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

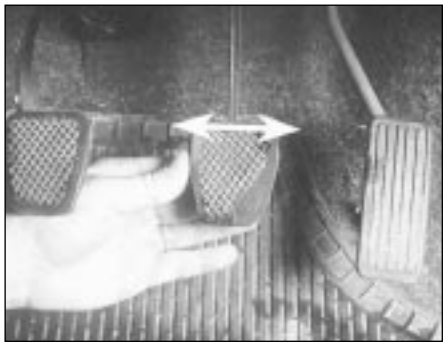
Handbrake

☐ 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

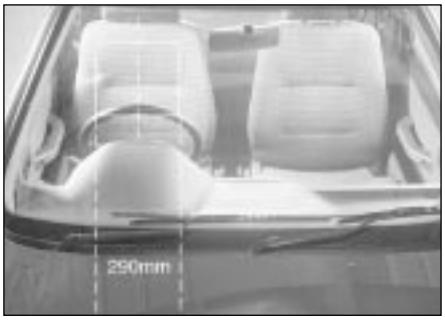
☐ Examine the steering wheel for fractures or looseness of the hub, spokes or rim.

☐ 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

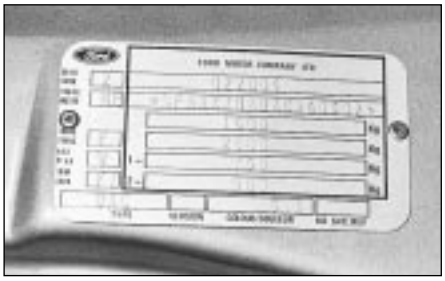
☐ Both front doors must be able to be opened and closed from outside and inside, and must latch securely when closed.

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.

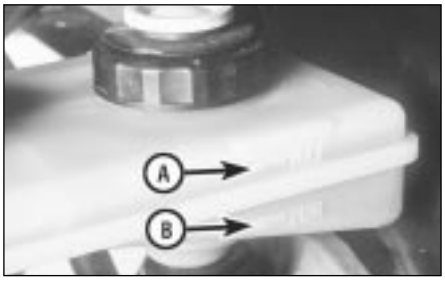
☐ Switch on the ignition and check the operation of the direction indicators (including the instrument panel tell-tale) and the hazard warning lights. Operation of the sidelights and stop-lights must not affect the indicators - if it does, the cause is usually a bad earth at the rear light cluster.

☐ 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.

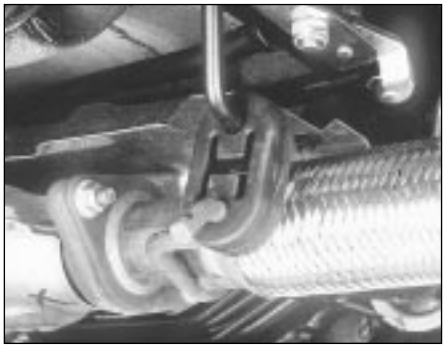
☐ Check that the vehicle is standing level, and at approximately the correct ride height.

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.

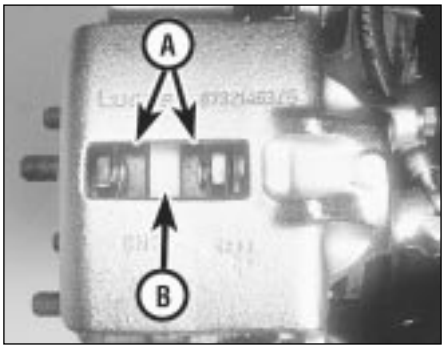
☐ Inspect the shock absorbers for signs of serious fluid leakage. Check for wear of the mounting bushes or attachments, or damage to the body of the unit.

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

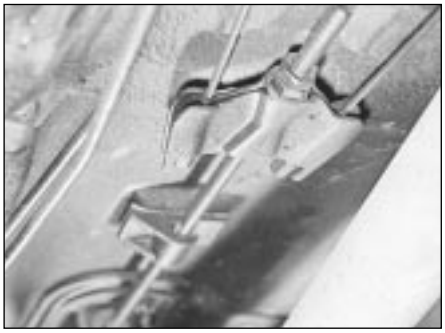
☐ If possible without dismantling, check brake pad wear and disc condition. Ensure that the friction lining material has not worn excessively, (A) and that the discs are not fractured, pitted, scored or badly worn (B).



☐ 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.

Introduction

A selection of good tools is a fundamental requirement for anyone contemplating the maintenance and repair of a motor vehicle. For the owner who does not possess any, their purchase will prove a considerable expense, offsetting some of the savings made by doing-it-yourself. However, provided that the tools purchased meet the relevant national safety standards and are of good quality, they will last for many years and prove an extremely worthwhile investment.

To help the average owner to decide which tools are needed to carry out the various tasks detailed in this manual, we have compiled three lists of tools under the following headings: *Maintenance and minor repair, Repair and overhaul*, and *Special*. Newcomers to practical mechanics should start off with the *Maintenance and minor repair* tool kit, and confine themselves to the simpler jobs around the vehicle. Then, as confidence and experience grow, more difficult tasks can be undertaken, with extra tools being purchased as, and when, they are needed. In this way, a *Maintenance and minor repair* tool kit can be built up into a *Repair and overhaul* tool kit over a considerable period of time, without any major cash outlays. The experienced do-it-yourselfer will have a tool kit good enough for most repair and overhaul procedures, and will add tools from the *Special* category when it is felt that the expense is justified by the amount of use to which these tools will be put.

Maintenance and minor repair tool kit

The tools given in this list should be considered as a minimum requirement if routine maintenance, servicing and minor repair operations are to be undertaken. We recommend the purchase of combination spanners (ring one end, open-ended the other); although more expensive than open-ended ones, they do give the advantages of both types of spanner.

- ☐ *Combination spanners:*
  Metric - 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 19, 21, 22, 24 & 26 mm
- ☐ *Adjustable spanner - 35 mm jaw (approx)*
- ☐ *Transmission drain plug key (Allen type)*
- ☐ *Set of feeler gauges*
- ☐ *Spark plug spanner (with rubber insert)*
- ☐ *Spark plug gap adjustment tool*
- ☐ *Brake bleed nipple spanner*
- ☐ *Screwdrivers:*
  Flat blade - approx 100 mm long x 6 mm dia
  Cross blade - approx 100 mm long x 6 mm dia
- ☐ *Combination pliers*
- ☐ *Hacksaw (junior)*
- ☐ *Tyre pump*
- ☐ *Tyre pressure gauge*
- ☐ *Oil can*
- ☐ *Oil filter removal tool*
- ☐ *Fine emery cloth*
- ☐ *Wire brush (small)*
- ☐ *Funnel (medium size)*

Repair and overhaul tool kit

These tools are virtually essential for anyone undertaking any major repairs to a motor vehicle, and are additional to those given in the *Maintenance and minor repair* list. Included in this list is a comprehensive set of sockets. Although these are expensive, they will be found invaluable as they are so versatile - particularly if various drives are included in the set. We recommend the half-inch square-drive type, as this can be used with most proprietary torque wrenches. If you cannot afford a socket set, even bought piecemeal, then inexpensive tubular box spanners are a useful alternative.

The tools in this list will occasionally need to be supplemented by tools from the *Special* list:

- ☐ *Sockets (or box spanners) to cover range in previous list*
- ☐ *Reversible ratchet drive (for use with sockets)* ***(see illustration)***
- ☐ *Extension piece, 250 mm (for use with sockets)*
- ☐ *Universal joint (for use with sockets)*
- ☐ *Torque wrench (for use with sockets)*
- ☐ *Self-locking grips*
- ☐ *Ball pein hammer*
- ☐ *Soft-faced mallet (plastic/aluminium or rubber)*
- ☐ *Screwdrivers:*
  Flat blade - long & sturdy, short (chubby), and narrow (electrician's) types
  Cross blade - Long & sturdy, and short (chubby) types
- ☐ *Pliers:*
  Long-nosed
  Side cutters (electrician's)
  Circlip (internal and external)
- ☐ *Cold chisel - 25 mm*
- ☐ *Scriber*
- ☐ *Scraper*
- ☐ *Centre-punch*
- ☐ *Pin punch*
- ☐ *Hacksaw*
- ☐ *Brake hose clamp*
- ☐ *Brake/clutch bleeding kit*
- ☐ *Selection of twist drills*
- ☐ *Steel rule/straight-edge*
- ☐ *Allen keys (inc. splined/Torx type)* ***(see illustrations)***
- ☐ *Selection of files*
- ☐ *Wire brush*
- ☐ *Axle stands*
- ☐ *Jack (strong trolley or hydraulic type)*
- ☐ *Light with extension lead*

Special tools

The tools in this list are those which are not used regularly, are expensive to buy, or which need to be used in accordance with their manufacturers' instructions. Unless relatively difficult mechanical jobs are undertaken frequently, it will not be economic to buy many of these tools. Where this is the case, you could consider clubbing together with friends (or joining a motorists' club) to make a joint purchase, or borrowing the tools against a deposit from a local garage or tool hire specialist. It is worth noting that many of the larger DIY superstores now carry a large range of special tools for hire at modest rates.

The following list contains only those tools and instruments freely available to the public, and not those special tools produced by the vehicle manufacturer specifically for its dealer network. You will find occasional references to these manufacturers' special tools in the text of this manual. Generally, an alternative method of doing the job without the vehicle manufacturers' special tool is given. However, sometimes there is no alternative to using them. Where this is the case and the relevant tool cannot be bought or borrowed, you will have to entrust the work to a franchised garage.

- ☐ *Valve spring compressor* ***(see illustration)***
- ☐ *Valve grinding tool*
- ☐ *Piston ring compressor* ***(see illustration)***
- ☐ *Piston ring removal/installation tool* ***(see illustration)***
- ☐ *Cylinder bore hone* ***(see illustration)***
- ☐ *Balljoint separator*
- ☐ *Coil spring compressors (where applicable)*
- ☐ *Two/three-legged hub and bearing puller* ***(see illustration)***

Sockets and reversible ratchet drive

Spline bit set

Spline key set

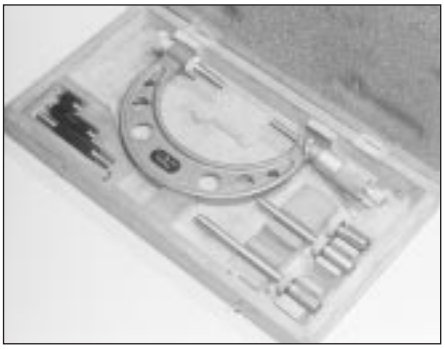
Valve spring compressor

Piston ring compressor

Piston ring removal/installation tool

Cylinder bore hone

Three-legged hub and bearing puller



Micrometer set

Vernier calipers

Dial test indicator and magnetic stand

Compression testing gauge

Clutch plate alignment set

Brake shoe steady spring cup removal tool

☐ *Impact screwdriver*
☐ *Micrometer and/or vernier calipers* ***(see illustrations)***
☐ *Dial gauge* ***(see illustration)***
☐ *Universal electrical multi-meter*
☐ *Cylinder compression gauge* ***(see illustration)***
☐ *Clutch plate alignment set* ***(see illustration)***
☐ *Brake shoe steady spring cup removal tool* ***(see illustration)***
☐ *Bush and bearing removal/installation set* ***(see illustration)***
☐ *Stud extractors* ***(see illustration)***
☐ *Tap and die set* ***(see illustration)***
☐ *Lifting tackle*
☐ *Trolley jack*

Buying tools

For practically all tools, a tool factor is the best source, since he will have a very comprehensive range compared with the average garage or accessory shop. Having said that, accessory shops often offer excellent quality tools at discount prices, so it pays to shop around.

Remember, you don't have to buy the most expensive items on the shelf, but it is always advisable to steer clear of the very cheap tools. There are plenty of good tools around at reasonable prices, but always aim to purchase items which meet the relevant national safety standards. If in doubt, ask the proprietor or manager of the shop for advice before making a purchase.

Care and maintenance of tools

Having purchased a reasonable tool kit, it is necessary to keep the tools in a clean and serviceable condition. After use, always wipe off any dirt, grease and metal particles using a clean, dry cloth, before putting the tools away. Never leave them lying around after they have been used. A simple tool rack on the garage or workshop wall for items such as screwdrivers and pliers is a good idea. Store all normal spanners and sockets in a metal box. Any measuring instruments, gauges, meters, etc, must be carefully stored where they cannot be damaged or become rusty.

Take a little care when tools are used. Hammer heads inevitably become marked, and screwdrivers lose the keen edge on their blades from time to time. A little timely attention with emery cloth or a file will soon restore items like this to a good serviceable finish.

Working facilities

Not to be forgotten when discussing tools is the workshop itself. If anything more than routine maintenance is to be carried out, some form of suitable working area becomes essential.

It is appreciated that many an owner-mechanic is forced by circumstances to remove an engine or similar item without the benefit of a garage or workshop. Having done this, any repairs should always be done under the cover of a roof.

Wherever possible, any dismantling should be done on a clean, flat workbench or table at a suitable working height.

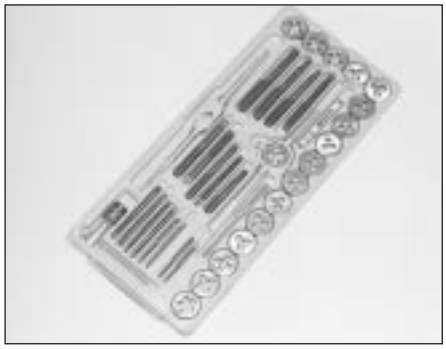
Any workbench needs a vice; one with a jaw opening of 100 mm is suitable for most jobs. As mentioned previously, some clean dry storage space is also required for tools, as well as for any lubricants, cleaning fluids, touch-up paints and so on, which become necessary.

Another item which may be required, and which has a much more general usage, is an electric drill with a chuck capacity of at least 8 mm. This, together with a good range of twist drills, is virtually essential for fitting accessories.

Last, but not least, always keep a supply of old newspapers and clean, lint-free rags available, and try to keep any working area as clean as possible.

Bush and bearing removal/installation set

Stud extractor set



Tap and die set

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.

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.

Engine

- ☐ Engine will not rotate when attempting to start
- ☐ Engine rotates, but will not start
- ☐ Engine hard to start when cold
- ☐ Engine hard to start when hot
- ☐ Starter motor noisy or excessively-rough in engagement
- ☐ Engine starts, but stops immediately
- ☐ Oil puddle under engine
- ☐ Engine idles erratically
- ☐ Engine misses at idle speed
- ☐ Engine misses throughout driving speed range
- ☐ Engine misfires on acceleration
- ☐ Engine surges while holding accelerator steady
- ☐ Engine stalls
- ☐ Engine lacks power
- ☐ Engine backfires
- ☐ Pinking or knocking engine sounds when accelerating or driving uphill
- ☐ Engine runs with oil pressure light on
- ☐ Engine runs-on after switching off

Engine electrical system

- ☐ Battery will not hold charge
- ☐ Ignition (no-charge) warning light fails to go out
- ☐ Ignition (no-charge) warning light fails to come on when key is turned

Fuel system

- ☐ Excessive fuel consumption
- ☐ Fuel leakage and/or fuel odour

Cooling system

- ☐ Overheating
- ☐ Overcooling
- ☐ External coolant leakage
- ☐ Internal coolant leakage
- ☐ Coolant loss
- ☐ Poor coolant circulation

Clutch

- ☐ Pedal travels to floor - no pressure or very little resistance
- ☐ Fluid in area of master cylinder dust cover and on pedal
- ☐ Fluid on slave cylinder
- ☐ Pedal feels “spongy” when depressed
- ☐ Unable to select gears
- ☐ Clutch slips (engine speed increases with no increase in vehicle speed)
- ☐ Grabbing (chattering) as clutch is engaged
- ☐ Noise in clutch area
- ☐ Clutch pedal stays on floor
- ☐ High pedal effort

Manual transmission

- ☐ Vibration
- ☐ Noisy in neutral with engine running
- ☐ Noisy in one particular gear
- ☐ Noisy in all gears
- ☐ Slips out of gear
- ☐ Leaks lubricant

Automatic transmission

- ☐ Fluid leakage
- ☐ Transmission fluid brown, or has a burned smell
- ☐ General shift mechanism problems
- ☐ Transmission will not kickdown with accelerator pedal pressed to the floor
- ☐ Engine will start in gears other than Park or Neutral
- ☐ Transmission slips, shifts roughly, is noisy, or has no drive in forward or reverse gears

Brakes

- ☐ Vehicle pulls to one side during braking
- ☐ Noise (high-pitched squeal) when the brakes are applied
- ☐ Brake vibration (pedal pulsates)
- ☐ Excessive pedal effort required to stop vehicle
- ☐ Excessive brake pedal travel
- ☐ Dragging brakes
- ☐ Grabbing or uneven braking action
- ☐ Brake pedal feels “spongy” when depressed
- ☐ Brake pedal travels to the floor with little resistance
- ☐ Handbrake does not hold

Suspension and steering

- ☐ Vehicle pulls to one side
- ☐ Abnormal or excessive tyre wear
- ☐ Wheel makes a “thumping” noise
- ☐ Shimmy, shake or vibration
- ☐ High steering effort
- ☐ Poor steering self-centring
- ☐ Abnormal noise at the front end
- ☐ Wandering or poor steering stability
- ☐ Erratic steering when braking
- ☐ Excessive pitching and/or rolling around corners or during braking
- ☐ Suspension bottoms
- ☐ Unevenly-worn tyres
- ☐ Excessive tyre wear on outside edge
- ☐ Excessive tyre wear on inside edge
- ☐ Tyre tread worn in one place
- ☐ Excessive play or looseness in steering system
- ☐ Rattling or clicking noise in steering gear

This Section provides an easy-reference guide to the more common problems which may occur during the operation of your vehicle. These problems and their possible causes are grouped under headings denoting various components or systems, such as Engine, Cooling system, etc. They also refer you to the Chapter and/or Section which deals with the problem.

Remember that successful fault diagnosis is not a mysterious black art practised only by professional mechanics. It is simply the result of the right knowledge combined with an intelligent, systematic approach to the problem. Always work by a process of elimination, starting with the simplest solution and working through to the most complex - and never overlook the obvious. Anyone can run the fuel tank dry or leave the lights on overnight, so don't assume that you are exempt from such oversights.

Finally, always establish a clear idea of why a problem has occurred, and take steps to ensure that it doesn't happen again. If the electrical system fails because of a poor connection, check all other connections in the system to make sure that they don't fail as well. If a particular fuse continues to blow, find out why - don't just renew one fuse after another. Remember, failure of a small component can often be indicative of potential failure or incorrect functioning of a more important component or system.

Engine

Engine will not rotate when attempting to start

- ☐ Battery terminal connections loose or corroded (Chapter 1).
- ☐ Battery discharged or faulty (Chapter 1).
- ☐ Automatic transmission not completely engaged in Park (Chapter 7B) or (on models with a clutch switch) clutch not completely depressed (Chapter 8).
- ☐ Broken, loose or disconnected wiring in the starting circuit (Chapters 5 and 12).
- ☐ Starter motor pinion jammed in flywheel ring gear (Chapter 5).
- ☐ Starter solenoid faulty (Chapter 5).
- ☐ Starter motor faulty (Chapter 5).
- ☐ Ignition switch faulty (Chapter 12).
- ☐ Starter pinion or flywheel teeth worn or broken (Chapter 5).
- ☐ Engine internal problem (Chapter 2B).

Engine rotates, but will not start

- ☐ Fuel tank empty.
- ☐ Battery discharged (engine rotates slowly) (Chapter 5).
- ☐ Battery terminal connections loose or corroded (Chapter 1).
- ☐ Leaking fuel injector(s), faulty fuel pump, pressure regulator, etc (Chapter 4).
- ☐ Fuel not reaching fuel injection system or carburettor (Chapter 4).
- ☐ Ignition components damp or damaged (Chapter 5).
- ☐ Fuel injector stuck open (Chapter 4).
- ☐ Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- ☐ Broken, loose or disconnected wiring in the starting circuit (Chapter 5).
- ☐ Loose distributor mounting bolts causing ignition timing to wander (Chapters 1 and 5).
- ☐ Broken, loose or disconnected wires at the ignition coil, or faulty coil (Chapter 5).

Engine hard to start when cold

- ☐ Battery discharged (Chapter 1).
- ☐ Fuel system malfunctioning (Chapter 4).
- ☐ Injector(s) leaking or carburettor automatic choke faulty (Chapter 4).
- ☐ Distributor rotor carbon-tracked (Chapter 5).

Engine hard to start when hot

- ☐ Air filter element clogged (Chapter 1).
- ☐ Fuel not reaching the fuel injection system or carburettor (Chapter 4).
- ☐ Corroded battery connections, especially earth (negative) connection (Chapter 1).

Starter motor noisy or excessively-rough in engagement

- ☐ Pinion or flywheel gear teeth worn or broken (Chapter 5).
- ☐ Starter motor mounting bolts loose or missing (Chapter 5).

Engine starts, but stops immediately

- ☐ Loose or faulty electrical connections at distributor, coil or alternator (Chapter 5).
- ☐ Insufficient fuel reaching the fuel injector(s) or carburettor (Chapters 1 and 4).
- ☐ Damaged fuel injection system speed sensors (Chapter 5).
- ☐ Faulty fuel injection relays (Chapter 5).

Oil puddle under engine

- ☐ Oil sump gasket and/or sump drain plug seal leaking (Chapter 2).
- ☐ Oil pressure sender unit leaking (Chapter 2).
- ☐ Valve cover gaskets leaking (Chapter 2).
- ☐ Engine oil seals leaking (Chapter 2).

Engine idles erratically

- ☐ Vacuum leakage (Chapter 4).
- ☐ Air filter element clogged (Chapter 1).
- ☐ Fuel pump not delivering sufficient fuel to the fuel injection system or carburettor (Chapter 4).
- ☐ Leaking head gasket (Chapter 2).
- ☐ Timing belt/chain and/or sprockets worn (Chapter 2).
- ☐ Camshaft lobes worn (Chapter 2).
- ☐ Faulty charcoal canister, where fitted (Chapter 6).

Engine misses at idle speed

- ☐ Spark plugs worn or incorrectly-gapped (Chapter 1).
- ☐ Faulty spark plug HT leads (Chapter 1).
- ☐ Vacuum leaks (Chapter 1).
- ☐ Incorrect ignition timing (Chapter 5).
- ☐ Uneven or low compression (Chapter 2).
- ☐ Faulty charcoal canister, where fitted (Chapter 6).

Engine misses throughout driving speed range

- ☐ Fuel filter clogged and/or impurities in the fuel system (Chapter 1).
- ☐ Low fuel output at the injectors, or partially-blocked carburettor jets (Chapter 4).
- ☐ Faulty or incorrectly-gapped spark plugs (Chapter 1).
- ☐ Incorrect ignition timing (Chapter 5).
- ☐ Cracked distributor cap, disconnected distributor HT leads, or damaged distributor components (Chapter 1).
- ☐ Faulty spark plug HT leads (Chapter 1).
- ☐ Faulty emission system components (Chapter 6).
- ☐ Low or uneven cylinder compression pressures (Chapter 2).
- ☐ Weak or faulty ignition system (Chapter 5).
- ☐ Vacuum leak in fuel injection system, intake manifold or vacuum hoses (Chapter 4).

Engine misfires on acceleration

- ☐ Spark plugs fouled (Chapter 1).
- ☐ Fuel injection system or carburettor malfunctioning (Chapter 4).
- ☐ Fuel filter clogged (Chapters 1 and 4).
- ☐ Incorrect ignition timing (Chapter 5).
- ☐ Intake manifold air leak (Chapter 4).

Engine surges while holding accelerator steady

- ☐ Intake air leak (Chapter 4).
- ☐ Fuel pump faulty (Chapter 4).
- ☐ Loose fuel injector harness connections (Chapters 4 and 6).
- ☐ Defective ECU (Chapter 5).

Engine lacks power

- ☐ Incorrect ignition timing (Chapter 5).
- ☐ Excessive play in distributor shaft (Chapter 5).
- ☐ Worn rotor, distributor cap or HT leads (Chapters 1 and 5).
- ☐ Faulty or incorrectly-gapped spark plugs (Chapter 1).
- ☐ Fuel injection system or carburettor malfunctioning (Chapter 4).
- ☐ Faulty coil (Chapter 5).
- ☐ Brakes binding (Chapter 1).
- ☐ Automatic transmission fluid level incorrect (Chapter 1).
- ☐ Clutch slipping (Chapter 8).
- ☐ Fuel filter clogged and/or impurities in the fuel system (Chapter 1).
- ☐ Emission control system not functioning properly (Chapter 6).
- ☐ Low or uneven cylinder compression pressures (Chapter 2).

Engine stalls

- ☐ Idle speed incorrect (Chapter 1).
- ☐ Fuel filter clogged and/or water and impurities in the fuel system (Chapter 1).
- ☐ Distributor components damp or damaged (Chapter 5).
- ☐ Faulty emissions system components (Chapter 6).
- ☐ Faulty or incorrectly-gapped spark plugs (Chapter 1).
- ☐ Faulty spark plug HT leads (Chapter 1).
- ☐ Vacuum leak in the fuel injection system, intake manifold or vacuum hoses (Chapter 4).

Engine backfires

- ☐ Emissions system not functioning properly (Chapter 6).
- ☐ Ignition timing incorrect (Chapter 5).
- ☐ Faulty secondary ignition system (cracked spark plug insulator, faulty plug HT leads, distributor cap and/or rotor) (Chapters 1 and 5).
- ☐ Fuel injection system or carburettor malfunctioning (Chapter 4).
- ☐ Vacuum leak at fuel injector(s), intake manifold or vacuum hoses (Chapter 4).
- ☐ Valve clearances incorrect (Chapter 1), or valve(s) sticking or damaged (Chapter 2).

Pinking or knocking engine sounds when accelerating or driving uphill

- ☐ Incorrect grade of fuel.
- ☐ Ignition timing incorrect (Chapter 5).
- ☐ Fuel injection system or carburettor in need of adjustment (Chapter 4).
- ☐ Damaged spark plugs or HT leads, or incorrect type fitted (Chapter 1).
- ☐ Worn or damaged distributor components (Chapter 5).
- ☐ Faulty emission system (Chapter 6).
- ☐ Vacuum leak (Chapter 4).

Engine runs with oil pressure light on

Caution: Stop the engine immediately if the oil pressure light comes on and establish the cause. Running the engine while the oil pressure is low can cause severe damage.

- ☐ Low oil level (Chapter 1).
- ☐ Idle speed too low (Chapter 1).
- ☐ Short-circuit in wiring (Chapter 12).
- ☐ Faulty oil pressure sender unit (Chapter 2).
- ☐ Worn engine bearings and/or oil pump (Chapter 2).

Engine runs-on after switching off

- ☐ Idle speed too high (Chapter 1).
- ☐ Excessive engine operating temperature (Chapter 3).
- ☐ Incorrect fuel octane grade.
- ☐ Spark plugs defective or incorrect grade (Chapter 1).

Engine electrical system

Battery will not hold charge

- ☐ Alternator drivebelt defective or not adjusted properly (Chapter 1).
- ☐ Electrolyte level low (Chapter 1).
- ☐ Battery terminals loose or corroded (Chapter 1).
- ☐ Alternator not charging properly (Chapter 5).
- ☐ Loose, broken or faulty wiring in the charging circuit (Chapter 5).
- ☐ Short in vehicle wiring (Chapters 5 and 12).
- ☐ Internally-defective battery (Chapters 1 and 5).
- ☐ Ignition (no-charge) warning light bulb blown - on some early models (Chapter 5)

Ignition (no-charge) warning light fails to go out

- ☐ Faulty alternator or charging circuit (Chapter 5).
- ☐ Alternator drivebelt defective or out of adjustment (Chapter 1).
- ☐ Alternator voltage regulator inoperative (Chapter 5).

Ignition (no-charge) warning light fails to come on when key is turned

- ☐ Warning light bulb defective (Chapter 12).
- ☐ Fault in the printed circuit, wiring or bulbholder (Chapter 12).

Fuel system

Excessive fuel consumption

- ☐ Dirty or clogged air filter element (Chapter 1).
- ☐ Ignition timing incorrect (Chapter 5).
- ☐ Emissions system not functioning properly (Chapter 6).
- ☐ Fuel injection internal parts or carburettor jets excessively worn or damaged (Chapter 4).
- ☐ Low tyre pressure or incorrect tyre size (Chapter 1).
- ☐ Unsympathetic driving style, or unfavourable conditions.

Fuel leakage and/or fuel odour

Warning: Don't drive the vehicle if a fuel leak is suspected. Leaking fuel in the engine compartment could catch fire.

- ☐ Leak in a fuel feed or vent line (Chapter 4).
- ☐ Tank overfilled.
- ☐ Fuel injector or carburettor parts excessively worn, or fuel system gaskets leaking (Chapter 4).

Cooling system

Overheating

- ☐ Insufficient coolant in system (Chapter 1).
- ☐ Water pump drivebelt defective or out of adjustment (Chapter 1).
- ☐ Radiator matrix blocked, or grille restricted (Chapter 3).
- ☐ Thermostat faulty (Chapter 3).
- ☐ Radiator cap not maintaining proper pressure (Chapter 3).
- ☐ Ignition timing incorrect (Chapter 5).

Overcooling

- ☐ Faulty thermostat (Chapter 3).

External coolant leakage

- ☐ Deteriorated/damaged hoses; loose clamps (Chapters 1 and 3).
- ☐ Water pump seal defective (Chapters 1 and 3).
- ☐ Leakage from radiator matrix, heater matrix or header tank (Chapter 3).
- ☐ Radiator/engine block drain plugs or water jacket core plugs leaking (Chapters 2 and 3).

Internal coolant leakage

- ☐ Leaking cylinder head gasket (Chapter 2).
- ☐ Cracked cylinder bore or cylinder head (Chapter 2).

Coolant loss

- ☐ Too much coolant in system (Chapter 1).
- ☐ Coolant boiling away because of overheating (see above).
- ☐ Internal or external leakage (see above).
- ☐ Faulty radiator cap (Chapter 3).

Poor coolant circulation

- ☐ Inoperative water pump (Chapter 3).
- ☐ Restriction in cooling system (Chapters 1 and 3).
- ☐ Water pump drivebelt defective/out of adjustment (Chapter 1).
- ☐ Thermostat sticking (Chapter 3).

Clutch

Pedal travels to floor - no pressure or very little resistance

- ☐ Master or slave cylinder faulty (Chapter 8).
- ☐ Fluid line burst or leaking (Chapter 8).
- ☐ Connections leaking (Chapter 8).
- ☐ No fluid in reservoir (Chapter 1).
- ☐ If fluid is present in master cylinder dust cover, master cylinder rear seal has failed (Chapter 8).
- ☐ Broken release bearing or fork (Chapter 8).

Fluid in area of master cylinder dust cover, and on pedal

- ☐ Rear seal failure in master cylinder (Chapter 8).

Fluid on slave cylinder

- ☐ Slave cylinder plunger seal faulty (Chapter 8).

Pedal feels "spongy" when depressed

- ☐ Air in system (Chapter 8).

Unable to select gears

- ☐ Faulty transmission (Chapter 7).
- ☐ Faulty clutch plate (Chapter 8).
- ☐ Fork and bearing not assembled properly (Chapter 8).
- ☐ Faulty pressure plate (Chapter 8).
- ☐ Pressure plate-to-flywheel bolts loose (Chapter 8).

Clutch slips (engine speed increases with no increase in vehicle speed)

- ☐ Clutch plate worn (Chapter 8).
- ☐ Clutch plate is oil-soaked by leaking rear main seal (Chapter 8).
- ☐ Warped pressure plate or flywheel (Chapter 8).
- ☐ Weak diaphragm spring (Chapter 8).
- ☐ Clutch plate overheated.

Grabbing (chattering) as clutch is engaged

- ☐ Oil on clutch plate lining, burned or glazed facings (Chapter 8).
- ☐ Worn or loose engine or transmission mountings (Chapters 2 and 7A).
- ☐ Worn splines on clutch plate hub (Chapter 8).
- ☐ Warped pressure plate or flywheel (Chapter 8).

Noise in clutch area

- ☐ Fork improperly fitted (Chapter 8).
- ☐ Faulty release bearing (Chapter 8).

Clutch pedal stays on floor

- ☐ Fork binding in housing (Chapter 8).
- ☐ Broken release bearing or fork (Chapter 8).

High pedal effort

- ☐ Fork binding in housing (Chapter 8).
- ☐ Pressure plate faulty (Chapter 8).
- ☐ Incorrect-size master or slave cylinder fitted (Chapter 8).

Manual transmission

Vibration

☐ Damaged propeller shaft (Chapter 8).
☐ Out-of-round tyres (Chapter 1).
☐ Tyre out-of-balance (Chapters 1 and 10).
☐ Worn propeller shaft universal joint (Chapter 8).

Noisy in neutral with engine running

☐ Worn clutch release bearing (Chapter 8).
☐ Worn transmission input shaft bearing (Chapter 7A).

Noisy in one particular gear

☐ Damaged or worn constant-mesh gears.
☐ Damaged or worn synchronisers.

Noisy in all gears

☐ Insufficient lubricant (Chapter 1).
☐ Damaged or worn bearings.
☐ Worn or damaged input gear shaft and/or output gear shaft.

Slips out of gear

☐ Worn or incorrectly-adjusted linkage (Chapter 7A).
☐ Transmission-to-engine mounting bolts loose (Chapter 7A).
☐ Shift linkage binding (Chapter 7A).
☐ Worn shift fork (Chapter 7A).

Leaks lubricant

☐ Excessive amount of lubricant in transmission (Chapters 1 and 7A).
☐ Loose or broken input shaft bearing retainer (Chapter 7A).
☐ Input shaft bearing retainer O-ring and/or lip seal damaged (Chapter 7A).

Automatic transmission

Note: *Due to the complexity of the automatic transmission, it is difficult for the home mechanic to properly diagnose and service this unit. For problems other than the following, the vehicle should be taken to a dealer or transmission specialist.*

Fluid leakage

☐ Automatic transmission fluid is a deep red colour. Fluid leaks should not be confused with engine oil, which can easily be blown by airflow onto the transmission.
☐ To pinpoint a leak, first remove all built-up dirt and grime from the transmission housing with degreasing agents and/or by steam-cleaning. Then drive the vehicle at low speed, so airflow will not blow the leak far from its source. Raise the vehicle and determine where the leak is coming from. Common areas of leakage are:
a) Transmission sump (Chapters 1 and 7B)
b) Filler pipe (Chapter 7B)
c) Transmission fluid cooler lines (Chapter 7B)
d) Speedometer sensor (Chapter 7B)

Transmission fluid brown, or has a burned smell

☐ Transmission fluid burned; fluid should be changed. May indicate transmission internal fault (Chapters 1 and 7B).

Transmission will not kickdown with accelerator pedal pressed to the floor

☐ Kickdown cable out of adjustment (Chapter 7B).

General shift mechanism problems

☐ Chapter 7B deals with checking and adjusting the shift linkage on automatic transmissions. Common problems which may be attributed to poorly-adjusted linkage are:
a) Engine starting in gears other than Park or Neutral.
b) Indicator on selector lever pointing to a gear other than the one actually being used.
c) Vehicle moves when in Park.
☐ Refer to Chapter 7B for the shift linkage adjustment procedure.

Engine will start in gears other than Park or Neutral

☐ Inhibitor switch malfunctioning (Chapter 7B).

Transmission slips, shifts roughly, is noisy, or has no drive in forward or reverse gears

☐ There are many probable causes for the above problems, but the home mechanic should be concerned with only one possibility - fluid level. Before taking the vehicle to an automatic transmission specialist, check the level and condition of the fluid as described in Chapter 1. Correct the fluid level as necessary, or change the fluid if needed. If the problem persists, have a professional diagnose the probable cause.

Brakes

Note: *Before assuming that a brake problem exists, make sure that:*
a) The tyres are in good condition and properly inflated (Chapter 1).
b) The wheel alignment (tracking) is correct (Chapter 10).
c) The vehicle is not loaded with weight in an unequal manner.

Vehicle pulls to one side during braking

- ☐ Incorrect tyre pressures (Chapter 1).
- ☐ Wheel alignment (tracking) incorrect (Chapter 10)
- ☐ Unmatched tyres on same axle.
- ☐ Restricted brake lines or hoses (Chapter 9).
- ☐ Malfunctioning caliper assembly (Chapter 9).
- ☐ Loose suspension parts (Chapter 10).
- ☐ Loose calipers (Chapter 9).

Noise (high-pitched squeal) when the brakes are applied

- ☐ Front and/or rear disc brake pads worn out. The noise comes from the wear sensor rubbing against the disc. Renew the pads immediately (Chapter 9).

Brake vibration (pedal pulsates)

Note: *If the vehicle has ABS, it is normal for the brake pedal to pulsate when the system is working.*

- ☐ Excessive lateral disc run-out (Chapter 9).
- ☐ Parallelism not within specifications (Chapter 9).
- ☐ Uneven pad wear - caused by caliper not sliding, due to improper clearance or dirt (Chapter 9).
- ☐ Defective disc (Chapter 9).

Excessive brake pedal travel

- ☐ Partial brake system failure (Chapter 9).
- ☐ Insufficient fluid in master cylinder (Chapters 1 and 9).
- ☐ Air trapped in system (Chapters 1 and 9).

Excessive pedal effort required to stop vehicle

- ☐ Malfunctioning brake servo unit (Chapter 9).
- ☐ Partial system failure (Chapter 9).
- ☐ Excessively-worn pads or shoes (Chapter 9).
- ☐ Caliper piston stuck or sluggish (Chapter 9).
- ☐ Brake pads contaminated with oil or grease (Chapter 9).
- ☐ New pads fitted and not yet seated. It will take a while for the new material to seat against the disc.

Dragging brakes

- ☐ Master cylinder pistons not returning correctly (Chapter 9).
- ☐ Restricted brakes lines or hoses (Chapters 1 and 9).
- ☐ Incorrect handbrake adjustment (Chapter 9).
- ☐ Rear drum brake self-adjuster mechanism faulty (when applicable) (Chapter 9).

Grabbing or uneven braking action

- ☐ Malfunction of brake servo unit (Chapter 9).
- ☐ Binding brake pedal mechanism (Chapter 9).

Brake pedal feels "spongy" when depressed

- ☐ Air in hydraulic lines (Chapter 9).
- ☐ Master cylinder mounting bolts loose (Chapter 9).
- ☐ Master cylinder defective (Chapter 9).

Brake pedal travels to the floor with little resistance

- ☐ Little or no fluid in the master cylinder reservoir, caused by leaking caliper piston(s), loose, damaged or disconnected brake lines (Chapter 9).

Handbrake does not hold

- ☐ Handbrake linkage incorrectly adjusted (Chapter 9).
- ☐ Handbrake shoe linings worn out or contaminated (Chapter 9).

Suspension and steering

Note: *Before assuming that a problem exists, check the following items:*

a) Tyre pressures and tyre condition (also check for out-of-round or out-of-balance tyres, and bent wheel rims).
b) Steering universal joints from the column to the steering gear (for play or wear).
c) Front and rear suspension, and the rack-and-pinion assembly (for loose or damaged parts).
d) Wheel bearings (wheel wobble or roughness when spun).

Vehicle pulls to one side

- ☐ Mismatched or uneven tyres (Chapter 10).
- ☐ Broken or sagging springs (Chapter 10).
- ☐ Front wheel or rear wheel alignment incorrect (Chapter 10).
- ☐ Front brake problem (Chapter 9).

Abnormal or excessive tyre wear

- ☐ Front wheel or rear wheel alignment incorrect (Chapter 10).
- ☐ Sagging or broken springs (Chapter 10).
- ☐ Tyre out of balance (Chapter 10).
- ☐ Worn shock absorber (Chapter 10).
- ☐ Overloaded vehicle or unsympathetic driving style.
- ☐ Tyres not rotated regularly.

Wheel makes a "thumping" noise

- ☐ Blister or bump on tyre (Chapter 10).
- ☐ Faulty shock absorber action (Chapter 10).
- ☐ Wheel bolts loose.

Shimmy, shake or vibration

- ☐ Tyre or wheel out of balance or out of round (Chapter 10).
- ☐ Loose, worn or incorrectly-adjusted wheel bearings (Chapter 1).
- ☐ Worn tie-rod ends (Chapter 10).
- ☐ Worn balljoints (Chapter 10).
- ☐ Excessive wheel run-out (Chapter 10).
- ☐ Blister or bump on tyre (Chapter 10).
- ☐ Wheel bolts loose.

High steering effort

- ☐ Lack of lubrication at balljoints, tie-rod ends and steering gear (Chapter 1).
- ☐ Incorrect front wheel alignment (Chapter 10).
- ☐ Low tyre pressure(s) (Chapter 1).
- ☐ Power steering fluid low, or steering pump drivebelt slipping, where applicable (Chapter 10)

Poor steering self-centring

- ☐ Lack of lubrication at balljoints and tie-rod ends (Chapter 1).
- ☐ Binding in balljoints (Chapter 10).
- ☐ Binding in steering column (Chapter 10).
- ☐ Lack of lubricant in steering gear (Chapter 10).
- ☐ Inaccurate front wheel alignment (Chapter 10).

Abnormal noise at the front end

- ☐ Lack of lubrication at balljoints and tie-rod ends (Chapter 1).
- ☐ Damaged shock absorber mounting (Chapter 10).
- ☐ Worn control arm bushings or tie-rod ends (Chapter 10).
- ☐ Loose anti-roll bar (Chapter 10).
- ☐ Loose wheel bolts.
- ☐ Loose suspension mounting bolts (Chapter 10).

Wandering or poor steering stability

- ☐ Mismatched or uneven tyres (Chapter 10).
- ☐ Lack of lubrication at balljoints and tie-rod ends (Chapter 1).
- ☐ Worn shock absorbers (Chapter 10).
- ☐ Loose anti-roll bar (Chapter 10).
- ☐ Broken or sagging springs (Chapter 10).
- ☐ Front or rear wheel alignment incorrect (Chapter 10).

Erratic steering when braking

- ☐ Wheel bearings worn (Chapter 1).
- ☐ Broken or sagging springs (Chapter 10).
- ☐ Leaking wheel cylinder (rear drum brake models) or caliper (Chapter 9).
- ☐ Warped discs (Chapter 9).

Excessive pitching and/or rolling around corners or during braking

- ☐ Loose anti-roll bar (Chapter 10).
- ☐ Worn shock absorbers or mountings (Chapter 10).
- ☐ Broken or sagging springs (Chapter 10).
- ☐ Overloaded vehicle.

Suspension bottoms

- ☐ Overloaded vehicle.
- ☐ Worn shock absorbers (Chapter 10).
- ☐ Broken or sagging springs, or incorrect springs fitted (Chapter 10).

Unevenly-worn tyres

- ☐ Front wheel or rear wheel alignment incorrect (Chapter 10).
- ☐ Worn shock absorbers (Chapter 10).
- ☐ Wheel bearings worn (Chapter 10).
- ☐ Excessive tyre or wheel run-out (Chapter 10).
- ☐ Worn balljoints (Chapter 10).

Excessive tyre wear on outside edge

- ☐ Tyre pressures incorrect (Chapter 1).
- ☐ Excessive cornering speed.
- ☐ Wheel alignment incorrect (excessive toe-in) (Chapter 10).
- ☐ Suspension components damaged (Chapter 10).

Excessive tyre wear on inside edge

- ☐ Tyre pressures incorrect (Chapter 1).
- ☐ Wheel alignment incorrect (excessive toe-out) (Chapter 10).
- ☐ Loose or damaged steering components (Chapter 10).

Tyre tread worn in one place

- ☐ Tyres out of balance.
- ☐ Damaged or buckled wheel. Inspect and renew if necessary.
- ☐ Defective tyre (Chapter 1).

Excessive play or looseness in steering system

- ☐ Wheel bearing(s) worn (Chapter 10.
- ☐ Tie-rod end loose or worn (Chapter 10).
- ☐ Steering gear mountings loose (Chapter 10).

Rattling or clicking noise in steering gear

- ☐ Insufficient or incorrect lubricant in rack-and-pinion assembly (Chapter 10).
- ☐ Steering gear mountings loose (Chapter 10).

Length (distance)

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

Volume (capacity)

Cubic inches (cu in; in^3)	x 16.387	=	Cubic centimetres (cc; cm^3)	x 0.061	=	Cubic inches (cu in; in^3)
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/in^2; lb/in^2)	x 0.070	=	Kilograms-force per square centimetre (kgf/cm^2; kg/cm^2)	x 14.223	=	Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Pounds-force per square inch (psi; lbf/in^2; lb/in^2)	x 0.068	=	Atmospheres (atm)	x 14.696	=	Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Pounds-force per square inch (psi; lbf/in^2; lb/in^2)	x 0.069	=	Bars	x 14.5	=	Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Pounds-force per square inch (psi; lbf/in^2; lb/in^2)	x 6.895	=	Kilopascals (kPa)	x 0.145	=	Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Kilopascals (kPa)	x 0.01	=	Kilograms-force per square centimetre (kgf/cm^2; kg/cm^2)	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/in^2; lb/in^2)	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/in^2; lb/in^2)	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)

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

Temperature

Degrees Fahrenheit = (°C x 1.8) + 32

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

A number of automotive chemicals and lubricants are available for use during vehicle maintenance and repair. They include a wide variety of products ranging from cleaning solvents and degreasers to lubricants and protective sprays for rubber, plastic and vinyl.

Cleaners

Carburettor cleaner and choke cleaner is a strong solvent for gum, varnish and carbon. Most carburettor cleaners leave a dry-type lubricant film which will not harden or gum up. Because of this film, it is not recommended for use on electrical components.

Brake system cleaner is used to remove grease and brake fluid from the brake system, where clean surfaces are absolutely necessary. It leaves no residue, and often eliminates brake squeal caused by contaminants.

Electrical cleaner removes oxidation, corrosion and carbon deposits from electrical contacts, restoring full current flow. It can also be used to clean spark plugs, carburettor jets, voltage regulators and other parts where an oil-free surface is desired.

Moisture dispersants remove water and moisture from electrical components such as alternators, voltage regulators, electrical connectors and fuse blocks. They are non-conductive and non-corrosive.

Degreasers are heavy-duty solvents used to remove grease from the outside of the engine and from chassis components. They can be sprayed or brushed on, and are usually rinsed off with water.

Lubricants

Engine oil is the lubricant formulated for use in engines. It normally contains a wide variety of additives to prevent corrosion and reduce foaming and wear. Engine oil comes in various weights (viscosity ratings) from 5 to 60. The recommended weight of the oil depends on the season, temperature and the demands on the engine. Light oil is used in cold climates and under light load conditions. Heavy oil is used in hot climates, and where high loads are encountered. Multi-viscosity (multigrade) oils are designed to have characteristics of both light and heavy oils, and are available in a number of weights from 5W-20 to 20W-50.

Gear oil is designed to be used in differentials, manual transmissions and other areas where high-temperature lubrication is required.

Chassis and wheel bearing grease is a heavy grease used where increased loads and friction are encountered, such as for wheel bearings, balljoints, tie-rod ends and universal joints.

High-temperature wheel bearing grease is designed to withstand the extreme temperatures encountered by wheel bearings in disc brake-equipped vehicles. It usually contains molybdenum disulphide (moly), which is a dry-type lubricant.

White grease is a heavy grease for metal-to-metal applications where water is a problem. White grease stays soft at both low and high temperatures, and will not wash off or dilute in the presence of water.

Assembly lube is a special extreme-pressure lubricant, usually containing moly, used to lubricate high-load parts (such as main and rod bearings and cam lobes) for initial start-up of a new engine. The assembly lube lubricates the parts without being squeezed out or washed away until the engine oiling system begins to function.

Silicone lubricants are used to protect rubber, plastic, vinyl and nylon parts.

Graphite lubricants are used where oils cannot be used due to contamination problems, such as in locks. The dry graphite will lubricate metal parts while remaining uncontaminated by dirt, water, oil or acids. It is electrically conductive, and will not foul electrical contacts in locks such as the ignition switch.

Penetrating oils loosen and lubricate frozen, rusted and corroded fasteners and prevent future rusting or freezing.

Heat-sink grease is a special electrically non-conductive grease that is used for mounting electronic ignition modules where it is essential that heat is transferred away from the module.

Sealants

RTV sealant is one of the most widely-used gasket compounds. Made from silicone, RTV is air-curing; it seals, bonds, waterproofs, fills surface irregularities, remains flexible, doesn't shrink, is relatively easy to remove, and is used as a supplementary sealer with almost all low- and medium-temperature gaskets.

Anaerobic sealant is much like RTV in that it can be used either to seal gaskets or to form gaskets by itself. It remains flexible, is solvent-resistant, and fills surface imperfections. The difference between an anaerobic sealant and an RTV-type sealant is in the curing. RTV cures when exposed to air, while an anaerobic sealant cures only in the absence of air. This means that an anaerobic sealant cures only after the assembly of parts, sealing them together.

Thread and pipe sealant is used for sealing hydraulic and pneumatic fittings and vacuum lines. It is usually made from a Teflon compound, and comes in a spray, a paint-on liquid and as a wrap-around tape.

Chemicals

Anti-seize compound prevents seizing, chafing, cold welding, rust and corrosion in fasteners. High-temperature anti-seize, usually made with copper and graphite lubricants, is used for exhaust system and exhaust manifold bolts.

Anaerobic locking compounds are used to keep fasteners from vibrating or working loose, and cure only after installation, in the absence of air. Medium-strength locking compound is used for small nuts, bolts and screws that may be removed later. High-strength locking compound is for large nuts, bolts and studs which aren't removed on a regular basis.

Oil additives range from viscosity index improvers to chemical treatments that claim to reduce internal engine friction. It should be noted that most oil manufacturers caution against using additives with their oils.

Fuel additives perform several functions, depending on their chemical make-up. They usually contain solvents that help dissolve gum and varnish that build up on carburettor, fuel injection and intake parts. They also serve to break down carbon deposits that form on the inside surfaces of the combustion chambers. Some additives contain upper cylinder lubricants for valves and piston rings, and others contain chemicals to remove condensation from the fuel tank.

Miscellaneous

Brake fluid is specially-formulated hydraulic fluid that can withstand the heat and pressure encountered in brake systems. It is poisonous and inflammable. Care must be taken so this fluid does not come in contact with painted surfaces or plastics. An opened container should always be resealed, to prevent contamination by water or dirt. Brake fluid absorbs moisture from the air, if left in an unsealed container.

Weatherstrip adhesive is used to bond weatherstripping around doors, windows and boot lids. It is sometimes used to attach trim pieces.

Underseal is a petroleum-based, tar-like substance that is designed to protect metal surfaces on the underside of the vehicle from corrosion. It also acts as a sound-deadening agent by insulating the bottom of the vehicle.

Waxes and polishes are used to help protect painted and plated surfaces from the weather. Different types of paint may require the use of different types of wax and polish. Some polishes utilise a chemical or abrasive cleaner to help remove the top layer of oxidised (dull) paint on older vehicles. In recent years, many non-wax polishes containing a wide variety of chemicals such as polymers and silicones have been introduced. These non-wax polishes are usually easier to apply, and last longer than conventional waxes and polishes.

Buying spare parts

Spare parts are available from many sources; for example, BMW garages, other garages and accessory shops, and motor factors. Our advice regarding spare part sources is as follows.

Officially-appointed BMW garages - This is the best source for parts which are peculiar to your vehicle, and which are not generally available (eg complete cylinder heads, internal transmission components, badges, interior trim etc). It is also the only place at which you should buy parts if the vehicle is still under warranty. To be sure of obtaining the correct parts, it will be necessary to give the storeman the full Vehicle Identification Number, and if possible, to take the old parts along for positive identification. Many parts are available under a factory exchange scheme - any parts returned should always be clean. It obviously makes good sense to go straight to the specialists on your vehicle for this type of part, as they are best equipped to supply you.

Other garages and accessory shops - These are often very good places to buy materials and components needed for the maintenance of your vehicle (eg oil filters, spark plugs, bulbs, drivebelts, oils and greases, touch-up paint, filler paste, 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 which wear out comparatively quickly (eg exhaust systems, brake pads, seals and hydraulic parts, clutch components, bearing shells, pistons, valves 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 numbers

Modifications are a continuing and unpublicised process in vehicle manufacture, quite apart from major model changes. Spare parts manuals and lists are compiled upon a numerical basis, the appropriate identification number or code being essential to correct identification of the component concerned.

When ordering spare parts, always give as much information as possible. Quote the vehicle model, year of manufacture, Vehicle Identification Number and engine numbers, as appropriate.

The *Vehicle Identification Number (VIN)* is located on the right-hand front wheel arch next to the front suspension strut upper mounting, on the driver's door, and on a plate on top of the facia, just inside the windscreen **(see illustrations).**

The *engine number* is stamped on a machined face on the left-hand side of the cylinder block, near the base of the oil level dipstick tube.

The *body number* is located on the seam between the left-hand front wing and inner panel.

The VIN (arrowed) is stamped on the bulkhead

The VIN is also present on the edge of the driver's door

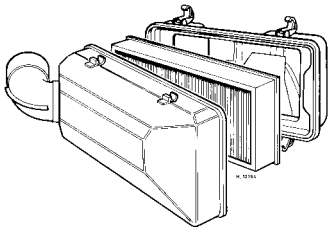
A

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.

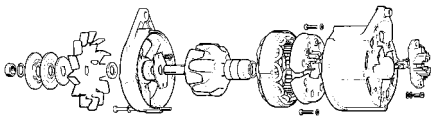


Air filter

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.

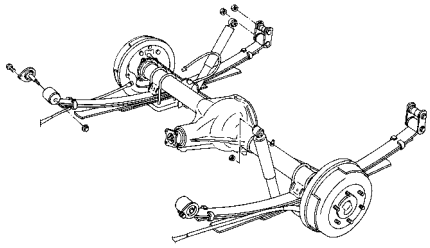
Antifreeze A substance (usually ethylene glycol) mixed with water, and added to a vehicle's cooling system, to prevent freezing of the coolant in winter. Antifreeze also contains chemicals to inhibit corrosion and the formation of rust and other deposits that would tend to clog the radiator and coolant 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

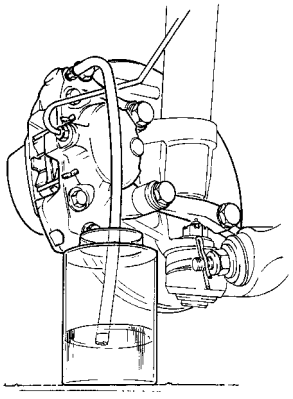
Ball bearing An anti-friction bearing consisting of a hardened inner and outer race with hardened steel balls between two races.

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

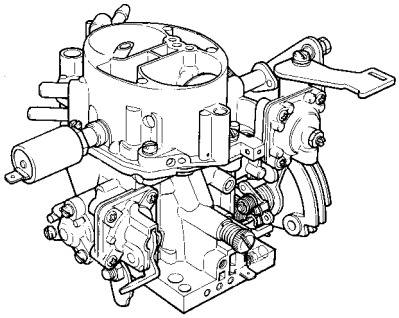
Caliper The non-rotating part of a disc-brake assembly that straddles the disc and carries the brake pads. The caliper also contains the hydraulic components that cause the pads to pinch the disc when the brakes are applied. A caliper is also a measuring tool that can be set to measure inside or outside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

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.



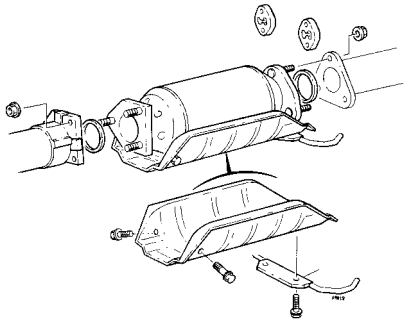
Carburettor

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.

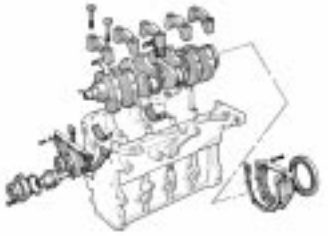
Compression ratio The relationship between cylinder volume when the piston is at top dead centre and cylinder volume when the piston is at bottom dead centre.

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

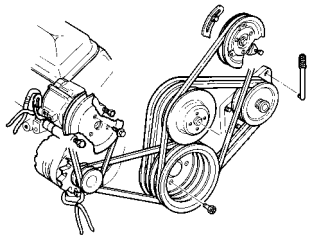
D

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.

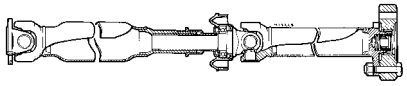
Double-overhead cam (DOHC) An engine that uses two overhead camshafts, usually one for the intake valves and one for the exhaust valves.

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.



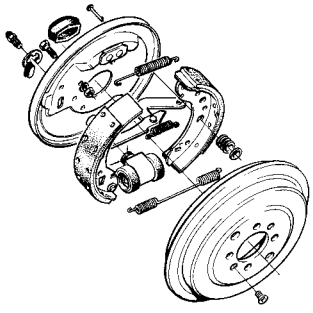
Accessory drivebelts

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



Driveshaft

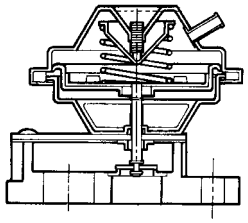
Drum brake A type of brake using a drum-shaped metal cylinder attached to the inner surface of the wheel. When the brake pedal is pressed, curved brake shoes with friction linings press against the inside of the drum to slow or stop the vehicle.



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.*

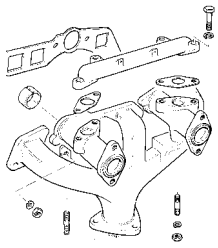
Electronic Fuel Injection (EFI) A computer controlled fuel system that distributes fuel through an injector located in each intake port of the engine.

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.

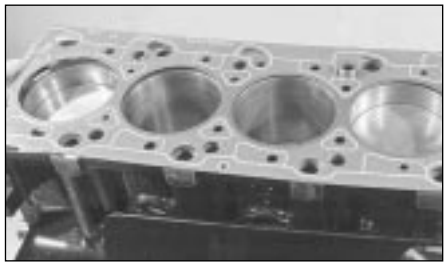
Fusible link A circuit protection device consisting of a conductor surrounded by heat-resistant insulation. The conductor is smaller than the wire it protects, so it acts as the weakest link in the circuit. Unlike a blown fuse, a failed fusible link must frequently be cut from the wire for replacement.

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.

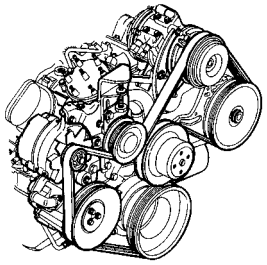
Runout The amount of wobble (in-and-out movement) of a gear or wheel as it's rotated. The amount a shaft rotates "out-of-true." The out-of-round condition of a rotating part.

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.*

Note: *References throughout this index relate to Chapter•page number*

R

S

T

U

V

W

Preserving Our Motoring Heritage

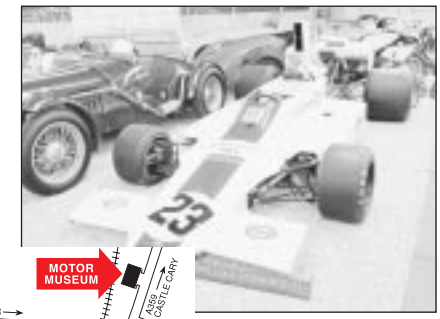
The Model J Duesenberg Derham Tourster. Only eight of these magnificent cars were ever built – this is the only example to be found outside the United States of America

Almost every car you've ever loved, loathed or desired is gathered under one roof at the Haynes Motor Museum. Over 300 immaculately presented cars and motorbikes represent every aspect of our motoring heritage, from elegant reminders of bygone days, such as the superb Model J Duesenberg to curiosities like the bug-eyed BMW Isetta. There are also many old friends and flames. Perhaps you remember the 1959 Ford Popular that you did your courting in? The magnificent 'Red Collection' is a spectacle of classic sports cars including AC, Alfa Romeo, Austin Healey, Ferrari, Lamborghini, Maserati, MG, Riley, Porsche and Triumph.

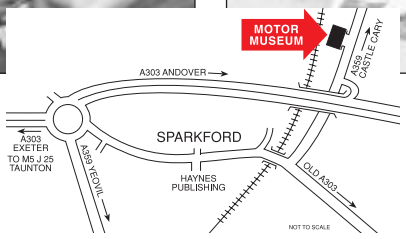
A Perfect Day Out

Each and every vehicle at the Haynes Motor Museum has played its part in the history and culture of Motoring. Today, they make a wonderful spectacle and a great day out for all the family. Bring the kids, bring Mum and Dad, but above all bring your camera to capture those golden memories for ever. You will also find an impressive array of motoring memorabilia, a comfortable 70 seat video cinema and one of the most extensive transport book shops in Britain. The Pit Stop Cafe serves everything from a cup of tea to wholesome, home-made meals or, if you prefer, you can enjoy the large picnic area nestled in the beautiful rural surroundings of Somerset.

John Haynes O.B.E., Founder and Chairman of the museum at the wheel of a Haynes Light 12.



Graham Hill's Lola Cosworth Formula 1 car next to a 1934 Riley Sports.



The Museum is situated on the A359 Yeovil to Frome road at Sparkford, just off the A303 in Somerset. It is about 40 miles south of Bristol, and 25 minutes drive from the M5 intersection at Taunton.

Open 9.30am - 5.30pm (10.00am - 4.00pm Winter) 7 days a week, *except Christmas Day, Boxing Day and New Years Day*

Special rates available for schools, coach parties and outings Charitable Trust No. 292048