Reference

Dimensions and weights

Note: *All figures and dimensions are approximate and may vary according to model. Refer to manufacturer's data for exact figures.*

Dimensions

Overall length:	
Visa Saloon	3.725 m
C15/Champ Van	3.995 m
BX Saloon	4.237 m
BX Estate	4.399 m
Overall width:	
Visa Saloon	1.526 m
C15/Champ Van	1.636 m
BX	1.682 m
Overall height:	
Visa Saloon	1:410 m
C15/Champ Van	1.801 m
BX Saloon	1.360 m
BX Estate	1.431 m
Wheelbase:	
Visa Saloon/Van	2.420 m
BX	2.660 m

Weights

Kerb weight:	
Visa Saloon	890 kg
C15/Champ Van	850 kg
BX Saloon (non-Turbo)	990 kg
BX Saloon (Turbo)	1025 kg
BX Estate (non-Turbo)	1037 kg
BX Estate (Turbo)	1077 kg
Maximum trailer weight:	
Visa Saloon/Van	750 kg
BX	1100 kg
Maximum roof rack load:	
Visa Saloon/Van	60 kg
BX Saloon	75 kg
BX Estate	100 kg
Gross train weight:	
Visa Saloon/Van	2050 kg
BX Saloon	2600 kg
BX Estate	2700 kg

Conversion factors

Length (distance)

Inches (in)	x 25.4	= Millimetres (mm)	x 0.0394	= Inches (in)
Feet (ft)	x 0.305	= Metres (m)	x 3.281	= Feet (ft)
Miles	x 1.609	= Kilometres (km)	x 0.621	= Miles

Volume (capacity)

Cubic inches (cu in; in³)	x 16.387	= Cubic centimetres (cc; cm³)	x 0.061	= Cubic inches (cu in; in³)
Imperial pints (Imp pt)	x 0.568	= Litres (l)	x 1.76	= Imperial pints (Imp pt)
Imperial quarts (Imp qt)	x 1.137	= Litres (l)	x 0.88	= Imperial quarts (Imp qt)
Imperial quarts (Imp qt)	x 1.201	= US quarts (US qt)	x 0.833	= Imperial quarts (Imp qt)
US quarts (US qt)	x 0.946	= Litres (l)	x 1.057	= US quarts (US qt)
Imperial gallons (Imp gal)	x 4.546	= Litres (l)	x 0.22	= Imperial gallons (Imp gal)
Imperial gallons (Imp gal)	x 1.201	= US gallons (US gal)	x 0.833	= Imperial gallons (Imp gal)
US gallons (US gal)	x 3.785	= Litres (l)	x 0.264	= US gallons (US gal)

Mass (weight)

Ounces (oz)	x 28.35	= Grams (g)	x 0.035	= Ounces (oz)
Pounds (lb)	x 0.454	= Kilograms (kg)	x 2.205	= Pounds (lb)

Force

Ounces-force (ozf; oz)	x 0.278	= Newtons (N)	x 3.6	= Ounces-force (ozf; oz)
Pounds-force (lbf; lb)	x 4.448	= Newtons (N)	x 0.225	= Pounds-force (lbf; lb)
Newtons (N)	x 0.1	= Kilograms-force (kgf; kg)	x 9.81	= Newtons (N)

Pressure

Pounds-force per square inch (psi; lbf/in²; lb/in²)	x 0.070	= Kilograms-force per square centimetre (kgf/cm²; kg/cm²)	x 14.223	= Pounds-force per square inch (psi; lbf/in²; lb/in²)
Pounds-force per square inch (psi; lbf/in²; lb/in²)	x 0.068	= Atmospheres (atm)	x 14.696	= Pounds-force per square inch (psi; lbf/in²; lb/in²)
Pounds-force per square inch (psi; lbf/in²; lb/in²)	x 0.069	= Bars	x 14.5	= Pounds-force per square inch (psi; lbf/in²; lb/in²)
Pounds-force per square inch (psi; lbf/in²; lb/in²)	x 6.895	= Kilopascals (kPa)	x 0.145	= Pounds-force per square inch (psi; lbf/in²; lb/in²)
Kilopascals (kPa)	x 0.01	= Kilograms-force per square centimetre (kgf/cm²; kg/cm²)	x 98.1	= Kilopascals (kPa)
Millibar (mbar)	x 100	= Pascals (Pa)	x 0.01	= Millibar (mbar)
Millibar (mbar)	x 0.0145	= Pounds-force per square inch (psi; lbf/in²; lb/in²)	x 68.947	= Millibar (mbar)
Millibar (mbar)	x 0.75	= Millimetres of mercury (mmHg)	x 1.333	= Millibar (mbar)
Millibar (mbar)	x 0.401	= Inches of water (inH_2O)	x 2.491	= Millibar (mbar)
Millimetres of mercury (mmHg)	x 0.535	= Inches of water (inH_2O)	x 1.868	= Millimetres of mercury (mmHg)
Inches of water (inH_2O)	x 0.036	= Pounds-force per square inch (psi; lbf/in²; lb/in²)	x 27.68	= Inches of water (inH_2O)

Torque (moment of force)

Pounds-force inches (lbf in; lb in)	x 1.152	= Kilograms-force centimetre (kgf cm; kg cm)	x 0.868	= Pounds-force inches (lbf in; lb in)
Pounds-force inches (lbf in; lb in)	x 0.113	= Newton metres (Nm)	x 8.85	= Pounds-force inches (lbf in; lb in)
Pounds-force inches (lbf in; lb in)	x 0.083	= Pounds-force feet (lbf ft; lb ft)	x 12	= Pounds-force inches (lbf in; lb in)
Pounds-force feet (lbf ft; lb ft)	x 0.138	= Kilograms-force metres (kgf m; kg m)	x 7.233	= Pounds-force feet (lbf ft; lb ft)
Pounds-force feet (lbf ft; lb ft)	x 1.356	= Newton metres (Nm)	x 0.738	= Pounds-force feet (lbf ft; lb ft)
Newton metres (Nm)	x 0.102	= Kilograms-force metres (kgf m; kg m)	x 9.804	= Newton metres (Nm)

Power

Horsepower (hp)	x 745.7	= Watts (W)	x 0.0013	= Horsepower (hp)

Velocity (speed)

Miles per hour (miles/hr; mph)	x 1.609	= Kilometres per hour (km/hr; kph)	x 0.621	= Miles per hour (miles/hr; mph)

Fuel consumption*

Miles per gallon (mpg)	x 0.354	= Kilometres per litre (km/l)	x 2.825	= Miles per gallon (mpg)

Temperature

Degrees Fahrenheit = (°C x 1.8) + 32

Degrees Celsius (Degrees Centigrade; °C) = (°F - 32) x 0.56

* *It is common practice to convert from miles per gallon (mpg) to litres/100 kilometres (l/100km), where mpg x l/100 km = 282*

Buying spare parts

Spare parts are available from many sources, including maker's appointed garages, accessory shops and motor factors. To be sure of obtaining the correct parts, it will sometimes be necessary to quote the vehicle identification number. If possible, it can also be useful to take the old part along for positive identification. Items such as starter motors and alternators may be available through a service exchange scheme - any parts returned should always be clean.

Our advice regarding spare part sources is as follows.

Officially appointed dealers

This is the best source of parts that are peculiar to your car, that are otherwise not generally available. It is also the only place at which you should buy parts if your vehicle is still under warranty.

Accessory shops

These are often very good places to buy materials and components needed for the maintenance of your car (e.g. oil filters, drivebelts, oils and greases, etc.). They also sell general accessories, usually have convenient opening hours, charge lower prices and can often be found not far from home.

Motor factors

Good factors will stock all the more important components that wear out relatively quickly (e.g. clutch components, pistons, valves, exhaust systems, brake cylinders/pipes/hoses/seals/shoes and pads, etc.). Motor factors will often provide new or reconditioned components on a part exchange basis - this can save a considerable amount of money.

Vehicle identification

Modifications are a continuing and unpublished process in vehicle manufacture, quite apart from major model changes. Spare parts manuals and lists are compiled upon a numerical basis, the individual vehicle numbers being essential to correct identification of the component required.

When ordering spare parts, always give as much information as possible. Quote the car model, year of manufacture and vehicle identification and/or engine numbers as appropriate **(see illustrations)**.

The *chassis or identification number* is stamped on the makers plate that is located on the right front wheel arch in the engine compartment. On some models a *chassis number* is also stamped onto a plate located on the front panel.

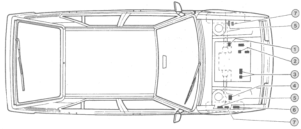
The *vehicle type* can be found stamped into the drip rail next to the right front wing.

The *engine serial number is* stamped in the centre and at the front of the engine.

The *transmission number* is stamped on the transmission casing.

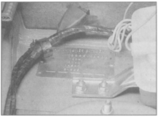
Some later models also have a *replacement parts identification number* on the right hand front wheel arch.

Individual components, such as the starter motor, alternator, injection pump, etc., also have identification numbers stamped on the components themselves.

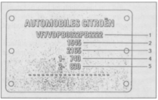


Vehicle identification plate locations (typical BX model)

1 Transmission number
2 Engine number
3 Manufacturers plate
4 Replacement parts number
5 Chassis number
6 Paint number
7 Model year



Location of vehicle identification plate (Visa models)



Vehicle identification plate

1 Vehicle identification number
2 Gross vehicle weight
3 Gross train weight
4 Maximum weight on front axle
5 Maximum weight on rear axle

Whenever servicing, repair or overhaul work is carried out on the car or its components, observe the following procedures and instructions. This will assist in carrying out the operation efficiently and to a professional standard of workmanship.

Joint mating faces and gaskets

When separating components at their mating faces, never insert screwdrivers or similar implements into the joint between the faces in order to prise them apart. This can cause severe damage which results in oil leaks, coolant leaks, etc upon reassembly. Separation is usually achieved by tapping along the joint with a soft-faced hammer in order to break the seal. However, note that this method may not be suitable where dowels are used for component location.

Where a gasket is used between the mating faces of two components, a new one must be fitted on reassembly; fit it dry unless otherwise stated in the repair procedure. Make sure that the mating faces are clean and dry, with all traces of old gasket removed. When cleaning a joint face, use a tool which is unlikely to score or damage the face, and remove any burrs or nicks with an oilstone or fine file.

Make sure that tapped holes are cleaned with a pipe cleaner, and keep them free of jointing compound, if this is being used, unless specifically instructed otherwise.

Ensure that all orifices, channels or pipes are clear, and blow through them, preferably using compressed air.

Oil seals

Oil seals can be removed by levering them out with a wide flat-bladed screwdriver or similar implement. Alternatively, a number of self-tapping screws may be screwed into the seal, and these used as a purchase for pliers or some similar device in order to pull the seal free.

Whenever an oil seal is removed from its working location, either individually or as part of an assembly, it should be renewed.

The very fine sealing lip of the seal is easily damaged, and will not seal if the surface it contacts is not completely clean and free from scratches, nicks or grooves. If the original sealing surface of the component cannot be restored, and the manufacturer has not made provision for slight relocation of the seal relative to the sealing surface, the component should be renewed.

Protect the lips of the seal from any surface which may damage them in the course of fitting. Use tape or a conical sleeve where possible. Lubricate the seal lips with oil before fitting and, on dual-lipped seals, fill the space between the lips with grease.

Unless otherwise stated, oil seals must be fitted with their sealing lips toward the lubricant to be sealed.

Use a tubular drift or block of wood of the appropriate size to install the seal and, if the seal housing is shouldered, drive the seal down to the shoulder. If the seal housing is unshouldered, the seal should be fitted with its face flush with the housing top face (unless otherwise instructed).

Screw threads and fastenings

Seized nuts, bolts and screws are quite a common occurrence where corrosion has set in, and the use of penetrating oil or releasing fluid will often overcome this problem if the offending item is soaked for a while before attempting to release it. The use of an impact driver may also provide a means of releasing such stubborn fastening devices, when used in conjunction with the appropriate screwdriver bit or socket. If none of these methods works, it may be necessary to resort to the careful application of heat, or the use of a hacksaw or nut splitter device.

Studs are usually removed by locking two nuts together on the threaded part, and then using a spanner on the lower nut to unscrew the stud. Studs or bolts which have broken off below the surface of the component in which they are mounted can sometimes be removed using a stud extractor. Always ensure that a blind tapped hole is completely free from oil, grease, water or other fluid before installing the bolt or stud. Failure to do this could cause the housing to crack due to the hydraulic action of the bolt or stud as it is screwed in.

When tightening a castellated nut to accept a split pin, tighten the nut to the specified torque, where applicable, and then tighten further to the next split pin hole. Never slacken the nut to align the split pin hole, unless stated in the repair procedure.

When checking or retightening a nut or bolt to a specified torque setting, slacken the nut or bolt by a quarter of a turn, and then retighten to the specified setting. However, this should not be attempted where angular tightening has been used.

For some screw fastenings, notably cylinder head bolts or nuts, torque wrench settings are no longer specified for the latter stages of tightening, "angle-tightening" being called up instead. Typically, a fairly low torque wrench setting will be applied to the bolts/nuts in the correct sequence, followed by one or more stages of tightening through specified angles.

Locknuts, locktabs and washers

Any fastening which will rotate against a component or housing during tightening should always have a washer between it and the relevant component or housing.

Spring or split washers should always be renewed when they are used to lock a critical component such as a big-end bearing retaining bolt or nut. Locktabs which are folded over to retain a nut or bolt should always be renewed.

Self-locking nuts can be re-used in non-critical areas, providing resistance can be felt when the locking portion passes over the bolt or stud thread. However, it should be noted that self-locking stiffnuts tend to lose their effectiveness after long periods of use, and should then be renewed as a matter of course.

Split pins must always be replaced with new ones of the correct size for the hole.

When thread-locking compound is found on the threads of a fastener which is to be re-used, it should be cleaned off with a wire brush and solvent, and fresh compound applied on reassembly.

Special tools

Some repair procedures in this manual entail the use of special tools such as a press, two or three-legged pullers, spring compressors, etc. Wherever possible, suitable readily-available alternatives to the manufacturer's special tools are described, and are shown in use. In some instances, where no alternative is possible, it has been necessary to resort to the use of a manufacturer's tool, and this has been done for reasons of safety as well as the efficient completion of the repair operation. Unless you are highly-skilled and have a thorough understanding of the procedures described, never attempt to bypass the use of any special tool when the procedure described specifies its use. Not only is there a very great risk of personal injury, but expensive damage could be caused to the components involved.

Environmental considerations

When disposing of used engine oil, brake fluid, antifreeze, etc, give due consideration to any detrimental environmental effects. Do not, for instance, pour any of the above liquids down drains into the general sewage system, or onto the ground to soak away. Many local council refuse tips provide a facility for waste oil disposal, as do some garages. If none of these facilities are available, consult your local Environmental Health Department, or the National Rivers Authority, for further advice.

With the universal tightening-up of legislation regarding the emission of environmentally-harmful substances from motor vehicles, most vehicles have tamperproof devices fitted to the main adjustment points of the fuel system. These devices are primarily designed to prevent unqualified persons from adjusting the fuel/air mixture, with the chance of a consequent increase in toxic emissions. If such devices are found during servicing or overhaul, they should, wherever possible, be renewed or refitted in accordance with the manufacturer's requirements or current legislation.

OIL CARE

OIL BANK LINE

0800 66 33 66

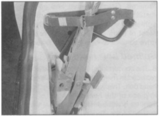
Note: It is antisocial and illegal to dump oil down the drain. To find the location of your local oil recycling bank, call this number free.

Jacking and vehicle support

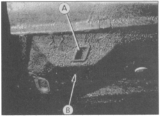
The jack supplied with the vehicle tool kit should only be used for changing roadwheels **(see illustrations)**. The jack and wheel brace are located either in the engine compartment or in the luggage compartment, depending on the model. When carrying out any other kind of work, raise the vehicle using a hydraulic jack, and always supplement the jack with axle stands positioned under the vehicle jacking points.

When jacking up the vehicle with a trolley jack, position the jack head under one of the relevant jacking points. **Do not** jack the vehicle under the sump or any of the steering or suspension components. Supplement the jack using axle stands. The jacking points are shown in the accompanying illustrations.

Never *work under, around, or near a raised vehicle, unless it is adequately supported in at least two places.*

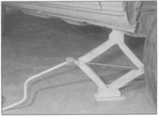


Jack and wheel brace on Visa Saloon models



Front jacking point (Visa model shown)

A Jack location hole
B Reinforced panel



Jacking the rear of the vehicle (Visa model shown)

Tools and equipment

Contents

1 Normal workshop tools

1 The decision as to what range of tools is necessary will depend on the work to be done, the range of vehicles which it is expected to encounter, and not least the financial resources available. The tools in the following list, with additions as necessary from the various categories of diesel-specific tools described later, should be sufficient for carrying out most routine maintenance and repair operations.

Combination spanners (see below)
Socket spanners (see below)
Ratchet, extension piece and universal joint (for use with sockets)
Torque wrench
Angle tightening indicator (see below)
Adjustable spanner
Set of sump drain plug keys
Strap or chain wrench (for fuel and oil filters)
Oil drain tray
Feeler gauges
Combination pliers
Long-nosed pliers
Self-locking pliers (Mole wrench)
Screwdrivers (large and small, flat blade and cross blade)
Set of Allen keys
Set of splined and Torx keys and sockets (see below)
Ball pein hammer
Soft-faced hammer
Puller (universal type, with inter-changeable jaws)
Cold chisel
Scriber
Scraper
Centre punch
Hacksaw
File
Steel rule/straight-edge
Axle stands and/or ramps
Trolley jack
Inspection light
Inspection mirror
Telescopic magnet/pick-up tool

Socket and spanner size

2 A good range of open-ended, ring and socket spanners will be required. Most modern vehicles use metric size fastenings throughout.

3 Split ring spanners (also known as flare nut spanners) are particularly useful for dealing with fuel pipe unions, on which a conventional ring or socket cannot be used because the pipe is in the way. The most common sizes are 17 mm and 19 mm on metric systems.

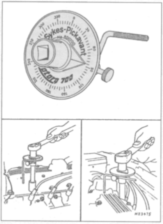
4 Sockets are available in various drive sizes. The half inch square drive size is most widely used and accepts most torque wrenches. Smaller drive sizes (⅜ or ¼ in) are useful for working in confined spaces, while for large high-torque fastenings (driveshaft or hub nuts, crankshaft pulley bolts) ¾ inch drive is most satisfactory.

5 The humble box spanner should not be overlooked. Box spanners are cheap and will sometimes serve as a substitute for a deep socket, though they cannot be used with a torque wrench and are easily deformed.

Angle tightening

6 For fastenings such as cylinder head bolts, many manufacturers now specify tightening in terms of angular rotation rather than an absolute torque. After an initial 'snug' torque wrench setting, subsequent tightening stages are specified as angles through which each bolt must be turned. Variations in tightening torque which could be caused by the presence or absence of dirt, oil etc. on the bolt threads thus have no effect. A further benefit is that there is no need for a high-range torque wrench.

7 The owner-mechanic who expects to use this method of tightening only once or twice in the life of the vehicle may be content to make up a cardboard template, or mark the bolt heads with paint spots, to indicate the angle required. Greater speed and accuracy will result from using one of the many angle tightening indicators commercially available. Most of them are intended for use with ½ in drive sockets or keys **(see illustration)**.



1.7 Sykes-Pickavant 800700 angle tightening gear

Splined bolt heads

8 The conventional hexagon head bolt is being replaced in many areas by the splined or 'Torx' head bolt. This type of bolt has multiple splines in place of the hexagon. A set of splined or Torx keys will be needed to deal with female splined heads. Torx bolts with male heads also exist, and for these Torx sockets will be needed. Both keys and sockets are available to accept ½ in square drives.

2 Diesel-specific tools

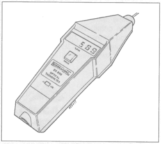
Basic tune-up and service

1 Besides the normal range of spanners, screwdrivers and so on, the following tools and equipment will be needed for basic tune-up and service operations :

Deep socket for removing and tightening screw-in injectors
Optical or pulse-sensitive tachometer
Electrical multi-meter, or dedicated glow plug tester
Compression or leakdown tester
Vacuum pump and/or gauge

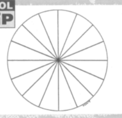
Injector socket

2 The size most commonly required is 27mm. The socket needs to be deep in order not to foul the injector body. On some engines it also needs to be thin-walled. Suitable sockets are sold by Dieseltune, Sykes-Pickavant and



2.5 Dieseltune DX 800 optical tachometer

TOOL TIP



Home-made tachometer disc

Snap-On, among others.

Tachometer

3 The type of tachometer which senses ignition system HT pulses via an inductive pick-up cannot be used on diesel engines, unless a device such as the Sykes-Pickavant timing light adapter is available.

4 If an engine is fitted with a TDC sensor and a diagnostic socket, an electronic tachometer which reads the signals from the TDC sensor can be used.

5 Not all engines have TDC sensors. On those which do not, the use of an optical or pulse-sensitive tachometer is necessary **(see illustration)**.

6 The optical tachometer registers the passage of a paint mark or (more usually) a strip of reflective foil placed on the crankshaft pulley. It is not so convenient to use as the electronic or pulse-sensitive types, since it has to be held so that it can 'see' the pulley, but it has the advantage that it can be used on any engine, petrol or diesel, with or without a diagnostic socket.

7 The pulse-sensitive tachometer uses a transducer similar to that needed for a timing light. The transducer converts hydraulic or mechanical impulses in an injector pipe into electrical signals, which are displayed on the tachometer as engine speed.

8 Some dynamic timing equipment for diesel engines incorporates a means of displaying engine speed. If this equipment is available, a separate tachometer will not be required.

9 Both optical and pulse-sensitive tachometers are sold by A. M. Test Systems and Kent-Moore. Optical tachometers are sold by (inter alia) Dieseltune, and pulse-sensitive by Souriau and Bosch.

DIY alternative tachometer

10 The owner-mechanic who only wishes to check the idle speed of one engine occasionally may well feel that the purchase of a special tachometer is not justified. Assuming that mains electric light is available, the use of a stroboscopic disc is a cheap alternative. The principle will be familiar to anyone who has used such a disc to check the speed of a record-player turntable.

11 A disc must be constructed of stiff paper or card to fit onto the crankshaft pulley (or camshaft pulley, if appropriate - but remember that this rotates at half speed). The disc should be white or light-coloured, and divided using a protractor into regular segments with heavy black lines **(see Tool Tip)**. The number of segments required will depend on the desired idle speed and the frequency of the alternating current supply. For the 50 Hz supply used in the UK and most of Europe the figures are as follows:

Speed (rpm)	No of segments	Angle per segment
706	17	21° 11'
750	16	22° 30'
800	15	24°
857	14	25° 43'
923	13	27° 42'

12 Attach the disc to the crankshaft pulley and position the car so that the disc can be viewed using only artificial light. A fluorescent tube is best. Failing this a low-wattage incandescent bulb will give better results than a high-wattage one. Run the engine at idle and observe the disc.

Warning : Do not run the engine in a confined space without some means of extracting the exhaust fumes.

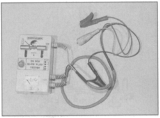
13 If the engine speed corresponds to the calculated disc speed, the disc segments will appear to be stationary. If the speed is different, the segments will appear to drift in the direction of engine rotation (too fast) or against it (too slow). The segments will also appear to be stationary at multiples or sub-multiples of the calculated speed - twice or half the speed, and so on - so some common sense must be used.

Electrical multi-meter or glow plug tester

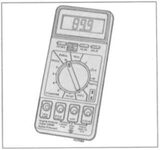
14 It is possible to test glow plugs and their control circuitry with a multi-meter, or even (to a limited extent) with a 12 volt test lamp. A purpose-made glow plug tester will do the job faster and is much easier to use, but on the other hand it will not do anything else **(see illustration)**.

15 If it is decided to purchase a multi-meter, make sure that it has a high current range - ideally 0 to 100 amps - for checking glow plug current draw. Some meters require an external shunt to be fitted for this. An inductive clamp connection is preferred for high current measurement since it can be used without breaking into the circuit. Other ranges required are dc voltage (0 to 20 or 30 volts is suitable for most applications) and resistance. Some meters have a continuity buzzer in addition to a resistance scale ; the buzzer is particularly useful when working single-handed **(see illustration)**.

16 Glow plug testers are available from makers such as Beru, Dieseltune and Kent-Moore. Some incorporate a 'hot test chamber' in which the heating of individual plugs can be observed.



2.14 Dieseltune DX 900 glow plug tester



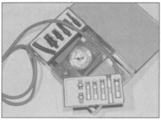
2.15 Sykes-Pickavant 300510 engine analyser/multi-meter

Compression tester

17 A tester specifically intended for diesel engines must be used **(see illustration)**. The push-in connectors used with some petrol engine compression testers cannot be used for diesel engines because of the higher pressures involved. Instead, the diesel engine compression tester screws into an injector or glow plug hole, using one of the adapters supplied with the tester.

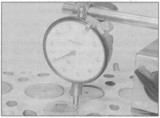
18 Most compression testers are used while

2.17 Dieseltune DX 511 compression tester

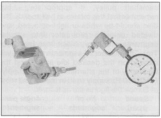


2.20 Sykes-Pickavant 013800 leak-down tester

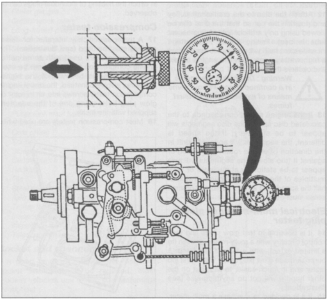
2.22 Dieseltune DX 760 'Mityvac' test kit



3.4 Dial test indicator and stand being used to check swirl chamber protrusion



3.6a DTI and locally-made bellcrank adapter for timing a Bosch VE pump



3.6b DTI and in-line adapter used for timing a Bosch VE pump

cranking the engine on the starter motor. A few, such as the Dieseltune DX 511, can be used with the engine idling. This gives more reliable results, since it is hard to guarantee that cranking speed will not fall in the course of testing all four cylinders, whereas idle speed will remain constant.

19 Recording testers, which produce a pen-and-ink trace for each cylinder, are available from A. M. Test Systems and Kent-Moore. Non-recording testers are more common and are available from Dieseltune and Sykes-Pickavant as well as the makers previously mentioned.

Leak-down tester

20 The leak-down tester measures the rate at which air pressure is lost from each cylinder, and can also be used to pinpoint the source of pressure loss (valves, head gasket or bores). It depends on the availability of a supply of compressed air, typically at 5 to 10 bar (73 to 145 lbf/in²). The same tester (with different adapters) can be used on both petrol and diesel engines **(see illustration)**.

21 In use, the tester is connected to an air line and to an adapter screwed into the injector or glow plug hole, with the piston concerned at TDC on the compression stroke. Leak-down testers are offered by Dieseltune, Sykes-Pickavant and others.

Vacuum pump and/or gauge

22 A vacuum gauge, with suitable adapters, is useful for locating blockages or air leaks in the supply side of the fuel system. A simple gauge is used with the engine running to create vacuum in the supply lines. A hand-held vacuum pump with its own gauge can be used without running the engine, and is also useful for bleeding the fuel system when a hand priming pump is not fitted **(see illustration)**.

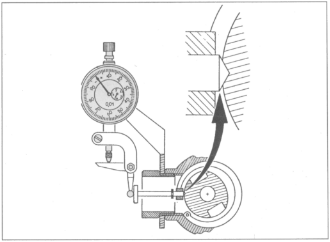
3 Injection pump timing tools

1 If work is undertaken which disturbs the position of the fuel injection pump, certain tools will be needed to check the injection timing on reassembly. This also applies if the pump drive is disturbed - including renewal of the timing belt on some models. Checking of the timing is also a necessary part of fault diagnosis when investigating complaints such as power loss, knock and smoke.

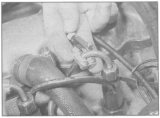
Static timing tools

2 Static timing is still the most widely-used method of setting diesel injection pumps. It is time-consuming and sometimes messy. Precision measuring instruments are often needed for dealing with distributor pumps. Good results depend on the skill and patience of the operator.

3 The owner-mechanic who will only be



3.7 DTI and adapter used for timing Lucas/CAV pump



3.14 Clamping a timing light transducer onto an injector pipe

dealing with one engine should refer to the appropriate text to find out what tools will be required. The diesel tune-up specialist will typically need the following :

Dial test indicator (DTI) with magnetic stand
DTI adapters and probes for Bosch or CAV distributor pumps
Timing gear pins or pegs (when applicable)
Crankshaft or flywheel locking pins (when applicable)

Dial test indicator and magnetic stand

4 This is a useful workshop tool for many operations besides timing. It is the most accurate means of checking the protrusion or recession of swirl chambers, pistons and liners when renewing cylinder head gaskets. If major overhauls are undertaken it can also be used for measuring values such as crankshaft endfloat **(see illustration)**.

5 Two DTIs may be needed for setting the timing on some engines - one to measure the pump plunger or rotor movement and one to measure engine piston position.

DTI adapters

6 Adapters and probes for fitting the DTI to the distributor pump are of various patterns, due partly to the need to be able to use them in conditions of poor access on the vehicle **(see illustrations)**. This means that the same adapter cannot necessarily be used on the same type of pump and engine if the under-bonnet layout is different. On the bench it is often possible to use simpler equipment.

7 A spring-loaded probe is used on some CAV/RotoDiesel pumps to find the timing groove in the pump rotor **(see illustration)**.

Timing gear pins or pegs

8 Pins or pegs are used on some engines to lock the pump and/or the camshaft in a particular position. They are generally specific to a particular engine or manufacturer. It is sometimes possible to use suitably sized dowel rods, drill shanks or bolts instead.

Crankshaft or flywheel locking pins

9 These are used for locking the crankshaft at TDC (or at the injection point on some models).

10 The crankshaft locking pin is inserted through a hole in the side of the crankcase after removal of a plug, and enters a slot in a crankshaft counterweight or web. The flywheel pin passes through a hole in the flywheel end of the crankcase and enters a hole in the flywheel. Again, suitably sized rods or bolts can sometimes be used instead.

Dynamic timing tools

11 Dynamic timing on diesel engines has not yet become widespread, due no doubt in part to the relatively expensive equipment required. Additionally, not all vehicle manufacturers provide dynamic timing values. In principle it makes possible much faster and more accurate checking of the injection timing, just as on petrol engines. It can also be used to verify the operation of cold start advance systems.

12 Most dynamic timing equipment depends on converting mechanical or hydraulic impulses in the injection system into electrical signals. An alternative approach is adopted by one or two manufacturers who use an optical-to-electrical conversion, with a sensor which screws into a glow plug hole and 'sees' the light of combustion. The electrical signals are used to trigger a timing light, or as part of the information fed into a diagnostic analyser.

13 Not all diesel engines have ready-made timing marks. If the engine has a TDC sensor (or provision for fitting one) and the timing equipment can read the sensor output, this is not a problem. Some engines have neither timing marks nor TDC sensors. In such cases there is no choice but to establish TDC accurately and make marks on the flywheel or crankshaft pulley.

Timing lights

14 The simplest dynamic timing equipment uses a transducer to convert the pressure pulse in the injector pipe into an electrical signal which triggers a timing light. Such transducers are of two types - in-line and clamp-on **(see illustration)**.

15 The in-line transducer is connected into No 1 injector pipe using adapters to suit the fuel pipe unions. The electrical connection from the transducer goes to the timing light, which will also require a 12 volt or mains supply to energise its tube.

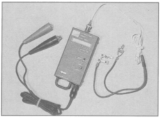
16 The clamp-on transducer is used in a similar way but instead of actually tapping into the injector pipe it clamps onto it. The transducer must be of the right size for the pipe concerned and any dirt, rust or protective coating on the pipe must be removed.

17 The position of the clamp-on transducer on the pipe is important. The injection pulse takes a finite amount of time to travel from one end of the pipe to the other. If the transducer is in the wrong place, a false result will be obtained. Place the transducer as directed by the equipment or engine manufacturer.

18 The timing light itself may be an existing inductive type light normally used on petrol engines, if the transducer output is suitable. Other types of transducer can only be used with their own timing light.

Diagnostic analysers

19 Diagnostic engine analysers (Crypton, AVL, Souriau etc.) will display timing and speed information with the aid of diesel adapters or interface units. These will normally be specific to the equipment concerned; consult the manufacturers for details.



3.22a Sykes-Pickavant 300540 diesel timing light adapter

20 The output from the Sykes-Pickavant diesel adapter can be used to drive the inductive HT pick-up on a diagnostic analyser.

Injection testers

21 Injection testers are halfway between simple timing light/tachometer combinations and full-blown diagnostic analysers. They interpret the transducer output to provide a 'start-of-injection' signal, enabling comparison to be made between all the injectors on an engine, so that defective injectors can be identified.

22 The diesel adapter sold by Sykes-Pickavant for use with a conventional inductive timing light has an injection testing facility **(see illustration)**. More sophisticated equipment, such as the AVL Diesel Injection Tester 873 **(see illustration)**, accepts an input from the engine's TDC sensor (if fitted) as well, giving a digital read-out of injection timing without the need for a stroboscope.

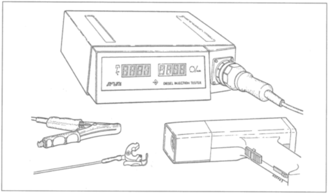
4 Injector testing equipment

Warning : Never expose the hands, face or any other part of the body to injector spray. The high working pressure can penetrate the skin, with potentially fatal results. When possible use injector test oil rather than fuel for testing. Take precautions to avoid inhaling the vaporised fuel or injector test fluid. Remember that even diesel fuel is inflammable when vaporised.

1 Some kind of injector tester will be needed if it is wished to identify defective injectors, or to test them after cleaning or prolonged storage. Various makes and models are available, but the essential components of all of them are a high pressure hand-operated pump and a pressure gauge.

2 For safety reasons, injector test or calibration fluid should be used for bench testing rather than diesel fuel or paraffin. Use the fluid specified by the maker of the test equipment if possible.

3 One of the simplest testers currently available is Dieseltune's DX 710 **(see illustrations)**. This has the advantage that (access permitting) it can be used to test opening pressure and back leakage without removing the injectors from the engine. Its small reservoir makes it of limited use for bench testing, but good results can be obtained with practice.

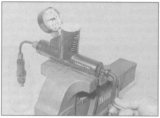


3.22b AVL Diesel Injection Tester 873

4 Another method of testing injectors on the engine is to connect a pressure gauge into the line between the injection pump and the injector. This test can also detect faults caused by the injection pump high pressure piston or delivery valve.

5 The workshop which tests or calibrates injectors regularly will need a bench-mounted tester. These testers have a lever-operated pump, and a larger fluid reservoir than the hand-held tester. The best models also incorporate a transparent chamber for safe viewing of the injector spray pattern and perhaps a test fluid recirculation system **(see illustration)**.

6 Some means of extracting the vapour produced when testing, such as a hood connected to the workshop's fume extraction system, is desirable. Although injector test fluid is relatively non-toxic, its vapour is not particularly pleasant to inhale.



4.3a Dieseltune DX 710 tester in use on the bench. . .

5 Injection pump testing and calibration equipment

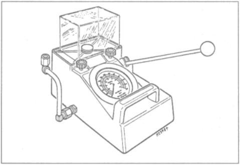
The equipment needed for testing and calibration of injection pumps is beyond the scope of this book. Any such work should be entrusted to the pump manufacturer's agent - though the opportunity is taken to say yet again that the injection pump is often blamed for faults when in fact the trouble lies elsewhere.

6 Smoke testing equipment

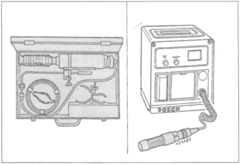
1 Smoke emission testing is part of the MOT test for cars and light commercial vehicles.

2 Smoke testing equipment falls into two categories - indirect and direct reading. With the indirect systems, a sample of exhaust gas is passed over a filter paper and the change in opacity of the paper is measured using a separate machine. With the direct systems, an optically sensitive probe measures the opacity

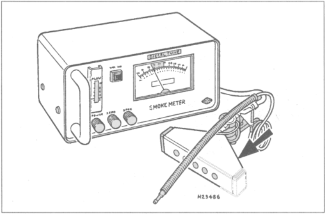
4.3b . . . and on the engine



4.5 Dieseltune 111 injector tester



6.3a Bosch smoke sampling kit (left) and measuring unit



6.3b Dieseltune Smokemeter

of the exhaust gas and an immediate read-out is available.

3 The smoke sampling kit from Bosch is an example of the indirect reading system and is used in conjunction with a photoelectric measuring unit. Dieseltune's Smokemeter is an example of the direct reading machine **(see illustrations)**.

4 As far as the DIY mechanic is concerned, the purchase of smoke testing equipment is unlikely to be an economic proposition. If accurate smoke testing is necessary, take the vehicle to an MOT testing station or a Diesel injection specialist.

MOT Test Checks

This is a guide to getting your vehicle through the MOT test. Obviously it will not be possible to examine the vehicle to the same standard as the professional MOT tester. However, working through the following checks will enable you to identify any problem areas before submitting the vehicle for the test.

Where a testable component is in borderline condition, the tester has discretion in deciding whether to pass or fail it. The basis of such discretion is whether the tester would be happy for a close relative or friend to use the vehicle with the component in that condition. If the vehicle presented is clean and evidently well cared for, the tester may be more inclined to pass a borderline component than if the vehicle is scruffy and apparently neglected.

It has only been possible to summarise the test requirements here, based on the regulations in force at the time of printing. Test standards are becoming increasingly stringent, although there are some exemptions for older vehicles. For full details obtain a copy of the Haynes publication Pass the MOT! (available from stockists of Haynes manuals).

An assistant will be needed to help carry out some of these checks.

The checks have been sub-divided into four categories, as follows:

1 Checks carried out **FROM THE DRIVER'S SEAT**

2 Checks carried out **WITH THE VEHICLE ON THE GROUND**

3 Checks carried out **WITH THE VEHICLE RAISED AND THE WHEELS FREE TO TURN**

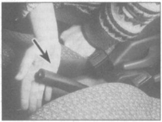
4 Checks carried out on **YOUR VEHICLE'S EXHAUST EMISSION SYSTEM**

1 Checks carried out FROM THE DRIVER'S SEAT

Handbrake

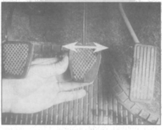
☐ Test the operation of the handbrake. Excessive travel (too many clicks) indicates incorrect brake or cable adjustment.

☐ Check that the handbrake cannot be released by tapping the lever sideways. Check the security of the lever mountings.



Footbrake

☐ Depress the brake pedal and check that it does not creep down to the floor, indicating a master cylinder fault. Release the pedal, wait a few seconds, then depress it again. If the pedal travels nearly to the floor before firm resistance is felt, brake adjustment or repair is necessary. If the pedal feels spongy, there is air in the hydraulic system which must be removed by bleeding.



☐ Check that the brake pedal is secure and in good condition. Check also for signs of fluid leaks on the pedal, floor or carpets, which would indicate failed seals in the brake master cylinder.

☐ Check the servo unit (when applicable) by operating the brake pedal several times, then keeping the pedal depressed and starting the engine. As the engine starts, the pedal will move down slightly. If not, the vacuum hose or the servo itself may be faulty.

Steering wheel and column

☐ Examine the steering wheel for fractures or looseness of the hub, spokes or rim.

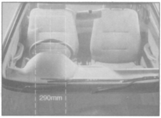
☐ Move the steering wheel from side to side and then up and down. Check that the steering wheel is not loose on the column, indicating wear or a loose retaining nut. Continue moving the steering wheel as before, but also turn it slightly from left to right.

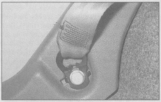
☐ Check that the steering wheel is not loose on the column, and that there is no abnormal

movement of the steering wheel, indicating wear in the column support bearings or couplings.

Windscreen and mirrors

☐ The windscreen must be free of cracks or other significant damage within the driver's field of view. (Small stone chips are acceptable.) Rear view mirrors must be secure, intact, and capable of being adjusted.





Seat belts and seats

Note: *The following checks are applicable to all seat belts, front and rear.*

☐ Examine the webbing of all the belts (including rear belts if fitted) for cuts, serious fraying or deterioration. Fasten and unfasten each belt to check the buckles. If applicable, check the retracting mechanism. Check the security of all seat belt mountings accessible from inside the vehicle.

☐ The front seats themselves must be securely attached and the backrests must lock in the upright position.

Doors

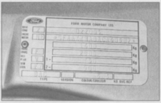
☐ Both front doors must be able to be opened and closed from outside and inside, and must latch securely when closed.

2 Checks carried out WITH THE VEHICLE ON THE GROUND

Vehicle identification

☐ Number plates must be in good condition, secure and legible, with letters and numbers correctly spaced – spacing at (A) should be twice that at (B).

☐ The VIN plate and/or homologation plate must be legible.



Electrical equipment

☐ Switch on the ignition and check the operation of the horn.

☐ Check the windscreen washers and wipers, examining the wiper blades; renew damaged or perished blades. Also check the operation of the stop-lights.

☐ Check the operation of the sidelights and number plate lights. The lenses and reflectors must be secure, clean and undamaged.

☐ Check the operation and alignment of the headlights. The headlight reflectors must not be tarnished and the lenses must be undamaged.

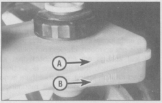
☐ Switch on the ignition and check the operation of the direction indicators (including the instrument panel tell-tale) and the hazard warning lights. Operation of the sidelights and stop-lights must not affect the indicators - if it does, the cause is usually a bad earth at the rear light cluster.

☐ Check the operation of the rear foglight(s), including the warning light on the instrument panel or in the switch.

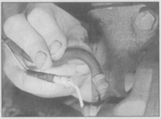
Footbrake

☐ Examine the master cylinder, brake pipes and servo unit for leaks, loose mountings, corrosion or other damage.

☐ The fluid reservoir must be secure and the fluid level must be between the upper (**A**) and lower (**B**) markings.



☐ Inspect both front brake flexible hoses for cracks or deterioration of the rubber. Turn the steering from lock to lock, and ensure that the hoses do not contact the wheel, tyre, or any part of the steering or suspension mechanism. With the brake pedal firmly depressed, check the hoses for bulges or leaks under pressure.



Steering and suspension

☐ Have your assistant turn the steering wheel from side to side slightly, up to the point where the steering gear just begins to transmit this movement to the roadwheels. Check for excessive free play between the steering wheel and the steering gear, indicating wear or insecurity of the steering column joints, the column-to-steering gear coupling, or the steering gear itself.

☐ Have your assistant turn the steering wheel more vigorously in each direction, so that the roadwheels just begin to turn. As this is done, examine all the steering joints, linkages, fittings and attachments. Renew any component that shows signs of wear or damage. On vehicles with power steering, check the security and condition of the steering pump, drivebelt and hoses.

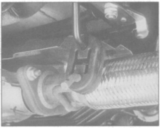
☐ Check that the vehicle is standing level, and at approximately the correct ride height.

Shock absorbers

☐ Depress each corner of the vehicle in turn, then release it. The vehicle should rise and then settle in its normal position. If the vehicle continues to rise and fall, the shock absorber is defective. A shock absorber which has seized will also cause the vehicle to fail.

Exhaust system

☐ Start the engine. With your assistant holding a rag over the tailpipe, check the entire system for leaks. Repair or renew leaking sections.



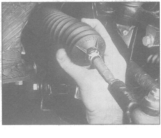
3 Checks carried out WITH THE VEHICLE RAISED AND THE WHEELS FREE TO TURN

Jack up the front and rear of the vehicle, and securely support it on axle stands. Position the stands clear of the suspension assemblies. Ensure that the wheels are clear of the ground and that the steering can be turned from lock to lock.

Steering mechanism

☐ Have your assistant turn the steering from lock to lock. Check that the steering turns smoothly, and that no part of the steering mechanism, including a wheel or tyre, fouls any brake hose or pipe or any part of the body structure.

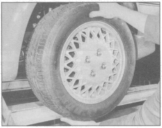
☐ Examine the steering rack rubber gaiters for damage or insecurity of the retaining clips. If power steering is fitted, check for signs of damage or leakage of the fluid hoses, pipes or connections. Also check for excessive stiffness or binding of the steering, a missing split pin or locking device, or severe corrosion of the body structure within 30 cm of any steering component attachment point.



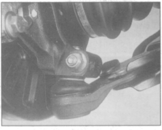
Front and rear suspension and wheel bearings

☐ Starting at the front right-hand side, grasp the roadwheel at the 3 o'clock and 9 o'clock positions and shake it vigorously. Check for free play or insecurity at the wheel bearings, suspension balljoints, or suspension mountings, pivots and attachments.

☐ Now grasp the wheel at the 12 o'clock and 6 o'clock positions and repeat the previous inspection. Spin the wheel, and check for roughness or tightness of the front wheel bearing.



☐ If excess free play is suspected at a component pivot point, this can be confirmed by using a large screwdriver or similar tool and levering between the mounting and the component attachment. This will confirm whether the wear is in the pivot bush, its retaining bolt, or in the mounting itself (the bolt holes can often become elongated).



☐ Carry out all the above checks at the other front wheel, and then at both rear wheels.

Springs and shock absorbers

☐ Examine the suspension struts (when applicable) for serious fluid leakage, corrosion, or damage to the casing. Also check the security of the mounting points.

☐ If coil springs are fitted, check that the spring ends locate in their seats, and that the spring is not corroded, cracked or broken.

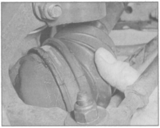
☐ If leaf springs are fitted, check that all leaves are intact, that the axle is securely attached to each spring, and that there is no deterioration of the spring eye mountings, bushes, and shackles.

☐ The same general checks apply to vehicles fitted with other suspension types, such as torsion bars, hydraulic displacer units, etc. Ensure that all mountings and attachments are secure, that there are no signs of excessive wear, corrosion or damage, and (on hydraulic types) that there are no fluid leaks or damaged pipes.

☐ Inspect the shock absorbers for signs of serious fluid leakage. Check for wear of the mounting bushes or attachments, or damage to the body of the unit.

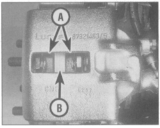
Driveshafts (fwd vehicles only)

☐ Rotate each front wheel in turn and inspect the constant velocity joint gaiters for splits or damage. Also check that each driveshaft is straight and undamaged.



Braking system

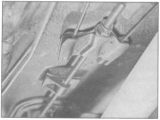
☐ If possible without dismantling, check brake pad wear and disc condition. Ensure that the friction lining material has not worn excessively, (A) and that the discs are not fractured, pitted, scored or badly worn (B).



☐ Examine all the rigid brake pipes underneath the vehicle, and the flexible hose(s) at the rear. Look for corrosion, chafing or insecurity of the pipes, and for signs of bulging under pressure, chafing, splits or deterioration of the flexible hoses.

☐ Look for signs of fluid leaks at the brake calipers or on the brake backplates. Repair or renew leaking components.

☐ Slowly spin each wheel, while your assistant depresses and releases the footbrake. Ensure that each brake is operating and does not bind when the pedal is released.



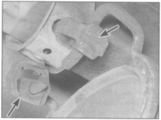
☐ Examine the handbrake mechanism, checking for frayed or broken cables, excessive corrosion, or wear or insecurity of the linkage. Check that the mechanism works on each relevant wheel, and releases fully, without binding.

☐ It is not possible to test brake efficiency without special equipment, but a road test can be carried out later to check that the vehicle pulls up in a straight line.

Fuel and exhaust systems

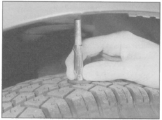
☐ Inspect the fuel tank (including the filler cap), fuel pipes, hoses and unions. All components must be secure and free from leaks.

☐ Examine the exhaust system over its entire length, checking for any damaged, broken or missing mountings, security of the retaining clamps and rust or corrosion.



Wheels and tyres

☐ Examine the sidewalls and tread area of each tyre in turn. Check for cuts, tears, lumps, bulges, separation of the tread, and exposure of the ply or cord due to wear or damage. Check that the tyre bead is correctly seated on the wheel rim, that the valve is sound and



properly seated, and that the wheel is not distorted or damaged.

☐ Check that the tyres are of the correct size for the vehicle, that they are of the same size and type on each axle, and that the pressures are correct.

☐ Check the tyre tread depth. The legal minimum at the time of writing is 1.6 mm over at least three-quarters of the tread width. Abnormal tread wear may indicate incorrect front wheel alignment.

Body corrosion

☐ Check the condition of the entire vehicle structure for signs of corrosion in load-bearing areas. (These include chassis box sections, side sills, cross-members, pillars, and all suspension, steering, braking system and seat belt mountings and anchorages.) Any corrosion which has seriously reduced the thickness of a load-bearing area is likely to cause the vehicle to fail. In this case professional repairs are likely to be needed.

☐ Damage or corrosion which causes sharp or otherwise dangerous edges to be exposed will also cause the vehicle to fail.

4 Checks carried out on **YOUR VEHICLE'S EXHAUST EMISSION SYSTEM**

Petrol models

☐ Have the engine at normal operating temperature, and make sure that it is in good tune (ignition system in good order, air filter element clean, etc).

☐ Before any measurements are carried out, raise the engine speed to around 2500 rpm, and hold it at this speed for 20 seconds. Allow the engine speed to return to idle, and watch for smoke emissions from the exhaust tailpipe. If the idle speed is obviously much too high, or if dense blue or clearly-visible black smoke comes from the tailpipe for more than 5 seconds, the vehicle will fail. As a rule of thumb, blue smoke signifies oil being burnt (engine wear) while black smoke signifies unburnt fuel (dirty air cleaner element, or other carburettor or fuel system fault).

☐ An exhaust gas analyser capable of measuring carbon monoxide (CO) and hydrocarbons (HC) is now needed. If such an instrument cannot be hired or borrowed, a local garage may agree to perform the check for a small fee.

CO emissions (mixture)

☐ At the time of writing, the maximum CO level at idle is 3.5% for vehicles first used after August 1986 and 4.5% for older vehicles. From January 1996 a much tighter limit (around 0.5%) applies to catalyst-equipped vehicles first used from August 1992. If the CO level cannot be reduced far enough to pass the test (and the fuel and ignition systems are otherwise in good condition) then the carburettor is badly worn, or there is some problem in the fuel injection system or catalytic converter (as applicable).

HC emissions

☐ With the CO emissions within limits, HC emissions must be no more than 1200 ppm (parts per million). If the vehicle fails this test at idle, it can be re-tested at around 2000 rpm; if the HC level is then 1200 ppm or less, this counts as a pass.

☐ Excessive HC emissions can be caused by oil being burnt, but they are more likely to be due to unburnt fuel.

Diesel models

☐ The only emission test applicable to Diesel engines is the measuring of exhaust smoke density. The test involves accelerating the engine several times to its maximum unloaded speed.

Note: *It is of the utmost importance that the engine timing belt is in good condition before the test is carried out.*

☐ Excessive smoke can be caused by a dirty air cleaner element. Otherwise, professional advice may be needed to find the cause.

Contents

1 Introduction

The majority of starting problems on small diesel engines are electrical in origin. The mechanic who is familiar with petrol engines but less so with diesel may be inclined to view the diesel's injectors and pump in the same light as the spark plugs and distributor, but this is generally a mistake.

When investigating complaints of difficult starting for someone else, make sure that the correct starting procedure is understood and is being followed. Some drivers are unaware of the significance of the preheating warning light - many modern engines are sufficiently forgiving for this not to matter in mild weather, but with the onset of winter problems begin.

As a rule of thumb, if the engine is difficult to start but runs well when it has finally got going, the problem is electrical (battery, starter motor or preheating system). If poor performance is combined with difficult starting, the problem is likely to be in the fuel system. The low pressure (supply) side of the fuel system should be checked before suspecting the injectors and injection pump.

HAYNES HINT *Normally the pump is the last item to suspect, since unless it has been tampered with there is no reason for it to be at fault.*

The following table lists various possible causes of faults. Further discussion of some faults will be found in the Sections indicated.

2 Fault diagnosis - symptoms and reasons

Engine turns but will not start (cold)

- ☐ Incorrect use of preheating system
- ☐ Preheating system fault
- ☐ Fuel waxing (in very cold weather) (Section 5)
- ☐ Overfuelling or cold start advance mechanism defective

Engine turns but will not start (hot or cold)

- ☐ Low cranking speed (see below)
- ☐ Poor compression (Section 3)
- ☐ No fuel in tank
- ☐ Air in fuel system (Section 4)
- ☐ Fuel feed restriction (Section 5)
- ☐ Fuel contaminated
- ☐ Stop solenoid defective (Section 17)
- ☐ Major mechanical failure
- ☐ Injection pump internal fault

Low cranking speed

- ☐ Inadequate battery capacity
- ☐ Incorrect grade of oil (*Lubricants, fluids and capacities*)
- ☐ High resistance in starter motor circuit
- ☐ Starter motor internal fault

Engine is difficult to start

- ☐ Incorrect starting procedure
- ☐ Battery or starter motor fault (Chapters 2 and 5)
- ☐ Preheating system fault
- ☐ Air in fuel system (Section 4)
- ☐ Fuel feed restriction (Section 5)
- ☐ Poor compression (Section 3)
- ☐ Valve clearances incorrect
- ☐ Valves sticking
- ☐ Blockage in exhaust system
- ☐ Valve timing incorrect
- ☐ Injector(s) faulty
- ☐ Injection pump timing incorrect
- ☐ Injection pump internal fault

Engine starts but stops again

- ☐ Fuel very low in tank
- ☐ Air in fuel system (Section 4)
- ☐ Idle adjustment incorrect
- ☐ Fuel feed restriction (Section 5)
- ☐ Fuel return restriction
- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Blockage in exhaust system
- ☐ Injector(s) faulty

Engine will not stop when switched off

- ☐ Stop solenoid defective (Section 17)

Misfiring/rough idle

- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Air in fuel system (Section 4)
- ☐ Fuel feed restriction (Section 5)
- ☐ Valve clearances incorrect
- ☐ Valve(s) sticking
- ☐ Valve spring(s) weak or broken
- ☐ Poor compression (Section 3)
- ☐ Overheating (Section 15)
- ☐ Injector pipe(s) wrongly connected or wrong type
- ☐ Valve timing incorrect
- ☐ Injector(s) faulty or wrong type
- ☐ Injection pump timing incorrect
- ☐ Injection pump faulty or wrong type

Lack of power (Section 6)

- ☐ Accelerator linkage not moving through full travel (cable slack or pedal obstructed)
- ☐ Injection pump control linkages sticking or maladjusted
- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Air in fuel system (Section 4)
- ☐ Fuel feed restriction (Section 5)
- ☐ Valve timing incorrect
- ☐ Injection pump timing incorrect
- ☐ Blockage in exhaust system
- ☐ Turbo boost pressure inadequate, when applicable (Section 7)
- ☐ Valve clearances incorrect
- ☐ Poor compression (Section 3)
- ☐ Injector(s) faulty or wrong type
- ☐ Injection pump faulty

Fuel consumption excessive (Section 8)

- ☐ External leakage
- ☐ Fuel passing into sump (Section 9)
- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Valve clearances incorrect
- ☐ Valve(s) sticking
- ☐ Valve spring(s) weak
- ☐ Poor compression (Section 3)
- ☐ Valve timing incorrect
- ☐ Injection pump timing incorrect
- ☐ Injector(s) faulty or wrong type
- ☐ Injection pump faulty

Engine knocks (Section 10)

- ☐ Air in fuel system (Section 4)
- ☐ Fuel grade incorrect or quality poor
- ☐ Injector(s) faulty or wrong type (Section 10)
- ☐ Valve spring(s) weak or broken
- ☐ Valve(s) sticking
- ☐ Valve clearances incorrect
- ☐ Valve timing incorrect
- ☐ Injection pump timing incorrect
- ☐ Piston protrusion excessive/head gasket thickness inadequate (after repair)

- ☐ Valve recess incorrect (after repair)
- ☐ Piston rings broken or worn
- ☐ Pistons and/or bores worn
- ☐ Crankshaft bearings worn or damaged
- ☐ Small-end bearings worn
- ☐ Camshaft worn

Black smoke in exhaust (Section 11)

- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Valve clearances incorrect
- ☐ Poor compression (Section 3)
- ☐ Turbo boost pressure inadequate, when applicable (Section 7)
- ☐ Blockage in exhaust system
- ☐ Valve timing incorrect
- ☐ Injector(s) faulty or wrong type
- ☐ Injection pump timing incorrect
- ☐ Injection pump faulty

Blue or white smoke in exhaust (Section 11)

- ☐ Engine oil incorrect grade or poor quality (*Lubricants, fluids and capacities*)
- ☐ Glow plug(s) defective, or controller faulty (smoke at start-up only)
- ☐ Air cleaner dirty(Chapter 2)
- ☐ Blockage in induction system
- ☐ Valve timing incorrect
- ☐ Injection pump timing incorrect
- ☐ Injector(s) defective, or heat shields damaged or missing
- ☐ Engine running too cool
- ☐ Oil entering via valve stems (Section 12)
- ☐ Poor compression (Section 3)
- ☐ Head gasket blown
- ☐ Piston rings broken or worn
- ☐ Pistons and/or bores worn

Oil consumption excessive (Section 13)

- ☐ External leakage (standing or running)
- ☐ New engine not yet run-in
- ☐ Engine oil incorrect grade or poor quality (*Lubricants, fluids and capacities*)
- ☐ Oil level too high
- ☐ Crankcase ventilation system obstructed
- ☐ Oil leaking from oil feed pipe into fuel feed pipe
- ☐ Oil leakage from ancillary component (vacuum pump etc.)
- ☐ Oil leaking into coolant
- ☐ Oil leaking into injection pump
- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Cylinder bores glazed (Section 14)
- ☐ Piston rings broken or worn
- ☐ Pistons and/or bores worn
- ☐ Valve stems or guides worn
- ☐ Valve stem oil seals worn

Overheating (Section 15)

- ☐ Coolant leakage
- ☐ Engine oil level too high
- ☐ Electric cooling fan malfunctioning
- ☐ Coolant pump defective
- ☐ Radiator clogged externally
- ☐ Radiator clogged internally
- ☐ Coolant hoses blocked or collapsed
- ☐ Coolant reservoir pressure cap defective or incorrect
- ☐ Coolant thermostat defective or incorrect
- ☐ Thermostat missing
- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Blockage in exhaust system
- ☐ Head gasket blown
- ☐ Cylinder head cracked or warped
- ☐ Valve timing incorrect
- ☐ Injection pump timing incorrect (over-advanced)
- ☐ Injector(s) faulty or wrong type
- ☐ Injection pump faulty
- ☐ Imminent seizure (piston pick-up)

Crankcase pressure excessive (oil being blown out)

- ☐ Blockage in crankcase ventilation system
- ☐ Leakage in vacuum pump
- ☐ Piston rings broken or sticking
- ☐ Pistons or bores worn
- ☐ Head gasket blown

Erratic running

- ☐ Operating temperature incorrect
- ☐ Accelerator linkage maladjusted or sticking
- ☐ Air cleaner dirty
- ☐ Blockage in induction system
- ☐ Air in fuel system (Section 4)
- ☐ Injector pipe(s) wrongly connected or wrong type
- ☐ Fuel feed restriction (Section 5)
- ☐ Fuel return restriction
- ☐ Valve clearances incorrect
- ☐ Valve(s) sticking
- ☐ Valve spring(s) broken or weak
- ☐ Valve timing incorrect
- ☐ Poor compression (Section 3)
- ☐ Injector(s) faulty or wrong type
- ☐ Injection pump mountings loose
- ☐ Injection pump timing incorrect
- ☐ Injection pump faulty

Vibration

- ☐ Accelerator linkage sticking
- ☐ Engine mountings loose or worn
- ☐ Cooling fan damaged or loose
- ☐ Crankshaft pulley/damper damaged or loose
- ☐ Injector pipe(s) wrongly connected or wrong type
- ☐ Valve(s) sticking
- ☐ Flywheel or (when applicable) flywheel housing loose
- ☐ Poor (uneven) compression (Section 3)

Low oil pressure

- ☐ Oil level low
- ☐ Oil grade or quality incorrect (*Lubricants, fluids and capacities*)
- ☐ Oil filter clogged
- ☐ Overheating (Section 15)
- ☐ Oil contaminated (Section 16)
- ☐ Gauge or warning light sender inaccurate
- ☐ Oil pump pick-up strainer clogged
- ☐ Oil pump suction pipe loose or cracked
- ☐ Oil pressure relief valve defective or stuck open
- ☐ Oil pump worn
- ☐ Crankshaft bearings worn

High oil pressure

- ☐ Oil grade or quality incorrect (*Lubricants, fluids and capacities*)
- ☐ Gauge inaccurate
- ☐ Oil pressure relief valve stuck shut

Injector pipe(s) break or split repeatedly

- ☐ Missing or wrongly located clamps
- ☐ Wrong type or length of pipe
- ☐ Faulty injector
- ☐ Faulty delivery valve

3 Poor compression

1 Poor compression may give rise to a number of faults, including difficult starting, loss of power, misfiring or uneven running and smoke in the exhaust.

2 Before looking for mechanical reasons for compression loss, check that the problem is not on the induction side. A dirty air cleaner or some other blockage in the induction system can restrict air inlet to the point where compression suffers.

3 Mechanical reasons for low compression include :

a) Incorrect valve clearances
b) Sticking valves
c) Weak or broken valve springs
d) Incorrect valve timing
e) Worn or burnt valve heads and seats
f) Worn valve stems and guides
g) Head gasket blown
h) Piston rings broken or sticking
j) Pistons or bores worn
k) Head gasket thickness incorrect (after rebuild)

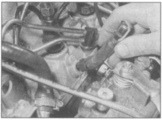
4 Compression loss on one cylinder alone can be due to a defective or badly seated glow plug, or a leaking injector sealing washer. Some engines also have a cylinder head plug for the insertion of a dial test indicator probe when determining TDC and this should not be overlooked.

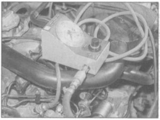
5 Compression loss on two adjacent cylinders is almost certainly due to the head gasket blowing between them. Sometimes the fault will be corrected by renewing the gasket but a blown gasket can also be an indication that the cylinder head itself is warped. Always check the head mating face for distortion when renewing the gasket. On wet liner engines also check liner protrusion.

Compression test

6 A compression tester specifically intended for diesel engines must be used, because of the higher pressures involved - see Chapter 3.


3.14a Leakdown test adapter being fitted to a glow plug hole


3.14b Whistle fitted to adapter to find TDC


3.15 Leakdown tester in use

The tester is connected to an adapter which screws into the glow plug or injector hole. Normally sealing washers must be used on both sides of the adapter.

7 Unless specific instructions to the contrary are supplied with the tester, observe the following points :

a) *The battery must be in a good state of charge, the air cleaner element must be clean and the engine should be at normal operating temperature*

b) *All the injectors or glow plugs should be removed before starting the test. If removing the injectors, also remove their heat shields (when fitted), otherwise they may be blown out*

c) *The stop control lever on the injection pump must be operated, or the stop solenoid disconnected, to prevent the engine from running or fuel from being discharged*

8 There is no need to hold the accelerator pedal down during the test because the diesel engine air inlet is not throttled. There are rare exceptions to this case, when a throttle valve is used to produce vacuum for servo or governor operation.

9 The actual compression pressures measured are not so important as the balance between cylinders. Typical values at cranking speed are:

Good condition - 25 to 30 bar (363 to 435 lbf/in²)
Minimum - 18 bar (261 lbf/in²)
Maximum difference between cylinders - 5 bar (73 lbf/in²)

10 The cause of poor compression is less easy to establish on a diesel engine than on a petrol one. The effect of introducing oil into the cylinders (wet testing) is not conclusive, because there is a risk that the oil will sit in the bowl in the piston crown (direct injection engines) or in the swirl chamber (indirect) instead of passing to the rings.

Leakdown test

11 A leakdown test measures the rate at which compressed air fed into the cylinder is lost. It is an alternative to a compression test and in many ways it is better, since it provides easy identification of where pressure loss is occurring (piston rings, valves or head gasket). However, it does require a source of compressed air.

12 Before beginning the test, remove the cooling system pressure cap. This is necessary because if there is a leak into the cooling system, the introduction of compressed air may damage the radiator. Similarly, it is advisable to remove the dipstick or the oil filler cap to prevent excessive crankcase pressurisation.

13 Connect the tester to a compressed air line and adjust the reading to 100% as instructed by the manufacturer.

14 Remove the glow plugs or injectors and screw the appropriate adapter into a glow plug or injector hole. Fit the whistle to the adapter and turn the crankshaft. When the whistle begins to sound, the piston in question is rising on compression. When the whistle stops, TDC has been reached **(see illustrations)**.

15 Engage a gear and apply the handbrake to stop the engine turning. Remove the whistle and connect the tester to the adapter. Note the tester reading, which indicates the rate at which the air escapes. Repeat the test on the other cylinders **(see illustration)**.

16 The tester reading is in the form of a percentage, where 100% is perfect. Readings of 80% or better are to be expected from an engine in good condition. The actual reading is less important than the balance between cylinders, which should be within 5%.

17 The areas from which escaping air emerges show where a fault lies, as follows:

Air escaping from	Probable cause
Oil filler cap or dipstick tube	*Worn piston rings or cylinder bores*
Exhaust pipe	*Worn or burnt exhaust valve*
Air cleaner/inlet manifold	*Worn or burnt inlet valve*
Cooling system	*Blown head gasket or cracked cylinder head*

18 Bear in mind that if the head gasket is blown between two adjacent cylinders, air escaping from the cylinder under test may emerge via an open valve in the cylinder adjacent.

4 Air in fuel system

The diesel engine will not run at all, or at best will run erratically, if there is air in the fuel lines. If the fuel tank has been allowed to run dry, or after operations in which the fuel supply lines have been opened, the fuel system must be bled before the engine will run. Methods of bleeding are given in Chapter 4.

Air will also enter the fuel lines through any leaking joint or seal, since the supply side is under negative pressure all the time that the engine is running.

5 Fuel feed restricted

1 Restriction in the fuel feed from the tank to the pump may be caused by any of the following faults :

a) *Fuel filter blocked*
b) *Tank vent blocked*
c) *Feed pipe blocked or collapsed*
d) *Fuel waxing (in very cold weather)*

Fuel waxing

2 In the case of fuel waxing, the wax normally builds up first in the filter. If the filter can be warmed this will often allow the engine to run. ***Caution : Do not use a naked flame for this.*** Only in exceptionally severe weather will waxing prevent winter grade fuel from being pumped out of the tank.

Microbiological contamination

3 Under certain conditions it is possible for micro-organisms to colonise the fuel tank and supply lines. These micro-organisms produce a black sludge or slime which can block the filter and cause corrosion of metal parts. The problem normally shows up first as an unexpected blockage of the filter.

4 If such contamination is found, drain the fuel tank and discard the drained fuel. Flush the tank and fuel lines with clean fuel and renew the fuel filter - in bad cases steam clean the tank as well. If there is evidence that the

contamination has passed the fuel filter, have the injection pump cleaned by a specialist.
5 Further trouble may be avoided by only using fuel from reputable outlets with a high turnover. Proprietary additives are also available to inhibit the growth of micro-organisms in storage tanks or in the vehicle fuel tank.

6 Lack of power

Complaints of lack of power are not always justified. If necessary, perform a road or dynamometer test to verify the condition. Even if power is definitely down, the complaint is not necessarily due to an engine or injection system fault.

Before commencing detailed investigation, check that the accelerator linkage is moving through its full travel. Also make sure that an apparent power loss is not caused by items such as binding brakes, under-inflated tyres, overloading of the vehicle, or some particular feature of operation.

7 Turbo boost pressure inadequate

If boost pressure is low, power will be down and too much fuel may be delivered at high engine speeds (depending on the method of pump control). Possible reasons for low boost pressure include :

a) Air cleaner dirty
b) Leaks in induction system
c) Blockage in exhaust system
d) Turbo control fault (wastegate or actuator)
e) Turbo mechanical fault

8 Fuel consumption excessive

Complaints of excessive fuel consumption, as with lack of power, may not mean that a fault exists. If the complaint is justified and there are no obvious fuel leaks, check the same external factors as for lack of power before turning to the engine and injection system.

9 Fuel in sump

If fuel oil is found to be diluting the oil in the sump, this can only have arrived by passing down the cylinder bores. Assuming that the problem is not one of excessive fuel delivery, piston and bore wear is indicated.

Fuel contamination of the oil can be detected by smell, and in bad cases by an obvious reduction in viscosity.

10 Knocking caused by injector fault

1 A faulty injector which is causing knocking noises can be identified as follows.
2 Clean around the injector fuel pipe unions. Run the engine at a fast idle so that the knock can be heard. Using for preference a split ring spanner, slacken and retighten each injector union in turn.
Warning: Protect yourself against contact with diesel fuel by covering each union with a piece of rag to absorb the fuel which will spray out.
3 When the union supplying the defective injector is slackened, the knock will disappear. Stop the engine and remove the injector for inspection.

11 Excessive exhaust smoke

1 Check first that the smoke is still excessive when the engine has reached normal operating temperature. A cold engine may produce some blue or white smoke until it has warmed up; this is not necessarily a fault.

Black smoke

2 This is produced by incomplete combustion of the fuel in such a way that carbon particles (soot) are formed. Incomplete combustion shows that there is a lack of oxygen, either because too much fuel is being delivered or because not enough air is being drawn into the cylinders. A dirty air cleaner is an obvious cause of air starvation; incorrect valve clearances should also be considered. Combustion may also be incomplete because the injection timing is incorrect (too far retarded) or because the injector spray pattern is poor.

Blue smoke

3 This is produced either by incomplete combustion of the fuel or by burning lubricating oil. This type of incomplete combustion may be caused by incorrect injection timing (too far advanced), by defective injectors or by damaged or missing injector heat shields.
4 All engines burn a certain amount of oil, especially when cold, but if enough is being burnt to cause excessive exhaust smoke this suggests that there is a significant degree of wear or some other problem.

White smoke

5 Not to be confused with steam, this is produced by unburnt or partially burnt fuel appearing in the exhaust gases. Some white smoke is normal during and immediately after start-up, especially in cold conditions. Excessive amounts of white smoke can be caused by a preheating system fault, by incorrect injection pump timing, or by too much fuel being delivered by the injection pump (overfuelling device malfunctioning). The use of poor quality fuel with a low cetane number, and thus a long ignition delay, can also increase emissions of white smoke.
6 Accurate measurement of exhaust smoke requires the use of a smoke meter. This is not a DIY job, but any garage which carries out diesel MoT tests will have such a meter.

12 Oil entering engine via valve stems

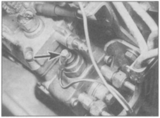
Excessive oil consumption due to oil passing down the valve stems can have three causes :

a) Valve stem wear
b) Valve guide wear
c) Valve stem oil seal wear

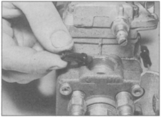
In the first two cases the cylinder head must be removed and dismantled so that the valves and guides can be inspected and measured for wear.

13 Oil consumption excessive

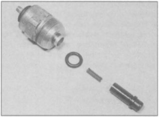
When investigating complaints of excessive oil consumption, make sure that the correct level checking procedure is being followed. If insufficient time is allowed for the oil to drain down after stopping the engine, or if the level is checked while the vehicle is standing on a slope, a false low reading may result. The unnecessary topping-up which follows may of itself cause increased oil consumption as a result of the level being too high.



17.3 Stop solenoid wire secured by nut (arrowed)



17.5a Removing the stop solenoid plunger from the pump



17.5b Stop solenoid components

14 Cylinder bore glazing

Engines which spend long periods idling can suffer from glazing of the cylinder bores, leading to high oil consumption even though no significant wear has taken place. The same effect can be produced by incorrect running-in procedures, or by the use of the incorrect grade of oil during running-in. The remedy is to remove the pistons, deglaze the bores with a hone or 'glaze buster' tool and to fit new piston rings.

15 Overheating

Any modern engine will certainly suffer serious damage if overheating is allowed to occur. The importance of regular and conscientious cooling system maintenance cannot be overstressed. Always use a good quality antifreeze and renew it regularly. When refilling the cooling system, follow the specified procedures carefully in order to eliminate any airlocks.

If overheating does occur, do not continue to drive. Stop at once and do not proceed until the problem is fixed.

16 Oil contamination

1 Oil contamination falls into three categories - dirt, sludge and dilution.

Dirt

2 Dirt or soot builds up in the oil in normal operation. It is not a problem if regular oil and filter changes are carried out. If it gets to the stage where it is causing low oil pressure, change the oil and filter immediately.

Sludge

3 This occurs when inferior grades of oil are used, or when regular oil changing has been neglected. It is more likely to occur on engines which rarely reach operating temperature. If sludge is found when draining, a flushing oil may be used if the engine manufacturer allows it. ***Caution : Some engine manufacturers forbid the use of flushing oil, because it cannot all be drained afterwards. If in doubt, consult a dealer or specialist.*** The engine should then be refilled with fresh oil of the correct grade and a new oil filter be fitted.

Dilution

4 This is of two kinds - fuel and coolant. In either case if the dilution is bad enough the engine oil level will appear to rise with use.

5 Coolant dilution of the oil is indicated by the 'mayonnaise' appearance of the oil and water mixture. Sometimes oil will also appear in the coolant. Possible reasons are :

a) Blown head gasket
b) Cracked or porous cylinder head or block
c) Cylinder liner seal failure (on wet liner engines)
d) Leaking oil-to-coolant oil cooler (when fitted)

6 With either type of dilution, the cause must be dealt with and the oil and filter changed.

17 Engine stop (fuel cut-off) solenoid - emergency repair

1 The solenoid valve cuts off the supply of fuel to the high pressure side of the injection pump when the ignition is switched off. If the solenoid fails electrically or mechanically so that its plunger is in the shut position, the engine will not run. One possible reason for such a failure is that the ignition has been switched off while engine speed is still high. In such a case the plunger will be sucked onto its seat with considerable force, and perhaps jam.

2 Should the valve fail on the road and a spare not be immediately available, the following procedure will serve to get the engine running again. ***Caution : It is important that no dirt is allowed to enter the injection pump via the solenoid hole.***

3 With the ignition off, disconnect the wire from the solenoid. Thoroughly clean around the solenoid where it screws into the pump **(see illustration)**.

4 Unscrew the solenoid and remove it. If a hand priming pump is fitted, operate the pump a few times while lifting out the solenoid to wash away any particles of dirt. Do not lose the sealing washer.

5 Remove the plunger from the solenoid (or from the recess in the pump, if it is stuck inside) **(see illustrations)**. Refit the solenoid body, making sure the sealing washer is in place, again operating the priming pump at the same time to flush away dirt.

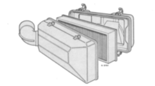
6 Tape up the end of the solenoid wire so that it cannot touch bare metal.

7 The engine will now start and run as usual, but it will not stop when the ignition is switched off. It will be necessary to use the manual stop lever (if fitted) on the injection pump, or to stall the engine in gear.

8 Fit a new solenoid and sealing washer at the earliest opportunity.

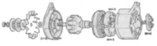
A

ABS (Anti-lock brake system) A system, usually electronically controlled, that senses incipient wheel lockup during braking and relieves hydraulic pressure at wheels that are about to skid.
Air bag An inflatable bag hidden in the steering wheel (driver's side) or the dash or glovebox (passenger side). In a head-on collision, the bags inflate, preventing the driver and front passenger from being thrown forward into the steering wheel or windscreen.
Air cleaner A metal or plastic housing, containing a filter element, which removes dust and dirt from the air being drawn into the engine.
Air filter element The actual filter in an air cleaner system, usually manufactured from pleated paper and requiring renewal at regular intervals.



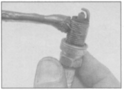
Air filter

Allen key A hexagonal wrench which fits into a recessed hexagonal hole.
Alligator clip A long-nosed spring-loaded metal clip with meshing teeth. Used to make temporary electrical connections.
Alternator A component in the electrical system which converts mechanical energy from a drivebelt into electrical energy to charge the battery and to operate the starting system, ignition system and electrical accessories.



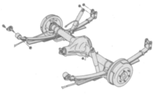
Alternator (exploded view)

Ampere (amp) A unit of measurement for the flow of electric current. One amp is the amount of current produced by one volt acting through a resistance of one ohm.
Anaerobic sealer A substance used to prevent bolts and screws from loosening. Anaerobic means that it does not require oxygen for activation. The Loctite brand is widely used.
Antifreeze A substance (usually ethylene glycol) mixed with water, and added to a vehicle's cooling system, to prevent freezing of the coolant in winter. Antifreeze also contains chemicals to inhibit corrosion and the formation of rust and other deposits that would tend to clog the radiator and coolant passages and reduce cooling efficiency.
Anti-seize compound A coating that reduces the risk of seizing on fasteners that are subjected to high temperatures, such as exhaust manifold bolts and nuts.



Anti-seize compound

Asbestos A natural fibrous mineral with great heat resistance, commonly used in the composition of brake friction materials. Asbestos is a health hazard and the dust created by brake systems should never be inhaled or ingested.
Axle A shaft on which a wheel revolves, or which revolves with a wheel. Also, a solid beam that connects the two wheels at one end of the vehicle. An axle which also transmits power to the wheels is known as a live axle.

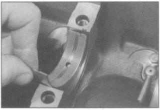


Axle assembly

Axleshaft A single rotating shaft, on either side of the differential, which delivers power from the final drive assembly to the drive wheels. Also called a driveshaft or a halfshaft.

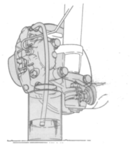
B

Ball bearing An anti-friction bearing consisting of a hardened inner and outer race with hardened steel balls between two races.



Bearing

Bearing The curved surface on a shaft or in a bore, or the part assembled into either, that permits relative motion between them with minimum wear and friction.
Big-end bearing The bearing in the end of the connecting rod that's attached to the crankshaft.
Bleed nipple A valve on a brake wheel cylinder, caliper or other hydraulic component that is opened to purge the hydraulic system of air. Also called a bleed screw.



Brake bleeding

Brake bleeding Procedure for removing air from lines of a hydraulic brake system.
Brake disc The component of a disc brake that rotates with the wheels.
Brake drum The component of a drum brake that rotates with the wheels.
Brake linings The friction material which contacts the brake disc or drum to retard the vehicle's speed. The linings are bonded or riveted to the brake pads or shoes.
Brake pads The replaceable friction pads that pinch the brake disc when the brakes are applied. Brake pads consist of a friction material bonded or riveted to a rigid backing plate.
Brake shoe The crescent-shaped carrier to which the brake linings are mounted and which forces the lining against the rotating drum during braking.
Braking systems For more information on braking systems, consult the *Haynes Automotive Brake Manual*.
Breaker bar A long socket wrench handle providing greater leverage.
Bulkhead The insulated partition between the engine and the passenger compartment.

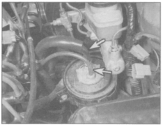
C

Caliper The non-rotating part of a disc-brake assembly that straddles the disc and carries the brake pads. The caliper also contains the hydraulic components that cause the pads to pinch the disc when the brakes are applied. A caliper is also a measuring tool that can be set to measure inside or outside dimensions of an object.

Glossary of technical terms

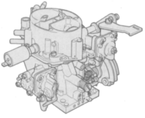
Camshaft A rotating shaft on which a series of cam lobes operate the valve mechanisms. The camshaft may be driven by gears, by sprockets and chain or by sprockets and a belt.

Canister A container in an evaporative emission control system; contains activated charcoal granules to trap vapours from the fuel system.



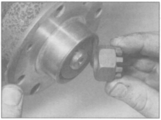
Canister

Carburettor A device which mixes fuel with air in the proper proportions to provide a desired power output from a spark ignition internal combustion engine.



Carburettor

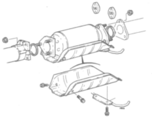
Castellated Resembling the parapets along the top of a castle wall. For example, a castellated balljoint stud nut.



Castellated nut

Castor In wheel alignment, the backward or forward tilt of the steering axis. Castor is positive when the steering axis is inclined rearward at the top.

Catalytic converter A silencer-like device in the exhaust system which converts certain pollutants in the exhaust gases into less harmful substances.



Catalytic converter

Circlip A ring-shaped clip used to prevent endwise movement of cylindrical parts and shafts. An internal circlip is installed in a groove in a housing; an external circlip fits into a groove on the outside of a cylindrical piece such as a shaft.

Clearance The amount of space between two parts. For example, between a piston and a cylinder, between a bearing and a journal, etc.

Coil spring A spiral of elastic steel found in various sizes throughout a vehicle, for example as a springing medium in the suspension and in the valve train.

Compression Reduction in volume, and increase in pressure and temperature, of a gas, caused by squeezing it into a smaller space.

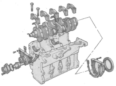
Compression ratio The relationship between cylinder volume when the piston is at top dead centre and cylinder volume when the piston is at bottom dead centre.

Constant velocity (CV) joint A type of universal joint that cancels out vibrations caused by driving power being transmitted through an angle.

Core plug A disc or cup-shaped metal device inserted in a hole in a casting through which core was removed when the casting was formed. Also known as a freeze plug or expansion plug.

Crankcase The lower part of the engine block in which the crankshaft rotates.

Crankshaft The main rotating member, or shaft, running the length of the crankcase, with offset "throws" to which the connecting rods are attached.



Crankshaft assembly

Crocodile clip See Alligator clip

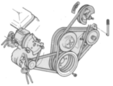
D

Diagnostic code Code numbers obtained by accessing the diagnostic mode of an engine management computer. This code can be used to determine the area in the system where a malfunction may be located.

Disc brake A brake design incorporating a rotating disc onto which brake pads are squeezed. The resulting friction converts the energy of a moving vehicle into heat.

Double-overhead cam (DOHC) An engine that uses two overhead camshafts, usually one for the intake valves and one for the exhaust valves.

Drivebelt(s) The belt(s) used to drive accessories such as the alternator, water pump, power steering pump, air conditioning compressor, etc. off the crankshaft pulley.

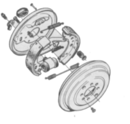


Accessory drivebelts

Driveshaft Any shaft used to transmit motion. Commonly used when referring to the axleshafts on a front wheel drive vehicle.

Driveshaft

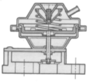
Drum brake A type of brake using a drum-shaped metal cylinder attached to the inner surface of the wheel. When the brake pedal is pressed, curved brake shoes with friction linings press against the inside of the drum to slow or stop the vehicle.



Drum brake assembly

E

EGR valve A valve used to introduce exhaust gases into the intake air stream.



EGR valve

Electronic control unit (ECU) A computer which controls (for instance) ignition and fuel injection systems, or an anti-lock braking system. For more information refer to the *Haynes Automotive Electrical and Electronic Systems Manual.*

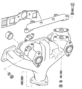
Electronic Fuel Injection (EFI) A computer controlled fuel system that distributes fuel through an injector located in each intake port of the engine.

Emergency brake A braking system, independent of the main hydraulic system, that can be used to slow or stop the vehicle if the primary brakes fail, or to hold the vehicle stationary even though the brake pedal isn't depressed. It usually consists of a hand lever that actuates either front or rear brakes mechanically through a series of cables and linkages. Also known as a handbrake or parking brake.

Endfloat The amount of lengthwise movement between two parts. As applied to a crankshaft, the distance that the crankshaft can move forward and back in the cylinder block.

Engine management system (EMS) A computer controlled system which manages the fuel injection and the ignition systems in an integrated fashion.

Exhaust manifold A part with several passages through which exhaust gases leave the engine combustion chambers and enter the exhaust pipe.

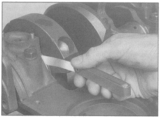


Exhaust manifold

F

Fan clutch A viscous (fluid) drive coupling device which permits variable engine fan speeds in relation to engine speeds.

Feeler blade A thin strip or blade of hardened steel, ground to an exact thickness, used to check or measure clearances between parts.



Feeler blade

Firing order The order in which the engine cylinders fire, or deliver their power strokes, beginning with the number one cylinder.

Flywheel A heavy spinning wheel in which energy is absorbed and stored by means of momentum. On cars, the flywheel is attached to the crankshaft to smooth out firing impulses.

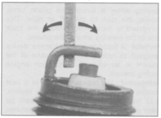
Free play The amount of travel before any action takes place. The "looseness" in a linkage, or an assembly of parts, between the initial application of force and actual movement. For example, the distance the brake pedal moves before the pistons in the master cylinder are actuated.

Fuse An electrical device which protects a circuit against accidental overload. The typical fuse contains a soft piece of metal which is calibrated to melt at a predetermined current flow (expressed as amps) and break the circuit.

Fusible link A circuit protection device consisting of a conductor surrounded by heat-resistant insulation. The conductor is smaller than the wire it protects, so it acts as the weakest link in the circuit. Unlike a blown fuse, a failed fusible link must frequently be cut from the wire for replacement.

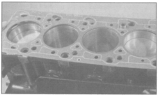
G

Gap The distance the spark must travel in jumping from the centre electrode to the side electrode in a spark plug. Also refers to the spacing between the points in a contact breaker assembly in a conventional points-type ignition, or to the distance between the reluctor or rotor and the pickup coil in an electronic ignition.



Adjusting spark plug gap

Gasket Any thin, soft material - usually cork, cardboard, asbestos or soft metal - installed between two metal surfaces to ensure a good seal. For instance, the cylinder head gasket seals the joint between the block and the cylinder head.



Gasket

Gauge An instrument panel display used to monitor engine conditions. A gauge with a movable pointer on a dial or a fixed scale is an analogue gauge. A gauge with a numerical readout is called a digital gauge.

H

Halfshaft A rotating shaft that transmits power from the final drive unit to a drive wheel, usually when referring to a live rear axle.

Harmonic balancer A device designed to reduce torsion or twisting vibration in the crankshaft. May be incorporated in the crankshaft pulley. Also known as a vibration damper.

Hone An abrasive tool for correcting small irregularities or differences in diameter in an engine cylinder, brake cylinder, etc.

Hydraulic tappet A tappet that utilises hydraulic pressure from the engine's lubrication system to maintain zero clearance (constant contact with both camshaft and valve stem). Automatically adjusts to variation in valve stem length. Hydraulic tappets also reduce valve noise.

I

Ignition timing The moment at which the spark plug fires, usually expressed in the number of crankshaft degrees before the piston reaches the top of its stroke.

Inlet manifold A tube or housing with passages through which flows the air-fuel mixture (carburettor vehicles and vehicles with throttle body injection) or air only (port fuel-injected vehicles) to the port openings in the cylinder head.

J

Jump start Starting the engine of a vehicle with a discharged or weak battery by attaching jump leads from the weak battery to a charged or helper battery.

L

Load Sensing Proportioning Valve (LSPV) A brake hydraulic system control valve that works like a proportioning valve, but also takes into consideration the amount of weight carried by the rear axle.
Locknut A nut used to lock an adjustment nut, or other threaded component, in place. For example, a locknut is employed to keep the adjusting nut on the rocker arm in position.
Lockwasher A form of washer designed to prevent an attaching nut from working loose.

M

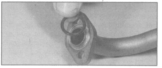
MacPherson strut A type of front suspension system devised by Earle MacPherson at Ford of England. In its original form, a simple lateral link with the anti-roll bar creates the lower control arm. A long strut - an integral coil spring and shock absorber - is mounted between the body and the steering knuckle. Many modern so-called MacPherson strut systems use a conventional lower A-arm and don't rely on the anti-roll bar for location.
Multimeter An electrical test instrument with the capability to measure voltage, current and resistance.

N

NOx Oxides of Nitrogen. A common toxic pollutant emitted by petrol and diesel engines at higher temperatures.

O

Ohm The unit of electrical resistance. One volt applied to a resistance of one ohm will produce a current of one amp.
Ohmmeter An instrument for measuring electrical resistance.
O-ring A type of sealing ring made of a special rubber-like material; in use, the O-ring is compressed into a groove to provide the sealing action.



O-ring

Overhead cam (ohc) engine An engine with the camshaft(s) located on top of the cylinder head(s).
Overhead valve (ohv) engine An engine with the valves located in the cylinder head, but with the camshaft located in the engine block.
Oxygen sensor A device installed in the engine exhaust manifold, which senses the oxygen content in the exhaust and converts this information into an electric current. Also called a Lambda sensor.

P

Phillips screw A type of screw head having a cross instead of a slot for a corresponding type of screwdriver.
Plastigage A thin strip of plastic thread, available in different sizes, used for measuring clearances. For example, a strip of Plastigage is laid across a bearing journal. The parts are assembled and dismantled; the width of the crushed strip indicates the clearance between journal and bearing.

Plastigage

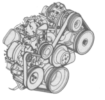
Propeller shaft The long hollow tube with universal joints at both ends that carries power from the transmission to the differential on front-engined rear wheel drive vehicles.
Proportioning valve A hydraulic control valve which limits the amount of pressure to the rear brakes during panic stops to prevent wheel lock-up.

R

Rack-and-pinion steering A steering system with a pinion gear on the end of the steering shaft that mates with a rack (think of a geared wheel opened up and laid flat). When the steering wheel is turned, the pinion turns, moving the rack to the left or right. This movement is transmitted through the track rods to the steering arms at the wheels.
Radiator A liquid-to-air heat transfer device designed to reduce the temperature of the coolant in an internal combustion engine cooling system.
Refrigerant Any substance used as a heat transfer agent in an air-conditioning system. R-12 has been the principle refrigerant for many years; recently, however, manufacturers have begun using R-134a, a non-CFC substance that is considered less harmful to the ozone in the upper atmosphere.
Rocker arm A lever arm that rocks on a shaft or pivots on a stud. In an overhead valve engine, the rocker arm converts the upward movement of the pushrod into a downward movement to open a valve.
Rotor In a distributor, the rotating device inside the cap that connects the centre electrode and the outer terminals as it turns, distributing the high voltage from the coil secondary winding to the proper spark plug. Also, that part of an alternator which rotates inside the stator. Also, the rotating assembly of a turbocharger, including the compressor wheel, shaft and turbine wheel.
Runout The amount of wobble (in-and-out movement) of a gear or wheel as it's rotated. The amount a shaft rotates "out-of-true." The out-of-round condition of a rotating part.

S

Sealant A liquid or paste used to prevent leakage at a joint. Sometimes used in conjunction with a gasket.
Sealed beam lamp An older headlight design which integrates the reflector, lens and filaments into a hermetically-sealed one-piece unit. When a filament burns out or the lens cracks, the entire unit is simply replaced.
Serpentine drivebelt A single, long, wide accessory drivebelt that's used on some newer vehicles to drive all the accessories, instead of a series of smaller, shorter belts. Serpentine drivebelts are usually tensioned by an automatic tensioner.



Serpentine drivebelt

Shim Thin spacer, commonly used to adjust the clearance or relative positions between two parts. For example, shims inserted into or under bucket tappets control valve clearances. Clearance is adjusted by changing the thickness of the shim.
Slide hammer A special puller that screws into or hooks onto a component such as a shaft or bearing; a heavy sliding handle on the shaft bottoms against the end of the shaft to knock the component free.
Sprocket A tooth or projection on the periphery of a wheel, shaped to engage with a chain or drivebelt. Commonly used to refer to the sprocket wheel itself.
Starter inhibitor switch On vehicles with an

automatic transmission, a switch that prevents starting if the vehicle is not in Neutral or Park.

Strut See MacPherson strut.

T

Tappet A cylindrical component which transmits motion from the cam to the valve stem, either directly or via a pushrod and rocker arm. Also called a cam follower.

Thermostat A heat-controlled valve that regulates the flow of coolant between the cylinder block and the radiator, so maintaining optimum engine operating temperature. A thermostat is also used in some air cleaners in which the temperature is regulated.

Thrust bearing The bearing in the clutch assembly that is moved in to the release levers by clutch pedal action to disengage the clutch. Also referred to as a release bearing.

Timing belt A toothed belt which drives the camshaft. Serious engine damage may result if it breaks in service.

Timing chain A chain which drives the camshaft.

Toe-in The amount the front wheels are closer together at the front than at the rear. On rear wheel drive vehicles, a slight amount of toe-in is usually specified to keep the front wheels running parallel on the road by offsetting other forces that tend to spread the wheels apart.

Toe-out The amount the front wheels are closer together at the rear than at the front. On front wheel drive vehicles, a slight amount of toe-out is usually specified.

Tools For full information on choosing and using tools, refer to the *Haynes Automotive Tools Manual*.

Tracer A stripe of a second colour applied to a wire insulator to distinguish that wire from another one with the same colour insulator.

Tune-up A process of accurate and careful adjustments and parts replacement to obtain the best possible engine performance.

Turbocharger A centrifugal device, driven by exhaust gases, that pressurises the intake air. Normally used to increase the power output from a given engine displacement, but can also be used primarily to reduce exhaust emissions (as on VW's "Umwelt" Diesel engine).

U

Universal joint or U-joint A double-pivoted connection for transmitting power from a driving to a driven shaft through an angle. A U-joint consists of two Y-shaped yokes and a cross-shaped member called the spider.

V

Valve A device through which the flow of liquid, gas, vacuum, or loose material in bulk may be started, stopped, or regulated by a movable part that opens, shuts, or partially obstructs one or more ports or passageways. A valve is also the movable part of such a device.

Valve clearance The clearance between the valve tip (the end of the valve stem) and the rocker arm or tappet. The valve clearance is measured when the valve is closed.

Vernier caliper A precision measuring instrument that measures inside and outside dimensions. Not quite as accurate as a micrometer, but more convenient.

Viscosity The thickness of a liquid or its resistance to flow.

Volt A unit for expressing electrical "pressure" in a circuit. One volt that will produce a current of one ampere through a resistance of one ohm.

W

Welding Various processes used to join metal items by heating the areas to be joined to a molten state and fusing them together. For more information refer to the *Haynes Automotive Welding Manual*.

Wiring diagram A drawing portraying the components and wires in a vehicle's electrical system, using standardised symbols. For more information refer to the *Haynes Automotive Electrical and Electronic Systems Manual*.