

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 adjuster spanner (where applicable)
- 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 bleeding kit
- Selection of twist drills



Sockets and reversible ratchet drive

- 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)



Spline bit set

Tools and Working Facilities



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.

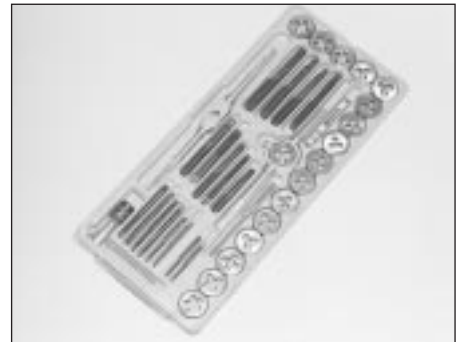
Last, but not least, always keep a supply of old newspapers and clean, lint-free rags available, and try to keep any working area as clean as possible.



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, it is necessary to 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, ensure that it is renewed on reassembly, and 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 not likely 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.

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 proprietary 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 in the course of 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 in such cases should 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. 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 for further advice.

With the universal tightening-up of legislation regarding the emission of environmentally-harmful substances from motor vehicles, most current 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 encountered during servicing or overhaul, they should, wherever possible, be renewed or refitted in accordance with the vehicle manufacturer's requirements or current legislation.



OIL BANK LINE
0800 66 33 66

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

Buying spare parts

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

Officially-appointed Ford 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 plate* is located on the engine compartment front crossmember (see illustration). In addition to many other details, it carries the Vehicle Identification Number, maximum vehicle weight information, and codes for interior trim and body colours.

The *Vehicle Identification Number* is given on the vehicle identification plate. It is also stamped on the engine compartment bulkhead, behind the air intake plenum chamber, and into the body, so that it can be seen through the bottom left-hand corner of the windscreen (see illustrations).



Vehicle identification plate on engine compartment front crossmember

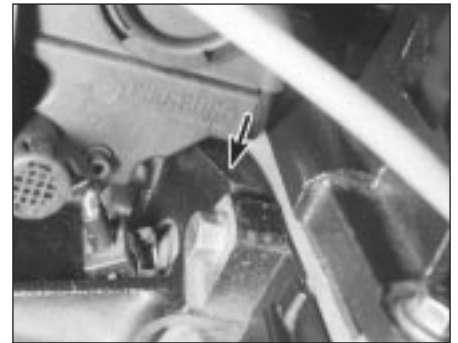


Vehicle identification number in body, visible through bottom left-hand corner of windscreen

The *engine number*, consisting of two letters and five digits, with the three-letter engine code nearby, is stamped into a flat-machined surface on the cylinder block/crankcase's forward-facing flange, between the pulse-air filter housing and the transmission. To read the number without removing the engine compartment air intake resonator - see Chapter 4 - it is easiest to raise and support the front of the vehicle on axle stands, so that the number can be seen from underneath (see illustration). If the number cannot be seen in this location, possible alternative sites are on a lower flange on the cylinder block's forward face, immediately above the sump mating surface, or on the left-hand end of the cylinder head, between the oil filler cap and ignition coil.



Vehicle identification number on engine compartment bulkhead



Engine number (arrowed) on front of cylinder block/crankcase - seen from beneath vehicle

<p>Engine</p> <ul style="list-style-type: none"> <input type="checkbox"/> Engine backfires <input type="checkbox"/> Engine difficult to start when cold <input type="checkbox"/> Engine difficult to start when hot <input type="checkbox"/> Engine fails to rotate when attempting to start <input type="checkbox"/> Engine hesitates on acceleration <input type="checkbox"/> Engine idles erratically <input type="checkbox"/> Engine lacks power <input type="checkbox"/> Engine misfires at idle speed <input type="checkbox"/> Engine misfires throughout the driving speed range <input type="checkbox"/> Engine noises <input type="checkbox"/> Engine rotates but will not start <input type="checkbox"/> Engine runs-on after switching off <input type="checkbox"/> Engine stalls <input type="checkbox"/> Engine starts but stops immediately <input type="checkbox"/> Oil pressure warning light illuminated with engine running <input type="checkbox"/> Starter motor noisy or excessively-rough in engagement 	1	<p>Automatic transmission</p> <ul style="list-style-type: none"> <input type="checkbox"/> Engine will not start in any gear, or starts in gears other than Park or Neutral <input type="checkbox"/> Fluid leakage <input type="checkbox"/> General gear selection problems <input type="checkbox"/> Transmission fluid brown, or has burned smell <input type="checkbox"/> Transmission slips, shifts roughly, is noisy, or has no drive in forward or reverse gears <input type="checkbox"/> Transmission will not downshift (kickdown) with accelerator fully depressed 	6
<p>Cooling system</p> <ul style="list-style-type: none"> <input type="checkbox"/> Corrosion <input type="checkbox"/> External coolant leakage <input type="checkbox"/> Internal coolant leakage <input type="checkbox"/> Overcooling <input type="checkbox"/> Overheating 	2	<p>Driveshafts</p> <ul style="list-style-type: none"> <input type="checkbox"/> Clicking or knocking noise on turns (at slow speed on full-lock) <input type="checkbox"/> Vibration when accelerating or decelerating 	7
<p>Fuel and exhaust systems</p> <ul style="list-style-type: none"> <input type="checkbox"/> Excessive fuel consumption <input type="checkbox"/> Excessive noise or fumes from exhaust system <input type="checkbox"/> Fuel leakage and/or fuel odour 	3	<p>Braking system</p> <ul style="list-style-type: none"> <input type="checkbox"/> Brake pedal feels spongy when depressed <input type="checkbox"/> Brakes binding <input type="checkbox"/> Excessive brake pedal effort required to stop vehicle <input type="checkbox"/> Excessive brake pedal travel <input type="checkbox"/> Judder felt through brake pedal or steering wheel when braking <input type="checkbox"/> Noise (grinding or high-pitched squeal) when brakes applied <input type="checkbox"/> Rear wheels locking under normal braking <input type="checkbox"/> Vehicle pulls to one side under braking 	8
<p>Clutch</p> <ul style="list-style-type: none"> <input type="checkbox"/> Clutch fails to disengage (unable to select gears) <input type="checkbox"/> Clutch slips (engine speed increases with no increase in vehicle speed) <input type="checkbox"/> Judder as clutch is engaged <input type="checkbox"/> Noise when depressing or releasing clutch pedal <input type="checkbox"/> Pedal travels to floor - no pressure or very little resistance 	4	<p>Suspension and steering systems</p> <ul style="list-style-type: none"> <input type="checkbox"/> Excessive pitching and/or rolling around corners, or during braking <input type="checkbox"/> Excessive play in steering <input type="checkbox"/> Excessively-stiff steering <input type="checkbox"/> Lack of power assistance <input type="checkbox"/> Tyre wear excessive <input type="checkbox"/> Vehicle pulls to one side <input type="checkbox"/> Wandering or general instability <input type="checkbox"/> Wheel wobble and vibration 	9
<p>Manual transmission</p> <ul style="list-style-type: none"> <input type="checkbox"/> Jumps out of gear <input type="checkbox"/> Lubricant leaks <input type="checkbox"/> Noisy in neutral with engine running <input type="checkbox"/> Noisy in one particular gear <input type="checkbox"/> Vibration 	5	<p>Electrical system</p> <ul style="list-style-type: none"> <input type="checkbox"/> Battery will not hold a charge for more than a few days <input type="checkbox"/> Central locking system inoperative, or unsatisfactory in operation <input type="checkbox"/> Electric windows inoperative, or unsatisfactory in operation <input type="checkbox"/> Horn inoperative, or unsatisfactory in operation <input type="checkbox"/> Ignition warning light fails to come on <input type="checkbox"/> Ignition warning light remains illuminated with engine running <input type="checkbox"/> Instrument readings inaccurate or erratic <input type="checkbox"/> Lights inoperative <input type="checkbox"/> Windscreen/tailgate washers inoperative, or unsatisfactory in operation <input type="checkbox"/> Windscreen/tailgate wipers inoperative, or unsatisfactory in operation 	10

Introduction

The vehicle owner who does his or her own maintenance according to the recommended service schedules should not have to use this section of the manual very often. Modern component reliability is such that, provided those items subject to wear or deterioration are inspected or renewed at the specified intervals, sudden failure is comparatively rare. Faults do not usually just happen as a result of sudden failure, but develop over a period of time. Major mechanical failures in particular are usually preceded by characteristic symptoms over hundreds or even thousands of miles. Those components which do occasionally fail without warning are often small and easily carried in the vehicle.

With any fault-finding, the first step is to decide where to begin investigations. Sometimes this is obvious, but on other occasions, a little detective work will be necessary. The owner who makes half a dozen haphazard adjustments or replacements may be successful in curing a fault (or its symptoms), but will be none the wiser if the fault recurs, and ultimately may have spent more time and money than was necessary. A calm and logical approach will be found to be more satisfactory in the long run. Always take into account any warning signs or abnormalities that may have been noticed in the period preceding the fault - power loss, high or low gauge readings, unusual smells, etc - and remember that failure of components such as fuses or spark plugs may only be pointers to some underlying fault.

The pages which follow provide an easy reference guide to the more common problems which may occur during the operation of the vehicle. These problems and their possible causes are grouped under

headings denoting various components or systems, such as Engine, Cooling system, etc. The Chapter and/or Section which deals with the problem is also shown in brackets. Whatever the fault, certain basic principles apply. These are as follows:

Verify the fault. This is simply a matter of being sure that you know what the symptoms are before starting work. This is particularly important if you are investigating a fault for someone else, who may not have described it very accurately.

Don't overlook the obvious. For example, if the vehicle won't start, is there petrol in the tank? (Don't take anyone else's word on this particular point, and don't trust the fuel gauge either!) If an electrical fault is indicated, look for loose or broken wires before digging out the test gear.

Cure the disease, not the symptom. Substituting a flat battery with a fully-charged one will get you off the hard shoulder, but if the underlying cause is not attended to, the new battery will go the same way. Similarly, changing oil-fouled spark plugs for a new set will get you moving again, but remember that the reason for the fouling (if it wasn't simply an incorrect grade of plug) will have to be established and corrected.

Don't take anything for granted. Particularly, don't forget that a "new" component may itself be defective (especially if it's been rattling around in the boot for months), and don't leave components out of a fault diagnosis sequence just because they are new or recently fitted. When you do finally diagnose a difficult fault, you'll probably realise that all the evidence was there from the start.

1 Engine

Engine fails to rotate when attempting to start

- Battery terminal connections loose or corroded (Chapter 5).
- Battery discharged or faulty (Chapter 5).
- Broken, loose or disconnected wiring in the starting circuit (Chapter 5).
- Defective starter solenoid or switch (Chapter 5).
- Defective starter motor (Chapter 5).
- Starter pinion or flywheel ring gear teeth loose or broken (Chapter 5).
- Engine earth strap broken or disconnected (Chapter 5).
- Automatic transmission not in Park/Neutral position, or selector lever position sensor faulty (Chapter 7, Part B).

Engine rotates but will not start

- Fuel tank empty.
- Battery discharged (engine rotates slowly) (Chapter 5).
- Battery terminal connections loose or corroded (Chapter 5).
- Ignition components damp or damaged (Chapters 1 and 5).
- Broken, loose or disconnected wiring in the ignition circuit (Chapters 1 and 5).
- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Major mechanical failure (eg camshaft drive) (Chapter 2, Part A).

Engine difficult to start when cold

- Battery discharged (Chapter 5).
- Battery terminal connections loose or corroded (Chapter 5).
- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Other ignition system fault (Chapters 1 and 5).
- Engine management system fault (Chapters 1, 4, 5 and 6)
- Low cylinder compressions (Chapter 2, Part A).

Engine difficult to start when hot

- Air filter element dirty or clogged (Chapter 1).
- Engine management system fault (Chapters 1, 4, 5 and 6)
- Low cylinder compressions (Chapter 2, Part A).
- Faulty hydraulic tappet(s) (Chapter 2, Part A).

Starter motor noisy or excessively-rough in engagement

- Starter pinion or flywheel ring gear teeth loose or broken (Chapter 5).
- Starter motor mounting bolts loose or missing (Chapter 5).
- Starter motor internal components worn or damaged (Chapter 5).

Engine starts but stops immediately

- Loose or faulty electrical connections in the ignition circuit (Chapters 1 and 5).
- Engine management system fault (Chapters 1, 4, 5 and 6)
- Vacuum leak at the inlet manifold (Chapters 1, 4 and 6).

Engine idles erratically

- Idle speed control valve faulty (Chapter 4).
- Engine management system fault (Chapters 1, 4, 5 and 6)
- Air filter element clogged (Chapter 1).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).
- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Faulty hydraulic tappet(s) (Chapter 2, Part A).
- Uneven or low cylinder compressions (Chapter 2, Part A).
- Camshaft lobes worn (Chapter 2).
- Timing belt incorrectly-tensioned (Chapter 2, Part A).

Engine misfires at idle speed

- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Faulty spark plug HT leads (Chapter 1).
- Idle speed control valve faulty (Chapter 4).
- Incorrect ignition timing (Chapters 5 and 6).
- Engine management system fault (Chapters 1, 4, 5 and 6)
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).
- Faulty hydraulic tappet(s) (Chapter 2, Part A).
- Uneven or low cylinder compressions (Chapter 2, Part A).
- Disconnected, leaking or perished crankcase ventilation hoses (Chapters 1 and 6).

Engine misfires throughout the driving speed range

- Fuel filter choked (Chapter 1).
- Fuel pump faulty or delivery pressure low (Chapter 4).
- Fuel tank vent blocked or fuel pipes restricted (Chapter 4).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).
- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Faulty spark plug HT leads (Chapter 1).
- Faulty ignition coil (Chapter 5).
- Engine management system fault (Chapters 1, 4, 5 and 6)
- Uneven or low cylinder compressions (Chapter 2, Part A).

Engine hesitates on acceleration

- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Engine management system fault (Chapters 1, 4, 5 and 6).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).

Engine stalls

- Idle speed control valve faulty (Chapter 4).
- Engine management system fault (Chapters 1, 4, 5 and 6).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).
- Fuel filter choked (Chapter 1).
- Fuel pump faulty or delivery pressure low (Chapter 4).
- Fuel tank vent blocked or fuel pipes restricted (Chapter 4).

Engine lacks power

- Incorrect ignition timing (Chapters 5 and 6).
- Engine management system fault (Chapters 1, 4, 5 and 6).
- Timing belt incorrectly fitted or incorrectly tensioned (Chapter 2, Part A).
- Fuel filter choked (Chapter 1).
- Fuel pump faulty or delivery pressure low (Chapter 4).
- Uneven or low cylinder compressions (Chapter 2, Part A).
- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).
- Brakes binding (Chapters 1 and 9).
- Clutch slipping (Chapter 8).
- Automatic transmission fluid level incorrect (Chapter 1).

Engine runs-on after switching off

- Idle speed excessively high (Chapters 4 and 6).
- Engine management system fault (Chapters 1, 4, 5 and 6).
- Excessive carbon build-up in engine (Chapter 2, Part A).
- High engine operating temperature (Chapter 3).

Engine backfires

- Ignition timing incorrect (Chapters 5 and 6).
- Engine management system fault (Chapters 1, 4, 5 and 6).
- Timing belt incorrectly fitted or incorrectly tensioned (Chapter 2, Part A).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).

Oil pressure warning light illuminated with engine running

- Low oil level or incorrect oil grade (Chapter 1).
- Faulty oil pressure warning light switch (Chapter 2, Part A).
- Worn engine bearings and/or oil pump (Chapter 2).
- High engine operating temperature (Chapter 3).
- Oil pressure relief valve defective (Chapter 2, Part A).
- Oil pick-up strainer clogged (Chapter 2, Part A).

Engine noises

Pre-ignition (pinking) or knocking during acceleration or under load

- Ignition timing incorrect (Chapters 5 and 6).
- Incorrect grade of fuel (Chapter 4).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1, 4 and 6).
- Excessive carbon build-up in engine (Chapter 2, Part A).

Whistling or wheezing noises

- Leaking inlet manifold gasket (Chapter 2, Part A).
- Leaking exhaust manifold gasket or downpipe-to-manifold joint (Chapters 1, 2 Part A, and 4).
- Leaking vacuum hose (Chapters 1, 4, 6 and 9).
- Blowing cylinder head gasket (Chapter 2, Part A).

Tapping or rattling noises

- Faulty hydraulic tappet(s) (Chapter 2, Part A).
- Worn valve gear or camshaft (Chapter 2, Part A).
- Worn timing belt or tensioner (Chapter 2, Part A).
- Ancillary component fault (water pump, alternator, etc) (Chapters 3 and 5).

Knocking or thumping noises

- Worn big-end bearings (regular heavy knocking, perhaps less under load) (Chapter 2, Part B).
- Worn main bearings (rumbling and knocking, perhaps worsening under load) (Chapter 2, Part B).
- Piston slap (most noticeable when cold) (Chapter 2, Part B).
- Ancillary component fault (water pump, alternator, etc) (Chapters 3 and 5).

2 Cooling system

Overheating

- Insufficient coolant in system (Chapter 1).
- Thermostat faulty (Chapter 3).
- Radiator core blocked or grille restricted (Chapter 3).
- Radiator electric cooling fan(s) or coolant temperature sensor faulty (Chapter 3).
- Engine management system fault (Chapters 1, 4, 5 and 6).
- Pressure cap faulty (Chapter 3).
- Auxiliary drivebelt worn or slipping (Chapter 1).
- Ignition timing incorrect (Chapters 5 and 6).
- Inaccurate coolant temperature gauge sender (Chapter 3).
- Air-lock in cooling system (Chapter 1).

Overcooling

- Thermostat faulty (Chapter 3).
- Inaccurate coolant temperature gauge sender (Chapter 3).

External coolant leakage

- Deteriorated or damaged hoses or hose clips (Chapter 1).
- Radiator core or heater matrix leaking (Chapter 3).
- Pressure cap faulty (Chapter 3).
- Water pump seal leaking (Chapter 3).
- Boiling due to overheating (Chapter 3).
- Core plug leaking (Chapter 2, Part B).

Internal coolant leakage

- Leaking cylinder head gasket (Chapter 2, Part A).
- Cracked cylinder head or cylinder bore (Chapter 2, Part B).

Corrosion

- Infrequent draining and flushing (Chapter 1).
- Incorrect antifreeze mixture, or inappropriate antifreeze type (Chapter 1).

3 Fuel and exhaust system

Excessive fuel consumption

- Unsympathetic driving style, or adverse conditions.
- Air filter element dirty or clogged (Chapter 1).
- Engine management system fault (Chapters 1, 4, 5 and 6).
- Ignition timing incorrect (Chapters 5 and 6).
- Tyres under-inflated (Chapter 1).

Fuel leakage and/or fuel odour

- Damaged or corroded fuel tank, pipes or connections (Chapter 1).
- Charcoal canister and/or connecting pipes leaking (Chapter 6).

Excessive noise or fumes from exhaust system

- Leaking exhaust system or manifold joints (Chapters 1, 2 Part A, and 4).
- Leaking, corroded or damaged silencers or pipe (Chapter 1).
- Broken mountings, causing body or suspension contact (Chapters 1 and 4).

4 Clutch

Pedal travels to floor - no pressure or very little resistance

- Broken clutch cable (Chapter 8).
- Incorrect clutch adjustment (Chapter 8).
- Broken clutch release bearing or fork (Chapter 8).
- Broken diaphragm spring in clutch pressure plate (Chapter 8).

Clutch fails to disengage (unable to select gears)

- Incorrect clutch adjustment (Chapter 8).
- Clutch disc sticking on transmission input shaft splines (Chapter 8).
- Clutch disc sticking to flywheel or pressure plate (Chapter 8).
- Faulty pressure plate assembly (Chapter 8).
- Clutch release mechanism worn or incorrectly assembled (Chapter 8).

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

- Incorrect clutch adjustment (Chapter 8).
- Clutch disc linings excessively worn (Chapter 8).

- Clutch disc linings contaminated with oil or grease (Chapter 8).
- Faulty pressure plate or weak diaphragm spring (Chapter 8).

Judder as clutch is engaged

- Clutch disc linings contaminated with oil or grease (Chapter 8).
- Clutch disc linings excessively worn (Chapter 8).
- Clutch cable sticking or frayed (Chapter 8).
- Faulty or distorted pressure plate or diaphragm spring (Chapter 8).
- Worn or loose engine/transmission mountings (Chapter 2, Part A).
- Clutch disc hub or transmission input shaft splines worn (Chapter 8).

Noise when depressing or releasing clutch pedal

- Worn clutch release bearing (Chapter 8).
- Worn or dry clutch pedal bushes (Chapter 8).
- Faulty pressure plate assembly (Chapter 8).
- Pressure plate diaphragm spring broken (Chapter 8).
- Broken clutch disc cushioning springs (Chapter 8).

5 Manual transmission

Noisy in neutral with engine running

- Input shaft bearings worn (noise apparent with clutch pedal released, but not when depressed) (Chapter 7, Part A).*
- Clutch release bearing worn (noise apparent with clutch pedal depressed, possibly less when released) (Chapter 8).

Noisy in one particular gear

- Worn, damaged or chipped gear teeth (Chapter 7, Part A).*

Difficulty engaging gears

- Clutch fault (Chapter 8).
- Worn or damaged gear linkage (Chapter 7, Part A).
- Incorrectly-adjusted gear linkage (Chapter 7, Part A).
- Worn synchroniser assemblies (Chapter 7, Part A).*

Vibration

- Lack of oil (Chapter 1).
- Worn bearings (Chapter 7, Part A).*

Jumps out of gear

- Worn or damaged gear linkage (Chapter 7, Part A).
- Incorrectly-adjusted gear linkage (Chapter 7, Part A).
- Worn synchroniser assemblies (Chapter 7, Part A).*
- Worn selector forks (Chapter 7, Part A).*

Lubricant leaks

- Leaking differential side gear oil seal (Chapter 7, Part A).
- Leaking housing joint (Chapter 7, Part A).*
- Leaking input shaft oil seal (Chapter 7, Part A).*
- Leaking selector shaft oil seal (Chapter 7, Part A).
- Leaking speedometer drive pinion O-ring (Chapter 7, Part A).

* Although the corrective action necessary to remedy the symptoms described is beyond the scope of the home mechanic, the above information should be helpful in isolating the cause of the condition, so that the owner can communicate clearly with a professional mechanic.

6 Automatic transmission

Note: Due to the complexity of the automatic transmission and its electronic control system, 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 service department or automatic transmission specialist.

Fluid leakage

- Automatic transmission fluid is usually deep red in colour. Fluid leaks should not be confused with engine oil, which can easily be blown onto the transmission by airflow.
- To determine the source of a leak, first remove all built-up dirt and grime from the transmission housing and surrounding areas, using a degreasing agent, or by steam-cleaning. Drive the vehicle at low speed, so airflow will not blow the leak far from its source. Raise and support the vehicle, and determine where the leak is coming from. The following are common areas of leakage:
 - (a) Housing joints (Chapters 1 and 7, Part B).
 - (b) Dipstick tube (Chapters 1 and 7, Part B).
 - (c) Transmission-to-fluid cooler pipes/unions (Chapters 3 and 7, Part B).
 - (d) Speedometer drive pinion O-ring (Chapter 7, Part B).
 - (e) Differential side gear oil seals (Chapter 7, Part B).

Transmission fluid brown, or has burned smell

- Transmission fluid level low, or fluid in need of renewal (Chapter 1).

Transmission will not downshift (kickdown) with accelerator pedal fully depressed

- Low transmission fluid level (Chapter 1).
- Incorrect selector cable adjustment (Chapter 7, Part B).
- Engine management system fault (Chapters 1, 4, 5 and 6).

General gear selection problems

- Chapter 7, Part B, deals with checking and adjusting the selector cable on automatic transmissions. The following are common problems which may be caused by a poorly-adjusted cable:
 - (a) Engine starting in gears other than Park or Neutral.
 - (b) Indicator on gear selector lever pointing to a gear other than the one actually being used.
 - (c) Vehicle moves when in Park or Neutral.
 - (d) Poor gear shift quality or erratic gear changes.Refer to Chapter 7, Part B for the selector cable adjustment procedure.

Engine will not start in any gear, or starts in gears other than Park or Neutral

- Incorrect selector lever position sensor adjustment (Chapter 7, Part B).
- Incorrect selector cable adjustment (Chapter 7, Part B).

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 a dealer or transmission specialist, check the fluid 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, professional help will be necessary.

7 Driveshafts

Clicking or knocking noise on turns (at slow speed on full-lock)

- Lack of constant velocity joint lubricant (Chapter 8).
- Worn outer constant velocity joint (Chapter 8).

Vibration when accelerating or decelerating

- Worn inner constant velocity joint (Chapter 8).
- Bent or distorted driveshaft (Chapter 8).

8 Braking system

Note: Before assuming that a brake problem exists, make sure that the tyres are in good condition and correctly inflated, that the front wheel alignment is correct, and that the vehicle is not loaded with weight in an unequal manner. Apart from checking the condition of all pipe and hose connections, any faults occurring on the Anti-lock Braking System (ABS) should be referred to a Ford dealer for diagnosis - the same applies to the components of the Traction Control System (TCS).

Vehicle pulls to one side under braking

- Worn, defective, damaged or contaminated front or rear brake pads/shoes on one side (Chapter 1).
- Seized or partially-seized front or rear brake caliper/wheel cylinder piston (Chapter 9).
- A mixture of brake pad/shoe lining materials fitted between sides (Chapter 1).
- Brake caliper mounting bolts loose (Chapter 9).
- Rear brake backplate mounting bolts loose (Chapter 9).
- Worn or damaged steering or suspension components (Chapter 10).

Noise (grinding or high-pitched squeal) when brakes applied

- Brake pad or shoe friction lining material worn down to metal backing (Chapter 1).
- Excessive corrosion of brake disc or drum (may be apparent after the vehicle has been standing for some time) (Chapter 1).
- Foreign object (stone chipping, etc) trapped between brake disc and splash shield (Chapter 1).

Excessive brake pedal travel

- Inoperative rear brake self-adjust mechanism (Chapter 9).
- Faulty master cylinder (Chapter 9).
- Air in hydraulic system (Chapter 9).

Brake pedal feels spongy when depressed

- Air in hydraulic system (Chapter 9).
- Deteriorated flexible rubber brake hoses (Chapter 9).
- Master cylinder mounting nuts loose (Chapter 9).
- Faulty master cylinder (Chapter 9).

Excessive brake pedal effort required to stop vehicle

- Faulty vacuum servo unit (Chapter 9).
- Disconnected, damaged or insecure brake servo vacuum hose (Chapter 9).
- Primary or secondary hydraulic circuit failure (Chapter 9).
- Seized brake caliper or wheel cylinder piston(s) (Chapter 9).
- Brake pads or brake shoes incorrectly fitted (Chapter 9).
- Incorrect grade of brake pads or brake shoes fitted (Chapter 1).
- Brake pads or brake shoe linings contaminated (Chapter 1).

Judder felt through brake pedal or steering wheel when braking

- Excessive run-out or distortion of front discs or rear drums (Chapter 9).
- Brake pad or brake shoe linings worn (Chapter 1).
- Brake caliper or rear brake backplate mounting bolts loose (Chapter 9).
- Wear in suspension or steering components or mountings (Chapter 10).

Brakes binding

- Seized brake caliper or wheel cylinder piston(s) (Chapter 9).
- Faulty handbrake mechanism (Chapter 9).
- Faulty master cylinder (Chapter 9).

Rear wheels locking under normal braking

- Rear brake shoe linings contaminated (Chapter 1).
- Faulty brake pressure regulator (Chapter 9).

9 Suspension and steering systems

Note: Before diagnosing suspension or steering faults, be sure that the trouble is not due to incorrect tyre pressures, mixtures of tyre types, or binding brakes. Apart from checking the condition of all electrical connections, any faults occurring on the Adaptive Damping System should be referred to a Ford dealer for diagnosis.

Vehicle pulls to one side

- Defective tyre (Chapter 1).
- Excessive wear in suspension or steering components (Chapter 10).
- Incorrect front wheel alignment (Chapter 10).
- Accident damage to steering or suspension components (Chapter 10).

Wheel wobble and vibration

- Front roadwheels out of balance (vibration felt mainly through the steering wheel) (Chapter 1).
- Rear roadwheels out of balance (vibration felt throughout the vehicle) (Chapter 1).
- Roadwheels damaged or distorted (Chapter 1).
- Faulty or damaged tyre (Chapter 1).
- Worn steering or suspension joints, bushes or components (Chapter 10).
- Roadwheel nuts loose (Chapter 1).

Excessive pitching and/or rolling around corners, or during braking

- Defective shock absorbers (Chapter 10).
- Broken or weak coil spring and/or suspension component (Chapter 10).
- Worn or damaged anti-roll bar or mountings (Chapter 10).

Wandering or general instability

- Incorrect front wheel alignment (Chapter 10).
- Worn steering or suspension joints, bushes or components (Chapter 10).
- Roadwheels out of balance (Chapter 1).
- Faulty or damaged tyre (Chapter 1).
- Roadwheel nuts loose (Chapter 1).
- Defective shock absorbers (Chapter 10).

Excessively-stiff steering

- Lack of steering gear lubricant (Chapter 10).
- Seized track-rod end balljoint or suspension balljoint (Chapter 10).
- Broken or slipping auxiliary drivebelt (Chapter 1).
- Incorrect front wheel alignment (Chapter 10).
- Steering rack or column bent or damaged (Chapter 10).

Excessive play in steering

- Worn steering column universal joint(s) or flexible coupling (Chapter 10).
- Worn steering track-rod end balljoints (Chapter 10).
- Worn rack-and-pinion steering gear (Chapter 10).
- Worn steering or suspension joints, bushes or components (Chapter 10).

Lack of power assistance

- Broken or slipping auxiliary drivebelt (Chapter 1).
- Incorrect power steering fluid level (Chapter 1).
- Restriction in power steering fluid hoses (Chapter 10).
- Faulty power steering pump (Chapter 10).
- Faulty rack-and-pinion steering gear (Chapter 10).

Tyre wear excessive

Tyres worn on inside or outside edges

- Tyres under-inflated (wear on both edges) (Chapter 1).
- Incorrect camber or castor angles (wear on one edge only) (Chapter 10).
- Worn steering or suspension joints, bushes or components (Chapter 10).
- Excessively-hard cornering.
- Accident damage.

Tyre treads exhibit feathered edges

- Incorrect toe setting (Chapter 10).

Tyres worn in centre of tread

- Tyres over-inflated (Chapter 1).

Tyres worn on inside and outside edges

- Tyres under-inflated (Chapter 1).

Tyres worn unevenly

- Tyres out of balance (Chapter 1).
- Excessive wheel or tyre run-out (Chapter 1).
- Worn shock absorbers (Chapter 10).
- Faulty tyre (Chapter 1).

10 Electrical system

Note: For problems associated with the starting system, refer to the faults listed under "Engine" earlier in this Section.

Battery will not hold a charge more than a few days

- Battery defective internally (Chapter 5).
- Battery electrolyte level low (Chapter 1).
- Battery terminal connections loose or corroded (Chapter 5).
- Auxiliary drivebelt worn or incorrectly-adjusted (Chapter 1).
- Alternator not charging at correct output (Chapter 5).
- Alternator or voltage regulator faulty (Chapter 5).
- Short-circuit causing continual battery drain (Chapters 5 and 12).

Ignition (no-charge) warning light remains illuminated with engine running

- Auxiliary drivebelt broken, worn, or incorrectly-adjusted (Chapter 1).
- Alternator brushes worn, sticking, or dirty (Chapter 5).
- Alternator brush springs weak or broken (Chapter 5).
- Internal fault in alternator or voltage regulator (Chapter 5).
- Broken, disconnected, or loose wiring in charging circuit (Chapter 5).

Ignition (no-charge) warning light fails to come on

- Warning light bulb blown (Chapter 12).
- Broken, disconnected, or loose wiring in warning light circuit (Chapters 5 and 12).
- Alternator faulty (Chapter 5).

Lights inoperative

- Bulb blown (Chapter 12).
- Corrosion of bulb or bulbholder contacts (Chapter 12).
- Blown fuse (Chapter 12).
- Faulty relay (Chapter 12).
- Broken, loose, or disconnected wiring (Chapter 12).
- Faulty switch (Chapter 12).

Instrument readings inaccurate or erratic

Instrument readings increase with engine speed

- Faulty voltage regulator (Chapter 12).

Fuel or temperature gauges give no reading

- Faulty gauge sender unit (Chapters 3 or 4).
- Wiring open-circuit (Chapter 12).
- Faulty gauge (Chapter 12).

Fuel or temperature gauges give continuous maximum reading

- Faulty gauge sender unit (Chapters 3 or 4).
- Wiring short-circuit (Chapter 12).
- Faulty gauge (Chapter 12).

Horn inoperative, or unsatisfactory in operation

Horn fails to operate

- Blown fuse (Chapter 12).
- Cable or cable connections loose, broken or disconnected (Chapter 12).
- Faulty horn (Chapter 12).

Horn emits intermittent or unsatisfactory sound

- Cable connections loose (Chapter 12).
- Horn mountings loose (Chapter 12).
- Faulty horn (Chapter 12).

Horn operates all the time

- Horn push either earthed or stuck down (Chapter 12).
- Horn cable to horn push earthed (Chapter 12).

Windscreen/tailgate wipers inoperative or unsatisfactory in operation

Wipers fail to operate, or operate very slowly

- Wiper blades stuck to screen, or linkage seized or binding (Chapter 12).
- Blown fuse (Chapter 12).
- Cable or cable connections loose, broken or disconnected (Chapter 12).
- Faulty relay (Chapter 12).
- Faulty wiper motor (Chapter 12).

Wiper blades sweep over too large or too small an area of the glass

- Wiper arms incorrectly-positioned on spindles (Chapter 1).
- Excessive wear of wiper linkage (Chapter 1).
- Wiper motor or linkage mountings loose or insecure (Chapter 12).

Wiper blades fail to clean the glass effectively

- Wiper blade rubbers worn or perished (Chapter 1).
- Wiper arm tension springs broken, or arm pivots seized (Chapter 1).
- Insufficient windscreen washer additive to adequately remove road film (Chapter 1).

Windscreen/tailgate washers inoperative, or unsatisfactory in operation

One or more washer jets inoperative

- Blocked washer jet (Chapter 1).
- Disconnected, kinked or restricted fluid hose (Chapter 1).
- Insufficient fluid in washer reservoir (Chapter 1).

Washer pump fails to operate

- Broken or disconnected wiring or connections (Chapter 12).
- Blown fuse (Chapter 12).
- Faulty washer switch (Chapter 12).
- Faulty washer pump (Chapter 12).

Washer pump runs for some time before fluid is emitted from jets

- Faulty one-way valve in fluid supply hose (Chapter 12).

Electric windows inoperative, or unsatisfactory in operation

Window glass will only move in one direction

- Faulty switch (Chapter 12).

Window glass slow to move

- Incorrectly-adjusted door glass guide channels (Chapter 11).
- Regulator seized or damaged, or in need of lubrication (Chapter 11).
- Door internal components or trim fouling regulator (Chapter 11).
- Faulty motor (Chapter 12).

Window glass fails to move

- Incorrectly-adjusted door glass guide channels (Chapter 11).
- Blown fuse (Chapter 12).
- Faulty relay (Chapter 12).
- Broken or disconnected wiring or connections (Chapter 12).
- Faulty motor (Chapter 12).

Central locking system inoperative, or unsatisfactory in operation

Complete system failure

- Blown fuse (Chapter 12).
- Faulty relay (Chapter 12).
- Broken or disconnected wiring or connections (Chapter 12).

Latch locks but will not unlock, or unlocks but will not lock

- Faulty master switch (Chapter 11).
- Broken or disconnected latch operating rods or levers (Chapter 11).
- Faulty relay (Chapter 12).

One lock motor fails to operate

- Broken or disconnected wiring or connections (Chapter 12).
- Faulty lock motor (Chapter 11).
- Broken, binding or disconnected latch operating rods or levers (Chapter 11).
- Fault in door latch (Chapter 11).

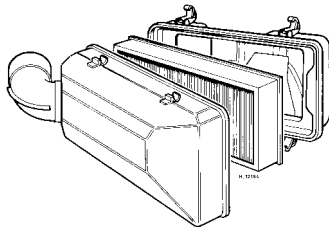
A

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 windshield.

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.

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.

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.

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 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.

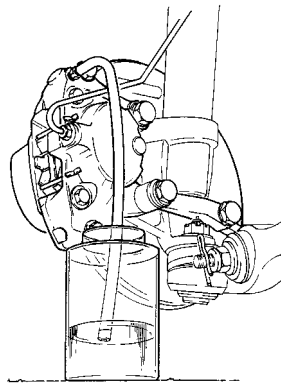


Bearing

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 Procedure for removing air from lines of a hydraulic brake system.



Brake bleeding

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.



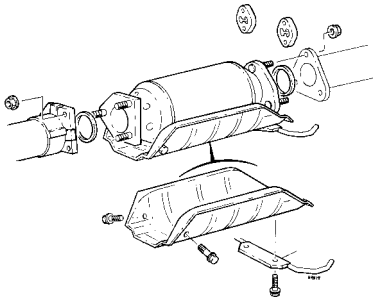
Canister

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.

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

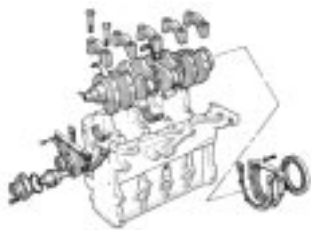
Compression ratio The relationship between cylinder volume when the piston is at top dead centre and cylinder volume when the piston is at bottom dead centre.

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

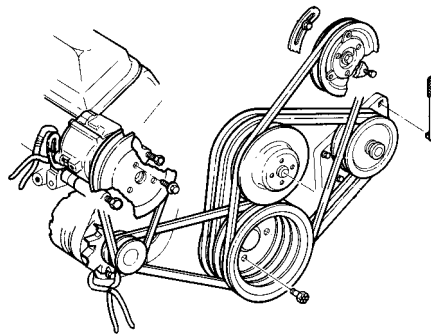
D

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.

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.

E

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

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.

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.

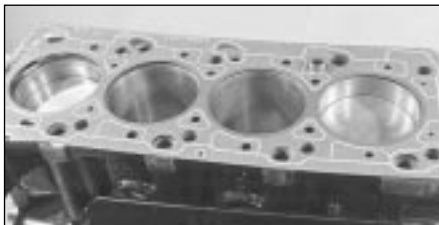
G

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.

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.

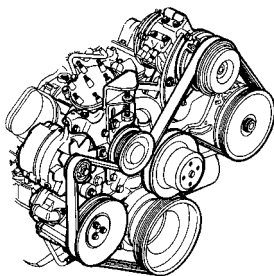
Runout The amount of wobble (in-and-out movement) of a gear or wheel as it's rotated. The amount a shaft rotates "out-of-true." The out-of-round condition of a rotating part.

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*.

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Washer pump fault - REF•12
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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

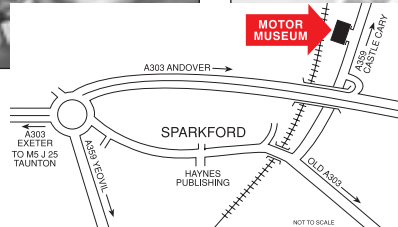
Each and every vehicle at the Haynes Motor Museum has played its part in the history and culture of Motoring. Today, they make a wonderful spectacle and a great day out for all the family. Bring the kids, bring Mum and Dad, but above all bring your camera to capture those golden memories for ever. You 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