
Perkins 4000 Series Vee-Form Gas

4012 and 4016 Series Engines

USER'S HANDBOOK

12 and 16 cylinder turbocharged gas engines

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WARNING

READ AND UNDERSTAND ALL SAFETY PRECAUTIONS AND WARNINGS MENTIONED IN THIS MANUAL.

IMPROPER OPERATION OR MAINTENANCE PROCEDURES COULD RESULT IN A SERIOUS ACCIDENT OR DAMAGE TO THE EQUIPMENT CAUSING INJURY OR DEATH.

NON-COMPLIANCE WITH THESE INSTRUCTIONS AND THOSE INCLUDED IN THE INSTALLATION MANUAL TSL4200 MAY INVALIDATE THE WARRANTY OFFERED WITH THE ENGINE.

MAKE QUITE CERTAIN THAT THE ENGINE CANNOT BE STARTED IN ANY WAY BEFORE UNDERTAKING ANY MAINTENANCE, PARTICULARLY IN THE CASE OF AUTOMATICALLY STARTING GENERATING SETS.

The purpose of this Manual is to enable the operator to carry out routine servicing of the engine. Before undertaking any work on the engine the appropriate section in the **Workshop Manual** should be read fully and completely understood prior to starting work. The information contained within the manual is based on such information as was available at the time of going to print. In line with Perkins Engines (Stafford) Limited policy of continual development and improvement that information may change at any time without notice. The engine user should therefore ensure that he has the latest information before starting work. The instructions contained in this Manual will, provided that they are correctly carried out, ensure the safe operation of the equipment. Users are respectfully advised that it is their responsibility to employ competent persons to operate, maintain and service the equipment in the interest of safety. Certain overhaul operations are impracticable without the use of special tools, and those operators who are not equipped to undertake major repairs are urged to consult their Perkins distributor. When not working on the engine, ensure that all covers, blank flanges, doors, etc., are refitted to openings to prevent the ingress of dirt, etc. Please quote the engine type and serial number with all your enquiries. This will help us to help you. The type and serial number are on a plate fitted to the crankcase. If any doubt exists regarding the installation, use or application of the engine, the Installation Manual should be consulted for further advice contact Applications Department at Perkins Engines (Stafford) Ltd. Oil change intervals may be changed according to operating experience by agreement with Perkins Engines (Stafford) Limited and subject to oil analysis being carried out at regular intervals. Please note that this 4000 Series manual also covers SE engines dispatched from the factory from 1 March 1996. A table of equivalent engine designations is given on **page 2**.

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In addition to the above companies, there are Perkins distributors in most countries. Perkins Engines (Peterborough) Limited or one of the above companies can provide distributor handbooks Publication No. 1407/4/97.

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INTRODUCTION

PERKINS ENGINES (STAFFORD) ENGINE DESIGNATIONS 4000 SERIES AND SE SERIES EQUIVALENT TERMS	
4000 SERIES	SE SERIES
4012TESI	12SETCWG
4016TESI	16SETCWG

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BRIEF DESCRIPTION OF THE 4012/16 GAS ENGINES

4012TESI (MINNOX)	12 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, low NOx emission levels, 9.5:1 compression ratio
4012TESI (MINNOX) 200 L.C.	12 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, with NOx emission of less than 200 g/GJ, 9.5:1 compression ratio.
4012TESI (MINNOX) 140 L.C.	12 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, with NOx emission of less than 140 g/GJ, 9.5:1 compression ratio.
4012TESI (MINNOX) 140 H.C.	12 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, with NOx emission of less than 140 g/GJ, 11.5:1 compression ratio.
4016TESI (MINNOX) 200 L.C.	16 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, with NOx emission level of 200 g/GJ or less, 9.5:1 compression ratio.
4016TESI (MINNOX) 140 L.C.	16 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, with NOx emission of 140 g/GJ or less, 9.5:1 compression ratio.
4016TESI (MINNOX) 140 H.C.	16 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, with NOx emission of 140 g/GJ or less, 11.5:1 compression ratio.
4016TESI (MINNOX) 90 H.C.	16 cylinder, 'V' form, 4 stroke, gas engine, water cooled, turbo-charged, water cooled charge air cooler with separate water pump and cooling circuit, lean burn, with NOx emission of 90 g/GJ or less, 11.5:1 compression ratio.

4012TESI (MINNOX)

4012TESI (MINNOX)

4016TESI (MINNOX)

4016TESI (MINNOX)

SAFETY**Engine lift equipment**

Use only the lift equipment which is designed for the engine.

Use lift equipment or obtain assistance to lift heavy engine components such as the cylinder block, cylinder head, flywheel housing, crankshaft and flywheel.

Check the engine lift brackets for security before the engine is lifted.

Asbestos joints

Some joints and gaskets contain compressed asbestos fibres see **Warning label Fig. 1** in a rubber compound or in a metal outer cover. The 'white' asbestos (Chrysotile) which is used is a safer type of asbestos and the danger of damage to health is extremely small.

Contact with asbestos particles normally occurs at joint edges or where a joint is damaged during removal, or where a joint is removed by an abrasive method.

To ensure that the risk is kept to a minimum, the procedures given below must be followed when an engine which has asbestos joints is dismantled or assembled.

- Work in an area with good ventilation.
- Do NOT smoke.
- Use a hand scraper to remove the joints - do NOT use a rotary wire brush.
- Ensure that the joint to be removed is wet with oil or water to contain any loose particles.
- Spray all asbestos debris with water and place it in a closed container which can be sealed for safe disposal.

Dangers from used engine oils

Prolonged and repeated contact with mineral oil will result in the removal of natural oils from the skin, leading to dryness, irritation and dermatitis. The oil also contains potentially harmful contaminants which may result in skin cancer.

Adequate means of skin protection and washing facilities should be readily available.

**Fig. 1**

1085.2

The following is a list of 'Health Protection Precautions', suggested to minimise the risk of contamination.

1. Avoid prolonged and repeated contact with used engine oils.
2. Wear protective clothing, including impervious gloves where applicable.
3. Do not put oily rags into pockets.
4. Avoid contaminating clothes, particularly underwear, with oil.
5. Overalls must be cleaned regularly. Discard unwashable clothing and oil impregnated footwear.
6. First aid treatment should be obtained immediately for open cuts and wounds.
7. Apply barrier creams before each period of work to aid the removal of mineral oil from the skin.
8. Wash with soap and hot water, or alternatively use a skin cleanser and a nail brush, to ensure that all oil is removed from the skin. Preparations containing lanolin will help replace the natural skin oils which have been removed.
9. Do NOT use petrol, kerosene, diesel fuel, gas oil, thinners or solvents for washing the skin.
10. If skin disorder appears, medical advice must be taken.
11. Degrease components before handling if practicable.
12. Where there is the possibility of a risk to the eyes, goggles or a face shield should be worn. An eye wash facility should be readily available.

Environmental protection

There is legislation to protect the environment from the incorrect disposal of used lubricating oil. To ensure that the environment is protected, consult your Local Authority who can give advice.

Viton seals

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

Viton is used by many manufacturers and is a safe material under normal conditions of operation.

If Viton is burned, a product of this burnt material is an acid which is extremely dangerous. Never allow this burnt material to come into contact with the skin or with the eyes.

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

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

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

Practical Information

To clean components

It is important that the work area is kept clean and that the components are protected from dirt and debris. Ensure that dirt does not contaminate the fuel system.

Before a component is removed from the engine, clean around the component and ensure that all openings, disconnected hoses and pipes are sealed.

Remove, clean and inspect each component carefully. If it is usable, put it in a clean dry place until needed. Ball and roller bearings must be cleaned thoroughly and inspected. If the bearings are usable, they must be flushed in low viscosity oil and protected with clean paper until needed.

Before the components are assembled, ensure that the area is free from dust and dirt as possible. Inspect each component immediately before it is fitted, wash all pipes and ports and pass dry compressed air through them before connections are made.

Use suitable gloves for protection when components are degreased or cleaned with trichloroethylene, white spirit, etc. Degreasing solutions which are basically trichloroethane are not recommended.

The figures quoted are based on engines set to meet the ISO 3046/1 1981 Condition. For full technical data please refer to the **Product Information Manual**. Type (Gas) 12 cylinder and 16 cylinder (MINNOX) 'V' form, water cooled, turbocharged, wet exhaust manifolds with separate raw water cooled charge air cooler.

RANGE	4012TESI (MINNOX)	4016TESI (MINNOX)
Cycle	4 stroke	
Configuration	'V' form	
Bore	160 mm	
Stroke	190 mm	
Total swept volume	45.842 litres	61.123 litres
Compression ratio	9.5:1 or 11.5:1	
Rotation	Anti-clockwise looking on flywheel end	
Firing order	1A,6B,5A,2B,3A,4B 6A,1B,2A,5B,4A,3B	1A,1B,3A,3B,7A,7B,5A,5B 8A,8B,6A,6B,2A,2B,4A,4B
Cylinder numbering	Cylinder 1 furthest from flywheel	
Cylinders designated A are on the left side of the engine when viewed from opposite end to the flywheel, with cylinders designated B on the right hand side of the engine. NOTE: This is NOT the same as the British Standard and ISO designation.		
Valve clearances	Exhaust 0.4 mm (0.016")	
Valve dia (mm) inlet & exhaust	48	
Valve timing	See Workshop Manual Section U7	
Valve setting	See page 39 onwards	
Ignition timing	See engine number plate	
Piston speeds	Engine r/min	m/s (ft/min)
	1000	6.33 (1247)
	1200	7.60 (1496)
	1500	9.50 (1870)

TYPICAL COOLING SYSTEM

Approved coolants	See page 17	
Total capacity engine including charge air cooler & wet exhaust manifolds	81 litres (17.8 gals)	110 litres (24.3 gals)
Total capacity engine and radiator	239 litres (52.6 gals)	278 litres (61.3 gals)
Total capacity engine and heat exchanger	153 litres (33.7 gals)	183 litres (40.3 gals)
Engine shut down temperature	96°C	
Max. temperature into engine	To be determined from heat dissipated and water flow through each particular engine model	
Thermostat opening temperature	71°C (nat. gas) 85°C (landfill or biogas) 92°C (HC engines)	
System pressure	0.5 - 0.7 bar	
Maximum pressure at jacket coolant pump outlet	2.5 bar max	

GAS SYSTEM

	4012TESI (MINNOX)	4016TESI (MINNOX)
Approved gas	British Natural Gas	
Lower calorific value	34.71 MJ/nm ³	
Carburettor mixing unit	Deltec 200 - 11	
Carburettor throttle body	Deltec 100 - 11	Deltec 140 - 11
Gas control valve	Deltec 36 mm dia.	Deltec 45 mm dia.
	Deltec 38 mm dia. 4016TESI (minnox 140 HE) ONLY	
Gas pressure min.	15 m bar (1.5 kPa)	
Gas pressure max.	50 m bar (5 kPa)	
Regulator type (Zero pressure)	Dungs FRS 220, 5065 or 5100	
Later engines	or Kromschroder GI50 R02 or GI65 R02	
Supply pressure	If above 50 mbar (5kPa), an additional regulator should be used in order to bring the supply pressure to between the max. & min. figures given above	
Additional items to meet The Institution of Gas Engineers procedures IGE/UP/3 for 4012/16 (Minnox)		
Low pressure detector	Perkins Part No. (see Spares Book) (low pressure gas supply only)	
Gas solenoid valves	Not Perkins supply	
Spit back detector	Perkins Part No. (see Spares Book)	
Manual gas shut-off valve	Perkins Part No. (see Spares Book) (if fitted)	

IGNITION SYSTEM

Ignition unit type	Altronic DISN 800
Ignition coil type	Altronic 501 061 (L.C. engines) Altronic 591 010 (H.C. engines)
Spark plug type	CHAMPION RN79G 14mm (earlier L.C. engines) CHAMPION RB77 WPC 18mm (later engines)
Spark plug gap	RN79G 0.5 mm (0.020") RB77WPC 0.4 mm (0.015")

GOVERNOR

Make	Heinzmann Electronic	
Type	2 x E6V	2 x E10

LUBRICATION SYSTEM

Recommended oil	See pages 14 - 16	
Type of system	Wet sump, external mounted oil pump	
Total oil capacity (oil cooler and filter)	178 litres (39 gals)	238 litres (51 gals)
Sump capacity (dipstick) min.	136 litres (30 gals)	147 litres (32 gals)
Sump capacity (dipstick) max.	159 litres (35 gals)	214 litres (47 gals)
Min. oil pressure (rated speed) to bearings	340 kPa (49 lb/in ²)	
Crankcase pressure max	25 mm water gauge	
Max. oil temperature in sump	105°C	
Lubricating oil filter	disposable canister type	
Crankcase breather	Closed circuit	

INDUCTION SYSTEM

	4012TESI (MINNOX)	4016TESI (MINNOX)
Air cleaner	Twin	
Type (paper element)	S551A	
Max. air intake depression	543 mm H ₂ O (40 mm Hg) (L.C. engines) 406 mm H ₂ O (30 mm Hg) (H.C. engines)	
Air restriction Indicator setting	380 mm H ₂ O	
Turbocharger	Twin Garrett (4016TESI 140 H.C. only) Twin Schwitzer (all other engines)	

EXHAUST SYSTEM

Manifold type	WET
Exhaust outlet flange	Vertical (twin)
Mating flange	2 x 6" Table D
Max. exhaust back pressure	40 mm Hg
Max. exhaust temperature (°C) (after turbocharger)	See Product Information Manual

FLYWHEEL

SAE Size	18"
No. of teeth on ring gear	156

FLYWHEEL HOUSING

SAE Size	'00'
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CRANKSHAFT

Maximum overhung weight on rear bearing	1700 Kg	
T.V. damper	1 x 18"	2 x 20"
NOTE: Subject to torsional vibration investigation different T.V. dampers may be fitted.		

DRY WEIGHT

Dry weight	4380 kg	5520 kg
Wet weight	4680 kg	5820 kg

HOLDING DOWN BOLT HOLES

Bolt size (engine feet)	22 mm
No. off	8

ELECTRICAL SYSTEM

Voltage	24	
Alternator type	Prestolite LNA4024/5 with internal regulator	
Alternator output (amps)	30 at a stabilised output of 28 volts	
Starter motor type (Twin) Prestolite/Butec	MS1/108	MS7/5
No. of teeth (gear ring)	156	
No. of teeth (starter motor)	12	
Battery capacity cold cranking amps to IEC Standard at 0°C (32°F)	286 (each battery)	286 (each battery)
Battery (lead acid)	24 V (2 x 12 V) at 0°C (32°F) (286 Ah)	

PROTECTION EQUIPMENT

Before resetting protection equipment, it must be established whether special settings (for that individual engine) have been specified in the engine sales contract. This is particularly important with ALL high water temperature settings, and ALL Cogen applications.

Standard settings for protection equipment are as follows:

High air manifold pressure switch 172 kPa (25.1 lb/in²)

Shutdown switches	Alarm	Shutdown
High oil temperature	115°C	120°C
Low oil pressure	2.06 bar (30 lb/in ²)	1.93 bar (28 lb/in ²)
High water temperature		
71°C Thermostat	91°C	96°C
85°C Thermostat	96°C	101°C
96°C Thermostat	100°C	105°C
Caution: The above standard settings <u>do not</u> supercede any settings specified in the engine sales contract.		
Overspeed	15% (on 1500 rev/min only)	
High air manifold bursting disc pressure (Early engines only)	75 lb/in ² at 42°C or 58 lb/in ² at 120°C	

AIR STARTING

Air Starter Pressure	150 lb/in ² (1034 kPa)
Compressed air supply	170 lb/in ² (1172 kPa)
Type	Ingersoll-Rand Type SS815

INSTRUMENT PANEL (ENGINE MOUNTED)

	Normal operation
Oil pressure	Between 300 - 560 kPa (42.6 - 80 lb/in ²)
Oil temperature	Between 80 - 90°C (176 - 194 °F)
Water temperature	Between 65 - 85°C (149 - 185 °F)
Exhaust temperature	See Product Information Manual
Boost pressure	See Test Certificate

COOLANT JACKET HEATING

Heater	2 x 4 kw
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WARNING



IT IS ESSENTIAL THAT THE CORRECT LENGTH OF SCREW OR BOLT IS USED. INSUFFICIENT THREAD MAY RESULT IN THE THREAD BEING STRIPPED. WHEREAS TOO LONG A THREAD MAY RESULT IN BOTTOMING IN A BLIND HOLE, OR CATCHING ON ADJACENT COMPONENTS.

NOTE: * Bolt and threads must be lubricated with clean engine oil.

** Cylinder head bolts to be lubricated under the heads, under the washers and on the threads with P.B.C. (Poly-Butyl-Cuprysil) grease. **Important:** See Section R10 in the Workshop Manual before fitting. All other bolt threads only to be lubricated with clean engine oil. Care must be taken not to oil the heads and faces.

TORQUE SETTINGS

CYLINDER HEAD GROUP

		lbf.ft	Nm	
** Cylinder head bolt (early type)] See Section R14	M24	550	750
** Cylinder head bolt (later (waisted) type)		M24	530	723
Rocker shaft bolt/nut		M16	90	120
Rocker adjuster nut inlet/exhaust		M12	35	50
Rocker box bolt		M10	35	50
Air manifold bolt		M10	35	50
Exhaust manifold bolt		M10	50	70
Turbocharger V-band clamp nuts - (Schwitzer)			7	9.5
(Mitsubishi)			7	9.5
(Garrett)			10	13.5
Sandwich plate retaining capscrew (if fitted)		M10	40	57

CRANKCASE AND CRANKSHAFT GROUPS

* Main bearing bolt	M24	580	783
Side bolts (main bearing caps)	M16	124	168
Bolts sump to crankcase	M10	40	57
* Connecting rod bolt	M16	210	285
Viscous damper bolts to crankshaft	M16	250	340
Flywheel bolt to crankshaft	M16	250	340
Front drive adaptor bolts to crankshaft	M16	250	340
Balance weight bolt	M16	250	340
Front crankshaft pulley bolt	M16	250	340
Piston cooling jet setscrew	M10	35	50
Flywheel housing bolt	M10	35	50

LUBRICATING OIL PUMP

Bolts, pump housing to gearcase plate	M10	35	50
Thin nut gear to drive shaft	M24	175	237

TORQUE SETTINGS

		lbf.ft	Nm
CAMSHAFT GROUP			
Camshaft gear bolt	M12	110	150
Camshaft thrust plate bolt	M10	35	50
Camshaft follower housing capscrew	M10	50	70
Cam follower housing bolt	M10	35	50
Idler gear hub bolts	M10	35	50
WATER PUMP AND OIL PUMP GROUPS			
Water pump/oil pump gear units	M24	170	230
Water header to oil cooler bolts	M10	35	50
Water header to gearcase bolts	M10	35	50
Raw water pump gear securing nut (non lubricated thread)	M35	184	250
Engine Feet	M12	70	95
GOVERNOR			
Control shaft mounting plate bolt	M10	35	50
FAN DRIVE			
Fan driven pulley taper lock bush screw	1/2" BSW	35	50
	5/8" BSW	124	170
ALTERNATOR			
Drive pulley taper lock bush screws	3/8" BSW	14	20
IGNITION SYSTEM			
Spark plug	M18 x 1.5	35	50
Adaptor clamp capscrew	M12	100	136
Adaptor clamp screw (earlier engines)	M10	50	68
Retaining bolt for timing disc cover	M10	35	50
Timing disc housing to mounting plate bolt	M10	35	50
Drive gear screw	M10	50	70
Drive coupling capscrew	M6	10	13.5
Driven gear capscrew	M10	50	70
Magnet disc to shaft nut	M12	35	50
Disc shaft flange to camshaft bolt	M12	120	171
FLEXIBLE COUPLING (HOLSET)			
Flexible coupling cover screw	M12 or 1/2" UNC	90	129
Coupling driving flange screws	(coupling size 2.15) M12 or 1/2" UNC	90	129
to flywheel	(coupling size 3.86) M16 or 5/8" UNC	175	250

GENERAL TORQUE LOADINGS

The following torque loadings are general for metric coarse threads for grade 8.8 steel and do not supersede the figures quoted above.

Thread Size (mm)	lbf.ft	Nm
8	18	25
10	35	50
M10-12.9 steel	50	70

These are based to BS 3692.

LUBRICATING OIL

QUANTITY OF OIL

	4012TESI	4016TESI
The total system capacity	178 litres (39 gallons)	238 litres (52 gallons)
The maximum sump capacity	159 litres (35 gallons)	214 litres (47 gallons)
The minimum dipstick mark indicates	136 litres (30 gallons)	147 litres (32 gallons)

CAUTION

In order to select a suitable lubricating oil for a gas engine it is necessary to consider the fuel quality.

NATURAL GAS ENGINES (NO ACIDIC PRODUCTS PRESENT)

The oil should be a grade that is specifically formulated by all the major oil companies for turbocharged and charge cooled natural gas engines. The oil should contain anti-wear and detergent/dispersant additives. The oil is to have high resistance to oxidation and have good thermal stability. Modern gas engine oils do not rely on a high total base number to achieve long life and the special additive packages that are now available from many of the major oil suppliers now meet this criteria.

Engines fitted with oxidizing catalysts (2 way) require a lubricant that is low in zinc and phosphorus, it is essential that the oil supplier confirms that the brand of oil supplied is compatible with the catalyst.

BIOGAS ENGINES (CONTAINING ACIDIC PRODUCTS AT LEVELS APPROVED BY PERKINS ENGINES (STAFFORD) LTD

These engine require a lubricating oil that has more reserve alkalinity than the natural gas engine and therefore the TBN should be more than 8 and less than 10 with the sulphated ash in the range of 0.5 to 1.1%. The oil supplier will assist with the selection of suitable oils when presented with the gas analysis. (TBN = Total Base Number).

NATURAL GAS BIOGAS ENGINES

Where gas engines oils are not available, please consult Perkins Engines (Stafford) Ltd for advice.

GRADE OF OIL

The viscosity of the oil used should be either SAE 30 or SAE 40. In general SAE 30 is used at temperature less than 30°C average ambient temperature and SAE 40 more than 30°C. As these engine are generally operating continuously, it is possible to use higher viscosity oils as sluggishness in starting is not generally critical.

The use of SAE40 will give reduced oil consumption but under certain conditions it will also give reduced oil change periods.

OIL CHANGE PERIOD (NATURAL GAS ENGINES)

For normal operation of gas engines, change the oil after the first 500 hours, after which the oil change period is 800 hours or annually which ever is the sooner.

It may be possible to extend the oil change period, where an oil change programme has been approved by Perkins Engines (Stafford) Ltd, based upon the analysis of oil samples taken during the first 1000 hours of engine use. However even if an analysis is showing a satisfactory oil quality, the oil life should not be extended above 1000 hours.

The following should be regarded as critical parameters:

Viscosity at 100°C	16.5 cSt maximum
Insolubles	1.5 maximum
Total Acid Number (TAN)	less than 4 times the TAN value for new oil.
Total Base Number (TBN)	50% less than new oil value.
Total base number (TBN) and total acid number (TAN) must not cross over.	
Nitration	25 maximum
Oxidation	25 maximum
Water	0.2% maximum
Iron	Less than 20ppm*
Copper	Less than 40ppm*

NB Oil samples should be taken from the mean level in the engine sump never from the sump drain plug.

Should there be a lubricating oil supply problem or a high sulphur content in the gas, Perkins Engines (Stafford) Ltd should be contacted to give advice in selecting suitable formulations.

OIL CHANGE PERIOD (BIOGAS ENGINES)

Engines that are operated on either digester gas or landfill gas are to be subjected to special conditions regarding the oil change periods.

When the engine/s are first commissioned an analysis of the site gas is to be submitted to Perkins Engines (Stafford) (this is addition to the analysis supplied at the order stage) and a description of the proposed lubricating oil that is to be used.

When the engine starts operating it is essential that oil samples are taken at intervals of every 150 hours with the result of the analysis being sent to Perkins Engines (Stafford) at the earliest opportunity.

This course of action is necessary because of the variability of the gas. If the oil is allowed to be used after it has deteriorated beyond the limits specified below then the engine may be damaged. The warranty on the engine is dependant on the oil being maintained in satisfactory condition. To meet this requirement it is necessary to continue the oil analysis programme throughout the warranty period. The frequency of the analysis can be extended but it must show that at the oil change point that the oil is still in acceptable limits.

CRITICAL PARAMETERS

Maximum viscosity at 100°C	16.5 cSt
Total acid number and total base number must not cross over	
TBN must not reduce to less than 50% the value of new oil	
Nitration must not exceed	25
Oxidation must not exceed	30
Insolubles >3 µ must not exceed	1.5
Water max %	0.2
Silicon max ppm	100
Sodium max ppm	50
Iron max ppm	35*
Copper max ppm	35*

LUBRICATING OIL

During the early life of the engine it will be found that the parameters marked * will have higher levels as a result of the running in procedure.

UNDER NO CIRCUMSTANCES IS THE OIL TO BE USED FOR MORE THAN 900 HOURS EVEN IF THE ANALYSIS SHOWS THAT THE OIL IS IN ACCEPTABLE CONDITION.

NOTE: When operating on methane based fuels, approximately one litre of water is produced for every cubic metre of methane burnt. It is essential to ensure that the piston blow by can not condense either in the crankcase or in any pipes associated with the breather. Water has a devastating effect on oil life due to the attack on the additive package in the oil. It is essential that the engine breather is functioning effectively. Water should be drained from the sump weekly.

WARNING



FAILURE TO COMPLY WITH THESE INSTRUCTIONS MAY RESULT IN ENGINE DAMAGE.

APPROVED LUBRICATING OILS (NATURAL GAS ENGINES)

(Suitable for British and Dutch natural gas)

Oil Company	Type
MOBIL	Pegasus 480 (Suitable for catalyst equipped engines)
MOBIL	Pegasus 489
ESSO	Estor Supreme LA 40
ESSO	Estor Protec LA 40
TEXACO	Geotex LA or HD
SHELL	Mysella MA 40
CASTROL	NG404-408

APPROVED LUBRICATING OILS (BIOGAS AND OTHER GASES)

Oil Company	Type
MOBIL	Pegasus 489 + *EM/PA programme

*EM/PA = Equipment Maintenance through Progressive Analysis

CATALYST EQUIPPED GAS ENGINES

These require oils with sulphated ash limited to 0.5%, zinc limited to 0.04% and phosphorous limited to 0.09% by weight, (see **the above table**).

WARNING

ALWAYS STOP THE ENGINE AND ALLOW THE PRESSURISED SYSTEM TO COOL BEFORE REMOVING THE FILLER CAP. AVOID SKIN CONTACT WITH ANTIFREEZE BY WEARING HAND PROTECTION.

ENGINE COOLING SYSTEM

To protect the engine cooling system against corrosion it is essential that the engine coolant contains suitable additives which will give the necessary protection.

Caution: untreated water is not suitable.

WATER QUALITY

The water that is mixed with the additive must have the following characteristics:

Chloride less than 80 PPMV (parts per million by volume)

Sulphates less than 80 PPMV

Total hardness less than 200 PPMV pH of water between 7 to 7.5 (i.e. neutral to slightly alkaline)

ADDITIVES TO WATER

Due to the complexity of the cooling system it is necessary to use an additive that contains a balanced package of corrosion inhibitors.

To achieve the required solution a 50/50 mix of Shell Safe Premium anti-freeze with water should be used at all times, even in areas where frost is unlikely.

This mixture will give frost protection down to -35°C. In areas where Shell anti-freeze is unobtainable contact Perkins Engines (Stafford) Ltd for advice.

Under no circumstances should an additive containing nitrites, borates, phosphates, chromates, nitrates or silicates be used, as these materials are not compatible with the materials used in the cooling system.

When mixing the anti-freeze with the water always follow the manufacturer's recommendation which is to add the anti-freeze to water and mix thoroughly before adding the mixture to the engine cooling system.

Mixing water to the anti-freeze can lead to the formation of gel in the mixture, due to over concentration, and this can lead to blockage of water passages and subsequent loss of water flow causing overheating.

MAINTENANCE OF COOLANT

The water/anti-freeze mixture should be replaced in operating engines at least once a year.

It is essential to maintain the coolant at the correct alkalinity level i.e. the pH should not increase above 7.5. A hydrometer only shows the proportion of ethylene glycol.

This is not a measure of protection against corrosion.

WARNING

FAILURE TO FOLLOW THE ABOVE RECOMMENDATIONS MAY RESULT IN ENGINE DAMAGE AND WILL INVALIDATE THE ENGINE

GAS SPECIFICATION

A new engine will be set to operate on clean natural gas conforming to the British natural gas specifications having a lower calorific value of 34.71 MJ/Sm³ (930 BTU/Sft³).

The difference between high calorific value (HCV) and low calorific value (LCV) is that (HCV) is the total amount of heat given off by the gas during combustion and the (LCV) is the high calorific value less the amount of heat used to vaporize the water content of the gas. Since the amount of heat lost in vaporizing the water is different for different gases, the lower calorific value of the gas is chosen as the basis for fuel consumption data. There must be no liquid hydrocarbon fractions in the gas.

WARNING



IF THE ENGINE IS NOT SET TO SUIT THE SITE GAS, UNECONOMICAL RUNNING, LOSS OF POWER OR DAMAGE MAY OCCUR, WHICH COULD RESULT IN INJURY.

Where gases other than British Natural Gas are to be used, such as wellhead gas, digester gas and landfill gas, it is essential that a detailed analysis of the gas is submitted to Perkins Engines (Stafford) Ltd. as resetting or changing the standard gas equipment may be necessary.

Limiting Values for British Natural Gas:

	4012/16TESI (MINNOX)	
	200 & 140 L.C.	140 & 90 H. C.
1) Methane number must exceed	65	80
2) Combustible constituents must exceed	85%	95%
3) Calorific value (LHV) to exceed	31.7 MJ/Nm ³ (850 BTU/Sf ³)	34 MJ/Nm ³ (912 BTU/Sft ³)
4) Ethane	6%	4.5%
5) Hydrogen content not to exceed	0.2%	0.1%
6) Propane must not exceed	2%	1%
7) Isobutane content not to exceed	0.2%	0.2%
8) Normal butane not to exceed	0.2%	0.2%
9) Normal pentane and higher fractions (hexane, heptane, etc.). The summation must not exceed.	0.02%	0.02%
10) Gas pressure at inlet to regulators must exceed	15 mbar (1.5 kPa)	15 mbar (1.5 kPa)
11) Gas pressure not to exceed without additional pressure regulators	50 mbar (5 kPa)	50 mbar (5 kPa)
12) Hydrogen sulphide not to exceed	0.01% or 100 ppm	0.01% or 100 ppm

NOTE: The rating may be reduced if lower calorific value of the fuel is lower than 34.71 MJ/Nm³ (930 BTU/Sft³). Also pressure must be constant to maintain emissions and stability. If any of the above parameters are not met, Perkins Engines (Stafford) Ltd should be consulted for advice.

GAS SAFETY REGULATIONS

There are legal requirements that within the U.K. gas fittings and equipment are installed and used in accordance with the GAS SAFETY (INSTALLATION AND USE) REGULATIONS. Only competent persons should install this equipment. Reference should be made to the Institute of gas engineers IGE UP/3. Outside the UK anyone undertaking work on the engine or associated with the engine and its gas equipment in particular should check with local and national regulations to ensure compliance.

DERATING

WARNING

IT IS ESSENTIAL THAT FULL ACCOUNT IS TAKEN OF ALL DERATING INFLUENCES WHETHER GAS SPECIFICATION, ALTITUDE, AMBIENT TEMPERATURE OR HUMIDITY. WHERE ANY OF THESE DEVIATE FROM THE STANDARD SPECIFIED IN THIS MANUAL THE RATING OF THE GAS ENGINE MUST BE ADJUSTED AS INSTRUCTED BELOW.

SETTING ENGINE POWER TO SUIT ACTUAL SITE CONDITIONS

Derating means reducing the power output of an engine from its normal rating at normal temperature and pressure conditions to allow for adverse effects of site conditions e.g. altitude and ambient temperature.

Perkins Engines (Stafford) Ltd. may be unaware of the final destination of an engine at the time of despatch from the works. The engine will be set to give the power output at normal temperature and pressure under ISO 3046 standard conditions, using gas conforming to British Natural Gas Specification, having a lower calorific value of 34.71 MJ/Nm³ (930 BTU/Sft³), which when operating under the actual site conditions, could result in severe damage to the engine (refer to **page 18**).

Providing that the actual gas being used meets with the above conditions, then the engine need only be derated for altitude and ambient temperature conditions.

Any engine so supplied must be derated in accordance with the published percentage derate figure as shown in the **Product Information manual**, by the Equipment Manufacturer on his premises, or even on site.

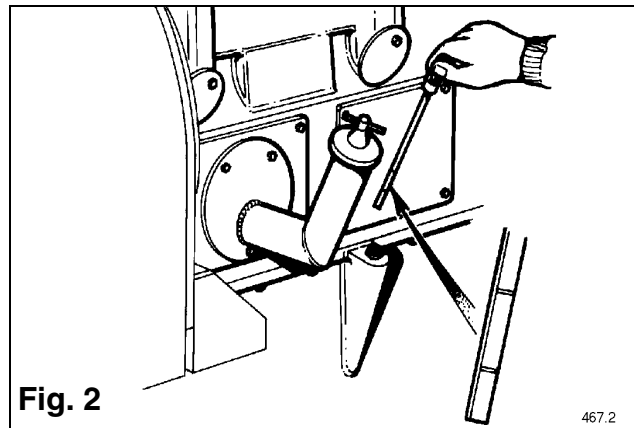
To derate, calculate, (using the above percentage derate figure) the new reduced power output of the engine, and run the engine or generating set on this load.

Where possible this maximum load limit should be set and locked in the engine control panel.

OPERATING INSTRUCTIONS

PREPARATION FOR INITIAL START FILLING THE ENGINE WITH OIL

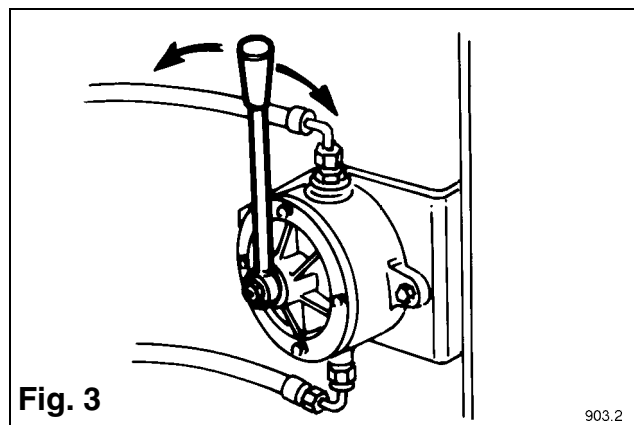
Remove the drain plug to ensure sump is clean and empty, refit and tighten the plug. Remove the oil filler plug situated on the left hand side of the gearcase by rotating T-bar anti-clockwise and pulling **Fig. 2**. Fill the sump to maximum mark on the dipstick with the appropriate grade and quality of oil specified, **see Pages 14 - 16** and replace the plug, rotating the T-bar to tighten and seal it.



PRIMING THE TURBOCHARGER

Before starting the engine for the first time, or if it has been stood idle for more than three months, the turbocharger bearings should be primed. Ensure that the gas supply is turned off, also the switch in the control panel is in the stop position, and the ignition is turned off.


Locate the semi-rotary hand pump which may be found immediately in front of the oil pump (see **Fig. 3**). Operating the pump conveys oil from the sump via a one way valve to the crankcase, pressurising the lubricating system through the oil filters. Pump until approximately 35 kPa (5lb/in²) is indicated on the oil pressure gauge. Continue pumping for a further 20 seconds to ensure that oil has reached the turbocharger.




BATTERIES (PERKINS BATTERIES ARE SUPPLIED DRY CHARGED. SEE INSTALLATION MANUAL TSL4200)

WARNING  **HAND PROTECTION MUST BE WORN WHEN CHECKING ELECTROLYTE LEVEL IN THE BATTERY. INFLAMMABLE GAS IS GIVEN OFF BY THE BATTERY. DO NOT CHECK WITH A NAKED FLAME.**

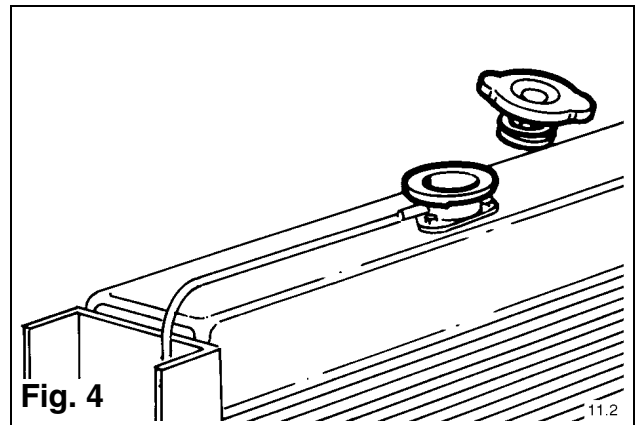
Check the level of electrolyte in each of the battery cells; it should be 8-16 mm above the plates. Using a hydrometer, check that the batteries are fully charged. A fully charged battery will have a specific gravity of 1.27 to 1.285, assuming the air temperature is below 32°C. For higher temperatures the specific gravity will be 1.24 to 1.255. When topping up the batteries always use pure distilled water and always replace the plugs after filling.

WARNING  **NEVER CONNECT A BATTERY INTO THE SYSTEM WITHOUT FIRST CHECKING THE POLARITY AND VOLTAGE. NEVER DISCONNECT THE BATTERY WHILST THE ENGINE IS RUNNING. NEVER FLASH CONNECTIONS TO CHECK FOR CURRENT FLOW.**

FILLING THE COOLING SYSTEM

WARNING  **THE COOLING SYSTEM IS PRESSURISED - DO NOT REMOVE THE FILLER CAP FROM THE RADIATOR WHILST THE ENGINE IS HOT. HAND PROTECTION MUST BE WORN.**

The use of plain drinking water is not recommended owing to chemical reactions which can result in corrosion and furring-up of the cooling system. A solution of either water and universal anti-freeze or water and corrosion preventative must be used. Refer to page 17.



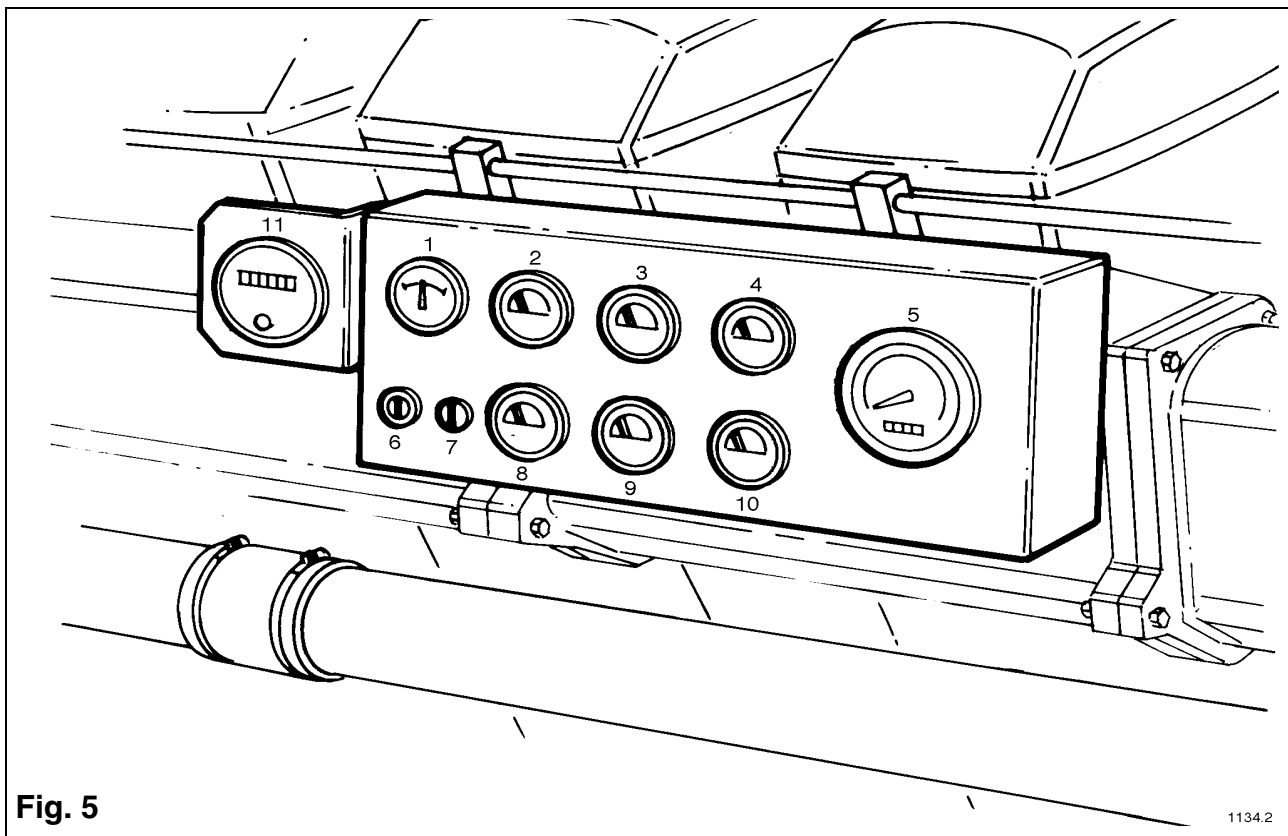
After installation and before the first start remove the radiator cap **Fig. 4** by rotating it anti-clockwise. Fill the cooling system with the required coolant. Should the engine be fitted with water cooled exhaust manifolds then these may need bleeding (see **Workshop Manual Section F7**). Run the engine off-load for one minute to ensure that the system is completely filled, then stop the engine and top up the system to 25 mm (1") below the top of the filter neck then replace the cap.

INSTRUMENT PANEL (ENGINE MOUNTED)

DESCRIPTION

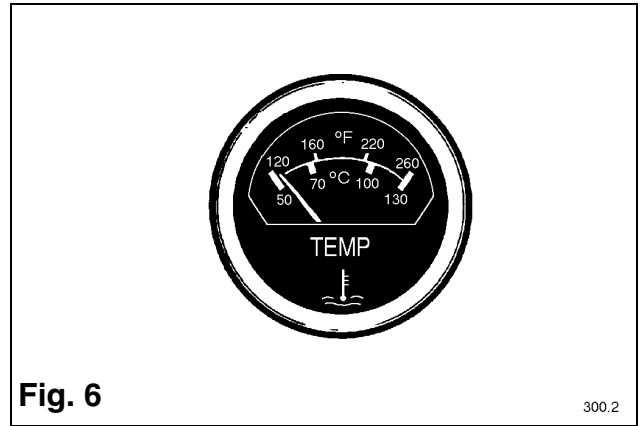
The instrument panel is flexibly mounted on the side of the engine between the air manifold flanges. Some instruments are duplicated giving readings for A and B bank (see Fig. 5).

- (1) Battery charging rate
- (2) Coolant temperature 'A' bank
- (3) Lubricating oil temperature 'A' bank
- (4) Lubricating oil pressure 'A' bank
- (5) Taco and hours run
- (6) Keyswitch
- (7) Fuse holder
- (8) Coolant temperature 'B' bank
- (9) Lubricating oil temperature 'B' bank
- (10) Lubricating oil pressure 'B' bank
- (11) Exhaust temperature gauge (when fitted)



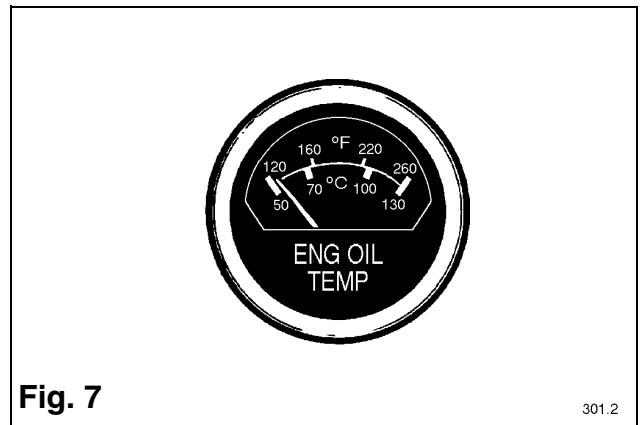
Engine water temperature gauge (Fahrenheit/Centigrade) Fig. 6

The coolant temperature during normal operation should be between 65°C - 85°C (149°F - 185°F). If the temperature should rise above 93°C (200°F) for a prolonged period of time, stop the engine and investigate the cause. The engine should, on the other hand, not be run at too low a temperature for long periods either.



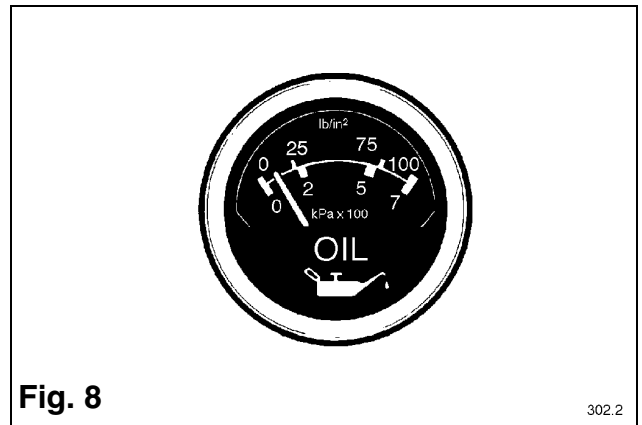
Engine oil temperature gauge (Fahrenheit/Centigrade) Fig. 7

The lubricating oil temperature should be between 80°C - 90°C (176°F - 194°F) when the engine is hot. If the temperature should rise above 115°C (240°F), stop the engine immediately and investigate the cause.



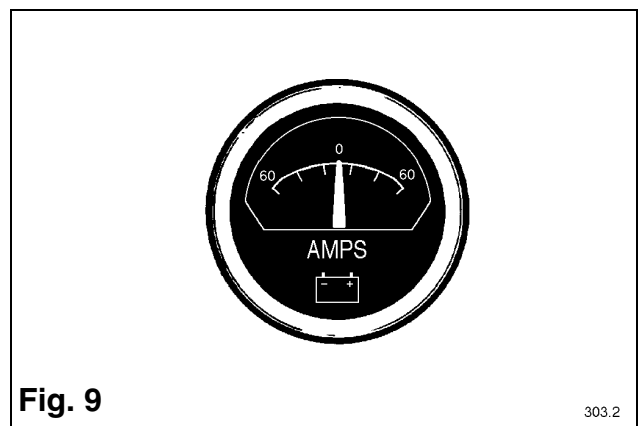
Engine oil pressure gauge Fig. 8

(pounds per square inch/kiloPascal x 100)
The lubricating oil pressure should be between 300 - 350 kPa (45 - 50 lb/in²) when the engine is hot. If the pressure should drop below 200 kPa (30 lb/in²) at higher engine speeds than idling, stop the engine immediately and investigate the cause.



Ammeter (Ampere) Fig. 9

The ammeter indicates at what charging current the battery is being charged by the alternator, or to what extent current is taken from the battery without the battery being recharged.



INSTRUMENT PANEL

Engine tachometer and hour counter

(revolutions per minute x 1000 and hours)
(see **Fig. 10**).

The electrically operated tachometer/hour counter shows the speed of the engine in rev per min. and the actual operating hours the engine has run. The tachometer/hour counter starts operating from an alternator voltage of 12 V onwards, which has already been reached at engine idling speed.

Exhaust temperature gauge (optional)

Temperature range $-20 +800^{\circ}\text{C}$

The gauge shows readings of turbine outlet temperature and is switched from A to B bank using the button (1) (see **Fig. 11**).

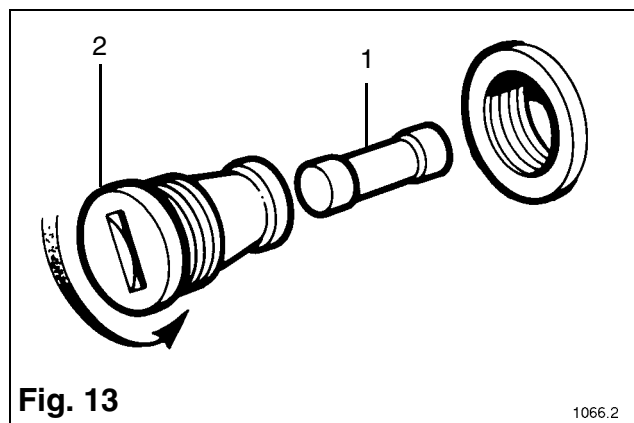
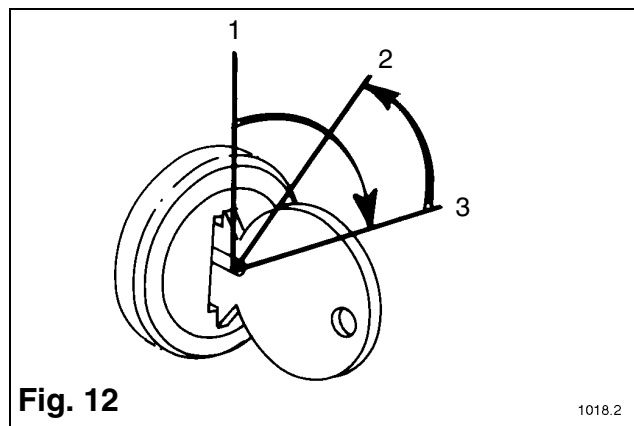
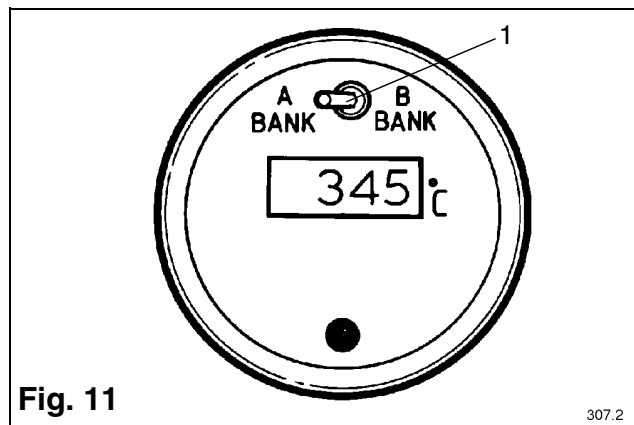
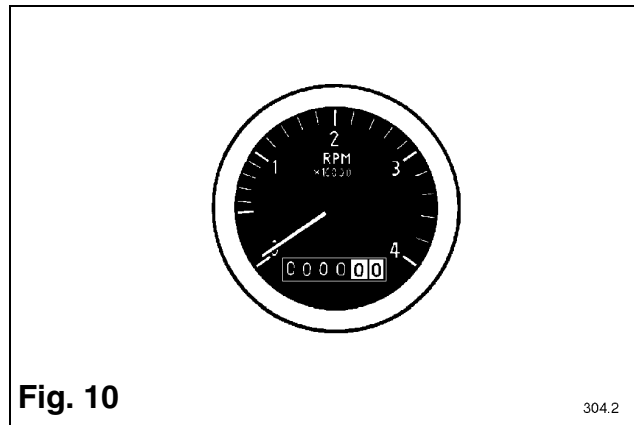
NOTE: Early engines may require a dry cell 9 volt battery.

Key switch (3 position) (Off/run/start)

The hand operated keyswitch with switch lock is moved by a separate key to the positions shown, (see **Fig. 12**) viewed from front of switch.


Fuse holder

To protect the instrument panel a 2 amp fuse is fitted to remove the fuse (1) unscrew its holder (2) (see **Fig. 13**).




FINAL CHECKS AND INITIAL STARTUP

Gas supply train must comply with British gas Code IM17. See **Fig. 1 page 16** in the **Workshop Manual**. Also gas pipework up to the solenoid operated valves must be tested at twice working pressure to ensure gas tightness and any leaks rectified.

WARNING  **IMPROPER OPERATION OF A GAS ENGINE CAN BE DANGEROUS. BE PREPARED TO CHECK FOR GAS LEAKS AFTER THE SOLENOID VALVES AS SOON AS THE ENGINE STARTS, USING A LEAK DETECTING FLUID. STOP THE ENGINE AND RECTIFY ANY LEAK FOUND.**

1. Starting and stopping must be on no load.
2. For automatic start and stop sequence see **Fig. 14 on page 27**.

WARNING  **IF THE ENGINE FAILS TO START AFTER TWO ATTEMPTS, TURN OFF THE GAS SUPPLY AND INVESTIGATE THE CAUSE. BEFORE ATTEMPTING TO RESTART THE ENGINE IT MUST BE PURGED OF GAS. TO DO THIS, WITH THE GAS SUPPLY AND THE IGNITION SYSTEM TURNED OFF, CRANK THE ENGINE WITH THE STARTER FOR NO MORE THAN 30 SECONDS. THIS SHOULD REMOVE ANY BUILD-UP OF GAS FROM THE ENGINE AND EXHAUST SYSTEM. ALTERNATIVELY THE SYSTEM MAY BE PURGED WITH COMPRESSED AIR. ALWAYS BE IN A POSITION TO STOP THE ENGINE IN THE EVENT OF A MALFUNCTION BY TURNING OFF THE GAS SUPPLY OR IN AN EMERGENCY BY PRESSING THE RED BUTTON, WHICH REMAINS OFF UNTIL RESET.**

3. Starting (manual)
 - 3.1) Turn on gas at manual valve.
 - 3.2) Press start button/turn ignition key.
 - 3.3) Governor now energised.
 - 3.4) Starter engages, starts to crank. Automatic 3 second purge time determined by control panel.
 - 3.5) Ignition on, gas solenoid valves open.
 - 3.6) Engine starts, starter disengages, runs up to rated speed.
 - 3.6.1) If engine fails to start, investigate the following probable causes:
 - a) High or low gas pressure.
 - b) Ignition system grounded.
 - c) Governor failed to energise.
 - d) Low cranking speed.
 - 3.6.2) Try again once more only commencing with 3.2 above.
 - 3.7) When engine is running, check oil pressure, warm engine through and apply the load.
 - 3.8) Check engine condition at full load, oil pressure, jacket coolant and charge air coolant temperatures.

OPERATING INSTRUCTIONS

4. Stopping

- 4.1) Remove load, run for 3 to 5 minutes to reduce combustion system temperatures and localised boiling of coolant and to prevent oil carburizing in the turbocharger bearing housing.
- 4.2) Stop engine by de-energising gas solenoid valves and governor. DO NOT press the red stop button for normal stopping procedure. If the ignition is switched off the system will be left full of gas, and must be purged.

WARNING



DO NOT RUN THE ENGINE

EXCESSIVELY AT RATED SPEED ON NO LOAD. IF THE ENGINE IS NOT BEING USED, SHUT IT DOWN.

Excessive running of the engine at rated speed no load results in a high depression in the cylinders, leading to high oil consumption and a build up of deposits on spark plugs, valves and pistons.

GAS ENGINE START/STOP SEQUENCE (AUTOMATIC)

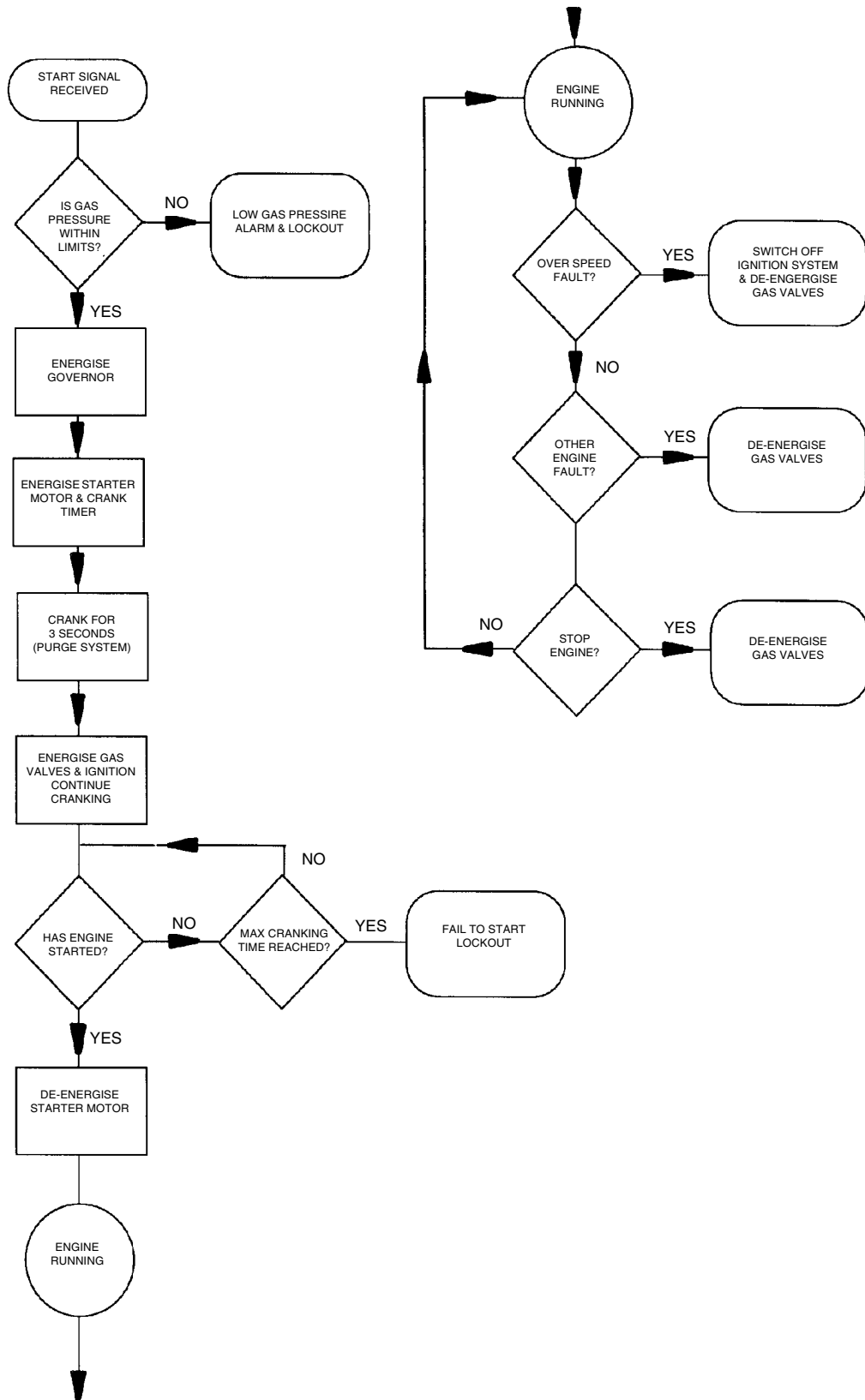


Fig. 14

MAINTENANCE PROCEDURES

Towards the rear of this section there is a check list sheet for continuous duty generator sets which is to be used as a guide for operators and maintenance personnel.

The following schedule details some of the maintenance to be carried out as in the maintenance check lists, however not all are detailed. In these cases please refer to the **Workshop Manual**.

The schedule within this section will be perfectly suitable for an engine working under average conditions. If your engine is working under particularly dirty or dusty conditions, more frequent servicing will be necessary particularly in respect of the lubricating oil and air cleaners. Correct and regular maintenance will help prolong engine life.

WARNING



MAKE QUITE CERTAIN THE

ENGINE CANNOT BE STARTED BEFORE UNDERTAKING ANY MAINTENANCE, PARTICULARLY IN THE CASE OF AUTOMATICALLY STARTING GENERATING SETS OR REMOTE STARTING ENGINES.

DAILY INSPECTION

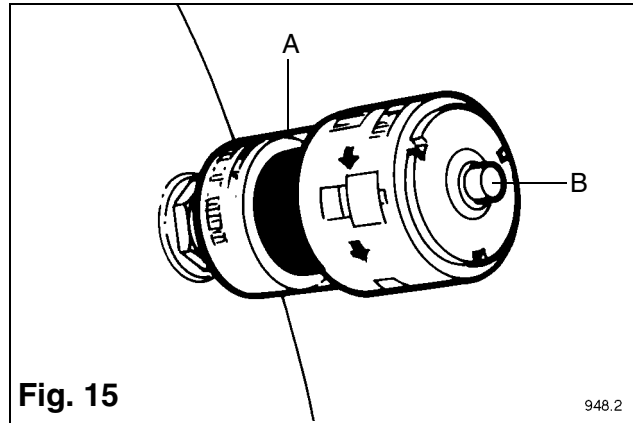
LUBRICATING OIL LEVEL

With the engine stopped for at least 5 minutes:-

- i) Withdraw the dipstick and wipe clean.
- ii) Re-insert the dipstick fully into the sump.
- iii) Wait for at least 5 seconds, withdraw and check the oil level in relation to the two marks on the dipstick.
- iv) Repeat operation (i) (ii) (iii) at least twice, until identical readings are observed.

If the oil level is below the top mark add sufficient of the same grade as that already in the engine to bring the oil level up to the top mark.

Always replace the filler plug immediately replenishment is completed.



COOLANT LEVEL

WARNING



THE COOLING SYSTEM IS

PRESSURISED - DO NOT REMOVE THE FILLER CAP WHEN THE ENGINE IS HOT. HAND PROTECTION MUST BE WORN.

With the engine stopped remove the radiator cap; the coolant should be 25 mm (1") below the top of the filler neck. If the level is low top up with a solution of water and inhibitor or water and anti-freeze similar to that already in the engine. Refer to **Engine Data section pages 7 to 10**.

LEAKS

Visually check the engine for gas, oil, coolant and exhaust leaks, repairing where necessary.


WEEKLY

Deal with items under DAILY INSPECTION.

AIR CLEANER RESTRICTION INDICATOR

The middle section of the restriction indicator 'A' will remain clear while the air cleaner is in a serviceable condition. When the filter reaches its contamination limit the restriction indicator will sense the change in manifold pressure and middle section 'A' will change to red. At this point the air filter must be changed (see **Operators Handbook page 37**). When the air filters have been changed reset the indicator by pressing button 'B'. (See **Fig. 15**).

BATTERIES

WARNING  **HAND PROTECTION MUST BE WORN WHEN CHECKING ELECTROLYTE LEVEL IN THE BATTERY. INFLAMMABLE GAS IS GIVEN OFF BY THE BATTERY. DO NOT CHECK WITH A NAKED FLAME.**

Remove the plugs or 'quick fill' covers and check the level of electrolyte. It should be approximately 3 mm above the top of the plates. If it is low, top-up with pure distilled water. Replace the plugs and wipe the top of the battery clean and dry (see page 21 for fuller information).

NOTE: Check the specific gravity (see **Maintenance Schedule**).

RADIATOR

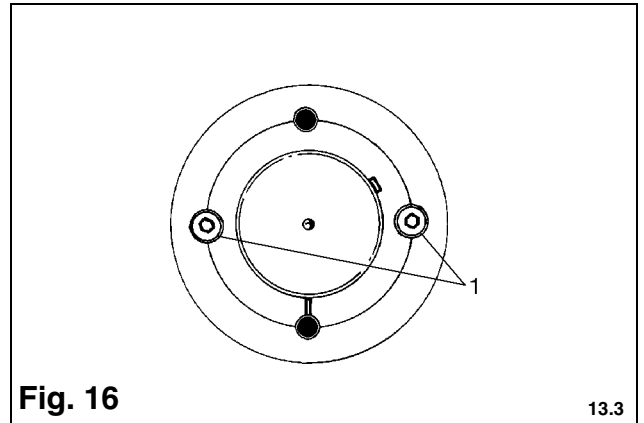
If the engine is working in dirty or dusty conditions check that the air passages in the radiator are not becoming choked. They can be cleaned out by blowing compressed air in the direction opposite to that of the normal air flow.

DRAINING WATER FROM THE SUMP (FOR ENGINE OPERATING ON LANDFILL GAS)

Unscrew the drain plug in the sump and drain off the accumulated water content until oil flows. Tighten the plug, check the oil level and add the required oil.

FENNER TAPE LOCK BUSHES MAINTENANCE INSTRUCTIONS

Experience has shown that taper lock bushes as fitted in the fan pulleys and battery alternator driven pulley can work loose shortly after being put into service. Check using a hexagon wrench to tighten allen screws (1) **Fig. 16** gradually and alternately until all are tightened to the required torque (see **Torque Settings on pages 11 - 13**). Full details of taper lock pulley see **Section B2 & Section U1 of the Workshop Manual**. Replace any guards removed before running the engine (see **Fig. 16**).



NEW OR REBUILT ENGINES

It is essential to carry out the following maintenance procedure after the initial 100 hours.

FLANGES AND FASTENERS

Check the torque on all external fasteners including the exhaust manifold and turbocharger flanges. Tighten all hose clips and pipe unions.

EQUALISE BRIDGE PIECES AND CHECK VALVE CLEARANCES

(see page 39).

MAINTENANCE PROCEDURES

TURBOCHARGERS

If the engine has been overhauled and a filter joint fitted to the turbocharger oil feed, this should now be removed and replaced with the standard joint. See **Service Bulletin 301 (Revised) and 1**.

FOR ENGINES OPERATING ON BIOGAS, LANDFILL GAS, ETC.

SPARK PLUGS

Clean and reset gaps as described in **Section N9** of the **Workshop manual**.

ENGINE OIL AND SPIN-ON FILTERS, ALSO CENTRIFUGAL OIL FILTER (WHERE FITTED)

Change engine oil and disposable filters (see **page 34**) clean centrifugal filter (see **page 33**).

ENGINE ALTERNATOR DRIVE BELT

WARNING



DISCONNECTING BATTERIES OR ANY OTHER MEANS OF STARTING.

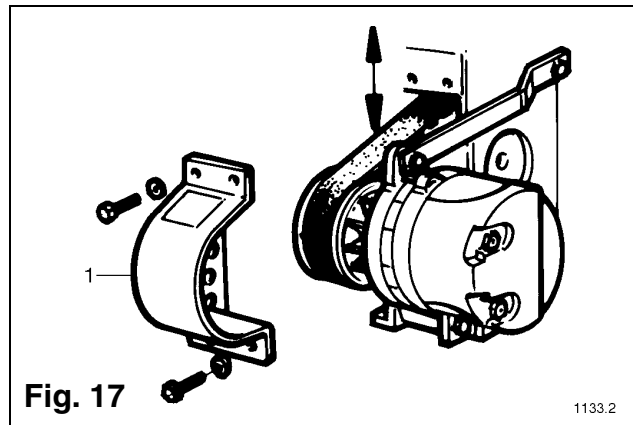
Remove the small mesh guard (1) around the alternator. The toothed belt used to drive the alternator relies on tooth engagement to transmit to load. It does not require preloading, however a slight initial tension to ensure that the belt fits snugly round the pulleys is desirable. Using light pressure midway between the two pulleys a total deflection of 1.5 mm ($1/16$ ") is satisfactory (see **Fig. 17**). Refit the guard.

SPARK PLUGS

Reset the plug gap as described in **Section N9 and N12** of the **Workshop Manual**.

ENGINE OIL AND FILTERS

On completion of the first 500 hours running, change the engine oil and filters.



FAN BEARINGS AND BELTS

WARNING  **DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING.**

Remove the mesh guard around the fan belts, grease the fan and jockey pulley bearings **Fig. 18** using high melting point lithium based grease (e.g. Shell Alvania R.A.)

Check the tension and condition of the fan belts. Using a spring balance and rule, or a belt tension indicator, check that the force compares with the kgf (lbf) values shown below for the correct belt deflection. See **Fig. 18**.

Deflection	kg Force	lb Force
11 mm	3 - 4.3	6,67 - 9.47

Fan belts if worn, should be replaced as a complete, matching set. Individual belts should NOT be replaced.

To adjust slacken the jockey pulley pivot and adjuster bolts, and operate the jockey pulley lever.

Moving the jockey pulley lever outwards will tension the belts and inwards will slacken the belts.

The correct tension is obtained by measuring the deflection at the mid point between the fan pulley and the crankshaft pulley when the above force is applied.

To apply the force place a rule across the outside width of the belts and attach spring balance as shown **Fig. 18** pull on the spring balance until the required force is reached and measure the belt deflection.

Adjust the position of the jockey pulley lever until the force on the spring balance and the belt deflection agree with the figures given.

Key (Fig. 18)

- 1. Force
- 2. Deflection

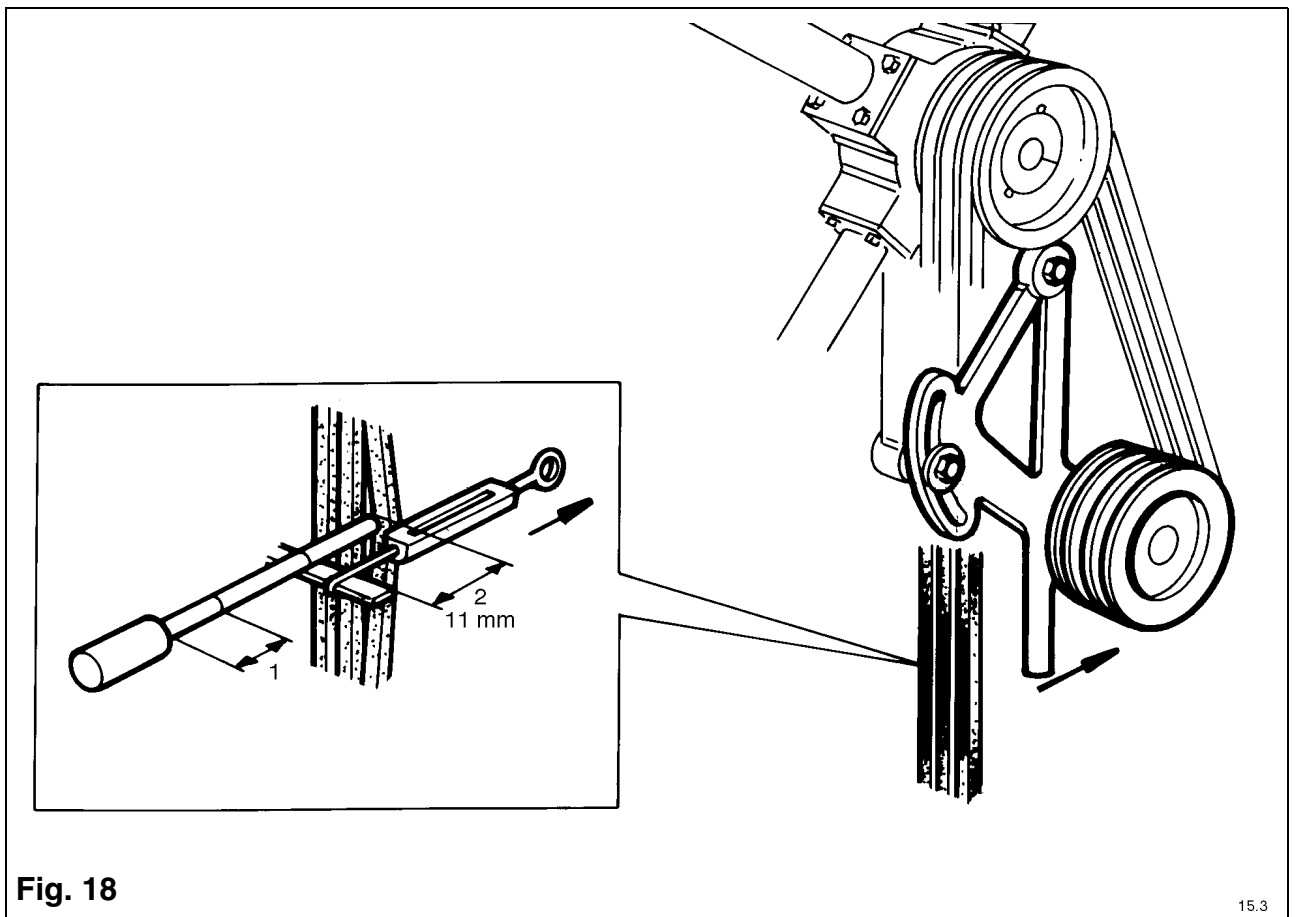


Fig. 18

WARNING



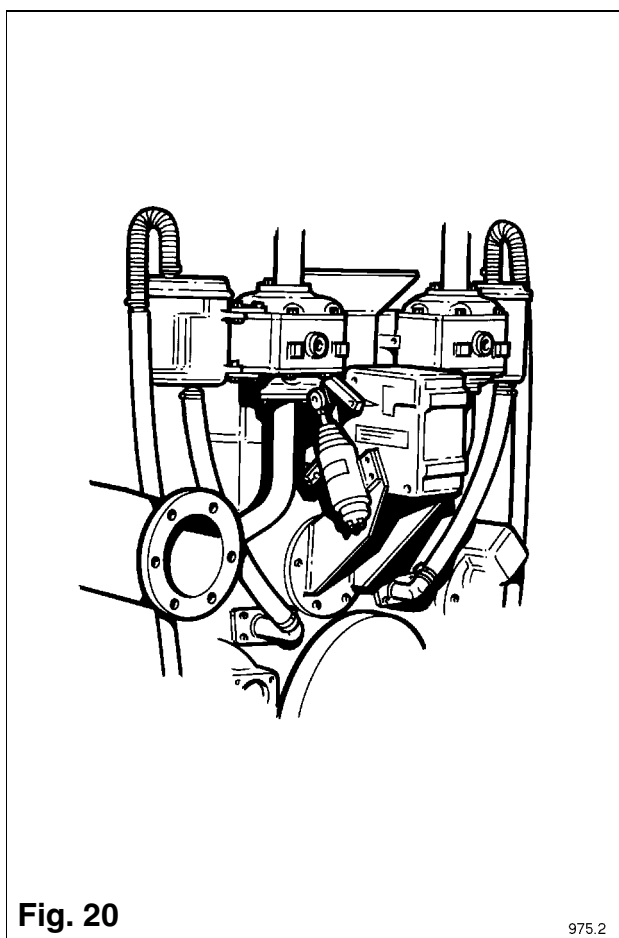
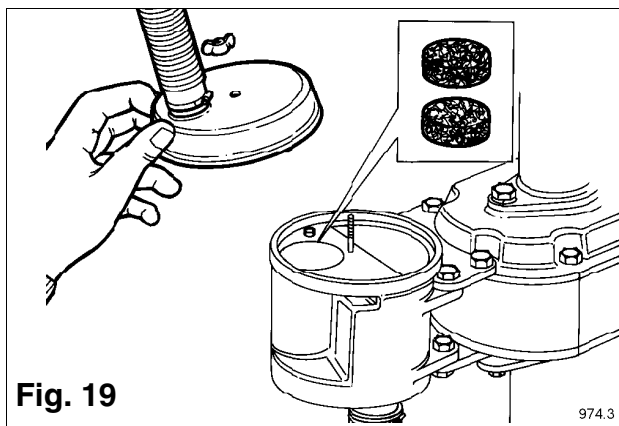
DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING. WHEN USING COMPRESSED AIR OR CLEANING AGENTS ALWAYS WEAR EYE PROTECTION, AND PROTECTIVE GLOVES.

CRANKCASE BREATHER (IMPROVED DESIGN) FITTED TO LATER ENGINES

The crankcase breather is mounted on the side of the thermostat housing **Fig. 19** and is connected to the engine via a flexible pipe and elbow fitted on the front of the gearcase (see **Fig. 20**).

To clean the breather remove the top cover and withdraw the two wire mesh elements and wash thoroughly using a suitable cleaning agent. Shake as dry as possible, finally blow dry with an compressed air. Refit the elements into the breather body, and fit the top cover firmly.

NOTE: When replacing the cover check the sealing gasket is in good condition and the cover has located on its dowel



WARNING  **DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING. ALWAYS WEAR PROTECTIVE GLOVES.**

FOR EXTENDED OIL CHANGE PERIOD (WITH OIL ANALYSIS PROGRAMME) SEE PAGES 14 - 16 ON ENGINES OPERATING ON BIO GAS AND OTHER GASES (NOT BRITISH NATURAL GAS)

CLEANING THE CENTRIFUGAL LUBRICATING OIL FILTER

Stop the engine, and allow time for lubricating oil to drain back to sump.

1. Slacken safety clamp (1) unscrew cover nut and lift off cover (A). (See Fig. 21).
2. Lift off rotor assembly (B) having allowed oil to drain from nozzles. The rotor should be removed and replaced on the spindle with extreme care in order to ensure that bearings are not damaged.
3. Secure rotor in dismantling tool T6253/292. Unscrew rotor cover nut (3) and separate rotor cover from body.
4. Remove standtube (4) using extraction tool T6253/293 and clean.
5. Remove sludge from inside the rotor by means of a spatula and wipe clean. Ensure that all rotor components are thoroughly cleaned and free from deposits of dirt before reassembling the rotor. Failure to do so could cause an out-of-balance condition which will accelerate bearing spindle wear.
6. Clean nozzle with brass wire. Examine 'O' ring (5) and renew if damaged.
7. Reassemble rotor complete and tighten top nut. **IMPORTANT:** Ensure that the rotor cover and rotor body are always matched by balance reference number and pin location.
DO NOT INTERCHANGE ROTOR COVERS.
8. Examine spindle journals, if damaged or worn replace with body assembly complete.

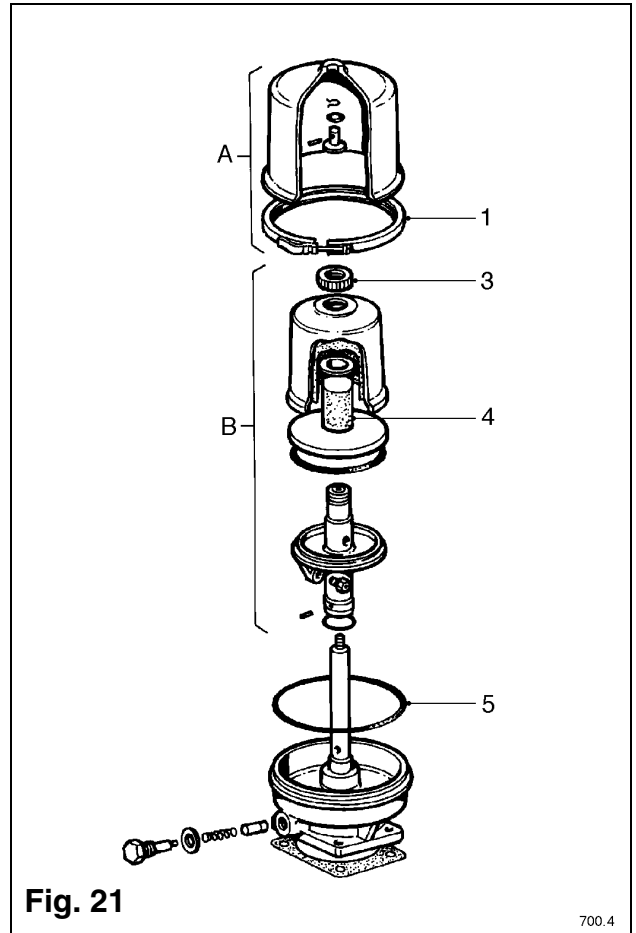


Fig. 21

700.4

9. Reassemble filter complete checking that rotor revolves freely then replace filter body cover. Tighten cover nut and secure safety clamp. The clamp ring should be securely fitted at all times and the filter should not be run without the clamp ring fitted.
10. With engine running check all joints for leakage. Check for excessive vibration.

MAINTENANCE PROCEDURES

NOTE: It is suggested that oil analysis tests are carried out at regular intervals to check that these maintenance intervals are satisfactory.

CHANGING ENGINE OIL AND STANDARD SPIN-ON TYPE LUBRICATING OIL FILTERS

WARNING  **DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING. ALWAYS WEAR PROTECTIVE GLOVES.**

With the engine stopped, place a suitable container of at least 150 to 250 litres (33 to 55 gal) beneath the drain plug. Remove the drain plug and allow the oil to drain. This operation is best carried out while the engine is still warm as the thinner oil will drain more efficiently. While the oil is draining remove the three oil filters per bank, turning them anti-clockwise using a strap wrench see **Fig. 22**.

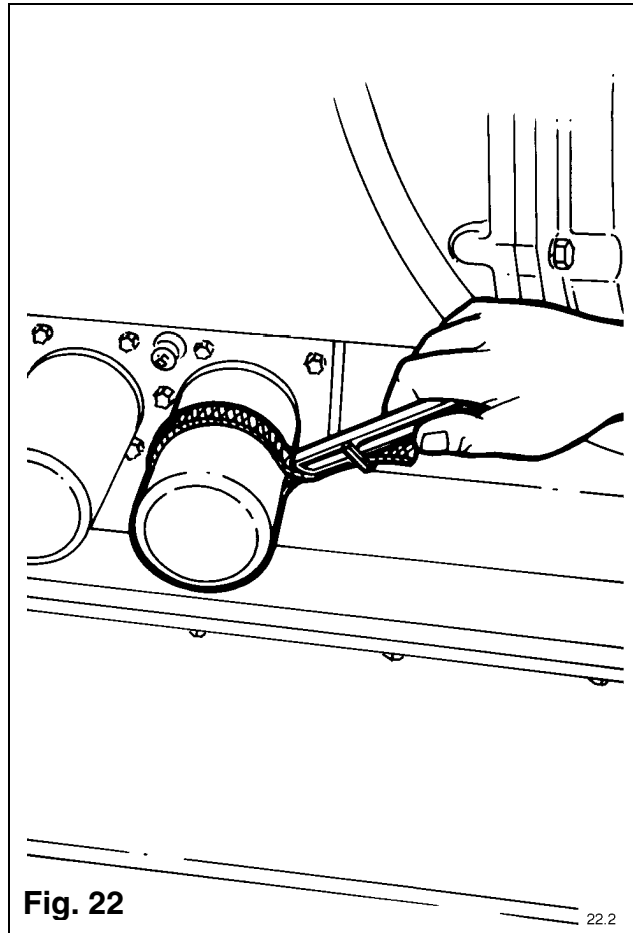
NOTE: Removal of the oil filters will allow an escape of oil from the filter manifolds, it is therefore recommended that a suitable container of at least 5 litres (1 gal) capacity is positioned under each filter prior to removal.

Wipe clean the sealing faces and threaded bosses of the oil header. Smear engine oil on the captive rubber sealing ring and carefully screw each new filter up to the oil header using firm hand pressure only.

Use only genuine Perkins oil filters. The use of other filters may cause serious damage to the engine.

Refit the drain plug and fill the engine with the appropriate grade of new oil (**see pages 11-13**). Ensure that the gas supply is turned off, also the switch on the control panel is in the stop position, and the ignition is grounded to prevent the engine firing. Turn the keyswitch to the start position, and crank the engine over until the oil pressure gauge registers 0.4 kg/cm² (5 lb/in²).

Continue cranking for a further 10 seconds which will ensure the oil has reached the turbocharger bearings.



See page 20 for instructions on priming with the semi-rotary pump. Stop cranking the engine and visually check the engine for oil leaks, top up the oil level.

WARNING  DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING. ALWAYS WEAR PROTECTIVE GLOVES.

CHANGING THE OPTIONAL CHANGE-OVER LUBRICATING OIL FILTERS

These special duplex filters are normally intended for use on long running engines, or where a servicing requirement may occur when it is impractical to stop the engine. For this reason they are fitted with a three way change-over valve in the head which enables the elements to be changed, one at a time, whilst the engine continues to run. They are normally mounted on the engine, but may be remotely mounted, and connected to the engine by means of flexible pipes.

NOTE: If the flexible connections to the filter are removed for any reason, it is essential that they are reconnected correctly to avoid unfiltered oil getting into the engine. See **Fig. 24 on page 36**. Failure to change filters when due can also lead to trouble from unfiltered oil.

CHANGING THE FILTER ELEMENTS WHEN THE ENGINE IS STOPPED

All that is necessary is to unscrew the canisters with a strap wrench as shown in **Fig. 23**, without moving the change-over valve, as there is no pressure in the system when the engine is stationary. The underside of the header is then wiped clean, and a smear of oil applied to the sealing rings on the new canisters, before screwing them up by hand and tightening them by no more than three quarters of a turn after the seals contact the header. Check the filter for leaks after the engine is restarted.

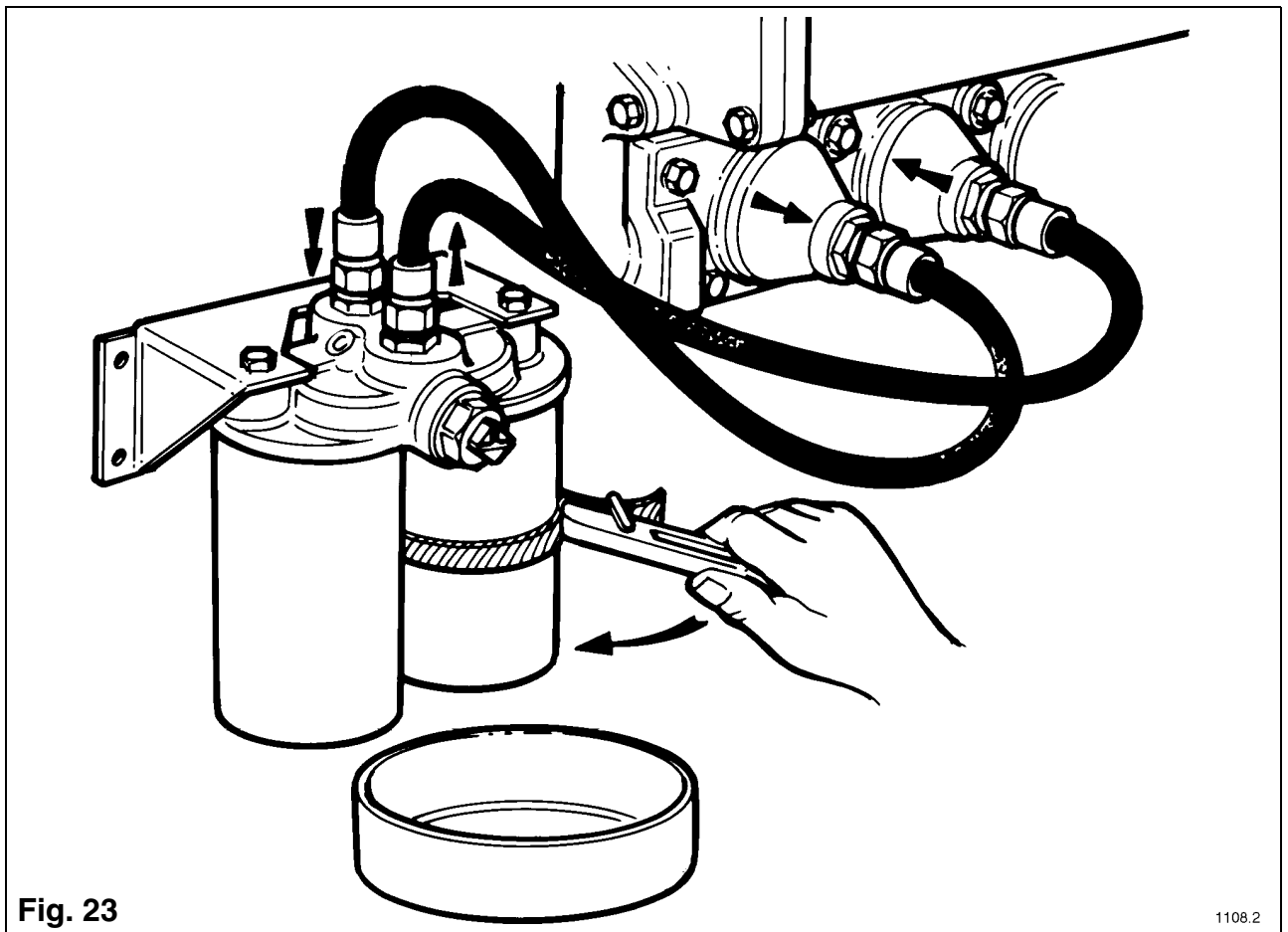


Fig. 23

1108.2

WARNING



REDUCE ENGINE SPEED TO IDLING IF CHANGING THE FILTERS WHILST ENGINE IS RUNNING.

NOTE: Prepare for a small spillage of oil from the filter as each canister is removed, by placing a container of about 5 litres or 1 gallon capacity under the filter.

CHANGING THE FILTER ELEMENTS WITHOUT STOPPING THE ENGINE

The normal position of the change-over valve is with marking on the valve spindle for the spanner showing the leg of the inverted T pointing upwards when both filter elements are in circuit. Turning the valve with the spanner provided so that the leg of the T points to the left, puts the right hand filter out of service, so that it may be exchanged for a new one, **fill the new filter with clean oil before fitting**. Turning the valve so that the leg points to the right, puts the left hand filter out of service, so that this one can now be exchanged for a new filter canister. The valve is then returned to its original position, so that both elements of the filter are back in service. Check for oil leaks.

Key (Fig. 24)

1. Change right filter
2. Normal
3. Change left filter
4. Dirty oil into filter
5. Clean oil into engine

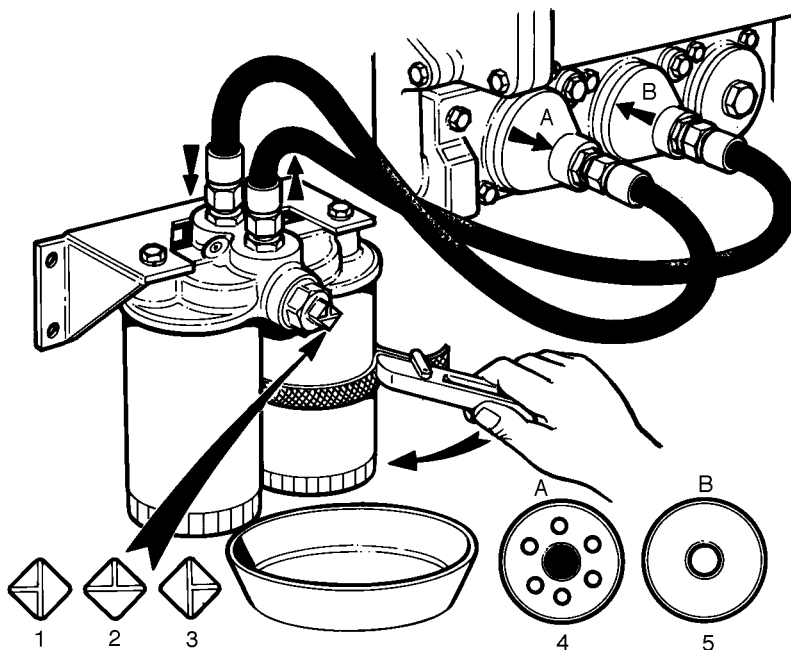


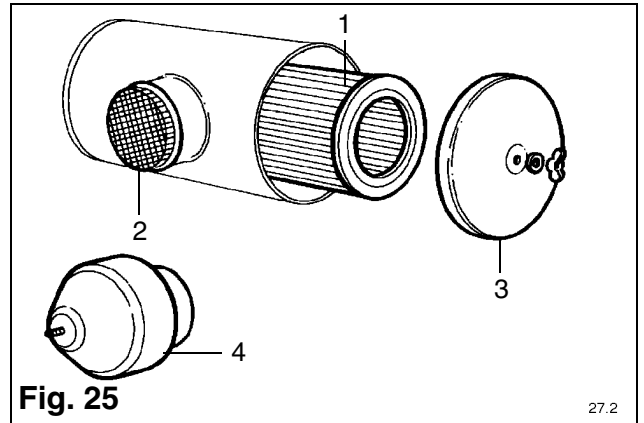
Fig. 24

80.3

WARNING  DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING THE ENGINE.

CHANGING AIR FILTER (SEE SECTION A1 IN THE WORKSHOP MANUAL) STANDARD


Remove the end cover (3) of the air filter housing, after unscrewing the retaining wing nut, carefully lift out the paper air filter element (1). For servicing the element see **General Servicing Instructions below**. When all servicing procedures are completed, fit the new or cleaned element into the housing. When fitting the end cover ensure it has seated fully in the housing before tightening the wing nut. Inspect and tighten all air filter connection before resuming equipment operation (see **Fig. 25**).



- (b) Dust accumulation on the inlet side of the housing is usually caused by leaking gaskets and/or damaged gasket surfaces. If this condition exists, leaking gaskets should be replaced and damaged gasket surfaces should be repaired before placing the unit back into service.

HEAVY DUTY

The heavy duty air filter incorporates a cyclone unit (4) fitted to the air intake of the filter (replacing the mesh guard (2)). To clean the cyclone unit remove it from the air filter and blow out any foreign matter within the unit. Changing the paper air filter element the procedure is the same as for the standard air filter above.

WARNING  REPLACE ANY ELEMENT WHICH IS DAMAGED. NEVER "BLOW" DIRT OUT OF THE FILTER HOUSING. THIS MAY INTRODUCE DUST INTO THE ENGINE. INSTEAD, USE A CLEAN, DAMP CLOT, DO NOT OIL THE ELEMENT. WHEN USING COMPRESSED AIR ALWAYS WEAR EYE PROTECTION.

GENERAL SERVICING INSTRUCTIONS

Servicing procedures include cleaning or replacing the filter element, cleaning the filter housing, and assuring that all piping and hose connection from the filter outlet to the turbocharger intake are sealed airtight.

ELEMENT CLEANING

If the filter element is in good condition with light dust contamination on its outer surface and the air flow restriction indicator (see **Page 28**) has not been triggered, the element can be cleaned using a vacuum cleaner or compressed air.

FILTER ELEMENT SERVICE

Clean the exterior of the filter housing and then carefully remove the element. Inspect the "clean air side" of the element and the outlet side of the filter housing for any unusual dust accumulations.

- (a) Dust accumulations on the clean air side of the element usually indicates a rupture in the filter medium. Immediate replacement of the element is necessary.

MAINTENANCE PROCEDURES

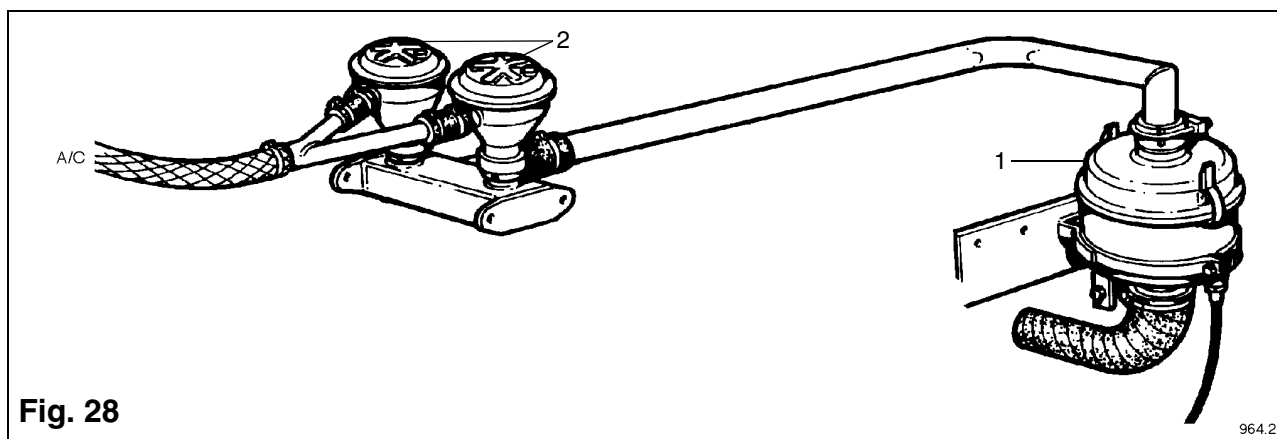
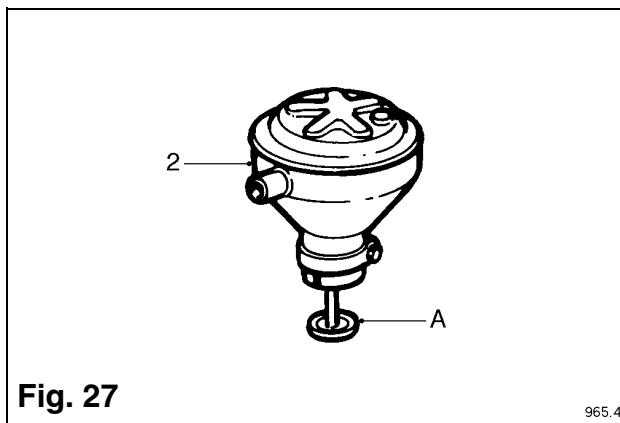
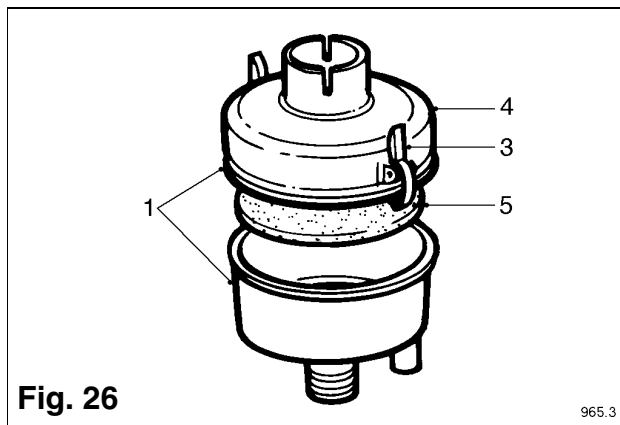
CLOSED CIRCUIT BREATHER

The closed circuit breather separators (1) are mounted on each side of the gearcase and are connected to the carburettor mixer inlet via the breather valve (2). To clean the breather separator remove the complete unit from the engine (see **Fig. 26**).

Release the retaining clips and remove the top cover (4) from the filter body. Remove the foam element (5) check it for oil sludge saturation wash thoroughly in a suitable cleaning agent, shake of excess solvent and blow dry with compressed air. Clean any oil sludge deposits from the filter body re-assemble and fit to engine.


The breather valve (2) is mounted at the flywheel end of the engine directly under the air filter. To remove release the pipe clips (see **Fig. 27**) and pull away from the valve manifold. Wash the breather thoroughly in a suitable solvent paying particular attention to any deposits on the internal area of the breather. Shake as dry as possible and blow dry with compressed air.

Before refitting ensure that the cup (A) at the base of the two breather valves are full of clean engine oil (see **Fig. 27**).



EQUALISING BRIDGE PIECES AND SETTING VALVE CLEARANCES

NOTE: The bridge pieces must be set before attempting to set the valve clearances.

WARNING  **DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING.**

Remove the 4 screws (1) from the rocker cover (2), lift off the cover peel off and throw away the old gasket (3) Pull the spark plug lead tube (4) from the spark plug bush (see **Fig. 29**).

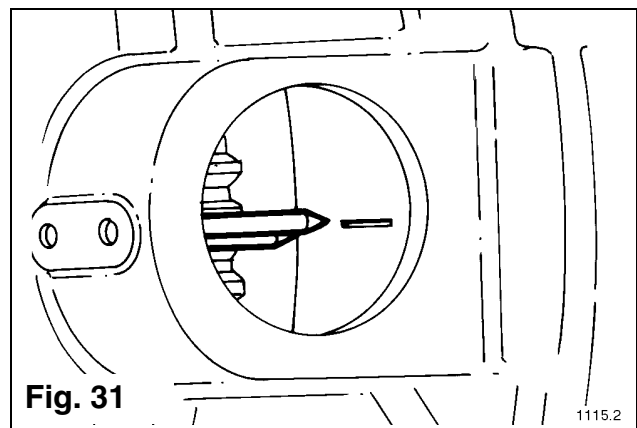
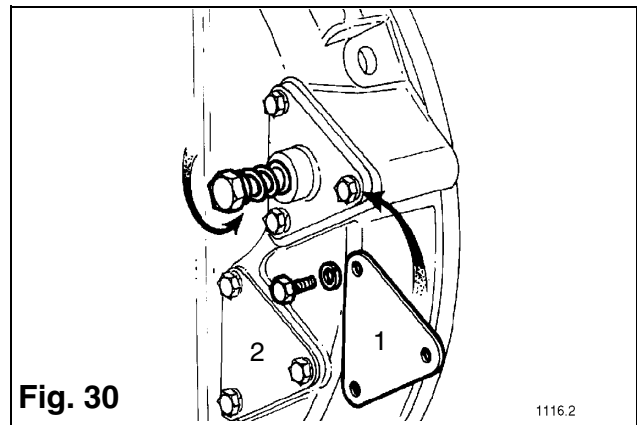
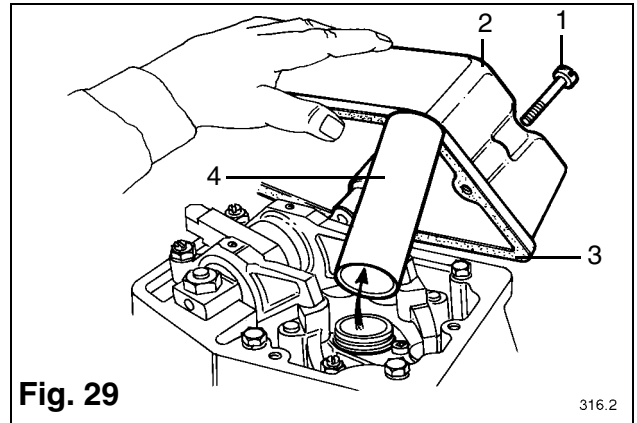
To equalise the bridge pieces the appropriate valves must be rocking, use the table below.

In order that the engine may be rotated while the batteries are disconnected a special cranking device (SE253) can be fitted to the spare starter motor hole in the flywheel housing (see **Fig. 30**). Using a socket and ratchet wrench press against the spring loaded bolt head until the pinion engages with the flywheel gear then crank the engine to the desired position.

If the valves required to be rocking are closed rotate the engine one revolution which will bring these valves to the rocking position. The flywheel housing has an inspection hole directly below the turbocharger through which the flywheel markings may be seen to line up with the pointer set in the flywheel housing (see **Fig. 31**).


The flywheel is marked: **T.D.C. (Top Dead Centre)**

4012TESI	4016TESI
A1-A6	A1-A8
A5-A2	A3-A6
A3-A4	A7-A2
B1-B6	A5-A4
B5-B2	B1-B8
B3-B4	B3-B6
	B7-B2
	B5-B4



MAINTENANCE PROCEDURES

EQUALISING THE BRIDGE PIECES

WARNING  **DISCONNECT BATTERIES OR ANY OTHER MEANS OF STARTING THE ENGINE.**

Having rotated the engine to the correct position, check that the inlet and exhaust rockers have clearance before continuing with the next operation. Loosen the lock nut (1) on each bridge piece, screw the adjuster (2) out until the fixed side of the bridge piece rests on its valve, hold the top edge down with one hand then screw the adjuster down until you feel it touch the valve, thereby equalising valve lift. Tighten the lock nut without moving the adjuster (see **Fig. 32**).

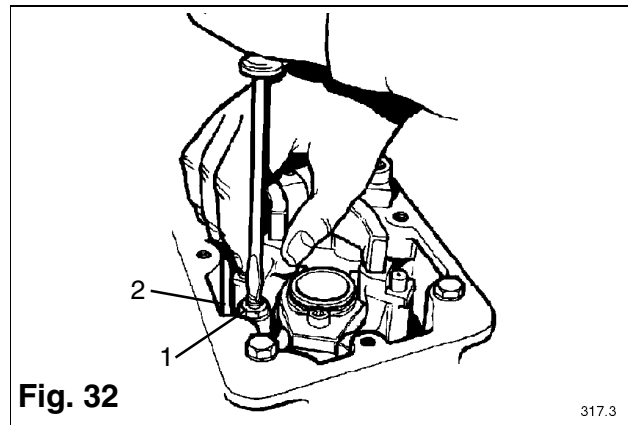


Fig. 32

SETTING VALVE CLEARANCE

With both bridge pieces equalised check the valve clearance of 0.4 mm (0.016") inlet and exhaust using a feeler gauge (1). If adjustment is required loosen the lock nut (2) and using the adjuster screw (3) set the clearance.

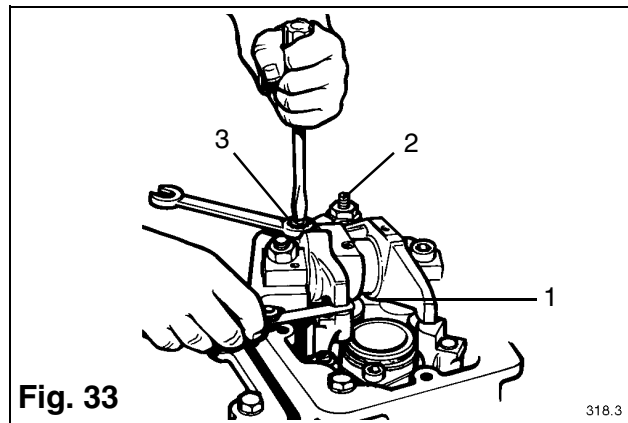


Fig. 33

Tighten the lock nut without moving the adjuster (see **Fig. 33**). The feeler gauge should be a slide fit between the rocker and bridge piece thereby giving the correct clearance. Refit the rocker cover with a new gasket.

ENGINE 4012TESI

T.D.C.	VALVES ROCKING ON CYLINDER NO.	SET BRIDGE PIECE AND VALVE CLEARANCE ON CYLINDER NO.
A1 & A6	A6	A1
B1 & B6	B1	B6
A2 & A5	A2	A5
B2 & B5	B5	B2
A3 & A4	A4	A3
B3 & B4	B3	B4
A1 & A6	A1	A6
B1 & B6	B6	B1
A2 & A5	A5	A2
B2 & B5	B2	B5
A3 & A4	A3	A4
B3 & B4	B4	B3

ENGINE 4016TESI

T.D.C.	VALVES ROCKING ON CYLINDER NO.	SET BRIDGE PIECE AND VALVE CLEARANCE ON CYLINDER NO.
A1 & A8	A8	A1
B1 & B8	B8	B1
A3 & A6	A6	A3
B3 & B6	B6	B3
A7 & A2	A2	A7
B7 & B2	B2	B7
A5 & A4	A4	A5
B5 & B4	B4	B5
A1 & A8	A1	A8
B1 & B8	B1	B8
A3 & A6	A3	A6
B3 & B6	B3	B6
A7 & A2	A7	A2
B7 & B2	B7	B2
A5 & A4	A5	A4
B5 & B4	B5	B4

MAINTENANCE PROCEDURES

BRITISH NATURAL GAS, BIOGAS AND OTHER GASES CONTINUOUS DUTY CHECK LIST (BASED ON ENGINES RUNNING AT 1500 RPM NORMAL OPERATION AND STANDARD OIL CHANGE PERIOD)

CONTINUOUS DUTY MAINTENANCE			OPERATIONS TO BE PERFORMED						
SYSTEM	OPERATION	DESCRIPTION	A	B	C	D	E	F	G
			FIRST 100 HOURS DAILY	DAILY	WEEKLY/50 HRS *	EVERY 500 HRS ★	EVERY 1000 HRS	EVERY 3000 HRS	EVERY 6000 HRS +
Lubricating	Check	For leaks and oil pressure	•	•	•	•	•	•	•
	Change	Engine oil level Full flow filters (normal or change-over)	•	•	•	•	•	•	•
	Clean	Engine oil	•		•	•	•	•	•
	Change	Crankcase Breather (and centrifugal oil filter, if fitted) Closed circuit crankcase breather Closed circuit crankcase breather separator elements	•		•	•	•	•	•
Cooling	Check	For radiator air restriction Operation of coolant heater Hoses and connections for leaks Coolant level and operating temperature Antifreeze & inhibitor concentration Belt condition & tension	•	•	•	•	•	•	•
	Change Grease	Fan and alternator belts		•	•	•	•	•	•
	Change	Fan hub & jockey pulley bearing		•	•	•	•	•	•
	Clean	Coolant Cooling system	EVERY 12 MONTHS						
Air	Check	For leaks Air cleaner restriction Pipes and connection	•	•	•	•	•	•	•
	Change	Air cleaner element		•	•	•	•	•	•
Gas	Check	For leaks	•	•	•	•	•	•	•
	Check	Governor linkage		•	•	•	•	•	•
	Check	Gas lines & connections	•		•	•	•	•	•
	Renew	Diaphragm in regulator				•	•	•	•
	Check	Wiring (incl. high tension lead, renew if required)				•	•	•	•
	Clean	Spark plugs (reset)				■	•	•	•
Exhaust	Adjust	Bridge pieces and valves First 100 hours and then	-----	-----	-----	-----	-----	-----	-----
	Change	Spark plugs				■	•	•	•
	Check	For leaks For exhaust restrictions Turbocharger comp wheel & diffuser Turbocharger bearing clearances	•	•	•	•	•	•	•
Engine Related	Check	Fenner taper lock bush (First 50 hours)					•	•	•
	Check	Vibration damper					•	•	•
	Check	Engine mountings					•	•	•
	Overhaul	Cylinder heads					•	•	•
	Re-ring	Piston (if necessary)					•	•	•
Electrical	Overhaul	Engine (new pistons, liners, etc.)					•	•	•
	Check	Battery charging system, ignition system			•	•	•	•	•
		Battery electrolyte level, specific gravity			•	•	•	•	•
		Belt condition & tension			•	•	•	•	•
		Clean & reset magnetic pick-ups				•	•	•	•
		Protection switches & alarms					•	•	•
Starter motor mounting bolts & terminals						•	•	•	

NOTE: All bolts, hose clips, terminal connections, pipes and joints, should be checked for tightness and leaks after the first 100 hrs and every 3 months thereafter.

- ★ First 500 hours then every 1,000 hours for British Natural Gas. For Biogas and other gases, first 250 hrs then every 400 hrs.
- Clean at first 500 hrs then every 1,000 hrs for British Natural Gas. For Biogas and other gases first 250 hrs then every 400 hrs. Change every 2,000 hrs for British Natural Gas and every 1,000 hrs for Biogas and other gases.
- + Major inspection at 12,000 hrs for British Natural Gas. For Biogas and other gases at 6,000 hrs check front and rear crankshaft oil seals
- ▲ Major overhaul at 20,000 hrs for British Natural Gas. For Biogas and other gases at 12,000 hrs
- * Whichever is sooner.

NOTE: On landfill gas engines drain condensate from sump every week.

**BRITISH NATURAL GAS
CONTINUOUS DUTY CHECK LIST (BASED ON ENGINES RUNNING AT 1500 RPM NORMAL
OPERATION AND EXTENDED OIL CHANGE PERIOD)**

CONTINUOUS DUTY MAINTENANCE			OPERATIONS TO BE PERFORMED							
			A	B	C	D	E	F	G	
SYSTEM	OPERATION	DESCRIPTION	FIRST 100 HOURS DAILY	DAILY	WEEKLY/50 HRS *	EVERY 500 HRS *	EVERY 1000 HRS	EVERY 3000 HRS	EVERY 12000 HRS	EVERY 20000 HRS
Lubricating	Check	For leaks and oil pressure	•	•	•	•	•	•	•	•
	Change	Engine oil level	•	•	•	•	•	•	•	•
	Change	Full flow filters (normal or change-over)	•	•	•	•	•	•	•	•
	Clean	Engine oil	•	•	•	•	•	•	•	•
Cooling	Check	Crankcase Breather (and centrifugal oil filter, if fitted)				•	•	•	•	•
	Change	Closed circuit crankcase breather				•	•	•	•	•
	Change	Closed circuit crankcase breather separator elements				•	•	•	•	•
	Change	Coolant				•	•	•	•	•
Air	Check	Cooling system				•	•	•	•	•
	Change	For radiator air restriction	•	•	•	•	•	•	•	•
	Change	Operation of coolant heater	•	•	•	•	•	•	•	•
	Change	Hoses and connections for leaks	•	•	•	•	•	•	•	•
Gas	Check	Coolant level and operating temperature	•	•	•	•	•	•	•	•
	Check	Antifreeze & inhibitor concentration	•	•	•	•	•	•	•	•
	Check	Belt condition & tension	•	•	•	•	•	•	•	•
	Check	Fan and alternator belts	•	•	•	•	•	•	•	•
Exhaust	Check	Fan hub & jockey pulley bearing	•	•	•	•	•	•	•	•
	Clean	Coolant	•	•	•	•	•	•	•	•
	Check	Cooling system	•	•	•	•	•	•	•	•
	Check	EVERY 12 MONTHS								
Engine Related	Check	For leaks	•	•	•	•	•	•	•	•
	Check	Air cleaner restriction	•	•	•	•	•	•	•	•
	Change	Pipes and connection	•	•	•	•	•	•	•	•
	Change	Air cleaner element	•	•	•	•	•	•	•	•
Electrical	Check	For leaks	•	•	•	•	•	•	•	•
	Check	Governor linkage	•	•	•	•	•	•	•	•
	Check	Gas lines & connections	•	•	•	•	•	•	•	•
	Check	Diaphragm in regulator	•	•	•	•	•	•	•	•
Electrical	Check	Wiring (incl. high tension lead, renew if required)	•	•	•	•	•	•	•	•
	Check	Spark plugs (reset)	•	•	•	•	•	•	•	•
	Adjust	Bridge pieces and valves	•	•	•	•	•	•	•	•
	Change	Spark plugs	•	•	•	•	•	•	•	•
Electrical	Check	First 500 hours and then	•	•	•	•	•	•	•	•
	Check	First 100 hours and then	•	•	•	•	•	•	•	•
	Check	EVERY 2000 HOURS								
	Check	EVERY 2000 HOURS								
Electrical	Check	For leaks	•	•	•	•	•	•	•	•
	Clean	For exhaust restrictions	•	•	•	•	•	•	•	•
	Check	Turbocharger comp wheel & diffuser	•	•	•	•	•	•	•	•
	Check	Turbocharger bearing clearances	•	•	•	•	•	•	•	•
Electrical	Check	Fenner taper lock bush (First 50 hours)	•	•	•	•	•	•	•	•
	Check	Vibration damper	•	•	•	•	•	•	•	•
	Check	Engine mountings	•	•	•	•	•	•	•	•
	Overhaul	Cylinder heads	•	•	•	•	•	•	•	•
Electrical	Overhaul	Piston (if necessary)	•	•	•	•	•	•	•	•
	Overhaul	Engine (new pistons, liners, etc.)	•	•	•	•	•	•	•	•
	Check	Battery charging system, ignition system	•	•	•	•	•	•	•	•
	Check	Battery electrolyte level, specific gravity	•	•	•	•	•	•	•	•
Electrical	Check	Belt condition & tension	•	•	•	•	•	•	•	•
	Check	Clean & reset magnetic pick-ups	•	•	•	•	•	•	•	•
	Check	Protection switches & alarms	•	•	•	•	•	•	•	•
	Check	Starter motor mounting bolts & terminals	•	•	•	•	•	•	•	•

NOTE: All bolts, hose clips, terminal connections, pipes and joints, should be checked for tightness and leaks after the first 100 hrs and every 3 months thereafter.

★ Change at first 500 hrs, then every 1000 hrs, until an extended oil change period has been established, which will depend on the result of a series of analyses (see pages 14-15).

■ Also check front and rear crankshaft oil seals.

* Whichever is sooner.

MAINTENANCE PROCEDURES

BIOGAS AND OTHER GASES (NOT BRITISH NATURAL GAS) CONTINUOUS DUTY CHECK LIST (BASED ON ENGINES RUNNING AT 1500 RPM NORMAL OPERATION AND EXTENDED OIL CHANGE PERIOD)

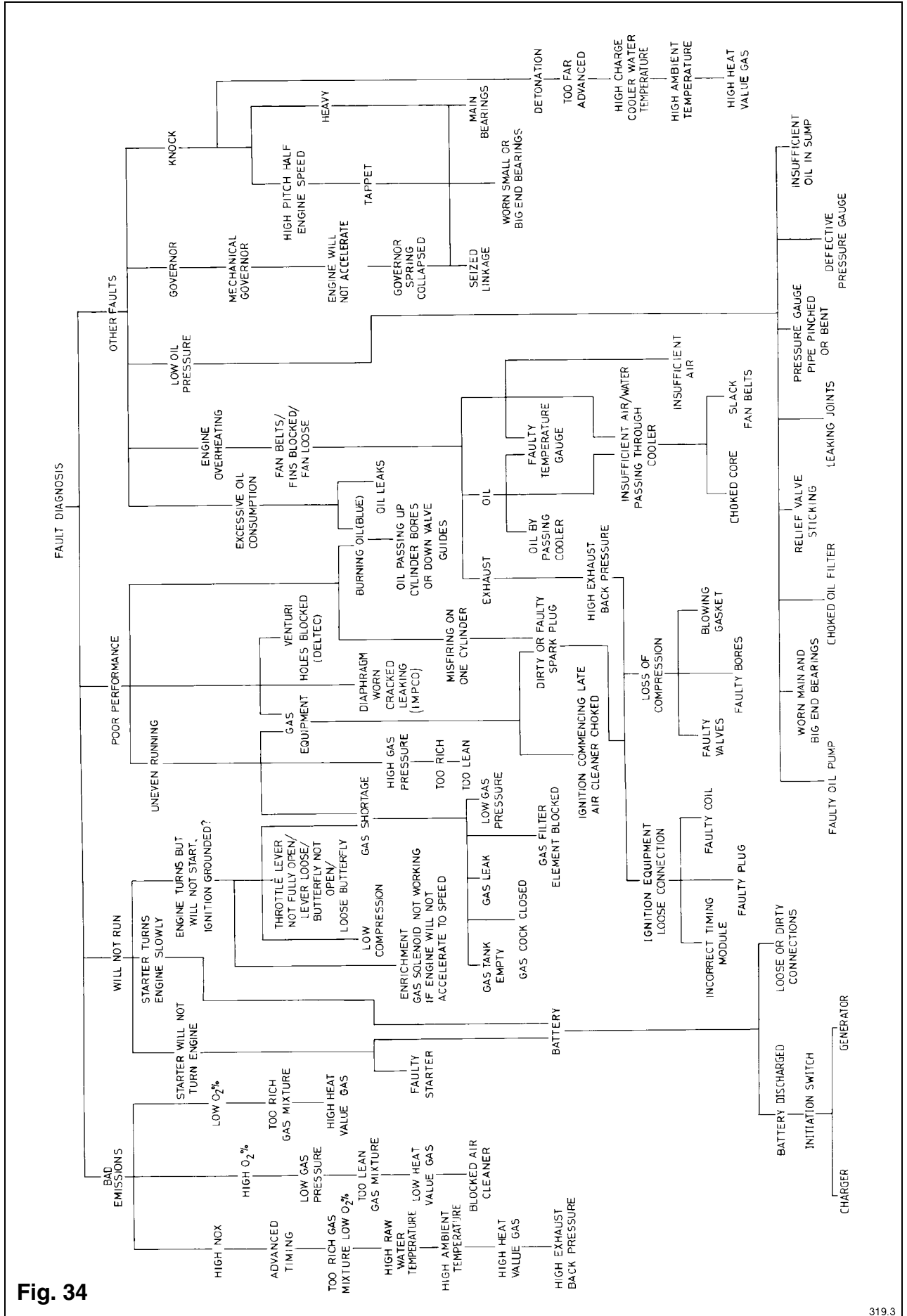
CONTINUOUS DUTY MAINTENANCE			OPERATIONS TO BE PERFORMED							
SYSTEM	OPERATION	DESCRIPTION	FIRST 100 HOURS DAILY	DAILY	WEEKLY/50 HRS *	EVERY 500 HRS ★	EVERY 1000 HRS	EVERY 3000 HRS	EVERY 6000 HRS	EVERY 12000 HRS
Lubricating	Check	For leaks and oil pressure	•	•	•	•	•	•	•	•
		Engine oil level	•	•	•	•	•	•	•	•
	Change	Full flow filter	•			★	•	•	•	•
		Engine oil				•	•	•	•	•
	Clean	Crankcase Breather				•	•	•	•	•
	Change	Closed circuit crankcase breather				•	•	•	•	•
	Change	Closed circuit crankcase breather separator elements				•	•	•	•	•
	Clean	Centrifugal lubricating oil filter First 250 hours and then	----- EVERY 400 HOURS							
	Check	Front and rear crankshaft oil seals							•	•
Cooling	Check	For radiator air restriction	•	•	•	•	•	•	•	•
		Operation of coolant heater			•	•	•	•	•	•
		Hoses and connections for leaks		•	•	•	•	•	•	•
		Change Grease	Coolant level and operating temperature		•	•	•	•	•	•
	Change	Antifreeze & inhibitor concentration				•	•	•	•	
	Clean	Belt condition & tension				•	•	•	•	
	Clean	Fan and alternator belts				•	•	•	•	
	Clean	Fan hub & jockey pulley bearing				•	•	•	•	
	Change	Coolant	----- EVERY 12 MONTHS							
	Clean	Cooling system							•	•
Air	Check	For leaks	•	•	•	•	•	•	•	•
		Air cleaner restriction		•	•	•	•	•	•	•
	Change	Pipes and connection					•	•	•	•
	Change	Air cleaner element					•	•	•	•
Gas	Check	For leaks	•	•	•	•	•	•	•	•
	Check	Governor linkage					•	•	•	•
	Check	Gas lines & connections	•				•	•	•	•
	Renew	Diaphragm in regulator					•	•	•	•
	Check	Wiring (incl. high tension lead, renew if required)					•	•	•	•
	Clean	Spark plugs (reset) First 250 hours and then				★	•	•	•	•
Adjust	Bridge pieces and valves First 100 hours and then				•	•	•	•	•	
	Change	Spark plugs					•	•	•	•
Exhaust	Check	For leaks	•	•	•	•	•	•	•	•
		For exhaust restrictions					•	•	•	•
	Clean	Turbocharger comp wheel & diffuser					•	•	•	•
	Check	Turbocharger bearing clearances					•	•	•	•
Engine Related	Check	Fenner taper lock bush (First 50 hours)						•	•	•
	Check	Vibration damper						•	•	•
	Check	Engine mountings						•	•	•
	Overhaul	Cylinder heads						•	•	•
	Re-ring	Piston (if necessary)							•	•
	Overhaul	Engine (new pistons, liners, etc.)							•	•
Electrical	Check	Battery charging system, ignition system			•	•	•	•	•	•
		Battery electrolyte level, specific gravity			•	•	•	•	•	•
		Belt condition & tension				•	•	•	•	•
		Clean & reset magnetic pick-ups					•	•	•	•
		Protection switches & alarms						•	•	•
		Starter motor mounting bolts & terminals							•	•

NOTE: All bolts, hose clips, terminal connections, pipes and joints, should be checked for tightness and leaks every 3 months.

★ Change first 250 hrs, then every 400 hrs, until an extended oil change period has been established, which will depend on a series of analyses (see pages 14-15). A centrifugal oil filter (see page 29) must be fitted and cleaned after first 250 hrs then every 400 hrs.

NOTE: It is normal practice when operating on gases other than natural gas for the oil to be continuously analysed at intervals of 100/150 hrs.

* Whichever is sooner.



4012/16TESI (MINNOX) WIRING DIAGRAM WITH CAV STARTER AND PROTECTION SWITCHES

Key

(Fig. 35)

1. Oil press switch
2. 220Ω5w resistor
3. Charging alternator
4. Repeater relay
5. Start motor
6. 'Start relay
7. Engine fault switches left/right banks
8. Water temp.
9. Oil press
10. All fault switches close on a fault. One side of all fault switches are identical. For the engine to run, immediately on depressing start button, Gov+ must be fed 24 volt +ve. To stop the engine break this +ve.
11. Left/right manifold high gas pressure detector switches
12. Pick-up sensing on flywheel
13. Left/right manifold switch gauges for manifold out of balance protection
14. Switch speed 700 rpm
15. Switch overspeed
16. Two switch speed unit

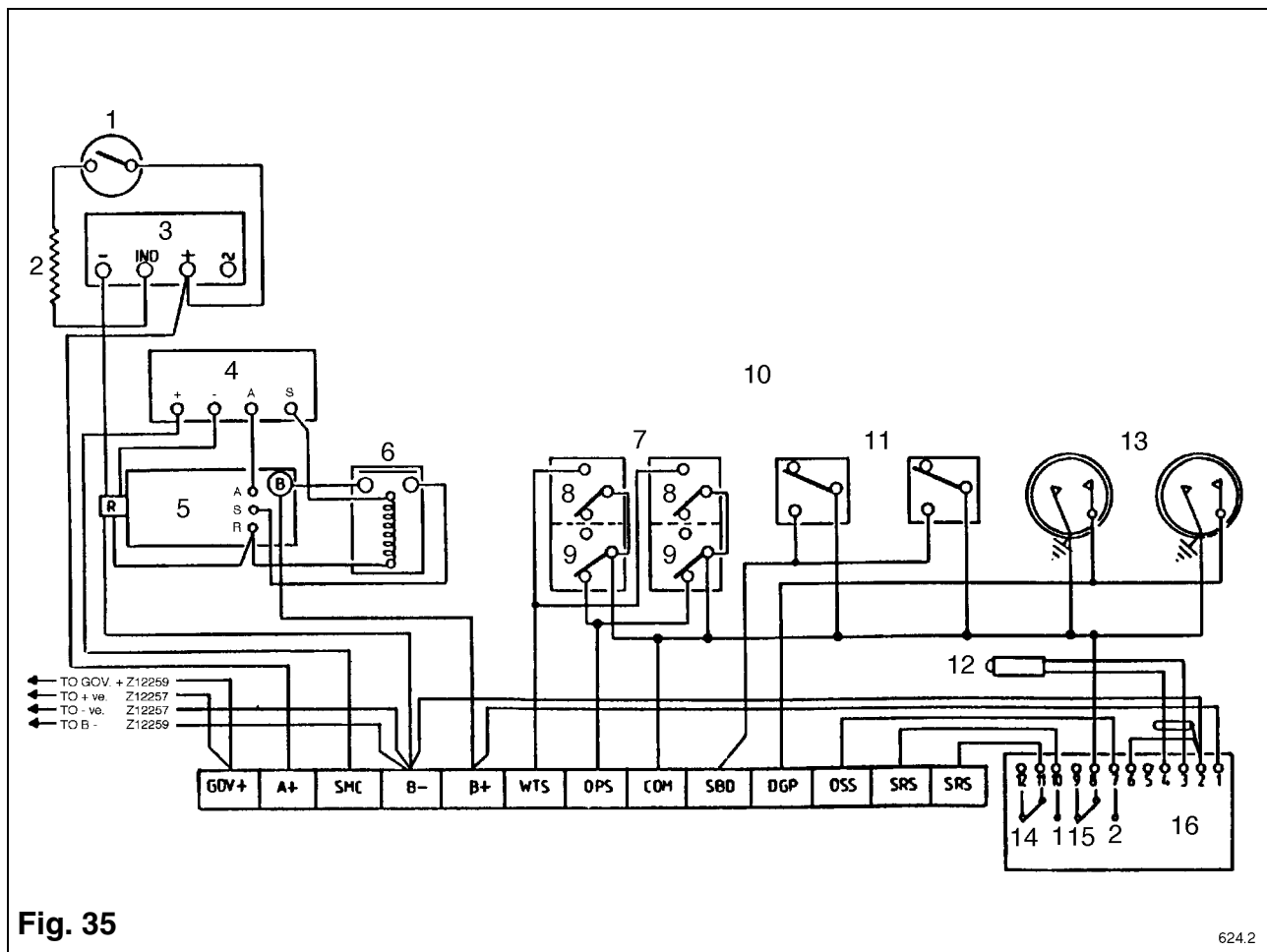


Fig. 35

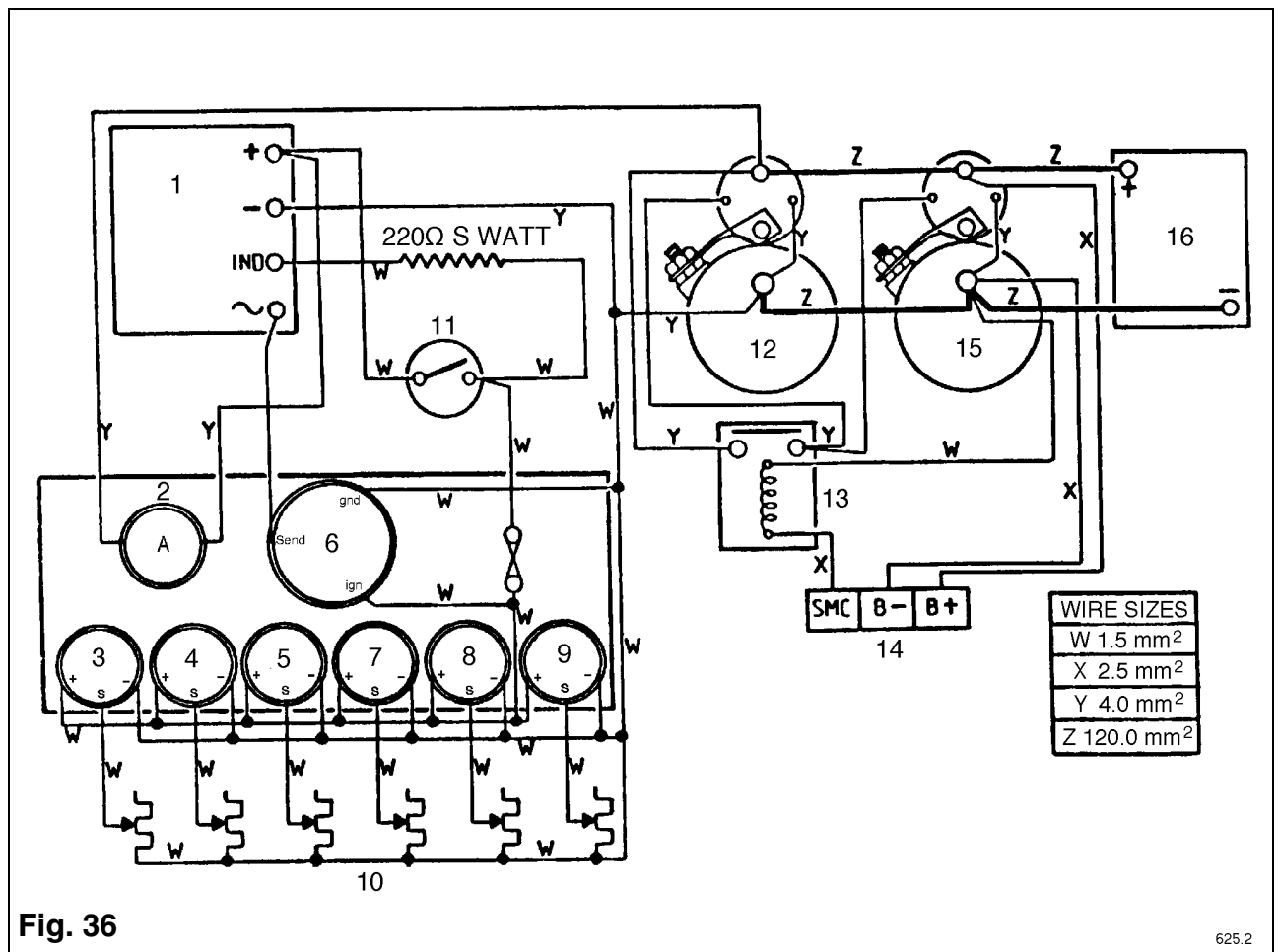
624.2

4012/16 (GAS) MINNOX ENGINE WIRING DIAGRAM STARTING CIRCUIT WITH BUTEC STARTERS AND OPTIONAL INSTRUMENT PANEL

Key

(Fig. 36)

1. Charging alternator
2. Ammeter
3. Oil press
4. Oil temp.
5. Water temp.
6. Tacho
7. Oil press
8. Oil temp.
9. Water temp.
10. Gauge senders
11. Oil press switch
12. No. 1 Starter motor
13. Start relay
14. Engine terminal block
15. No. 2 Starter motor
16. 24 Volt Start batteries

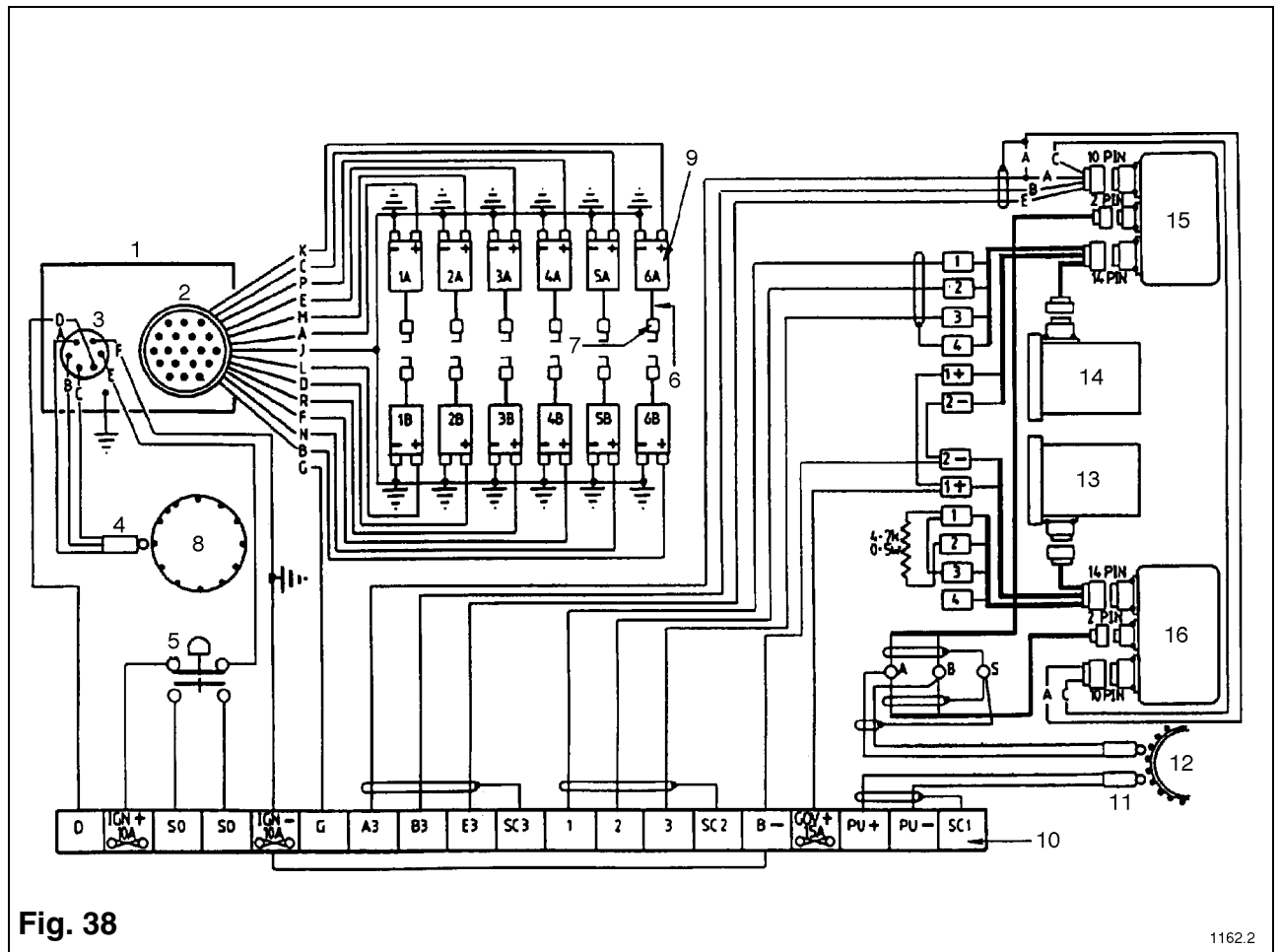


625.2

Key

(Fig. 38)

1. DISN Unit
2. 19 Pin plug
3. 6 Pin plug
4. Pick-up
5. Engine fitted emergency stop button
6. H.T. Leads
7. Spark plugs
8. Magnetic disc
9. Ignition coils
10. Terminal box
11. Magnetic pick-up
12. Engine flywheel
13. Heinzmann actuator 'A' bank
14. Heinzmann actuator 'B' bank
15. Heinzmann control box 'B' bank right
16. Heinzmann control box 'A' bank left



4012/16 (GAS) MINNOX ENGINE WIRING DIAGRAM OF STANDARD PROTECTION PACK AND OPTIONAL BRITISH GAS COUNCIL PROTECTION EQUIPMENT

Key

(Fig. 39)

1. Standard fitted equipment
2. Magnetic pick-up
3. Engine flywheel
4. Two switch speed unit
5. Switch 2 over speed
6. Switch 1 speed 600 rpm
7. Engine terminal box
8. **NOTE:**
 1. High manifold gas pressure and gas spitback can be on the same fault channel.
 2. Manifold out of balance switch gauges can be earth return type.
9. Left/right banks engine fault switches.
10. Water temp.
11. Oil press
12. Left/right banks manifold out of balance switch gauges
13. Left/right banks high manifold gas pressure fault switches
14. Optional equipment
15. Left/right banks gas spitback fault switches
16. Low gas pressure fault switch

17. Gas solenoid valves not normally supplied by Perkins can be four off depending on gas pipe work arrangement
18. Energised to run gas line solenoid valves
19. Low water level fault switch

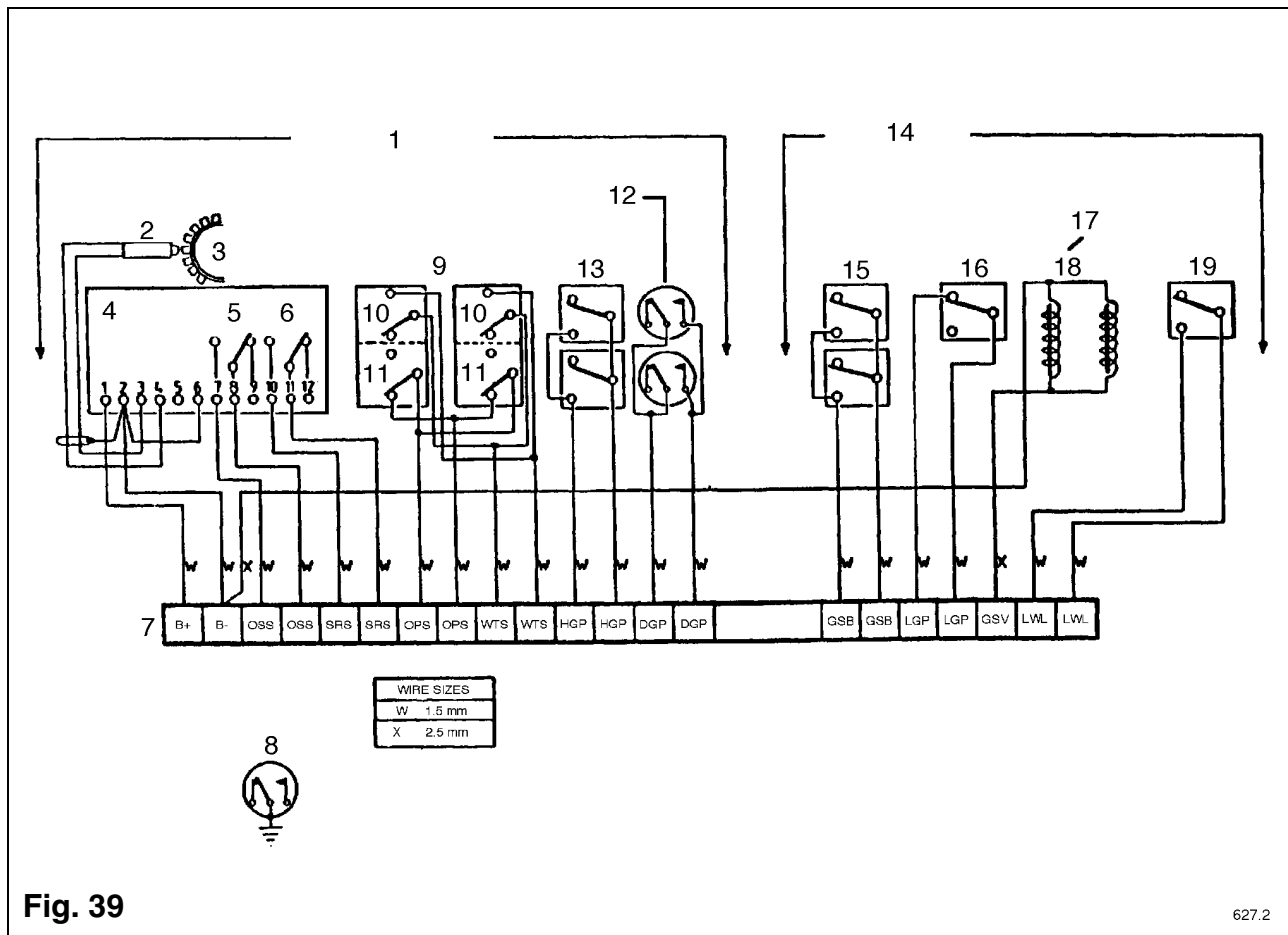


Fig. 39

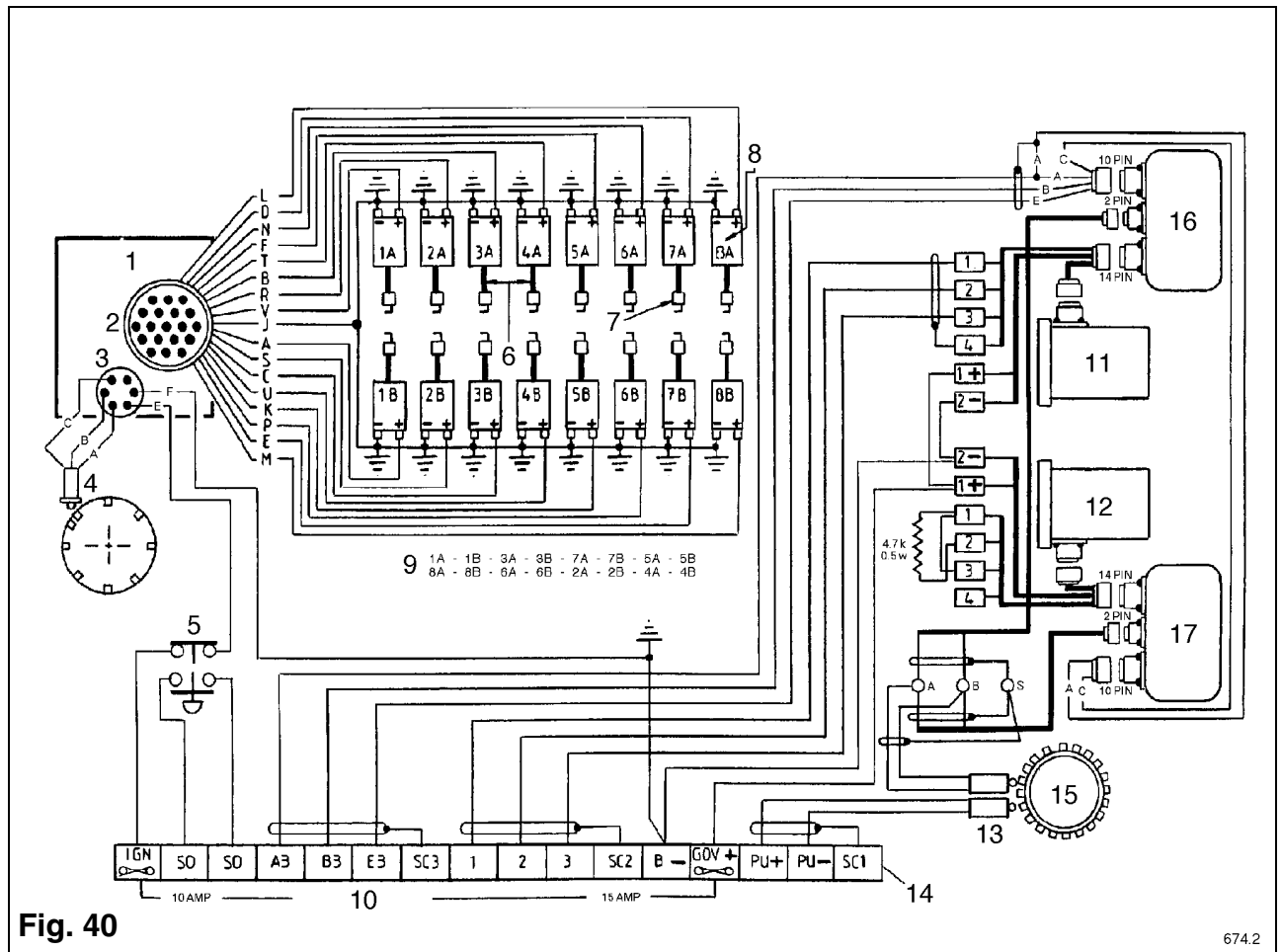
627.2

EARLY 4016 SERIES GAS IGNITION AND HEINZMANN WIRING SYSTEM

Key

(Fig. 40)

1. DISN Unit
2. 19 Pin plug
3. 6 Pin plug
4. Pick-up
5. Engine fitted emergency stop button
6. H.T. Leads
7. Spark plugs
8. Ignition coils
9. Firing order
10. Fused terminals
11. Heinzmann actuator 'A' bank left
12. Heinzmann actuator 'B' bank right
13. Magnetic pick-ups
14. Engine fitted terminal box
15. Engine flywheel
16. Heinzmann control box 'A' bank left
17. Heinzmann control box 'B' bank right



674.2

CURRENT 4016 SERIES GAS IGNITION AND HEINZMAN WIRING SYSTEM

Key

(Fig. 41)

1. DISN Unit
2. 19 Pin plug
3. 6 Pin plug
4. Pick-up
5. Engine fitted emergency stop button
6. HT Leads
7. Spark plugs
8. Ignition Coils
9. Magnetic Disc
10. Heinzmann actuator 'A' bank left
11. Heinzmann actuator 'B' bank right
12. Magnetic pick-ups
13. Engine fitted terminal box
14. Engine flywheel
15. Heinzmann control box 'A' bank left
16. Heinzmann control box 'B' bank right

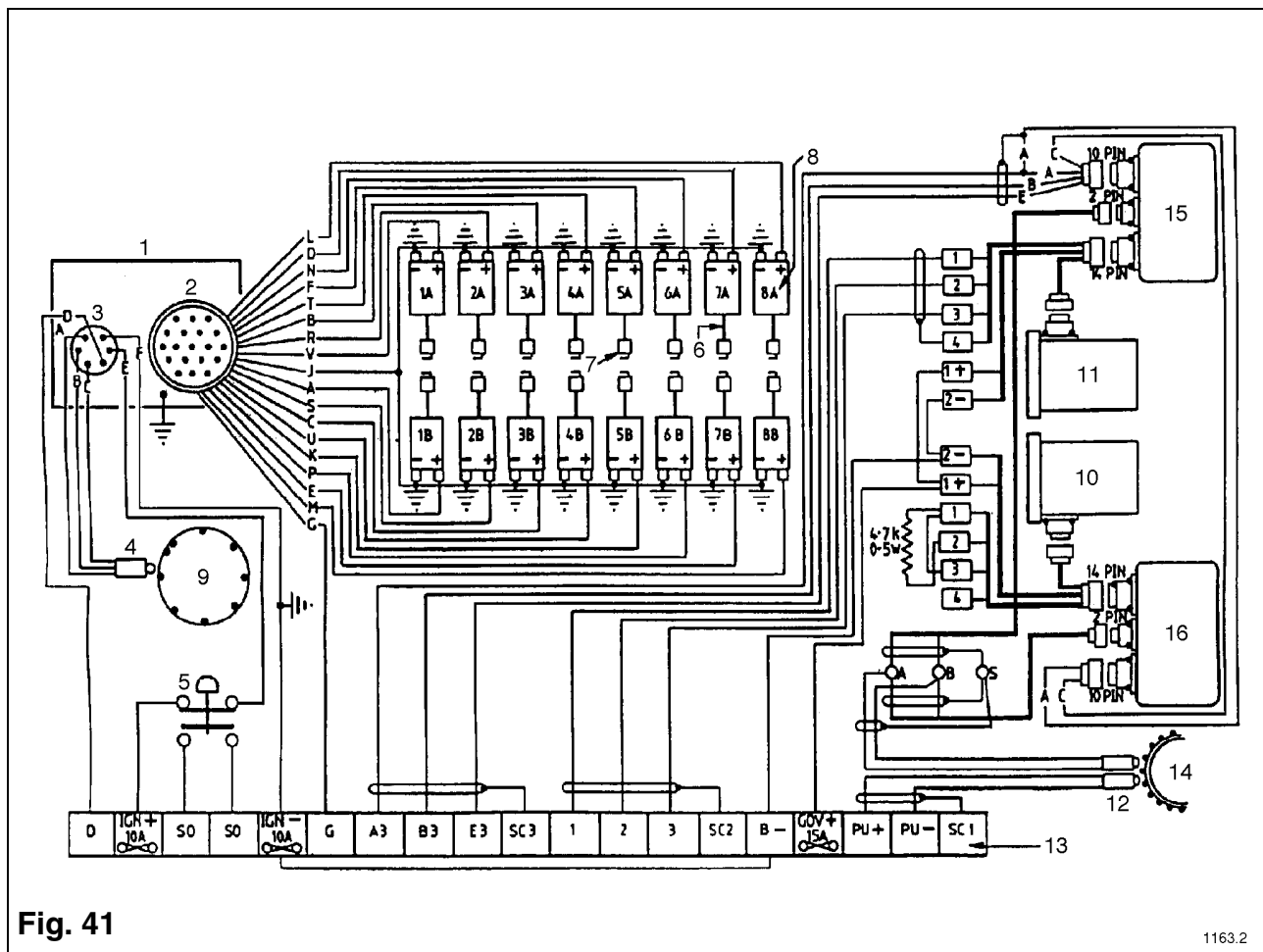


Fig. 41

1163.2