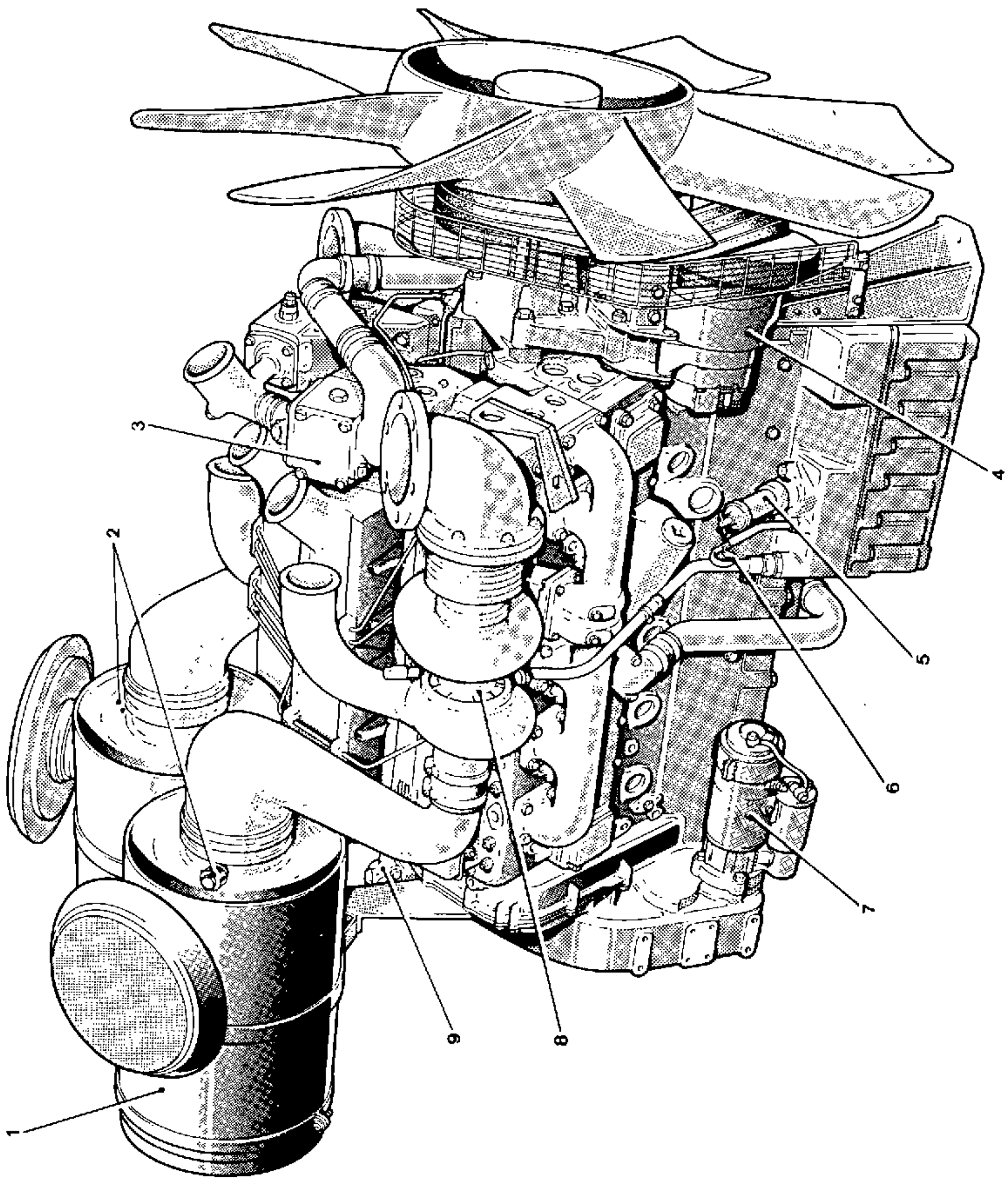




CV 12 - 'SERVEX' short engine

Fig. 1 Frontispiece - 'A' bank

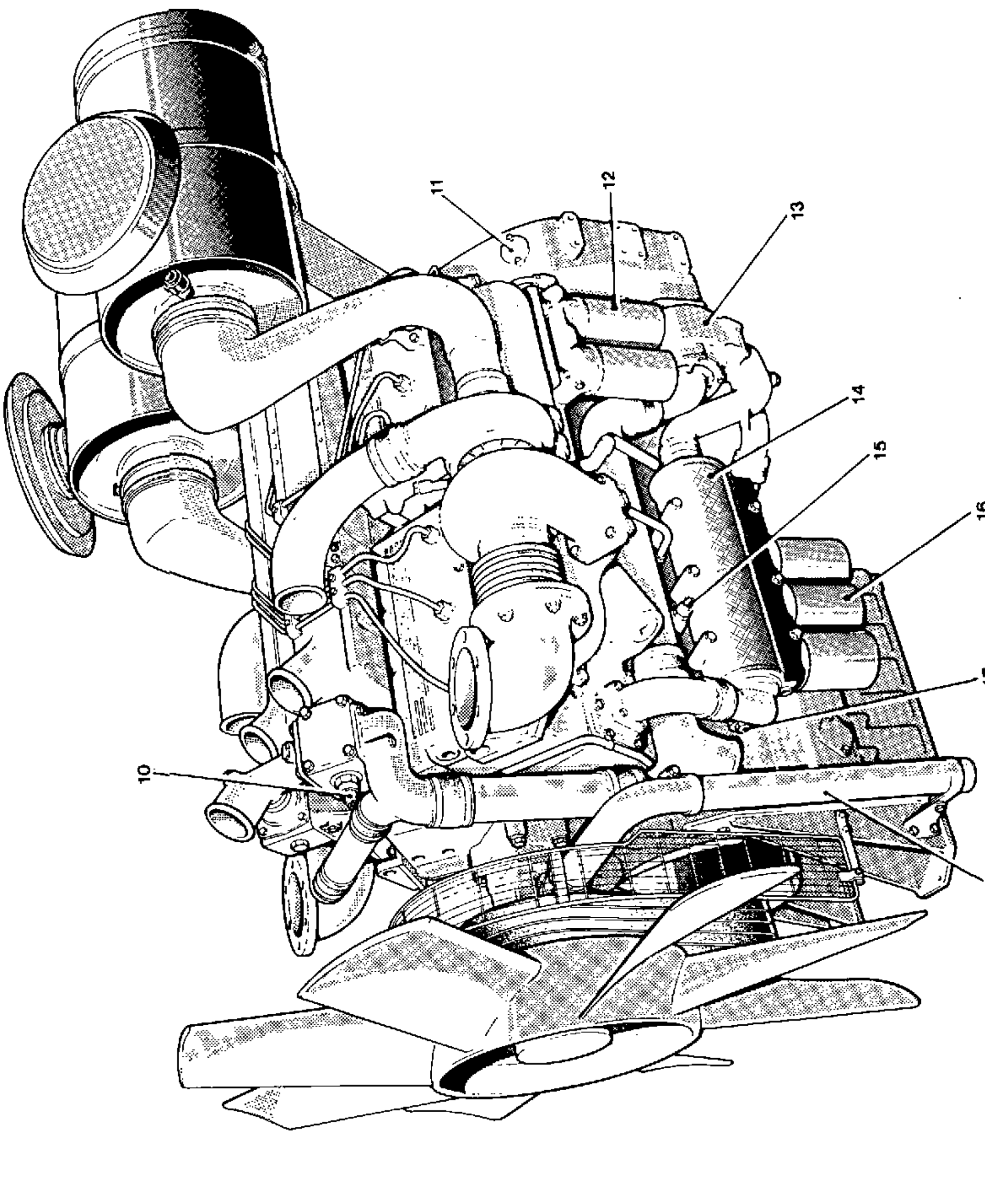
1 'A' bank air cleaner
2 Air restriction indicators
3 Thermostat housing
4 Alternator
5 Oil filler pipe
6 Dipstick
7 Starter motor
8 'A' bank turbocharger
9 Fuel feed pump



CV 12 Engine - View on 'A' bank side

Fig. 2 Frontispiece - 'B' bank

10 Coolant temperature switch
11 Flywheel timing cover
12 Fuel filter
13 Coolant pump
14 Oil-to-coolant heat exchanger
15 Oil pressure switch
16 Lubricating oil filters
17 Oil pressure relief valve
18 Crankcase breather pipe



CV 12 Engine - View on 'B' bank side

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CHAPTER 1 - DESCRIPTION AND DATA

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The Perkins CV 12 is a four stroke, turbocharged, direct injection, compression ignition, liquid cooled engine with air charge cooling. The 12 cylinders are arranged in two banks, in a 60 deg. 'V' configuration.

Engine identification

The engine number, designation and build line number are stamped on the Data Plate, attached to the crankcase.

Major assemblies such as the fuel injection pump, turbochargers and starter motor also carry their own identification plates.

These details should be quoted in full when ordering spare parts or raising a query.

Bank and cylinder bore identification

Viewed from the front (free end) of the engine, 'A' bank is to the left, 'B' bank is to the right.

The cylinders are numbered from front to rear, A1 to A6 and B1 to B6.

Crankcase

The crankcase is a monobloc casting in close grained, high duty iron dipped in a special sealing compound to seal all non-machined surfaces against contamination.

Each bearing assembly is held in place by a forged steel bearing cap; the centre and each end cap are attached with four bolt fixings, the remainder with two bolts per cap. Lateral security is by setbolts fitted through the crankcase side walls into location pads on each side of the bearing caps.

Two banks each of six cylinders are formed in a 60 deg. included angle 'V' formation. The cylinder bores are in a conventional staggered pattern with 'B' bank leading. The bores are machined to accept full length slip fit dry liners.

Studs are fitted into the crankcase with thread locking compound to locate and secure the four monobloc cylinder heads, with smaller diameter setbolts centrally disposed between each pair of tappet bores.

Cylinder liners

The full length, slip fit, pre-finished liners are made from centrifugally cast iron and machined to close tolerances.

Crankshaft

The crankshaft is made from a chrome molybdenum steel forging, nitride hardened, with the exception of the front and rear end faces, the dowel hole and the tapped holes.

The bearing surfaces consist of seven main journals and six crankpins, each crankpin serving two connecting rods.

Oil transfer is by centrally machined holes through the diameter of each main journal, with holes drilled through each crankshaft web to connect with the journal oilways. These holes open into conventional sludge traps, with oil flow to the crankpin bearings through two holes drilled from the crankpin periphery into each sludge trap.

Small holes are sealed, where necessary, with cup plugs. The larger sludge trap openings are blanked off with an aluminium disc and 'O' ring seal, secured with a spring clip.

Crankpins are disposed for each pair of cylinders in the following order : 1 and 6, 2 and 5, 3 and 4 with each pair 120 deg. out of phase with the others, giving a firing sequence of A1, B6, A4, B3, A2, B5, A6, B1, A3, B4 A5 and B2.

Around the flywheel end of the crankshaft a 45 toothed helical gear is machined, serving as the primary drive to the main gear train. The end face has 16 equally spaced, tapped holes and one dowel hole, with which to locate and secure the flywheel and starter ring assembly, using a dowel and socket head capscrews respectively.

Around the front end of the crankshaft, a helical gear is machined to drive the lubricating oil pump via an idler gear. The front end face is drilled and tapped to accomodate 12 equally spaced setbolts, which secure the viscous damper and drive belt pulleys to the shaft.

The crankshaft is balanced statically and dynamically at the machining stage, and requires no further compensation when assembled.

Main bearings

The main bearings consist of steel backed half bearing shells with a lead bronze lining, and a precision plated lead indium surface

The upper half of each bearing shell has an oil groove machined centrally around the inner surface. An oil transfer hole, drilled into the centre of the groove, aligns with an oil feed drilling in the crankcase.

The lower half bearing shells have shortened machined grooves to allow a smooth transfer of oil to the lower bearing surfaces.

Locating tangs, pressed out from the edge of each half shell, align with corresponding grooves machined in the crankcase and bearing caps.

Thrust washers

The thrust washers,which are steel backed with lead bronze faces, locate on on each side of the centre main journal, in recesses machined in the bearing cap and crankcase housing. The lower half of each thrust washer has an integral locating tang at one end.

Lubrication is from the centre main bearing, with grooves machined across the face of each washer to assist in oil flow.

Connecting rods

The connecting rods, manufactured from chrome molybdenum steel forgings, are machined to accept steel backed, lead bronze, small-end bearings. The bearings, constructed as rolled bushes with clinch butt joints, are pressed into the small-end eye with the joint located at 45 deg. in the upper portion of the bore. This, in turn, positions the bearing oil holes in a 120 deg. arc, adjacent to the connecting rod column.

The small-end of each rod is of wedge design to assist pressure loading of the small-end and piston. An oil hole, bored centrally through the column, allows pressurised oil to be fed intermittently from the crankpin, to provide small-end and gudgeon pin lubrication.

Four special bolts, with bi-hexagon nuts, are used to secure each big-end bearing cap to its associated rod. Markings on each connecting rod assembly give rod to cap correlation, weight and, when allocated, the cylinder bore number.

The big-end bearing shells are similar to the main bearings, but do not have machined grooves in the bearing surfaces.

When assembling, it is important to note that the large internal chamfer on one face of each big-end, is to the outside of each pair.

Pistons

The pistons are cast from high silicon aluminium alloy, with the crowns machined to form open toroidal combustion chambers. Each piston carries three compression rings and one oil control ring in machined grooves. To reduce wear, the top ring is carried in an austenitic iron insert. The ring sequence is as follows :

Top - Inlaid molybdenum surface

Second - Chrome plated

Third - Ferrox treated surface

Bottom - Composite chrome plated oil control ring

Each piston is tin-plated on all surfaces, after machining, except for the gudgeon pin bore.

The gudgeon pin is fully floating, and is secured by the conventional circlip method.

Camshafts

The camshafts are manufactured in an alloy cast iron, with chill hardened cam noses. The cam lobes are of the high lift, short duration type, with precision machined tapers across the contact faces.

The two shafts are unidentical, which is necessary to accomodate the off-setting of the cylinder bores.

The 'A' bank camshaft can be identified by the shorter bearing surface at the drive gear end. The flanged end accomodates the phasing gear, which is secured by six setbolts.

The 'B' bank camshaft flange end accomodates the phasing gear and drive gear, mounted in tandem, and secured by six setbolts.

Each shaft operates six pairs of exhaust and inlet valves, through conventional push rod and rocker assemblies.

The camshafts are high mounted inside the crankcase 'V', and positioned axially by thrust plates.

The camshaft bearings, which are pre-finished, steel backed, lead bronze rolled bushes with clinch butt joints, are disposed singly in the 'A' bank camshaft housings, with the exception of the central position, where two bushes are fitted. In the 'B' bank housings, two bushes are fitted in the central and rear locations. The bushes are drilled and grooved for lubrication and, to complete the assembly, the front end crankcase bores are sealed with cup plugs or, in the case of the 'A' bank, with a bobbin assembly, if necessary.

Push rods and tappets

The push rods are manufactured from medium steel bar, with forged spherical seating ends. Each end is induction hardened, with the convex foot end machine polished. The mating ends of the push rods and the rocker arm adjusting screws are radiused to allow maximum surface contact during angular operation.

The tappets are made from an alloy cast iron with chill-hardened bases. Each is fully machined with a spherical face, and subjected to a surface treatment to give an oil retaining finish. The tappets run in the parent crankcase metal, and are lubricated by pressure feed from the auxiliary oil galleries. The cam action is transmitted to the rocker arms via the tappets and push rods.

Gear train

The wheelcase, mounted on the rear of the crankcase, incorporates a train of helical gears, with the crankshaft pinion driving the main idler gear. Gear drive is transmitted through the compounded idler to the cam phasing gears, auxiliary drive gear and the coolant pump.

The timing gears are positioned across centres, using a machined spot on the side of one tooth, locating between two machined spots on the engaged gear. All the gears are secured by hexagon headed setbolts.

The oil passes from the pump to the oil-to-coolant heat exchanger, mounted on the 'B' bank side of the crankcase. From the heat exchanger, the oil passes through three full flow canister type filters, which are screwed directly to the base of the heat exchanger housing, and into the main oil gallery. Drillings from the main gallery supply oil to the main bearings, idler gear axles and two auxiliary galleries, which in turn, supply oil to the camshaft bearings and valve gear.

Connecting rod big-end and small-end bearings are supplied with oil from the main bearings via drillings in the crankshaft, and holes bored longitudinally through the connecting rods.

Small pressure jets, bolted between the main bearings, supply cooling oil to the underside of the piston crowns.

External pipework delivers oil, from unions in the heat exchanger mounting adaptor, to the turbocharger bearings, injection pump and governor and returns drain oil to the crankcase and sump.

Oil-to-coolant heat exchanger

The heat exchanger, comprising a single tube pack in an alloy casing, is mounted on an adaptor assembly on the 'B' bank side of the crankcase. Coolant flows through the tubes whilst oil is directed over the outside of the tubes, by a series of baffles, to achieve maximum heat transference between the fluids.

Pressure relief valve

The oil pressure relief valve, integral with the heat exchanger mounting adaptor, is a conventional plunger and spring arrangement, and allows excess oil to return to the sump at pressures exceeding 4,2 kgf/sq.cm (60 lbf/sq.inch).

Oil filler and dipstick

The oil filler, consisting of a simple pipe with a sealing cap, is mounted over the 'A' bank side of the sump well.

The dipstick, held in a curved tube adjacent to the filler, consists of a flat, spring steel blade which is cranked to lie clear of the tube wall. Notches, machined in the blade edge, indicate maximum and minimum permissible lubricating oil levels.

Induction and exhaust system

Twin turbochargers, mounted alongside the two front end cylinder heads, draw the induction air through the two dry element type air cleaners and deliver it under pressure to engine. Charge coolers, integral with the radiator, cool the air before it is delivered to the induction manifolds.

The exhaust gases from each cylinder are directed, via a twin discharge on the front section of each exhaust manifold, to the turbine of each turbocharger. After passing through the turbines, the exhaust gases pass through flexible bellows units and elbow connections to which appropriate pipework and silencers may be fitted, dependent on installation requirements.

Electrical equipment

A Butec Type A 3024 alternator with integral regulator, or a Butec Type A 13 alternator with separate Type R1 regulator, provides a 24 volt, 30 amp charging circuit for the starter batteries.

Engine starting is by a Butec Type MS6 starter motor, with an external solenoid control switch.

Two Teddington warning/shutdown switches connected to a solenoid control, protect the engine against low oil pressure and/or high coolant temperatures.

Engine service counter (E.S.C.)

On early engines, an E.S.C., mounted adjacent to the fuel feed pump, is geared to record one unit for each hour running at the r.p.m. rating stamped on its data plate.

On later engines, the E.S.C. is omitted and engine operation is recorded in running hours, which may be read from a counter normally mounted in the main control panel.

For all practical purposes, Servicing Schedules given in total running hours may be safely read across to those engines fitted with an E.S.C.

ENGINE DATA

GENERAL

Engine type	Direct injection, liquid cooled, four stroke compression ignition, pressure charged with charge cooling.
Number of cylinders	12
Arrangement	60 deg. included angle 'V' configuration.
Total swept volume	26.11 litres (1593.24 cu. inches).
Bore	135 mm (5.315 inches).
Stroke	152 mm (5.984 inches).
Compression ratio	14 : 1
Firing order	A1, B6, A4, B3, A2, B5, A6, B1, A3, B4, A5 and B2.
Rotation	Anti-clockwise viewed on flywheel.
Rated output	350 to 550 kW
Maximum rated speed	1800 r.p.m.
Valve tappet clearances (Hot or cold)	
Inlet valves	0,2 mm (0.008 inch).
Exhaust valves	0,5 mm (0.020 inch).
Injection timing	As stamped on engine data plate.
Dry weight of bare engine (Approx. for handling)	2120 kg (4674 lbs).

COOLING SYSTEM

Type	Liquid cooled.
Pump	Centrifugal, gear driven unit.
Coolant capacities	
Engine and pipework	68 litres (15 Imp. gallons).
Engine/radiator pack	164 litres (36 Imp. gallons).
System pressure	Up to 69 kNf/sq. m (10 lbf/sq. inch).
Temperature (normal)	70 to 100 deg. C.
Thermostats	Two, Western Thomson wax capsule. Type 6-533.

Cooling fan	1400 mm (55 inch) diam. aluminium alloy, 8 blades, belt driven.
Approved coolant	See leaflet T.S.D. 3187 in rear cover pocket.

FUEL SYSTEM

Type	Pressurised supply to injection pump with through flow return to tank.
Injection pump	C.A.V. Maximec. 12 element in-line unit.
Governor	C.A.V. mechanical, Type CS, Servo assisted integral with injection pump.
Feed pump	Bosch FP/KD cam operated.
Fuel feed pressure	100 to 170 kNf/sq.m (15 to 25 lbf/sq.inch).
Fuel injectors	C.A.V. axial feed, low spring type. Six spray holes.
Injection pressure	240 bar (240 atmospheres).
Main fuel filters	Two, spin-on type expendable canisters.
Approved fuel	See leaflet T.S.D. 3187 in rear cover pocket.

LUBRICATION SYSTEM

Type	Wet sump.
Capacities	
Sump	45 litres (10 Imp. gallons).
System total	66 litres (14.5 Imp. gallons).
Pressure	
Normal load conditions	415 kNf/sq.m. (60 lbf/sq.inch).
Minimum at rated speed	*207 kNf/sq.m. (30 lbf/sq.inch).
Pump	Spur gear type, gear driven.
Pressure relief valve	Spring loaded plunger, non-adjustable.
Heat exchanger	Tube pack and shell, baffled and finned.
Filters	3, spin-on type expendable canisters.
Maximum recommended bulk oil temperature	120 deg. C.
Approved lubricating oil	See leaflet T.S.D. 3187 in rear cover pocket.

*Important for the protection of turbocharger bearings.

INDUCTION/EXHAUST SYSTEM

Aspiration	Pressure charged by two, Garret Airesearch TV 61 turbochargers.
Charge coolers	Two, air-to-air type, integral with radiator.
Air cleaners	Two Donaldson paper element, Type FHG or EGB.

ELECTRICAL EQUIPMENT

Alternator	Butec, Type A 3024, with integral regulator. or Butec, Type A 13, with Type R1 regulator.
Starter motor	Single, flange mounted Butec, Type MS6.
Stop control	Lucas C.A.V., solenoid operated. Type 368. or Synchro-Start solenoid, Type 2001.
Warning and shutdown switches	Teddington temperature switch. Type DCA/AB/096 96 deg.C. setting. Teddington pressure switch. Type DCA/BC/152 152 kNf/sq.m. (22 lbf/sq.inch) setting.

LUBRICANTS AND FLUIDS APPROVED FOR USE DURING SERVICING AND OVERHAUL

(Equivalents of alternative manufacture are acceptable)

	Manufacturer	Brand or specification
ALTERNATOR		
Diode cleaning fluid	Applied Chemicals Ltd.	Fluid grade 8-23
Diode grease	-	Silicon MS200, MS4, MS5.
COOLING SYSTEM		
Hose and 'O' ring lubricant	-	Castor oil
EXHAUST SYSTEM		
Screw thread anti--seize compound	Slip Group	Copaslip
INDUCTION SYSTEM		
Emulsifying solvent	Morris's Shrewsbury	Pavan

JOINTS

Jointing compound	Wellworthy Ltd.	Wellseal
	Marston and Bentley Lubricants Limited.	Hylomar PL 32
Sealant and thread locking where specified	Douglas Kane Sealants	Loctite AVV, 601, 542, 290, 270 and 241

STARTER MOTOR

Commutator cleaning fluid	I.C.I. Ltd.	Genklene N
Spline lubricant	Shell Oil Limited	Aeroshell DID 5598
'O' ring lubricant	-	Glycerine
Lubricator wick	Various	Mineral oil SAE 5W/20

GENERAL CLEANING AND INHIBITION

Detailed information concerning all the products listed below, will be found on the Manufacturer's data sheets.

ARDROX 667 : Ardrox Limited, Brentford, Middlesex.

MAXAN 774 : Henkel Chemicals Limited, Edgeware Road, London.

These products are methylene chloride based and are safe to use on most metals for the removal of carbon build up and for paint stripping. They are harmful to rubber and most plastic materials.

Method of use

The components to be cleaned must be immersed in the cleaning fluid long enough to produce the required standard of cleanliness. After cleaning, the components must be thoroughly rinsed in clean water. In use, maintain a water seal of at least 76 mm (3 inches) above the cleaning fluid to prevent evaporation and the escape of toxic fumes.

Goggles and protective clothing must be worn at all times when using these fluids, and the container must be in a well ventilated area.

Do NOT smoke in the vicinity of the cleaning tank.

DUROCLEAN 150 POWDER : Diversey Limited, Northampton.

This product is an alkali based degreasing compound and is safe to use on brass, copper and ferrous metals. It must not be used on aluminiun, lead, tin and zinc.

Method of use

The components to be degreased must be immersed in a solution of the compound, heated to 65 deg. C., until all contamination has been removed. It is recommended that Duroclean 150 be used at the top concentration of 50 grammes per litre of water. Rinse off the concentrate with clean water; if desired, a suitable inhibitor may be added to the final rinse.

Goggles and protective clothing must be worn when using this product.

CRODAFLUID CR2 : Croda Chemicals Limited, Goole, Yorkshire.

This product is an inhibited, acid based solution for the derusting of ferrous components.

Method of use

Crodafluid CR2 must be held in a tank lined with, or made from, an acid resistant material. The components to be treated must be degreased before being immersed in the derusting solution. For medium to heavy deposits of rust, the solution may be heated to 70 deg. C. Inspect the components occasionally to check the derusting progress. Light rust may be removed in a few minutes. Finally, wash the components thoroughly in clean water.

Goggles and protective clothing must be worn at all times during the above process.

DIVERSPRAY 30 : Diversey limited, Northampton.

This product is a mild, alkali based cleaning compound containing rust inhibitors, and may be sprayed over the components to be cleaned, or held in a tank, for immersion of the components, with agitation. Diverspray 30 may be added to rinse water of components which require inhibiting after other treatments, e.g. derusting.

TORQUE LOADINGS

Note : The following torque loadings apply to threads in oil-wetted condition, unless the use of thread locking compound is specified.

It must not be assumed that application of the specified torque loading is, in itself, sufficient to ensure that the components concerned are adequately secured together. The recommended method of assembling and, where applicable, the tightening sequence must also be observed. This information is given in the relevant Section of this Manual.

Where a bolt or nut is secured with a lock washer, lockplate or split pin, the specified torque loading may be exceeded, if necessary, by the MINIMUM amount required to reach a locking position.

	Nm	lbf.ft.
ALTERNATOR		
Pulley nut	95	70
AUXILIARY DRIVE SHAFT		
Flange nut (18 mm 27 A/F)	200	148
(22 mm 32 A/F)	300	220
CAMSHAFTS		
Drive gear setbolts - 'A' bank	40	30
- 'B' bank	80	59
Thrust plate C/S head screws	70	52
CONNECTING RODS		
Big-end bearing nuts	60	44
CRANKCASE		
Main bearing cap setbolts		
Front, centre and rear	177	130
Intermediate	488	360
Lateral setbolts		
Front, centre and rear	114	84
Intermediate	177	130
Cylinder head studs	35	26
CRANKSHAFT		
Damper and pulley setbolts	71	52
Flywheel socket capscrews	315	232

	Nm	lbf.ft.
CYLINDER HEADS		
Securing setbolts	200	148
Securing nuts	200	148
	(plus further 90 deg.)	
Rocker box setbolts	41	30
Rocker box socket capscrews	35	26
Rocker cover setbolts	21	15
Bridge piece adjusting screw locknut	40	30
Tappet adjusting screw locknut	40	30
COOLANT PUMP		
Bearing locknut	100	74
Drive gear nut	88	65
EXHAUST MANIFOLDS		
Securing setbolts	47	35
FAN ADAPTOR		
Bearing securing nuts	280	207
FLYWHEEL HOUSING		
Securing setbolts	71	52
FUEL FEED PUMP (Mechanical)		
Cam securing nut	54	40
FUEL FILTER HEADER		
Bracket securing setbolts	54	40
FUEL INJECTION PUMP		
Adjustable coupling socket capscrews	69	51
Camshaft hub nut	149	110
Delivery valve holders	122	90
Pump mounting setbolts	41	30
Spring plate coupling nuts	120	88
FUEL INJECTORS		
Clamp socket capscrews	60	44
Nozzle cap nut	81	60
Spill connection	27	20

		Nm	lbf.ft.
GEAR TRAIN			
Auxiliary drive gear setbolts		58	43
Compounded idler setbolts		40	30
Compounded idler axle setbolts	(See Note 1)	71 or 135	52 or 100
Main idler axle setbolts	(See Note 1)	71 or 135	52 or 100
Coolant pump idler axle setbolt	(See Note 1)	71 or 135	52 or 100
Oil pump idler axle setbolt	(See Note 1)	71 or 135	52 or 100
LUBRICATING OIL PUMP			
Casing setbolts		21	15
Drive gear securing nut		120	88
SUMP			
Securing setbolts		55	41
Drain plug insert		305 to 340	225 to 250
Drain plug		110 to 115	81 to 85
TURBOCHARGERS			
'V' band clamps			
Multi-segment (See Note 2)		13,5	10
Single segment		18	13
Turbine housing		13,5	10
Captive 'T' bolt		17	12.5
Quick release		9	7

Note 1 : On early engines, the idler axle setbolts are to be tightened to the lower torque loading figure. The setbolts used on later engines are stamped with the Part Number, CV 12174, on the bolt head and must be tightened to the higher torque loading figure.

Note 2 : Tighten multi-segment to 13,5 Nm plus a further 120 deg.; slacken and retighten to 13,5 Nm.

CHAPTER 2 - OPERATING

CHAPTER 2 - OPERATING

ROUTINE PROCEDURE WITH A NEW OR OVERHAULED ENGINE

Note : Every new or reconditioned engine supplied by Perkins Engines (Shrewsbury) Limited is run in before leaving the Factory.

1 Check that all wrappings and sealing blanks have been removed.

2 Refit any components removed for storage or transportation.

3 Ensure that all coolant and lubricating oil drain plugs are securely fitted.

4 Dependent on installation, connect remote control linkage, pressure gauge pipework, air intake ducting and exhaust pipework.

5 Connect the fuel supply pipework and the electrical wiring.

6 Fill the fuel supply tank(s) with the correct grade of fuel. (See leaflet T.S.D. 3187).

7 Fill the cooling system with the approved coolant mixture. (See leaflet T.S.D. 3187).

8 Fill the sump to the UPPER mark on the dipstick, with the correct grade of lubricating oil. (See leaflet T.S.D. 3187).

9 Prime the turbochargers with clean engine lubricating oil, as described in Chapter 3, Section 6.

10 Bleed the fuel system, as described in Chapter 3, Section 4.

11 Lubricate all control linkage and check for freedom of movement throughout its full range.

12 With the stop control in the STOP position, motor the engine on the starter until oil pressure is registered on the gauge.

ROUTINE STARTING

Carry out the daily servicing checks, as described in the Servicing Schedule, Chapter 3, Section 1.

Normal start :

Fuel cock	-	ON.
Stop control	-	In RUN position.
Start button	-	Press and release when engine fires.

After starting, check that correct oil pressure is registered on the gauge and switch on the engine protection devices.

Initial start of a newly installed engine or, after a period of more than three months storage or lay-up :

Carry out the daily servicing checks
Prime the turbocharger bearings

Fuel cock	-	ON
Stop control	-	Secure in STOP position.
Start button	-	Press for 10 seconds.
		Release for 10 seconds.
		Press for 20 seconds.
		Release for 20 seconds.
Stop control	-	In RUN position.
Start button	-	Press and release when engine fires.

STARTING IN LOW AMBIENT TEMPERATURES

An excess fuel device (fig. 1), integral with the stop control lever shaft, facilitates starting in ambient temperatures below freezing.

Before attempting to start the engine, push the button of the excess fuel device control rod, fully inwards.

When the start button is pressed and the engine fires, the control rod of the excess fuel device will return automatically to its original position

Note : The excess fuel device must not be used in conjunction with any other cold starting aids, as the excess fuel will make starting more difficult.

RUNNING THE ENGINE

The following precautions will help to ensure a long and trouble-free engine life :

1 Do not subject the engine to 'full load' until working temperature is reached

2 Avoid long periods of 'off load' running.

3 Maintain full fuel tanks to avoid condensation.

STOPPING THE ENGINE

1 Run the engine for three minutes, off load, to allow the turbochargers to reduce speed and temperature.

2 Switch off the engine protection devices, if applicable, and move the stop control to the STOP position.

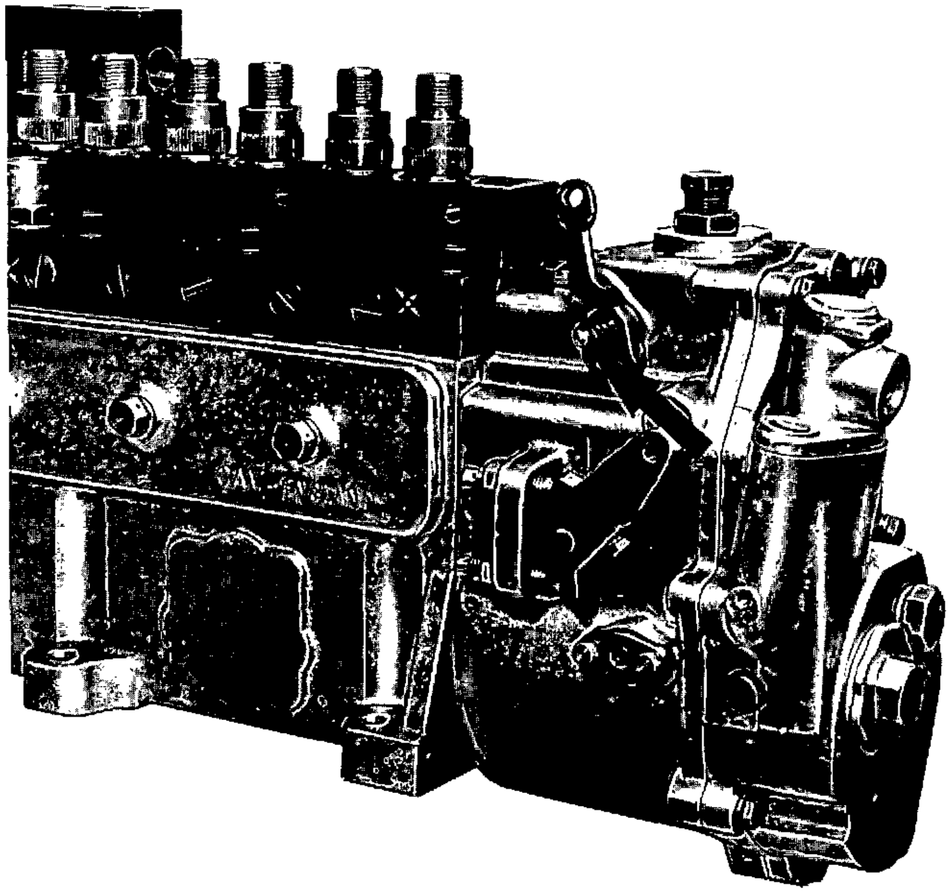


Fig. 1 Excess fuel device (arrowed)

CHAPTER 3 - SERVICING

CHAPTER 3 - SERVICING

CONTENTS

SECTION 1 - SERVICING SCHEDULES

IMPORTANT NOTES

1 If experience on a particular installation indicates the necessity for amendment of the Servicing Schedules, consult the Service Department of Perkins Engines (Shrewsbury) Limited.

2 Engines under Guarantee must be serviced in accordance with the Servicing Schedules, unless otherwise agreed by Perkins Engines (Shrewsbury) Limited.

3 To comply with the terms of the Perkins Guarantee, use only genuine Perkins parts, which are themselves guaranteed for six months. The use of counterfeit spares, notably filter elements, may not only invalidate any current Guarantee but could seriously reduce engine life and performance.

4 The servicing intervals quoted in the Schedules, may be reduced at the discretion of the Operator to suit local conditions but must NOT be exceeded.

5 In addition to the servicing operations in the following Schedules, make regular checks to ensure that the fuel, cooling, lubrication, induction and exhaust systems are free from leaks. This will be made easier if the engine and surrounding areas are maintained in a clean condition.

6 The following Schedules are based on total engine running hours. Previously, the periods were quoted in E.S.C. units, which were recorded by an Engine Service Counter, actuated by the auxiliary drive shaft. Any documents quoting these units may be safely read across to the later, running hour intervals.

ENGINES IN CONSTANT USE

DAILY, OR EVERY 10 HOURS RUNNING — SECTION

Cooling system — 3

Check that the coolant level is above the baffle in the radiator top tank. Replenish if necessary, with the same type of coolant mixture as that already in the system.

Warning : Take care when removing the filler cap on a hot engine, as the system will be pressurised.

DAILY, OR EVERY 10 HOURS RUNNING	SECTION

Lubrication system 5

Check the oil level on the dipstick. The level should be above the LOWER mark, with the engine running. With the engine stopped, the oil level should be at the UPPER mark on the dipstick. Replenish with oil of the same grade as that already in the system, if necessary. Do NOT overfill.

Induction system 6

Check the air restrication indicators. If the red warning sleeves are visible, service the air cleaners. Under favourable operating conditions, air cleaner servicing intervals may be extended to 100 running hours.

EVERY 100 HOURS RUNNING

Adjustments 2

Check the tension and condition of the alternator and fan driving belts; adjust or renew as necessary.

EVERY 400 HOURS RUNNING

Cooling system 3

Check the specific gravity and pH value of the coolant mixture.

Induction system 6

Check the turbochargers for security.

Lubrication system 4

Drain the system, whilst hot, and refill with fresh engine oil of the approved grade and specification.

Unscrew and discard the oil filter canisters. Fit new Perkins replacement canisters.

Fuel system 5

Dismantle and clean the primary fuel filter.

Discard and renew the main filter canisters.

Check the tightness of the injection pump drive coupling bolts. (See Chapter 1 - Data).

EVERY 1200 HOURS RUNNING — SECTION

Fuel system — 5

Check the injection pump timing.

Service or renew the injectors. (See 'Adjustments' - below).

Induction system — 6

Remove the induction trunking from each turbocharger and spin the rotor; check for rubbing and bearing wear.

Adjustments — 2

Check and adjust tappet clearances, whilst injectors are removed.

EVERY 2400 HOURS RUNNING

Electrical equipment — 7

Service the alternator.

EVERY 4800 HOURS RUNNING

Top overhaul — W.M.

Carry out a top overhaul. See the Workshop Manual, T.S.D. Publication 3169, for full details.

Fuel system — W.M.

Calibrate and service the fuel injection pump, or fit a replacement unit. See T.S.D. 3169 for full details.

EVERY 6 MONTHS

Electrical equipment — 7

Check the operation of the warning and shutdown switches.

EVERY 12 MONTHS

Cooling system — 3

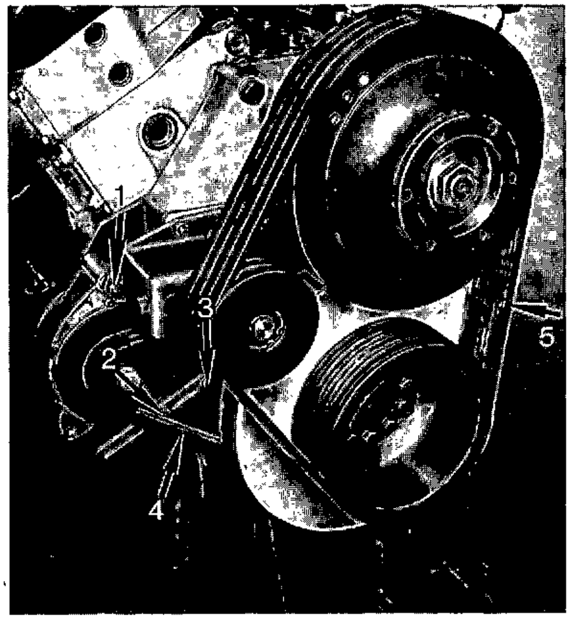
Drain the system immediately after shutdown. Flush through with clean fresh water and refill with a fresh coolant mixture.

ENGINES IN INTERMITTENT USE

For engines in this Category (e.g. those powering fire pumps and emergency generating sets, etc.), which are in use for a total of less than 500 hours running in 12 months, the Servicing Schedule should be supplemented by the following calender-based Schedule, to avoid deterioration due to prolonged intervals between servicings.

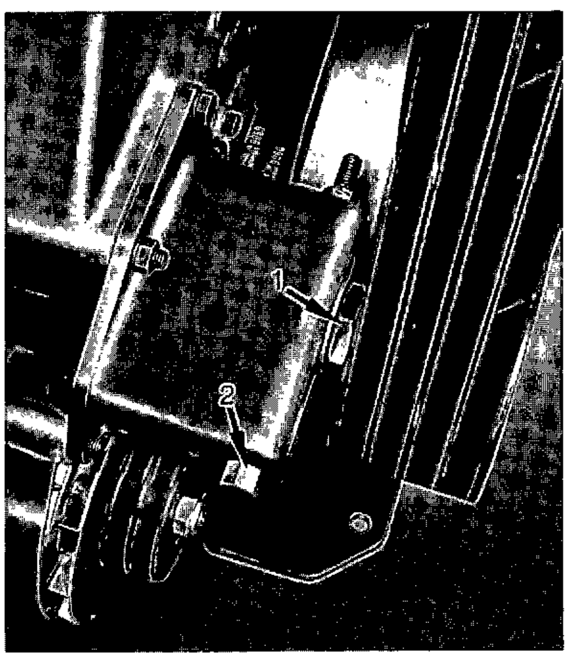
WEEKLY	SECTION
Lubrication system	4
Check the lubricating oil level and top up, if necessary, to the UPPER mark on the dipstick.	
Cooling system	3
Check the coolant level and replenish, as necessary, with the correct coolant mixture.	
MONTHLY	
Cooling system	3
Check the specific gravity and the pH value of the coolant mixture.	
Induction system	6
If the engine has not been running during the month, prime the turbochargers with clean engine oil.	
EVERY 6 MONTHS	
Lubrication system	4
Drain the engine lubricating oil and refill the system with the approved grade of new oil. Discard and renew the oil filter canisters.	
EVERY 12 MONTHS	
Fuel system	W.M.
Inspect the injectors for corrosion and check their operation on a test rig. Service or renew as necessary, refit, and vent the high pressure fuel system.	
Cooling system	3
Drain and flush the cooling system. Refill with a fresh coolant mixture.	

SECTION 2 - ADJUSTMENTS



1 Pivot bolt
2 Sliding link bolt
3 Fixed link bolt
4 Alternator belt deflection test point
5 Fan belt deflection test point

Fig. 1 Alternator belt adjustment



1 Locknut
2 Adjusting bolt

Fig. 2 Fan belt adjustment

SECTION 2 - ADJUSTMENTS

Warning : To avoid personal injury or accidental damage to components, it is strongly advised that the starting batteries be disconnected, prior to working on the engine.

DRIVING BELTS

The life and efficiency of driving belts depends, to a great extent, on correct alignment and tensioning. Where multi-belt drive is used, each belt must share equal loading. Should a driving belt fail, a new set of matched belts should be fitted. DO NOT mix new and used belts on the same multi-belt driving pulleys.

At the intervals specified in the Servicing Schedule (Section 1), remove the belt guards and check the tension and condition of all driving belts; adjust or renew as necessary.

1 To adjust alternator belts (fig. 1), slacken the link bolts and pivot bolt, move the alternator to the required position and re-tighten the three bolts when the correct belt tension is obtained. The correct tension for each alternator belt is such, that the deflection at mid-point of the belt run is 12,5 mm (0.5 inch) under firm thumb pressure.

To renew the alternator belt(s), the fan and fan belts must first be removed, as described below.

Fan belt tensioning is facilitated by means of an adjustable jockey pulley, mounted above the alternator driving belt(s) (fig. 2).

2 To tension the fan belts, slacken the large locknut and turn the adjusting bolt until a deflection of 12,5 mm (0.5 inch) is obtained for each individual belt, as indicated in figure 1. Tighten the locknut securely.

The jockey pulley bearings are pre-packed with grease and do not require servicing between engine overhauls.

3 To renew the fan belts, remove the six setbolts securing the fan to the pulley, and push the fan forward into the radiator cowling. Slacken back the jockey pulley and lift off the old belts.

4 Ensure that all the pulley grooves are free from grease and dirt and fit a new set of belts. Refit the fan and tighten the setbolts securely. Set the fan belts to the correct tension and refit the belt guards.

5 *To renew the alternator belt(s), slacken the three alternator link and* pivot bolts, and lift the old belt(s) from the pulleys. Check all the pulley grooves for grease and dirt and fit the new belt(s).

6 Adjust the belt(s) tension as previously described, fit and adjust the fan belts, followed by the fan and belt guards.

After fitting new belts, run the engine for 15 minutes then re-check the tension. Check the tension of new belts each week for four weeks, then at the intervals specified in the Servicing Schedule.

VALVE TAPPETS

At the intervals specified in the Servicing Schedule, check the tappet clearances as follows :

1 Secure the stop control in the STOP position, disconnect and remove high pressure fuel pipes and the rocker covers, then remove the fan belt guard.

2 Using a flat steel bar in the holes in the crankshaft pulley, turn the crankshaft in its normal direction of rotation, until the valves on 'A6' cylinder are 'rocking', i.e. exhaust valves just closing, inlet valves just opening. The valves over the 'A1' cylinder will then be closed, with the piston at T.D.C. on compression stroke.

3 Slacken back the tappet adjusting screws and, using the appropriate feeler gauge, set the 'A1' inlet valve tappet clearance to 0,2 mm (0.008 inch), as shown in figure 3. Tighten the adjusting screw locknut to a torque loading of 40 Nm (30 lbf.ft.).

4 Set the 'A1' exhaust valve tappet clearance to 0,5 mm (0.020 inch), and tighten the adjusting screw locknut as for the inlet valve tappet.

After tightening the locknuts, re-check the clearances before proceeding to the next unit.

To simplify tappet clearance adjustment, the following sequence should be followed :

Valves rocking on	**Set clearance on**
A6	A1
B1	B6
A3	A4
B4	B3
A5	A2
B2	B5
A1	A6
B6	B1
A4	A3
B3	B4
A2	A5
B5	B2

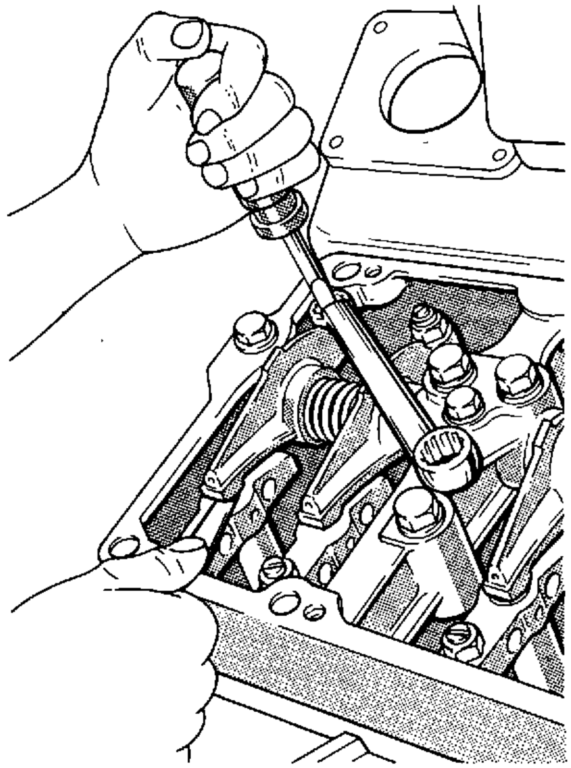


Fig. 3 Setting tappet clearances

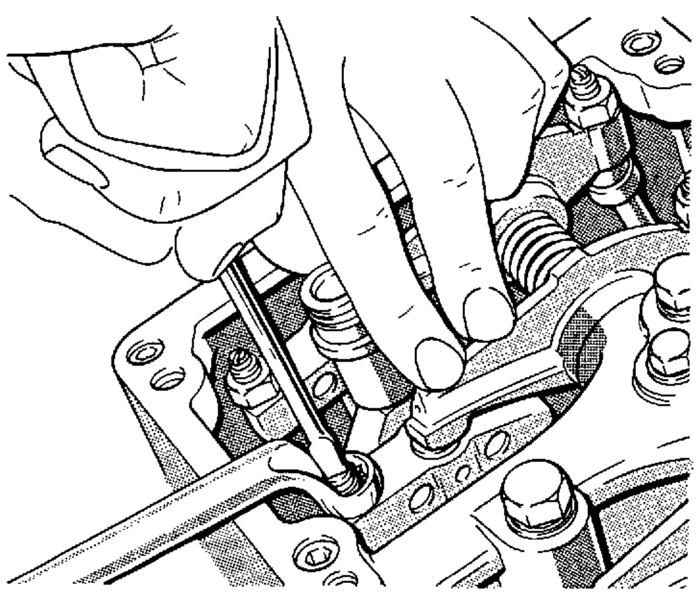


Fig. 4 Setting valve bridges

Valve bridge pieces will not normally require adjustment between overhauls, but if adjustment is found necessary, the following procedure should be carried out :

7 Close the valves, as for tappet clearance setting, and slacken the adjusting screw on the faulty unit.

8 Press down firmly on the centre of the bridge piece and turn the adjusting screw until it is felt to just touch the valve stem tip (see fig. 4).

9 Tighten the screw a further 60 deg. (1/6 of a turn) and tighten the locknut to a torque loading of 40 Nm (30 lbf.ft.).

10 Check the tappet clearances after adjusting the bridge pieces.

On completion of adjustments, oil the valve gear liberally and refit all the removed items, using new gaskets on all joint faces.

Warning : Ensure that the barring tool has been removed from the pulley holes, before attempting to start the engine.

VALVE TIMING

As the camshafts are gear operated from the crankshaft, it is not possible for the valve timing to slip. However, during engine rebuild, if doubts exist it will be reassuring to check the valve timing in the following manner :

1 Turn the engine by hand until the valves over the 'A1' cylinder are rocking and the 'A6' T.D.C. mark on the flywheel is opposite the pointer (fig. 5).

2 Set the A6' inlet valve tappet clearance to 1,1 mm (0.043 inch) and turn the engine one complete revolution until the 'A6' T.D.C. mark is again opposite the timing pointer.

3 Grip the 'A6' inlet valve pushrod with the thumb and forefinger and gently twist it. The rod should be just trapped between the rocker arm and the camshaft, indicating that the 'A6' inlet valves are beginning to open. This proves that the 'A' bank valve timing is correct.

It follows that if the timing marks on the gears are correctly meshed, then the 'B' bank valve timing is also correct.

After checking the valve timing, ensure that the tappet clearances are correctly set before running the engine.

FUEL INJECTION TIMING

Should the engine performance deteriorate during service, it may be necessary to check the injection timing. The following procedure should be followed :

1 Secure the stop lever in ther STOP position.

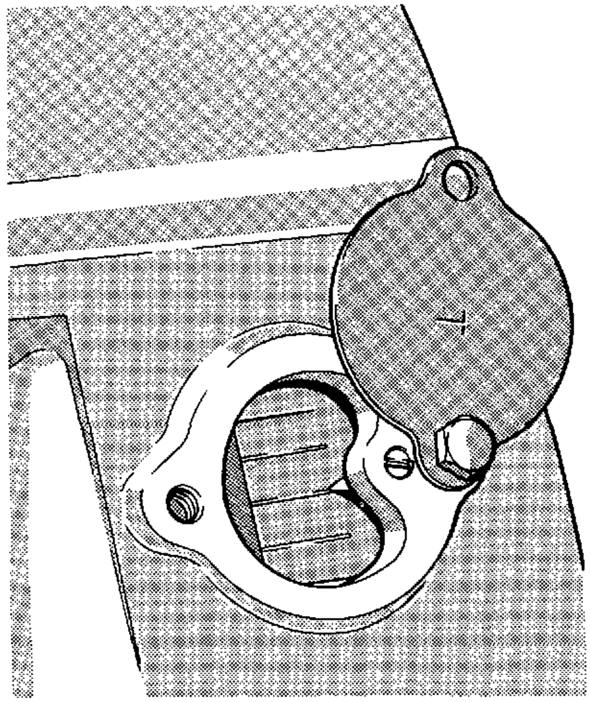


Fig. 5 Flywheel timing cover

2 Remove the high pressure fuel pipework and rocker cover from the cylinder head serving the cylinders A4, A5 and A6.

3 Remove the timing cover, stamped 'T', from the flywheel housing (fig. 5).

4 Turn the engine by hand, in the normal direction of rotation, until the injection timing figure (as stamped on the engine data plate) is opposite the pointer, with the valves on 'A6' cylinder closed, i.e., 'A6' piston at the top of its compression stroke.

5 Check that the timing mark on the injection pump hub is in line with the pointer (fig. 6).

If the timing mark on the hub fails to align with its pointer, check the fuel injection pump drive shaft and couplings, to ensure that they are secure and undamaged, then proceed as follows :

6 Set the flywheel timing mark to the correct figure (as stamped on the engine data plate), and slacken the socket capscrews on the injection pump adjustable coupling (fig. 7).

7 Turn the hub in its normal direction of rotation by hand, then turn the hub back until the timing mark on the hub is correctly aligned with the pointer. Tighten the four capscrews.

8 Using the barring device, turn the engine back a quarter of a turn, then forwards in the normal direction of rotation until the flywheel timing mark is correctly aligned with its pointer.

9 Check that the fuel injection pump timing marks are correctly aligned.

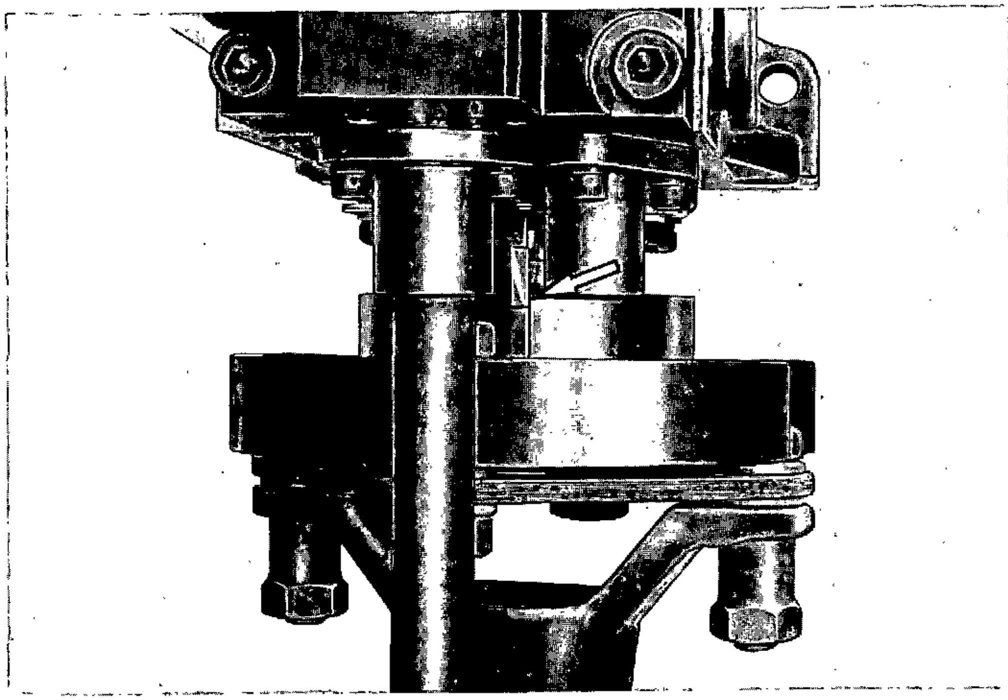
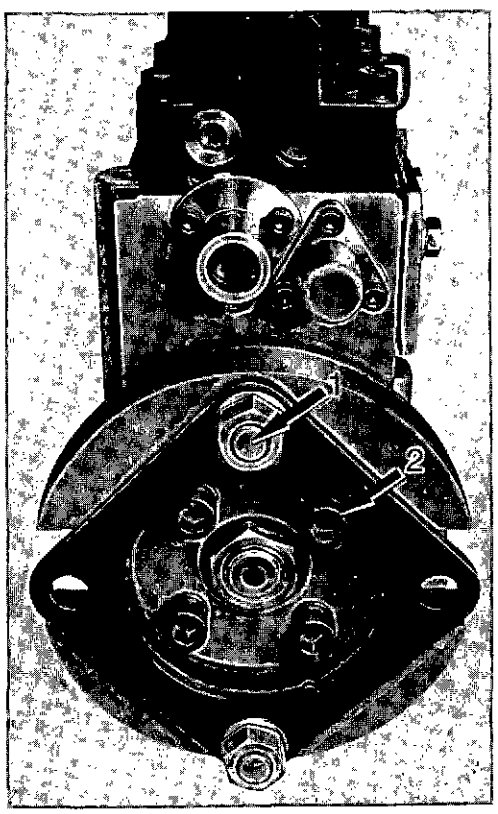
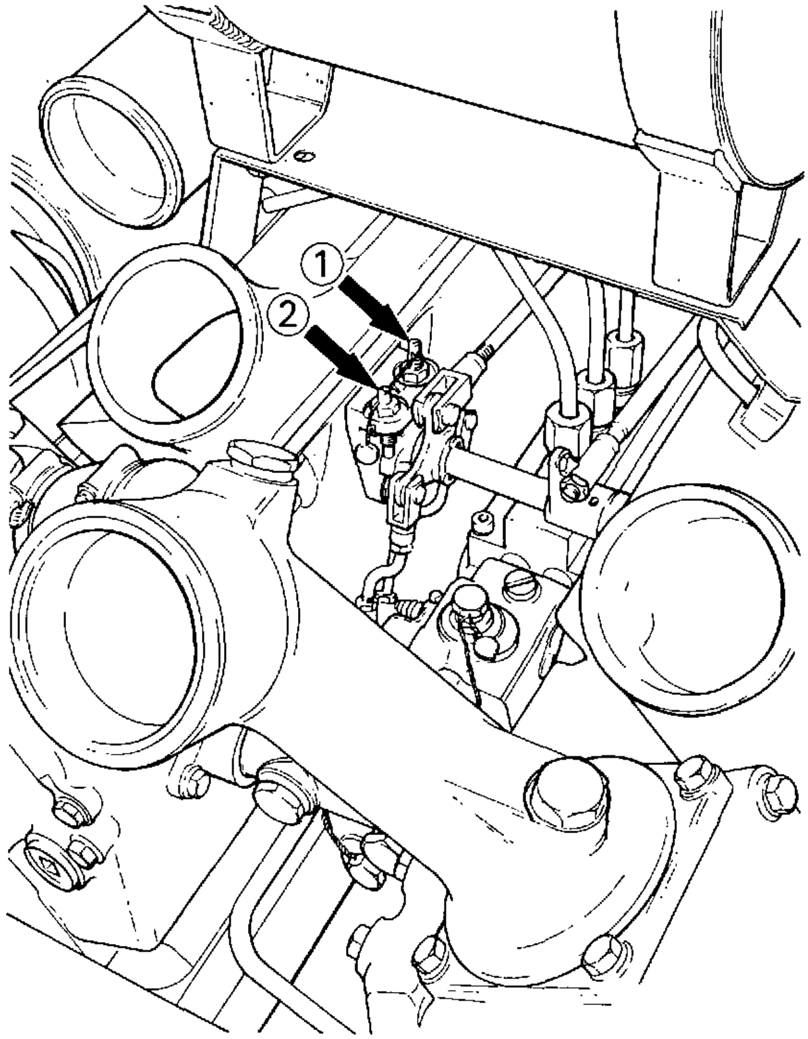


Fig. 6 Injection pump timing marks



1 Spring plate coupling bolts
2 Adjustable coupling socket capscrews

Fig. 7 Injection pump coupling



1 Maximum speed stop
2 Minimum speed stop

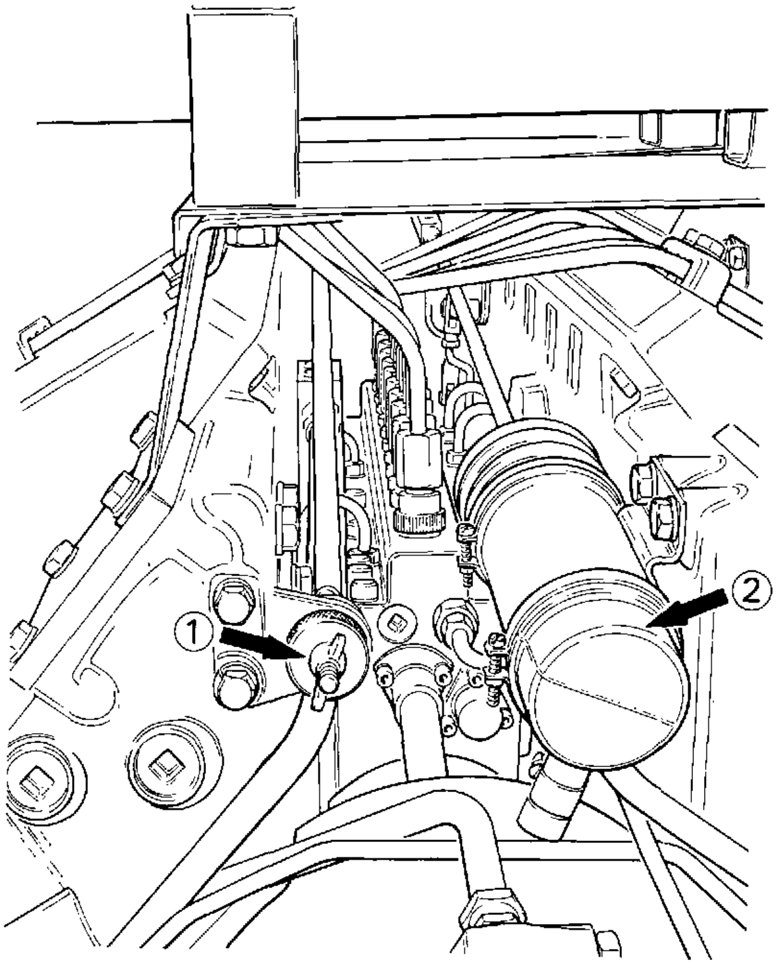
Fig. 8 Governor speed setting screws

GOVERNOR SPEED AND DROOP ADJUSTMENT

The C.A.V. Maximec CS governor, fitted to CV 12 generator set engines, may be adjusted for 1500 or 1800 engine r.p.m. operation for power outputs at 50 or 60 Hz.

A variable droop feature enables fine adjustments to be carried out whilst the unit is in position on the engine, and without the necessity of changing the governor springs.

Any adjustments to the speed setting will affect the droop setting and vice versa, therefore both settings must be adjusted to maintain a correct balance. Before adjustments to either function are attempted, operation of the overspeed protection device must be checked and a suitable load, ideally capable of absorbing full engine power, should be available.



1 Vernier control
2 Shutdown solenoid

Fig. 9 Shutdown and speed controls

Adjustment procedure

ENGINE SPEED

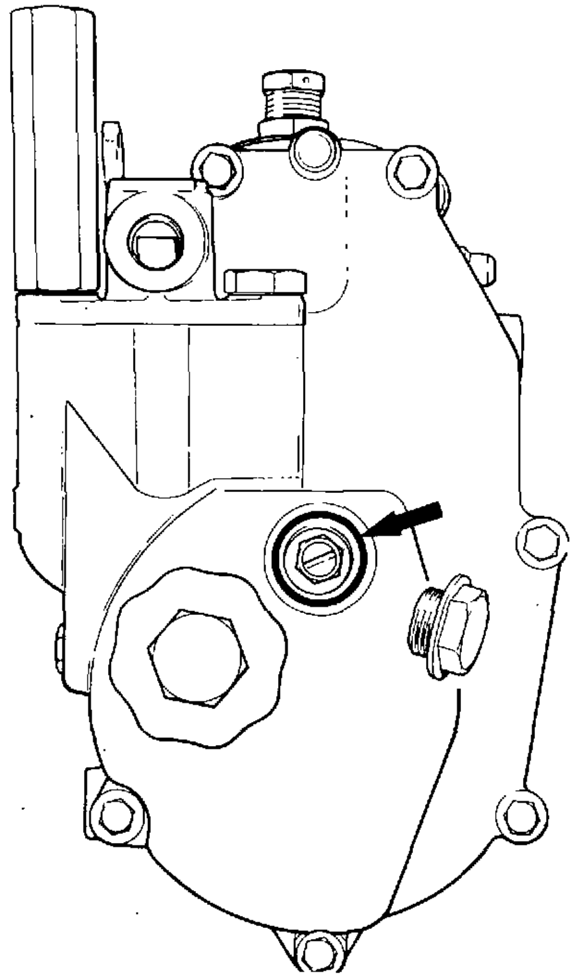
1 Break the wire locks on the maximum and minimum speed stop screws (fig. 8), slacken the locknuts and back off the screws, clear of the control lever.

2 Start the engine, allow it to run 'Off load', and set the required engine r.p.m. by means of the vernier control (fig. 9), as follows :

(a) Slacken the wing type locknut and turn the knurled knob clockwise to increase the engine r.p.m., or anti-clockwise to decrease the r.p.m., until the required speed is achieved.

(b) Apply 'Full load' to the engine and re-adjust the vernier control if necessary , tightening the locknut after each adjustment.

(c) Gradually reduce the engine load, check the run-out speed and calculate the droop.



Blanking cover seal (arrowed)

Fig. 10 Droop control screw

DROOP SETTING

1 Stop the engine and remove the blanking cover (fig. 10), from the rear face of the governor casing to gain access to the control screw.

2 Using the Box Spanner, Part No. VT 13740, slacken the control screw locknut and, using the Screwdriver, Part No. VT 13819, in conjunction with the box spanner, turn the control screw a maximum of two complete turns as necessary.

Turn the screw clockwise to reduce droop; turn anti-clockwise to increase droop.

Caution : Excessive clockwise adjustment will cause uncontrolled overspeeding of the engine, so it is essential that each adjustment is limited to two turns.

3 Restart the engine, apply 'Full load' and adjust the engine r.p.m. with the vernier control to give rated speed, as previously described.

4 Continue with the above procedure until the required droop and engine r.p.m. are achieved; refit the blanking cover to the governor casing.

When the droop and engine r.p.m. settings are completed, the maximum and minimum speed stop screws must be reset as follows :

1 Start the engine and apply 'Full load'.

2 Slacken the vernier control locknut and increase the engine speed to 20 r.p.m. above the rated speed.

3 Turn the maximum speed stop screw until it just touches the control lever; tighten the locknut and rewire the lock.

4 Remove the load and adjust the engine r.p.m. on the vernier control to give 100 r.p.m. below rated speed.

5 Turn the minimum speed stop screw until it just touches the control lever; tighten the locknut and rewire the lock.

6 Reset the vernier to give the rated speed; tighten the locknut.

If the rated speed alteration is to be permanent, the E.S.C. must be changed (if fitted), to enable the correct Servicing Schedule to be adhered to and to allow an accurate assessment of engine running hours to be made.

The following Engine Service Counters are available :

Part Number OE 43816 for engines rated at 1500 r.p.m.
Part Number OE 43812 for engines rated at 1800 r.p.m.

Where an engine running hours counter is incorporated in the main control panel, as on later engines, no further action will be necessary.

SECTION 3 - COOLING SYSTEM

COOLING SYSTEM

1	Thermostat housings	4	Coolant pump
2	Induction manifold gallery	5	Drain cock or plug
3	Inlet to 'A' bank gallery	6	Oil-to-coolant heat exchanger

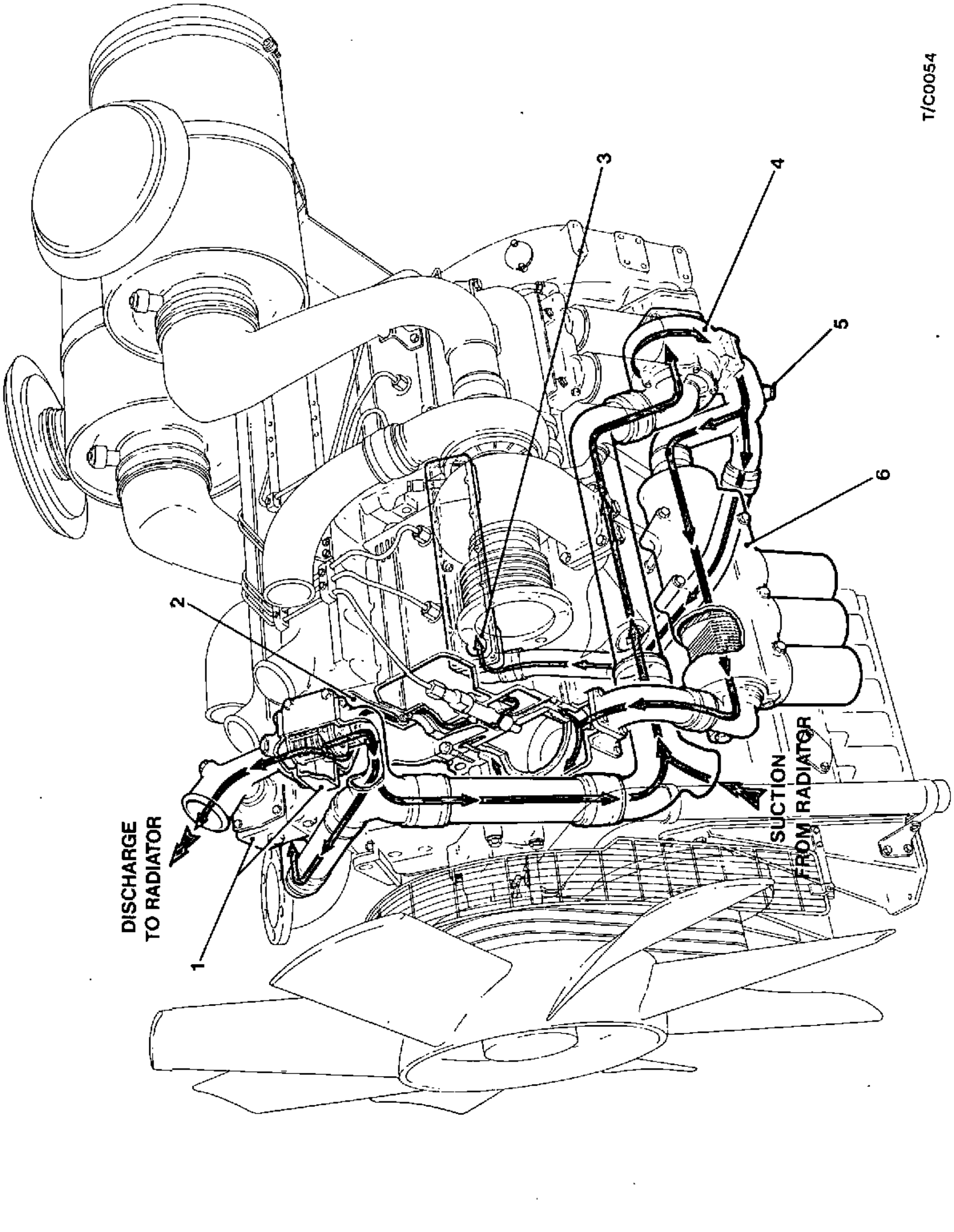


Fig. 1 Cooling system - CV12 Industrial engines.

SECTION 3 - COOLING SYSTEM

Description

Coolant is drawn from the radiator by a gear driven pump and delivered, via a bifurcated pipe, to the coolant galleries in each bank of cylinders, the 'B' bank coolant having first passed through the engine oil-to-coolant heat exchanger. From the cylinder block, the coolant is directed through the cylinder heads and into galleries integral with each induction manifold.

Wax capsule type thermostats, mounted at the front of each manifold, then direct the coolant to the radiator or back to the pump suction for recirculation of the engine.

COOLANT

The recommended coolant, for use at all times, is a mixture of 50% clean fresh water with 50% inhibited propylene glycol or 50% inhibited ethylene glycol.

Perkins Engines (Shrewsbury) do NOT recommend the use of methanol based anti--freeze products, in any of their range of diesel engines.

Clean fresh water

Clean fresh water means water in which the combined level of chlorides and sulphates does not exceed 150 parts per million, and the total hardness does not exceed 250 parts per million.

If any doubts exist about the quality of the water supply, the local Water Supply Authority should be able to quote levels in their areas.

Every attempt to meet the above mentioned purity levels will be advantageous. Where these levels cannot be met, distilled, de-ionised or filtered rain water should be used.

The use of more highly contaminated water should be avoided because of the possibility of deposits, harmful to heat transfer and coolant flow, with the consequent risk of engine overheating.

Anti-freeze

As there is no British Standard Specification covering the corrosion inhibiting performance of anti-freeze products, Operators are advised to obtain the manufacturer's assurance on the suitability of their product for the protection of cooling systems incorporating ferrous, brass, copper and aluminium alloy components.

Anti-freeze blends are based on carefully balanced mixtures of several anti-corrosion inhibitors, each brand containing different inhibitor formulations. If different brands are mixed in a cooling system, the balance of inhibitors may be upset, resulting in loss of anti-corrosion protection and/or sludging in the system.

Inhibited propylene glycol

This means any commercially available propylene based anti-freeze product, which does not contain ethylene glycol or methanol. The specific gravity of propylene glycol is very similar to that of water, making it difficult to determine the specific gravity of the coolant mixture using a conventional hydrometer. Perkins Engines (Shrewsbury) recommend the use of a 'Refractometer', obtainable from the manufacturer of the propylene glycol based product.

The advantage of propylene glycol over ethylene glycol is that it is considerably less toxic in content.

The following propylene glycol based product meets the Perkins Engines (Shrewsbury) requirements :

Manufacturer	Brand Name
Dow Chemical Company	Dowfrost 123

Inhibited ethylene glycol

This means any commercially available ethylene glycol based anti-freeze product, which does not contain propylene glycol or methanol.

The specific gravity of coolant mixtures containing inhibited ethylene glycol may be checked using a suitable hydrometer and thermometer. The 'Polar Master' hydrometer, obtainable from most Lucas/C.A.V. dealers, is capable of determining the specific gravity of ethylene glycol mixtures of up to 60% concentration levels.

The following ethylene glycol based productss meet the Perkins Engines (Shrewsbury) requirements :

Manufacturer	Brand Name
BP	BP Anti-freeze
Castrol	Castrol Anti-freeze
Daltons	Eskimo Universal
Esso	Esso Anti-freeze
ICI	ICI 100
Marston	Sentinel
Mobil	Mobil Anti-freeze
Morris	Golden Film
Petrofina	Fina Thermidor
Texaco	Texaco Anti-freeze
Union Carbide	Anti-freeze UT-184

Coolant inhibitor

Where the ambient temperature never falls below freezing point, or where glycol is not available, the coolant inhibitor, available fromn Perkins Engines (Shrewsbury), may be added to clean fresh water in the ratio of 1 : 100, i.e., 0,5 litre of inhibitor to 50 litres (11 Imperial gallons) of water, and used in place of anti-freeze solution. The inhibitor may also be added to anti-freeze mixtures, in order to increase the level of inhibition, should the strength become low or depleted.

Other advantages of the inhibitor are :

1 It is non-toxic

2 It contains a lubricant to help increase the life of coolant pump seals.

3 Slight overdosing will have no harmful effects on cooling system components.

The coolant inhibitor is available in 0,5 litre and 1,0 litre bottles under Part Numbers OE 45141 and OE 45142 respectively. Full instructions for use are given on the label of each bottle.

COOLANT CHECKS

The coolant, if correctly checked and maintained, will give the required protection for 12 months. The pH value and the specific gravity of the coolant mixture must be checked at the intervals specified in the Servicing Schedule (Section 1), using a sample drained from the system, after stopping the engine and before any deposits have settled.

pH Value

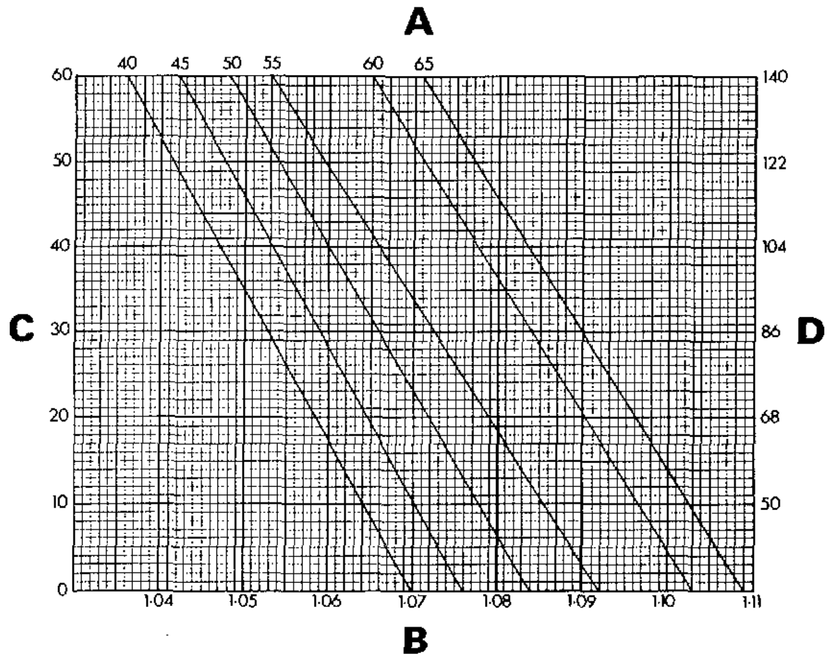
The corrosion inhibitors added to the coolant are gradually consumed in service, and the coolant can become excessively acid or alkaline. Acidity will cause corrosion in the ferrous metals, whilst alkalinity similarly affects the non-ferrous metals in the cooling system.

The degree of acidity or alkalinity is known as the pH value, and may be determined simply by means of test papers, available from manufacturing chemists or, more accurately , by the use of a pH meter.

The pH value of the coolant in the system must not be less than pH 7 or greater than pH 9.5. If these limits are exceeded, the pH value may be restored by adding inhibitor to the same specification as that already in use. Alternatively, the system must be drained, flushed through and refilled with a fresh coolant mixture.

Specific gravity

In all cases, the new anti-freeze solution should be mixed in a clean container, and its specific gravity measured as follows :



A = Percentage of anti-freeze
B = Specific gravity
C = Mixture temperature (Deg.C.)
D = Mixture temperature (Deg.F.)

Fig. 2 Specific gravity chart

1 Mixtures containing inhibited ethylene glycol.

(a) Place the hydrometer and a reliable thermometer in the anti-freeze solution, and check the readings on both instruments.

(b) Check the readings obtained against the graph (fig. 2), and adjust the mixture strength accordingly.

2 Mixtures containing inhibited propylene glycol.

(a) Hinge up the slide cover of the Refractometer, ensure that the slide is perfectly clean and, using a small syringe, place a few drops of the coolant mixture on the slide.

(b) Smear the coolant over the full area of the slide, close the cover and, holding the Refractometer horizontal with the slide facing upwards, examine the sample through the eye piece.

(c) Compare the reading with the chart on the instruction leaflet; adjust the mixture strength accordingly.

Note : If the slide is not thoroughly cleaned before use, any traces of the fluid previously tested, will nullify the reading of the coolant sample.

Dependent on the percentage of anti-freeze used in the engine, protection against freezing is as follows :

Anti-freeze/water (% by volume)	**Protection down to** deg. C.
50/50	-35
60/40	-40

FILLING THE SYSTEM

Fill the system slowly to the required level, with the approved coolant mixture. Run the engine until the coolant reaches normal working temperature. Stop the engine, check the coolant level and replenish as necessary.

Warning : Remove the filler cap carefully when the engine is hot, as the cooling system will be under pressure.

CLEANING THE SYSTEM

It is important that the cooling system be kept free of deposits and contamination; flushing through at least once every 12 months is essential. The system can be cleaned by using the Perkins inhibitor at normal strength as follows :

1 Drain the coolant whilst warm, before deposits have settled

2 Flush the system through with clean fresh water, until it runs clear from all drain cocks or plugs.

3 Close all cocks and tighten all drain plugs, and fill the system with correctly inhibited clean fresh water.

4 Run the engine in normal use for two weeks, then drain and flush the system

5 Refill the system with the approved coolant mixture.

Caution : Do NOT clean the system by this method if there is the possibility of sub-zero temperatures.

TOPPING-UP

Always 'top-up' with the same coolant mixture as that already in the system. Never 'top-up' with water alone

Every 'topping-up', even with approved coolant, adds contaminents. Therefore, to keep 'topping-up' to a minimum, make regilar checks to locate and rectify coolant leaks.

DO'S and **DON'TS** - The following should always be observed.

1 DO use either the approved inhibitor or an approved inhibited anti-freeze AT ALL TIMES and at the recommended strength.

DO NOT put in anti-freeze just for the winter and then forget about it for the rest of the year. NEVER USE ANY KIND OF WATER ALONE.

2 DO always maintain the inhibitor or anti-freeze mixture at the recommended strength.

DO NOT base the mixture strength of your anti-freeze solution solely on the temperature protection you require.

3 DO always 'top-up' with the correct solution of inhibitor or anti-freeze.

DO NOT 'top-up' with water alone.

4 DO drain and flush the cooling system, using Perkins inhibitor solution, at least once a year, and refill with new anti-freeze mixture or inhibitor solution.

DO NOT continue to use the same coolant for more than one year, even if 'topping-up' with a correct mixture.

5 DO remember that hard water contains mineral salts which will be deposited, causing restriction and abrasion.

DO NOT expect inhibitors to remove or absorb mineral salts; they will not, but remember that these salts will adversely affect any inhibitors added to the system.

6 DO remember that corrosion can be virtually eliminated by careful maintenance of engine and coolant.

DO NOT expect inhibitors to do your work for you. They cannot cope with the effects of entrained air or combustion gases.

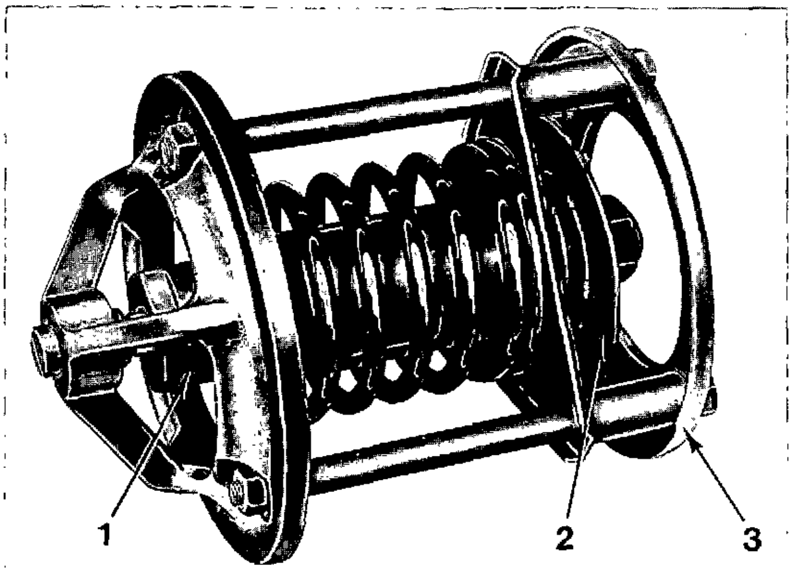
7 DO remember that although erosion may be caused by vibration and coolant flow characteristics, it is increased by lack of coolant control or inhibition.

DO NOT continue to run an engine with excessive vibration or an aerating cooling system.

If you are in doubt, the Service Department of Perkins Engines (Shrewsbury) will be pleased to advise.

THERMOSTATS

Each wax capsule type, Western Thomson thermostat (fig. 3), is factory set to operate at a pre-determined temperature and must NOT be adjusted by Operators.



1 Main flow valve opening
2 By-pass valve
3 By-pass valve seat

Fig. 3 Thermostat

In operation, the main flow valve of the thermostat begins to open when the coolant temperature reaches 68 to 73 deg.C. and the by-pass valve begins to close a corresponding amount. The normal working travel of the main flow valve is 12,7 mm (0.5 inch), which is achieved at a temperature of 78 to 83 deg.C. When this temperature is reached, the by-pass valve is fully closed, ensuring that the full fglow of coolant passes through the radiator. At higher temperatures, the main flow valve will open to a maximum of 23,8 mm (0.937 inch), the extra travel being taken up by compression of the by-pass valve spring.

The thermostats require no servicing and, if defective, must be renewed.

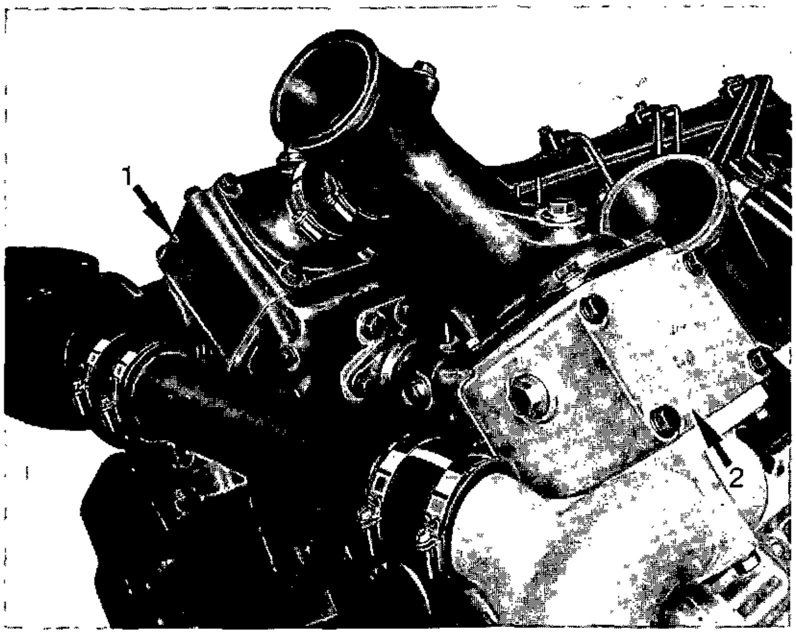
Cleaning the thermostats

1 Drain the coolant to below the level of the thermostat housings (fig. 4).

2 Remove the housing cover and pipework where necessary, and withdraw each thermostat unit.

3 Thoroughly clean the thermostat, using a mild detergent and a small bristle brush, such as an old tooth brush.

4 Check each thermostat for distortion, cracks, damage and sticking valve spindles. Sticking valve spindles may often be freed, by applying silicone grease to the spindle, and operating the valves by hand to work the grease into the glands.



1 'A' bank thermostat housing   2 'B' bank thermostat housing

Fig. 4 Thermostat housings

Note : Silicone grease should be applied to the valve spindles of replacement units, or to thermostats fitted to any engine which is to stand with the cooling system drained. A suitable lubricant is MS4 silicone grease, manufactured by Ambersil Limited, Basingstoke, Hampshire.

Checking the operating characteristics

1 Place the unit in a tank containing water at a constant 20 deg.C., for five minutes

2 Using suitable tongs, plunge the unit into a tank containing water at a constant 100 deg.C.

Note the time taken for the valve to open sufficiently to admit a 0.05 mm (0.002 inch) feeler gauge; this should be between 30 and 40 seconds.

Note the time taken for the valve to open 12,7 mm (0.5 inch); this should be between 90 and 120 seconds.

3 Finally, plunge the unit into a tank containing water at 20 deg. C. and note the time taken for the valve to close completely; this should be between 25 and 35 seconds.

Thermostat units are extremely reliable so incorrect operating characteristics indicate a loss of wax. In such cases, the unit must be renewed.

Locate the thermostat in its housing and, using new hose connections, refit the housing cover with new gaskets, lightly coated with jointing compound.

Top up the system with the approved coolant mixture.

CHAPTER 4 - FAULT DIAGNOSIS

Symptom or Condition	Possible cause	Action	Refer to Chapter 3, Section
1 FAILURE TO START			
(a) Starter will not turn engine.	Discharged battery.	Renew battery.	-
	Faulty starter circuit.	Check switch terminals and starter motor. Check cables for damage.	-
	Defective starter.	Change starter.	7
	Starter pinion not engaging.	Bar engine round and try again.	7
(b) Engine turns but will not start.	Insufficient engine rpm.	Check battery state.	-
	Air in fuel system.	Check feed pump suction connections.	4
	No fuel at injectors.	Check fuel level and fuel cock.	4
	Water or dirt in fuel.	Drain water trap, if fitted; renew filter canisters.	4
	Faulty feed pump.	Change or service pump.	4
	Injection pump timing incorrect.	Reset pump timing.	4

	Symptom or Condition	Possible cause	Action	Refer to Chapter 3, Section
2	ENGINE FIRES BUT WILL NOT START	Faulty fuel supply.	Check system.	4
		Faulty feed pump.	Change or service pump.	4
		Fuel filters choked.	Renew filter canisters.	4
		Air cleaners choked.	Service air cleaners.	6
		Faulty injectors.	Change injectors.	4
3	MISFIRING	Air in fuel system.	Check feed pump suction connections.	4
		Fractured injector pipe.	Renew pipe.	4
		Faulty injectors.	Change injectors.	4
		Incorrect tappet clearance.	Reset clearance.	2
		Faulty injection pump.	Change pump.	4
4	LOW OIL PRESSURE (Sudden drop, not due to normal wear)	Low oil level.	Replenish sump.	5
		Faulty pressure gauge.	Renew gauge.	-
		Filters choked.	Renew filter canisters.	5
		High lubricating oil temperature.	See Item 5.	-
5	OVERHEATING	Coolant level low.	Replenish and check for leaks.	3
		Slipping, broken or damaged fan belts.	Adjust or renew fan belts.	2
		Fouled cooling system.	Clean and refill system.	3

	Symptom or Condition	Possible cause	Action	Refer to Chapter 3, Section
		Faulty thermostat.	Test, and renew if necessary.	3
		Choked radiator matrix.	Clean matrix.	-
		Injection pump timing incorrect.	Reset timing.	4
		Turbocharger failure.	Inspect turbo-chargers; fit replacements if necessary.	6
6	LOW FUEL PRESSURE	Leak in feed pump suction.	Locate and rectify..	4
		Faulty feed pump.	Change or service pump.	4
		Faulty relief valves.	Change the valves.	4
7	LOSS OF POWER	Low fuel pressure.	See Item 6.	-
		Injection pump timing incorrect.	Reset timing.	4
		Faulty injectors.	Change injectors.	4
		Air cleaners choked.	Service air cleaners.	6
		Incorrect tappet clearance.	Reset tappet clearance.	2
		Leaking joints at cylinder head or induction manifold.	Renew gaskets.	-
		Turbocharger failure.	Inspect turbo-chargers; fit re-placements if necessary.	6
8	BLACK EXHAUST SMOKE	Overfuelling.	Check MAX.FUEL stop seal. If broken, change pump or reset on test rig.	

Symptom or Condition	Possible cause	Action	Refer to Chapter 3, Section
	Faulty injectors.	Change injectors.	4
	Injection pump timing incorrect.	Reset timing.	4
	Air cleaners choked.	Service air cleaners.	6
	Turbocharger failure.	Inspect turbo-chargers.	6

SERVICE INSTRUCTIONS

This Issue, dated August 1987, of T.S.D. Publication 3138, contains all the relevant information from Service Instructions up to and including CV.I. 24.

Subsequent Service Instructions should be inserted behind this page, reference notes being made at the appropriate places in the Manual.

Emergency action

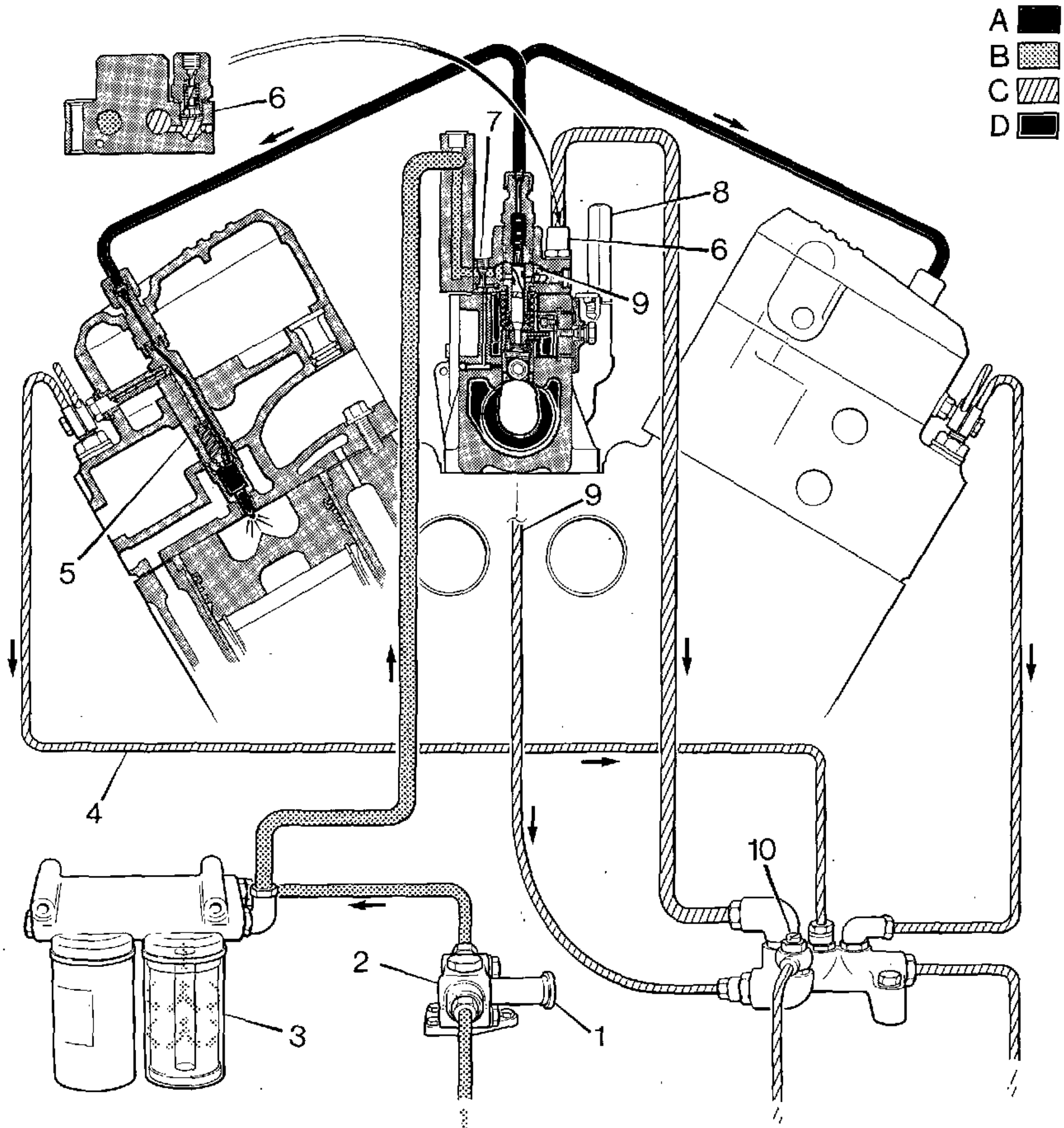
If replacement thermostats are not available, it will be necessary, **as a temporary measure only**, to jack the thermostat valves fully open and run the engine with the radiator partially blanked off.

Caution : In no circumstances should the engine be run without thermostats, as the by-pass ports would then be permanently open, causing overheating of the engine.

OIL-TO-COOLANT HEAT EXCHANGER

See Section 5 - 'Lubrication system'.

SECTION 4 - FUEL SYSTEM



1	Hand priming plunger	6	Relief valve	A	High pressure fuel
2	Feed pump	7	Lubricating oil inlet	B	Low pressure fuel
3	Main filters	8	Governor oil inlet	C	Spill return to tank
4	Injector spill	9	Injection pump spill	D	Lubricating oil
5	Fuel injector	10	Bleed screw		

Fig. 1 Fuel system (schematic)

SECTION 4 - FUEL SYSTEM

Description

Depending on application, a mechanical or electrically driven fuel feed pump draws fuel through a primary filter and delivers it, via the main filters, to the injection pump gallery. The gallery pressure is maintained at a constant pressure of 90 to 117 kN/sq.m (13 to 17 lbf./sq.inch) by two low pressure relief valves mounted on the injection pump casing.

Fuel enters the pump elements from the gallery, and is delivered at high pressure to the 12 low spring type injectors, which are set to operate at 240 atmospheres.

A spill block, mounted on the 'B' bank side of the wheelcase, returns excess fuel and spill from the injection pump, and spill from the fuel injectors, back to the supply tank.

A bleed screw and drip pipe assembly is housed in the spill block to facilitate venting of the low pressure fuel system.

CARE OF THE SYSTEM

Scrupulous cleanliness, careful handling of the components and servicing in accordance with the Servicing Schedule (Section 1), will greatly assist in preventing serious trouble during service.

Thoroughly clean any component and its surrounding area before dismantling, and fit sealing caps or plugs to all unions immediately following any disconnections.

HIGH PRESSURE FUEL PIPES

These pipes will require no attention between engine overhauls if the following precautions are observed :

1 Never bend or strain a pipe when changing injectors, or for any other reason. If a pipe obstructs the work in hand, remove it completely.

2 When slackening or tightening gland nuts, ensure that the pipe does not twist. DO NOT OVERTIGHTEN GLAND NUTS.

3 Immediately prior to fitting a pipe, blow through it with clean, dry, compressed air.

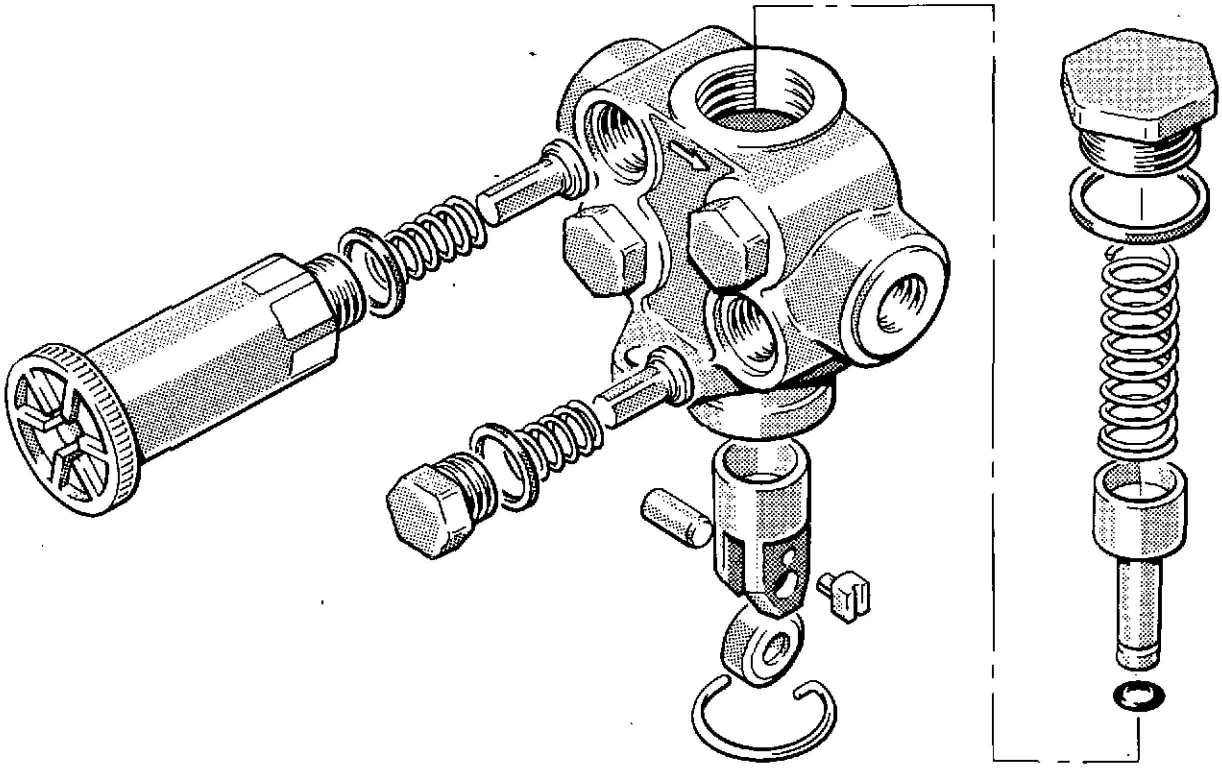


Fig. 2 Fuel feed pump (mechanical)

4 Ensure that each pipe lies naturally between its unions before the gland nut threads are engaged. When fitting securing clips and vibration dampers, check that the pipe is not pulled out of alignment and that the damper rubber is not distorted.

PRIMING AND VENTING

If air enters the fuel system, the injection pump pressure may become insufficient to operate the injector valves and, depending on circumstances, the engine may stop, misfire or fail to start. To remove air from the system, the following procedure should be adopted :

Low pressure system

1 Depending on application, slacken the bleed screw on the spill block or injection pump body, two or three turns. Unscrew the priming pump cap on the fuel feed pump (fig. 2), and operate the hand priming pump until bubble-free fuel emerges from the drain pipe.

2 Tighten the bleed screw, press in the pump plunger and screw the plunger cap down, finger tight, to prevent fuel leakage.

If an electrically powered feed pump is fitted, slacken the bleed screw as above, operate the pump and tighten the bleed screw when bubble-free fuel emerges. Switch off the pump.

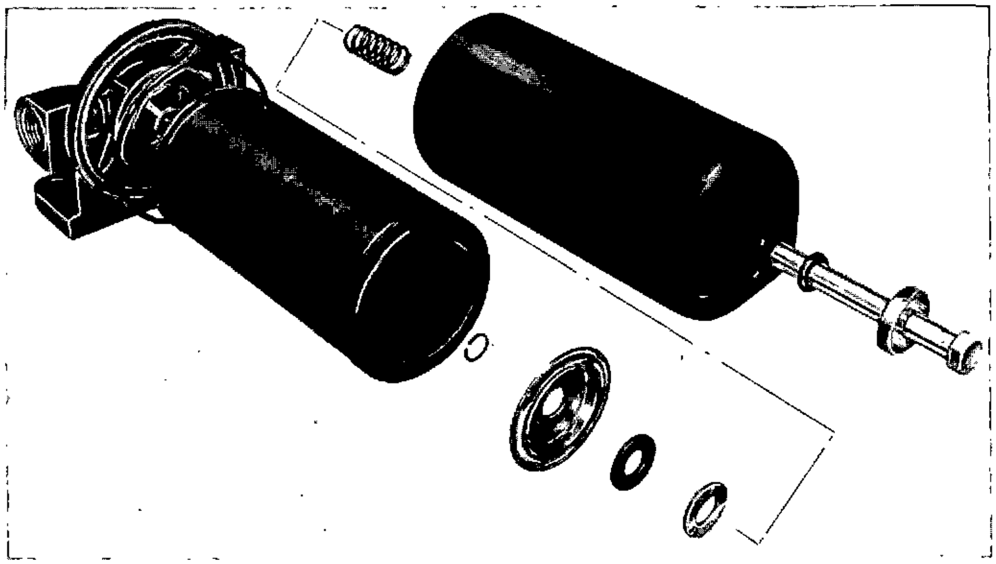


Fig. 3 Primary fuel filter (Purolator)

High pressure system

Air in the high pressure system must be released at the fuel injectors, as follows :

1 Set the stop control in the RUN position and motor the engine on the starter.

2 Slacken each injector gland nut in turn and re-tighten when bubble-free fuel emerges. DO NOT overtighten.

If the engine fires during this operation, but runs erratically, continue venting each injector in turn until the system is free of air, or until the engine note is steady. Return the stop control to the STOP position.

PRIMARY FILTER

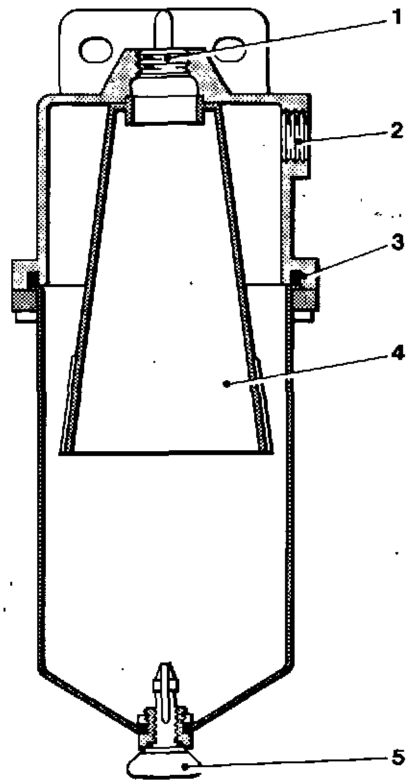
Purolator PU 464

The Purolator PU 464 primary filter, provided with earlier engines (fig. 3), consists of a bowl with a washable, wire wound element, bolted to a header bracket. A conventional spring loaded ball valve, integral with the header bracket, allows fuel to by-pass the filter should the element become choked. The by-pass valve requires no servicing between engine overhauls. If it is suspected that the by-pass valve is faulty or damaged, the header bracket must be renewed.

Service the filter at the intervals specified in the Servicing Schedule (Section 1), as follows :

1 Unscrew the bowl retaining setbolt and withdraw the element.

2 Wash the element in petrol or paraffin and blow dry, in the reverse flow direction, with a compressed air jet. Do NOT wipe the element with rag.



1 Fuel to feed pump
2 Fuel from supply tank
3 Sealing ring
4 Swirl cone
5 Drain cock

Fig. 4 Primary fuel filter (Harwood)

3 Wash and dry the bowl assembly and reassemble the components to the header bracket, using new sealing rings. Do NOT overtighten the bowl retaining setbolt.

If the element winding becomes damaged, a replacement unit, Part Number, OF 1609, is available from Dealers and Distributors.

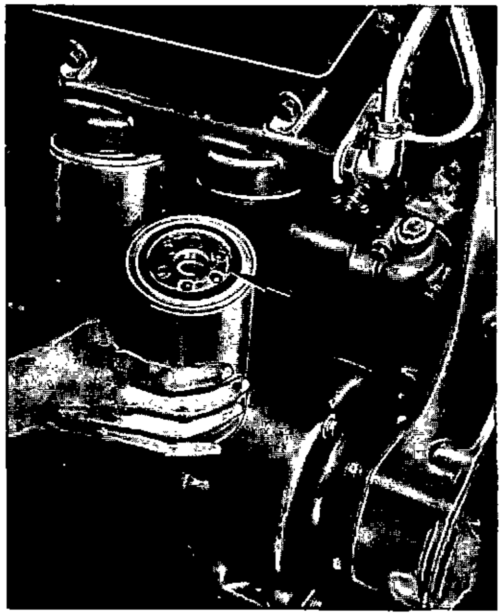
Harwood separator/filter

The Harwood separator/filter (fig. 4), provided with the later engines, works on the centrifugal principle. Fuel is delivered to the bowl at a tangent, and swirls around a cone in the centre of the bowl. Any water or sediment in the fuel is forced outwards, and sinks to the bottom of the bowl. A drain cock, fitted in the base of the filter bowl, allows any water or sediment to be regularly drained off.

During engine overhaul, unscrew the three clamping ring setbolts and lift off the filter bowl. Clean all the components with paraffin and blow dry with a compressed air jet. Using a new rubber sealing ring, refit the bowl to the header, align the clamping ring and tighten the three setbolts.

MAIN FILTERS

The two parallel flow main filters (fig. 5) are of the expendable canister type, and must be discarded at intervals specified in the Sevicing Schedule (Section 1), and renewed as follows :



Outer sealing ring arrowed

Fig. 5 Main fuel filters

1 Unscrew the canisters and remove the sealing ring from around each of the screwed adaptors. Ensure that the contact faces on the header are clean, and fit two new sealing rings around the adaptors.

2 Check that the outer sealing rings are correctly located in the new filter canisters, and screw each canister on to the its adaptor until the sealing rings just touch the contact face. Tighten each canister a further $^{3}/4$ of a turn, by hand. Do NOT overtighten.

3 Turn the fuel supply ON and vent the low pressure system as described in 'PRIMING AND VENTING', in this Section.

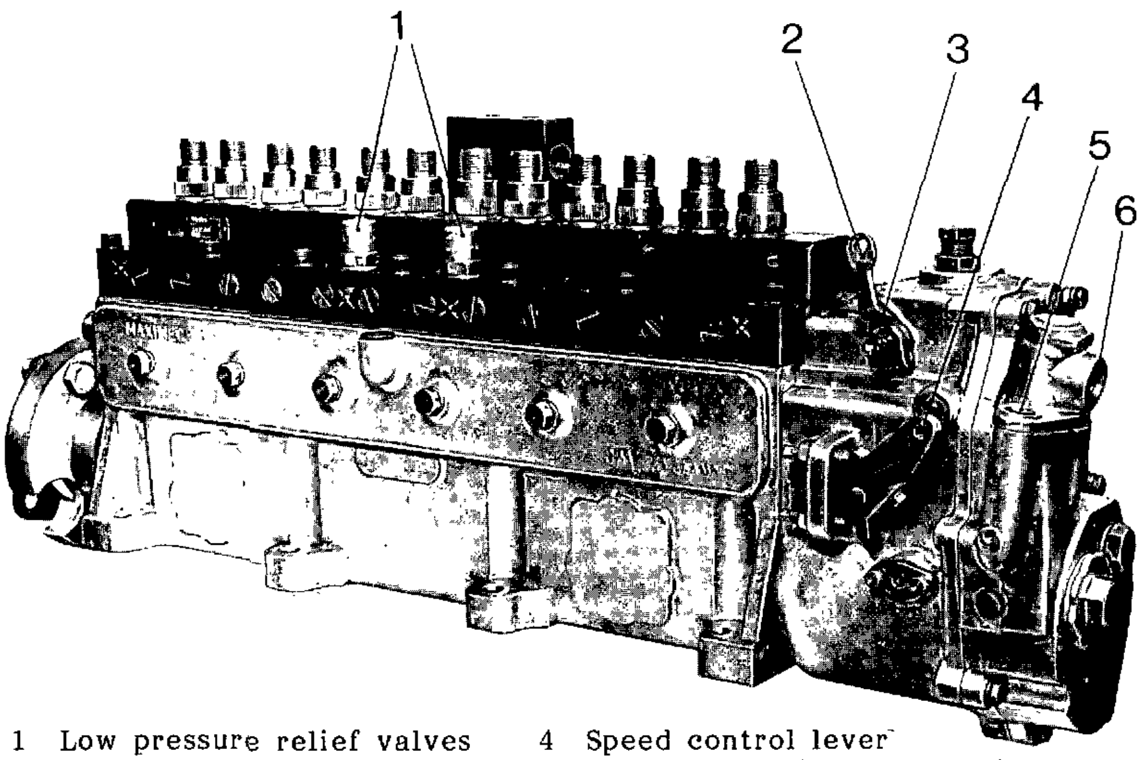
Replacement filter canisters are available from Dealers and Distributors under Part Number OD 19596.

Note: Stubborn filter canisters may be removed using the filter wrench, Part Number GA 5074.

FUEL FEED PUMP (Mechanical)

The feed pump (fig. 2), is a piston type unit, cam operated from the auxiliary drive shaft.

Four spring loaded nylon valves, two suction and two delivery, are housed in the pump body. Three of the valves are retained by hexagon headed plugs, the fourth is retained by the hand priming pump housing. Each valve may be removed for inspection, cleaning or renewal, as necessary.



1 Low pressure relief valves
2 Stop control lever
3 Excess fuel device
4 Speed control lever
5 Governor oil feed connection
6 Governor oil drain connection

Fig. 6 Fuel injection pump assembly

The hand priming pump is of the simple spring plunger type and is secured in its housing, when not in use, by a screw cap. The cap must be screwed down, finger tight, to prevent fuel leakage.

LOW PRESSURE RELIEF VALVES

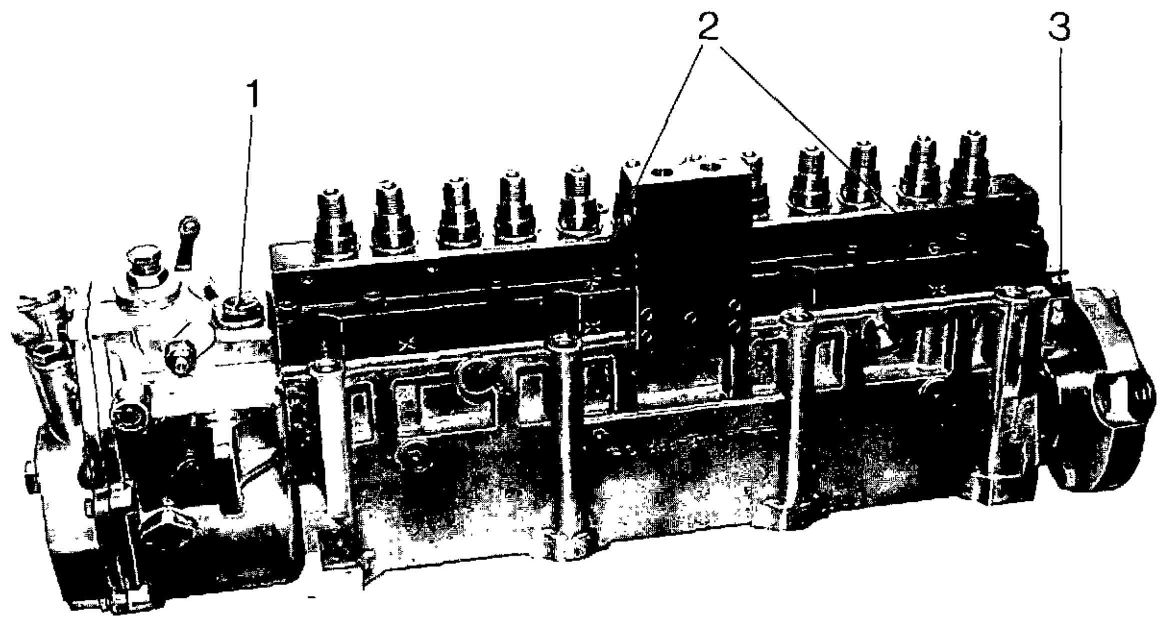
Two low pressure relief valves, working in parallel, are mounted over the fuel injection pump gallery (fig. 6). The valves are designed to operate at 90 to 117 kN/sq.m (13 to 17 lbf/sq.inch), and allow excess fuel to return to the supply tank. No servicing is necessary and, if a valve becomes faulty, a new unit must be fitted.

INJECTION PUMP AND GOVERNOR

The fuel injection pump (figs. 6 and 7), centrally mounted in the crankcase 'V', is driven at 0.5 engine speed through flexible spring steel couplings.

The mechanical governor, integral with the injection pump, controls engine r.p.m. under varying load conditions, the governor stop control lever being actuated by a solenoid unit. A vernier control, coupled to the speed control lever, provides for fine setting of engine speed.

External pipework, with connections on the pump and governor, deliver lubricating oil from the heat exchanger adaptor gallery. External pipework from each unit, returns drain oil to the crankcase.



1 Oil priming plug
2 Engine oil feed connections
3 Injection pump oil drain

Fig. 7 Fuel injection pump assembly

Routine servicing

1 At regular intervals, lubricate the control linkage and check for security, freedom and range of movement. Check all bolts, nuts and unions for tightness and check the pump and governor for leaks.

2 At the intervals specified in the Servicing Schedule (Section 1), check the ignition timing, as described in Section 2, and tighten the pump drive spring coupling bolts to a torque loading of 120 Nm (88 lbf.ft.).

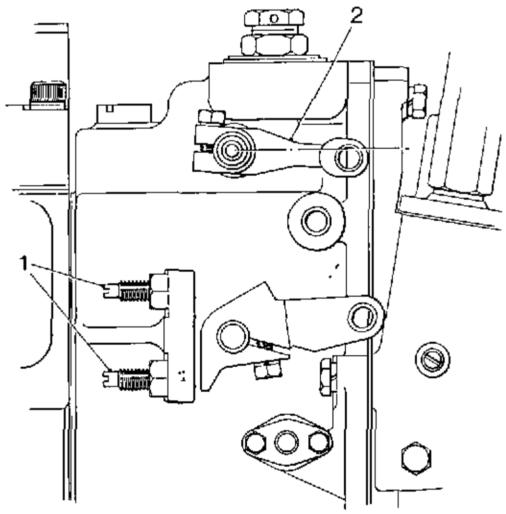
3 At the intervals specified in the Servicing Schedule (Section 1), remove the injection pump and governor for calibrating and servicing.

Fitting a replacement assembly

If it is necessary to fit a replacement injection pump/governor assembly, the governor stop control and speed control levers must be correctly positioned before fitting the assembly into the crankcase 'V', as follows :

1 Set the stop control lever on its shaft so that in the NO FUEL position, the lever dips just below the horizontal line, taken from the centre of the shaft (fig. 8). Tighten the lever clamp setbolt.

2 Remove the two speed control lever stop screws, and set the speed control lever on its shaft so that in the MAX. FUEL position, the lower face of the 'cam' is parallel to the stop screw bracket (fig. 8). Tighten the lever clamp setbolt.



1 Speed control lever stop screws
2 Stop control lever - NO FUEL position

Fig. 8 Governor controls

Note: On CV 12 engines, the speed control lever is, itself, controlled by stop screws located in the cross shaft support bracket. (See figure 8, page 9, of Section 2 - Adjustments). The stop screws fitted to the governor bracket may be discarded or fully backed off and locked, as shown in figure 8.

3 Remove the screwed plug in the top face of the governor housing and, using a clean funnel and container, fill the pump cambox with clean engine lubricating oil, as recommended in the leaflet T.S.D.3187 in the rear cover pocket, until the oil level reaches the oil return port in the drive end face of the cambox. Refit the screwed plug.

Fit the injection pump/governor assembly, and connect the shutdown solenoid and speed control linkage. For full details of pump fitting, linkage adjustment and injection pump calibration, see Section 13 of the Workshop Manual, T.S.D. 3169.

FUEL INJECTORS

Service or renew the injectors at the intervals specified in the Servicing Schedule (Section 1). Do not attempt to service injectors unless proper workshop facilities are available.

If the engine is misfiring, and a faulty injector is suspected, it is sometimes possible to locate it by momentarily slackening the gland nut of each injector in turn, whilst the engine is running. If the injector is serviceable, the misfiring will increase; if the injector is faulty, the engine note will not change.

Injector renewal

1 Disconnect and remove the high pressure fuel pipework from the three *injectors in the appropriate rocker box.*

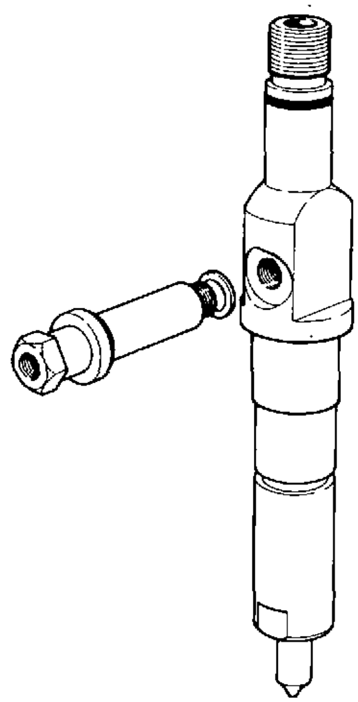


Fig. 9 Fuel injector

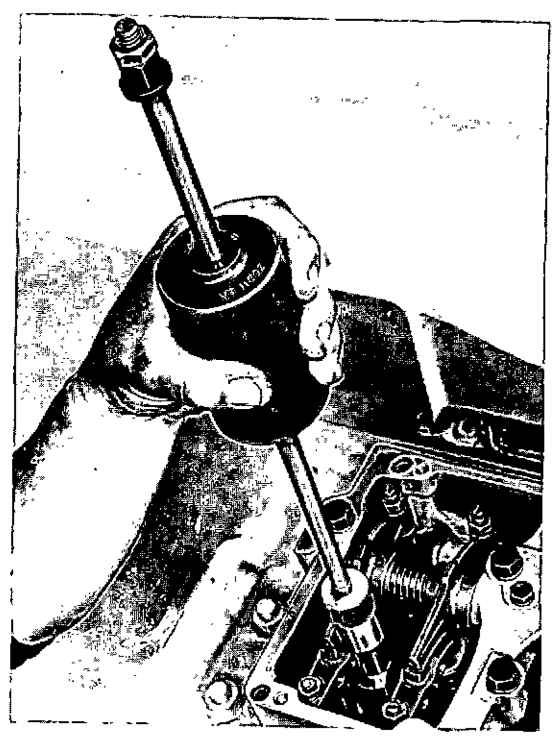


Fig. 10 Using slide hammer

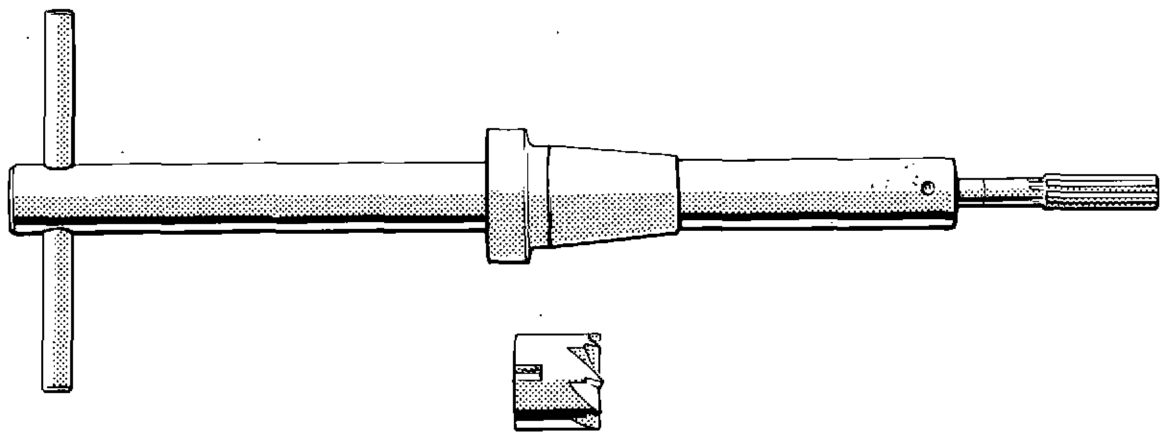


Fig. 11 Reamer and face cutter

2 Unscrew the injector spill connection (fig. 9) from each injector to be renewed, and remove the rocker cover.

3 Release the injector clamp socket capscrew, lift off the finger clamp and spherical washer and withdraw the injector. A sticking injector may be freed using the Slide Hammer, GA 5100, with Adaptor, GA 5100-5. Care must be taken to avoid slackening the copper sleeve in its housing when using the slide hammer (fig. 10).

4 Recondition the injector sleeve using the Reamer, GA 5020, and Face Cutter, GA 5020-2 (fig. 11).

Note: Grease the reamer and cutting tool before use, to retain carbon and metal particles. Do not remove more metal than is absolutely necessary to restore the seating face. The maximum permissible depth of the seating face, measured from the cylinder head top face, is 104,25 mm (4.104 inches).

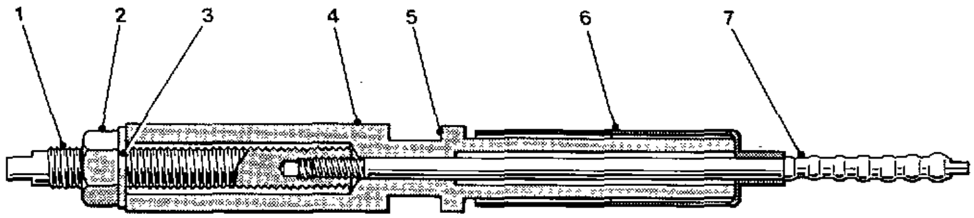
5 Apply a light smear of Rocol-J166 copper-grease or an equivalent to the outside of the fuel injector barrel, prior to fitting, taking care to prevent the injector nozzle becoming contaminated.

6 Fit a new 'O' ring seal around the groove in the body of the replacement injector, and slide the injector into its sleeve. Do NOT fit a sealing washer between the injector and the sleeve face.

7 Screw the spill connection into the injector, through the side wall of the rocker box, using a new copper sealing washer and outer rubber seal; nip up, finger tight.

8 Fit the finger clamp over the injector, position the spherical washer in the clamp and screw in the socket capscrew. Tighten the screw to a torque loading of 60 Nm (42 lbf.ft.).

9 Tighten the spill connection to a torque loading of 27 Nm (20 lbf.ft.).



1 Stud
2 Nut
3 Thrust washer
4 Tool body
5 Tool shoulder
6 Replacement sleeve
7 Ballizer

Fig. 12 Injector sleeve ballizer

INJECTOR SLEEVES

Renewing injector sleeves

If the face of the sleeve has been cut beyond the permissible depth, or coolant is leaking from around the expanded areas of the sleeve and cannot be rectified by further expanding, the sleeve must be renewed as follows :

1 Turn the crankshaft until the piston beneath the sleeve to be renewed is at the bottom of its stroke, i.e.,at BDC.

2 Pack the lower half of the damaged sleeve with a wad of cloth, or a suitable plug, to prevent metal cuttings from entering the cylinder through the nozzle opening.

3 Using the Tap, GA 5023, cut a thread in the sleeve to a depth of at least 25 mm (1 inch).

4 Run the nut of the Extractor, GA 5022, to the top of its thread and screw the stud fully into the injector sleeve tapping.

5 Tighten the nut down against the thrust face of the stud housing and continue turning the nut until the injector sleeve is freed from its cylinder head pocket.

6 Clean out the sealing groove in the cylinder head, taking care not to allow any debris to fall into the cylinder through the nozzle opening. Check for any damage to the sealing faces in the cylinder head.

7 Unscrew the 'ballizing' section of the Expander Tool, GA 5121, from the stud (fig. 12), and slide it through the nozzle of the replacement injector sleeve Part No. CV 7428, as shown in the illustration. Screw the 'ballizer' into the stud, finger tight, with the sleeve locating over the narrow end of the body of the tool.

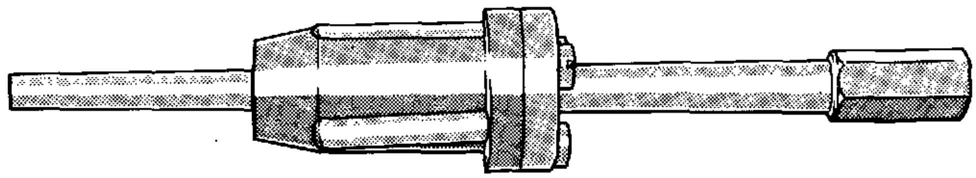


Fig. 13 Sleeve rolling tool

8 Dip the protruding 'ballizer' in a container of clean diesel fuel, and lubricate the stud thread with clean engine oil. Carefully position the sleeve and tool assembly in the cylinder head pocket.

9 Fit the finger clamp, with its spherical washer and socket capscrew, so that it locates on the shoulders of the tool body. Tighten the capscrew securely.

10 Holding the top end of the stud with an open jawed spanner, tighten down the large nut against the thrust washer, until the 'ballizer' is drawn through the nozzle of the sleeve. Unscrew the clamp capscrew and lift out the tool.

11 Locate the roller housing of the Expander Tool, GA 5026 (fig. 13), in the top of the sleeve, with its shoulder resting on the cylinder head top face; slide the tapered shaft through the roller housing

12 Using a suitable socket spanner and speed brace, rotate the shaft whilst applying a steady downward pressure. Keep a continual check on the rolling out process and remove the tool when a band of different coloured metal appears, where the sealing groove encircles the sleeve.

13 Grease the Reamer, GA 5020, and Face Cutter, GA 5020-2, to retain metal particles, and carefully remove any burrs from the nozzle and seating face of the new injector sleeve. Check the depth of the injector seating face.

Renew any other injector sleeves in the same manner, turning the crankshaft as necessary to ensure that the piston beneath the damaged sleeve is at the bottom of its stroke.

Clean the joint faces and, using new self adhesive gaskets, refit the rocker covers. Tighten the cover securing setbolts to a torque loading of 21 Nm (15 lbf.ft.).

Refit the high pressure fuel pipes as described in 'CARE OF THE SYSTEM' in this Section. Refit the spill pipework using new copper sealing washers, and vent the high pressure system as described in 'PRIMING AND VENTING' in this Section.

FUEL INJECTION TIMING

Check the fuel injection timing at the intervals specified in the Servicing Schedule (Section 1), or when a fault is suspected. The injection timing figure is stamped on the engine data plate; for further details, see Section 2 - 'Adjustments'.

SECTION 5 - LUBRICATION SYSTEM

LUBRICATION SYSTEM

1 Governor oil return
2 Governor oil inlet
3 Injection pump oil inlet
4 Injection pump oil return
5 'B' bank auxiliary gallery
6 Pressure inlet to main gallery
7 Oil pump suction strainers
8 Oil-to-coolant heat exchanger
9 Parallel flow filters
10 Pressure relief valve
11 Oil pump casing
12 Piston cooling jets

A High pressure system
B Restricted flow system
C Suction, spill and splash lubrication
D Crankshaft oilways

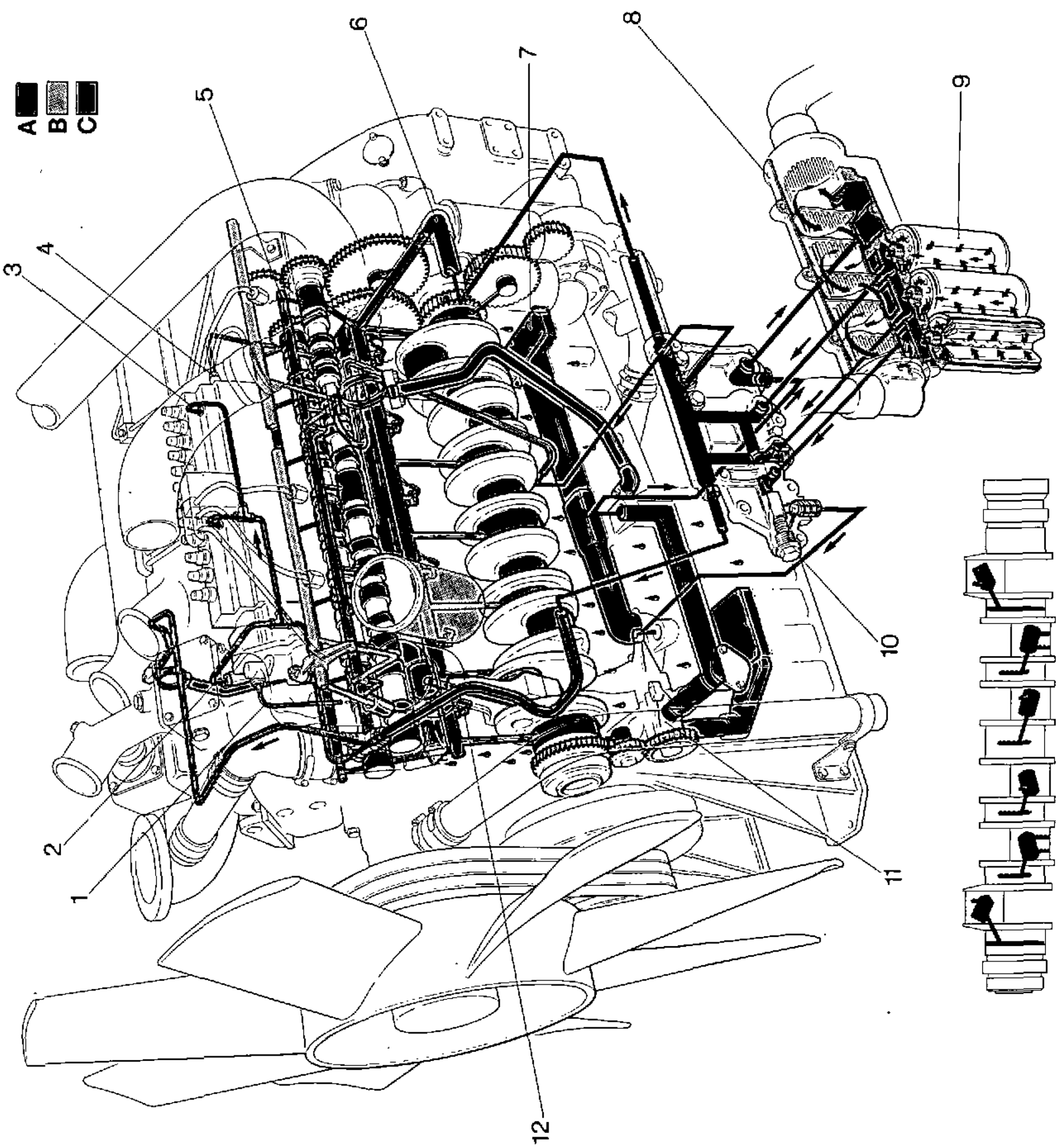


Fig 1 Lubrication system - CV12 Industrial engines

SECTION 5 - LUBRICATION SYSTEM

Description

The wet sump system incorporates a conventional spur gear type pump, driven from the crankshaft front end gearing. The pressurised oil is directed through the oil-to-coolant heat exchanger then through the parallel flow filters, before entering the main oil gallery

Drillings into the main gallery carry oil to the main bearings and, via oilways in the crankshaft and connecting rods, to the big-end and small-end bearings.

Pressure jets assemblies, bolted in the centre of the crankcase and fed from the main gallery, direct cooling jets of oil to the underside of each piston crown.

Two auxiliary galleries, fed from the main gallery, deliver oil to the camshaft bearings, tappets and valve gear.

Drillings, from the front main bearing, deliver oil to the idler axles in the main gear train.

External pipework carries oil, direct from the heat exchanger mounting adaptor, to the turbocharger bearings and, via a 'T' piece connection in the 'A' bank turbocharger supply pipework, to the injection pump and governor.

A pressure relief valve, integral with the heat exchanger mounting adaptor, operates at a pressure of 414 kNf/sq.m (60 lbf/sq.inch), to return excess oil to the engine sump.

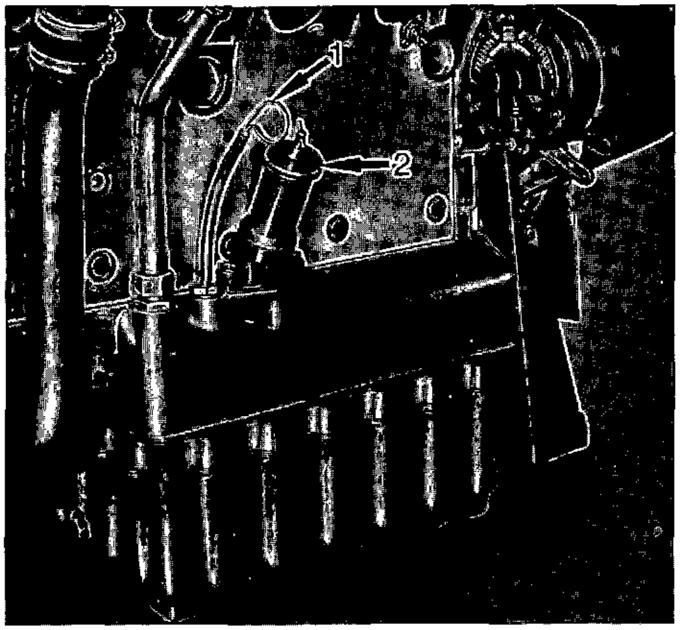
DIPSTICK AND FILLER

The dipstick (fig. 2), carried in a tube secured to the 'A' bank side of the sump adaptor, consists of a flat spring steel blade, cranked at the lower end to lie clear of the tube wall. Notches cut in the cranked section, indicate the maximum and minimum permissible operating oil levels. A mild steel plug with a ring pull handle is brazed to the upper end of the dipstick blade.

The oil filler pipe (fig. 2), is fitted with an expanding rubber plug type cap. To remove the cap, the 'T' piece handle must be turned anti-clockwise. When replacing the cap, do NOT overtighten.

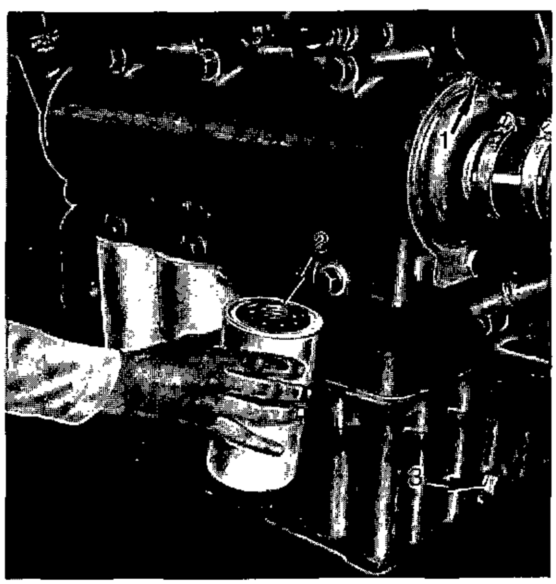
DRAIN PLUG

On early engines, the sump drain plug was fitted in the rear wall of the sump (fig. 3). On current engines, the drain plug is located in the base of the sump adjacent to the original plug position.



1 Dipstick
2 Oil filler cap

Fig. 2 Dipstick and oil filler



1 Tube pack locating screw (2)
2 Oil filter sealing ring
3 Sump drain plug

Fig. 3 Heat exchanger and oil filters

OIL FILTERS

Three expendable canister type filters (fig. 3), are mounted beneath the oil-to-coolant heat exchanger. Each canister has a built-in by-pass valve which opens to allow oil circulation of the system if the element becomes choked.

FILLING AND DRAINING

At the intervals specified in the Servicing Schedule (Section 1), drain the oil from the sump whilst still hot and before sediment has had time to settle.

Place a suitable container beneath the heat exchanger and remove and discard the three filter canisters. Stubborn canisters may be slackened using the Filter Wrench, GA 5074.

Using a new sealing washer, refit the sump drain plug and tighten to a torque loading of 110 to 115 Nm (81 to 85 lbf.ft.).

Clean the contact faces of the filter header, fill three new canisters with the approved type of lubricating oil and screw the canisters on to their adaptors, until the sealing rings just touch the contact face of the header. Tighten each canister a further 3/4 of a turn by hand. DO NOT OVERTIGHTEN.

Using a clean funnel and oil container, fill the sump with the approved type of oil to the UPPER mark on the dipstick. Pause periodically during filling to check the oil level.

Refit the filler cap and run the engine to circulate the oil. Stop the engine and check the oil level. Replenish to the UPPER mark on the dipstick, if necessary.

OIL-TO-COOLANT HEAT EXCHANGER

The heat exchanger (fig. 4) is a single tube pack unit in an aluminium alloy housing, crankcase mounted on the 'B' bank side of the engine. Coolant flows through the tubes, whilst oil is directed over the outside of the tubes by a series of baffles. The multi-finned tube pack construction ensures maximum heat transference efficiency.

Under normal operating conditions, no servicing of the heat exchanger should be necessary between engine overhauls. If scale or sediment is allowed to build up in either system, it may cause overheating which will necessitate the cleaning of the assembly as follows :

1 Drain the engine cooling system, retaining the coolant for re-use if necessary.

2 Place a container beneath the heat exchanger and remove the oil filter canisters.

3 Remove the hose connections from the heat exchanger coolant inlet and discharge pipework.

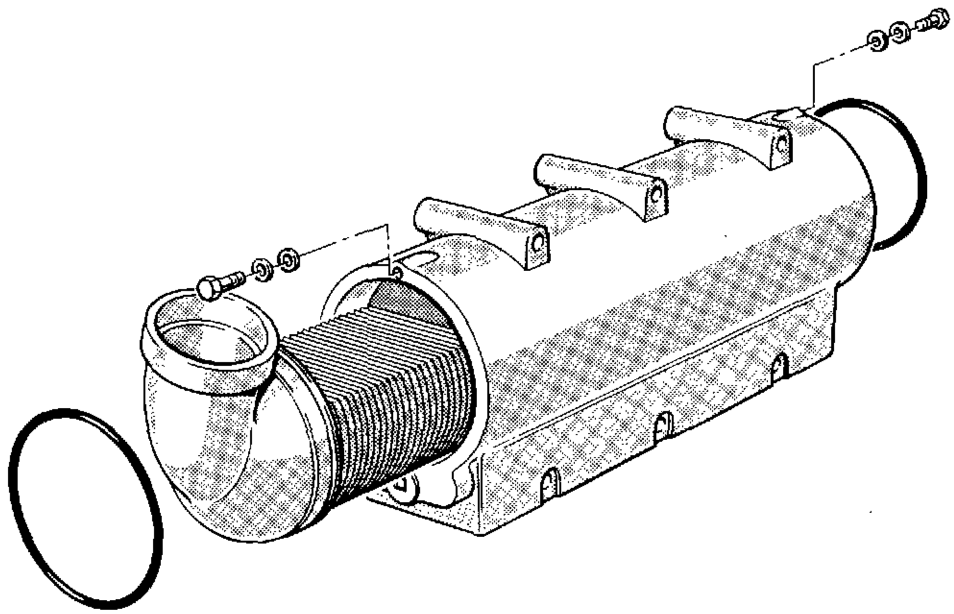


Fig. 4 Heat exchanger assembly

4 Unscrew the six securing setbolts from the heat exchanger, and lift the assembly clear of the mounting adaptor. Remove and discard the four 'O' ring seals from their locating grooves around the oil ports, in the mounting face of the heat exchanger housing.

With the assembly on a workbench, remove the two tube pack locating screws and washers and proceed :

5 Push the tube pack inwards, from the front end, until the rear end 'O' ring seal is clear of the housing; remove the seal.

6 Carefully push the tube pack forwards and out of the housing, taking care not the damage the fins and baffles during the process. Remove the front end 'O' ring seal.

7 Wash the tube pack in paraffin, blow through with compressed air and wash the pack in hot fresh water.

8 Clean the alloy housing, using an emulsifying solvent such as 'Pavan', and wash with hot fresh water.

If hard deposits remain in the tube bores after cleaning, they may be removed as follows :

9 Immerse the pack in a bath containing a solution of one part of inhibited hydrochloric acid to three parts of fresh water.

10 When frothing ceases, immerse the pack in a solution of washing soda in hot fresh water at the following concentration, 0,5 kg to 25 litres (1 lb to 5 Imperial gallons).

11 Remove the pack, blow throught the tube bores with an air jet and wash the pack in hot fresh water.

Inspect the tube pack for corrosion and damage and, if possible, subject the pack to a pressure test by applying air at 172 kNf/sq.m (25 lbf/sq.inch) to the tube bores, with the pack submerged in water at 80 deg. C.

Assemble the heat exchanger as follows :

12 Carefully guide the tube pack in, through the front end of the housing, until the rear 'O' ring groove clears the housing.

13 Fit a new 'O' ring seal, coated with clean engine lubricating oil and, with the locating screw holes aligned with the machined locations in the pack, gently push the tube pack forwards until the front end 'O' ring groove clears the housing.

14 Fit a new 'O' ring seal, coated with clean engine oil, into the front end groove and and push the pack back into the housing.

15 Using new spring washers, insert the two locating screws into the housing and tighten securely.

16 Fit four new 'O' ring seals into the grooves in the heat exchanger mounting face.

Refit the heat exchanger as follows :

17 Check that the contact face of the mounting adaptor is clean.

18 Slide new hose connections, with their hose clips, to the coolant pump discharge pipe and coolant gallery inlet pipe.

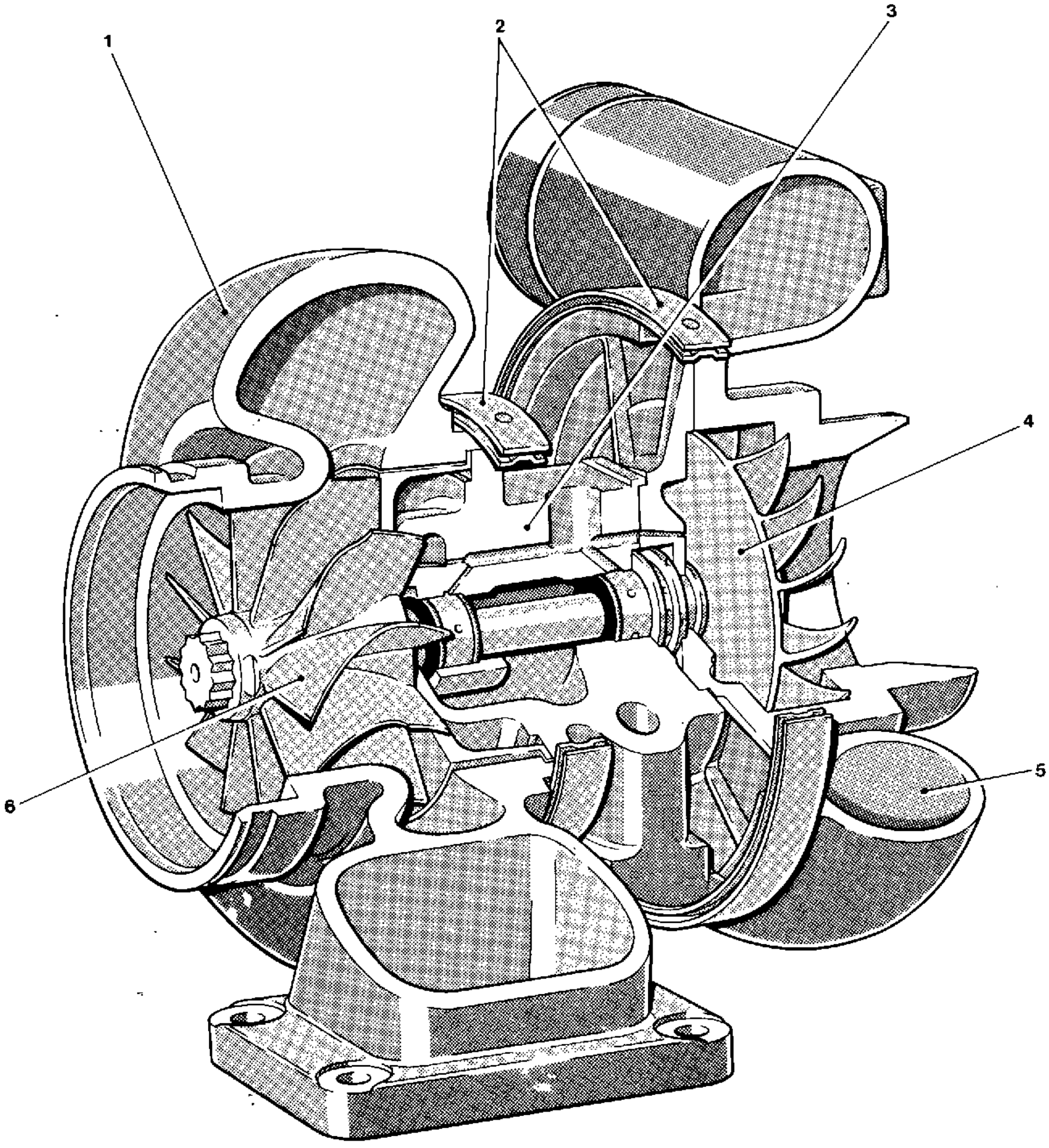
19 Using locally made guide studs, position the heat exchanger assembly against the mounting adaptor and fit the six securing setbolts, with plain and new spring washers. Tighten the setbolts securely.

20 Slide the two hose connections over the pipe joints, and align and tighten the four hose clips.

Fill three new filter canisters with oil of the same specification as that already in use, and fit them as described in 'FILLING AND DRAINING' in this Section.

Fill the cooling system and run the engine; check for leaks and replenish each system as necessary.

SECTION 6 - INDUCTION/EXHAUST SYSTEM



1 Turbine housing
2 'V' band clamps
3 Bearing housing
4 Compressor wheel
5 Compressor housing
6 Turbione wheel

Fig. 1 Turbocharger assembly

SECTION 6 - INDUCTION/EXHAUST SYSTEM

Description

The induction system is designed to provide an adequate volume of clean air to each cylinder, to enable complete combustion of the fuel/air mixture to take place under all engine operating conditions. Leaks or restrictions in the system will adversely affect engine performance.

Ambient air is drawn through the air cleaners by a pair of engine mounted turbochargers and delivered under pressure to the air-to-air charge cooler, which is integral with the radiator.

The charge air passes through rows of finned tubes, which are cooled by the engine driven cooling fan. Connections at each side of the radiator direct the air charge through separate ducts, to each induction manifold.

RESTRICTION INDICATORS

Each air cleaner is fitted with an indicator (fig. 2), which gives visual warning when fouling of the element occurs.

As fouling increases, a red sleeve gradually moves into view in the indicator 'sight glass'. At the limit of fouling, the sleeve will reach the service level and will remain there when the engine is shut down. At this stage, the air cleaner must be serviced immediately.

If, during engine operation, the sleeve shows partial restrication of the cleaner element, there will be no immediate need to service the air cleaner if engine shutdown would be impracticable or inconvenient. It is strongly advised however, that servicing of the cleaner be undertaken at the normal shutdown , before restarting the engine.

After servicing the air cleaner, press the reset button in the top of the indicator to return the red sleeve to its original position, if necessary.

AIR CLEANERS

The two Donaldson, paper element type air cleaners (fig. 3), are normally mounted over the centre or rear end of the engine. The air cleaners are of simple construction and are easily dismantled for servicing.

To service an air cleaner, proceed as follows :

1 Slacken the clamp ring and remove the dust bowl and baffle assembly.

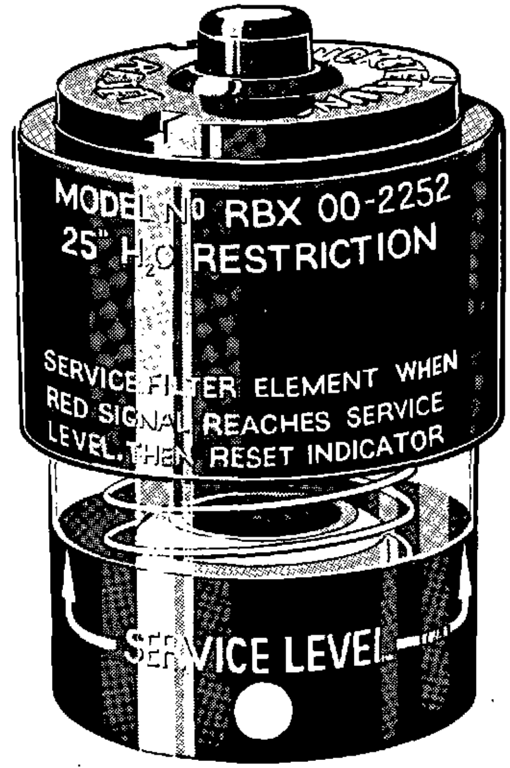


Fig. 2 Air restrication indicator

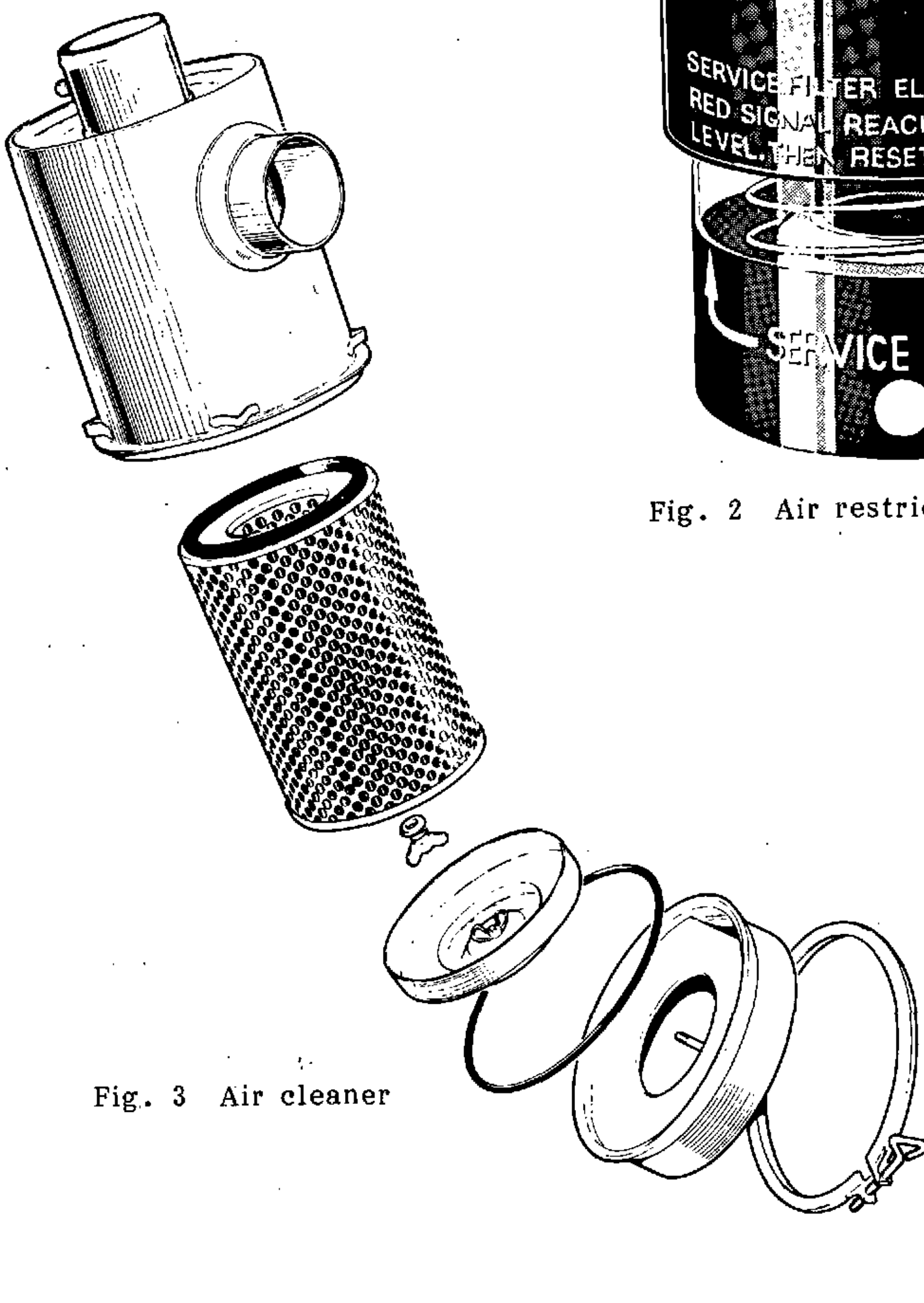


Fig. 3 Air cleaner

SECTION 8 - MISCELLANEOUS

SECTION 8 - MISCELLANEOUS

RUNNING-IN AFTER REPAIR

Every new or reconditioned engine supplied by Perkins Engines (Shrewsbury) Limited, is run-in before leaving the Factory and requires no special treatment when put into service.

When a partial overhaul has involved renewal of cylinder liners and piston rings, it is advisable to subject the engine to a statutory running-in period on a fully equipped test bed, full details of which are given in the Workshop Manual, T.S.D. Publication 3169.

STORAGE

Short term - All engines

Up to seven days - No treatment is necessary.

Up to three months - Each week, run the engine until normal operating temperature is reached. If the engine cannot be run, turn the crankshaft by hand a minimum of three revolutions.

Long term - All engines

If it is necessary to store an engine for a period of between three and twelve months, the following inhibiting procedures must be followed :

1 Remove and clean the thermostats as described in Chapter 3, Section 3.

2 Apply silicone grease, such as MS4, to the thermostat valve spindles, operating the valves by hand to work the grease into the glands. Reassemble each thermostat in its housing.

3 Run the engine until normal working temperature is reached, shut the engine down, and immediately drain the lubricating oil from the sump and oil filter canisters. See 'Note' on page 6.

4 Fill the oil filter canisters with PX4 inhibitor and refit the canisters to the header bracket.

5 Fill the sump to the normal oil level with PX4 inhibitor and, once again, run the engine until normal working temperature is reached.

6 Stop the engine, disconnect the fuel supply and reconnect to a supply of PX4 inhibitor. Restart the engine, whilst still hot, and run it off load for ten minutes. Stop the engine.

Marine engines

If the engine coolant passes through a sea water heat exchanger, as on some marine engines, the sea water inlet and discharge valves must be closed and the sea water system drained.

7 *Flush the sea water system through with clean fresh water.*

8 Connect the sea water pump inlet to a slave tank containing a standard coolant mixture, i.e. 50% inhibited ethylene glycol or inhibited propylene glycol, to which 1% of soluble oil such as Shell Dromus oil, has been added.

9 Route the outlet of the sea water system, back to the tank to complete the circuit.

10 Run the engine briefly, to ensure a thorough circulation of the sea water system. Stop the engine and drain the system completely.

All engines

11 Disconnect the supply of PX4 inhibitor to the fuel system, and blank off the end of the pipe. Drain the fuel filters. See 'Note' on page 6.

Attach a label in a prominent position, to indicate that the fuel system has been disconnected.

12 Remove the fuel injectors and immerse them in a container of PX4 inhibitor.

13 Set the fuel control to the **NO FUEL** position, remove the rocker covers and disconnect the air inlet ducting from the induction manifolds.

14 Motor the engine on the starter and, simultaneously, spray PX4 inhibitor into the manifolds, until vapour emerges from each injector orifice. Reconnect the air inlet ducting.

15 Using a suitable self-metering spray gun, spray 40 ccs. of PX4 inhibitor into each cylinder, through the fuel injector orifice. Refit the injectors.

Note: The engine must NOT be rotated after this operation, and should carry a prominent notice to this effect.

16 Spray the valve gear with PX4 inhibitor; refit the rocker covers.

17 Drain the PX4 inhibitor from the engine sump and oil filter canisters. Attach a **NO OIL** notice to the oil filler cap.

18 Drain the cooling system and refill with a fresh coolant mixture of inhibited ethylene glycol or inhibited propylene glycol and clean fresh water.

Note: The mixture must NOT contain less than 50% inhibited ethylene glycol or propylene glycol, and may contain up to 90% by volume.

19 Allow the system to settle for 15 minutes, then drain the coolant mixture completely. Attach a **NO COOLANT** notice to the coolant filler cap.

20 Disconnect the exhaust pipework at the turbocharger diffuser outlets. Inject two grammes of VPI 260 powder into each diffuser and fit blanking plates. Do NOT reconnect the exhaust pipework.

21 Disconnect the air ducting between the air cleaners and turbochargers.

22 Inject two grammes of VPI 260 powder into each turbocharger.

23 Inject two grammes of VPI 260 powder into each paper element type air cleaner. Oil bath, wire mesh or dry nylon type air cleaners may be sprayed internally with PX4 inhibitor or VPI 260 powder. Refit the air ducting.

24 Brush coat or spray all unpainted areas of the engine and auxiliary equipment with Crodafluid PM47, paying particular attention to to the fuel control linkage.

Caution : Do NOT spray PM47 into the vent apertures of the alternator.

25 Wrap the alternator and starter motor in mouldable wax wrapping, and seal with adhesive tape

26 Seal the air cleaner inlets, crankcase breather and any other openings, with mouldable wax wrapping and adhesive tape.

27 Remove all driving belts, dust them liberally with french chalk and place them in a sealed polythene bag, attached to the engine.

28 Finally, affix a label in a prominent position, stating :

(a) That the exhaust system has been sealed off.

(b) The dates on which the engine was inhibited, and will require re-inhibiting.

If the engine is to remain in strorage for more than one year, the above procedure must be carried out at the end of each twelve months period.

Approved products for engine inhibiting

Component	Product	Manufacturer
Thermostat	MS4 silicone grease	Ambersil Limited Whitney Road Basingstoke Hampshire
Lubrication system	PX4 inhibitor	Croda Chemicals Limited Thelson Works Churchill Road Doncaster Yorkshire
Fuel system	PX4 inhibitor	Croda Chemicals Limited
Cooling system	Inhibited ethylene glycol or inhibited propylene glycol	Various
Induction/exhaust system	PX4 inhibitor and VPI 260 powder	Croda Chemicals Limited Shell Chemicals Limited Stanlow Terminal Ellesmere Port Wirral Cheshire
Engine and auxiliaries - exterior	Crodafluid PM47 Mouldable wax wrapping	Croda Chemicals Limited Carrs Paper Limited Shirley Solihull West Midlands

Note: Spin-on type oil and fuel filter canisters are designed so that when mounted above the header bracket, the lubricating oil or fuel does not drain back into the sump or supply tank from their respective canisters, when the engine is stopped.

To drain a filter canister for inhibition purposes, hold the canister over a suitable container and, using a small blunt instrument inserted into one of the fluid inlet openings, gently press open the rubber, non-return seal.

During this operation, care must be taken not to damage the rubber seal or the internal element of the filter.

REMOVAL FROM STORAGE

All instructions for removal from storage, will be found in Chapter 2 - 'Operating'.

CHAPTER 4 - FAULT DIAGNOSIS

PERKINS ENGINES (SHREWSBURY) LIMITED

SENTINEL WORKS

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2 Unscrew the wing nut and separate the bowl and baffle.

3 Empty the bowl, clean both components and reassesmble them.

4 Unscrew the element-securing wing nut and carefully withdraw the element.

5 Direct a jet of air up and down the inside of the element pleats. DO NOT use air pressure greater than 690 kNf/sq.m (100 lbf/sq.inch), and DO NOT hold the jet nozzle too near the element.

6 Inspect the element for damage by placing a light bulb inside. Thin areas or perforations indicate that the element must be renewed immediately.

7 Clean out any dirt from the air cleaner body, refit the element and dust bowl assembly and tighten up the clamp ring.

8 Reset the restrication indicator.

An alternative method of cleaning the element is to soak it in a solution of special detergent D 1400. If using by this method, the element should not be cleaned more than six times during its service life.

Instructions for use of the special detergent are given on the packet, which may be obtained direct from the manufacturers : Donaldson Filter Components Limited, Haydock, Lancashire, or their agents.

TURBOCHARGERS

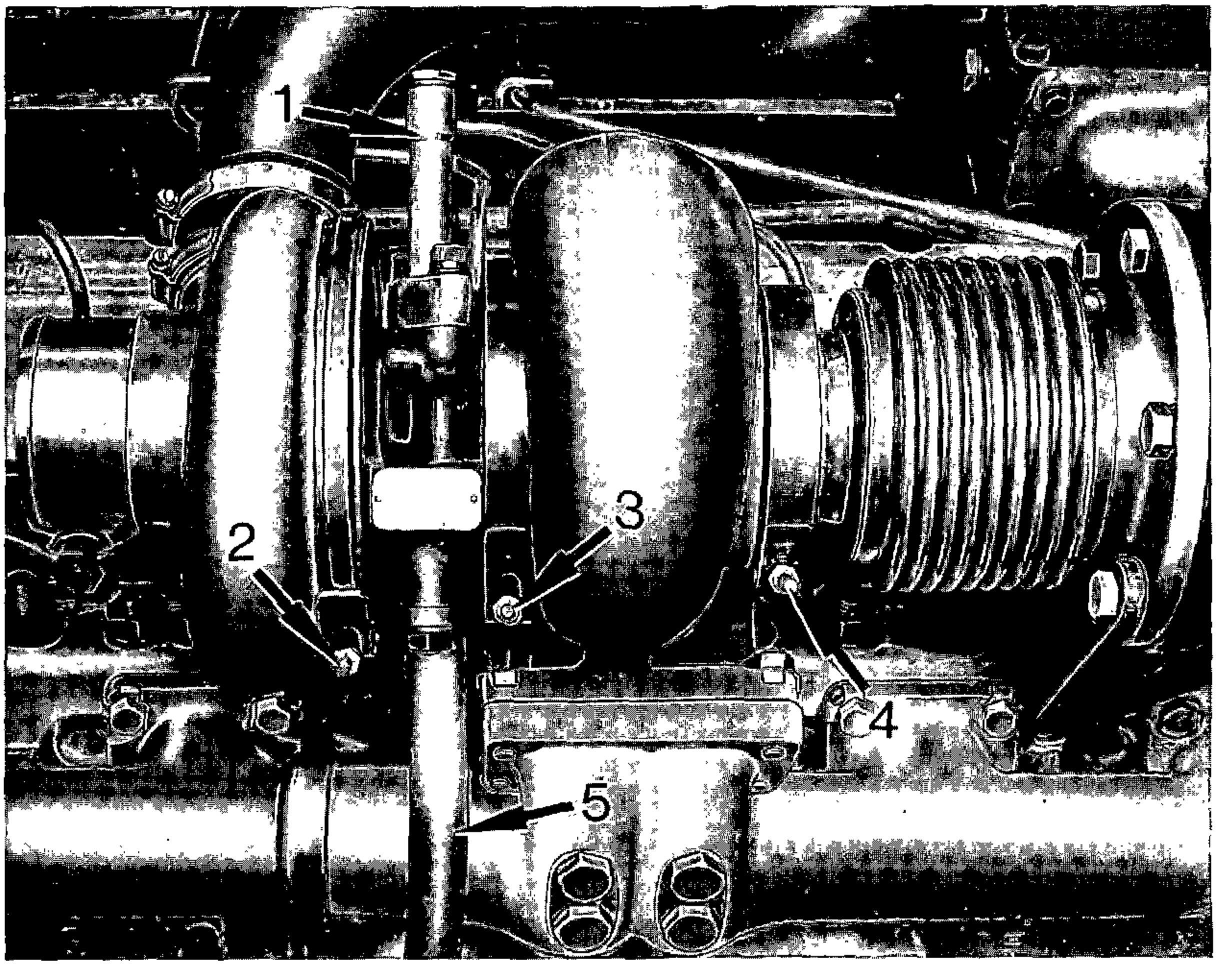
Two Garrett Airesearch Type TV 61 turbochargers (fig. 4), are incorporated in the system. Though simple in principle, a turbocharger is manufactured to fine tolerances and requires careful handling during maintenance operations.

A turbine and compressor wheel, mounted at either end of a common shaft, are supported by fully floating bearings. The compressor and turbine housings are attached to the bearing housing, and are rotationally adjustable to suit the exhaust inlet and compressor outlet connections.

The turbocharger bearings are provided with oil direct from the heat exchanger mounting adaptor oil gallery, with a large bore pipe return to the crankcase.

The waste energy of the exhaust gases is used to drive the unit to increase the induction air flow to the cylinders. Dependent on the application, the exhaust gases then pass through a silencer and out to atmosphere.

Note : For optimum turbocharger efficiency, exhaust back pressure should not exceed 51 mm (2 inches) Hg.



1 Oil priming pipe (if fitted)
2 Compressor housing clamp bolt
3 Turbine housing clamp bolt
4 Exhaust bellows clamp bolt
5 Oil drain pipe

Fig. 4 Turbocharger ('A' bank)

Operating precautions

Before a new or overhauled engine equipped with a turbocharger is run at the Factory, an expendable filter is fitted in the turbocharger oil inlet connection. This filter protects the turbocharger bearings during the initial running-in period; afterwards, the filter is removed and destroyed. Operators adopting this precaution are reminded that the filter MUST be *removed before the engine goes into service.* As the filter cannot be cleaned, it is important that it is destroyed to prevent re-use.

If the engine has been out of use for a month or longer, the turbocharger bearings must be primed before engine start-up as follows :

1 Unscrew the plug in each priming pipe or turbocharger bearing housing, as applicable (fig. 4).

2 Using a clean funnel and container, pour 0,2 litre ($^1/3$ pint) of clean engine oil into each bearing housing. Refit the plug and tighten securely.

Before engine shutdown, run the engine 'off load' for three minutes, to allow the turbochargers to cool down.

Never continue to run an engine if the oil pressure drops below 207 kNf/sq.m (30 lbf/sq.inch), at rated speed.

Maintenance in service

The following points should receive particular attention :

1 Service the air cleaners at the intervals specified in the Servicing Schedule (Section 1).

2 At frequent intervals, inspect the induction and exhaust systems for leaks and deterioration of hose connections, which could cause overheating. If either system is disturbed, the components must be reassembled carefully to ensure perfect joints, and to prevent cracking of manifolds due to uneven tightening.

3 During service, take care to prevent dirt or loose articles from entering the induction and exhaust systems, where they could cause damage to the compressor wheel or turbine blades.

4 At frequent intervals, check that the turbocharger oil feed and drain pipes are undamaged. Restriction of oil flow in either pipe could result in bearing failure. At oil change intervals, check the drain pipe bore.

5 Ensure that the crankcase breather pipe is unrestricted at all times. Pressurisation of the crankcase will prevent free return of oil from the turbocharger bearings.

6 Use the recommended grade of lubricating oil and maintain the lubrication system in accordance with the Servicing Schedule (Section 1).

7 Periodically, check the exhaust system for restrications, e.g., choked silencer or damaged exhaust pipes. Overheating and loss of performance will occur if the exhaust back pressure exceeds 51 mm (2 inches) Hg. under full load conditions.

8 If investigation of an engine fault involves checking a turbocharger, remove the induction ducting and spin the rotor assembly by hand. Check for freedom of movement and listen for sounds indicating rubbing or binding. To avoid imbalance of the assembly, it is not advisable to remove deposits from the turbine or compressor wheel. If necessary, remove the turbocharger for cleaning and bearing checks as described later.

Turbocharger failure

The cause of failure must be found and rectified before a replacement unit is fitted. It will also be necessary to check if the failure has caused damage to other engine components.

A damaged compressor will necessitate inspection of the entire induction system to locate the cause. The engine cylinders must checked for damage and the induction and exhaust systems, including the charge cooler tube bores, cleared of debris.

A damaged turbine may be due to loose particles from the exhaust manifold or engine cylinders. These components must be examined and the exhaust system cleaned out before a replacement turbocharger is fitted.

Excessive bearing wear can result in the compressor rubbing on its housing. Particles of aluminium, produced by this contact, may be drawn into the engine liners, causing piston scuffing and liner wear.

Faulty lubrication is the most probable cause of turbocharger bearing failure. This may be the result of low oil pressure or restricated oil flow, but is more likely to be attributable to contaminated or diluted oil.

Following turbocharger bearing failure, the engine lubricating oil must be changed and the oil filters renewed before fitting a replacement turbocharger.

Incorrect air delivery pressure

Pressure below normal may be caused by :

(a) Choked air cleaner.

(b) Insufficient fuelling.

(c) Leaks in induction or exhaust system.

(d) Damaged turbine.

(e) Dirty or damaged compressor.

Pressure above normal may be caused by :

(a) Excessive fuelling.

(b) Build up of carbon in the turbine housing.

If the injection pump MAX. FUEL stop seal is broken, the pump must be removed for fuelling adjustment on a test rig.

If the seal is unbroken, the turbocharger must be dismantled for inspection of the turbine housing.

Cleaning and serviceability checks

1 Remove the ducting between the air cleaner and the compressor inlet.

2 Remove the hose connection from the compressor outlet/charge cooler ducting, and remove the 'V' band clamp from the exhaust bellows connection.

3 Disconnect the oil inlet and oil drain pipes from the bearing housing.

4 Remove the four turbocharger securing nuts and washers and lift off the turbocharger. *Cover all openings against the ingress of dirt.*

5 With the turbocharger on a workbench, remove the two 'V' band clamps from the bearing housing and carefully lift off the outer housings, taking care not to damage the rotor blades.

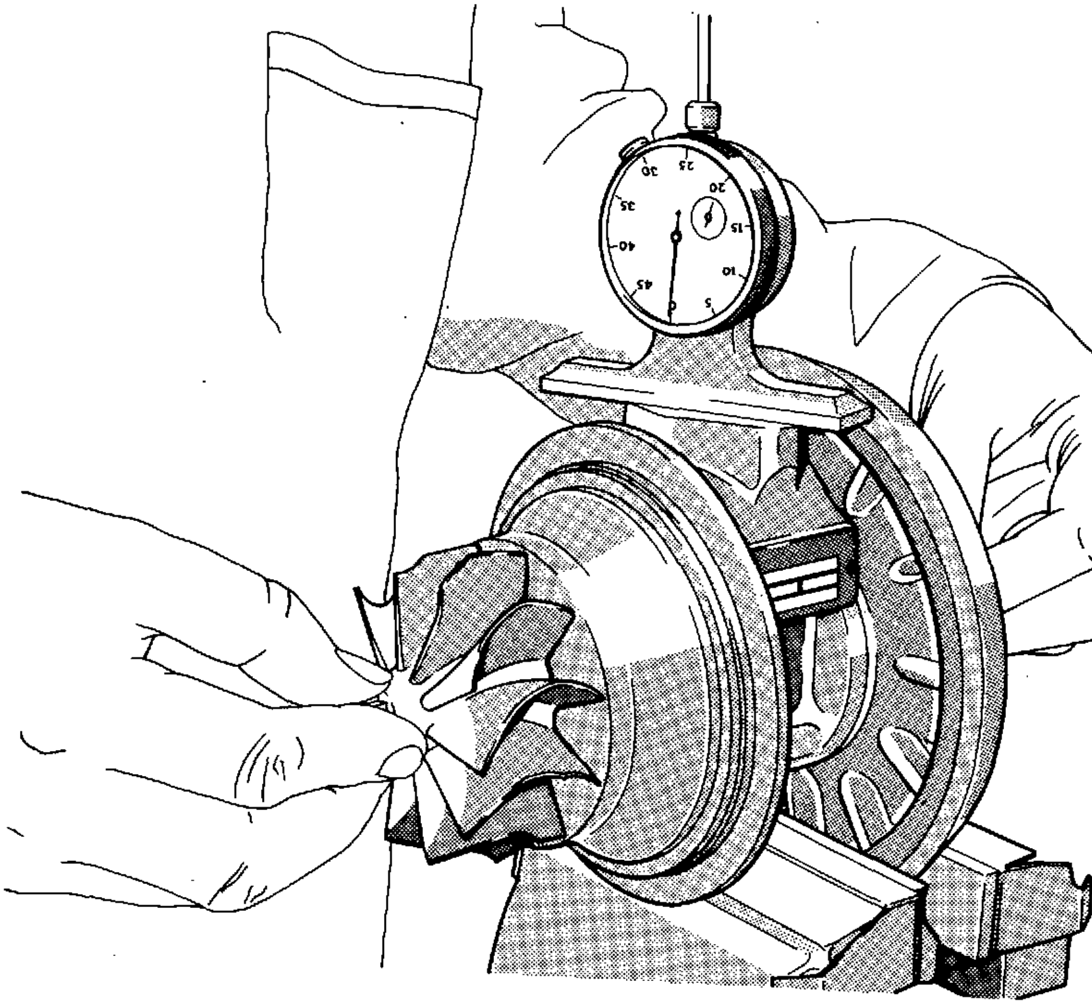


Fig. 5 Radial movement check

6 Check the housings and the rotor blades for signs of rubbing, and clean the components in a non-caustic cleaning solution.

7 Remove any build-up of carbon or dirt with a bristle brush or plastic scraper, ensuring that no deposits remain which might cause imbalance of the assembly.

8 Check the radial movement of the rotor shaft assembly by mounting a D.T.I. on the oil inlet flange, as shown in figure 5, with the button resting on the shaft. Holding the shaft at each end, raise and lower the assembly to its full extent and check the readings on the dial. The total reading should not exceed 0,15 mm (0.006 inch).

9 Mount a D.T.I. as shown in figure 6, with the button resting on the compressor end of the rotor shaft. Move the shaft axially to its full extent in both directions and check the readings on the dial. The total end float should not exceed 0,25 mm (0.010 inch).

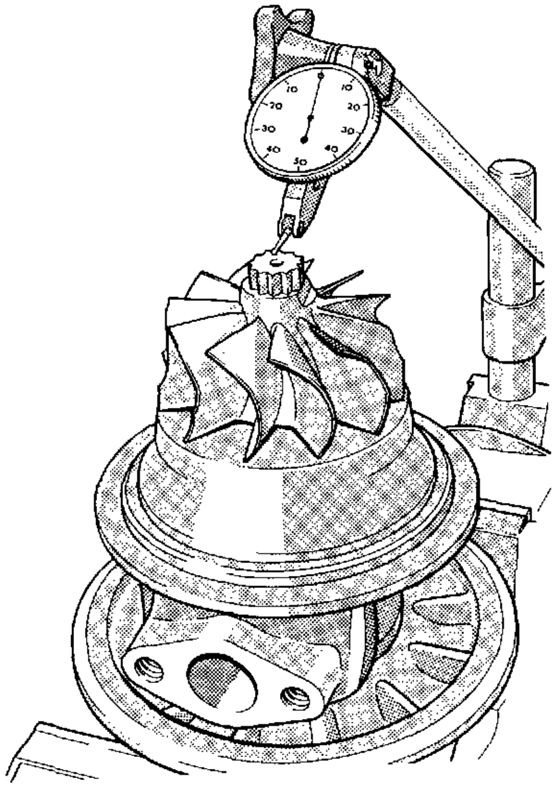


Fig. 6 End float check

Readings beyond these limits will involve a complete overhaul of the turbocharger. For relevant information, consult the Service Department of Perkins Engines (Shrewsbury) Limited.

Reassemble the turbocharger housings, lightly nipping the two 'V' band clamp nuts. Spin the rotor assembly and listen for any sounds of rubbing or binding.

Refit the turbocharger as follows :

10 Clean the exhaust manifold supporting flange, oil inlet and drain pipe flanges, exhaust bellows unit contact face, and check the charge cooler ducting for cleanliness; slide a new hose connection and two hose clips over the end of the ducting.

11 Locate the turbocharger over the studs on the exhaust manifold flange, coat the stud threads with 'Copaslip' anti-seize compound and, using new locking washers, fit the four retaining nuts. Tighten the nuts securely and tab up the locking washers.

12 Fit the 'V' band clamp over the turbocharger/bellows unit joint and tighten the clamp nuts of the turbine housing, and bellows unit, to the correct torque loading.

13 Slacken the compressor housing 'V' band clamp nut, align the compressor outlet with the charge cooler ducting and slide the hose connection over the joint. Tighten the 'V' band clamp nut to the correct torque loading; align and tighten the two hose clips.

14 Using a new gasket, fit the oil inlet pipe to the top of the bearing housing; tighten the two securing setbolts.

15 Remove the priming plug and prime the turbocharger with clean engine lubricating oil, as described under 'Operating precautions'. Spin the compressor wheel by hand to work the oil into the bearings.

Before fitting the air inlet ducting, the turbocharger oil feed should be checked as follows :

16 Place a suitable container beneath the turbocharger oil drain connection and, holding the compressor nut with the appropriate socket spanner, run the engine briefly the check for an adequate flow of oil from the drain connection. Stop the engine and remove the spanner.

17 Using a new gasket, fit the oil drain pipe to the base of the bearing housing, and tighten the two securing setbolts.

18 Check the air cleaner ducting for cleanliness and fit a hose connection and two hose clips over each end.

19 Position the ducting between the compressor inlet and the air cleaner, slide the two hose connections over the joints, and align and tighten the four hose clips.

CHARGE COOLER

The charge cooler, of aluminium construction, is integral with the radiator and consists of a series of finned tubes, over which air is forced by the engine driven fan.

Servicing of this component is minimal and consists of maintaining the induction system in a clean condition, and ensuring that the tube fins are not allowed to become choked with dirt.

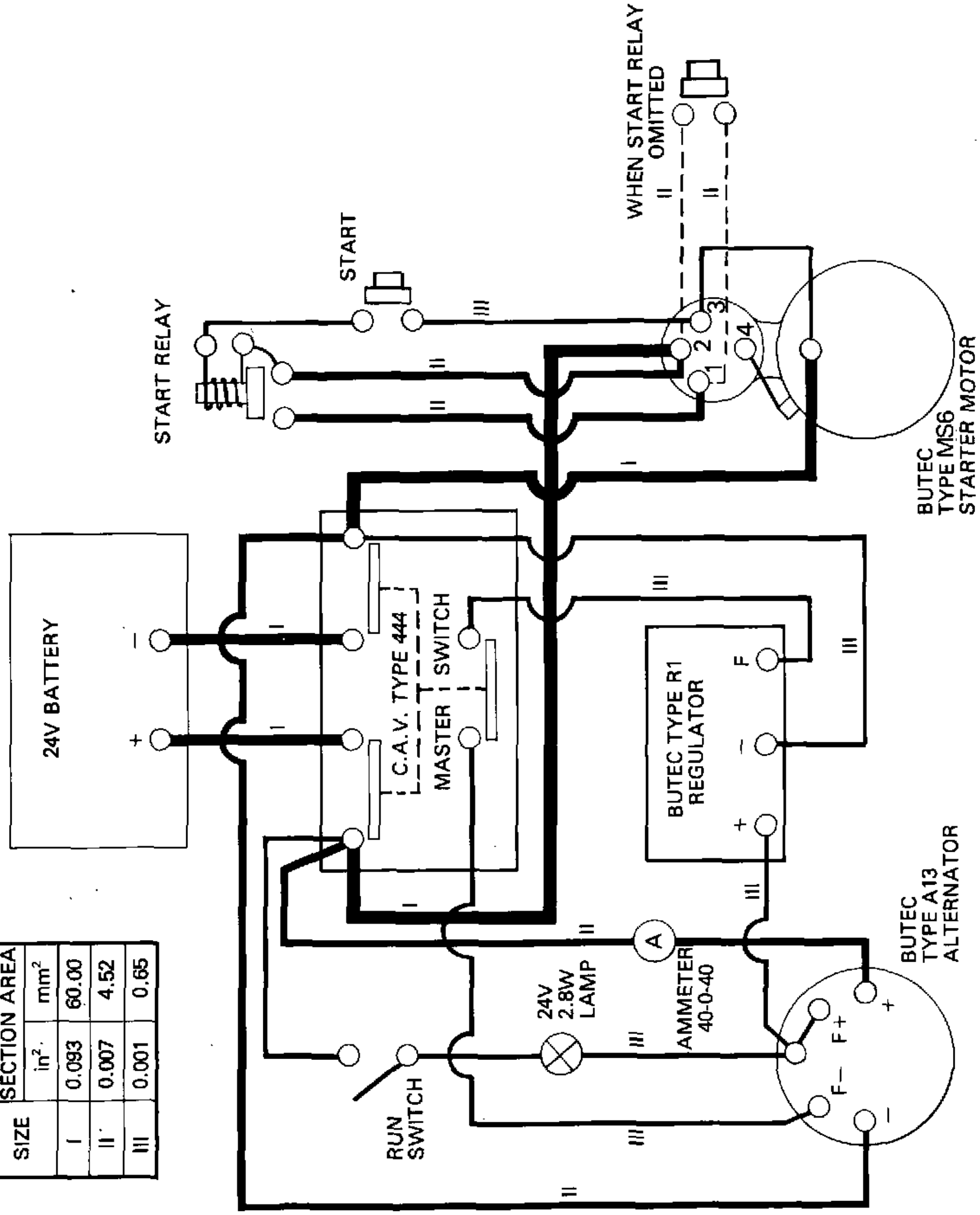
To remove oil or dirt adhering to the fins, use a bristle brush and detergent solution, rinse with clean water and blow dry with a compressed air jet.

Cleaning aluminium components

If the induction system is allowed to become contaminated with oil, as could happen if the turbocharger oil deflector or piston rings become damaged or worn, the components may be cleaned using an emulsifying solvent, such as 'Pavan'. Ideally, each component should be immersed in a bath of the solvent, washed thoroughly with clean water, and dried before refitting. Repeat the operation if necessary.

As it may be impracticable to immerse the charge cooler, the radiator must be partially dismantled to enable the solvent to be sprayed into each tube. Ensure that all deposits are thoroughly wetted and allowed to soak for 10 to 15 minutes. Wash the tubes with a steam cleaner or high pressure water jet, and dry thoroughly before reassembling the radiator.

SECTION 7 - ELECTRICAL EQUIPMENT



CABLE DATA		
SIZE	SECTION AREA	
	in²	mm²
I	0.093	60.00
II	0.007	4.52
III	0.001	0.65

Fig. 1 Typical wiring diagram

SECTION 7 - ELECTRICAL EQUIPMENT

Description

There are two types of belt driven alternators currently in use on CV 12 Industrial engines, the Butec Type A 3024, with an integral regulator, and the Butec Type A13, with a separate Type R1 regulator. Each alternator provides a nominal output of 24 volts for the battery charging circuit.

The output voltage from the Type R1 regulator is continuously variable between the normal 'high' and 'low' level limits, to suit the Operator's requirements.

A Butec Type MS 6 starter motor, flange mounted on the flywheel housing, engages with a conventional toothed starter ring, integral with the flywheel.

Two Teddington control switches, incorporated in the lubrication and cooling systems, are connected to a solenoid stop control unit which is mounted in the crankcase 'V'. The switches operate at a pre-selected oil pressure or coolant temperature, to shut down the engine for component protection.

The solenoid, which may be a C.A.V. Type 368 or a Synchrostart Type 2001 unit, is directly linked to the shutdown stop control lever, on the injection pump governor.

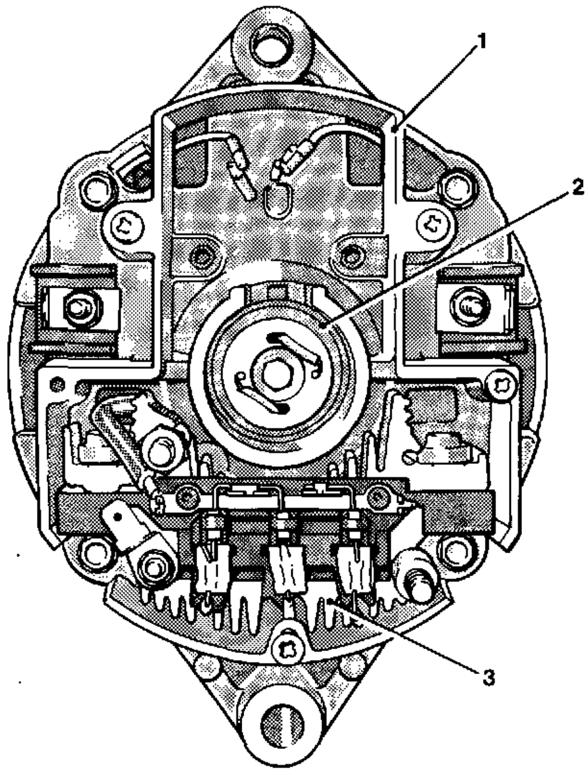
ALTERNATOR (Type A 3024)

The three phase star connected alternator (fig. 2), is of the rotating field, stationary armature (stator) type. The twelve pole rotor is dynamically balanced, to ensure safe operation at high speed.

Rectification of the output is by six silicon diodes contained in two heat sinks, mounted in the slip ring end housing. An integral regulator, which utilises thick film circuitry, is mounted on the slip ring end housing and controls the output.

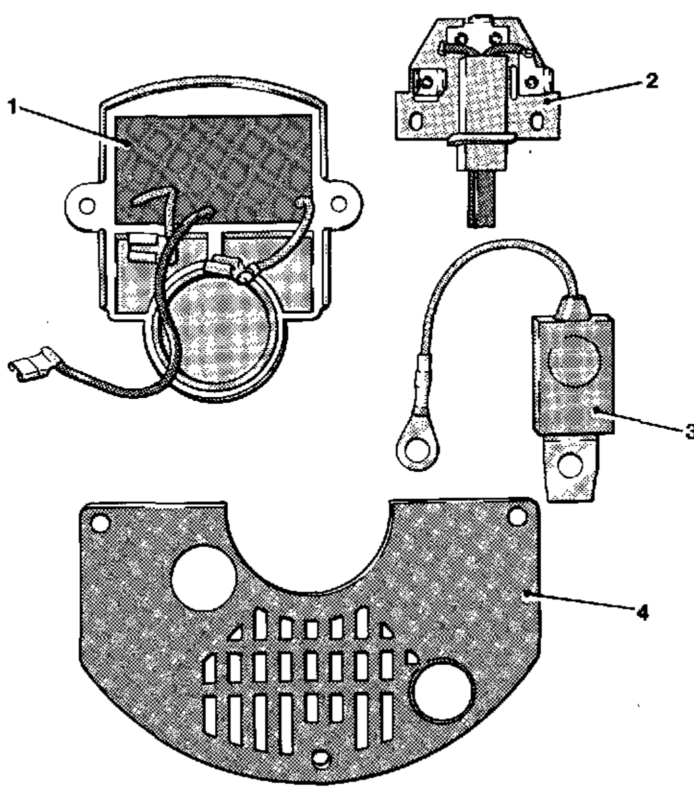
Field excitation is provided through three auxiliary diodes, mounted in the centre of the rectifier assembly.

A centrifugal fan draws cooling air through the alternator, over the heat sink fins.



1 Brush gear housing
2 Slip ring assembly
3 Rectifier assembly

Fig. 2a Butec Type 3024 alternator



1 Regulator
2 Brush box assembly
3 Capacitor
4 Plastic cover

Fig. 2b Butec Type 3024 alternator

Technical data

Voltage..24 volts.
Maximum rated output (hot).............32 amps at 28 volts.
Cut-in speed....................................900 rpm.
Max. continuous operating speed.................10 000 rpm.
Stator resistance across two phases.............0.483 ohms.
Rotor resistance........................13.8 to 14.2 ohms.
Rotation.....................................Reversible.
Maximum ambient temperature.....................93 deg. C.

Servicing

Periodically, dependent on operating conditions, clean the exterior of the alternator and ensure that the ventilation apertures are clear. Fouling in the vicinity of the diodes can cause flashover, and should be removed by spraying with an approved cleaning fluid such as Electronic Cleaning Fluid, Grade 8-23, available in aerosol or bulk form, from Applied Chemicals Limited, Uxbridge, Middlesex.

At the intervals specified in the Servicing Schedule (Section 1) :

1 Check the condition and tension of the driving belt; adjust or renew, if necessary, as described in Section 2.

2 Remove the two securing screws from the regulator assembly, lift off the regulator and, noting the positions for reassembling, disconnect the two regulator leads from the brush box terminals.

3 Noting the positions for reassembly, disconnect the two alternator-to-brush box leads. Remove the two brush box retaining screws and lift out the assembly. Check the condition of the brushes and ensure that each brush protrudes at least 10,0 mm (0.394 inch) from the brush box. See the Workshop Manual T.S.D. 3169, for details of brush renewal.

4 Remove the four securing screws, withdraw the brush gear housing, and inspect the slip ring assembly.

5 Clean off any dirt from the components using a soft cloth moistened with petrol or white spirit. Worn or scored slip rings must be renewed as described in the Workshop Manual, T.S.D. 3169.

ALTERNATOR (Type A13)

The three phase, delta connected alternator (fig. 3) is of the rotating field, stationary armature (stator) type, with a self limiting current output. Rectification is by six, replaceable, heavy duty silicon diodes, carried in suitably finned heat sinks. Three auxiliary, field sensing diodes, attached to the A.C. terminals, allow the use of a warning light.

The rotor bearings are sealed for life, and the slip ring assembly and brush gear are shielded to prevent ingress of dirt.

A centrifugal type fan, mounted on the drive end of the rotor shaft, draws cooling air through the alternator and over the heat sink fins.

1 Aux. diode capsule
2 Brush assembly

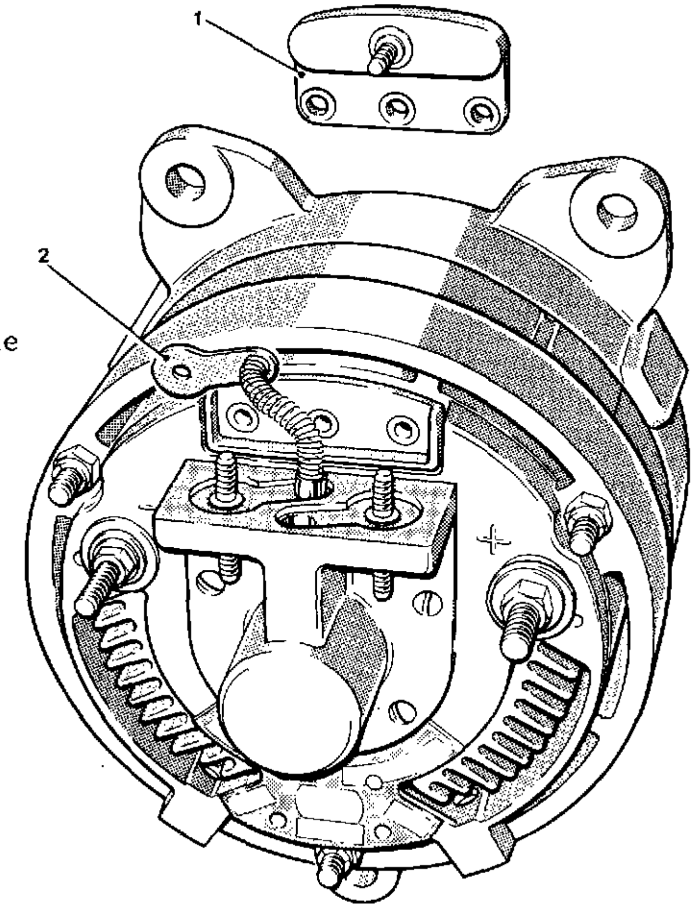


Fig. 3 Butec Type A13 alternator

Technical data

Maximum rated output (hot)	30 amps at 28 volts.
Cut-in speed (hot)	830 rpm.
Max. cont. operating speed	10 000 rpm.
Stator phase resistance	0.454 to 0.494 ohms at 20 deg.C.
Rotor resistance	13.6 to 15.2 ohms at 20 deg.C.
Rotation	Reversible.
Max. ambient temperature	93 deg.C.

Servicing

Periodically, dependent on operating conditions, clean the exterior of the alternator and ensure that the ventilation apertures are clear. Fouling in the vicinity of the diodes can cause flashover, and should be removed by spraying with an approved cleaning fluid such as Electronic Cleaning Fluid, Grade 8-23, available in aerosol or bulk form, from Applied Chemicals Limited, Uxbridge, Middlesex.

At the intervals specified in the Servicing Schedule (Section 1) :

1 Check the condition and tension of the driving belts, and adjust or renew them if necessary as described in Section 2.

2 Remove the securing screws from the auxiliary diode capsule and lift off the capsule.

3 Remove the two securing nuts, cover and gasket from the brush gear. Lift out each brush assembly and check the brush condition and spring tension. Minimum permissible brush length is 4,76 mm (0.187 inch).

4 Remove the four securing screws from the brush gear housing, lift off the housing and examine the slip rings. Clean off grease and dirt using a soft cloth, moistened with petrol or white spirit. Worn or scored slip rings must be renewed, as described in the Workshop Manual, T.S.D. 3169.

VOLTAGE REGULATOR

The self-limiting properties of the alternator allow the use of a regulator of simple and reliable design. The Butec Type R1 regulator utilisers a printed circuit board, with no moving parts, and is suitable for positive, negative or earth return systems.

The semi-conductors in the circuit control the alternator field current which regulates the output current over the full operating range. The unit requires no maintenance during service.

MAINTENANCE PRECAUTIONS

Caution : The diodes and transistors in the battery charging system will be destroyed if they are subjected to voltage changes or high temperatures. To prevent this from occuring, DO NOT :

1 Disconnect the battery whilst the alternator is still running.

2 Disconnect any leads without first stopping the alternator and turning all switches to OFF.

3 Connect any lead without ensuring that it is being fitted to the correct terminal.

4 'Flash' a connection to check current flow.

5 Permit anyone other than a qualified electrician to work on the system.

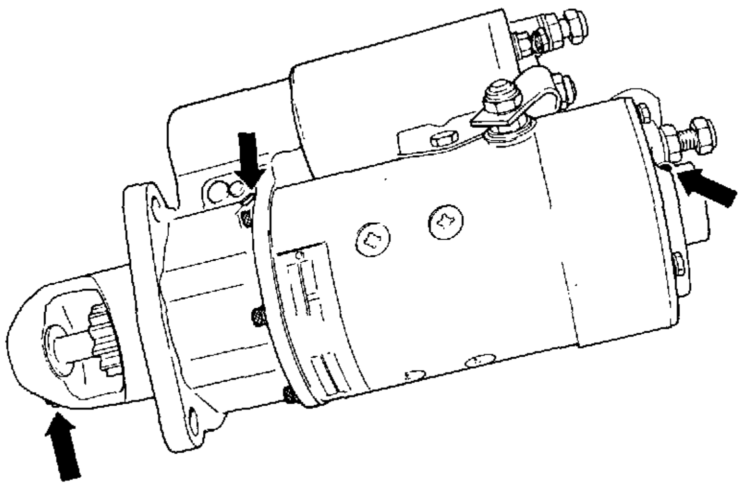
6 Permit any arc welding to be carried out in the vicinity of the electrical circuits, without first isolating all the components.

STARTER MOTOR

Description

The Butec Type MS6 starter motor incorporates an externally mounted solenoid switch.

When the start button is pressed, a pull-in coil in the solenoid moves the plunger until the starter contacts close. At this point, the pull-in circuit will be in parallel with the contacts and no current will flow in the coil. A second circuit in the solenoid flows through a hold-in coil, which maintains the plunger in the starter operating position, until the start button is released. The solenoid plunger action is transmitted to the starter pinion via a hinged lever arm arrangement.



Grease points arrowed

Fig. 4 Butec Type MS6 starter motor

An over-running clutch, incorporated in the pinion assembly, prevents damage to the starter ring teeth, pinion teeth and the armature, when the engine fires.

When the start button is released, a return spring drives the pinion back along the splined armature shaft, to its original position.

Servicing

The MS6 starter is designed to operate with the minimum of servicing. Every 12 months :

1 Disconnect and remove the starter motor from the flywheel housing. Clean the starter casing and remove gummy deposits from the drive splines with petrol or paraffin.

2 Remove the commutator cover band and, using an air jet, blow out any dirt or carbon particles from the brush gear.

3 Check the commutator for wear or damage; a dark brown discoloration indicates a satisfactory condition. A worn or damaged commutator must be renewed or reconditioned, as detailed in the Workshop Manual, T.S.D. 3169.

4 Ensure that the brushes slide freely in their holders and that the spring loading is 1,42 to 1,68 kgf (50 to 59 ozs) as each brush just clears the commutator. A significantly lower figure indicates worn brushes, which must be renewed as a set and bedded to the curvature of the commutator using fine glass paper, NOT emery or carborundum. The minimum permissible brush length is 15,9 mm (0.625 inch).

5 Blow out any abrasive particles from the brush gear, using an air jet, and check that all brush leads are clear of other components.

6 Apply glycerine to the cover band gasket and refit the band so that the joint is over a rib of the starter casing.

7 Remove the screwed plugs (fig. 4), and apply two or three drops of clean S.A.E. 5W/20 engine oil to each lubricator wick. Refit the plugs securely.

Note : Replacement starter motors should be lubricated in this manner, before fitting.

8 Apply a thin film of light graphite grease to the drive splines, and check that the pinion slides freely.

9 Refit the starter motor to the flywheel housing and tighten the securing bolts

10 Ensure that the terminals are clean and firmly secured before connecting the cables.

SOLENOID STOP CONTROL

Description

The solenoid switch, which may be either of two types, a Synchro-Start Type 2001, or a C.A.V. Type 368, is mounted on the inner wall of the 'A' bank induction manifold. The solenoid is used in the energised-to-run mode, and is connected, via a linkage, to the governor stop control lever.

On energising, the dual circuits in the solenoid actuate a plunger which, in turn, moves the stop control lever to the RUN position.

A pull-in coil draws the plunger in the direction of the arrow (fig. 5) until the internal switch contacts are open. This breaks the circuit in the pull-in coil and leaves a low consumption hold-in coil energised, maintaining the stop lever in the RUN position. On de-energisation, a coil spring returns the plunger to its rest position and the stop control lever to STOP. This occurs when the STOP button is pressed, when an engine protection device breaks the circuit or as the result of an electrical failure.

Adjustments

Both types of unit require accurate adjustment of the control linkage between the solenoid and the stop control lever. Incorrect setting can cause damage to the fuel injection pump or, cause the pull-in windings to overheat and eventually burn out.

Before the electrical connections are made, adjust the solenoid linkage as follows :

C.A.V. Type 368

1 Ensure that the stop control lever is positioned on its shaft so that in the NO FUEL position, the lever dips just below the horizontal line taken through the centre of the shaft.

2 Remove the rubber boot from the terminal block to observe the switch and connect the solenoid control rod to the bellcrank lever. Operate the unit manually to check that the switch opens when the plunger is pressed fully home, with a further 0,5 to 0,8 mm (0.02 to 0.03 inch) travel to compress the spring in the spherical joint.

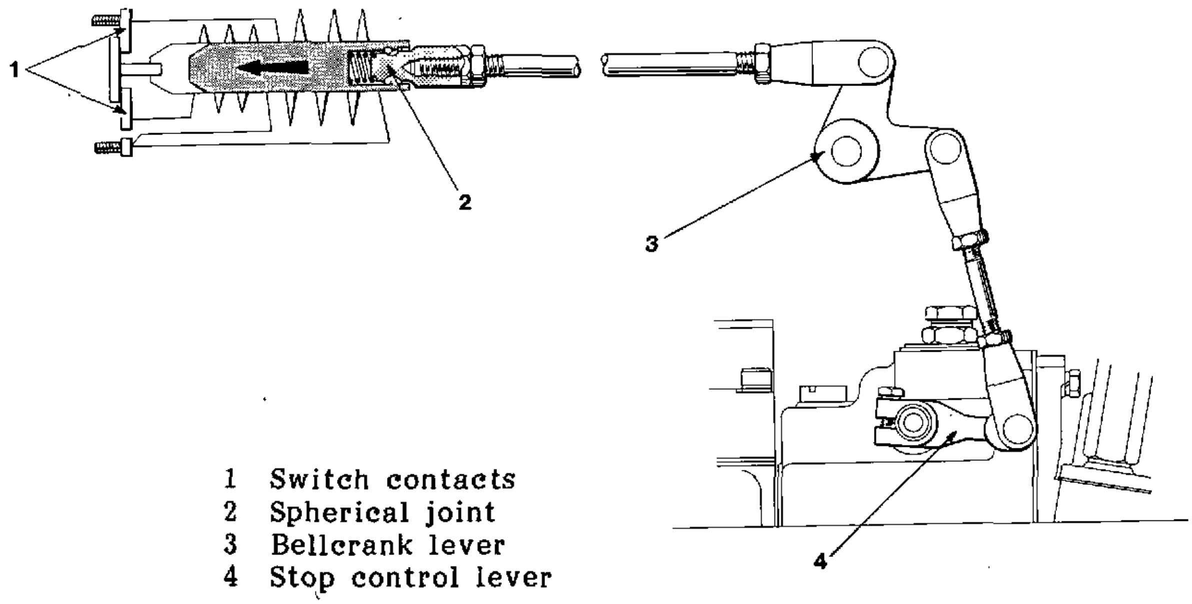


Fig. 5 Solenoid stop control (C.A.V.)

3 Adjust the control rod length to achieve the above requirements then tighten the locknuts.

4 Connect the electrical wiring to the terminals and fit the rubber boot, ensuring that the securing clips are tightened.

Synchro-Start Type 2001

1 Position the stop control lever as for the C.A.V. type solenoid.

2 Connect the control rod to the solenoid so that when the stop control lever is in the RUN position, the plunger 'bottoms' in the solenoid housing. This is to ensure that the internal switch contacts are open in the energised position. Tighten the locknuts.

3 Connect the electrical wiring, secure the terminal cover and check that the rubber boot at the linkage end of the solenoid is correctly located.

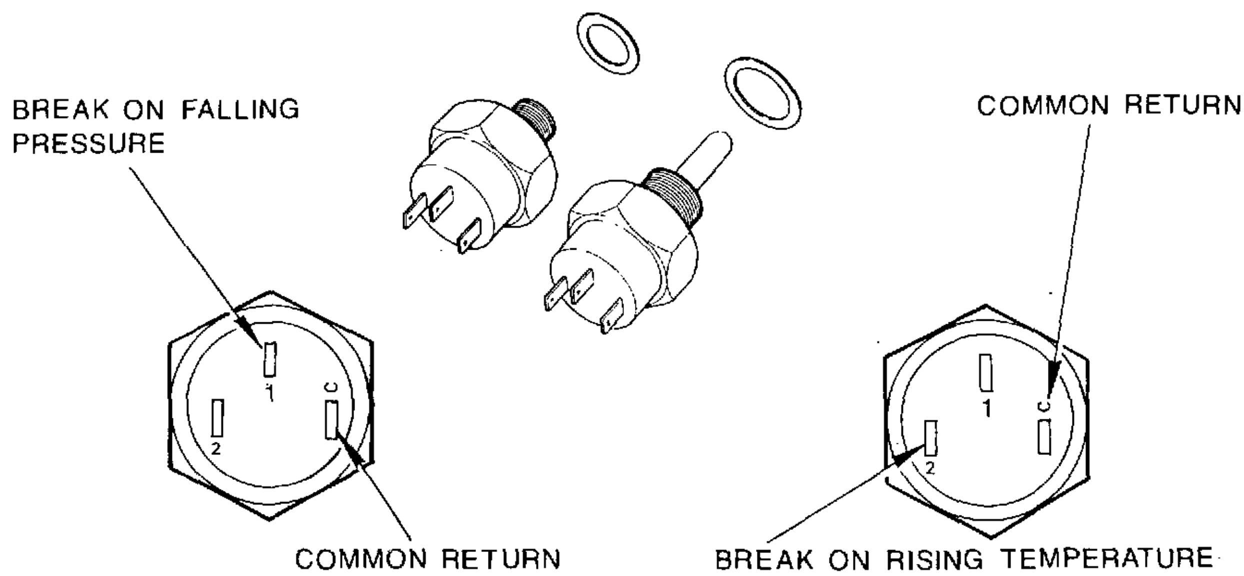
Caution : Solenoids are available in a variety of voltages and settings to suit individual applications, and it is essential that a replacement unit corresponds exactly to the original.

WARNING AND SHUTDOWN SWITCHES

Description

Two Teddington Type DCA switches are incorporated in the cooling and lubricating oil systems to provide engine protection, should the coolant temperature or oil pressure extend beyond the permissible operating range.

The switches may be wired to operate on rising or falling temperatures and pressures, to suit the individual application.



Oil pressure switch | Coolant temperature switch

Fig. 6 Teddington control switches

No servicing is necessary on the switches, but it is strongly recommended that they be checked for operating efficiency at regular intervals, as engine operating conditions permit. Ideally, the checks should be carried out every six months or less.

The switches (fig. 6), are factory set to operate within a selected range of temperatures and pressures, and no attempt must be made to alter the settings.

Testing

1 Oil pressure switch

(a) Screw the oil pressure switch into a suitable pressure fitting and apply pressure in excess of 207 kNf/sq.m (30 lbf/sq. inch).

(b) Connect a battery and appropriate light bulb across the switch terminals, and gradually reduce the system pressure. Note the pressure at which the light is extinguished; this should be between 138 and 165 kNf/sq.m (20 and 24 lbf/sq. inch).

2 Coolant temperature switch

(a) Connect a battery and appropriate light bulb across the switch terminals, and immerse the switch sensor in in a suitable container of oil; place an accurate thermometer close to the sensor.

(b) Heat the oil to 94 deg.C. and maintain this temperature for 15 minutes.

(c) Gradually increase the temperature and note the thermometer reading at which the light is extinguished; this should not be above 100 deg.C.

If the pressure or temperature readings extend beyond the above limits, a replacement switch must be fitted where appropriate.