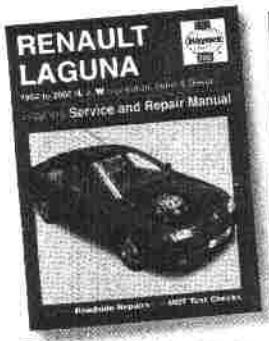
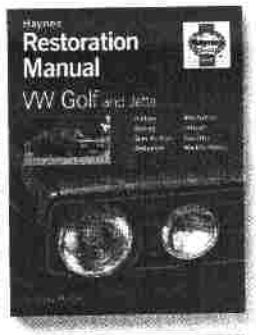
VOLVO 740 & 760

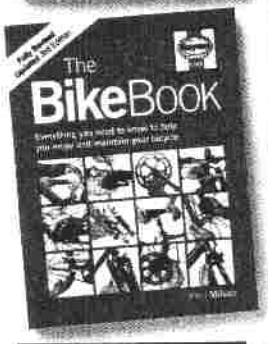
1982 to 1991 (up to **J** registration) Petrol

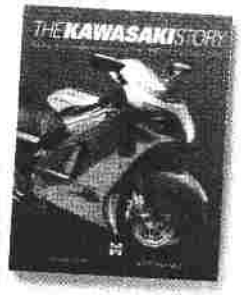
Haynes **Service and Repair Manual**

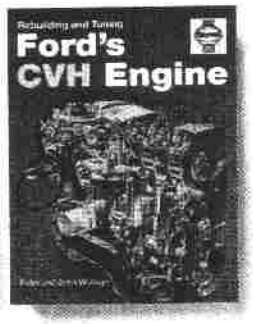
Includes **Roadside Repairs** and **MOT Test Checks**

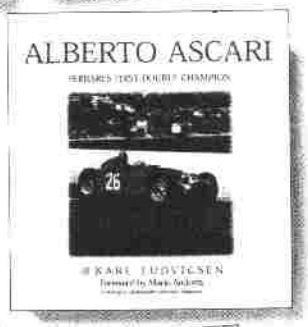


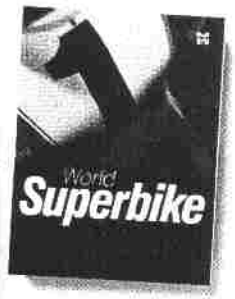












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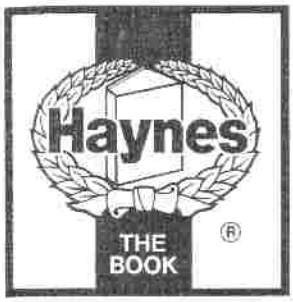

Volvo 740 & 760

Service and Repair Manual

Matthew Minter and John Mead

Models covered *(1258 - 288 - 5AB6)*

Volvo 740 & 760 models with petrol engines, including 2.3 litre 16 valve DOHC engine, Turbo & special/limited editions
1986 cc, 2316 cc & 2849 cc

Does not cover Diesel engine models

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ABCD

Printed in the USA

A book in the **Haynes Service and Repair Manual Series**

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REPAIRS & OVERHAUL

REFERENCE

The Volvo 760 Saloon was introduced to the UK market in July 1982, followed by the 740 Saloon in October 1984. Estate versions became available for the 1986 model year.

Engines available in the 760 range are a 2.8 litre V-6 and a turbocharged 2.3 litre in-line four-cylinder, both with fuel injection. The turbocharged engine is also available in the 740 range, other options being the same engine without the turbo, with either fuel injection or a carburettor. In August 1987, a fuel-injected, 2.0 litre in-line, four-cylinder engine became available in the 740 range, followed a year later by a 2.3 litre DOHC 16-valve version.

Both manual and automatic transmissions are available throughout the range. The manual transmission may be 5-speed, or 4-speed plus overdrive. The automatic transmission fitted to UK models may be 4-speed, or 3-speed plus overdrive. Drive is taken to the rear wheels via a traditional live rear axle or, on later 760 Saloon models, via independent rear suspension. A limited slip differential is available as an optional extra.

Braking is by discs all round, the handbrake acting on separate drums on the rear wheels. Anti-lock braking (ABS) is available on later models, sometimes in conjunction with electronic traction control (ETC). Steering is power-assisted on all models.

Volvo 760 Turbo Saloon

Volvo 740 Turbo Estate

The Volvo 740 & 760 Team

Haynes manuals are produced by dedicated and enthusiastic people working in close co-operation. The team responsible for the creation of this book included:

Authors	Matthew Minter John Mead
Sub-editor	Sophie Yar
Editor & Page Make-up	Steve Churchill
Workshop manager	Paul Buckland
Photo Scans	John Martin Paul Tanswell
Cover illustration & Line Art	Roger Healing

We hope the book will help you to get the maximum enjoyment from your car. By carrying out routine maintenance as described you will ensure your car's reliability and preserve its resale value.

Your Volvo manual

The aim of this manual is to help you get the best from your car. It can do so in several ways. It can help you decide what work must be done (even should you choose to get it done by a garage), provide information on routine maintenance and servicing and give a logical course of action and diagnosis when random faults occur. However, it is hoped that you will use the manual by tackling the work yourself. On simpler jobs it may even be quicker than booking the car into a garage and going there twice to leave and collect it. Perhaps most important, a lot of money can be saved by avoiding the costs the garage must charge to cover its labour and overheads.

The manual has drawings and descriptions to show the function of the various components so that their layout can be understood. Then the tasks are described and photographed in a step-by-step sequence so that even a novice can do the work.

References to the 'left' or 'right' of the vehicle are in the sense of a person in the driver's seat facing forwards.

Acknowledgements

Thanks are due to Champion Spark Plug, who supplied the illustrations showing spark plug conditions. Certain other illustrations are the copyright of AB Volvo, and are used with their permission. Thanks are also due to Sykes-Pickavant Limited, who provided some of the workshop tools. Special thanks are due to all those people at Sparkford who helped in the production of this manual.

We take great pride in the accuracy of information given in this manual, but vehicle manufacturers make alterations and design changes during the production run of a particular vehicle of which they do not inform us. No liability can be accepted by the authors or publishers for loss, damage or injury caused by any errors in, or omissions from, the information given.

Working on your car can be dangerous. This page shows just some of the potential risks and hazards, with the aim of creating a safety-conscious attitude.

General hazards

Scalding

• Don't remove the radiator or expansion tank cap while the engine is hot.
• Engine oil, automatic transmission fluid or power steering fluid may also be dangerously hot if the engine has recently been running.

Burning

• Beware of burns from the exhaust system and from any part of the engine. Brake discs and drums can also be extremely hot immediately after use.

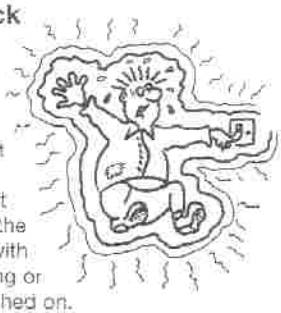
Crushing

• When working under or near a raised vehicle, always supplement the jack with axle stands, or use drive-on ramps. ***Never venture under a car which is only supported by a jack.***
• Take care if loosening or tightening high-torque nuts when the vehicle is on stands. Initial loosening and final tightening should be done with the wheels on the ground.

Fire

• Fuel is highly flammable; fuel vapour is explosive.
• Don't let fuel spill onto a hot engine.
• Do not smoke or allow naked lights (including pilot lights) anywhere near a vehicle being worked on. Also beware of creating sparks (electrically or by use of tools).
• Fuel vapour is heavier than air, so don't work on the fuel system with the vehicle over an inspection pit.
• Another cause of fire is an electrical overload or short-circuit. Take care when repairing or modifying the vehicle wiring.
• Keep a fire extinguisher handy, of a type suitable for use on fuel and electrical fires.

Electric shock



• Ignition HT voltage can be dangerous, especially to people with heart problems or a pacemaker. Don't work on or near the ignition system with the engine running or the ignition switched on.
• Mains voltage is also dangerous. Make sure that any mains-operated equipment is correctly earthed. Mains power points should be protected by a residual current device (RCD) circuit breaker.

Fume or gas intoxication

• Exhaust fumes are poisonous; they often contain carbon monoxide, which is rapidly fatal if inhaled. Never run the engine in a confined space such as a garage with the doors shut.
• Fuel vapour is also poisonous, as are the vapours from some cleaning solvents and paint thinners.

Poisonous or irritant substances

• Avoid skin contact with battery acid and with any fuel, fluid or lubricant, especially antifreeze, brake hydraulic fluid and Diesel fuel. Don't syphon them by mouth. If such a substance is swallowed or gets into the eyes, seek medical advice.
• Prolonged contact with used engine oil can cause skin cancer. Wear gloves or use a barrier cream if necessary. Change out of oil-soaked clothes and do not keep oily rags in your pocket.
• Air conditioning refrigerant forms a poisonous gas if exposed to a naked flame (including a cigarette). It can also cause skin burns on contact.

Asbestos

• Asbestos dust can cause cancer if inhaled or swallowed. Asbestos may be found in gaskets and in brake and clutch linings. When dealing with such components it is safest to assume that they contain asbestos.

Special hazards

Hydrofluoric acid

• This extremely corrosive acid is formed when certain types of synthetic rubber, found in some O-rings, oil seals, fuel hoses etc, are exposed to temperatures above 400°C. The rubber changes into a charred or sticky substance containing the acid. *Once formed, the acid remains dangerous for years. If it gets onto the skin, it may be necessary to amputate the limb concerned.*
• When dealing with a vehicle which has suffered a fire, or with components salvaged from such a vehicle, wear protective gloves and discard them after use.

The battery

• Batteries contain sulphuric acid, which attacks clothing, eyes and skin. Take care when topping-up or carrying the battery.
• The hydrogen gas given off by the battery is highly explosive. Never cause a spark or allow a naked light nearby. Be careful when connecting and disconnecting battery chargers or jump leads.

Air bags

• Air bags can cause injury if they go off accidentally. Take care when removing the steering wheel and/or facia. Special storage instructions may apply.

Diesel injection equipment

• Diesel injection pumps supply fuel at very high pressure. Take care when working on the fuel injectors and fuel pipes.

Warning: Never expose the hands, face or any other part of the body to injector spray; the fuel can penetrate the skin with potentially fatal results.

Remember...

DO

• Do use eye protection when using power tools, and when working under the vehicle.
• Do wear gloves or use barrier cream to protect your hands when necessary.
• Do get someone to check periodically that all is well when working alone on the vehicle.
• Do keep loose clothing and long hair well out of the way of moving mechanical parts.
• Do remove rings, wristwatch etc, before working on the vehicle – especially the electrical system.
• Do ensure that any lifting or jacking equipment has a safe working load rating adequate for the job.

DON'T

• Don't attempt to lift a heavy component which may be beyond your capability – get assistance.
• Don't rush to finish a job, or take unverified short cuts.
• Don't use ill-fitting tools which may slip and cause injury.
• Don't leave tools or parts lying around where someone can trip over them. Mop up oil and fuel spills at once.
• Don't allow children or pets to play in or near a vehicle being worked on.

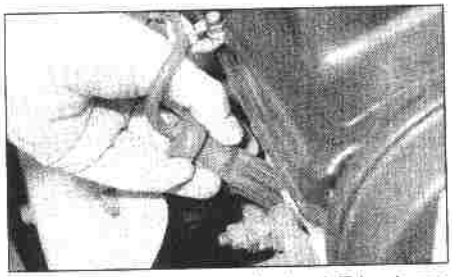
The following pages are intended to help in dealing with common roadside emergencies and breakdowns. You will find more detailed fault finding information at the back of the manual, and repair information in the main chapters.

If your car won't start and the starter motor doesn't turn

- ☐ If it's a model with automatic transmission, make sure the selector is in 'P' or 'N'.
- ☐ Open the bonnet and make sure that the battery terminals are clean and tight.
- ☐ Switch on the headlights and try to start the engine. If the headlights go very dim when you're trying to start, the battery is probably flat. Get out of trouble by jump starting (see next page) using a friend's car.

If your car won't start even though the starter motor turns as normal

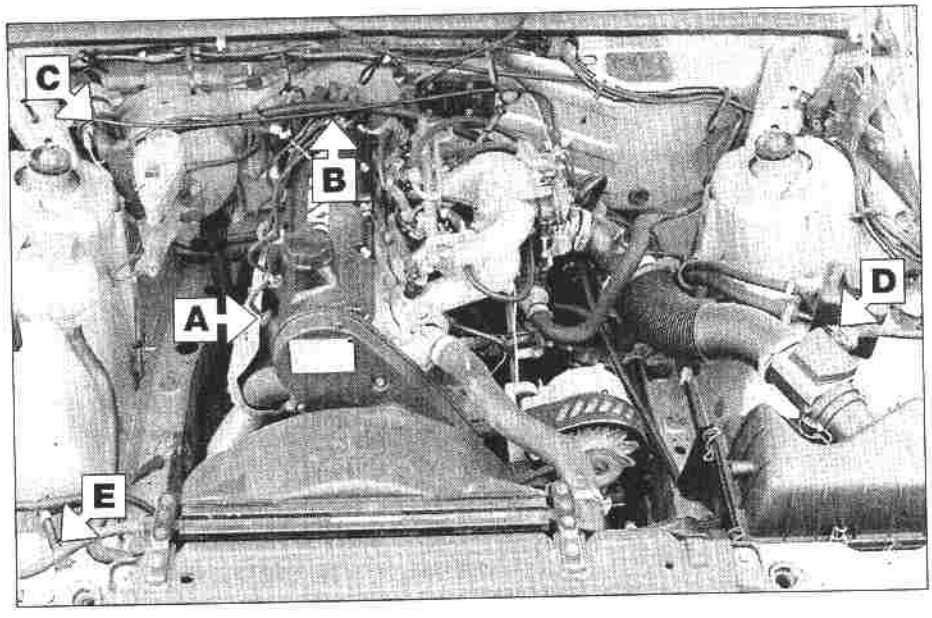
- ☐ Is there fuel in the tank?
- ☐ Is there moisture on electrical components under the bonnet? Switch off the ignition, then wipe off any obvious dampness with a dry cloth. Spray a water-repellent aerosol product (WD-40 or equivalent) on ignition and fuel system electrical connectors like those shown in the photos. Pay special attention to the ignition coil wiring connector and HT leads. (Note that Diesel engines don't normally suffer from damp.)



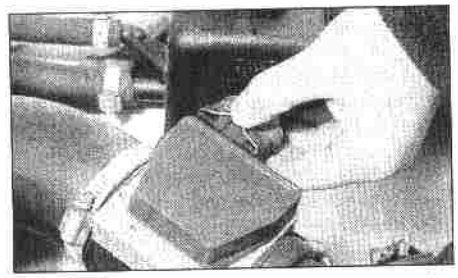
A Check that the spark plug HT leads are securely connected by pushing them onto the plugs.

B Check that the HT leads are securely connected to the distributor (where fitted) and the wiring connector is securely connected.

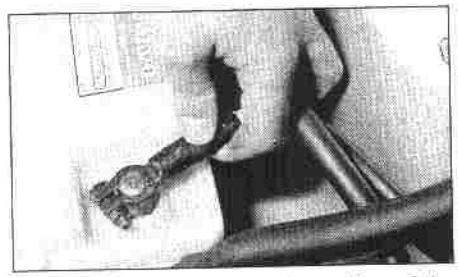
C Check that the HT lead and wiring connector are securely connected to the ignition HT coil.



Check that electrical connections are secure (with the ignition switched off) and spray them with a water dispersant spray like WD40 if you suspect a problem due to damp



D Check the airflow meter wiring connector (where applicable) with the ignition switched off.



E Check the security and condition of the battery terminals.

Jump starting

HAYNES HiNT *Jump starting will get you out of trouble, but you must correct whatever made the battery go flat in the first place. There are three possibilities:*

***1** The battery has been drained by repeated attempts to start, or by leaving the lights on.*

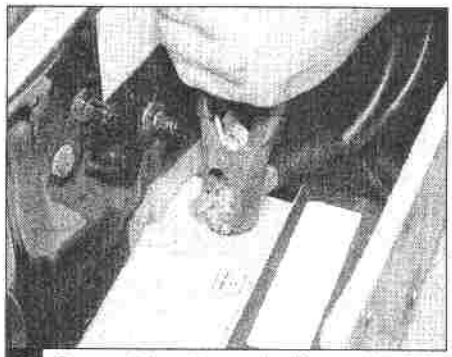
***2** The charging system is not working properly (alternator drivebelt slack or broken, alternator wiring fault or alternator itself faulty).*

***3** The battery itself is at fault (electrolyte low, or battery worn out).*

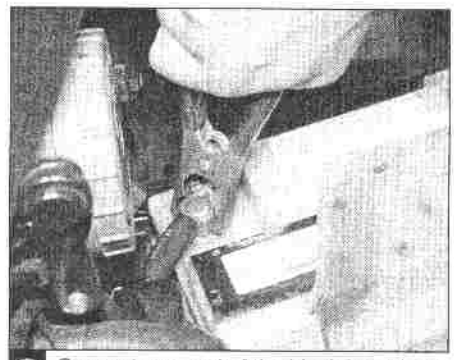
When jump-starting a car using a booster battery, observe the following precautions:

- ✔ Before connecting the booster battery, make sure that the ignition is switched off.
- ✔ Ensure that all electrical equipment (lights, heater, wipers, etc) is switched off.
- ✔ Take note of any special precautions printed on the battery case.
- ✔ Make sure that the booster battery is the same voltage as the discharged one in the vehicle.
- ✔ If the battery is being jump-started from the battery in another vehicle, the two vehicles MUST NOT TOUCH each other.
- ✔ Make sure that the transmission is in neutral (or PARK, in the case of automatic transmission).

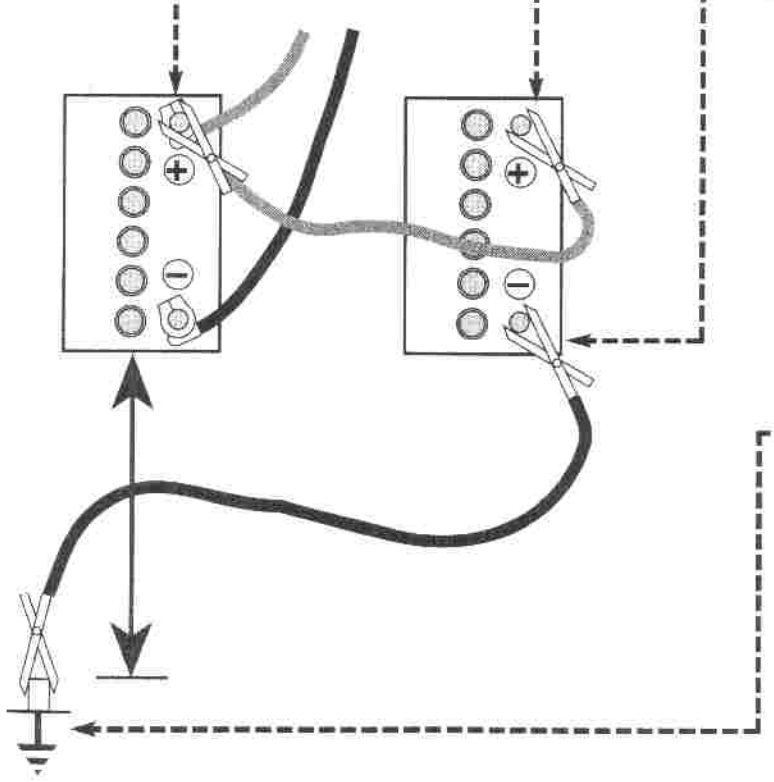
1 Connect one end of the red jump lead to the positive (+) terminal of the flat battery

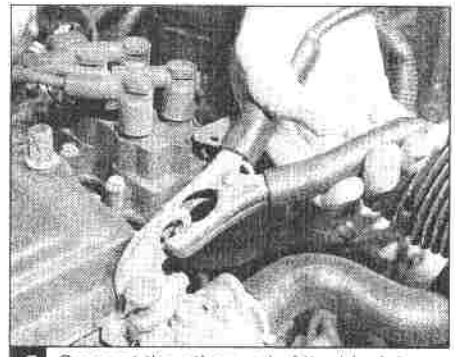


2 Connect the other end of the red lead to the positive (+) terminal of the booster battery.



3 Connect one end of the black jump lead to the negative (-) terminal of the booster battery





4 Connect the other end of the black jump lead to a bolt or bracket on the engine block, well away from the battery, on the vehicle to be started.

5 Make sure that the jump leads will not come into contact with the fan, drivebelts or other moving parts of the engine.

6 Start the engine using the booster battery and run it at idle speed. Switch on the lights, rear window demister and heater blower motor, then disconnect the jump leads in the reverse order of connection. Turn off the lights etc.

Wheel changing

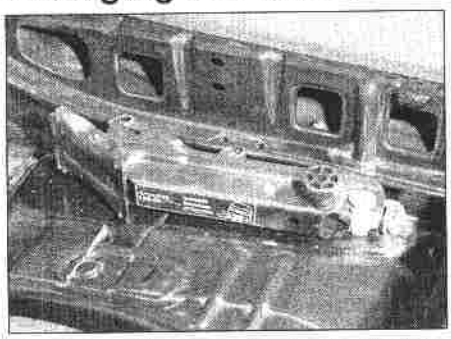
Some of the details shown here will vary according to model. For instance, the location of the spare wheel and jack is not the same on all cars. However, the basic principles apply to all vehicles.

Warning: Do not change a wheel in a situation where you risk being hit by other traffic. On busy roads, try to stop in a lay-by or a gateway. Be wary of passing traffic while changing the wheel – it is easy to become distracted by the job in hand.

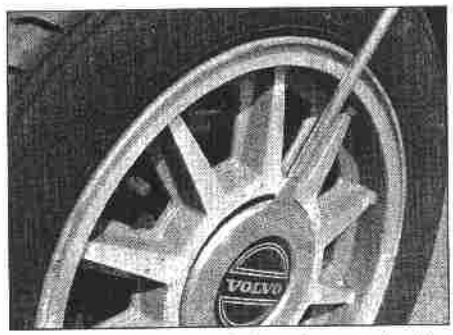
Preparation

- ☐ When a puncture occurs, stop as soon as it is safe to do so.
- ☐ Park on firm level ground, if possible, and well out of the way of other traffic.
- ☐ Use hazard warning lights if necessary.
- ☐ If you have one, use a warning triangle to alert other drivers of your presence.
- ☐ Apply the handbrake and engage first or reverse gear (or Park on models with automatic transmission.
- ☐ Chock the wheel diagonally opposite the one being removed – a couple of large stones will do for this.
- ☐ If the ground is soft, use a flat piece of wood to spread the load under the jack.

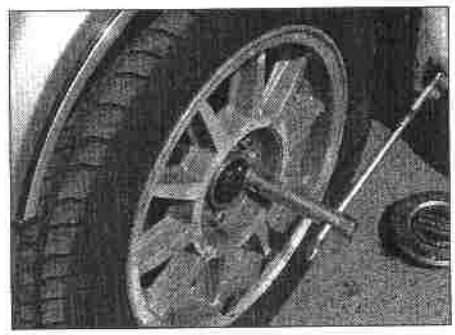
Changing the wheel



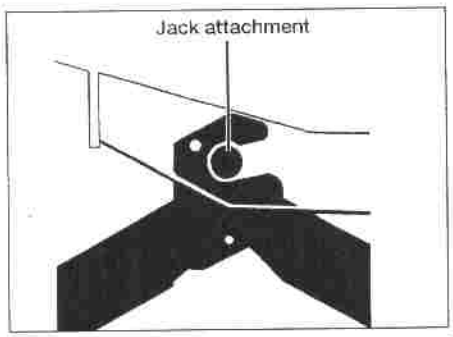
1 Remove the spare wheel and jack which are located in the luggage compartment.



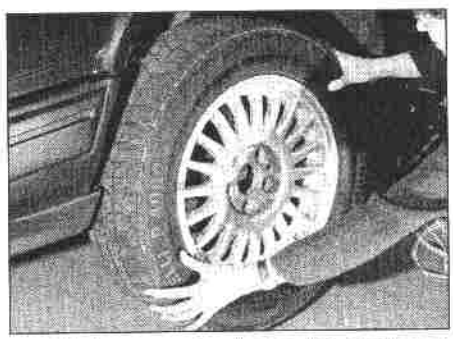
2 Remove the wheel trim, when applicable, for access to the wheel nuts. Prise the trim off if necessary using a screwdriver.



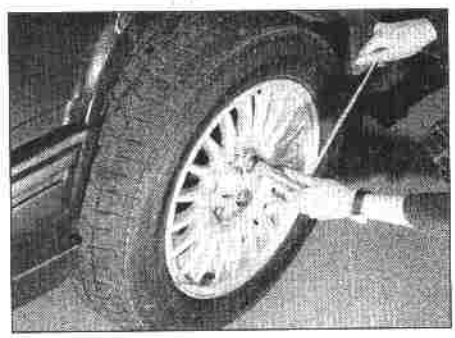
3 Slacken the wheel nuts half a turn each using the wheelbrace. Some wheels are positively located by a spigot on the hub to aid refitting.



4 Engage the jack head on the underside of the sills nearest the wheel being removed. Turn the jack handle clockwise to lower the foot of the jack to the ground. Jack up the vehicle until the wheel is clear of the ground, then remove the wheel nuts and lift the wheel off the studs.



5 Fit the new wheel onto the studs and secure it with the nuts. Tighten the nuts until they are snug, but do not tighten them fully yet. Then lower the vehicle and remove the jack.



6 Carry out the final tightening of the wheel nuts in criss-cross sequence. The use of a torque wrench is strongly recommended, especially when light alloy wheels are fitted. Refit the wheel trim, when applicable.

Finally...

- ☐ Remove the wheel chocks.
- ☐ Stow the jack and tools in the correct locations in the car.
- ☐ Check the tyre pressure on the wheel just fitted. If it is low, or if you don't have a pressure gauge with you, drive slowly to the nearest garage and inflate the tyre to the right pressure.
- ☐ Have the damaged tyre or wheel repaired as soon as possible.

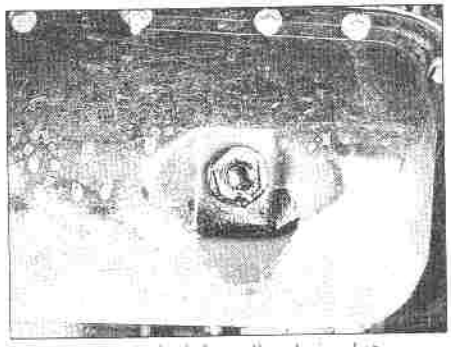
Identifying leaks

Puddles on the garage floor or drive, or obvious wetness under the bonnet or underneath the car, suggest a leak that needs investigating. It can sometimes be difficult to decide where the leak is coming from, especially if the engine bay is very dirty already. Leaking oil or fluid can also be blown rearwards by the passage of air under the car, giving a false impression of where the problem lies.

Warning: Most automotive oils and fluids are poisonous. Wash them off skin, and change out of contaminated clothing, without delay.

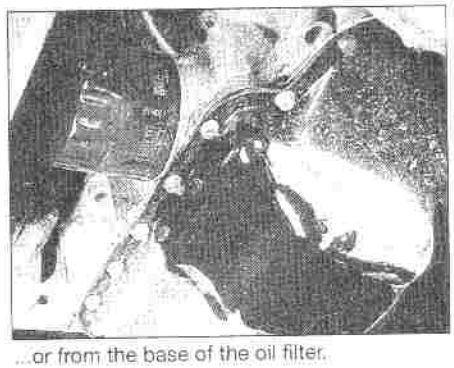
HAYNES HiNT ***The smell of a fluid leaking from the car may provide a clue to what's leaking. Some fluids are distinctively coloured. It may help to clean the car carefully and to park it over some clean paper overnight as an aid to locating the source of the leak.***
Remember that some leaks may only occur while the engine is running.

Sump oil



Engine oil may leak from the drain plug...

Oil from filter



...or from the base of the oil filter.

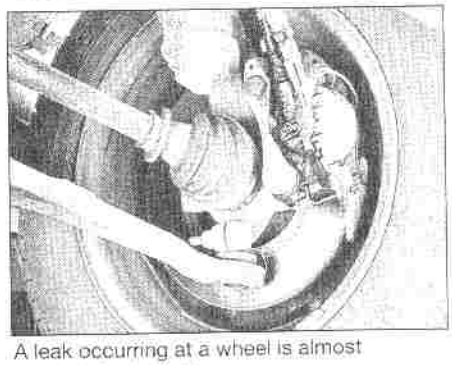
Gearbox oil

Gearbox oil can leak from the seals at the inboard ends of the driveshafts.

Antifreeze

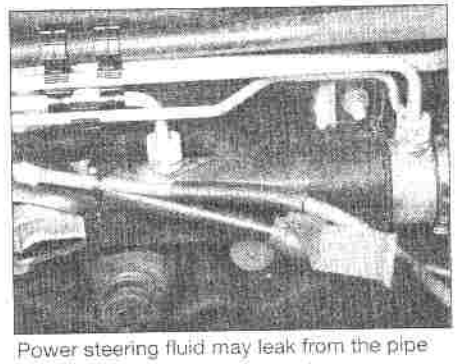
Leaking antifreeze often leaves a crystalline deposit like this.

Brake fluid



A leak occurring at a wheel is almost certainly brake fluid.

Power steering fluid



Power steering fluid may leak from the pipe connectors on the steering rack.

Towing

When all else fails, you may find yourself having to get a tow home – or of course you may be helping somebody else. Long-distance recovery should only be done by a garage or breakdown service. For shorter distances, DIY towing using another car is easy enough, but observe the following points:

☐ Use a proper tow-rope – they are not expensive. The vehicle being towed must display an 'ON TOW' sign in its rear window.

☐ Always turn the ignition key to the 'on' position when the vehicle is being towed, so that the steering lock is released, and that the direction indicator and brake lights will work.

☐ Only attach the tow-rope to the towing eyes provided.

☐ Before being towed, release the handbrake and select neutral on the transmission.

☐ Note that greater-than-usual pedal pressure will be required to operate the brakes, since the vacuum servo unit is only operational with the engine running.

☐ On models with power steering, greater-than-usual steering effort will also be required.

☐ The driver of the car being towed must keep the tow-rope taut at all times to avoid snatching.

☐ Make sure that both drivers know the route before setting off.

☐ Only drive at moderate speeds and keep the distance towed to a minimum. Drive smoothly and allow plenty of time for slowing down at junctions.

☐ On models with automatic transmission, special precautions apply. If in doubt, do not tow, or transmission damage may result.

Introduction

There are some very simple checks which need only take a few minutes to carry out, but which could save you a lot of inconvenience and expense.

These "Weekly checks" require no great skill or special tools, and the small amount of time they take to perform could prove to be very well spent, for example;

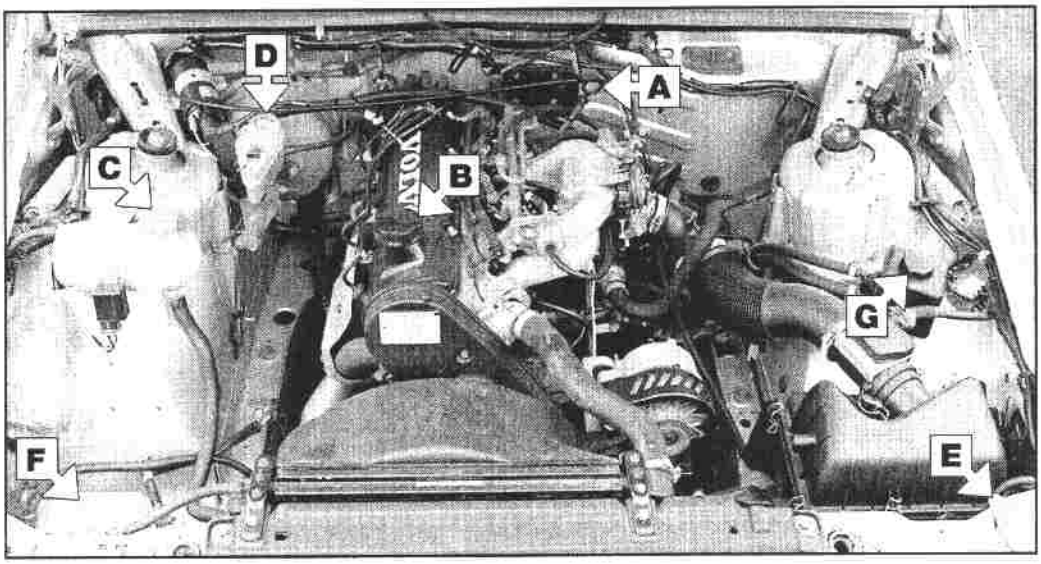
☐ Keeping an eye on tyre condition and pressures, will not only help to stop them wearing out prematurely, but could also save your life.

☐ Many breakdowns are caused by electrical problems. Battery-related faults are particularly common, and a quick check on a regular basis will often prevent the majority of these.

☐ If your car develops a brake fluid leak, the first time you might know about it is when your brakes don't work properly. Checking the level regularly will give advance warning of this kind of problem.

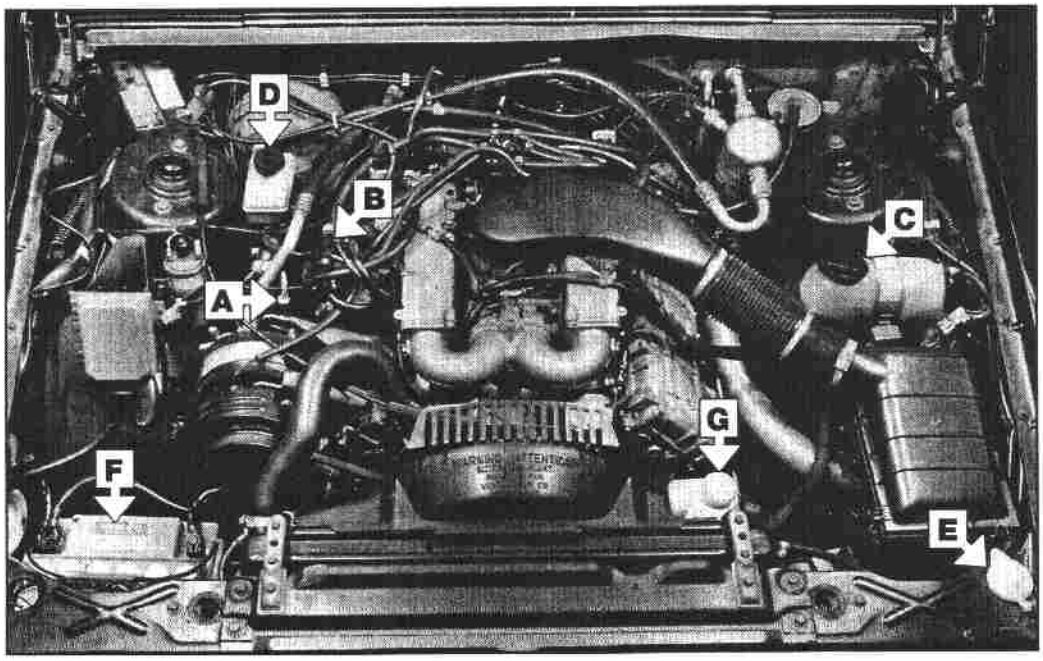
☐ If the oil or coolant levels run low, the cost of repairing any engine damage will be far greater than fixing the leak, for example.

Underbonnet check points



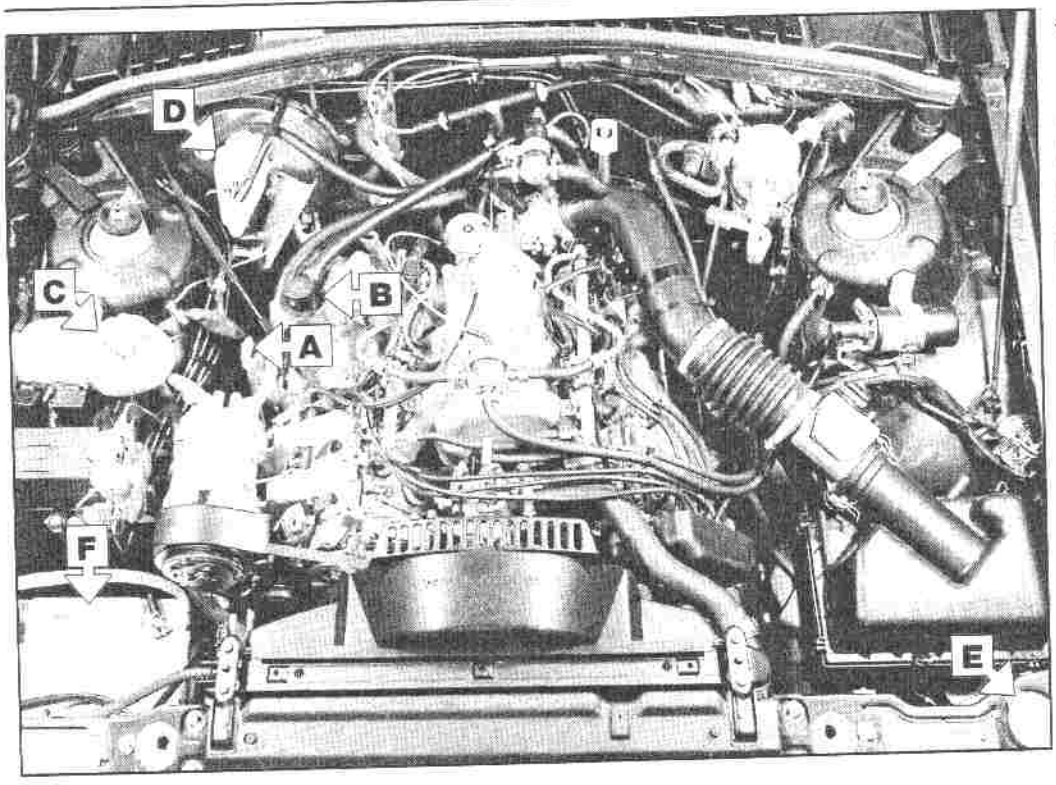
◀ Volvo 740

A *Engine oil level dipstick*
B *Engine oil filler cap*
C *Coolant expansion tank*
D *Brake fluid reservoir*
E *Screen washer fluid reservoir*
F *Battery*
G *Power steering fluid reservoir*



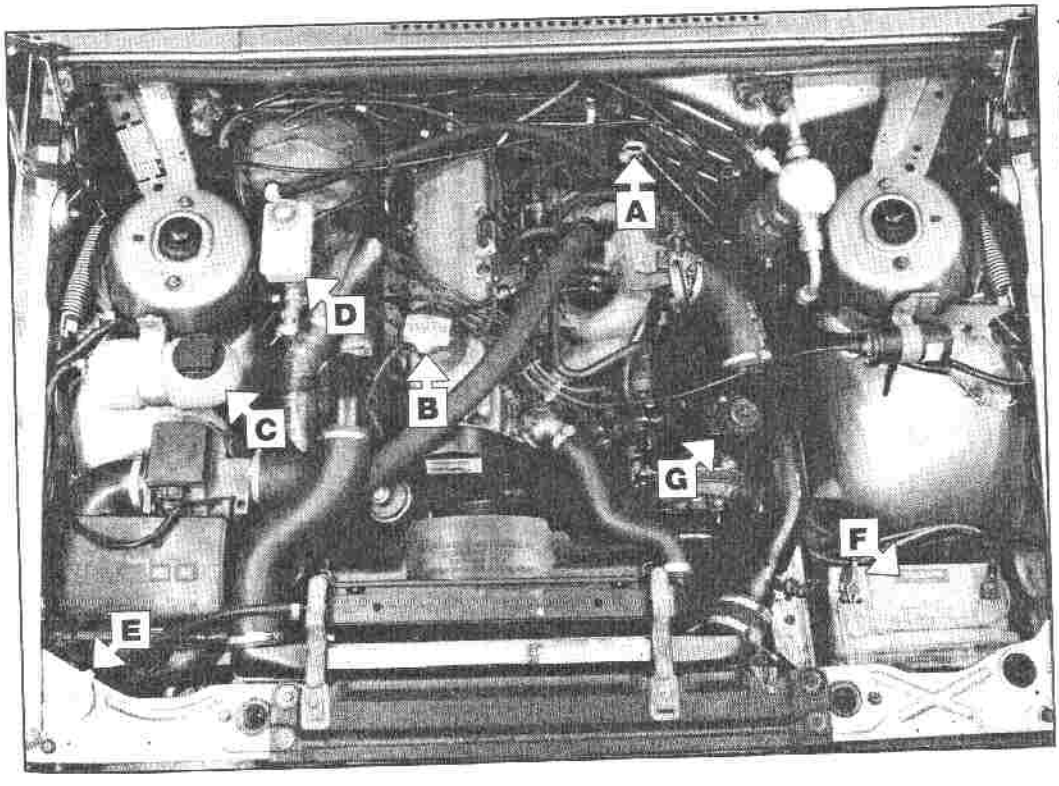
◀ Volvo 760 GLE (early model)

A *Engine oil level dipstick*
B *Engine oil filler cap*
C *Coolant expansion tank*
D *Brake fluid reservoir*
E *Screen washer fluid reservoir*
F *Battery*
G *Power steering fluid reservoir*



Volvo 760 GLE
(1989 model)

A *Engine oil level dipstick*
B *Engine oil filler cap*
C *Coolant expansion tank*
D *Brake fluid reservoir*
E *Screen washer fluid reservoir*
F *Battery*



Volvo 760 Turbo

A *Engine oil level dipstick*
B *Engine oil filler cap*
C *Coolant expansion tank*
D *Brake/clutch fluid reservoir*
E *Screen washer fluid reservoir*
F *Battery*
G *Power steering pump and fluid reservoir*

Engine oil level

Before you start

✔ Make sure that your car is on level ground.
✔ Check the oil level before the car is driven, or at least 5 minutes after the engine has been switched off.

> **HAYNES HiNT** ***If the oil is checked immediately after driving the vehicle, some of the oil will remain in the upper engine components, resulting in an inaccurate reading on the dipstick!***

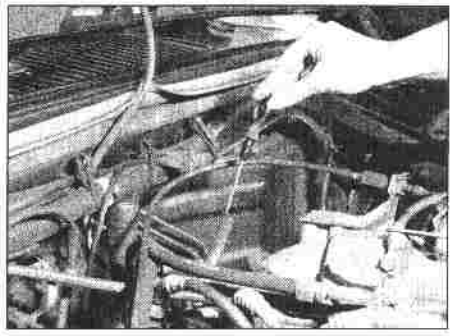
The correct oil

Modern engines place great demands on their oil. It is very important that the correct oil for your car is used (See "Lubricants, fluids and tyre pressures").

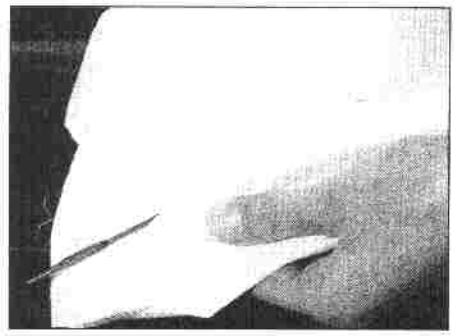
Car Care

● If you have to add oil frequently, you should check whether you have any oil leaks. Place some clean paper under the car overnight, and check for stains in the morning. If there are no leaks, the engine may be burning oil *(see "Fault Finding").*

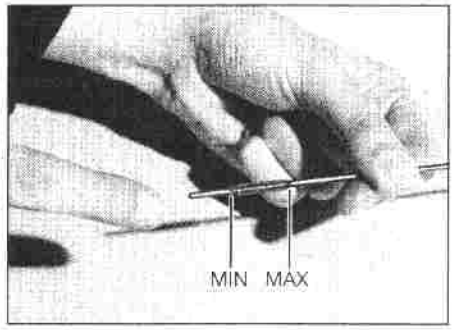
● Always maintain the level between the upper and lower dipstick marks (see photo 3). If the level is too low severe engine damage may occur. Oil seal failure may result if the engine is overfilled by adding too much oil.



1 The dipstick location varies between models, (see *"Underbonnet check points"* on pages 0•10 and 0•11 for exact location). Withdraw the dipstick.



2 Using a clean rag or paper towel remove all oil from the dipstick. Insert the clean dipstick into the tube as far as it will go, then withdraw it again.



3 Note the oil level on the end of the dipstick, which should be between the hatched area on the dipstick. Approximately 1.0 litre of oil will raise the level from the lower mark to the upper mark.

4 Oil is added through the filler cap. Unscrew the cap and top-up the level; a funnel may help to reduce spillage. Add the oil slowly, checking the level on the dipstick often. Don't overfill (see *"Car Care" left*).

Coolant level

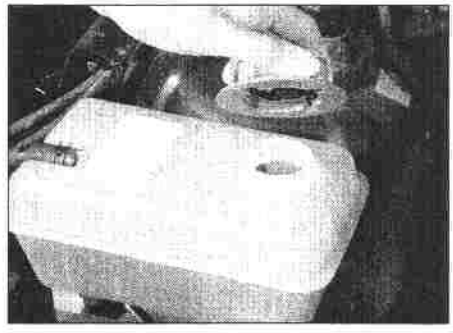
> ***Warning: DO NOT attempt to remove the expansion tank pressure cap when the engine is hot, as there is a very great risk of scalding. Do not leave open containers of coolant about, as it is poisonous.***

Car Care

● With a sealed-type cooling system, adding coolant should not be necessary on a regular basis. If frequent topping-up is required, it is likely there is a leak. Check the radiator, all hoses and joint faces for signs of staining or wetness, and rectify as necessary.

● It is important that antifreeze is used in the cooling system all year round, not just during the winter months. Don't top-up with water alone, as the antifreeze will become too diluted.

1 The coolant level varies with engine temperature. When cold, the coolant level should be between the "MAX" and "MIN" marks. When the engine is hot, the level may rise slightly above the "MAX" mark.



2 If topping up is necessary, **wait until the engine is cold**. Slowly unscrew the expansion tank cap, to release any pressure present in the cooling system, and remove it.

3 Add a mixture of water and antifreeze to the expansion tank until the coolant level is up to the "MAX" mark. Refit the cap and tighten it securely.

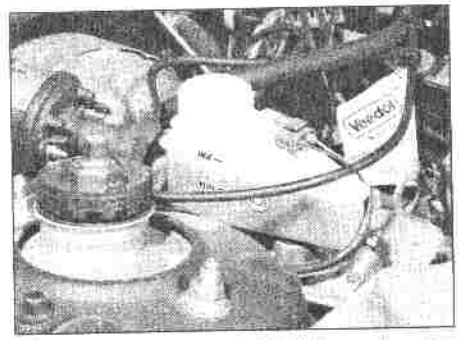
Brake/clutch fluid level

Warning:
- *Brake fluid can harm your eyes and damage painted surfaces, so use extreme caution when handling and pouring it.*
- *Do not use fluid that has been standing open for some time, as it absorbs moisture from the air, which can cause a dangerous loss of braking effectiveness.*

The brake master cylinder and fluid reservoir are mounted on the front of the vacuum servo unit in the engine compartment. On vehicles with an hydraulically operated clutch, the brake fluid reservoir also supplies the clutch hydraulic system.

HAYNES HiNT

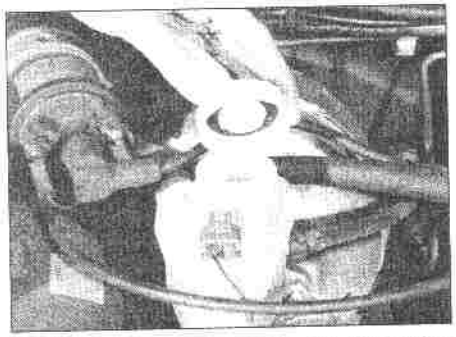
• Make sure that your car is on level ground.
• The fluid level in the reservoir will drop slightly as the brake pads wear down, but the fluid level must never be allowed to drop below the "MIN" mark.



1 The "MAX" and "MIN" marks are indicated on the side of the reservoir. The fluid level must be kept between the marks at all times.

Safety First!

- If the reservoir requires repeated topping-up this is an indication of a fluid leak somewhere in the system, which should be investigated immediately.
- If a leak is suspected, the car should not be driven until the braking system has been checked. Never take any risks where brakes are concerned.



2 If topping-up is necessary, first wipe clean the area around the filler cap to prevent dirt entering the hydraulic system. Unscrew the reservoir cap.

3 Carefully add fluid, taking care not to spill it onto the surrounding components. Use only the specified fluid; mixing different types can cause damage to the system. After topping-up to the correct level, securely refit the cap and wipe off any spilt fluid.

Power steering fluid level

Before you start:

- ✔ Park the vehicle on level ground.
- ✔ Set the steering wheel straight-ahead.
- ✔ The engine should be turned off.

HAYNES HiNT

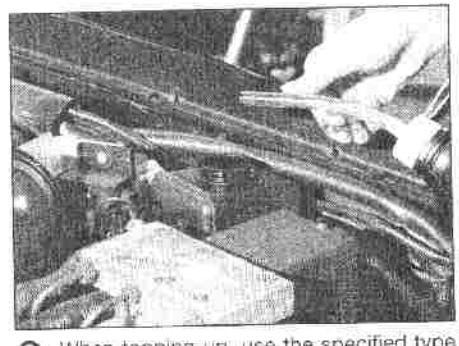
For the check to be accurate, the steering must not be turned once the engine has been stopped.

1 The power steering fluid reservoir can be remotely mounted on the radiator or inner wing. On types with visible markings on the side of the reservoir, the fluid level should not be above the "MAX" mark.

2 Alternately, it can be mounted on the power steering pump. Dipstick markings can be calibrated both for hot and cold fluid; use the correct markings. Again, the level should not rise above the "MAX" mark.

Safety First!

- The need for frequent topping-up indicates a leak, which should be investigated immediately.



3 When topping-up, use the specified type of fluid and do not overfill the reservoir. When the level is correct, securely refit the cap.

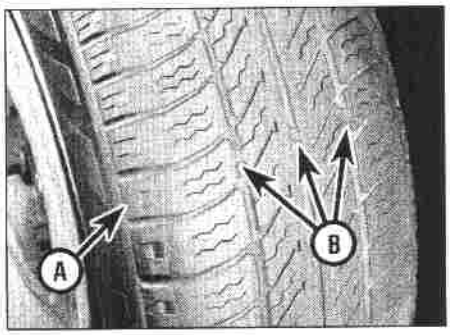
Tyre condition and pressure

It is very important that tyres are in good condition, and at the correct pressure - having a tyre failure at any speed is highly dangerous. Tyre wear is influenced by driving style - harsh braking and acceleration, or fast cornering, will all produce more rapid tyre wear. As a general rule, the front tyres wear out faster than the rears. Interchanging the tyres from front to rear ("rotating" the tyres) may result in more even wear. However, if this is completely effective, you may have the expense of replacing all four tyres at once!

Remove any nails or stones embedded in the tread before they penetrate the tyre to cause deflation. If removal of a nail does reveal that the tyre has been punctured, refit the nail so that its point of penetration is marked. Then immediately change the wheel, and have the tyre repaired by a tyre dealer.

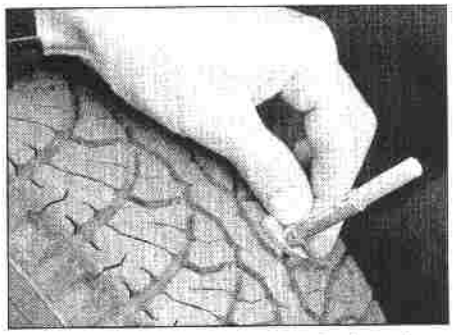
Regularly check the tyres for damage in the form of cuts or bulges, especially in the sidewalls. Periodically remove the wheels, and clean any dirt or mud from the inside and outside surfaces. Examine the wheel rims for signs of rusting, corrosion or other damage. Light alloy wheels are easily damaged by "kerbing" whilst parking; steel wheels may also become dented or buckled. A new wheel is very often the only way to overcome severe damage.

New tyres should be balanced when they are fitted, but it may become necessary to re-balance them as they wear, or if the balance weights fitted to the wheel rim should fall off. Unbalanced tyres will wear more quickly, as will the steering and suspension components. Wheel imbalance is normally signified by vibration, particularly at a certain speed (typically around 50 mph). If this vibration is felt only through the steering, then it is likely that just the front wheels need balancing. If, however, the vibration is felt through the whole car, the rear wheels could be out of balance. Wheel balancing should be carried out by a tyre dealer or garage.



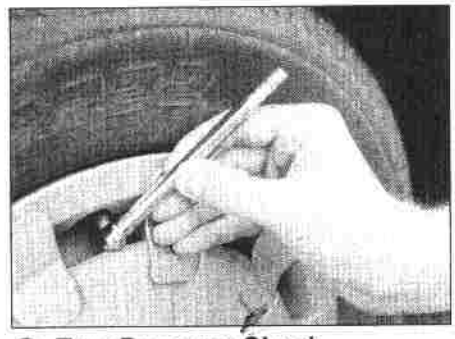
1 Tread Depth - visual check

The original tyres have tread wear safety bands (B), which will appear when the tread depth reaches approximately 1.6 mm. The band positions are indicated by a triangular mark on the tyre sidewall (A).



2 Tread Depth - manual check

Alternatively, tread wear can be monitored with a simple, inexpensive device known as a tread depth indicator gauge.



3 Tyre Pressure Check

Check the tyre pressures regularly with the tyres cold. Do not adjust the tyre pressures immediately after the vehicle has been used, or an inaccurate setting will result. Tyre pressures are shown on Page 0•16.

Tyre tread wear patterns

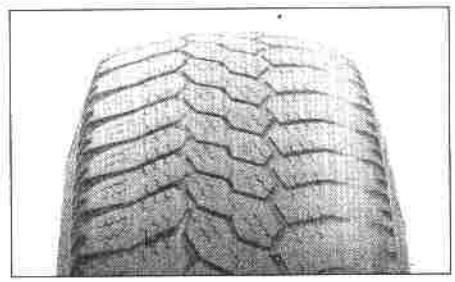
Shoulder Wear

Underinflation (wear on both sides)
Under-inflation will cause overheating of the tyre, because the tyre will flex too much, and the tread will not sit correctly on the road surface. This will cause a loss of grip and excessive wear, not to mention the danger of sudden tyre failure due to heat build-up.
Check and adjust pressures
Incorrect wheel camber (wear on one side)
Repair or renew suspension parts
Hard cornering
Reduce speed!

Centre Wear

Overinflation
Over-inflation will cause rapid wear of the centre part of the tyre tread, coupled with reduced grip, harsher ride, and the danger of shock damage occurring in the tyre casing.
Check and adjust pressures

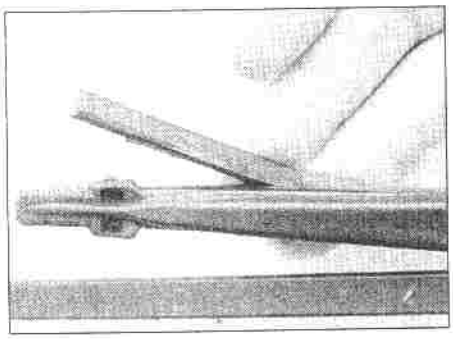
If you sometimes have to inflate your car's tyres to the higher pressures specified for maximum load or sustained high speed, don't forget to reduce the pressures to normal afterwards.



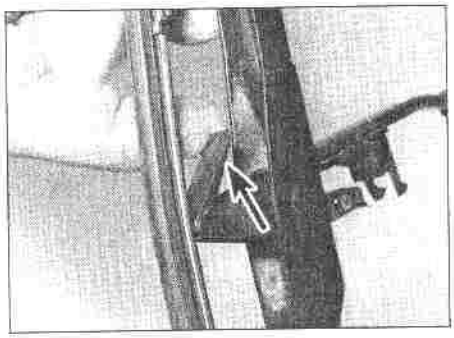
Uneven Wear

Front tyres may wear unevenly as a result of wheel misalignment. Most tyre dealers and garages can check and adjust the wheel alignment (or "tracking") for a modest charge.
Incorrect camber or castor
Repair or renew suspension parts
Malfunctioning suspension
Repair or renew suspension parts
Unbalanced wheel
Balance tyres
Incorrect toe setting
Adjust front wheel alignment
Note: *The feathered edge of the tread which typifies toe wear is best checked by feel.*

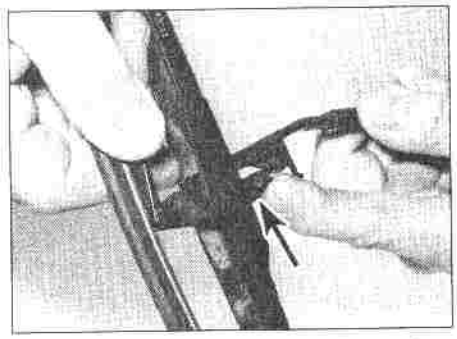
Wiper blades



1 Check the condition of the wiper blades; if they are cracked or show any signs of deterioration, or if the glass swept area is smeared, renew them. Wiper blades should be renewed annually.



2 To remove a windscreen wiper blade, pull the arm fully away from the screen until it locks. Swivel the blade through 90°, press the locking tab with your fingers and slide the blade out of the arm's hooked end.



3 Don't forget to check the tailgate wiper blade as well. To remove the blade, depress the retaining tab and slide the blade out of the hooked end of the arm.

Battery

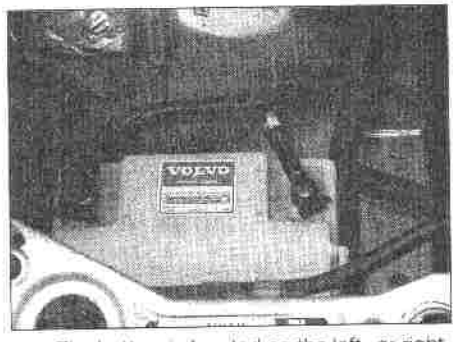
Caution: *Before carrying out any work on the vehicle battery, read the precautions given in "Safety first" at the start of this manual.*

✔ Make sure that the battery tray is in good condition, and that the clamp is tight. Corrosion on the tray, retaining clamp and the battery itself can be removed with a solution of water and baking soda. Thoroughly rinse all cleaned areas with water. Any metal parts damaged by corrosion should be covered with a zinc-based primer, then painted.

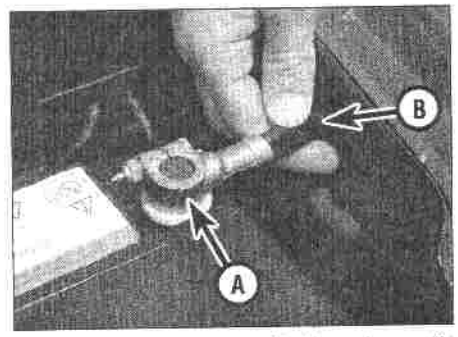
✔ Periodically (approximately every three months), check the charge condition of the battery as described in Chapter 5A.

✔ If the battery is flat, and you need to jump start your vehicle, see ***Roadside Repairs***.

Battery corrosion can be kept to a minimum by applying a layer of petroleum jelly to the clamps and terminals after they are reconnected.

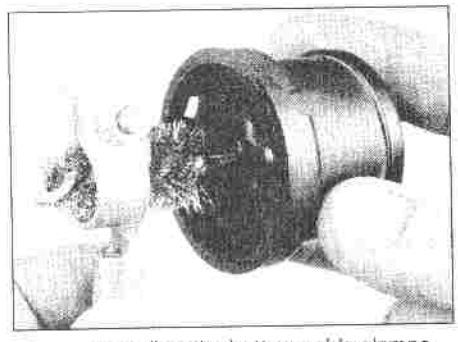


1 The battery is located on the left- or right-hand side of the engine compartment depending on model. The exterior of the battery should be inspected periodically for damage such as a cracked case or cover.



2 Check the tightness of battery clamps (A) to ensure good electrical connections. You should not be able to move them. Also check each cable (B) for cracks and frayed conductors.

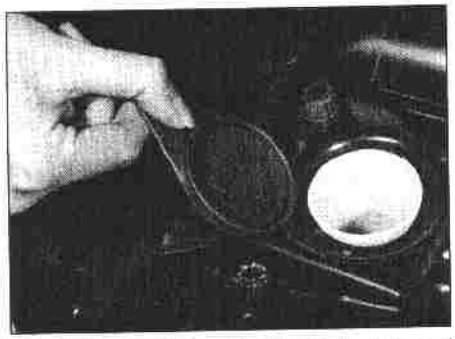
3 If corrosion (white, fluffy deposits) is evident, remove the cables from the battery terminals, clean them with a small wire brush, then refit them. Automotive stores sell a tool for cleaning the battery post . . .



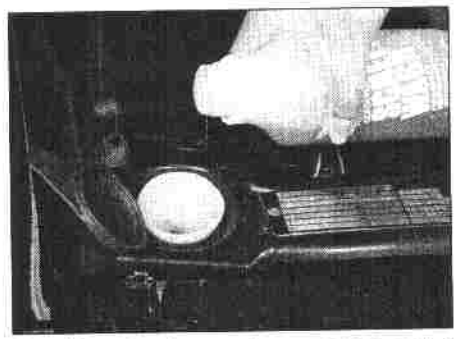
4 . . . as well as the battery cable clamps

Screen washer fluid level

Screenwash additives not only keep the winscreen clean during foul weather, they also prevent the washer system freezing in cold weather - which is when you are likely to need it most. Don't top up using plain water as the screenwash will become too diluted, and will freeze during cold weather. ***On no account use coolant antifreeze in the washer system - this could discolour or damage paintwork.***



1 Fluid for the windscreen/ tailgate/ headlight washer system is stored in a plastic reservoir, the filler neck of which is located at the right-hand front corner of the engine compartment on in-line engine models, or at the left-hand front corner on V-6 engine models. Check the level by opening the cap and looking down the filler neck.



2 When topping-up the reservoir, add a screenwash additive in the quantities recommended on the bottle.

Lubricants and fluids

Engine oil	Multigrade engine oil, SAE 10W/30 to 15W/50, to API SG/CD
Coolant	50/50 mixture of water and ethylene glycol-based antifreeze
Brake/clutch fluid	Universal brake fluid
Power steering fluid	Automatic transmission fluid type A, F or G
Manual transmission	Volvo Thermo oil
Automatic transmission:	
Up to 1983	Automatic transmission fluid type A, F or G
1983 onward	Dexron IID
Rear axle:	
Models without limited slip differential	Hypoid gear oil, viscosity SAE 90 EP to API GL 5 or 6
Models with limited slip differential	Volvo oil (No. 1 161 276-9)

Tyre pressures (cold)

	Front	Rear
Saloon, up to 3 occupants	1.9 bars (28 psi)	1.9 bars (28 psi)
Saloon, fully laden	2.1 bars (31 psi)	2.3 bars (33 psi)
Estate, up to 3 occupants	1.9 bars (28 psi)	2.1 bars (31 psi)
Estate, fully laden	2.1 bars (31 psi)	2.8 bars (41 psi)
For sustained high speeds (over 72 mph) add	0.3 bars (4 psi)	0.3 bars (4 psi)
"Space saver" spare		
155/R15	3.5 bars (51 psi)	3.5 bars (51 psi)
165/14	2.8 bars (41 psi)	2.8 bars (41 psi)

Note: *Refer to the tyre pressure data sticker on the driver's door for the correct tyre pressures for your particular vehicle. Pressures apply only to original-equipment tyres, and may vary if other makes or type is fitted; check with the tyre manufacturer or supplier for correct pressures if necessary.*

Chapter 1
Routine maintenance and servicing

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Lubricants and fluids	Refer to *"Weekly checks"*

Capacities

Engine oil	
Drain and refill including filter change:	
B23/B200/B230 engines	3.85 litres (plus 0.6 litres for turbo oil cooler - if drained)
B234F engines	4.0 litres
B28 engines	6.5 litres
B280 engines	6.0 litres
Cooling system	
B23/B230 engines	9.5 litres
B200 engines	8.5 litres
B28/B280 engines	10.0 litres
B234F engines:	
Manual gearbox	9.5 litres
Automatic gearbox	9.3 litres
Transmission	
Manual transmission:	
M46	2.3 litres
M47	1.3 litres
M47II	1.6 litres
Automatic transmission:	
Drain and refill:	
AW71/72	3.9 litres
ZF4HP22	2.0 litres
From dry:	
AW70/71	7.5 litres
ZF4HP22	7.7 litres
Rear axle	
Models without independent rear suspension	1.3 to 1.6 litres
Models with independent rear suspension	1.4 litres
Fuel tank	60 or 82 litres depending on model and year

Engine

Oil filter	Champion C102
Valve clearances:	
In-line engine (inlet and exhaust):	
Checking value:	
Cold engine	0.30 to 0.40 mm
Warm engine	0.35 to 0.45 mm
Setting value:	
Cold engine	0.35 to 0.40 mm
Warm engine	0.40 to 0.45 mm
Adjusting shims available	3.30 to 4.50 mm in steps of 0.05 mm
B234F engines have hydraulic tappets - no need to adjust valve clearances.	
V-6 engine:	
Inlet:	
Cold engine	0.10 to 0.15 mm
Warm engine	0.15 to 0.20 mm
Exhaust:	
Cold engine	0.25 to 0.30 mm
Warm engine	0.30 to 0.35 mm

Cooling system

Specified antifreeze mixture	50% antifreeze/50% water

Fuel system

Carburettor models:	
Idle speed:	
Manual transmission models	800 rpm
Automatic transmission models	900 rpm
Idle mixture CO content:	
Pierburg 2B5 carburettor:	
Setting value	1.0%
Checking value	0.5 to 2.0%
Pierburg 2B7 carburettor:	
Setting value	1.0%
Checking value	0.5 to 1.5%

Fuel system (continued)

Fuel-injected models:	
Idle speed:	
B200/230E engines	900 rpm
B23ET engines	900 rpm
B280E engines	700 rpm (basic idle speed)
Idle speed controlled by constant idle speed system:	
B28E engines	900 rpm (adjust to 850 rpm)
B230ET engines	900 rpm (adjust to 850 rpm)
B234F engines	850 rpm (not adjustable)
Idle speed for LH2.4-Jetronic system in limp-home mode	480 to 520 rpm

Idle mixture CO content:	Setting value	Checking value
B28E engines	2.0%	1.0 to 3.0%
B200E engines	1.0%	0.5 to 2.0%
B230E engines	1.0%	0.5 to 2.0%
B23ET engines	1.5%	1.0 to 2.5%
B230ET engines	1.0%	0.5 to 2.0%
B234F engines	0.6% (not adjustable)	0.2 to 1.0% (with Lambdasond disconnected)

Air filter element:	
B23ET/B230ET engines	Champion U532
B230E engines	Champion U547
B230K engines	Champion U547
B28E engines	Champion U554
B200E/B280E/B234F engines	Champion type not available
Fuel filter:	
Carburettor models	Champion type not available
Fuel-injected models	Champion L204

Ignition system

Ignition timing	Refer to Chapter 5B
Spark plugs	
B23ET	Champion N7YCC or N7YC
B230ET	Champion RN7YCC or RN7YC
B200E	Champion N7YCC or N7YC
B230K (to 1986)	Champion N9YCC or N9YC
B230K (1987)	Champion N7YCC or N7YC
B230K (1988-on)	Champion RN7YCC or RN7YC
B230E (to 1987)	Champion N7YCC or N7YC
B230E (1987-on)	Champion RN7YCC or RN7YC
B28E	Champion S7YCC or S7YC
B280E	Champion RS9YCC or RS9YC
B234F	Champion type not available
Spark plug electrode gap:	
N7YCC, RN7YCC, N9YCC, RS9YCC and S7YCC	0.8 mm
N7YC, RN7YC, N9YC, RS9YC and S7YC	0.7 mm

Clutch

Cable free play at release fork	1.0 to 3.0 mm

Brakes

Front brake pad minimum lining thickness	3.0 mm
Rear brake pad minimum lining thickness:	
Models without independent rear suspension	2.0 mm
Models with independent rear suspension	3.0 mm
Handbrake lever travel:	
After adjustment	3 to 5 clicks
In service	11 clicks maximum

Tyre pressures

See *"Weekly checks"*

Torque wrench settings

	Nm	lbf ft
Roadwheel nuts	85	63
Spark plugs (dry threads):		
In-line engines	25 ± 5	18 ± 14
V-6-engines	12 ± 2	9 ± 1.5

Volvo 740 & 760 - maintenance schedule

The maintenance intervals in this manual are provided with the assumption that you, not the dealer, will be carrying out the work. These are the minimum maintenance intervals recommended by the manufacturer for vehicles driven daily. If you wish to keep your vehicle in peak condition at all times, you may wish to perform some of these procedures more often. We encourage frequent maintenance because it enhances the efficiency, performance and resale value of your vehicle. If the vehicle is driven in dusty areas, used to tow a trailer, driven frequently at slow speeds (idling in traffic) or on short journeys, more frequent maintenance intervals are recommended.

Every 250 miles (400 km) or weekly

- ☐ Refer to "Weekly checks".

Every 6000 miles (10 000 km) or six months, whichever comes first

In addition to the items listed above, carry out the following:

- ☐ Renew the engine oil and filter (Section 3).
- ☐ Check the condition of the brake pads (Section 4).
- ☐ Check the coolant antifreeze concentration (Section 5).
- ☐ Renew the spark plugs (Section 6).
- ☐ Check the idle speed and CO level (Section 7).

Every 12 000 miles (20 000 km) or twelve months, whichever comes first

In addition to the items listed above, carry out the following:

- ☐ Inspect the in-line fuel filter (carburettor models) (Section 8).
- ☐ Check the condition and tension of accessory drivebelts (Section 9).
- ☐ Lubricate the distributor felt pad (B28E engine only) (Section 10).
- ☐ Inspect the distributor cap, rotor arm and HT leads (Section 10).
- ☐ Check the turbo boost pressure switches (where applicable) (Section 11).
- ☐ Thoroughly inspect the engine for fluid leaks (Section 12).
- ☐ Check the handbrake adjustment (Section 13).
- ☐ Check the front wheel bearing adjustment (Section 14).
- ☐ Check the condition and security of the steering and suspension components (Section 15).
- ☐ Inspect the clutch hydraulic components (where applicable) (Section 16).
- ☐ Check the adjustment of the clutch cable (where applicable) (Section 16).
- ☐ Check the manual transmission oil level (Section 17).
- ☐ Inspect the underbody and the brake hydraulic pipes and hoses (Section 18).

Every 12 000 miles (20 000 km) or twelve months, whichever comes first (continued)

- ☐ Check the condition of the fuel lines (Section 18).
- ☐ Inspect the propeller shaft, centre bearing and universal joints (Section 19).
- ☐ Check the condition and security of the exhaust system (Section 20).
- ☐ Check the rear axle oil level (Section 21).
- ☐ Check the condition of the seat belts (Section 22).
- ☐ Lubricate the locks and hinges (Section 23).
- ☐ Check the condition of the underseal and paintwork (Section 24).
- ☐ Check the operation of the kickdown cable (automatic transmission models) (Section 25).
- ☐ Check the automatic transmission selector adjustment (Section 25).
- ☐ Road test (Section 26).
- ☐ Check the operation of the brake servo (Section 26).
- ☐ Check the automatic transmission fluid level (Section 27).

Every 24 000 miles (40 000 km) or two years, whichever comes first

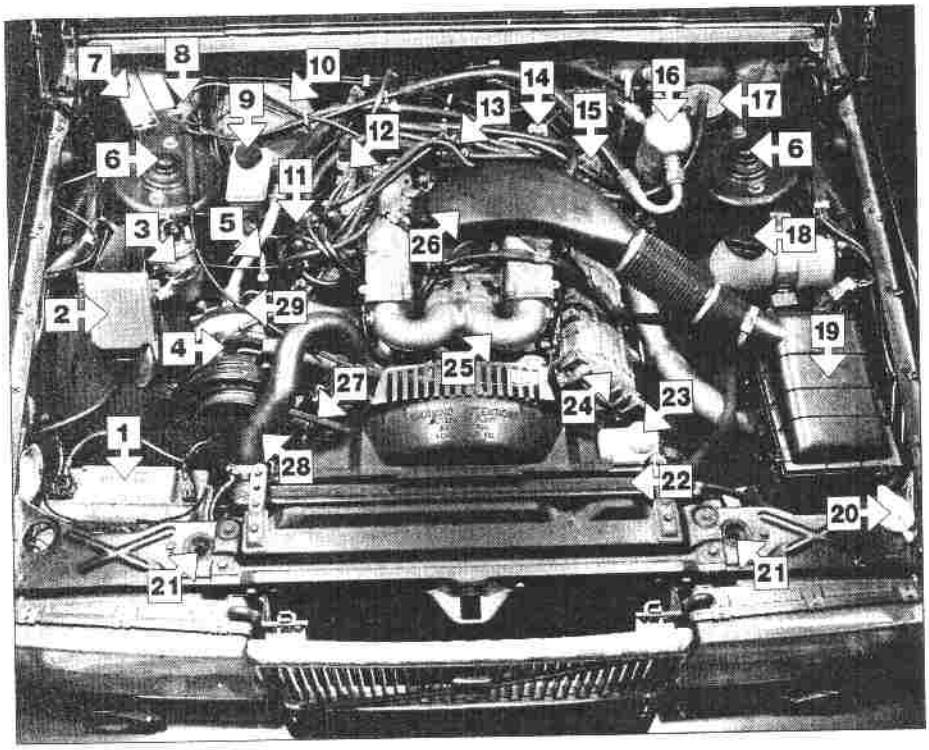
In addition to the items listed above, carry out the following:

- ☐ Renew the automatic transmission fluid (Section 28).
- ☐ Renew the fuel filter (Section 29).
- ☐ Renew the air cleaner element (Section 30).
- ☐ Check the emission control equipment (Section 31).
- ☐ Check the valve clearances (Section 32).
- ☐ Perform a compression test (Section 33).
- ☐ Renew the coolant (Section 34).
- ☐ Renew the brake fluid (Section 35).

Every 48 000 miles (80 000 km) or four years, whichever comes first

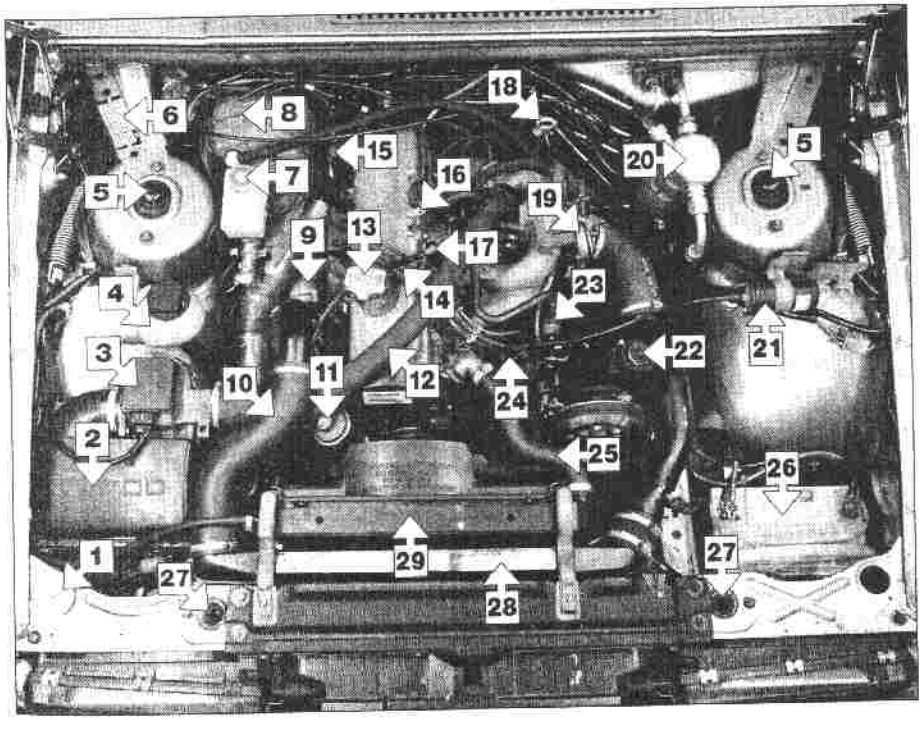
In addition to the items listed above, carry out the following:

- ☐ Renew the camshaft drivebelt (in-line engines) (Section 36).



Underbonnet view of a Volvo 760 GLE

1 Battery
2 Ignition control unit
3 Ignition coil
4 Air conditioning compressor
5 Engine oil dipstick
6 Suspension turrets
7 Identification plate
8 Ignition vacuum advance valve
9 Brake fluid reservoir
10 Brake servo
11 Engine oil filler cap
12 Air control valve
13 Fuel distributor
14 Automatic transmission dipstick
15 Vacuum pump
16 Air conditioner receiver/drier
17 Fuel filter
18 Coolant expansion tank
19 Air cleaner
20 Screen washer filler cap
21 Bonnet catches
22 Radiator
23 Power steering reservoir
24 Left-hand rocker cover
25 Inlet manifold
26 Air inlet
27 Compressor drivebelt
28 Radiator top hose
29 Throttle cable

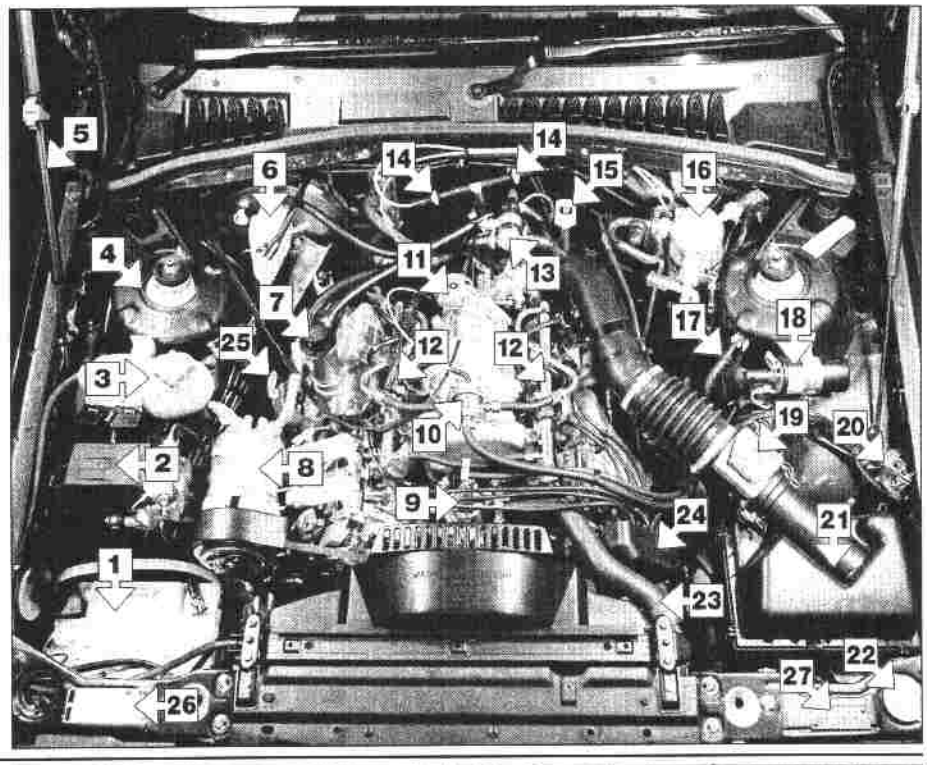


Underbonnet view of a Volvo 760 Turbo

1 Screen washer filler cap
2 Air cleaner
3 Airflow meter
4 Coolant expansion tank
5 Suspension turrets
6 Identification plate
7 Brake and clutch fluid reservoir
8 Brake servo
9 Turbocharger
10 Turbo air outlet
11 Bypass valve
12 Bypass valve hose
13 Engine oil filler cap
14 HT leads
15 Clutch master cylinder
16 Auxiliary air valve
17 Vacuum delay valve
18 Engine oil dipstick
19 Throttle linkage
20 Air conditioner receiver/drier
21 Ignition coil
22 Power steering pump and reservoir
23 Fuel pressure regulator
24 Ignition distributor
25 Radiator top hose
26 Battery
27 Bonnet catches
28 Intercooler
29 Radiator

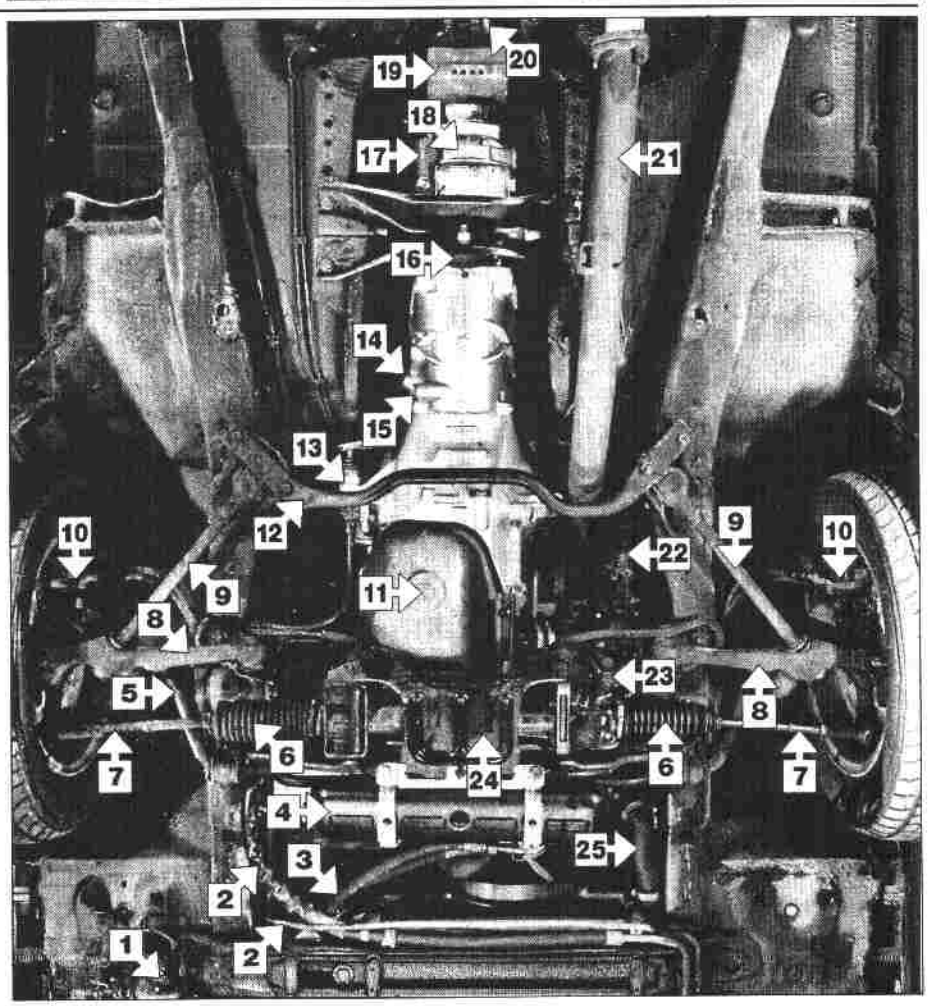
Underbonnet view of a 1989 760 GLE

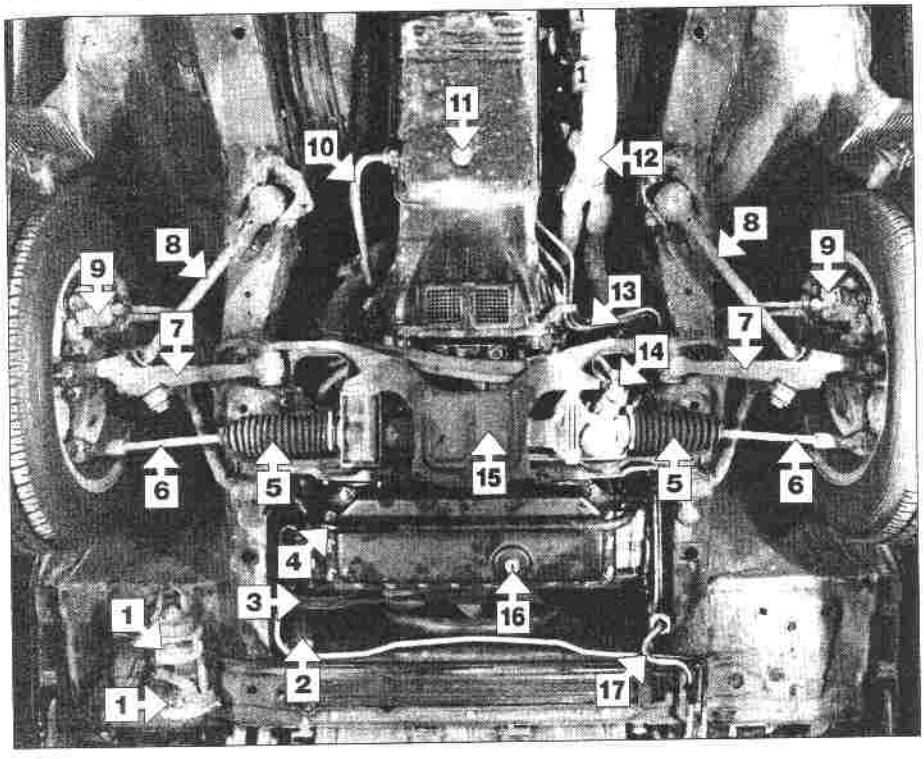
1 Battery
2 ABS hydraulic modulator
3 Expansion tank
4 Suspension turret
5 Bonnet strut
6 Brake fluid reservoir
7 Engine oil filler cap
8 Air conditioning compressor
9 Thermostat housing
10 Fuel pressure regulator
11 Throttle cable drum
12 Fuel injector rails
13 Air control valve
14 Vacuum non-return valves
15 Transmission fluid dipstick
16 Air conditioner receiver/drier
17 Fuel return line
18 Ignition coil
19 Airflow meter
20 Electrical connectors
21 Air cleaner
22 Washer reservoir cap
23 Radiator top hose
24 Distributor cover
25 Engine oil dipstick
26 Identification plate
27 Body number



Front underside view of a Volvo 760 Turbo

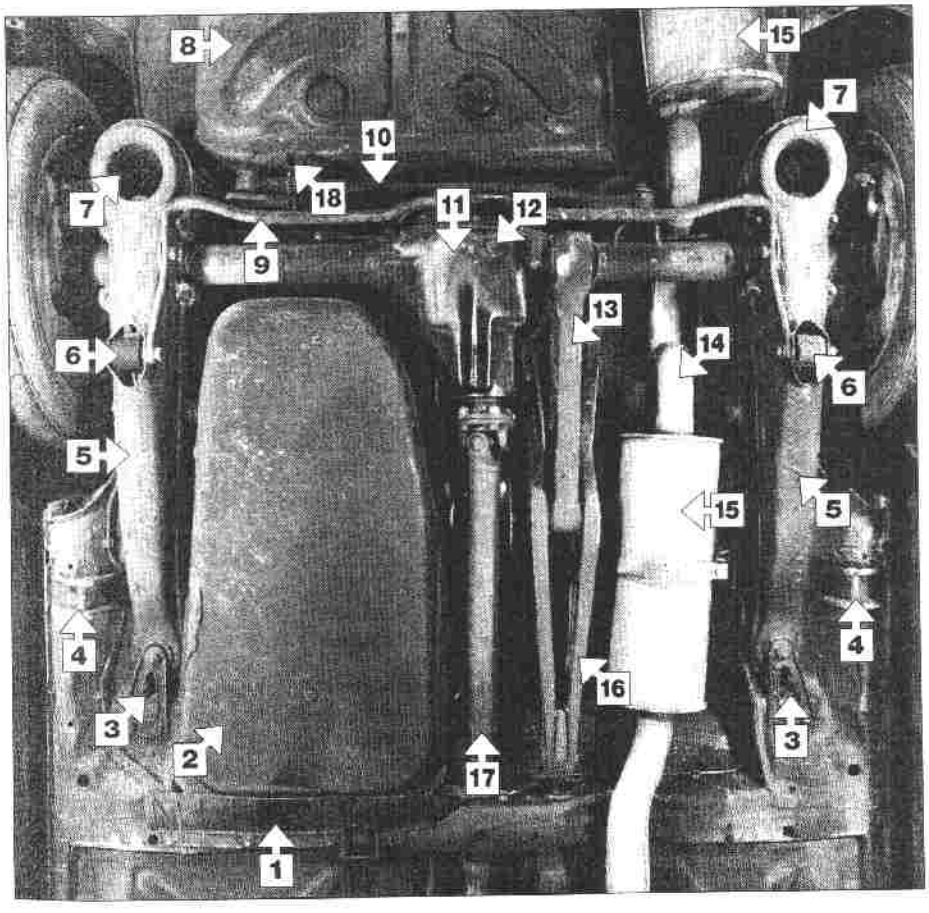
1 Horn
2 Refrigerant lines (air conditioning)
3 Oil cooler hoses
4 Vacuum tank
5 Anti-roll bar
6 Steering rack bellows
7 Track rods
8 Control arms
9 Radius rods
10 Brake calipers
11 Engine oil drain plug
12 Brace
13 Clutch slave cylinder
14 Gearbox filler/level plug
15 Gearbox drain plug
16 Gearbox mounting
17 Overdrive solenoid
18 Overdrive
19 Damper
20 Propeller shaft flange
21 Exhaust downpipe
22 Steering intermediate shaft
23 Steering hydraulic unions
24 Jacking plate
25 Radiator bottom hose





Front underside view of a Volvo 760 GLE

1 Horns
2 Radiator bottom hose
3 Steering pump
4 Anti-roll bar
5 Steering rack bellows
6 Track rods
7 Control arms
8 Radius rods
9 Brake calipers
10 Transmission dipstick/filler tube
11 Transmission drain plug
12 Exhaust downpipe
13 Transmission fluid cooler lines
14 Steering hydraulic unions
15 Jacking plate
16 Engine oil drain plug
17 Refrigerant lines (air conditioning)

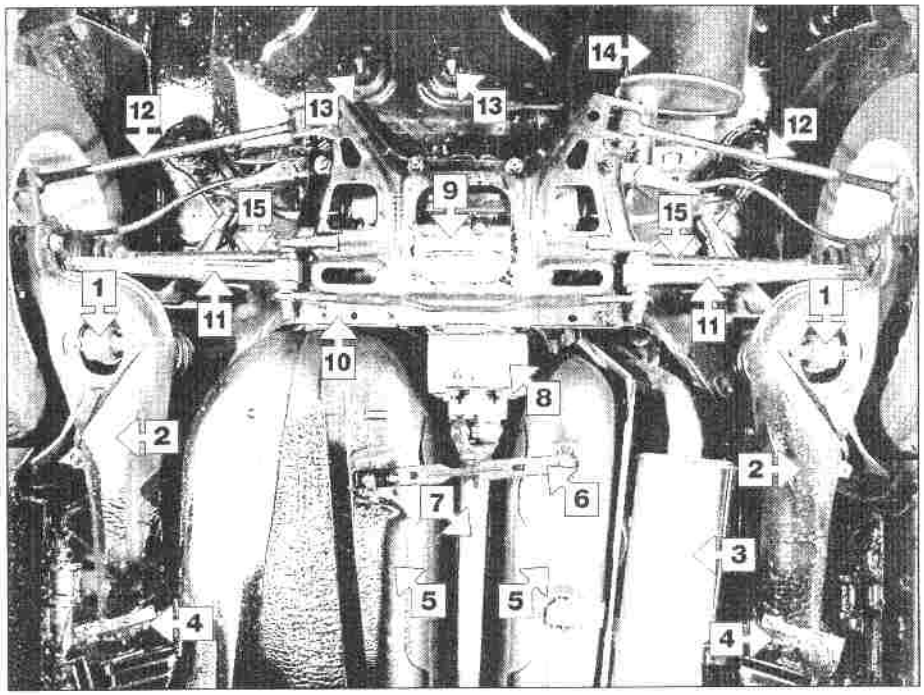


Rear underside view of a Volvo 760 Turbo

1 Mud deflector
2 Main fuel tank
3 Trailing arm brackets
4 Rear jacking points
5 Trailing arms
6 Shock absorber lower mountings
7 Spring pans
8 Spare wheel well
9 Anti-roll bar
10 Panhard rod
11 Rear axle
12 Rear axle drain plug
13 Torque rod
14 Exhaust pipe
15 Silencers
16 Subframe
17 Propeller shaft
18 Fuel tank breather

Rear underside view of a 760 GLE with independent rear suspension

1 *Shock absorber lower mountings/spring seats*
2 *Support arms*
3 *Intermediate silencer*
4 *Support arm front mountings*
5 *Fuel tank*
6 *Bracing strap*
7 *Propeller shaft*
8 *Vibration damper*
9 *Final drive unit*
10 *Rear axle member lower section*
11 *Lower links*
12 *Track rods*
13 *Boot drain holes*
14 *Rear silencer*
15 *Driveshafts*



Maintenance procedures

1 Introduction

1 This Chapter is designed to help the home mechanic maintain his/her vehicle for safety, economy, long life and peak performance.

2 This Chapter contains a master maintenance schedule, followed by Sections dealing specifically with each task in the schedule. Visual checks, adjustments, component renewal and other helpful items are included. Refer to the accompanying illustrations of the engine compartment and the underside of the vehicle for the locations of the various components.

3 Servicing your vehicle in accordance with the mileage/time maintenance schedule and the following Sections will provide a planned maintenance programme, which should result in a long and reliable service life. This is a comprehensive plan, so maintaining some items but not others at the specified service intervals will not produce the same results.

4 As you service your vehicle, you will discover that many of the procedures can - and should - be grouped together, because of the particular procedure being performed, or because of the close proximity of two otherwise-unrelated components to one another. For example, if the vehicle is raised for any reason, the exhaust should be inspected at the same time as the suspension and steering components.

5 The first step of this maintenance programme is to prepare yourself before the actual work begins. Read through all the Sections relevant to the work to be carried out, then make a list and gather together all the parts and tools required. If a problem is encountered, seek advice from a parts specialist or a dealer service department.

2 Intensive maintenance

1 If, from the time the vehicle is new, the routine maintenance schedule is followed closely, and frequent checks are made of fluid levels and high-wear items, as suggested throughout this manual, the engine will be kept in relatively good running condition, and the need for additional work will be minimised.

2 It is possible that there will be some times when the engine is running poorly due to the lack of regular maintenance. This is even more likely if a used vehicle, which has not received regular and frequent maintenance checks, is purchased. In such cases, additional work may need to be carried out, outside of the regular maintenance intervals.

3 If engine wear is suspected, a compression test (refer to the relevant Part of Chapter 2) will provide valuable information regarding the overall performance of the main internal components. Such a test can be used as a basis to decide on the extent of the work to be carried out. If, for example, a compression test indicates serious internal engine wear, conventional maintenance as described in this Chapter will not greatly improve the performance of the engine, and may prove a waste of time and money, unless extensive overhaul work (Chapter 2C) is carried out first.

4 The following series of operations are those often required to improve the performance of a generally poor-running engine:

Primary operations

a) Clean, inspect and test the battery (See "Weekly checks").
b) Check all the engine-related fluids (See "Weekly checks").
c) Check the condition and tension of the accessory drivebelts (Section 9).
d) Adjust the valve clearances (Section 32).
e) Renew the spark plugs (Section 6).
f) Inspect the distributor cap, rotor arm and HT leads (Section 10).
g) Check the condition of the air cleaner filter element and renew if necessary (Section 30).
h) Check the fuel filter (Section 8 and 29 - as applicable).
i) Check the condition of all hoses, and check for fluid leaks (Section 12).
j) Check the idle speed and mixture settings (Section 7).

5 If the above operations do not prove fully effective, carry out the following operations:

Secondary operations

All the items listed under "Primary operations", plus the following:

a) Check the charging system (Chapter 5A).
b) Check the ignition system (Chapter 5B).
c) Check the fuel system (Chapter 4).
d) Renew the distributor cap and rotor arm (Section 10).
e) Renew the ignition HT leads (Section 10).

6000 mile / six month service

3 Engine oil and filter renewal

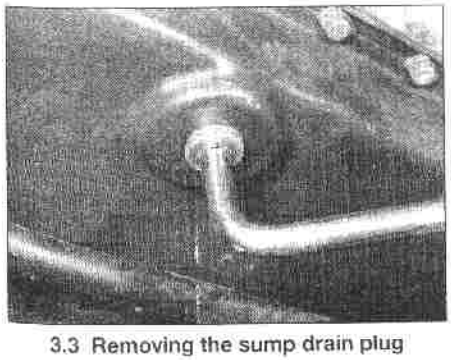
Note: *An 8 mm square drive key will be required to undo the sump drain plug on V-6 engines. Such a key can be obtained from most motor factors or from Volvo dealers.*

1 Frequent oil changes are the best preventive maintenance the home mechanic can give the engine, because ageing oil becomes diluted and contaminated, which leads to premature engine wear.

2 Make sure that you have all the necessary tools before you begin this procedure. You should also have plenty of rags or newspapers handy, for mopping up any spills. The oil should preferably be changed when the engine is still fully warmed-up to normal operating temperature, just after a run; warm oil and sludge will flow out more easily. Take care, however, not to touch the exhaust or any other hot parts of the engine when working under the vehicle. To avoid any possibility of scalding, and to protect yourself from possible skin irritants and other harmful contaminants in used engine oils, it is advisable to wear gloves when carrying out this work. Access to the underside of the vehicle is greatly improved if the vehicle can be lifted on a hoist, driven onto ramps, or supported by axle stands (see *"Jacking and vehicle support"*). Whichever method is chosen, make sure that the vehicle remains level, or if it is at an angle, that the drain point is at the lowest point.

3 Position the draining container under the drain plug, and unscrew the plug. If possible, try to keep the plug pressed into the sump while unscrewing it by hand the last couple of turns **(see illustration)**.

> **HAYNES HiNT** ***As the drain plug releases from the threads, move it away sharply, so the stream of oil issuing from the sump runs into the container, not up your sleeve!***



3.3 Removing the sump drain plug

4 Allow the oil to drain into the container, and check the condition of the plug's sealing washer; renew it if worn or damaged.

5 Allow some time for the old oil to drain, noting that it may be necessary to reposition the container as the oil flow slows to a trickle; when the oil has completely drained, wipe clean the drain plug and its threads in the sump and refit the plug, tightening it securely.

6 On in-line engines, the oil filter is located low down on the right-hand side of the cylinder block; access is not very good on Turbo models. On the V-6 engine the filter is located on the left-hand side of the cylinder block and is relatively easily accessible.

7 Reposition the draining container under the oil filter then, using a suitable filter removal tool if necessary, slacken the filter initially, then unscrew it by hand the rest of the way; be prepared for some oil spillage **(see illustration)**. Empty the oil in the old filter into the container.

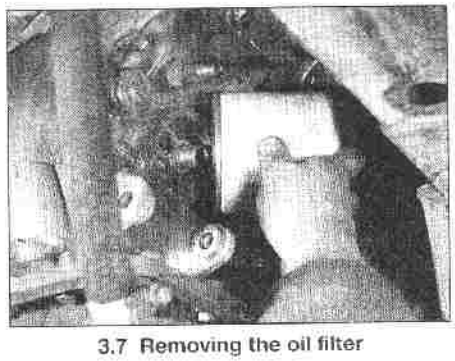
8 Using a clean, lint-free rag, wipe clean the cylinder block around the filter mounting. Check the old filter to make sure that the rubber sealing ring hasn't stuck to the engine; if it has, carefully remove it.

9 Apply a light coating of clean engine oil to the sealing ring on the new filter. Screw the filter into position on the engine until it seats, then tighten it firmly by hand only - do not use any tools.

10 Remove the old oil and all tools from under the vehicle, then lower the vehicle to the ground.

11 Remove the dipstick and the oil filler cap from the engine. Fill the engine with oil, using the correct grade and type of oil *(see "Weekly checks")*. Pour in half the specified quantity of oil first, then wait a few minutes for the oil to fall to the sump. Continue adding oil a small quantity at a time, until the level is up to the lower portion of hatch marks on the dipstick. Adding approximately 0.5 to 1.0 litre will raise the level to the upper portion of hatch marks on the dipstick.

12 Start the engine. The oil pressure warning light will take a few seconds to go out while the new filter fills with oil; do not race the engine while the light is on. Run the engine for a few minutes, while checking for leaks around the oil filter seal and the drain plug.



3.7 Removing the oil filter

13 Switch off the engine, and wait a few minutes for the oil to settle in the sump once more. With the new oil circulated and the filter now completely full, recheck the level on the dipstick, and add more oil as necessary.

14 Dispose of the used engine oil safely and in accordance with environmental regulations *(see "General repair procedures")*.

4 Brake pad wear check

1 Jack up the front or rear of the vehicle in turn, and support it on axle stands (see *"Jacking and vehicle support"*).

2 For better access to the brake calipers, remove the wheels.

3 Look through the inspection window in the caliper, and check that the thickness of the friction lining material on each of the pads is not less than the recommended minimum thickness given in the Specifications. If any one of the brake pads has worn down to, or below, the specified limit, *all four* pads at that end of the car must be renewed as a set (ie all the front pads or all the rear pads).

4 For a comprehensive check, the brake pads should be removed and cleaned. The operation of the brake calipers can then be checked, and the brake discs can be fully examined. Refer to Chapter 9 for details.

5 Coolant antifreeze concentration

1 The cooling system should be maintained all year round with a water/ethylene glycol-based antifreeze solution in a mixture of 50% antifreeze and 50% clean soft water (by volume). Alternatively, if the local climate requires it, the strength should be sufficient to prevent freezing down to at least -25°C, or lower. Antifreeze also provides protection against corrosion, and increases the coolant boiling point.

2 The strength of the antifreeze can only be checked with a hydrometer; these devices are readily available from accessory shops and should be used in accordance with the maker's instructions. If preferred, the check can be carried out by a dealer or garage at modest cost. If it is found that the antifreeze concentration is considerably below the recommended strength, the cooling system should be drained, flushed and refilled with a fresh antifreeze/water mixture. If the strength is satisfactory, then top-up if necessary with the specified mixture.

3 Before adding antifreeze, check all hoses and hose connections, because antifreeze tends to leak through very small openings. Engines don't normally consume coolant, so if the level goes down, find the cause and correct it.

4 Mix the required quantity in a clean container and then either fill the system as described in Section 34, or top-up as described in "*Weekly checks*".

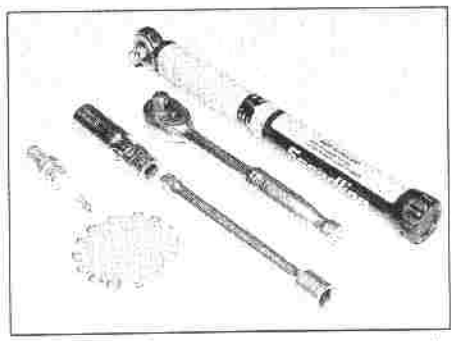
6 Spark plug renewal

Note: *Spark plug renewal at this service interval is a Volvo recommendation. Current spark plug manufacturing techniques may allow the plugs to remain in a serviceable condition for considerably longer. Consult your dealer for latest recommendations.*

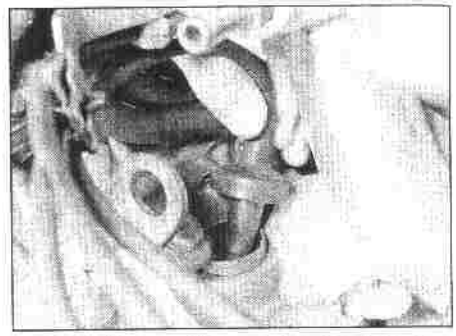
1 It is vital for the correct running, full performance and proper economy of the engine that the spark plugs perform with maximum efficiency. The most important factor in ensuring this, is that the plugs fitted are appropriate for the engine (a suitable type is specified at the front of this Chapter). If this type is used and the engine is in good condition, the spark plugs should not need attention between scheduled renewal intervals. Spark plug cleaning is rarely necessary, and should not be attempted unless specialised equipment is available, as damage can easily be caused to the firing ends.

2 Spark plug removal and refitting requires a spark plug socket, with an extension which can be turned by a ratchet handle or similar. This socket is lined with a rubber sleeve, to protect the porcelain insulator of the spark plug, and to hold the plug while you insert it into the spark plug hole. You will also need a wire-type feeler blade, to check and adjust the spark plug electrode gap, and a torque wrench to tighten the new plugs to the specified torque **(see illustration)**.

3 To remove the spark plugs, open the bonnet and remove any air cleaner trunking or similar items obstructing access to the spark plugs. Note how the spark plug (HT) leads are routed and secured by clips, and on some engines, how they're positioned along the camshaft cover. To prevent the possibility of mixing up spark plug (HT) leads, it is a good idea to try to work on one spark plug at a time. On B234F engines the spark plugs and (HT) leads are underneath a cover plate mounted centrally on top of the camshaft cover. You might need to clean the spark plug wells before removing the plugs.



6.2 Tools required for spark plug removal, gap adjustment and refitting



6.5 Pulling an HT lead off a spark plug

4 If the marks on the original-equipment spark plug (HT) leads cannot be seen, mark the leads 1 to 4 (or 1 to 6), to correspond to the cylinder the lead serves.

5 Pull the leads from the plugs by gripping the rubber boot, not the lead, otherwise the lead connection may be fractured **(see illustration)**.

6 Unscrew the spark plugs, ensuring that the socket is kept in alignment with each plug - if the socket is forcibly moved to either side, the porcelain top of the plug may be broken off. If any undue difficulty is encountered when unscrewing any of the spark plugs, carefully check the cylinder head threads and tapered sealing surfaces for signs of wear, excessive corrosion or damage; if any of these conditions is found, seek the advice of a dealer as to the best method of repair.

7 As each plug is removed, examine it as follows - this will give a good indication of the condition of the engine. If the insulator nose of the spark plug is clean and white, with no deposits, this is indicative of a weak mixture.

8 If the tip and insulator nose are covered with hard black-looking deposits, then this is indicative that the mixture is too rich. Should the plug be black and oily, then it is likely that the engine is fairly worn, as well as the mixture being too rich.

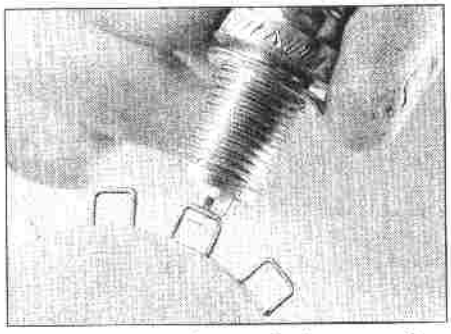
9 If the insulator nose is covered with light tan to greyish-brown deposits, then the mixture is correct, and it is likely that the engine is in good condition.

10 The spark plug electrode gap is of considerable importance as, if it is too large or too small, the size of the spark and its efficiency will be seriously impaired. The gap should be set to the value given in the Specifications.

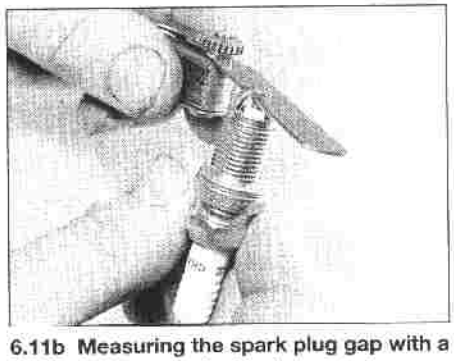
11 To set the electrode gap, measure the gap with a feeler blade or adjusting tool, and then bend open, or closed, the outer plug electrode until the correct gap is achieved **(see illustrations)**. The centre electrode should never be bent, as this may crack the insulation and cause plug failure, if nothing worse. If the outer electrode is not exactly over the centre electrode, bend it gently to align them.

12 Before fitting the spark plugs, check that the threaded connector sleeves at the top of the plugs are tight, and that the plug exterior surfaces and threads are clean.

13 On installing the spark plugs, first check that the cylinder head thread and sealing surface are as clean as possible; use a clean rag wrapped around a paintbrush to wipe clean the sealing surface. Apply a smear of copper-based grease or anti-seize compound to the threads of each plug, and screw them in by hand where possible. Take extra care to enter the plug threads correctly.

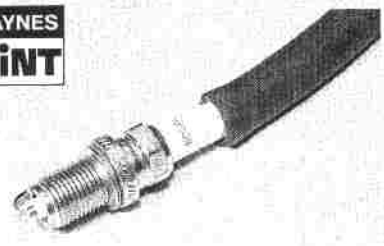


6.11a Measuring the spark plug gap with a wire gauge

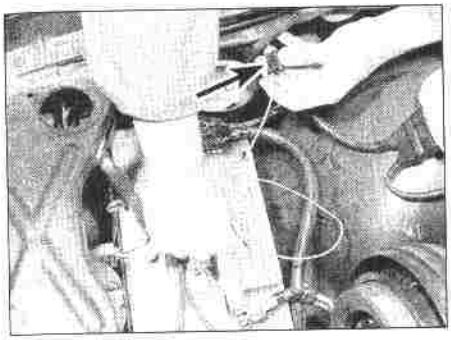


6.11b Measuring the spark plug gap with a feeler blade

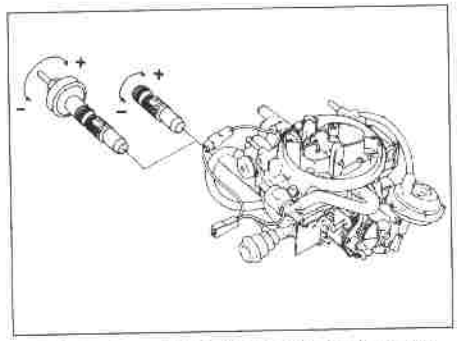
HAYNES HiNT



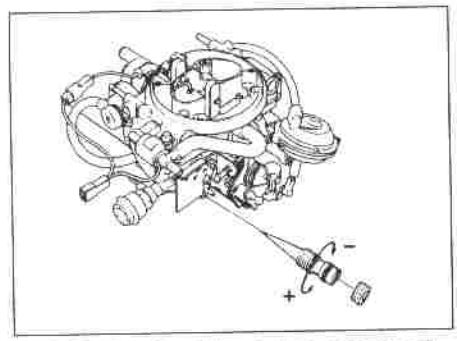
It's often difficult to insert spark plugs into their holes without cross-threading them. To avoid this possibility, fit a short piece of rubber hose over the end of the spark plug. The flexible hose acts as a universal joint, to help align the plug with the plug hole. Should the plug begin to crossthread, the hose will slip on the spark plug, preventing thread damage.



7.5 Earthing the constant idle speed system test wire. One end of the earth wire must fit the test connector (arrowed)



7.6 Carburettor idle speed adjustment screw. Compensation device (models with air conditioning) is on the left



7.8 Carburettor idle mixture adjustment screw and tamperproof plug

14 When each spark plug is started correctly on its threads, screw it down until it just seats lightly, then tighten it to the specified torque wrench setting.

15 Reconnect the spark plug (HT) leads in their correct order, using a twisting motion on the boot until it is firmly seated.

7 Engine idle speed and CO content check

1 Experienced home mechanics with a considerable amount of skill and equipment (including a tachometer and an accurately calibrated exhaust gas analyser) may be able to check the exhaust CO level and the idle speed. In practice, however, these systems rarely need adjustment and only go "out of tune" through lack of regular maintenance of the other fuel system related items.

2 If it is felt that the exhaust CO level and idle speed require adjustment, ideally the car should be taken to a dealer for this work to be done. For those with the necessary experience and equipment, the adjustment procedures are as follows.

3 The engine valve clearances must be correct, the crankcase ventilation system hoses connected, the air cleaner element and the ignition system in good condition. Air conditioning and major electrical loads must be switched off. The throttle cable must be correctly adjusted (see Chapter 4).

4 Bring the engine to normal operating temperature. Connect the tachometer and exhaust gas analyser as instructed by the manufacturers. Allow the engine to idle.

5 On most B28E and all B230ET and B234F engines, there is a constant idle speed system. On B28E and B230ET engines, disable the system by earthing the black and white test wire near the right-hand suspension turret **(see illustration)**. The idle speed is then adjusted to a lower value than that normally maintained. For B234F engines, see the note preceding paragraph 13.

Carburettor models

6 Adjust the idle speed if necessary by turning the idle speed adjustment screw (models without air conditioning) or the idle compensation device (models with air conditioning) **(see illustration)**.

7 On models so equipped, the Pulsair system must be blocked off when checking or adjusting the CO level, or false readings will result. This is most easily done by clamping the hose between the air cleaner and the non-return valves.

8 Read the CO level and adjust if necessary by turning the idle mixture adjustment screw. This may be covered by a tamperproof plug **(see illustration)**.

9 Readjust the idle speed if necessary.

Fuel injection models (not Turbo)

Continuous injection systems and Motronic systems

10 Adjust the idle speed using the adjustment screw on the inlet manifold **(see illustration)**. (On B28E models, do not touch the other two screws.)

11 Read the CO level and adjust if necessary by turning the mixture adjustment screw next to the fuel distributor **(see illustration)**. A long Allen key will be needed. After each adjustment, remove the Allen key, rev the engine briefly and allow the CO reading to stabilise before rechecking.

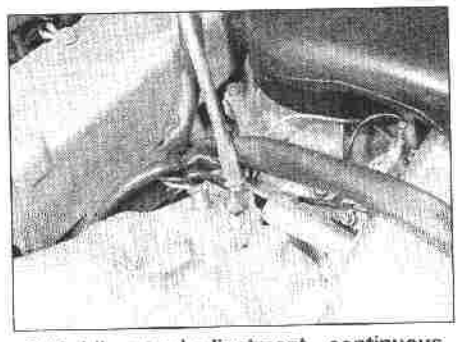
12 Readjust the idle speed if necessary.

LH-Jetronic systems

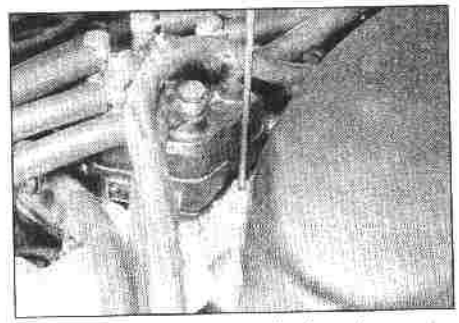
Note: *On LH2.4-Jetronic systems (fitted to B234F engines), adaptive control is applied to the idling speed and CO content, using data accumulated from previous driving conditions, and no adjustment is possible (except for idling speed during limp-home mode). If either the idling speed or CO content are not correct, there is likely to be a faulty component and you will need to check the diagnostic unit for fault codes (See Chapter 4B). If there is an emission-related problem, a light on the dashboard will turn on. In some circumstances, when the control unit receives incorrect signals, it will go into limp-home mode and then you can adjust the idling speed from the throttle adjustment screw. The idling speed during limp-home should be lower than usual (See Specifications). If you wish, you can manually invoke limp-home mode by connecting a jumper between terminals 1 and 2 of the throttle switch wiring connector.*

13 Note that the oil filler cap should be removed while checking the CO level.

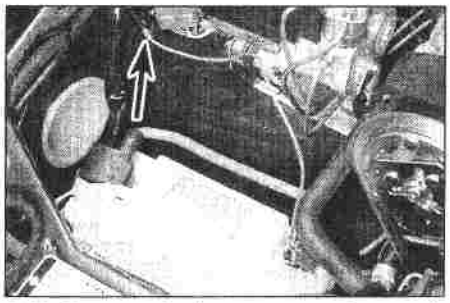
14 Locate the air control valve diagnostic connector - a small (2-pole) connector tucked under the cooling system expansion tank. Temporarily disable the valve by connecting



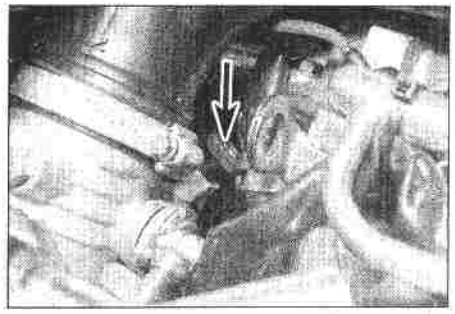
7.10 Idle speed adjustment - continuous injection system and Motronic system. On B28E engines, do not touch the other two screws shown



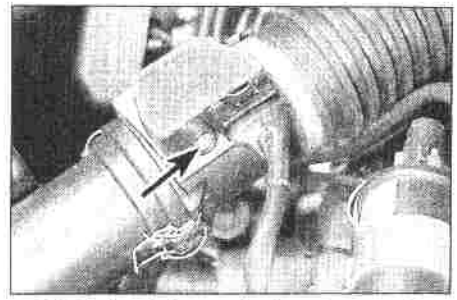
7.11 Idle mixture adjustment on continuous injection systems and Motronic systems using a long Allen key



7.14 Air control valve connector (arrowed) connected to the battery earth terminal - LH Jetronic systems



7.15 Idle speed adjuster screw (arrowed) - LH Jetronic systems



7.17 Idle mixture adjustment screw is beneath the tamperproof cap (arrowed) - LH Jetronic systems

the red and white wire in the connector to the battery earth (negative) terminal **(see illustration)**.

15 Basic idle speed should now be as given in the Specifications. Adjust if necessary by turning the knurled adjuster screw on the throttle housing **(see illustration)**.

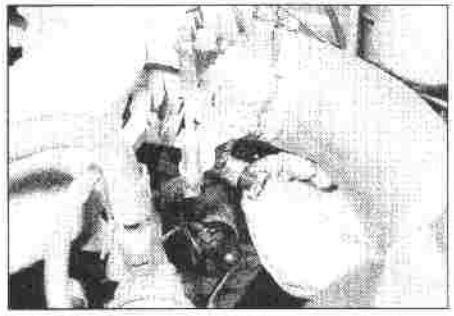
16 Disconnect the earthing wire from the diagnostic connector. Idle speed should now rise to the regulated value and remain steady. Fluctuations may be caused by leaks around the throttle housing or air control valve.

17 Read the CO level. Adjustment should only be attempted if it is outside the limits specified for checking values. The adjustment screw is located in the air mass meter, beneath a tamperproof cap next to the multi-plug **(see illustration)** - except for LH2.4-Jetronic which is not adjustable. The cap is removed by drilling two small holes in it and pulling it out with circlip pliers.

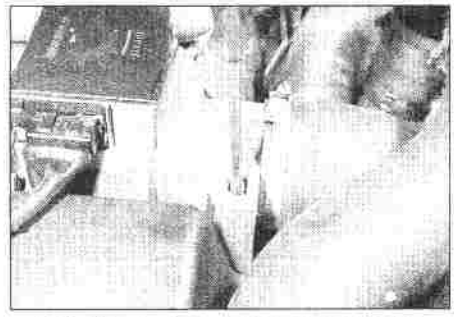
18 Turn the CO adjustment screw clockwise to increase CO level, anti-clockwise to reduce it, until the specified setting value is obtained.

Fuel injection models (Turbo)

19 Adjust the idle speed if necessary by turning the knurled adjustment screw next to the throttle housing **(see illustration)**.



7.19 Idle speed adjustment on Turbo models



7.20 Idle mixture adjustment on Turbo models

20 Read the CO level and adjust if necessary by turning the adjustment screw on the airflow meter **(see illustration)**.

21 Readjust the idle speed if necessary.

All models

22 If the CO reading is initially too high, but falls substantially when the crankcase ventilation hose is disconnected from the oil trap (in-line engines) or when the oil filler cap is removed (V6 engines), this suggests that fuel contamination of the oil is affecting the readings. Change the engine oil before proceeding.

23 When the idle speed and mixture are within the specified limits, stop the engine and disconnect the test gear.

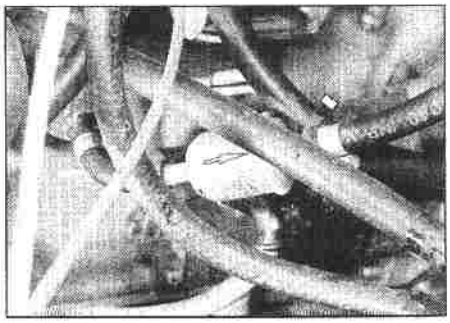
24 On models with a constant idle speed system, disconnect the test wire earth lead.

25 Fit new tamperproof seals when required.

12 000 mile / twelve month service

8 In-line fuel filter check

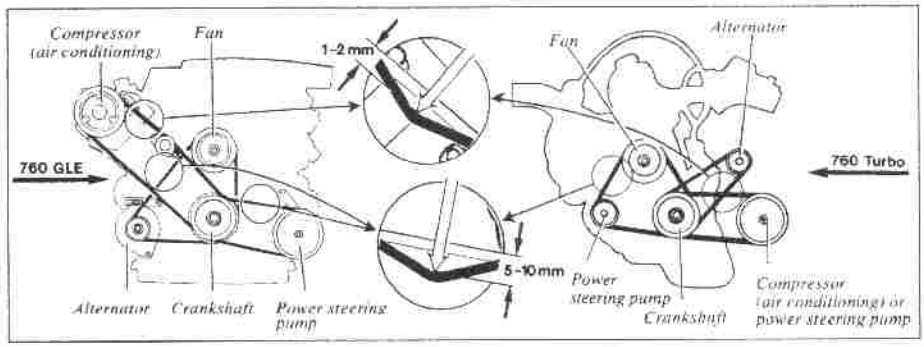
The in-line fuel filter fitted to carburettor models is located in the engine compartment in the carburettor fuel feed line. The filter body is made of translucent material allowing the internal element to be easily inspected for signs of dirt or sediment **(see illustration)**. If the filter appears excessively dirty, it should be renewed as described in Section 29.



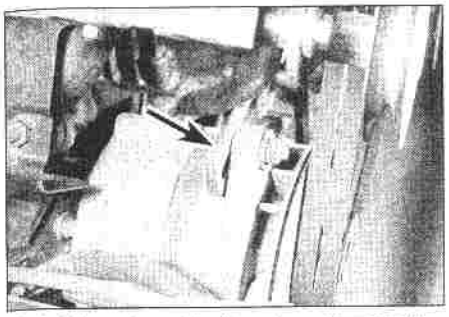
8.1 Carburettor in-line fuel filter. Arrow indicates direction of flow

9 Accessory drivebelts check and renewal

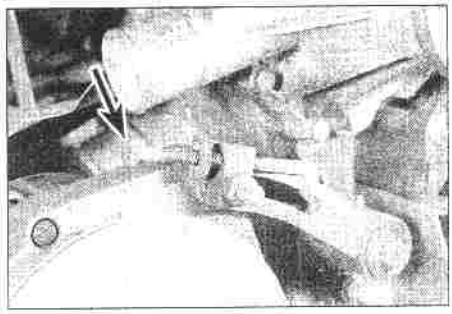
1 The accessory drivebelts transmit power from the crankshaft pulley to the alternator,



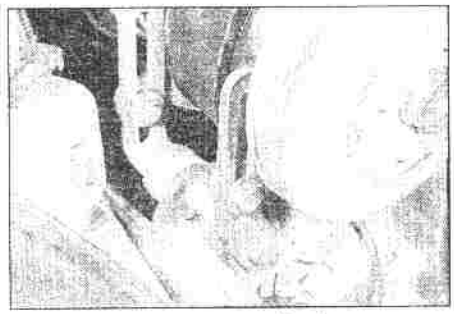
9.1 Some typical accessory drivebelt layouts



9.6 Alternator adjusting strap (arrowed) - without positive tensioner



9.7 Alternator adjusting strap with positive tensioner. Adjusting screw is arrowed



9.11a Steering pump adjusting strap - in-line engine

water pump/viscous fan, steering pump and air conditioning compressor (as applicable). A variety of belt arrangements and tensioning methods will be found, according to equipment and engine type. A representative selection is shown **(see illustration)**.

Check

2 With the engine switched off, open and support the bonnet, then locate the accessory drivebelts fitted to your car (Be very careful, and wear protective gloves to minimise the risk of burning your hands on hot components, if the engine has recently been running).

3 Using an inspection light or a small electric torch, and rotating the engine when necessary with a spanner applied to the crankshaft pulley bolt, check the whole length of the drivebelt for cracks, separation of the rubber, and torn or worn ribs. Also check for fraying and glazing, which gives the drivebelt a shiny appearance. Both sides of the drivebelt should be inspected, which means you will have to twist the drivebelt to check the underside. Use your fingers to feel the drivebelt where you can't see it. If you are in any doubt as to the condition of the drivebelt, renew it.

Renewal and adjustment

4 When removing a particular drivebelt, it will obviously be necessary to remove those in front of it first.

5 Twin belts should always be renewed in pairs, even if only one is broken.

Water pump/alternator drivebelt(s)

6 Slacken the alternator pivot and adjusting strap nuts and bolts **(see illustration)**.

7 Move the alternator towards the engine to release the belt tension. On some models a positive tensioning device is used: undo the tensioner screw to move the alternator inwards **(see illustration)**.

8 Slip the belts off the pulleys and remove them.

9 When refitting, move the alternator away from the engine until the belts can be deflected 5 to 10 mm by firm thumb pressure in the middle of the longest run. Tighten the pivot and adjusting strap nuts and bolts in this position and recheck the tension.

10 On models with a positive tensioning device, be careful not to overtension the belt. On models without such a device, it may be helpful to lever the alternator away from the engine to achieve the desired tension. Only use a wooden or plastic lever, and only lever at the pulley end.

Steering pump drivebelt

11 Proceed as for the water pump/alternator drivebelt, noting the location of the pivot and adjuster strap nuts and bolts **(see illustrations)**. On V6 models, access to the steering pump is easier from below.

Air conditioning compressor drivebelt

12 On models where the compressor mountings allow it to be pivoted, proceed as for the water pump/alternator drivebelt. Note, however, that the desired deflection of the belt is only 1 to 2 mm.

13 On models where the compressor mounting is rigid, belt tension is controlled by varying the number of shims between segments of the crankshaft pulley **(see illustration)**.

14 To remove the drivebelt, unbolt the pulley from its hub. Remove the pulley segments and the shims. The drivebelt can now be removed **(see illustration)**.

15 When refitting, experiment with the number of shims between the segments until belt tension is correct. Inserting shims decreases the tension, and *vice versa*. Fit unused shims in front of the pulley for future use.

All drivebelts

16 Recheck the tension of a new belt after a few hundred miles.

10 Distributor, rotor arm and HT lead check

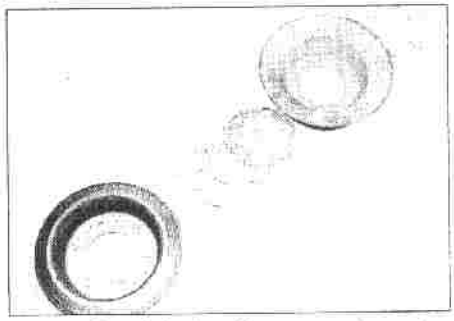
1

Warning: Voltages produced by an electronic ignition system are considerably higher than those produced by conventional ignition systems. Extreme care must be taken when working on the system if the ignition is switched on. Persons with surgically-implanted cardiac pacemaker devices should keep well clear of the ignition circuits, components and test equipment.

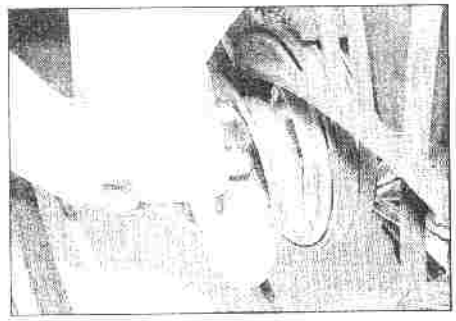
1 The spark plug (HT) leads should be inspected one at a time, to prevent mixing up the firing order, which is essential for proper engine operation. Gain access to the leads and disconnect them as described previously for the spark plug check and renewal.

2 Check inside the boot for corrosion, which will look like a white crusty powder. Clean this off as much as possible; if it is excessive, or if cleaning leaves the metal connector too badly

9.11b Steering pump adjusting strap - V-6 engine



9.13 Crankshaft pulley segments and shims



9.14 Removing the pulley front segment

corroded to be fit for further use, the lead must be renewed. Push the lead and boot back onto the end of the spark plug. The boot should fit tightly onto the end of the plug - if it doesn't, remove the lead and use pliers carefully to crimp the metal connector inside the boot until the fit is snug.

3 Using a clean rag, wipe the entire length of the lead to remove built-up dirt and grease. Once the lead is clean, check for burns, cracks and other damage. Do not bend the lead sharply, because the conductor might break.

4 Inspect the remaining spark plug (HT) leads, ensuring that each is securely fastened at the distributor cap and spark plug when the check is complete. If any sign of arcing, severe connector corrosion, burns, cracks or other damage is noticed, obtain new spark plug (HT) leads, renewing them as a set.

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If new spark plug leads are to be fitted, remove the leads one at a time and fit each new lead in exactly the same position as the old one.

5 Refer to Chapter 5B and remove the distributor cap then thoroughly clean it inside and out with a dry lint-free rag.

6 Examine the HT lead segments inside the cap. If they appear badly burned or pitted renew the cap. Also check the carbon brush in the centre of the cap, ensuring that it is free to move and stands proud of its holder. Make sure that there are no sign of cracks or black "tracking" lines running down the inside of the cap, which will also mean renewal if evident.

7 On the B28E engines lubricate the felt pad under the distributor rotor arm with a couple of drops of engine oil. Do not over-lubricate.

8 Refit the cap as described in Chapter 5B on completion.

11 Turbo boost pressure switches check

Testing of the boost pressure switch operation on turbo models entails the use of special gauges and a pressure pump and should be entrusted to a Volvo dealer.

12 Underbonnet check for fluid leaks and hose condition

Warning: Renewal of air conditioning hoses must be left to a dealer service department or air conditioning specialist who has the equipment to depressurise the system safely. Never remove air conditioning components or hoses until the system has been depressurised.

General

1 High temperatures in the engine compartment can cause the deterioration of the rubber and plastic hoses used for engine, accessory and emission systems operation. Periodic inspection should be made for cracks, loose clamps, material hardening and leaks.

2 Carefully check the large top and bottom radiator hoses, along with the other smaller-diameter cooling system hoses and metal pipes; do not forget the heater hoses/pipes which run from the engine to the bulkhead. Inspect each hose along its entire length, replacing any that is cracked, swollen or shows signs of deterioration. Cracks may become more apparent if the hose is squeezed.

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A leak in the cooling system will usually show up as white- or rust-coloured deposits on the areas adjoining the leak.

3 Make sure that all hose connections are tight. If the spring clamps that are used to secure the hoses in this system appear to be slackening, they should be renewed to prevent the possibility of leaks.

4 Some other hoses are secured to their fittings with clamps. Where clamps are used, check to be sure they haven't lost their tension, allowing the hose to leak. If clamps aren't used, make sure the hose has not expanded and/or hardened where it slips over the fitting, allowing it to leak.

5 Check all fluid reservoirs, filler caps, drain plugs and fittings etc, looking for any signs of leakage of oil, transmission and/or brake hydraulic fluid, coolant and power steering fluid. If the vehicle is regularly parked in the same place, close inspection of the ground underneath it will soon show any leaks; ignore the puddle of water which will be left if the air conditioning system is in use. As soon as a leak is detected, its source must be traced and rectified. Where oil has been leaking for some time, it is usually necessary to use a steam cleaner, pressure washer or similar, to clean away the accumulated dirt, so that the exact source of the leak can be identified.

Vacuum hoses

6 It's quite common for vacuum hoses, especially those in the emissions system, to be numbered or colour-coded, or to be identified by coloured stripes moulded into them. Various systems require hoses with different wall thicknesses, collapse resistance and temperature resistance. When renewing hoses, be sure the new ones are made of the same material.

7 Often the only effective way to check a hose is to remove it completely from the vehicle. If more than one hose is removed, be sure to label the hoses and fittings to ensure correct installation.

8 When checking vacuum hoses, be sure to include any plastic T-fittings in the check. Inspect the fittings for cracks, and check the hose where it fits over the fitting for distortion, which could cause leakage.

9 A small piece of vacuum hose can be used as a stethoscope to detect vacuum leaks. Hold one end of the hose to your ear, and probe around vacuum hoses and fittings, listening for the "hissing" sound characteristic of a vacuum leak.

Warning: When probing with the vacuum hose stethoscope, be very careful not to come into contact with moving engine components such as the auxiliary drivebelt, radiator electric cooling fan, etc.

Fuel hoses

Warning: Before carrying out the following operation, refer to the precautions given in "Safety first!" at the beginning of this manual, and follow them implicitly. Petrol is a highly dangerous and volatile liquid, and the precautions necessary when handling it cannot be overstressed.

10 Check all fuel hoses for deterioration and chafing. Check especially for cracks in areas where the hose bends, and also just before fittings, such as where a hose attaches to the fuel filter.

11 High-quality fuel line, usually identified by the word "Fluoroelastomer" printed on the hose, should be used for fuel line renewal. Never, under any circumstances, use unreinforced vacuum line, clear plastic tubing or water hose for fuel lines.

12 Spring-type clamps are commonly used on fuel lines. These clamps often lose their tension over a period of time, and can be "sprung" during removal. Replace all spring-type clamps with screw clamps whenever a hose is replaced.

Metal lines

13 Sections of metal piping are often used for fuel line between the fuel filter and the engine. Check carefully to be sure the piping has not been bent or crimped, and that cracks have not started in the line.

14 If a section of metal fuel line must be renewed, only seamless steel piping should be used, since copper and aluminium piping don't have the strength necessary to withstand normal engine vibration.

15 Check the metal brake lines where they enter the master cylinder and ABS hydraulic unit (if used) for cracks in the lines or loose

fittings. Any sign of brake fluid leakage calls for an immediate and thorough inspection of the brake system.

13 Handbrake check and adjustment

1 The handbrake should be fully applied within the specified number of clicks of the lever ratchet. Adjustment will be necessary periodically to compensate for lining wear and cable stretch.
2 Remove the rear ashtray and the cigarette lighter/seat belt warning light panel for access to the cable adjuster **(see illustration)**.
3 Release the locking sleeve from the front of the adjuster, either by driving the sleeve forwards or by pulling the adjuster back. Turn the adjuster nut until handbrake operation occurs within the specified number of clicks. Check that the brake is not binding when the lever is released.
4 Re-engage the locking sleeve and refit the panel and rear ashtray.

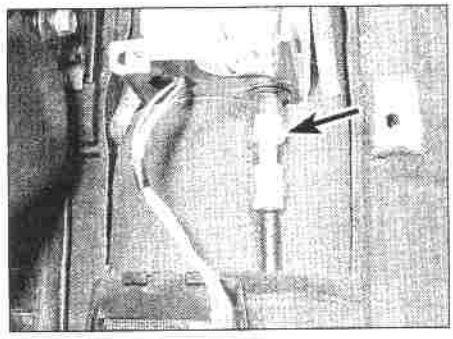
14 Front wheel bearing adjustment

Refer to Chapter 10.

15 Steering and suspension check

Front suspension and steering check

1 Apply the handbrake, then raise the front of the vehicle and support it on axle stands (see *"Jacking and vehicle support"*).
2 Visually inspect the balljoint dust covers and the steering gear gaiters for splits, chafing or deterioration. Any wear of these components will cause loss of lubricant, together with dirt and water entry, resulting in rapid deterioration of the balljoints or steering gear.
3 Check the power-assisted steering fluid hoses for chafing or deterioration, and the pipe and hose unions for fluid leaks. Also check for signs of fluid leakage under pressure from the steering gear rubber gaiters, which would indicate failed fluid seals within the steering gear.
4 Check for signs of fluid leakage around the shock absorber body, or from the rubber boot around the piston rod (where fitted). Should any fluid be noticed, the shock absorber is defective internally, and renewal is necessary.
5 Grasp the roadwheel at the 12 o'clock and 6 o'clock positions, and try to rock it. Very slight free play may be felt, but if the movement is appreciable, further investigation



13.2 Handbrake cable adjuster (arrowed) with surrounding trim removed

is necessary to determine the source. Continue rocking the wheel while an assistant depresses the footbrake. If the movement is now eliminated or significantly reduced, it is likely that the wheel bearings are at fault or in need of adjustment (where applicable). If the free play is still evident with the footbrake depressed, then there is wear in the suspension joints or mountings.
6 Now grasp the wheel at the 9 o'clock and 3 o'clock positions, and try to rock it as before. Any movement felt now may again be caused by wear in the wheel bearings or the steering track rod balljoints. If the outer track rod end balljoint is worn, the visual movement will be obvious. If the inner joint is suspect, it can be felt by placing a hand over the rack-and-pinion rubber gaiter, and gripping the track rod. If the wheel is now rocked, movement will be felt at the inner joint if wear has taken place.
7 Using a large screwdriver or flat bar, check for wear in the suspension mounting bushes by levering between the relevant suspension component and its attachment point. Some movement is to be expected as the mountings are made of rubber, but excessive wear should be obvious. Also check the condition of any visible rubber bushes, looking for splits, cracks or contamination of the rubber.
8 With the vehicle standing on its wheels, have an assistant turn the steering wheel back-and-forth, about an eighth of a turn each way. There should be very little, if any, lost movement between the steering wheel and roadwheels. If this is not the case, closely observe the joints and mountings previously described, but in addition, check the steering column universal joints for wear, and also check the rack-and-pinion steering gear itself.
9 The efficiency of the shock absorber may be checked by bouncing the car at each front corner. Generally speaking, the body will return to its normal position and stop after being depressed. If it rises and returns on a rebound, the shock absorber is probably suspect. Examine also the shock absorber upper and lower mountings for any signs of wear.

Rear suspension check

10 Chock the front wheels, then raise the rear of the vehicle and support it on axle stands (see *"Jacking and vehicle support"*).
11 Check the rear hub bearings for wear, using the method described for the front hub bearings (paragraph 5 and 6).
12 Using a large screwdriver or flat bar, check for wear in the suspension mounting bushes by levering between the relevant suspension component and its attachment point. Some movement is to be expected as the mountings are made of rubber, but excessive wear should be obvious. Check the condition of the shock absorbers as described previously.

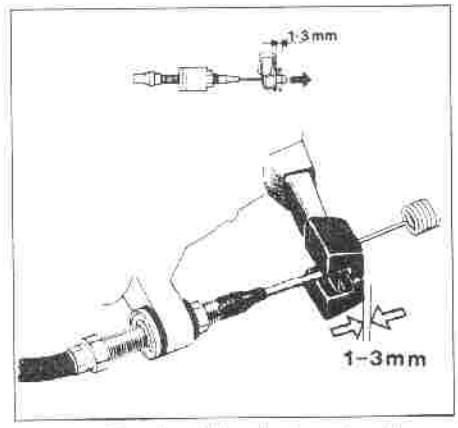
16 Clutch hydraulic check/cable adjustment

Hydraulic check

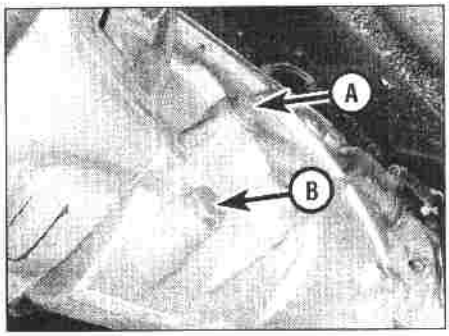
1 On models with an hydraulically operated clutch, check that the clutch pedal moves smoothly and easily through its full travel, and that the clutch itself functions correctly, with no trace of slip or drag.
2 Remove the closing panels under the facia for access to the clutch pedal and apply a few drops of light oil to the pedal pivot. Refit the panel.
3 From within the engine compartment check the condition of the fluid lines and hoses. Now have a look under the car at the clutch slave cylinder. Check for signs of fluid leaks around the rubber boot and check the security of the linkage. Apply a few drops of oil to the pushrod clevis pin and linkage.

Cable adjustment

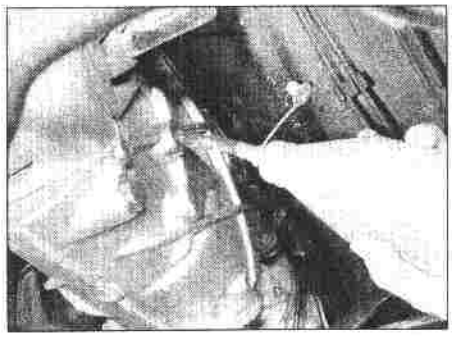
4 On models with a cable-operated clutch, check the clutch operation generally as described in paragraphs 1 and 2, and in addition check that the clutch cable is adjusted correctly. Cable adjustment is correct when the free play at the release fork is as given in the Specifications. Adjust if necessary by means of the locknuts and threaded adjuster at the end of the cable outer **(see illustration)**.



16.4 Clutch cable adjustment at the release fork - with return spring (bottom) or without (top)



17.1 Manual transmission filler/level plug (A) and drain plug (B)



17.2 Topping-up the manual transmission oil

17 Manual transmission oil level check

1 The manual transmission does not have a dipstick. To check the oil level, raise the vehicle and support it securely on axle stands, making sure that the vehicle is level (see *"Jacking and vehicle support"*). On the left-hand side of the transmission casing you will see the filler/level plug and drain plug **(see illustration)**. Wipe all around the filler/level plug (the upper one of the two) with a clean rag then unscrew and remove it. If the lubricant level is correct, the oil should be up to the lower edge of the hole.

2 If the transmission needs more lubricant (if the oil level is not up to the hole), use a syringe, or a plastic bottle and tube, to add more **(see illustration)**. Stop filling the transmission when the lubricant begins to run out of the hole. Make sure that you use the correct type of lubricant *(see "Weekly checks")*.

3 Refit the filler/level plug, and tighten it securely. Drive the vehicle a short distance, then check for leaks.

4 A need for regular topping-up can only be due to a leak, which should be found and rectified without delay.

18 Underbody and fuel/brake line check

1 With the vehicle raised and supported on axle stands (see *"Jacking and vehicle support"*), or over an inspection pit, thoroughly inspect the underbody and wheel arches for signs of damage and corrosion. In particular, examine the bottom of the side sills, and any concealed areas where mud can collect. Where corrosion and rust is evident, press and tap firmly on the panel with a screwdriver, and check for any serious corrosion which would necessitate repairs. If the panel is not seriously corroded, clean away the rust, and apply a new coating of underseal. Refer to Chapter 11 for more details of body repairs.

2 At the same time, inspect the PVC-coated lower body panels for stone damage and general condition.

3 Inspect all of the fuel and brake lines on the underbody for damage, rust, corrosion and leakage. Also make sure that they are correctly supported in their clips. Where applicable, check the PVC coating on the lines for damage.

4 Inspect the flexible brake hoses in the vicinity of the calipers, where they are subjected to most movement. Bend them between the fingers (but do not actually bend them double, or the casing may be damaged) and check that this does not reveal previously-hidden cracks, cuts or splits.

19 Propeller shaft, centre bearing and universal joint check

1 Ideally the vehicle should be raised at the front and rear and securely supported on axle stands with the rear wheels free to rotate (see *"Jacking and vehicle support"*).

2 Check around the rubber portion of the centre bearing for any signs of cracks, oil contamination or deformation of the rubber. If any of these conditions are apparent, the centre bearing should be renewed as described in Chapter 8.

3 At the same time, check the condition of the universal joints by holding the propeller shaft in one hand and the transmission or rear axle flange in the other. Try to twist the two components in opposite direction and look for any movement in the universal joint spiders. Repeat this check at the centre bearing and in all other areas where the individual parts of the propeller shaft or universal joints connect. If any wear is evident, refer to Chapter 8 for repair procedures. If grating or squeaking noises have been heard from below the vehicle, or if there is any sign of rust coloured deposits around the universal joint spiders, this indicates an advanced state of wear and should be seen to immediately.

4 Also check the condition of the rubber coupling, looking for any signs of swelling, oil contamination or cracks and splits in the rubber, particularly around the bolt holes.

5 On vehicles with independent rear suspension, check the condition of the driveshaft rubber gaiters and constant velocity joints as follows.

6 The driveshaft rubber gaiters are very important, because they prevent dirt, water and foreign material from entering and damaging the constant velocity (CV) joints. External contamination can cause the gaiter material to deteriorate prematurely, so it's a good idea to wash the gaiters with soap and water occasionally.

7 Slowly rotate each rear wheel in turn and inspect the condition of the outer constant velocity (CV) joint rubber gaiters, squeezing the gaiters to open out the folds. Check for signs of cracking, splits, or deterioration of the rubber, which may allow the escape of grease, and lead to the ingress of water and grit into the joint. Also check the security and condition of the retaining clips. Repeat these checks on the inner CV joints. If any damage or deterioration is found, the driveshaft should first be removed as described in Chapter 8, Section 13.

8 At the same time, check the general condition of the outer CV joints themselves, by first holding the driveshaft and attempting to rotate the wheels. Repeat this check on the inner joints, by holding the inner joint yoke and attempting to rotate the driveshaft.

9 Any appreciable movement in the CV joint indicates wear in the joint, wear in the driveshaft splines, or a loose driveshaft retaining nut.

20 Exhaust system check

1 With the engine cold (at least three hours after the vehicle has been driven), check the complete exhaust system, from its starting point at the engine to the end of the tailpipe. Ideally, this should be done on a hoist, where unrestricted access is available; if a hoist is not available, raise and support the vehicle on axle stands (see *"Jacking and vehicle support"*).

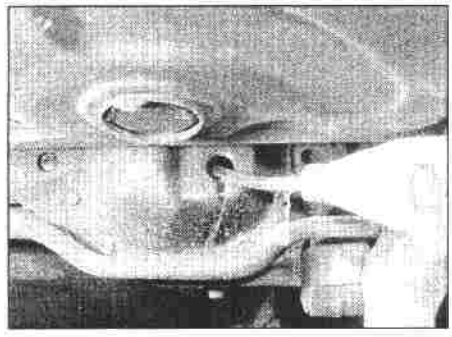
2 Check the pipes and connections for evidence of leaks, severe corrosion, or damage. Make sure that all brackets and rubber mountings are in good condition, and tight; if any of the mountings are to be renewed, ensure that the replacements are of the correct type. Leakage at any of the joints or in other parts of the system will usually show up as a black sooty stain in the vicinity of the leak.

3 At the same time, inspect the underside of the body for holes, corrosion, open seams, etc. which may allow exhaust gases to enter the passenger compartment. Seal all body openings with silicone or body putty.

4 Rattles and other noises can often be traced to the exhaust system, especially the rubber mountings. Try to move the system, silencer(s) and catalytic converter (where fitted). If any components can touch the body or suspension parts, secure the exhaust system with new mountings.

21 Rear axle oil level check

1 Ideally, the vehicle should be standing on its wheels for this check but if this is a problem (and you can't squeeze underneath) either raise it at the front and rear and support it on axle stands or use a hoist or pit (see *"Jacking and vehicle support"*).
2 Wipe all around the filler/level plug on the rear axle then unscrew the plug. The filler/level is located on the rear of the final drive casing cover on models with a live rear axle, and on the front of the final drive casing itself on models with independent rear suspension. The best way to check the level is to use a "dipstick" made up from a bent piece of wire. Put the wire in the hole (but don't drop it in) and check the level.
3 If the axle needs more lubricant, use a syringe, or a plastic bottle and tube, to add more **(see illustration)**. Stop filling the axle when the lubricant begins to run out of the hole. Make sure that you use the correct grade of lubricant *(see "Weekly checks")*.
4 Refit the filler/level plug, and tighten it securely.
5 A need for regular topping-up can only be due to a leak, which should be found and rectified without delay.



21.3 Topping-up the rear axle oil

22 Seat belt check

Check the seat belts for satisfactory operation and condition. Inspect the webbing for fraying and cuts. Check that they retract smoothly and without binding into their reels.

Check the seat belt mountings, ensuring that all the bolts are securely tightened.

23 Door, boot, tailgate and bonnet check and lubrication

Check that the doors, bonnet and tailgate/boot lid close securely. Check that the bonnet safety catch operates correctly. Check the operation of the door check straps.

Lubricate the hinges, door check straps, the striker plates and the bonnet catch sparingly with a little oil or grease.

24 Bodywork, paint and exterior trim check

1 The best time to carry out this check is after the car has been washed so that any surface blemish or scratch will be clearly evident and not hidden by a film of dirt.
2 Starting at one front corner check the paintwork all around the car, looking for minor scratches or more serious dents. Check all the trim and make sure that it is securely attached over its entire length.
3 Check the security of all door locks, door mirrors, badges, bumpers radiator grille and wheel trim. Anything found loose, or in need of further attention should be done with reference to the relevant Chapters of this manual.
4 Rectify any problems noticed with the paintwork or body panels as described in Chapter 11.

25 Automatic transmission kickdown cable operation and selector cable adjustment

Refer to Chapter 7B.

26 Road test

Check the operation and performance of the braking system

1 Make sure that the vehicle does not pull to one side when braking, and that the wheels do not lock prematurely when braking hard.
2 Check that there is no vibration through the steering when braking.
3 Check that the handbrake operates correctly, without excessive movement of the lever, and that it holds the vehicle stationary on a slope.
4 With the engine switched off, test the operation of the brake servo unit as follows. Depress the footbrake four or five times to exhaust the vacuum, then start the engine. As the engine starts, there should be a noticeable "give" in the brake pedal as vacuum builds up. Allow the engine to run for at least two minutes, and then switch it off. If the brake pedal is now depressed again, it should be possible to detect a hiss from the servo as the pedal is depressed. After about four or five applications, no further hissing should be heard, and the pedal should feel considerably harder.

Steering and suspension

5 Check for any abnormalities in the steering, suspension, handling or road "feel".
6 Drive the vehicle, and check that there are no unusual vibrations or noises.
7 Check that the steering feels positive, with no excessive sloppiness or roughness, and check for any suspension noises when cornering and driving over bumps.

Drivetrain

8 Check the performance of the engine, transmission and driveline.
9 Check that the engine starts correctly, both when cold and when hot.
10 Listen for any unusual noises from the engine and transmission.
11 Make sure that the engine runs smoothly when idling, and that there is no hesitation when accelerating.
12 On manual transmission models, check that all gears can be engaged smoothly without noise, and that the gear lever action is not abnormally vague or "notchy".
13 On automatic transmission models, make sure that the drive seems smooth without jerks or engine speed "flare-ups". Check that all the gear positions can be selected with the vehicle at rest. If any problems are found, they should be referred to a Volvo dealer.

Clutch

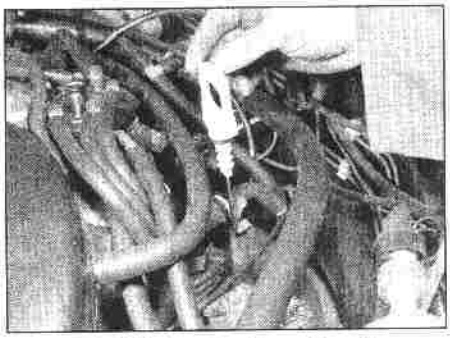
14 Check that the clutch pedal moves smoothly and easily through its full travel, and that the clutch itself functions correctly, with no trace of slip or drag. If the movement is uneven or stiff in places, check the system components with reference to Chapter 6.

Instruments and electrical equipment

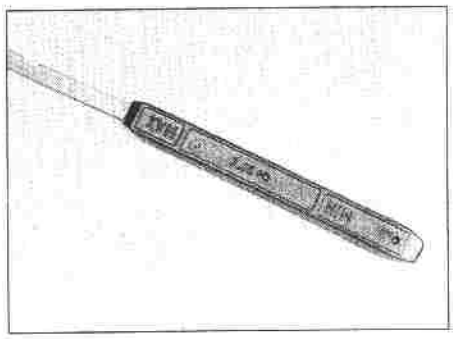
15 Check the operation of all instruments and electrical equipment.
16 Make sure that all instruments read correctly, and switch on all electrical equipment in turn, to check that it functions properly.

27 Automatic transmission fluid level check

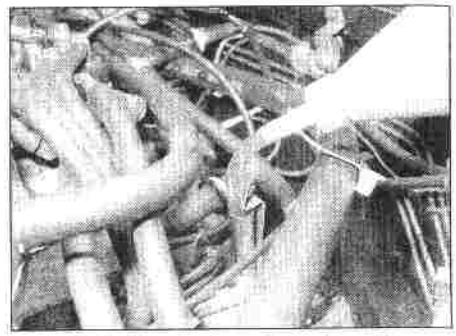
1 The level of the automatic transmission fluid should be carefully maintained. Low fluid level can lead to slipping or loss of drive, while overfilling can cause foaming, loss of fluid and transmission damage.
2 The transmission fluid level should only be checked when the transmission is hot (at its normal operating temperature). If the vehicle has just been driven over 10 miles (15 miles in a cold climate), and the fluid temperature is 160 to 175°F, the transmission is hot.
3 Park the vehicle on level ground, apply the handbrake, and start the engine. While the engine is idling, depress the brake pedal and move the selector lever through all gear positions then returning to the "P" position.



27.4 Withdrawing the automatic transmission dipstick



27.6a Automatic transmission dipstick markings



27.6b Topping -up the automatic transmission fluid

4 Wait two minutes then, with the engine still idling, remove the dipstick from its tube which is located at the rear of the engine **(see illustration)**. Note the condition and colour of the fluid on the dipstick.

5 Wipe the fluid from the dipstick with a clean rag, and re-insert it into the filler tube until the cap seats.

6 Pull the dipstick out again, and note the fluid level. The level should be between the "MIN" and "MAX" marks, on the side of the dipstick marked "HOT". If the level is on the "MIN" mark, stop the engine, and add the specified automatic transmission fluid (see *"Weekly checks"*) through the dipstick tube, using a clean funnel if necessary **(see illustrations)**. It is important not to introduce dirt into the transmission when topping-up.

7 Add the fluid a little at a time, and keep checking the level as previously described until it is correct. The difference between the "MIN" and "MAX" marks on the dipstick is approximately 0.5 litre.

8 The need for regular topping-up of the transmission fluid indicates a leak, which should be found and rectified without delay.

9 The condition of the fluid should also be checked along with the level. If the fluid at the end of the dipstick is black or a dark reddish-brown colour, or if it has a burned smell, the fluid should be changed. If you are in doubt about the condition of the fluid, purchase some new fluid, and compare the two for colour and smell.

24 000 mile / two year service

28 Automatic transmission fluid renewal

1 Raise and securely support the vehicle (see *"Jacking and vehicle support"*). ***Caution: This procedure may entail the engine to be running with the car raised and supported. Ensure adequate safety precautions are taken.***

AW71/AW72 transmission

2 If no drain plug is fitted, proceed from paragraph 3. If a drain plug is fitted, remove it and allow the contents of the sump to drain into a suitable container. **Caution: *If the vehicle has just been run, the transmission fluid may be very hot.*** Refit and tighten the drain plug **(see illustration)**. Add 2.0 litres of fresh automatic transmission fluid of the specified type (see *"Weekly checks"*) via the dipstick tube.

3 Clean the oil cooler return union (the rearmost one) on the side of the transmission **(see illustration)**. Disconnect the union and attach a clear plastic hose to the line from the cooler. Lead the hose into the draining container.

4 Start the engine and allow it to idle. Fluid will flow into the draining container. When bubbles appear in the fluid, stop the engine.

5 Add 2.0 litres of fresh automatic transmission fluid of the specified type via the dipstick tube.

6 Repeat paragraph 4, then remove the plastic hose and reconnect the oil cooler union.

7 Add a further 2.0 litres of fresh automatic transmission fluid.

8 Lower the vehicle. Check the fluid level as described in Section 27, but use the "COLD" or "+ 40°C" side of the dipstick. Top-up as necessary.

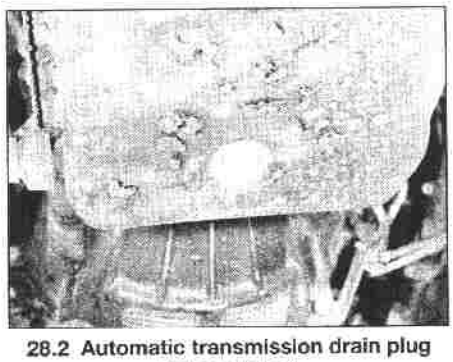
9 Dispose of the old fluid safely (see *"General repair procedures"*).

ZFHP422 transmission

10 Proceed as described above for the AW71/AW72 transmission, but note the following points:

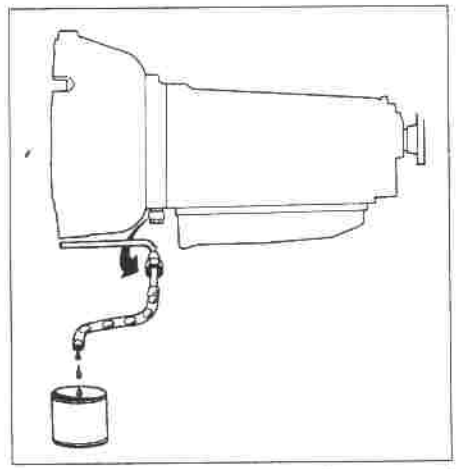
a) Add fluid in increments of 2.5 litres.

b) The oil cooler return union is the lower of the two ***(see illustration)***.

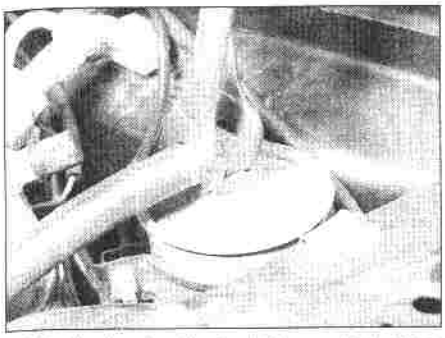


28.2 Automatic transmission drain plug (where fitted)

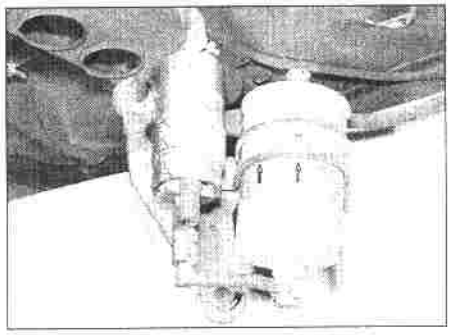
28.3 Oil cooler return union (arrowed) - AW71 transmission



28.10 Oil cooler return union disconnected from transmission for fluid changing (ZF transmission)



29.5 Slackening the fuel filter outlet union - under-bonnet filter



29.10 Under-car fuel filter (right) and fuel pump (left) on Turbo models. Arrow indicates direction of flow

29 Fuel filter renewal

Warning: Before carrying out the following operation, refer to the precautions given in "Safety first!" at the beginning of this manual, and follow them implicitly. Petrol is a highly dangerous and volatile liquid, and the precautions necessary when handling it cannot be overstressed.

1 Disconnect the battery negative lead.

Carburettor models

2 The fuel filter is located under the bonnet, in the carburettor fuel feed line (see illustration 8.1 on page 1•12). Slacken the hose clips and disconnect the hoses from the filter; be prepared for fuel spillage.

3 Fit the new filter, observing any direction of flow markings. Renew hoses and clips if necessary.

Fuel injection models

4 The filter is located under the bonnet, or with the main fuel pump, under the car.

Under-bonnet filter

5 Slacken the fuel outlet union on top of the filter. Be prepared for fuel spillage. Disconnect the unions **(see illustration)**.

6 Slacken the filter clamp. Lift up the filter and disconnect the inlet union. Be prepared for further spillage.

7 Remove the old filter.

8 Fit the new filter, making sure it is the same way round as the old one. Use new copper washers on the unions (when applicable) and secure the filter in the clamp.

Under-car filter

9 Raise the vehicle on ramps or drive it over a pit (see *"Jacking and vehicle support"*).

10 Unbolt the fuel pump cradle from the underside of the vehicle **(see illustration)**. Pull the cradle off the grommets.

11 Disconnect the fuel supply and outlet pipes from the filter. Be prepared for fuel spillage.

12 Unbolt the filter clamp and lift out the filter.

13 Fit the new filter, making sure it is the same way round as the old one. Observe the arrow on the new filter showing the direction of fuel flow. Use new copper washers on the unions (when applicable) and secure the filter in the clamp.

14 Locate the cradle on the grommets and secure in position. Lower the vehicle to the ground.

All models

15 Reconnect the battery. Run the engine and check that there are no leaks.

16 Dispose of the old filter safely.

30 Air cleaner element renewal

1 Release the clips which secure the air cleaner lid **(see illustration)**.

2 On Turbo models, disconnect the airflow meter multi-plug and the meter-to-turbo trunking **(see illustrations)**. The multi-plug is released by levering out the wire clip.

3 On B280 engines, release the clips securing the air mass meter to the air cleaner lid.

4 Lift off the lid, with airflow meter when applicable, and remove the air cleaner element **(see illustration)**.

5 Wipe clean inside the housing and lid with a cloth. Be careful not to sweep debris into the airflow meter or air inlet.

6 Fit the new element, making sure it is the right way up. Press the seal on the rim of the element into the groove on the housing.

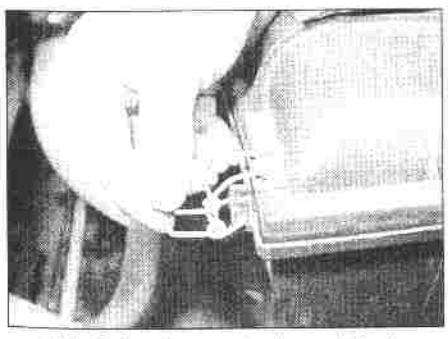
7 Refit the lid and secure it with the clips.

8 When applicable, reconnect the airflow meter or air mass meter.

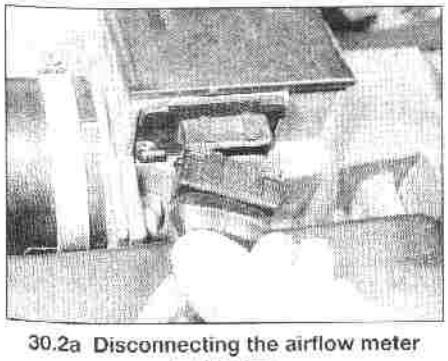
31 Emission control equipment check

1 Of the emission control systems that may be fitted, only the crankcase ventilation system requires regular checking, and even then, the components of this system require no attention other than to check that the hoses are clear and undamaged.

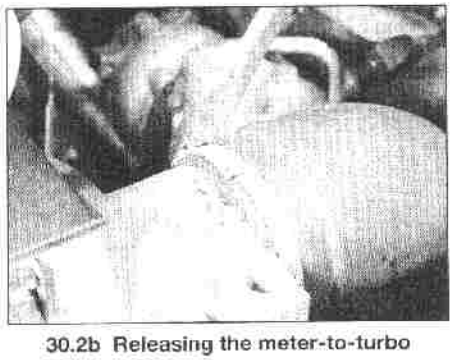
2 Should it be felt that the other systems (where fitted) are not functioning correctly, the advice of a dealer should be sought.



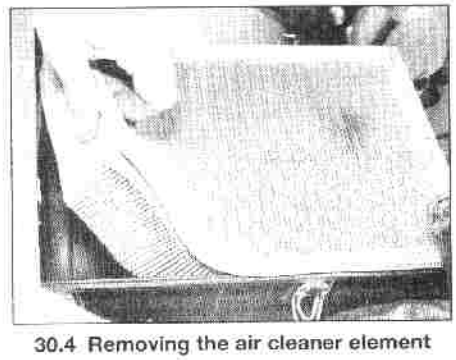
30.1 Releasing an air cleaner lid clip



30.2a Disconnecting the airflow meter multi-plug



30.2b Releasing the meter-to-turbo trunking



30.4 Removing the air cleaner element

1

32 Valve clearance check and adjustment

Note: *B234F engines have hydraulic tappets which do not need to be adjusted as part of regular maintenance. However, if there is tappet noise, they need to be checked and renewed as described in Chapter 2A. Do not run the engine at more than 3000 rpm while there is tappet noise.*

In-line engines

1 Disconnect or remove items such as HT leads, vacuum/breather/boost pressure hoses, and if necessary the throttle cable, in order to gain access to the camshaft cover. Also unbolt the auxiliary air valve from the camshaft cover, where applicable.

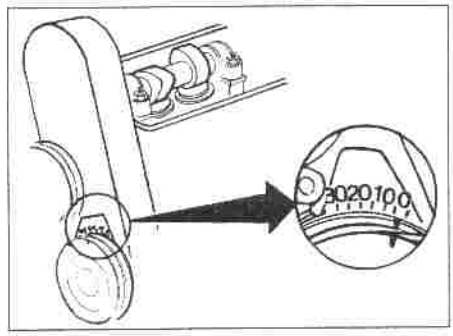
2 Remove the securing nuts and lift off the camshaft cover. Note the location of the earth strap, the HT lead clip and similar items (refer to Chapter 2A if necessary). Recover the gasket.

3 Using a spanner on the crankshaft pulley centre bolt, bring the engine to TDC, No 1 cylinder firing. (This will be easier if the spark plugs are removed.) No 1 piston is at TDC when the notch on the crankshaft pulley is in line with the figure "O" on the timing scale, and the cam lobes for No 1 cylinder (at the front) are both pointing obliquely upwards **(see illustration)**.

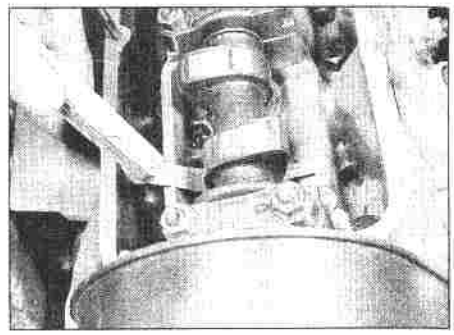
4 With the engine in this position, measure and record the clearance between the base of the front cam lobe and the tappet shim beneath it. Insert various thicknesses of feeler blade until a firm sliding fit is obtained **(see illustration)**. This thickness is the clearance for No 1 exhaust valve. Write it down.

5 Repeat the measurement and recording on the second cam from the front. This gives No 1 inlet valve clearance.

6 Turn the crankshaft 180° (half a turn) clockwise so that the cam lobes for No 3 cylinder are pointing obliquely upwards. Measure and record the clearances for these two valves. The exhaust valve is always nearer the front.



32.3 In-line engine pulley and cam lobe positions - No 1 at TDC firing



32.4 Measuring No 1 exhaust valve clearance

7 Turn the crankshaft a further 180° and deal with No 4 cylinder, then 180° again for No 2.

8 Compare the clearances recorded with those given in the Specifications. If the recorded clearances are within limits, commence reassembly (paragraph 16). Otherwise, adjust the clearances as follows.

9 Gather together a small screwdriver or scriber, a pair of long-nosed pliers and a stout C-spanner or square section screwdriver. These will substitute for the special tools normally required to change the shims with the camshaft in position. (Alternatively, the camshaft can be removed, but this involves much extra work.)

10 With the cam lobes in the same position as for checking, depress the tappet with the C-spanner or screwdriver. Only press on the edge of the tappet. Flick the shim out of the top of the tappet with the small screwdriver and remove it with the long-nosed pliers. Release the tappet **(see illustrations)**.

11 The correct thickness of shim must now be calculated. First the thickness of the old shim must be known. It may be engraved on the underside, but ideally the actual thickness should be measured with a micrometer or vernier gauge. This will take account of any wear.

12 The required shim thickness can now be calculated as shown in this example:

Specified clearance (A) = 0.40 mm
Measured clearance (B) = 0.28 mm
Original shim thickness (C) = 3.95 mm
Shim thickness required = C-A+B = 3.83 mm

In this example the shim to be fitted would have to be 3.85 mm or 3.80 mm, giving clearances of 0.38 mm or 0.43 mm respectively.

13 Lubricate a new shim of the required thickness. Depress the tappet and insert the shim, marked side downwards. Release the tappet and check that the shim is properly located.

14 Repeat the operations on the adjacent tappet, if necessary, then proceed to the other valves, each time turning the crankshaft to position the cam lobes upwards. Do not turn the crankshaft whilst shims are missing from tappets, as the cam lobes may jam in them.

15 When all the required shims have been fitted, turn the crankshaft through several complete turns, then check all the clearances again.

16 Make sure that the rubber plug to the rear of the camshaft (B 23 only) is securely fitted and in good condition. Renew it if necessary.

17 Refit the camshaft cover, using a new gasket. Fit and tighten the nuts, remembering to fit the HT lead bracket and earth strap.

18 Reconnect the HT leads, vacuum hoses etc, then run the engine and check that there are no oil leaks from the camshaft cover.

V-6 engines

19 Disconnect the battery negative lead.

20 Disconnect the ignition harness connector on the right-hand inner wing.

21 Unbolt the control pressure regulator (without disconnecting it) and place it on the inlet manifold.

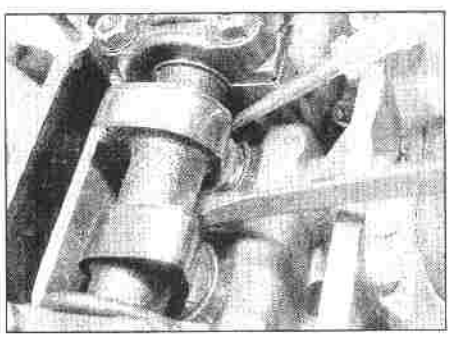
22 Remove the air inlet trunking, the oil filler cap and the crankcase ventilation hoses.

23 Unbolt and remove the vacuum pump.

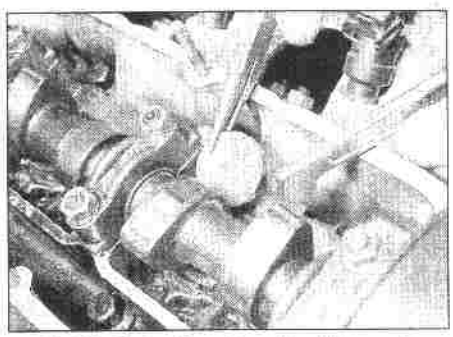
24 Remove the air conditioning compressor drivebelt (see Section 9). Unbolt the compressor brackets from the engine and move the compressor and brackets to one side. Do not disconnect any refrigerant hoses, nor allow the weight of the compressor to hang on them.

25 Unbolt and remove both rocker covers. Recover the gaskets.

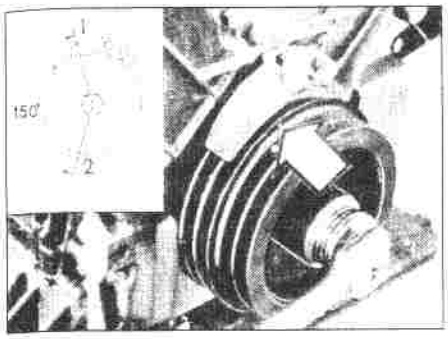
26 Using a 36 mm socket on the crankshaft pulley nut, or (manual gearbox) by pushing the car along with a gear engaged, bring the engine to TDC, No 1 firing. This is achieved when the No 1 pulley notch is aligned with the "O" mark on the timing scale, and both rocker arms for No 1 cylinder (LH rear) have a small



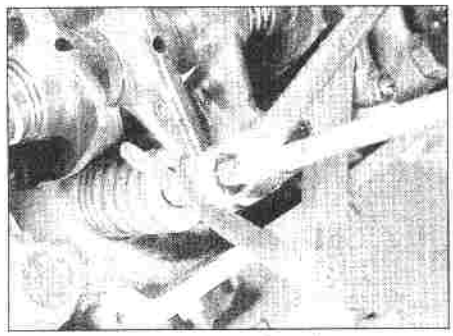
32.10a Freeing a tappet shim - the tappet is being held down with a square section screwdriver



32.10b Extracting the shim. Here a C-spanner is being used to depress the tappet



32.26 No 1 cylinder notch in the TDC position - V-6 engines



32.28 Adjusting a valve clearance

amount of free play, showing that the valves are closed **(see illustration)**.

27 Insert a feeler blade of the specified thickness between the adjuster screw and valve stem on No 1 cylinder exhaust valve (the rearmost valve). The blade should be a firm sliding fit, neither tight nor slack.

28 If adjustment is required, slacken the locknut and turn the adjuster screw until the clearance is correct. Hold the adjuster screw stationary and tighten the locknut without disturbing the position of the screw. Recheck the fit of the feeler blade **(see illustration)**.

29 Similarly check the clearances of the exhaust valves on cylinders No 3 and 6, and the inlet valves on cylinders No 1, 2 and 4. Remember that inlet and exhaust clearances are different. Inlet valves are nearest the centre of the engine, exhaust valves nearest the outside **(see illustration)**.

30 Turn the crankshaft 360° (one full turn) clockwise, so that the No 1 pulley notch is again aligned with the "O" mark, but this time No 1 cylinder rocker arms have no free play. In this position check the clearances of the exhaust valves on cylinders No 2, 4 and 5, and the inlet valves on cylinders No 3, 5 and 6 **(see illustration)**.

31 Recheck all clearances, turning the crankshaft as necessary.

32 Refit the rocker covers, using new gaskets.

33 Refit the remaining components in the reverse order to removal. Tension the air conditioning compressor drivebelt (Section 9).

34 Run the engine and check that there are no oil leaks from the rocker covers.

33 Compression test

Refer to Chapter 2A or 2B as applicable.

34 Coolant renewal

Warning: Wait until the engine is cold before starting this procedure. Do not allow antifreeze to come into contact with your skin, or with painted surfaces of the vehicle. Rinse off spills immediately with plenty of water. Never leave antifreeze lying around in an open container, or in a puddle in the driveway or on the garage floor. Children and pets are attracted by its sweet smell, but antifreeze can be fatal if ingested.

Coolant draining

1 To drain the system, first remove the expansion tank filler cap (see *"Weekly checks"*). Move the heater temperature control to the hot position.

2 If the additional working clearance is required, raise the front of the vehicle and support it securely on axle stands (see *"Jacking and vehicle support"*).

3 Where fitted, remove the engine undertray, then place a large drain tray underneath the radiator. Slacken the radiator bottom hose clip and pull the bottom hose off the radiator stub. Direct as much of the escaping coolant as possible into the tray.

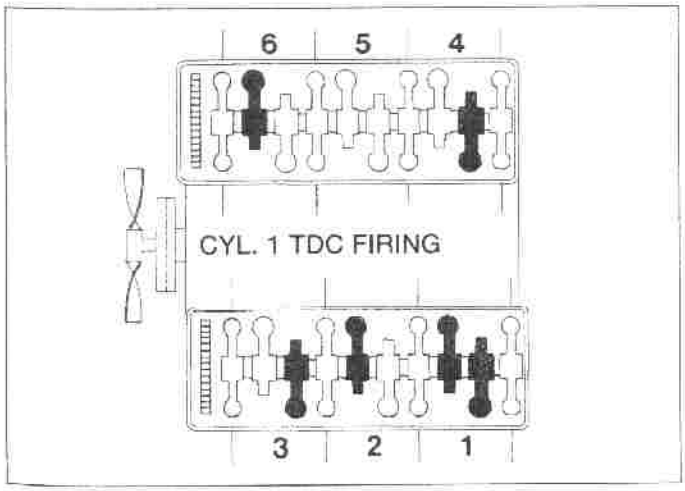
4 On in-line engines, when the radiator has drained, move the tray to the right-hand side of the engine and unscrew the cylinder block drain tap. Allow the cylinder block to drain. On early V-6 engines there are two drain taps, one on each side of the block. On later V-6 engines the drain tap on the left-hand side is replaced by a banjo union which is part of the oil cooler coolant circuit. Drain the left-hand cylinder bank by slackening this banjo union.

System flushing

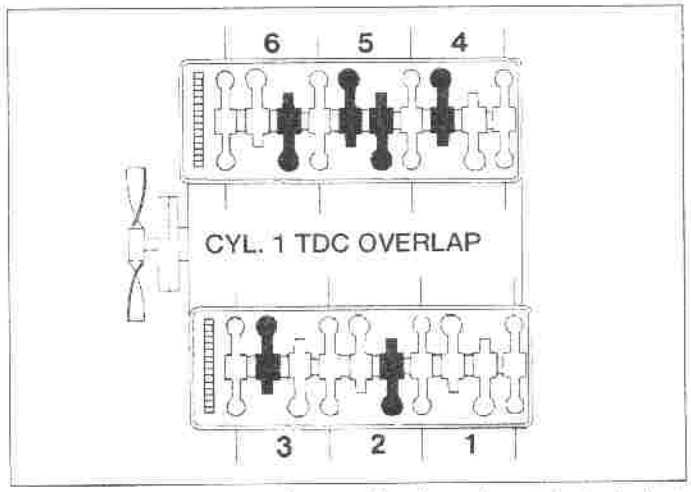
5 With time, the cooling system may gradually lose its efficiency, as the radiator core becomes choked with rust, scale deposits from the water, and other sediment. To minimise this, as well as using only good-quality antifreeze and clean soft water, the system should be flushed as follows whenever any part of it is disturbed, and/or when the coolant is renewed.

6 With the coolant drained, refit the drain plugs and refill the system with fresh water. Refit the expansion tank filler cap, start the engine and warm it up to normal operating temperature, then stop it and (after allowing it to cool down completely) drain the system again. Repeat as necessary until only clean water can be seen to emerge, then refill finally with the specified coolant mixture.

7 If only clean, soft water and good-quality antifreeze has been used, and the coolant has



32.29 With No 1 cylinder piston in the firing position, adjust the valves in the dark coloured positions



32.30 With No 1 cylinder piston ending the exhaust stroke (valves overlapping) adjust the other valves shown

been renewed at the specified intervals, the above procedure will be sufficient to keep the system clean for a considerable length of time. If, however, the system has been neglected, a more thorough operation will be required, as follows.

8 First drain the coolant, then disconnect the radiator top and bottom hoses. Insert a garden hose into the top hose, and allow water to circulate through the radiator until it runs clean from the bottom outlet.

9 To flush the engine, insert the garden hose into the thermostat water outlet, and allow water to circulate until it runs clear from the bottom hose. If, after a reasonable period, the water still does not run clear, the radiator should be flushed with a good proprietary cleaning agent.

10 In severe cases of contamination, reverse-flushing of the radiator may be necessary. To do this, remove the radiator (Chapter 3), invert it, and insert the garden hose into the bottom outlet. Continue flushing until clear water runs from the top hose outlet. A similar procedure can be used to flush the heater matrix.

11 The use of chemical cleaners should be necessary only as a last resort. Normally, regular renewal of the coolant will prevent excessive contamination of the system.

Coolant filling

12 With the cooling system drained and flushed, ensure that all disturbed hose unions are correctly secured, and that the cylinder block drain taps are securely tightened. Refit the engine undertray if it was removed for access. If it was raised, lower the vehicle to the ground.

13 Prepare a sufficient quantity of the specified coolant mixture (see Section 5); allow for a surplus, so as to have a reserve supply for topping-up.

14 Slowly fill the system through the expansion tank; since the tank is the highest point in the system, all the air in the system should be displaced into the tank by the rising liquid. Slow pouring reduces the possibility of air being trapped and forming air-locks.

15 Continue filling until the coolant level reaches the expansion tank "MAX" level line, then cover the filler opening to prevent coolant splashing out.

16 Start the engine and run it at idle speed, until it has warmed-up to normal operating temperature. If the level in the expansion tank drops significantly, top-up to the "MAX" level line, to minimise the amount of air circulating in the system.

17 Stop the engine, allow it to cool down *completely* (overnight, if possible), then uncover the expansion tank filler opening and top-up the tank to the "MAX" level line. Refit the filler cap, tightening it securely, and wash off any spilt coolant from the engine compartment and bodywork.

18 After refilling, always check carefully all components of the system (but especially any unions disturbed during draining and flushing) for signs of coolant leaks. Fresh antifreeze has a searching action, which will rapidly expose any weak points in the system.

Note: *If, after draining and refilling the system, symptoms of overheating are found which did not occur previously, then the fault is almost certainly due to trapped air at some point in the system, causing an air-lock and restricting the flow of coolant; usually, the air is trapped because the system was refilled too quickly. In some cases, air-locks can be released by tapping or squeezing the various hoses. If the problem persists, stop the engine and allow it to cool down completely, before unscrewing the expansion tank filler cap or disconnecting hoses to bleed out the trapped air.*

35 Brake fluid renewal

Warning: Brake hydraulic fluid can harm your eyes and damage painted surfaces, so use extreme caution when handling and pouring it. Do not use fluid that has been standing open for some time as it absorbs moisture from the air. Excess moisture can cause a dangerous loss of braking effectiveness.

The procedure is similar to that for the bleeding of the hydraulic system as described in Chapter 9, except that the brake fluid reservoir should be emptied by syphoning, and allowance should be made for the old fluid to be removed from the circuit when bleeding a section of the circuit.

HAYNES HiNT

Old hydraulic fluid is invariably much darker in colour than the new, making it easy to distinguish between the two.

Every 48 000 miles or four years

36 Camshaft drivebelt renewal (in-line engines)

All in-line engines have a camshaft drivebelt underneath the timing cover. After renewing and tensioning a camshaft drivebelt, it needs to be re-tensioned again after a specific interval of time depending on the engine type. On B234F engines there is also a balance shaft belt which should be renewed together with the camshaft belt. For details of belt renewal and tensioning, see Chapter 2A.

Chapter 2 Part A:
In-line engine in-car repair procedures

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

Engine (general)

Identification:	
B23ET	Fuel injection, turbocharged, up to 1984
B230E	Fuel injection, normally-aspirated, from 1985 model year
B230ET	Fuel injection, turbocharged, from 1985 model year
B230K	Carburettor, normally-aspirated, from 1985 model year
B200E	Fuel injection, normally-aspirated from 1987 model year
B234F	Fuel injection, normally-aspirated from 1988 model year
Bore:	
All except B200E	96 mm (nominal)
B200E	88.9 mm (nominal)
Stroke	80 mm
Cubic capacity:	
All except B200E	2316 cc
B200E	1986 cc
Compression ratio:	
B23ET and B230ET	9.0:1
B230E and B230K	10.3:1
B200E and B234F	10.0:1
Compression pressure:	
Overall value	9 to 11 bar
Variation between cylinders	2 bar maximum
Firing order	1-3-4-2 (No 1 at front of engine)
Direction of crankshaft rotation	Clockwise (viewed from front of engine)
Valve clearances	See Chapter 1 Specifications

Camshaft

Identification letter (stamped on end):	
B23ET	B
B230E	V
B230ET	A
B230K	X
B200E	V
B234F	U1 (on inlet side) U (on exhaust side)
Maximum lift:	
A	10.50 mm
B	10.60 mm
V	11.37 mm
X	10.65 mm
U/U1	9.38 mm
Bearing journal diameter	29.950 to 29.970 mm
Bearing running clearance:	
New	0.030 to 0.071 mm
Wear limit	0.15 mm
Endfloat:	
B23/B200/B230	0.1 to 0.4 mm
B234F	0.05 to 0.4 mm

Tappets (cam followers)

Diameter	36.975 to 36.995 mm
Height	30.000 to 31.000 mm
Shim clearance in tappet	0.009 to 0.064 mm
Tappet clearance in cylinder head	0.030 to 0.075 mm

B234F has hydraulic tappets with no shims, mounted in camshaft carrier.

Balance shafts (B234F only)

Endfloat	0.06 to 0.19 mm

Flywheel

Run-out	0.02 mm per 100 mm diameter

Lubrication system (B23/B200/B230)

Oil pump type	Twin toothed gear pump, driven from intermediate shaft
Oil pressure (warm engine @ 2000 rpm)	2.5 to 6.0 bar
Oil pump clearances:	
Endfloat	0.02 to 0.12 mm
Gear side clearance	0.02 to 0.09 mm
Backlash	0.15 to 0.35 mm
Driving gear bearing clearance	0.032 to 0.070 mm
Idler gear bearing clearance	0.014 to 0.043 mm
Relief valve spring free length:	39.20 mm

Lubrication system (B234F)

Oil pump type	Eaton gear pump with 4-lobed rotor inside 5-lobed ring, driven by camshaft belt
Oil pressure:	
Minimum @ 900 rpm	1.0 bar
Minimum @ 2000 rpm	2.5 bar
Minimum @ 3000 rpm	5.0 bar
Maximum (relief valve setting)	8.0 bar
Oil pump endfloat, inner and outer rotors with pump dry	0.05 to 0.10 mm
Relief valve spring:	
Free length:	47.6 mm
Length @ 44 ± 4 N	32.0 mm
Length @ 61 ± 6 N	26.0 mm

Torque wrench settings*

	Nm	lbf ft
Cylinder head bolts:		
Stage 1	20	15
B23/B200/B230		
Stage 2	60	44
Stage 3	Angle tighten 90° further	
B234F		
Stage 2	40	30
Stage 3	Angle tighten 115° further	

Torque wrench settings* (continued)	Nm	lbf ft
Main bearing caps	110	81
Connecting rod bearing caps (B23 engines):		
New bolts	70	52
Used bolts	63	47
Connecting rod bearing caps (B200/B230/B234F engines)†:		
Stage 1	20	15
Stage 2	Angle tighten 90° further	
Flywheel/driveplate (use new bolts)	70	52
Camshaft sprocket	50	37
Intermediate shaft sprocket (B23/B200/B230 engines)	50	37
Oil pump pulley (B234F engines):		
Stage 1	20	15
Stage 2	Angle tighten 60° further	
Camshaft bearing caps	20	15
Camshaft carrier, central bolted joint (B234F engines)	20	15
Crankshaft pulley/sprocket bolt (B23 engines)*	165	122
Crankshaft pulley/sprocket bolt (B200/B230/B234F engines):		
Stage 1	60	44
Stage 2	Angle tighten 60° further	
Camshaft drivebelt:		
Idler pulleys	25	18
Tensioner locknut (except for automatic tensioner)	50	37
Automatic tensioner (B234F engines):		
pulley arm	40	20
mounting bolts:		
Top	25	18
Bottom	50	37
Balance shaft (B234F engines):		
Pulley/sprocket bolt	50	37
Belt tensioner locking bolt	40	30
Bolted joint between two halves of housing:		
Stage 1 (housing removed from cylinder block)	5	3.7
Stage 2 (housing fitted to cylinder block)	8	6
Cylinder block bolts:		
Stage 1	20	15
Stage 2 (slacken then re-tighten)	10	7.5
Stage 3	Angle tighten 90° further	
Oil pump, Eaton type, cylinder block bolts (B234F engines)	10	7.5
Oil pressure relief valve (B234F engines)	40	30
Sump bolts	11	8

Oiled threads unless otherwise stated
†Renew bolts if length exceeds 55.5 mm

1 General information

How to use this Chapter

This Part of Chapter 2 describes those repair procedures that can reasonably be carried out on the in-line engine (2.0 and 2.3 litre engine) while it remains in the car. If the engine has been removed from the car and is being dismantled as described in Part C, any preliminary dismantling procedures can be ignored. Refer to Part B for information on the V-6 engine (2.8 litre) models.

Note that, while it may be possible physically to overhaul items such as the piston/connecting rod assemblies while the engine is in the car, such tasks are not normally carried out as separate operations. Usually, several additional procedures (not to mention the cleaning of components and of oilways) have to be carried out. For this reason, all such tasks are classed as major overhaul procedures, and are described in Part C of this Chapter.

Part C describes the removal of the engine/transmission from the vehicle, and the full overhaul procedures that can then be carried out.

Engine description

The four-cylinder engine is of the overhead camshaft type. The cylinders are in line and the engine is mounted vertically and is in a "north-south" attitude in the engine bay. Cooling is by water.

The B23, B230 and B234F series engines are all of 2.3 litre capacity while the B200 is a 2.0 litre unit. The different capacity is achieved by the use of a smaller cylinder bore diameter on the B200 engine.

Drive to the camshaft is by toothed belt and sprockets. The camshaft drivebelt also engages with a sprocket which drives the oil pump. On all models except B234F the oil pump sprocket is mounted on an auxiliary shaft which protrudes into the engine block and drives the oil pump and (on B23 engines) the distributor. On B234F engines there is no auxiliary shaft. Instead the oil pump is mounted outside the engine block and the sprocket fits directly onto the pump. Other accessories are driven from the crankshaft pulley by V-belts.

On B234F engines, there are balance shafts on either side of the engine to reduce vibration. These are driven by an additional toothed belt, mounted behind the camshaft drivebelt.

The cylinder block is of cast iron and the cylinder head of aluminium alloy, with pressed-in valve guides and valve seats. The cylinder head is of the crossflow type, the inlet ports being on the left-hand side and the exhaust ports on the right. On B234F engines, there are two camshafts mounted on a camshaft carrier which is bolted to the top of

the cylinder head, while on all other engines there is a single camshaft mounted directly on the cylinder head.

The crankshaft runs in five shell type main bearings; the connecting rod big-end bearings are also of the shell type. Crankshaft endfloat is taken by thrust flanges on No 5 main bearing (B23 and B234F) or by separate thrustwashers on No 3 main bearing (B200/B230). The camshaft runs in plain bearings machined directly in the cylinder head.

Valve actuation is direct, the camshaft being located above the valves. The cam lobes depress bucket type tappets. Valve clearance is determined by the thickness of the shim in the recess in the top of each tappet, except for the B234F which has self-adjusting hydraulic tappets.

The lubrication system is of the full-flow, pressure-feed type. The oil pump is a twin toothed wheel gear pump, except for B234F engines which have an Eaton type gear pump. Oil is drawn from the sump and passes under pressure through a full-flow filter before being fed to the various shaft bearings and to the valve gear. On some models an external oil cooler is fitted, mounted next to the radiator. Turbo models also have an oil feed and return for the turbocharger bearings.

Although the B200/B230 engine series represents a considerable advance on the B23, with many engine components having been redesigned, from the mechanic's point of view the two engine types are almost identical. Significant differences will be found in the Specifications or in the appropriate sections of text.

The B234F is a further development, with 16 valves and balance shafts giving a very smooth running engine.

Repair operations possible with the engine in the car

The following work can be carried out with the engine in the car:

a) Compression pressure - testing.
b) Camshaft cover - removal and refitting.
c) Camshaft and balance shaft drivebelts - removal, refitting and tensioning.
d) Camshaft / balance shaft / auxiliary shaft oil seals - renewal.
e) Camshaft and tappets - removal, inspection and refitting.
f) Cylinder head - removal and refitting.
g) Cylinder head and pistons - decarbonising.
h) Sump - removal and refitting.*
i) Oil pump - removal, inspection and refitting.*
j) Crankshaft oil seals - renewal.
k) Flywheel/driveplate - removal, inspection and refitting.
l) Balance shafts - removal, inspection and refitting
m) Engine mountings - removal and refitting.

**It is possible to remove the sump with the engine installed, but the amount of preparatory work is formidable - see Section 8. On all engines except B234F, the sump has to be removed to access the oil pump.*

2 Compression test - description and interpretation

1 When engine performance is down, or if misfiring occurs which cannot be attributed to the ignition or fuel systems, a compression test can provide diagnostic clues as to the engine's condition. If the test is performed regularly, it can give warning of trouble before any other symptoms become apparent.

2 The engine must be fully warmed-up to normal operating temperature, the battery must be fully charged, and all the spark plugs must be removed (Chapter 1). The aid of an assistant will also be required.

3 Disable the ignition system by disconnecting the ignition coil LT feed.

4 Fit a compression tester to the No 1 cylinder spark plug hole - the type of tester which screws into the plug thread is to be preferred.

5 Have the assistant hold the throttle wide open, and crank the engine on the starter motor; after one or two revolutions, the compression pressure should build up to a maximum figure, and then stabilise. Record the highest reading obtained.

6 Repeat the test on the remaining cylinders, recording the pressure in each.

7 All cylinders should produce very similar pressures; a difference of more than 2 bars between any two cylinders indicates a fault. Note that the compression should build up quickly in a healthy engine; low compression on the first stroke, followed by gradually-increasing pressure on successive strokes, indicates worn piston rings. A low compression reading on the first stroke, which does not build up during successive strokes, indicates leaking valves or a blown head gasket (a cracked head could also be the cause). Deposits on the undersides of the valve heads can also cause low compression.

8 If the pressure in any cylinder is low, carry out the following test to isolate the cause. Introduce a teaspoonful of clean oil into that cylinder through its spark plug hole, and repeat the test.

9 If the addition of oil temporarily improves the compression pressure, this indicates that bore or piston wear is responsible for the pressure loss. No improvement suggests that leaking or burnt valves, or a blown head gasket, may be to blame.

10 A low reading from two adjacent cylinders is almost certainly due to the head gasket having blown between them; the presence of coolant in the engine oil will confirm this.

11 If one cylinder is about 20 percent lower than the others and the engine has a slightly rough idle, a worn camshaft lobe could be the cause.

12 If the compression reading is unusually high, the combustion chambers are probably coated with carbon deposits. If this is the case, the cylinder head should be removed and decarbonised.

13 On completion of the test, refit the spark plugs and reconnect the ignition system.

3 Camshaft cover - removal and refitting

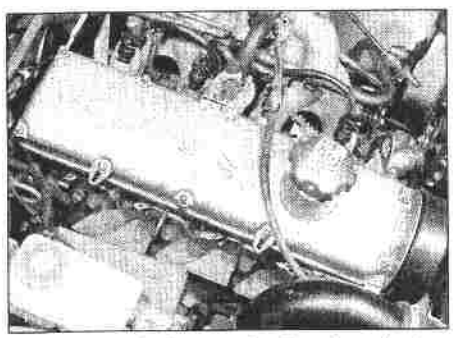
Removal

1 Disconnect the battery negative lead.

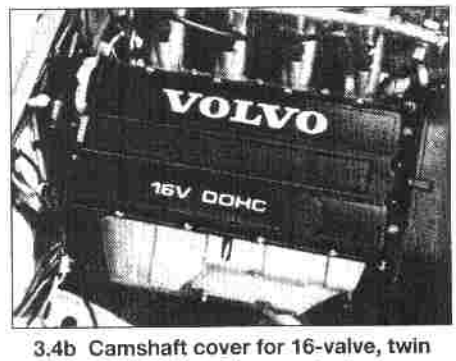
2 Check that the spark plug HT leads are numbered to aid refitting, then detach them from the spark plugs. If no numbers can be seen, label them accordingly. Also detach the HT lead support clip where this is attached to the camshaft cover.

3 According to engine type, disconnect or remove the vacuum/breather/boost pressure hoses, and if necessary the throttle cable, in order to gain access to the camshaft cover. Also unbolt the auxiliary air valve from the cover, where applicable.

4 Remove the securing nuts and lift off the camshaft cover. Note the location of the earth strap, support clips and similar items **(see illustrations)**. Recover the gasket. Examine the gasket for signs of damage and deterioration, and if necessary, renew it.



3.4a Camshaft cover for 8-valve, single camshaft engine



3.4b Camshaft cover for 16-valve, twin camshaft engine. The spark plugs are under the central cover plate

3.7 Fitting the rubber plug at the rear of the camshaft

Refitting

5 Carefully clean the cylinder head and cover mating surfaces, and remove all traces of oil.
6 Fit the gasket to the cylinder head, ensuring that it is correctly seated along its entire length. Note that during 1987, an asbestos-free gasket was introduced for the camshaft cover. When fitting this type of gasket, apply silicone sealant to the camshaft front and rear bearing caps. On B234F engines, fit the spark plug well gasket with the marking upwards and the arrow pointing toward the No. 1 cylinder (timing belt end).
7 On some engines there is a rubber plug at the rear of the camshaft. This occurs on the B23 engine **(see illustration)** and on the exhaust side camshaft on the B234F engine. Make sure that the plug is securely fitted and in good condition. Renew it if necessary.
8 Locate the cover over the cylinder head then fit and tighten the nuts, remembering to fit the HT lead bracket and earth strap.
9 Reconnect the HT leads, vacuum hoses and all other components removed for access. Reconnect the battery then run the engine and check that there are no oil leaks from the camshaft cover joint.

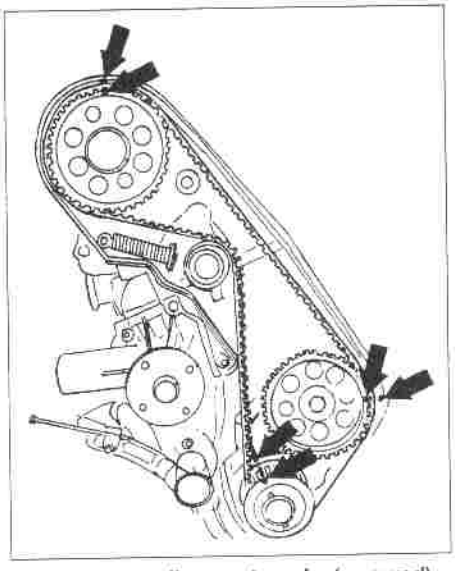
4 Camshaft and balance shaft drivebelts - removal, refitting and tensioning

Removal

1 Disconnect the battery negative lead.
2 Remove the accessory drivebelts (see Chapter 1).
3 Refer to Chapter 3 and remove the viscous coupled fan and the fan shroud. Remove the splashguard under the engine, if fitted. On B200/B230/B234F engines, also remove the water pump pulley.

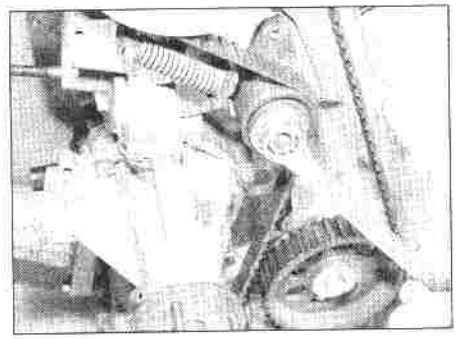
Camshaft drivebelt removal - B23/B200/B230 engine

4 Unbolt and remove the camshaft drivebelt cover. (On B200/B230 engines, just remove the top half of the cover.)
5 Using a spanner on the crankshaft pulley centre bolt, bring the engine to TDC with No 1 piston on the firing stroke. This is indicated

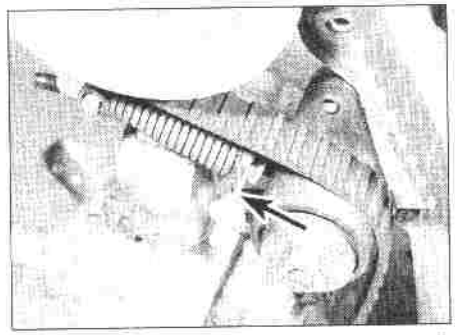


4.5 Sprocket alignment marks (arrowed) - No 1 at TDC and firing. Auxiliary shaft marks are not critical

when the mark on the camshaft sprocket is in line with the mark on the camshaft cover or the drivebelt backplate. At the same time the marks on the crankshaft sprocket guide plate and the oil seal housing will be in line. (The pulley mark cannot be used even if the pulley is still in place, since the timing scale is on the drivebelt cover.) Although it is not critical, the position of the auxiliary shaft sprocket timing mark should also be noted **(see illustration)**.
6 On B200/B230 engines, remove the starter motor (see Chapter 5), or the flywheel bottom cover plate. Have an assistant lock the ring gear teeth, then slacken the crankshaft pulley bolt without disturbing the set position of the crankshaft. Remove the bolt and the pulley, then remove the lower half of the camshaft drivebelt cover.
7 On B23 engines, if the crankshaft pulley was not removed with the accessory drivebelts, remove it now.
8 Slacken the belt tensioner nut. Pull on the belt to compress the tensioner spring. Lock the tensioner in this position, either by tightening the nut again or by inserting a nail



4.8a Slacken the tensioner nut . . .

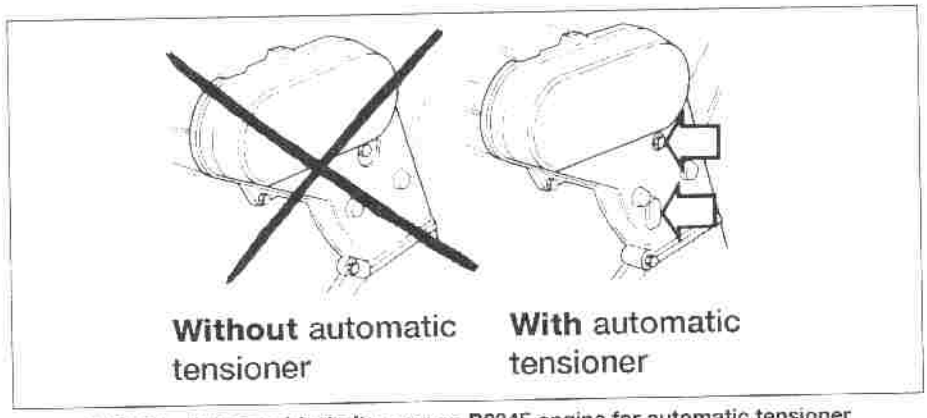


4.8b . . . and insert a nail or rivet (arrowed) to restrain the spring

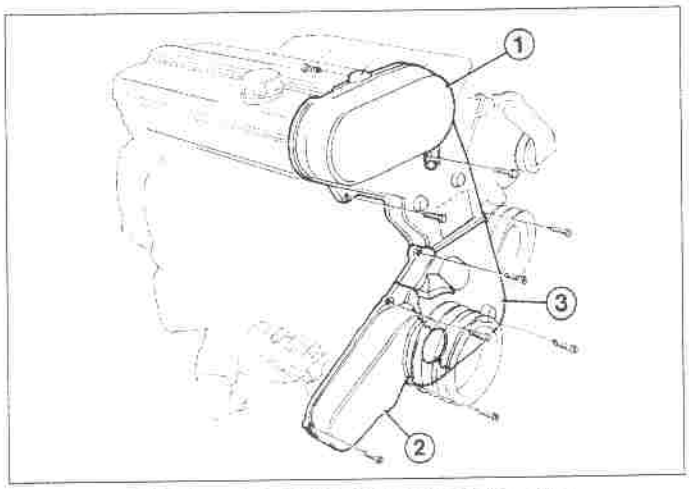
or similar into the hole in the tensioner shaft **(see illustrations)**.
9 Mark the running direction of the belt if it is to be re-used, then slip it off the sprockets and tensioner roller and remove it. Do not rotate the crankshaft, camshaft or auxiliary shaft with the belt removed.
10 Spin the tensioner roller and check for roughness or shake; renew if necessary.
11 Inspect the camshaft drivebelt and renew it if necessary. See paragraph 28.

Camshaft drivebelt removal - B234F engine

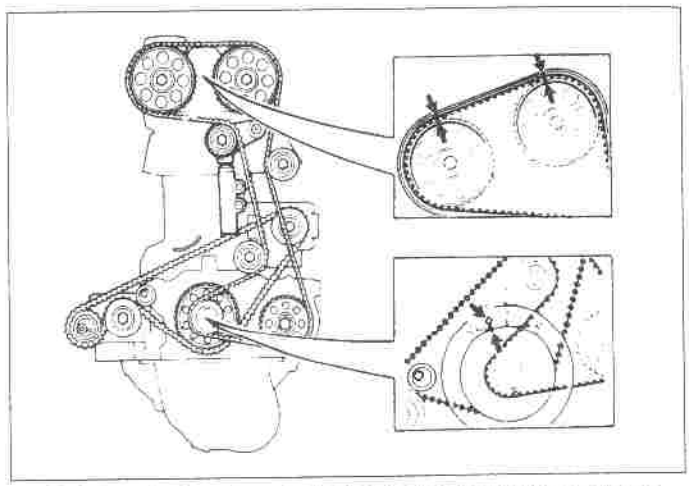
12 Check whether or not the engine is equipped with an automatic drivebelt tensioner, by inspecting the upper drivebelt cover **(see illustration)**.
13 Unbolt and remove all three drivebelt



4.12 Check upper drivebelt cover on B234F engine for automatic tensioner



4.13 Three drivebelt covers on B234F engine



4.14 Camshaft and crankshaft sprocket alignment marks on B234F engine

covers, starting with the top one **(see illustration)**.

14 Using a spanner on the crankshaft pulley centre bolt, bring the engine to TDC with No 1 piston on the firing stroke. This is indicated when the marks on the camshaft sprockets are in line with the marks on the drivebelt backplate. At the same time the marks on the crankshaft sprocket guide plate should be opposite the TDC mark on the cylinder block **(see illustration)**.

15 On models with automatic tensioners, wait 5 minutes after rotating the crankshaft to allow the tensioner to settle, then check the belt tension with gauge 998 8500. Place the gauge between the exhaust camshaft pulley and tensioner and take a reading **(see illustration)**. If the tension is correct, the gauge should read 3.0 to 4.6 units. If the tension is incorrect, the tensioner must be renewed.

16 On models with automatic tensioners, remove the upper mounting bolt, slacken the lower mounting and twist the tensioner until the bolt is free, then remove the bolt and the tensioner **(see illustration)**.

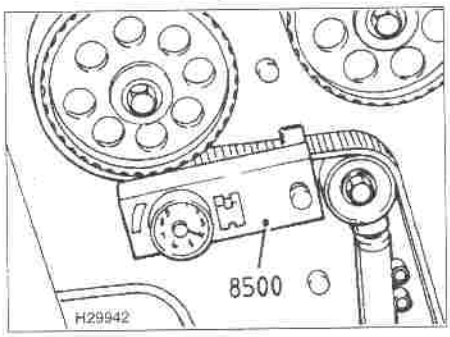
17 On models without automatic tensioners, slacken the belt tensioner locknut **(see illustration)**. Pull on the belt to compress the tensioner spring. Lock the tensioner in this position, either by tightening the nut again or by inserting a nail or similar into the hole in the tensioner shaft.

18 Mark the running direction of the belt if it is to be re-used, then slip it off the sprockets and tensioner roller and remove it. Do not rotate the crankshaft or camshafts with the belt removed.

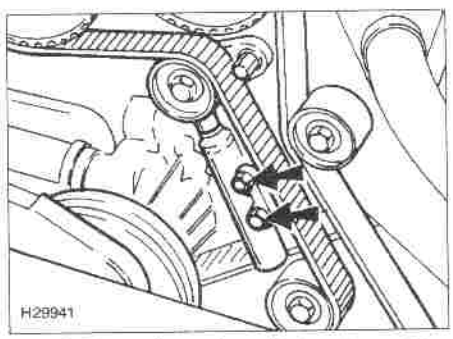
19 Spin the tensioner roller and idler pulleys and check for roughness or shake; renew if necessary. Check the idler pulley mountings and tighten to torque. On models with automatic tensioners, check the tensioner pulley arm and tighten to torque.

20 Automatic tensioners require inspection and should be renewed if necessary. Place the tensioner in a vice and depress the plunger by turning the vice handle approximately 20 degrees every five seconds. The plunger should offer some resistance. Renew the tensioner if it offers no resistance, or if the plunger cannot be depressed, or if there is leakage. Insert a 2mm locking pin in the plunger.

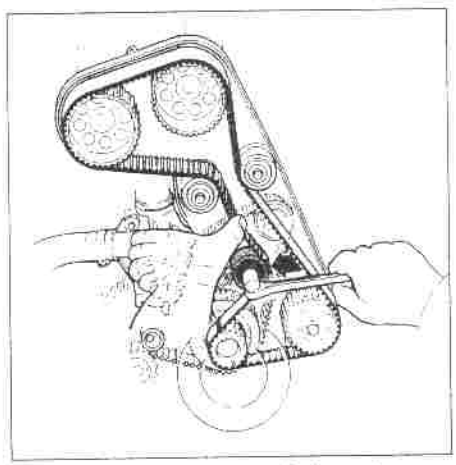
21 Inspect the camshaft drivebelt and renew it if necessary. See paragraph 28.



4.15 Measuring belt tension on B234F engine



4.16 Removing automatic tensioner on B234F engine

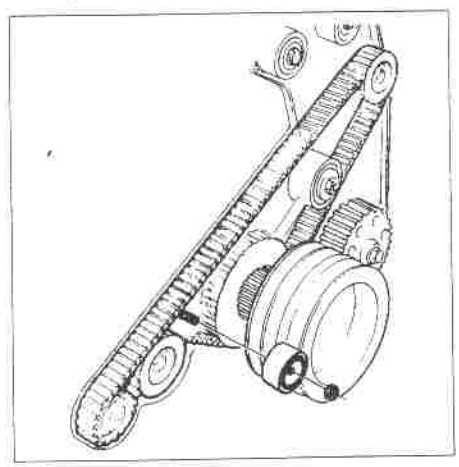


4.17 Slacken the timing belt tensioner locknut on B234F models without automatic tensioner

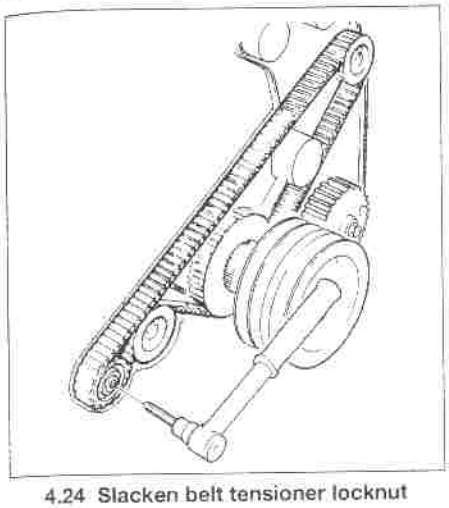
Balance shaft drivebelt removal - B234F engine

22 Remove the camshaft drivebelt as described in the section above, beginning at paragraph 12.

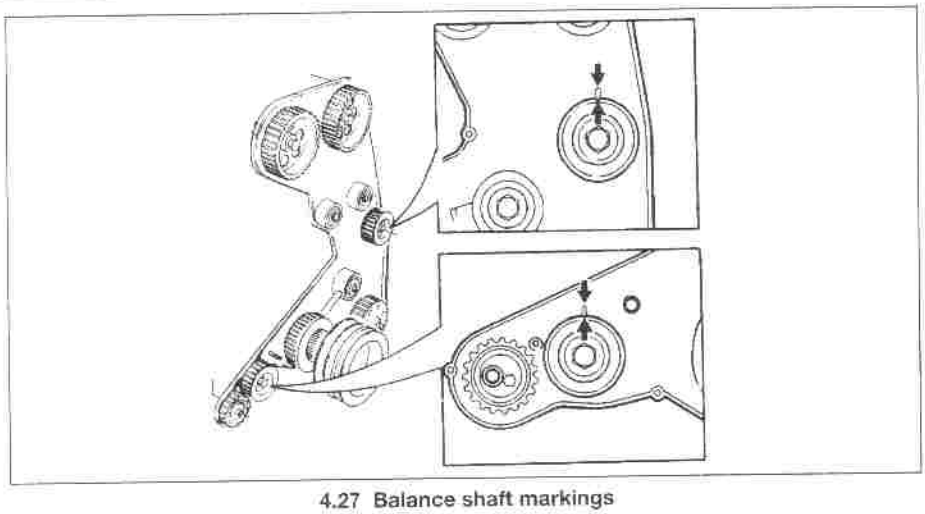
23 Remove the balance shaft belt idler pulley **(see illustration)** and check the surface and bearing for wear.



4.23 Remove balance shaft idler pulley



4.24 Slacken belt tensioner locknut



4.27 Balance shaft markings

24 Slacken the belt tensioner locknut **(see illustration)**.

25 Mark the running direction of the belt if it is to be re-used, then slide it off the drive pulleys and tensioner and remove it.

26 Check the tensioner bearing and inspect for oil leakage from shaft seals.

27 Check that the balance shaft markings coincide with the markings on the backplate **(see illustration)**. At the same time, the crankshaft mark should be opposite the TDC mark on the cylinder block.

Drivebelt inspection - all models

28 On B234F models there are two belts, the camshaft belt and balance shaft belt. On all other models there is just the camshaft belt. Check the belts carefully for any signs of uneven wear, splitting or oil contamination. Pay particular attention to the roots of the teeth. Renew the belts if there is the slightest doubt about their condition. If the engine is undergoing an overhaul, and has covered more than 36,000 miles (60,000 km) with the existing belts fitted, renew the belts as a matter of course, regardless of their apparent condition. The cost of a new belt is nothing when compared to the cost of repairs, should they break in service. If signs of oil contamination are found, trace the source of the oil leak and rectify it. Wash down the belt area and all related components, to remove all traces of oil.

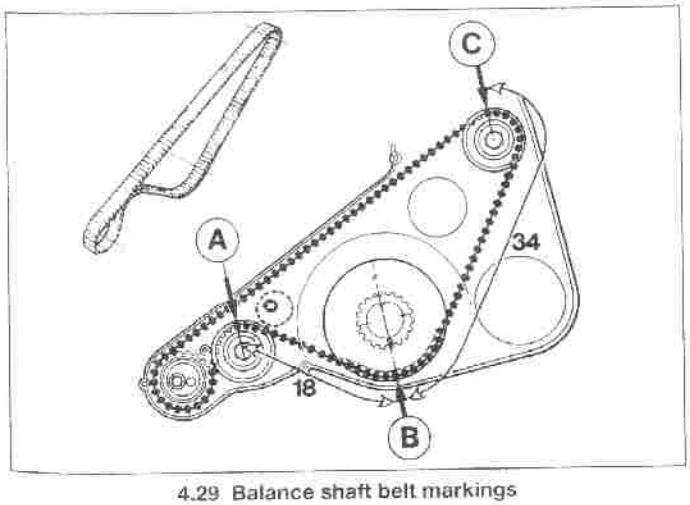
Refitting and tensioning

Balance shaft drivebelt refitting and tensioning - B234F engine

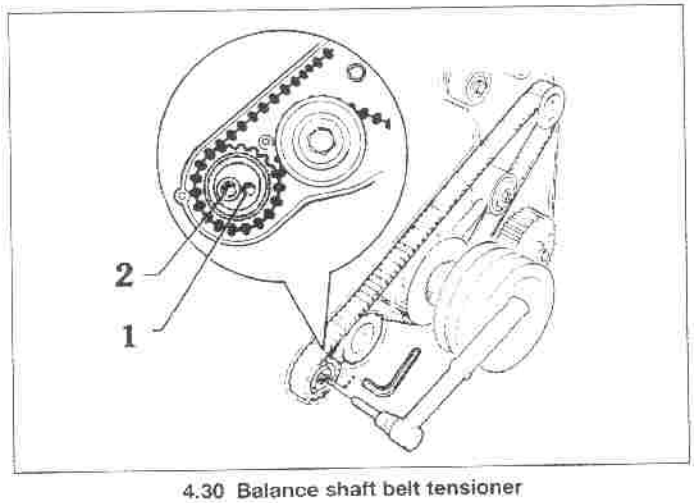
29 Note the positions of the markings A, B and C on the balance shaft drivebelt **(see illustration)**. There are 18 teeth between the yellow dot A and the blue dot B, and 34 teeth between B and the yellow dot C. Carefully work the belt under the crankshaft pulley assembly and make sure the blue dot B is opposite the bottom TDC marking on the belt guide plate at the bottom of the crankshaft. Fit the belt around the upper balance shaft on the inlet side of the engine with the yellow dot C opposite the mark on the pulley. Fit the belt over the top of the lower balance shaft on the exhaust side with the yellow dot A opposite the mark on the pulley, then fit the belt around the tensioner. When fitted, make sure all the belt markings are still aligned in the correct position.

30 Tension the belt using an Allen key in the adjusting hole (1) in the tensioner **(see illustration)**. Turn the crankshaft carefully through a few degrees on either side of the TDC position to ensure that the belt engages properly in the pulleys, then return the crankshaft to the TDC position. Make sure the adjusting hole (1) is immediately below 3 o'clock and insert the Allen key as a counterhold, then tighten the locking bolt (2) to torque.

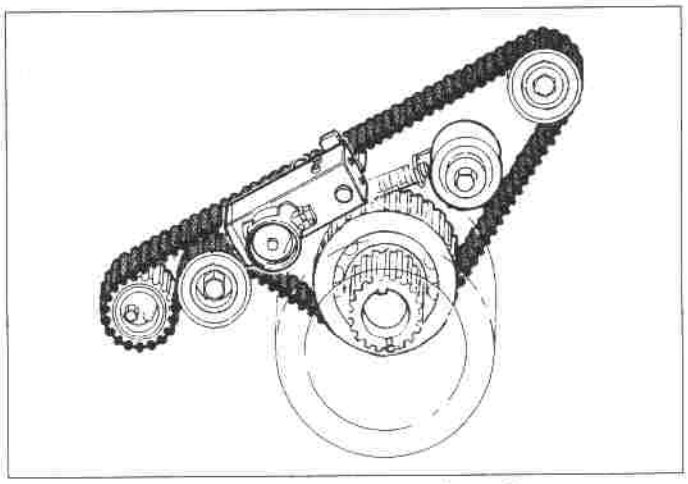
31 Check the belt tension with gauge 998 8500 at the location of the dismantled idler



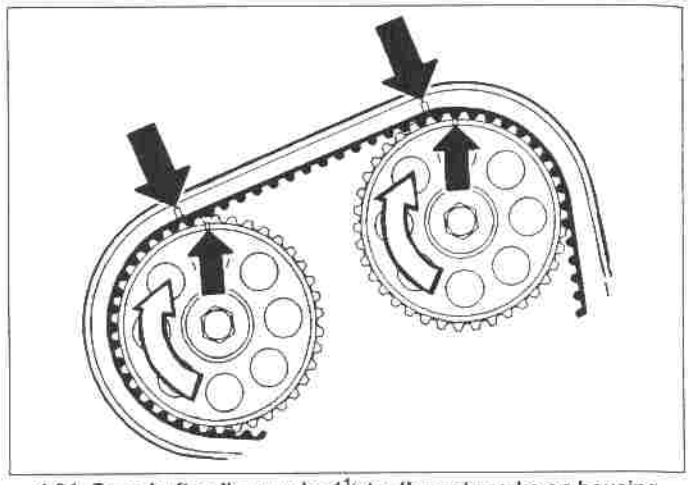
4.29 Balance shaft belt markings



4.30 Balance shaft belt tensioner



4.31 Check balance shaft belt tension



4.34 Camshaft pulley marks 1½ teeth past marks on housing

(see illustration). The belt tension must be within 1-4 units. If the tension is outside this range, re-tension the belt by repeating paragraph 30. Do not refit the idler pulley yet as the balance shaft belt will have to be re-tensioned again after the camshaft belt has been fitted.

Camshaft drivebelt refitting and tensioning - B234F engine

32 Before refitting, make sure the crankshaft sprocket and the two camshaft sprockets are in the correct positions with the engine at TDC with No 1 piston on the firing stroke (paragraph 14). Slip the belt over the sprockets and round the rollers, observing the correct running direction if the old belt is being re-used. When fitted, recheck the alignment of the timing marks.

33 On models with automatic tensioners, refit the tensioner and insert the two mounting bolts. Tighten the upper and lower bolts to their respective torques, then remove the locking pin. Turn the crankshaft clockwise through two revolutions and again check the alignment of the timing marks.

34 On models without automatic tensioners, slacken the tensioner locknut so that the spring is released. Turn the crankshaft clockwise through two revolutions so that the timing marks are again in alignment. Then turn the crankshaft clockwise a little further until the camshaft sprocket marks are 1½ teeth past the marks on the housing **(see illustration)** and tighten the tensioner locknut.

35 Re-check the balance shaft belt tension (paragraph 31), which should be 3.8 ± 0.2 units at 20 °C. If the tension is too low, correct it by adjusting the tensioner clockwise. If it is too high, re-tension it according to paragraph 30.

36 Ensure that the balance shaft belt guide is in position **(see illustration)** and fit the middle timing belt cover, fan shroud, heater hose tie, radiator fan and pulley, and all auxiliary drive belts. Re-connect the battery negative earth lead.

37 Run the engine to operating temperature, then switch it off. Once again, bring the engine to TDC with No 1 piston on the firing stroke.

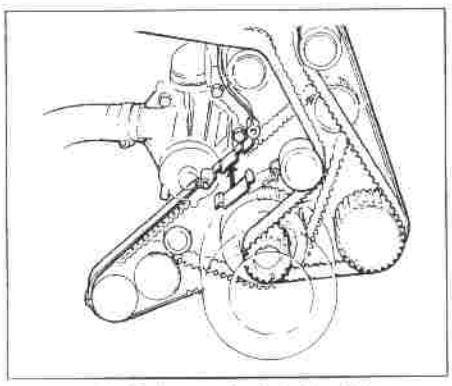
38 On models without automatic tensioners, check the camshaft drivebelt tension again by positioning the gauge between the exhaust camshaft pulley and idler. The tension should be 5.5 ± 0.2 units. If it is outside this range, remove the access plug from the front of the drivebelt cover **(see illustration)**. Slacken the tensioner nut once more and insert a screwdriver between the tensioner pulley and spring carrier pin. If the belt tension is too low, move the roller to adjust the belt tension to 6.0 ± 0.2 units. If the tension is too high, adjust it to 5.0 ± 0.2. Then tighten the tensioner locknut. Turn the crankshaft clockwise until it again comes to TDC with No 1 piston on the firing stroke. Measure the camshaft drivebelt tension again and it should be 5.5 ± 0.2. If not, continue making adjustments, rotating the crankshaft each time, until you achieve this value. Then refit the access plug.

39 Re-check the balance shaft belt tension, which should be 4.9 ± 0.2 units. If the tension is too low, correct it by adjusting the tensioner clockwise. If it is too high, re-tension it according to paragraph 30. If any adjustment has been made, turn the crankshaft clockwise so the engine is again at TDC with No 1 piston on the firing stroke, then measure the tension again, which should be 4.9 ± 0.2 units. If not, continue making adjustments, rotating the crankshaft each time, until you achieve this value.

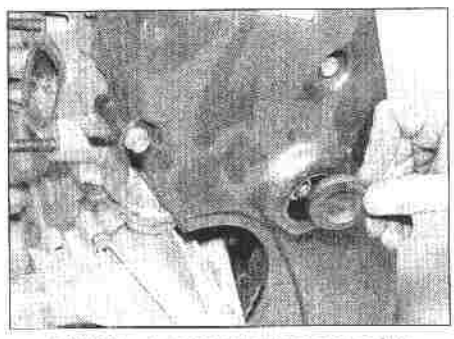
40 Refit the balance shaft belt idler which was removed earlier (paragraph 23). Fit a new one if the surface or bearing is worn.

41 Refit the upper and lower drivebelt covers. Make sure all accessories are refitted.

42 If a new camshaft drivebelt has been fitted to an engine without an automatic tensioner, it needs to be checked and re-tensioned again after approximately 6000 miles (10000 km) with the engine warm to touch (about 40°C). Remove the upper timing cover and turn the crankshaft clockwise so that the engine is at TDC with No 1 piston on the firing stroke. Check the camshaft drivebelt tension by positioning the gauge between the exhaust camshaft pulley and idler. The tension should be 3.7 ± 0.5 units. If it is outside this range, remove the access plug from the middle drivebelt cover and slacken the tensioner locknut. Turn the crankshaft two full turns so that it again reaches TDC, then turn it clockwise a little further until the camshaft sprocket marks are 1½ teeth past the marks on the housing and tighten the tensioner



4.36 Balance shaft belt guide



4.38 The tensioner nut access plug

locknut. Turn the crankshaft clockwise again to TDC and check the belt tension, which should be 3.8 ± 0.3 units. If it is outside this range, slacken the tensioner locknut and insert a screwdriver between the tensioner pulley and spring carrier pin. If the belt tension is too low, move the roller to adjust the belt tension to 4.4 ± 0.3 units. If the tension is too high, adjust it to 3.4 ± 0.3. Then tighten the tensioner locknut. Turn the crankshaft clockwise until it again comes to TDC. Measure the camshaft drivebelt tension again and it should be 3.9 ± 0.3. If not, continue making adjustments, rotating the crankshaft each time, until you achieve this value. Then tighten the tensioner locknut to torque and refit the access plug.

Camshaft drivebelt refitting and tensioning - B23/B200/B230 engine

43 Before refitting, make sure that all three sprockets are in the correct positions (paragraph 5). Slip the belt over the sprockets and round the roller, observing the correct running direction if the old belt is being re-used.

44 Recheck the alignment of the sprocket marks, then release the belt tensioner by slackening the nut or pulling out the nail. Tighten the tensioner nut.

45 On B200/B230 engines, refit the drivebelt lower cover and the crankshaft pulley. Make sure that the dowel (guide pin) on the sprocket engages with the hole in the pulley. Lock the ring gear teeth and tighten the pulley bolt to the specified torque. Refit the starter motor or flywheel cover.

46 On all engines, rotate the crankshaft two full turns clockwise. Stop at TDC, No 1 piston on the firing stroke, and check that the various timing marks still align. Slacken and retighten the tensioner nut.

47 Refit the drivebelt cover (or the top section), then refit the accessory drivebelts, pulleys, fan etc, referring to the relevant Chapters of this manual as necessary. Reconnect the battery negative lead.

48 Run the engine to operating temperature, then switch it off. Once again, bring the engine to TDC, No 1 piston on the firing stroke. Remove the access plug from the front of the drivebelt cover (see illustration, paragraph 38), slacken the tensioner nut once more and then retighten it. Refit the access plug.

49 If a new belt has been fitted, repeat paragraph 48 after approximately 600 miles (1000 km).

5 Camshaft/balance shaft/auxiliary shaft oil seals - renewal

Note: *Before renewing a seal, check that the flame trap is not blocked. The flame trap is part of the crankcase ventilation system (see Chapter 4C) and the symptoms of blockage are oil leaks, knocking and the dipstick rising in the tube. Clean out the flame trap, then renew the seal if oil leakage persists.*

Note: *On B234F engines, there is no auxiliary shaft protruding into the engine block, driving an oil pump. Instead, the oil pump is outside the block and is driven directly by the oil pump sprocket. You can remove the sprocket and renew the oil pump seal.*

1 Remove the camshaft drivebelt (see Section 4).

2 Unbolt and remove the appropriate sprockets for access to the failed seal. Restrain the sprockets with a suitable tool through the holes in their faces, or by clamping an old drivebelt around them **(see illustration)**. If removing the camshaft sprocket, do not allow the camshaft to move, or piston/valve contact may occur. Note the position of any front plates, backplates and/or washers when removing the sprockets. If necessary, also remove the drivebelt tensioner, idler pulleys and backplate.

3 Carefully extract the seal by prising it out with a small screwdriver or hooked tool. Do not damage the shaft sealing face.

4 Clean the seal seat. Examine the shaft sealing face for wear or damage which could cause premature failure of the new seal.

5 Lubricate the new oil seal. Fit the seal over the shaft, lips inwards, and tap it home with a piece of tube.

6 Refit the other disturbed components, then refit and tension the camshaft drivebelt (Section 4). Fit a new drivebelt if the old one was oil-soaked.

6 Camshaft and tappets - removal, inspection and refitting

Note: *If a new camshaft is to be fitted, the lubrication system must be flushed with two consecutive oil and filter changes* **before** *removing the old camshaft. Drain the oil and renew the filter, then run the engine for 10 minutes. Fresh oil and a new filter must be provided for the new camshaft. Failure to observe this may cause rapid wear of the new camshaft.*

Inspection of hydraulic tappets - B234F engine

Note: *B234F engines have hydraulic tappets which need no adjustment as part of regular maintenance, but should be inspected and renewed if noise is heard from the tappets. Change the oil and filter twice, same as if you were fitting a new camshaft, but first run the engine at 2000-3000 rpm for approximately 15 minutes at the correct oil level and pressure. Do not run the engine at more than 3000 rpm while noise is heard from the tappets.*

1 Remove the camshaft cover (see Section 3).

2 Each tappet needs to be checked with the base circle of the cam, and not the cam lobe, in contact with the tappet. Turn the engine to TDC with no. 1 cylinder on the firing stroke. The cam pairs on the intake and exhaust sides should both be facing obliquely upwards.

3 Depress the following tappets firmly with your thumb or with a brass rod to see if they feel spongy **(see illustration)**:

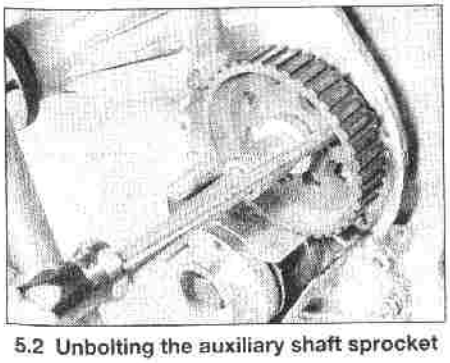
No. 1 cylinder intake/exhaust
No. 2 cylinder intake
No. 3 cylinder exhaust

4 Turn the engine to TDC with no. 4 cylinder on the firing stroke. The cam pairs on the intake and exhaust sides should both be facing obliquely upwards.

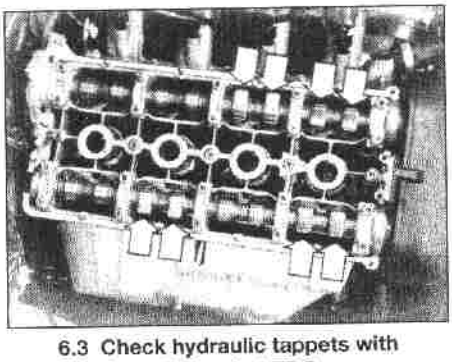
5 Depress the following tappets **(see illustration)**:

No. 2 cylinder exhaust
No. 3 cylinder intake
No. 4 cylinder intake/exhaust

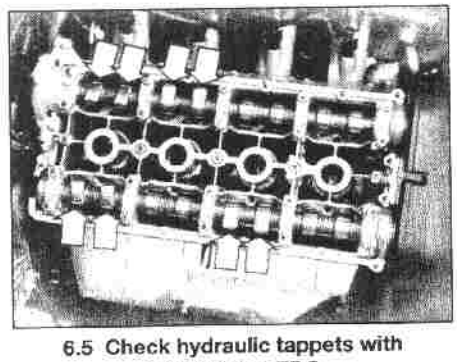
If any tappet feels spongy, it needs to be renewed.



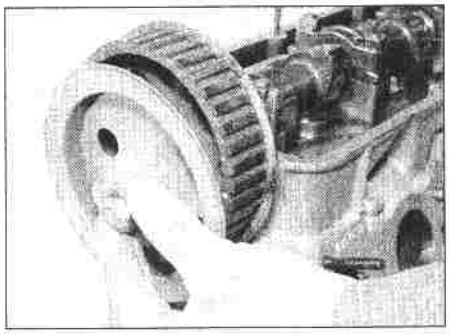
5.2 Unbolting the auxiliary shaft sprocket



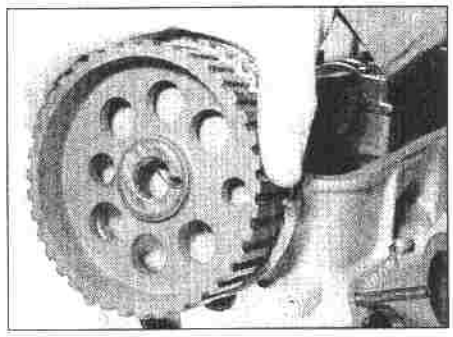
6.3 Check hydraulic tappets with cylinder 1 at TDC



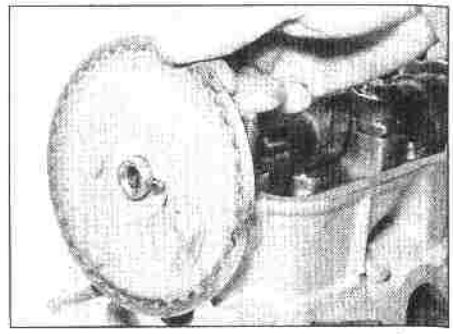
6.5 Check hydraulic tappets with cylinder 4 at TDC



6.8a Removing the bolt, washer and front plate . . .



6.8b the camshaft sprocket itself . . .



6.8c . . . and the sprocket backplate. Other engines may differ slightly

Removal

6 Remove the camshaft drivebelt (see Section 4). The belt can stay on the lower sprockets if wished.

7 Restrain the camshaft sprocket with a suitable tool through the holes in its face, or by clamping an old drivebelt around it. Slacken the camshaft sprocket bolt. Do not allow the camshaft to move, or piston/valve contact may occur.

8 Remove the sprocket bolt and the sprocket itself. Note the position of any front plates, backplates and washers **(see illustrations)**.

9 On B200/B230/B234F engines, remove the distributor (See Chapter 5B). On B234F engines remove the camshaft drivebelt tensioner and idlers as required, then remove the upper backplate.

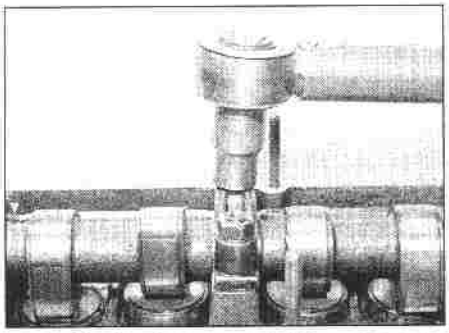
10 Remove the camshaft cover (see Section 3).

11 Make identification marks if necessary, then progressively slacken the camshaft bearing cap nuts **(see illustration)**. The camshaft will rise up under the pressure of the valve springs - be careful that it does not stick and then suddenly jump up. Remove the bearing caps.

12 Lift out the camshaft complete with front oil seal. Be careful of the lobes, which may have sharp edges.

13 Have ready a box divided into segments, or some other means of keeping matched components together.

14 Lift out the tappets (and the shims in the case of mechanical tappets), keeping them identified for position by placing them in the segmented box **(see illustration)**. Hydraulic tappets should be stored upside down to prevent drainage of oil.



6.11 Slackening a camshaft bearing cap nut

Inspection

15 Inspect the cam lobes and the camshaft bearing journals for scoring or other visible evidence of wear. Once the surface hardening of the lobes has been penetrated, wear will progress rapidly.

16 Measure the bearing journals with a micrometer and check for ovality and taper. The bearing running clearances can be established by refitting the camshaft to the head and using Plastigage (see Part C of this Chapter). If the bearing caps and seats in the head are damaged, the head will have to be renewed.

17 Inspect the tappets for scuffing, cracking or other damage; measure their diameter in several places with a micrometer. Tappet clearance in the bore can be established by measuring bore diameter and subtracting tappet diameter from it. Renew the tappets if they are damaged or worn.

18 On models with mechanical tappets, inspect the tappet shims for visible damage; renew them if they are obviously worn. A selection of new shims should be available in any case for setting the valve clearances.

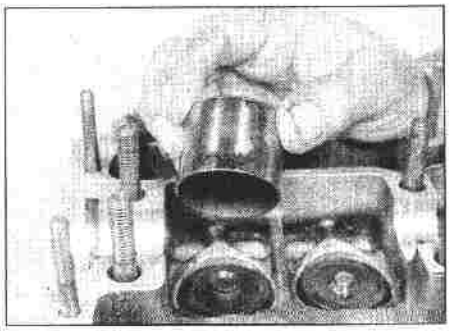
19 If it is wished to measure the camshaft endfloat, refit the camshaft and the rear bearing cap; measure the endfloat between the cap and the camshaft flange **(see illustration)**. Excessive endfloat, if not due to wear of the camshaft itself, can be corrected by renewing the rear bearing cap.

Refitting

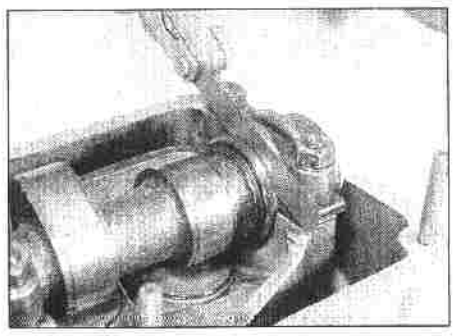
20 Commence refitting by liberally oiling the tappets, shims, the camshaft bearings and caps and the cam lobes. Use clean engine oil, or special camshaft lubricant if supplied with a new shaft.

21 Insert the tappets into their original bores unless they have been renewed. On all engines with mechanical tappets, measure and record the thickness of each tappet shim for reference later, then place each shim on its original tappet.

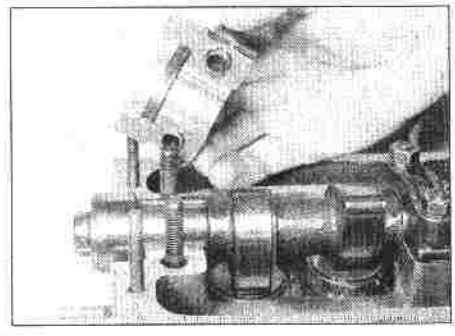
22 Fit the camshaft in approximately the correct position for No 1 piston on the firing stroke (No 1 lobes both pointing obliquely upwards on single-camshaft engines, and the same on both the inlet and exhaust side of B234F engines). Apply sealant to the head mating surfaces of the front and rear bearing caps **(see illustration)**. Fit all the bearing caps in their correct positions and pull them down



6.14 Removing a tappet



6.19 Measuring camshaft endfloat



6.22 Fitting the camshaft front bearing cap

by tightening the nuts a little at a time. When all the caps are seated, tighten the nuts to the specified torque.

23 Lubricate a new oil seal and fit it to the front of the camshaft, lips inwards. Tap it home with a piece of tube.

24 Refit the camshaft sprocket and associated components. Restrain the sprocket and tighten the bolt to the specified torque.

25 Refit the distributor if it was removed and fit new O-rings.

26 Refit and tension the camshaft drivebelt (Section 4).

27 Check and adjust the valve clearances as described in Chapter 1 (except for B234F engines which have hydraulic tappets and need no adjustment).

28 Refit the camshaft cover (Section 3).

29 If a new camshaft has been fitted, run it in at moderate engine speeds for a few minutes (neither idling nor racing), or as directed by the manufacturer. On B234F engines with hydraulic tappets there might be some noise from the tappets when the engine is first started, but this will disappear as the tappets are filled with oil. Do not run the engine at more than 3000 rpm while there is tappet noise.

7 Cylinder head - removal and refitting

Removal

1 Disconnect the battery negative lead.

2 Drain the cooling system (see Chapter 1).

3 Disconnect the radiator top hose from the thermostat housing.

4 Remove the fan and fan shroud.

5 Remove all accessory drivebelts and the water pump pulley (see Chapter 1).

6 On B230 engines, remove the distributor cap.

7 Remove the camshaft drivebelt cover. (If the cover is in more than one section, just remove the upper section.)

8 Bring the engine to TDC, No 1 piston on the firing stroke, then remove the camshaft drivebelt and tensioner (see Section 4). The drivebelt can stay on the lower sprockets if wished. Do not rotate the crankshaft or camshafts from now on.

9 On B200/B230/B234F engines, unbolt and remove the camshaft sprocket and the spacer washer. Remove any other components fitted to the cylinder head through the backplate, such as the tensioner and idler pulleys.

10 Remove the bolts which secure the drivebelt backplate to the cylinder head, but leave the backplate bolted to the cylinder block.

11 Remove the nuts which secure the inlet and exhaust manifolds to the cylinder head. Where necessary, disconnect temperature sensor connectors and heating hoses from the inlet side. Pull the manifolds off their studs to the sides of the engine bay, supporting them if necessary. Recover the gaskets.

12 Remove the camshaft cover and recover the gaskets (see Section 3).

13 On B234F engines the twin camshafts are mounted on a camshaft carrier on top of the cylinder head **(see illustration)**. Remove the camshafts and hydraulic tappets (see Section 6), then undo the five nuts on the central bolted joint and detach the camshaft carrier from the cylinder head. Tap it carefully with a plastic mallet if it is stuck to the head. Remove the O-rings from around the spark plug wells.

14 Slacken the cylinder head bolts, half a turn at a time to begin with, in the reverse order to that shown in illustration 7.26. Remove the bolts.

15 Lift off the cylinder head. On B200/B230/B234F engines it will be necessary to bend the drivebelt backplate forwards a little.

16 Set the head down on a couple of wooden blocks to avoid damage to protruding valves. Recover the old head gasket.

17 If the cylinder head is to be dismantled for overhaul, remove the camshaft as described in Section 6 (except for B234F engines which have a camshaft carrier), then refer to Part C of this Chapter.

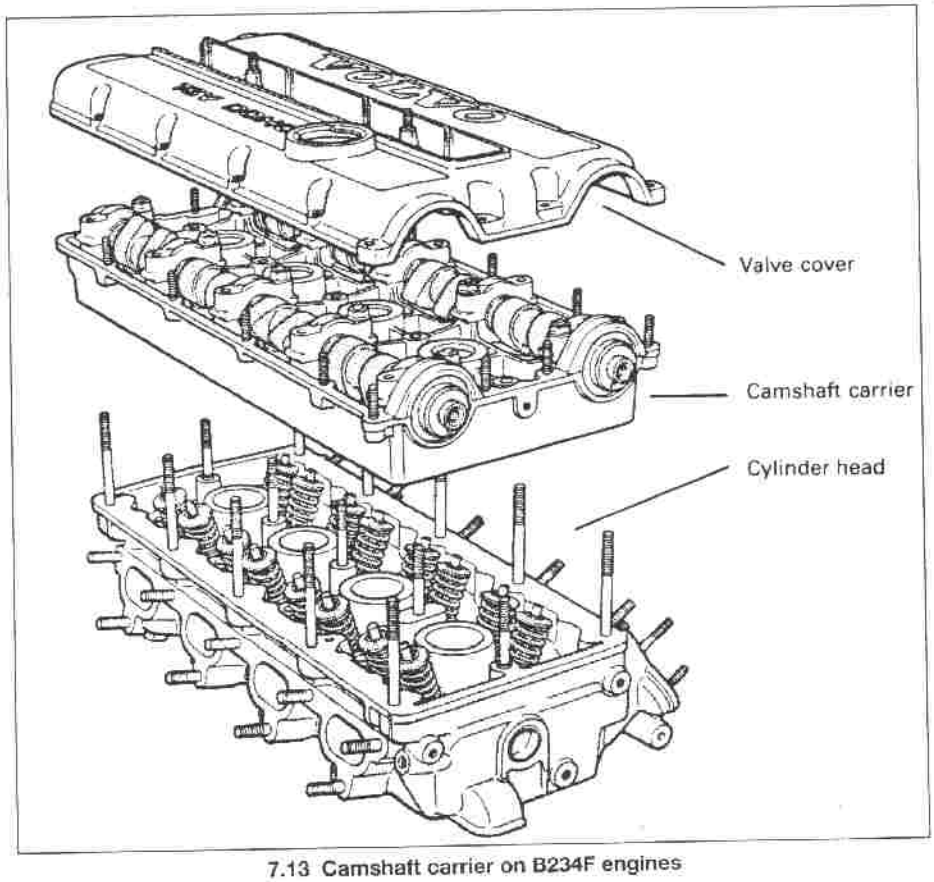
Preparation for refitting

18 The mating faces of the cylinder head and cylinder block must be perfectly clean before refitting the head. Use a hard plastic or wood scraper to remove all traces of gasket and carbon; also clean the piston crowns. Take particular care during the cleaning operations, as aluminium alloy is easily damaged. Also, make sure that the carbon is not allowed to enter the oil and water passages - this is particularly important for the lubrication system, as carbon could block the oil supply to the engine's components. Using adhesive tape and paper, seal the water, oil and bolt holes in the cylinder block/crankcase. To prevent carbon entering the gap between the pistons and bores, smear a little grease in the gap. After cleaning each piston, use a small brush to remove all traces of grease and carbon from the gap, then wipe away the remainder with a clean rag. Clean all the pistons in the same way.

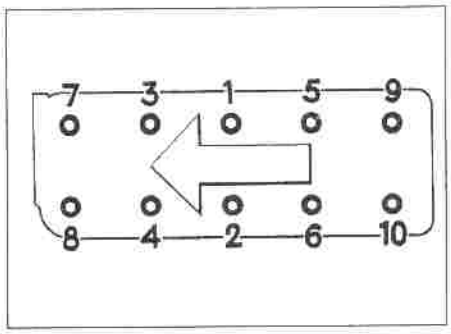
19 Check the mating surfaces of the cylinder block and the cylinder head for nicks, deep scratches and other damage. If slight, they may be removed carefully with a file, but if excessive, machining may be the only alternative to renewal.

20 If warpage of the cylinder head gasket surface is suspected, use a straight-edge to check it for distortion. Refer to Part C of this Chapter if necessary.

21 Check the condition of the cylinder head bolts, and particularly their threads, whenever they are removed. Wash the bolts in suitable solvent, and wipe them dry. Check each for any sign of visible wear or damage, renewing



7.13 Camshaft carrier on B234F engines



7.26 Cylinder head bolt tightening sequence

any bolt if necessary. Measure the length of each bolt, to check for stretching (although this is not a conclusive test, in the event that all ten bolts have stretched by the same amount). It is strongly recommended that the bolts should be renewed as a complete set whenever they are disturbed.

22 On B234F engines, a liquid sealing compound is used to join the camshaft carrier to the cylinder head. Plug the openings in the cylinder head with paper, then dissolve the remains of the sealing compound with solvent. Carefully scrape the joint surfaces clean with a hard plastic or wood scraper, then blow the camshaft carrier completely clean with compressed air. Wipe the surfaces with a degreasing agent. In the same way, clean the camshaft bearing cap joint faces.

Refitting

23 Commence refitting by placing a new head gasket on the cylinder block. Make sure it is the right way up - all the bolt holes, oilways etc must line up. On B234F engines, fit a new O-ring seal for the water pump.

24 On all engines except B234F, make sure that the camshaft is set to the No 1 piston on the firing stroke position, both cam lobes for No 1 cylinder pointing obliquely upwards.

25 Lower the cylinder head carefully into position, taking care to avoid damaging the gasket.

26 Oil the threads of the cylinder head bolts, then fit the bolts and tighten them, in the sequence shown, to the specified Stage 1 torque **(see illustration)**.

27 In the same sequence tighten the bolts to the Stage 2 torque, then go round again and tighten the bolts through the angle specified for Stage 3. (If the engine is on the bench, it may be preferable to leave Stage 3 tightening until after engine refitting.) No further tightening is required.

28 On B234F engines, use a short-haired roller to apply liquid sealing compound to the joint between the camshaft carrier and cylinder head, and to the camshaft bearing cap joint faces. Fit new O-rings in the grooves around the spark plug wells and carefully position the camshaft carrier on the cylinder head. Refit the five nuts on the central bolted joint. Refit the camshafts and tappets (see Section 6). Tighten the camshaft bearing cap nuts and the five nuts on the central bolted joint to torque.

29 The remainder of refitting is a reversal of the removal procedure. Use new gaskets etc where necessary.

30 On all engines except B234F, check the valve clearances (Chapter 1) before starting the engine. On B234F engines the tappets are hydraulic and need no adjustment, but the engine needs to be run at less than 3000 rpm until tappet noise has disappeared.

8 Sump - removal and refitting

Note: *Although it is possible to remove the sump with the engine in the car, it is a complicated operation. Read through this procedure first to see what is involved. Depending on facilities and experience, it may be preferable to remove the engine.*

Removal

1 Raise and securely support the front of the vehicle, or drive it over a pit.

2 Disconnect the battery negative lead.

3 Drain the engine oil (see Chapter 1).

4 Remove the splash guard from below the engine.

5 Disconnect the exhaust downpipe from the silencer (or the catalytic converter if fitted).

6 Remove the nuts which secure the engine mountings to the crossmember.

7 Release the clamp bolts and disconnect the shaft from the steering gear.

8 Support the engine from above, either with a hoist or with an adjustable support resting on the inner wings or suspension turrets. Satisfy yourself as to the security of the support arrangements before proceeding.

9 Release the fan shroud and remove the engine oil dipstick. Remove the air mass meter, if there is one, from the air inlet. Raise the engine slightly to take the weight off the mountings. On B200/B230/B234F engines, be careful not to crush the distributor against the bulkhead.

10 Remove the engine mounting on the left-hand side. Cut the cable-tie which secures the power steering hose nearby. Also remove the inlet manifold bracing strut (not on carburettor engines).

11 Remove the bolts which secure the front crossmember to the body.

12 Remove the flywheel/driveplate bottom cover plate.

13 Pull the front crossmember downwards to give adequate clearance below the sump. Disconnect or move aside power steering hoses as necessary.

14 Remove the sump securing bolts. Separate the sump from the block - if it is stuck, tap it with a soft-faced hammer. Do not lever between the mating faces.

15 Lower the sump, twist it to free it from the oil pump pick-up and remove it.

Refitting

16 Clean the sump internally. Remove all traces of gasket from the sump and block faces.

17 Commence refitting by sticking a new gasket to the sump with grease.

18 Offer the sump to the block, being careful not to displace the gasket. Secure the sump with two bolts in opposite corners.

19 Fit all the sump bolts and tighten them progressively to the specified torque.

20 The remainder of refitting is a reversal of the removal procedure. Check that the drain plug is tight, then refill the engine with oil on completion (Chapter 1).

9 Oil pump - removal, inspection and refitting (B23/B200/B230 engine)

Removal

1 Remove the sump (see Section 8).

2 Remove the two bolts which secure the oil pump. Note that one of these bolts also secures the oil trap drain hose guide. Remove the pump and the guide.

3 Separate the oil pump delivery pipe from the pump. Recover the seals from each end of the pipe.

Inspection

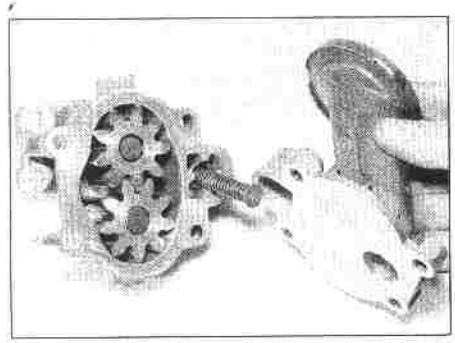
4 Remove the Allen screws which hold the two halves of the pump together.

5 Remove the pick-up pipe and gear cover from the gear housing. Be prepared for the ejection of the relief valve spring **(see illustration)**.

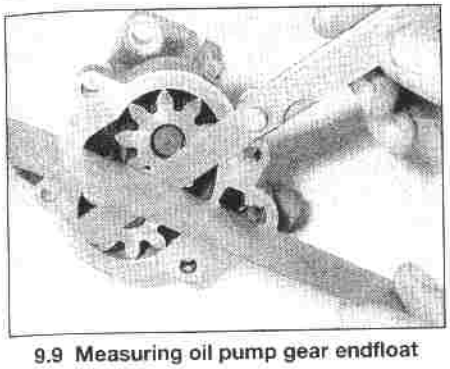
6 Remove the relief valve spring and plunger (or ball on early models) and the pump gears.

7 Clean all components, paying particular attention to the pick-up screen, which is partly obscured by its housing. Inspect the gears, housing and gear cover for signs of wear or damage.

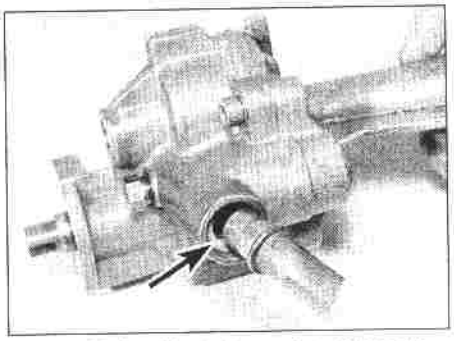
8 Measure the relief valve spring, and if possible compare its characteristics with those in the Specifications. Renew it if it is weak or distorted. Also inspect the plunger or ball for scoring or other damage.



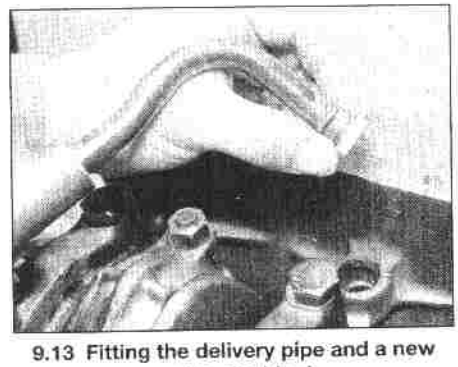
9.5 Separating the pick-up pipe and cover from the pump body



9.9 Measuring oil pump gear endfloat



9.12 Fitting the delivery pipe to the oil pump. New seal (arrowed) is in the pump



9.13 Fitting the delivery pipe and a new seal to the block

9 Refit the gears to the casing. Using a straight-edge and feeler blades, check the gear side clearance and endfloat **(see illustration)**. Also check the backlash between the teeth. If the clearances are outside the specified limits, renew the pump.

10 If the clearances are satisfactory, liberally lubricate the gears. Lubricate and fit the relief valve plunger (or ball) and spring.

11 Refit the pick-up pipe and gear cover. Fit and tighten the Allen screws.

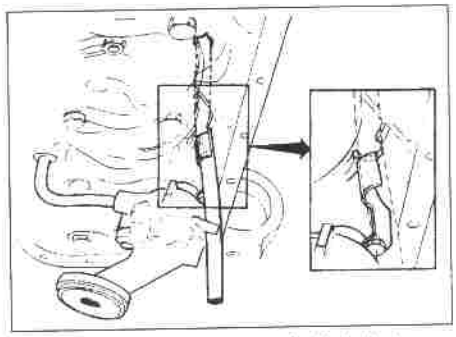
Refitting

12 Commence refitting by fitting the delivery pipe, with new seals, to the pump **(see illustration)**.

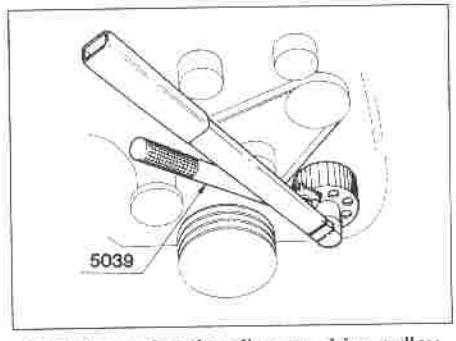
13 Fit the pump to the block, engaging the pump drivegear and the delivery pipe at the same time **(see illustration)**.

14 Fit the two bolts and the drain hose guide. Tighten the bolts.

15 Make sure that the oil drain hose is correctly positioned, then refit the sump **(see illustration)**.



9.15 Correct positioning of oil drain hose



10.2 Removing the oil pump drive pulley

10 Oil pump - removal, inspection and refitting (B234F engine)

Note: *B234F engines require a higher flow of oil to supply the balance shafts, extra camshaft and hydraulic tappets, especially when the engine is hot. An Eaton type gear pump is used, consisting of a 4-lobed rotor inside a 5-lobed ring. The oil pump is mounted externally on the cylinder block, making it accessible without removing the sump.*

Removal

1 Remove the camshaft drivebelt (see Section 4).

2 Use a counterhold 5039 if available, or other suitable tool to lock the oil pump drive pulley. Undo the central bolt and remove the pulley **(see illustration)**. Clean the area around the pump joint.

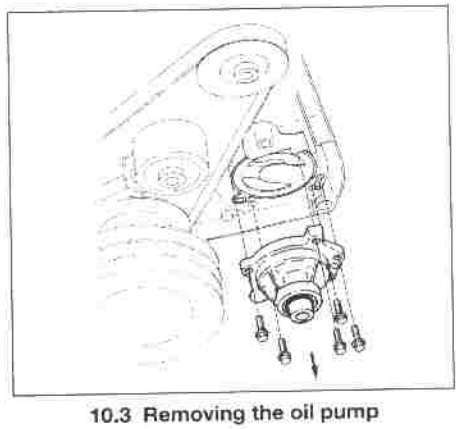
3 Place some paper or a container on the splashguard to collect any leakage of oil. Undo the oil pump mounting bolts and remove the pump **(see illustration)**.

4 Remove the seal from the seating groove in the cylinder block **(see illustration)**. Clean the joint face and groove.

Inspection

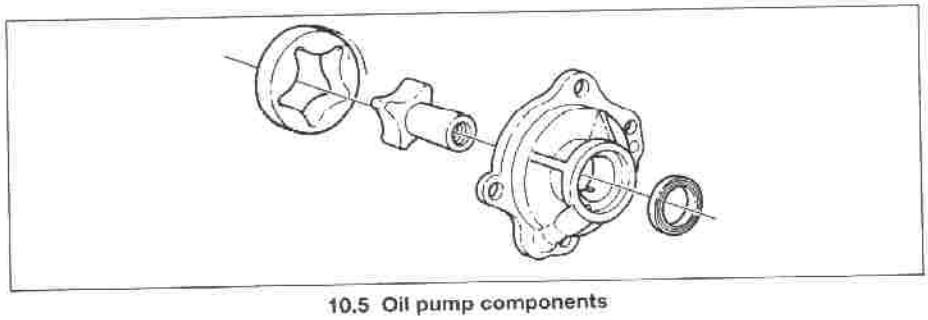
5 Mark the outer rotor with a felt pen to ensure the same direction of rotation on reassembly, then remove the rotors and shaft seal from the oil pump housing **(see illustration)**. Clean the components and inspect them for visible signs of wear.

6 Place a steel rule across the face of the pump housing, where it meets the cylinder block, and check for distortion. Then refit the rotors, making sure the outer rotor is the right

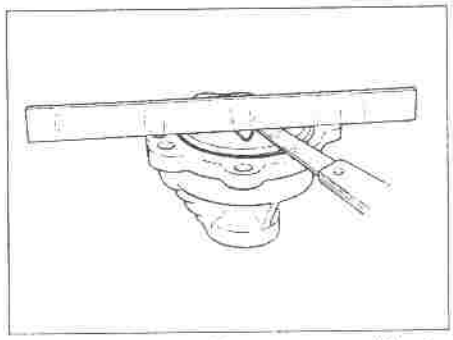


10.3 Removing the oil pump

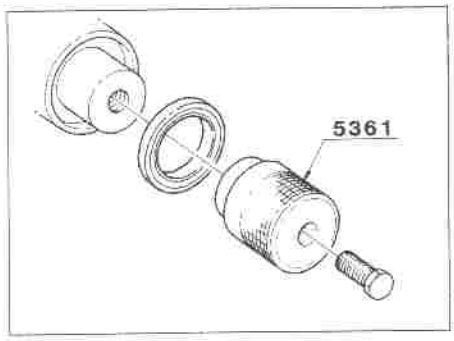
10.4 Removing seal from cylinder block



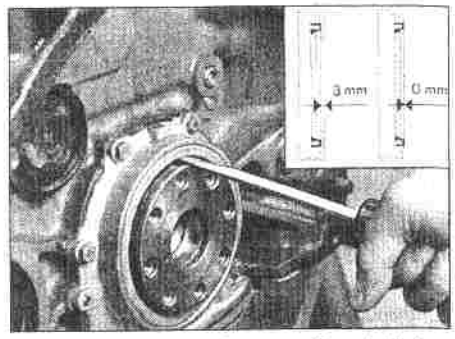
10.5 Oil pump components



10.6 Measuring oil pump gear endfloat



10.10 Fitting the oil pump seal with special tool



11.4 Levering out the rear oil seal. Note recessed depth (inset)

way round, and check the endfloat of the inner and outer rotors **(see illustration)**. If the housing is distorted or the clearances are not correct, obtain a new pump.

Refitting

7 Fit a new seal in the groove in the cylinder block.

8 Remove the pump rotors and lubricate them generously, then refit them in the housing, making sure the outer rotor is the right way round.

9 Place the pump on the cylinder block and insert the bolts. Take care not to turn the pump, because the rotor shaft might fall out of position in the housing. Tighten the bolts to the recommended torque.

10 Fit a new oil pump seal. If possible, use assembly tool 5361 **(see illustration)**. The face if the seal should normally be in line with the chamfered edge of the housing. However, if the shaft end shows signs of wear, the seal may be located approximately 2 mm further in.

11 Refit the drive pulley on the shaft and rotate it to align the locating chamfer. Use counterhold 5039 or other suitable device to lock the pulley in position and tighten the centre bolt to stage 1 torque, then angle tighten.

12 Refit the camshaft drivebelt (see Section 4) and tension it if there is no automatic tensioner.

13 Refit the accessory drivebelts and all other components that have been removed. Remember to remove the paper or the container that was placed on the splashguard.

11 Crankshaft oil seals - renewal

Note: *Before renewing a seal, check that the flame trap is not blocked. The flame trap is part of the crankcase ventilation system (see Chapter 4C) and the symptoms of blockage are oil leaks, knocking and the dipstick rising in the tube. Clean out the flame trap, then renew the seal if oil leakage persists.*

Front oil seal

1 The front oil seal renewal procedure is essentially the same as that for the camshaft/auxiliary shaft oil seals. Refer to Section 5 for details.

Rear oil seal

2 Remove the flywheel or driveplate (see Section 12).

3 Note whether the old seal is flush with the end of its carrier, or recessed into it.

4 Carefully prise out the old oil seal. Do not damage the carrier or the surface of the crankshaft **(see illustration)**. Alternatively, punch or drill two small holes opposite each other in the oil seal. Screw a self-tapping screw into each, and pull on the screws with pliers to extract the seal.

5 Clean the oil seal carrier and the crankshaft. Inspect the crankshaft for a wear groove or ridge left by the old seal.

6 Lubricate the carrier, the crankshaft and the new seal. Fit the seal, lips inwards, and use a piece of tube (or the old seal, inverted) to tap it home. If there is any wear on the crankshaft sealing surface, fit the new seal more deeply recessed than the old one. The seal may be recessed up to 6 mm within the carrier.

7 Refit the flywheel or driveplate (Section 12).

12 Flywheel/driveplate - removal, inspection and refitting

Note: *New flywheel/driveplate retaining bolts will be required for refitting.*

Removal

Flywheel (models with manual transmission)

1 Remove the transmission (see Chapter 7A).

2 Remove the clutch pressure plate and driven plate (see Chapter 6).

3 Make alignment marks so that the flywheel can be refitted in the same position relative to the crankshaft. (If the flywheel is refitted incorrectly, the electronic ignition system will not work).

4 Unbolt the flywheel and remove it. Do not drop it, it is heavy. Obtain new bolts for reassembly.

Driveplate (models with automatic transmission)

5 Remove the automatic transmission (see Chapter 7B).

6 Make alignment marks so that the driveplate can be refitted in the same position relative to the crankshaft. (If the driveplate is refitted incorrectly, the electronic ignition system will not work).

7 Unbolt the driveplate and remove it, noting the location and orientation of the large washers on each side. Obtain new bolts for reassembly.

Inspection

8 On manual transmission models, if the flywheel's clutch mating surface is deeply scored, cracked or otherwise damaged, the flywheel must be renewed. However, it may be possible to have it surface-ground; seek the advice of a Volvo dealer or engine reconditioning specialist.

9 If the ring gear is badly worn or has missing teeth, it must be renewed. This job is best left to a Volvo dealer or engine reconditioning specialist. The temperature to which the new ring gear must be heated for installation is critical and, if not done accurately, the hardness of the teeth will be destroyed.

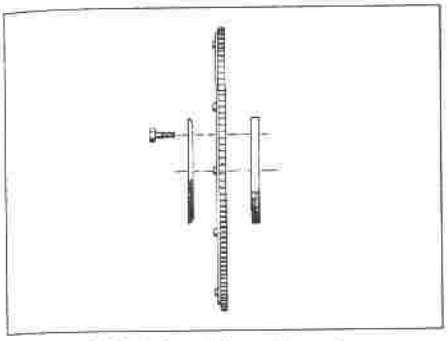
10 On models equipped with automatic transmission, check the torque converter driveplate carefully for signs of distortion. Look for any hairline cracks around the bolt holes or radiating outwards from the centre, and inspect the ring gear teeth for signs of wear or chipping. If any signs of wear or damage are found, the driveplate must be renewed.

Refitting

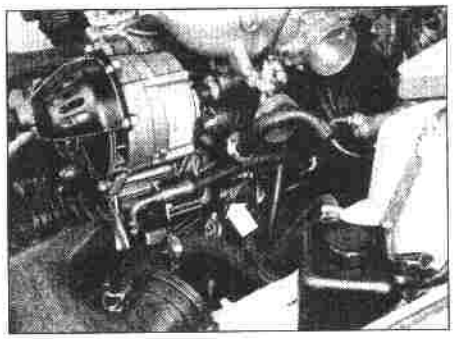
Flywheel (models with manual transmission)

11 Clean the mating surfaces of the flywheel and crankshaft. Remove any remaining locking compound from the threads of the crankshaft holes, using the correct-size tap, if available.

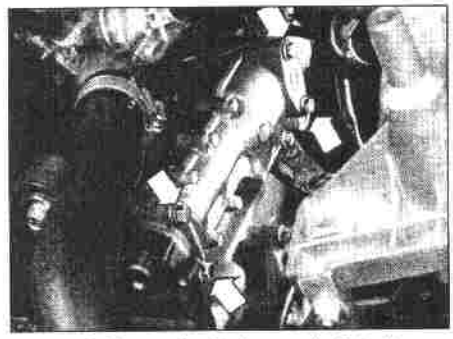
HAYNES HiNT ***If a suitable tap is not available, cut two slots into the threads of one of the old flywheel bolts and use the bolt to remove the locking compound from the threads.***



12.15 Driveplate and washers



13.4 Unbolting alternator and servo pump bracket



13.5 Removing balance shaft bolts

12 Continue refitting by reversing the removal operations. Apply thread locking compound to the new flywheel retaining bolts (if not already pre-coated) and tighten them to the specified torque.

13 Refit the clutch as described in Chapter 6.

14 Before refitting the transmission, check that the electronic ignition trigger "slug" in the rim of the flywheel passes the (so-called) TDC sensor when No 1 piston is at 90° BTDC.

Driveplate (models with automatic transmission)

15 Proceed as described above for manual transmission models but ignoring any references to clutch. Note the location and orientation of the large washers on each side of the driveplate **(see illustration)**.

13 Balance shafts - removal, inspection and refitting (B234F engine)

Removal

1 Remove the camshaft and balance shaft drivebelts (see Section 4)

2 Remove the appropriate left or right balance shaft pulley. Use counterhold 5362 or other suitable tool to lock the pulley and undo the central bolt.

3 Remove the air mass meter and inlet hose.

Left-hand balance shaft (inlet side)

4 Unbolt the alternator and servo steering pump bracket **(see illustration)**. Tie the bracket and assembly to the wheel housing, and take care to protect the wheel housing from scratches.

5 Place a container underneath the balance shaft joint (or some paper on the crossmember) to collect oil spillage from the housing. Remove the four balance shaft bolts **(see illustration)**.

6 Use extractor 5376 on the rear mounting point **(see illustration)** and a similar tool such as 5196 on the front mounting point. Use the two extractors simultaneously to carefully prise the housing free from both ends. It must be removed evenly if it is to be re-used.

Right-hand balance shaft (exhaust side)

7 Remove the balance shaft belt tensioner and the bolt that goes through the backplate into the balance shaft housing **(see illustration)**.

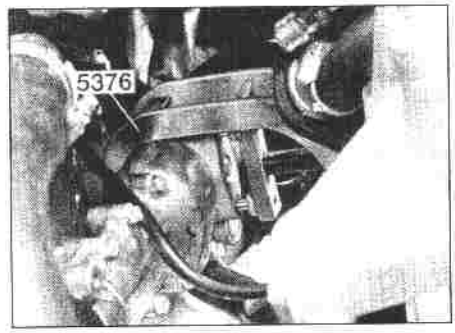
8 Remove the air preheating hose from the bottom heat shield under the exhaust manifold, then remove the four nuts securing the right-hand engine mounting to the crossmember.

9 Lift the engine using suitable lifting gear attached to the right-hand lifting lug, checking that there is some clearance between the brake master cylinder and intake manifold. Remove the complete engine mounting from the block, including the insulating pad and lower mounting plate **(see illustration)**.

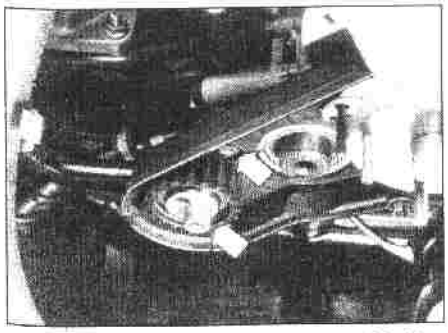
10 Use a container or some paper to catch oil spillage and remove the four bolts from the balance shaft housing, then use special tools to prise off the housing evenly at both ends, same as in paragraphs 5 and 6.

Inspection

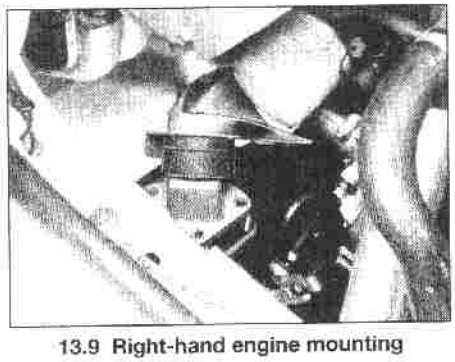
11 Remove the two O-ring seals from the oilways on the balance shaft housing. Remove the bolts from the housing joint, then prise the two halves apart by inserting a large screwdriver between the projections at the four points around the joint **(see illustration)**. Prise the joint open carefully at each point in turn, so that the deviation in parallelism between the joint faces does not exceed 1mm.



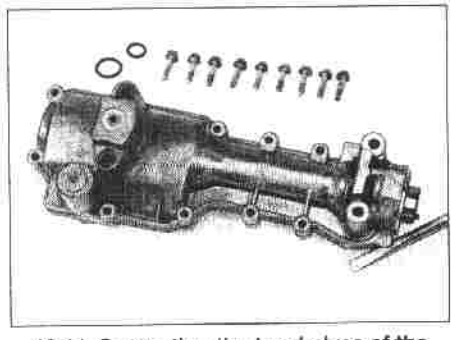
13.6 Using a special tool to remove the balance shaft housing



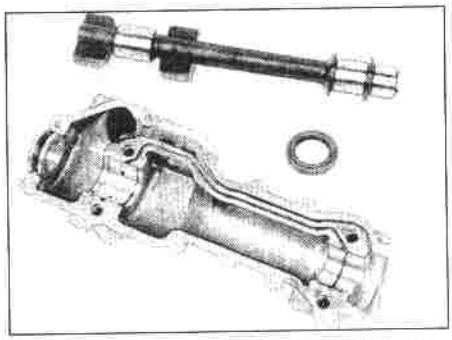
13.7 Removing belt tensioner and bolt



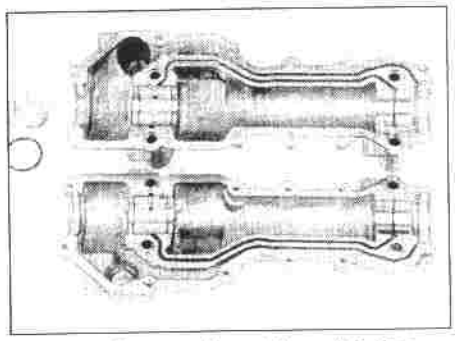
13.9 Right-hand engine mounting



13.11 Separating the two halves of the balance shaft housing



13.12 Balance shaft and front sealing ring removed from housing



13.13 Rear sealing plate and O-ring removed from housing

12 Lift the balance shaft out of the housing and remove the front sealing ring from the shaft **(see illustration)**.

13 Remove the rear sealing plate and remove the O-ring from the groove in the plate **(see illustration)**.

14 Remove the rear bearing shells from the housing halves **(see illustration)**.

15 Use solvent to remove the remains of the liquid sealing compound from the joint faces, and scrape them clean with a plastic putty knife or other soft instrument. Wipe the components with a degreasing agent and blow them clean with compressed air. Inspect the joint and bearing surfaces and renew any components that are visibly worn.

16 Install the rear bearing shells. Apply liquid sealing compound to the housing half from which you removed the shaft, taking care not to get any compound in the oilways. Lubricate the balance shaft bearings on both halves of the housing, taking care not to get any oil on the joint faces or in contact with the liquid sealing compound.

17 Place the shaft in the housing half to which the liquid sealing compound has been applied, then install the rear sealing plate with a new O-ring fitted in the groove.

18 Carefully place the two halves of the housing together. Insert the bolts and tighten them evenly around the joint, to stage 1 torque, making sure that the shaft does not seize in the housing.

Refitting

19 Clean the mounting points on the cylinder block. Fit new O-ring seals in the grooves around the balance shaft housing oilways and fix them in position by packing them with grease **(see illustration)**. Lubricate the housing joint faces with a thin coating of grease.

20 Fit the housing onto the cylinder block and insert the four mounting bolts. Make sure the housing is aligned evenly on the front and rear mountings, with a maximum deviation of 1mm. Tighten the bolts alternately in a diagonal pattern, half a turn at a time. Tighten them first to stage 1 torque, then slacken and retighten to stage 2 torque, then angle tighten. Check that the shaft does not seize within the housing while tightening.

21 Tighten the bolts around the joint between the two housing halves to stage 2 torque.

22 Fit the drive pulley on the balance shaft, with the slot in the pulley hub aligned with the guide pin on the shaft end, and the shallower side of the pulley facing inwards. Using tool 5362 or other suitable tool as a counterhold, tighten the centre bolt to the recommended torque.

23 Check the endfloat on the balance shaft. Use a dial gauge mounted on a magnetic stand if available.

Left-hand balance shaft (inlet side)

24 Refit the alternator and servo steering pump bracket, with the cable tie attached to the bolt from which is was removed. Check the alternator and servo pump connections.

25 Refit the air mass meter, inlet hose and connections. Lower the engine if it has been raised to provide access to the right hand balance shaft housing.

26 Refit the camshaft and balance shaft drivebelts (see Section 4). Refit the accessory drivebelts and all other components that have been removed.

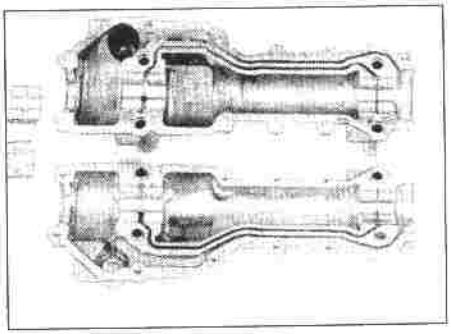
Right-hand balance shaft (exhaust side)

27 Refit the engine mounting to the cylinder block, complete with the insulating pad and lower mounting plate. Lower the engine into position on the front crossmember so that the lower mounting plate fits over the studs, then fit the nuts and remove the lifting gear.

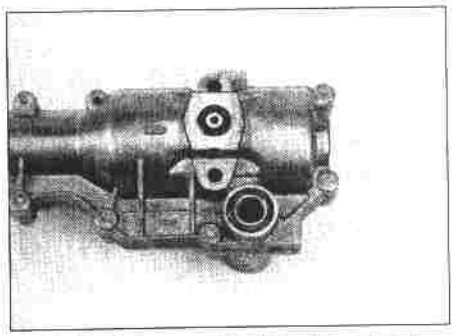
28 Refit the air mass meter, inlet hose and connections, then retighten the engine mounting and air preheating hose.

29 Refit the balance shaft belt tensioner and the bolt that goes through the backplate into the balance shaft housing (see paragraph 7).

30 Refit the camshaft and balance shaft drivebelts (see Section 4). Refit the accessory drivebelts and all other components that have been removed.



13.14 Rear bearing shells removed from housing



13.19 O-ring seals in housing oilways

14 Engine mountings - removal and refitting

Removal

1 Disconnect the battery negative lead.

2 Remove the nuts from the mounting to be removed.

3 Fit lifting tackle to the engine, or support it in some other way. Do not jack up directly onto the sump, as damage may result.

4 Take the weight off the mounting and remove it. It may be necessary to move aside power steering hoses, and (on fuel injection engines) to remove the inlet manifold bracing strut.

Refitting

5 Refit by reversing the removal operations.

Chapter 2 Part B:
V-6 engine in-car repair procedures

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

Engine (general)

Identification:	
B28E	Fuel injection, normally-aspirated
B280E	Fuel injection, normally-aspirated from 1987 model year
Bore	91 mm (nominal)
Stroke	73 mm
Cubic capacity	2849 cc
Compression ratio:	
B28E	9.5:1
B280E	10.0:1
Compression pressure:	
Overall value	8 to 11 bar
Variation between cylinders	2 bar maximum
Firing order	1-6-3-5-2-4 (No 1 LH rear of engine)
Direction of crankshaft rotation	Clockwise (viewed from front of engine)
Valve clearances	See Chapter 1 Specifications

Cylinder head

Warp limit - acceptable for use	0.05 mm per 100 mm length
Warp limit - acceptable for refinishing	No refinishing allowed
Height (new)	111.07 mm

Camshafts

Identification letter	
B28E	F
B280E	R
Identification number:	
B28E:	
Left	615 or 977
Right	616 or 978
B280E:	
Left	957
Right	959
Maximum lift (at lobe):	
B28E	5.96 mm
B280E:	
Inlet	6.08 mm
Exhaust	5.85 mm

Camshafts (continued)

Bearing journal diameters:	
1	40.440 to 40.465 mm
2	41.040 to 41.065 mm
3	41.640 to 41.665 mm
4	42.240 to 42.265 mm
Bearing running clearance	0.035 to 0.085 mm
Endfloat:	
New	0.070 to 0.144 mm
Wear limit	0.5 mm

Flywheel

Run-out	0.05 mm maximum

Lubrication system

Oil pressure (warm engine):	
At 900 rpm	1 bar minimum
At 3000 rpm	4 bar
Oil pump type	Gear, chain-driven from crankshaft sprocket
Oil pump clearances:	
Endfloat	0.025 to 0.084 mm
Gear side clearance	0.110 to 0.185 mm
Backlash	0.17 to 0.27 mm
Driving gear bearing clearance	0.015 to 0.053 mm
Idler gear bearing clearance	0.015 to 0.051 mm
Relief valve spring free length	89.5 mm
Relief valve spring length under load of 88 N (20 lbf)	56.5 to 60.5 mm

Torque wrench settings*

	Nm	lbf ft
Connecting rod bearing caps	45 to 50	33 to 37
Crankshaft pulley nut	240 to 280	177 to 207
Camshaft sprocket	70 to 90	52 to 66
Flywheel (use new bolts)	45 to 50	33 to 37
Rocker cover	15	11
Cylinder head bolts (see text):		
Early type bolts:		
Stage 1	60	44
Slacken, then Stage 2A	20	15
Stage 2B	Angle tighten 106° further	
Stage 3 (after warm-up and cooling)	Angle tighten 45° further	
Later type bolts with fixed washer:		
Stage 1	60	44
Slacken, then Stage 2A	40	30
Stage 2B	Angle tighten 160° to 180° further	
Main bearing nuts (see text):		
Stage 1	30	22
Slacken, then Stage 2A	30 to 35	22 to 26
Stage 2B	Angle-tighten 73 to 77° further	
Main bearing cap side bolts (B280E)	20 to 25	15 to 18
Oil pump to block	10 to 15	7 to 11
Timing cover bolts	10 to 15	7 to 11

**Oiled threads unless otherwise stated*

1 General information

How to use this Chapter

This Part of Chapter 2 describes those repair procedures that can reasonably be carried out on the V-6 engine (2.8 litre engine) while it remains in the car. If the engine has been removed from the car and is being dismantled as described in Part C, any preliminary dismantling procedures can be ignored. Refer to Part A for information on the in-line engine (2.0 and 2.3 litre engine) models.

Part C describes the removal of the engine/transmission from the vehicle, and the full overhaul procedures that can then be carried out.

Engine description

The V6 engine is a product of the PRV (Peugeot-Renault-Volvo) co-operative. It is well proven and is found in a wide selection of European cars destined for the upper end of the market.

The cylinder block, cylinder heads and crankcase are all made of aluminium alloy. The crankcase is split horizontally at the level of the crankshaft; a pressed steel sump is bolted onto the bottom of the lower crankcase.

A 90° "V" configuration is used for the two banks of cylinders. Cast iron cylinder liners of the "wet" type are used, as is common French practice: coolant circulates freely between the liners and the block. The liners are sealed at the top by the head gasket and at the base by individually selected seals.

The crankshaft runs in four renewable shell bearings, with endfloat controlled by thrustwashers at the flywheel end. Each crankpin is shared by two connecting rods. The connecting rod big-end bearings are also of the shell type.

The cylinder heads are of the crossflow type, the common inlet manifold sitting in the centre of the engine and the exhaust manifolds being on the outside. Each head carries valves, a camshaft and rocker gear. The camshafts are driven by separate chains with hydraulic tensioners.

The lubrication system is conventional. A gear type pump, driven from the crankshaft by a third chain, draws oil from the sump. Oil under pressure passes through an external canister filter before being supplied to the crankshaft, camshafts and rocker gear. The pistons and gudgeon pins are lubricated by splash. The timing chains are lubricated by spillage from the camshaft front bearings and the chain tensioner.

Repair operations possible with the engine in the car

The following work can be carried out with the engine in the car:

a) Compression pressure - testing
b) Rocker covers - removal and refitting
c) Timing chains and sprockets - removal, inspection and refitting
d) Cylinder heads - removal and refitting
e) Cylinder head and pistons - decarbonising
f) Camshafts and rocker gear - removal, inspection and refitting
g) Crankshaft oil seals - renewal
h) Oil pump - removal, inspection and refitting
i) Flywheel/driveplate - removal, inspection and refitting
j) Engine mountings - removal and refitting

2 Compression test - description and interpretation

Proceed as described in Part A, Section 2, but first perform the following with reference to Chapter 4B:

a) Remove the air inlet trunking.
b) Unplug the auxiliary air valve or air control valve connector.
c) Disconnect the hose which joins the auxiliary air valve and the start injector.

3 Rocker covers - removal and refitting

Removal

Note: *Carry out the following operations as applicable according to the side being worked on.*

B28 engines

1 Disconnect the battery negative lead.
2 Unbolt the control pressure regulator (without disconnecting it) from the right-hand rocker cover and place it on the inlet manifold.
3 Remove the air inlet trunking, the oil filler cap and the crankcase ventilation hoses.
4 Unbolt and remove the vacuum pump from the left-hand rocker cover and move it aside.
5 Remove the air conditioning compressor accessory drivebelt (see Chapter 1). Unbolt the compressor brackets from the engine and move the compressor and brackets to one side. Do not disconnect any refrigerant hoses, nor allow the weight of the compressor to hang on them.
6 Remove the ten bolts which secure each rocker cover, noting the locations of the various lengths of bolt.
7 Remove the rocker covers and recover the gaskets.

B280 engines

8 Disconnect the battery negative lead. Cover the battery with a piece of wood or plastic, or remove it completely, so that its terminal will not be short-circuited by the air conditioning compressor.
9 Remove the air conditioning compressor accessory drivebelt (see Chapter 1).
10 Remove the oil filler cap and the crankcase ventilation hoses attached to it.
11 Disconnect the air conditioning compressor control lead.
12 Unbolt the compressor mountings from the engine and move the compressor to one side, complete with mounting bracket and belt tensioner pulley. Do not disconnect any refrigerant hoses, nor allow the weight of the compressor to hang on them.
13 Unbolt the compressor drivebelt idler pulley from the right-hand rocker cover. Slacken the bolt which holds the idler to the timing chain cover and move the idler out of the way.
14 Remove the engine oil dipstick.
15 Unbolt any remaining cable clamps from the right-hand rocker cover.
16 Remove the air cleaner and the air mass meter (see Chapter 4B). Also remove the air inlet trunking which connects the air mass meter to the throttle body housing.
17 Disconnect the HT leads from the left-hand bank of spark plugs and move them aside. Note the inductive pick-up on No 1 HT lead.
18 Unbolt the HT lead clip from the left-hand rocker cover.
19 Free the remaining wiring harnesses and fuel lines from their brackets, cutting cable-ties where necessary. Use new ties on reassembly.
20 Remove the rocker cover securing bolts, noting the location of the different lengths of bolt. Note also the earth strap under one of the left-hand bolts.
21 Remove the rocker covers and recover the gaskets.

Refitting

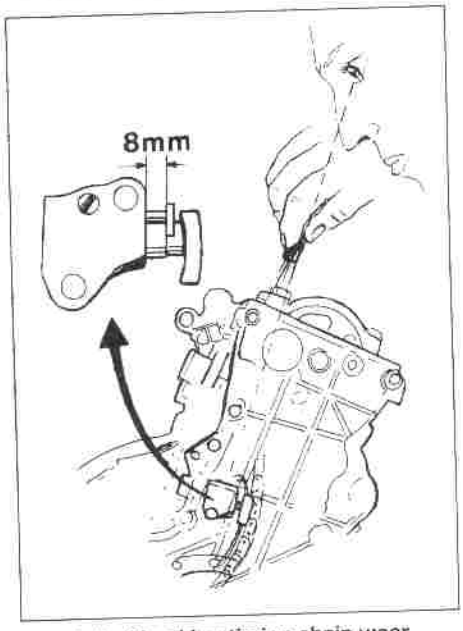
All engines

22 Carefully clean the cylinder head and rocker cover mating surfaces, and remove all traces of oil.
23 Fit the rocker cover gasket ensuring that it is correctly seated along its entire length.
24 Locate the cover over the cylinder head then fit and tighten the nuts, remembering to fit the earth strap, where applicable.
25 Reconnect the remainder of the components using a reversal of removal. Reconnect the battery then run the engine and check that there are no oil leaks from the rocker cover joints.

4 Timing chains and sprockets - removal, inspection and refitting

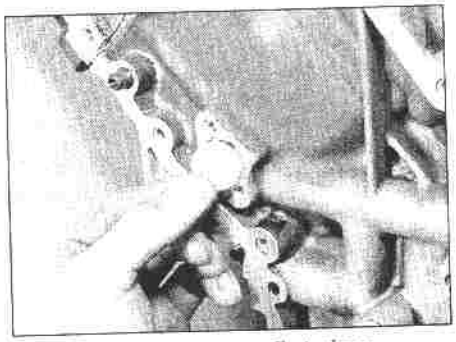
Removal

1 Disconnect the battery negative lead.
2 Remove all the accessory drivebelts (see Chapter 1).
3 Remove the radiator, fan shroud and fan. When fitted, also remove the ATF cooler (see Chapter 3).
4 Remove both rocker covers (see Section 3).
5 Unbolt and move aside the power steering pump with its bracket.
6 On the B280 engine, remove the distributor (see Chapter 5B).
7 Using a 36 mm socket on the crankshaft pulley nut, bring the engine to TDC, with No 1 piston on the firing stroke. This is achieved when the No 1 pulley notch is aligned with the "O" mark on the timing scale, and both rocker arms for No 1 cylinder (LH rear) have a small amount of free play, showing that the valves are closed.
8 Remove the blanking plate from the unused starter motor opening. Jam the starter ring gear through this opening, either by having an assistant brace a tyre lever or a large screwdriver in the gear teeth, or (preferably) by bolting a suitably shaped metal segment to engage with the teeth.
9 Using a 36 mm socket, undo the crankshaft pulley centre nut. This nut is very tight. Remove the ring gear jamming device.
10 Check that the keyway in the crankshaft pulley is upwards, then remove the pulley. (If the keyway were downwards, the key might fall into the sump.)
11 Remove the 25 bolts which secure the timing cover. Also remove the drivebelt idler pulleys, which share some of the timing cover bolts. Note the locations of the various lengths of bolt.
12 Move aside the wiring harness which passes in front of the timing cover.
13 Pull the timing cover off its dowels and remove it. Cover the holes leading to the sump with paper or rag, then recover the timing cover gasket.
14 Restrain the camshaft sprockets and slacken their centre bolts with a 10 mm Allen key.

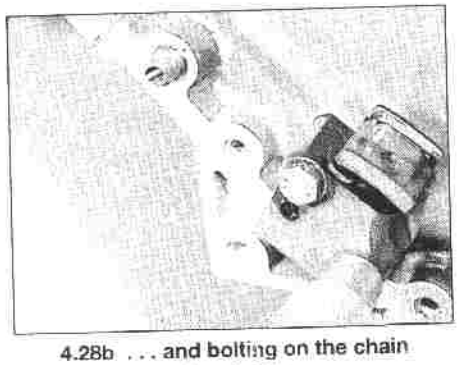


4.15 Checking timing chain wear

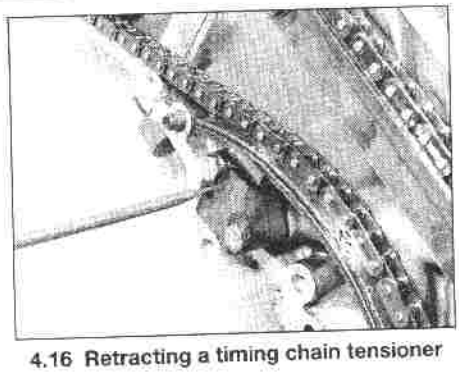
15 Before removing the chains and tensioners completely, it is a good idea at this stage to observe the chain tensioner plungers, noting how far they protrude from the tensioner body. This will provide an indication as to chain wear, and can confirm whether renewal of the chains may be necessary. If the tensioner plunger protrudes by four notches (8 mm) or more, wear is excessive and the chains must be renewed **(see illustration)**.



4.28a Fitting a new oil strainer . . .



4.28b . . . and bolting on the chain tensioner



4.16 Retracting a timing chain tensioner

16 Retract each timing chain tensioner by turning the locking device anti-clockwise with a small screwdriver, at the same time pushing in the plunger **(see illustration)**.

17 Unbolt the oil pump sprocket. Remove the sprocket and chain.

18 Unbolt and remove the timing chain tensioners. Identify them if they are to be re-used. Recover the oil strainer from behind each tensioner.

19 Unbolt and remove the timing chain guides and dampers.

20 Check whether any markings are visible on the timing chain links. If there are none, and the existing timing chain is to be re-used, initially read paragraphs 32, 33, 34, 36 and 37 of this Section and make alignment marks on the chains when the crankshaft and camshaft sprockets are in the stated positions.

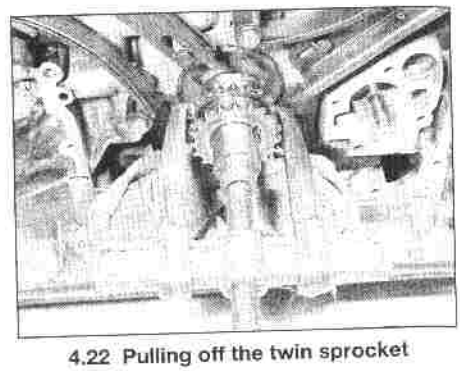
21 Remove the camshaft sprocket centre bolts, the camshaft sprockets and the timing chains. Identify left-hand and right-hand components.

22 Remove the oil pump drive sprocket, the outer Woodruff key, the spacer, the twin sprocket and the inner key. A puller may be needed **(see illustration)**.

Inspection

23 Worn timing chains make a characteristic thrashing sound. Of itself chain wear is not serious, but if the chain stretches too far, a plunger may fall out of one of the tensioners. This will cause loss of oil pressure and possibly serious damage to the engine.

4.29a Refitting a chain damper



4.22 Pulling off the twin sprocket

24 Chains and sprockets wear together and should always be renewed together. To do otherwise is risking noise and rapid wear. An indication of chain wear will have been gained during the removal sequence (paragraph 15), but a further examination should be carried out as follows.

25 Inspect the chain guides and dampers. Renew them if they are badly grooved or otherwise damaged.

26 Inspect the chain tensioners, but do not dismantle them. If the plunger is removed from a tensioner, the tensioner must be renewed. Check that the tensioner oilways are not blocked.

27 Renew the tensioner oil strainers, the timing cover gasket and the camshaft cover gaskets as a matter of course. Also renew the crankshaft front oil seal unless it is known to be in perfect condition.

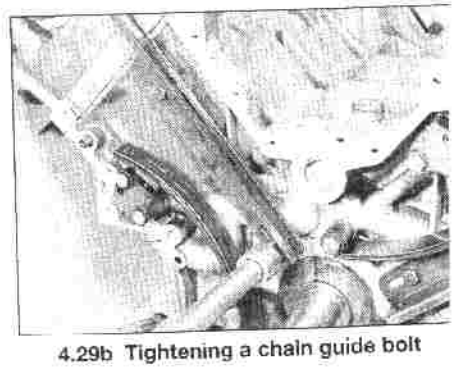
Refitting

28 Commence reassembly by fitting new oil strainers to the chain tensioner recesses in the block. Refit and secure the chain tensioners, using thread locking compound on the bolts **(see illustrations)**.

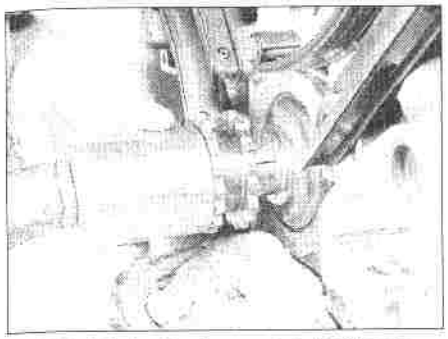
29 Refit and secure the chain guides and dampers, again using thread locking compound **(see illustrations)**.

30 Oil the crankshaft nose and fit the inner Woodruff key to it.

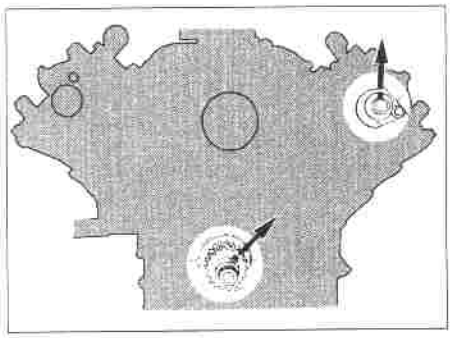
31 Fit the twin drive sprocket to the crankshaft. The mark on the sprocket must face outwards. Drive the sprocket home with a piece of tube if it is tight **(see illustration)**. Be careful not to dislodge the Woodruff key.



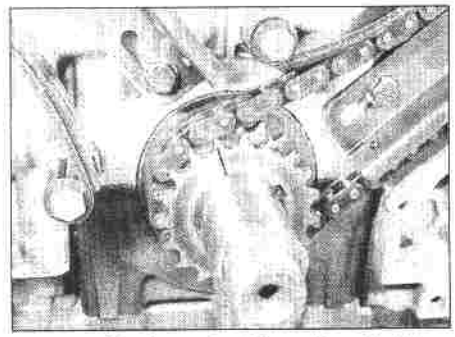
4.29b Tightening a chain guide bolt



4.31 Driving the inner sprocket home



4.32 Keyway and groove positions for fitting the left-hand timing chain



4.33a Single marked line aligned with crankshaft sprocket mark . . .

32 Prepare to fit the left-hand timing chain. (Remember, left and right refer to the engine, not to the mechanic). Temporarily refit the crankshaft pulley nut and turn the crankshaft until the keyway points to the left-hand camshaft. Turn the left-hand camshaft so that the sprocket locating groove points directly upwards **(see illustration)**.

33 Fit the left-hand timing chain to the camshaft sprocket so that the two marked links on the chain are on each side of the mark on the sprocket. Offer the chain to the innermost section of the crankshaft sprocket so that the single marked link is in line with the mark on the sprocket. Tension the chain on the driving side (next to the straight guide) and fit the camshaft sprocket to the camshaft. The sprocket must locate in the groove **(see illustrations)**.

34 Fit the bolt to the left-hand camshaft sprocket, but do not tighten it fully yet.

35 Prepare to fit the right-hand chain. Turn the crankshaft clockwise until the keyway points vertically downwards. Turn the right-hand camshaft until the sprocket locating groove is facing outwards and parallel with the head mating face **(see illustration)**.

36 Fit the right-hand chain and sprockets in the same way as the left-hand one, with the twin marked links straddling the camshaft sprocket mark and the single marked link aligned with the crankshaft sprocket mark. Turn the crankshaft a little if necessary to achieve alignment.

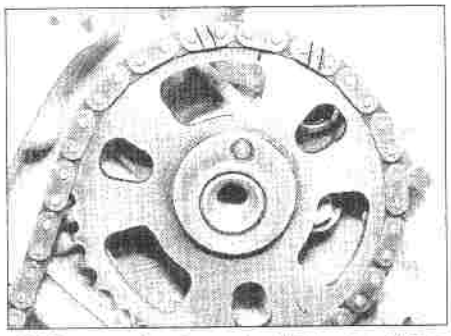
37 Fit the bolt to the right-hand camshaft sprocket. Tighten both camshaft sprocket bolts to the specified torque, restraining the sprockets with a screwdriver.

38 Release the timing chain tensioners by turning the locking devices a quarter turn clockwise. Do not force the plungers out.

39 Rotate the crankshaft through two full turns clockwise to set the chain tension. (The marks will no longer align - see paragraph 20.) Turn the crankshaft a further half turn clockwise so that the keyway points upwards again.

40 Remove the crankshaft pulley nut. Fit the spacer, the outer Woodruff key and the oil pump driving sprocket **(see illustrations)**.

41 Fit the oil pump driven sprocket and chain. Use thread locking compound on the sprocket bolts.



4.33b . . . and twin marked links straddling the camshaft sprocket mark

42 Oil the chains and remove the rag or paper from the sump holes. Check that nothing has been overlooked.

43 Refit the timing cover, using a new gasket. Insert and tighten the 25 bolts, applying thread locking compound to the four bottom bolts. Remember to fit the wiring harness behind the idler pulleys.

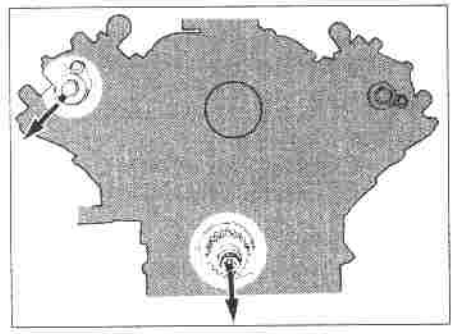
44 Fit a new oil seal to the timing cover if necessary (Section 8), then refit the crankshaft pulley. Be careful not to dislodge the Woodruff key.

45 Turn the starter ring gear. Fit the crankshaft pulley nut and tighten it to the specified torque. Remove the jamming device.

46 Refit the starter motor blanking plate.

47 Trim the protruding ends of the timing cover gasket flush with the cylinder heads.

48 Refit the rocker covers (Section 3).



4.35 Keyway and groove positions for fitting the right-hand timing chain

49 Refit the remaining components by reversing the removal procedure, referring to other Chapters as necessary.

50 If a new timing cover has been fitted, or if the position of the timing scale has been altered, check the timing scale position (Section 11).

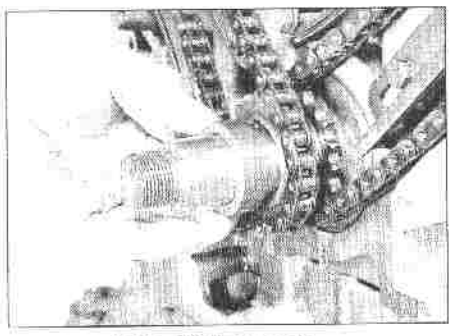
51 Check the ignition timing (Chapter 5B) and the idle speed and mixture (Chapter 1).

5 Oil pump - removal, inspection and refitting

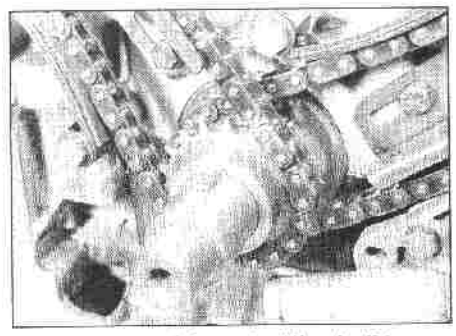
Removal

1 Proceed as for timing chain removal (Section 4, paragraphs 1 to 13).

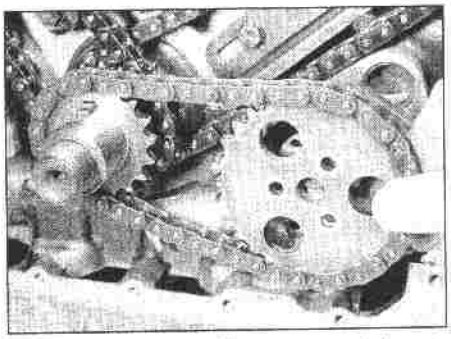
2 Unbolt the oil pump sprocket. Remove the sprocket and chain **(see illustration)**.



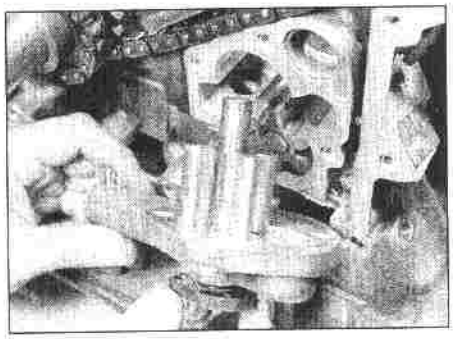
4.40a Fit the spacer . . .



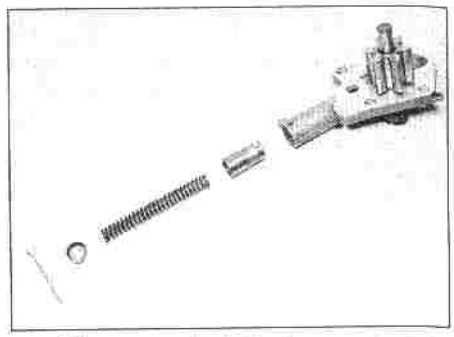
4.40b . . . and the outer Woodruff key



5.2 Removing the oil pump sprocket and chain



5.3 Removing the oil pump from the block. Idler gear will stay behind



5.4 Oil pump and relief valve components

3 Remove the four bolts which secure the oil pump to the block. Withdraw the pump and recover the idler gear **(see illustration)**.

Inspection

4 Remove the relief valve components by depressing the cap and extracting the split pin. Remove the cap, spring and plunger **(see illustration)**.

5 Clean the pump body and the gears and inspect them for wear and damage. If evident, the pump must be renewed complete. Although clearances and wear limits are specified, they are not easy to measure because of the design of the pump. If in doubt, renew the pump.

6 Inspect the relief valve plunger for scoring. Measure the spring free length and if possible check its load/length characteristic - see Specifications. Relief valve spares are available.

7 Reassemble the pump and relief valve components. Use a new split pin.

Refitting

8 Clean the pump and block mating faces, and clean out the pump recess in the block.

9 Commence refitting by oiling all components liberally. Insert the idler gear into the recess, fit the pump and secure it with the four bolts. Tighten the bolts to the specified torque.

10 Refit the sprocket and chain. Use thread locking compound on the sprocket bolts.

11 Refit the timing cover and associated components (Section 4).

6 Cylinder heads and rocker gear - removal and refitting

Note: *Read through this procedure before starting work to understand what is involved. In particular, note that if the cylinder liners are accidentally disturbed, the engine may have to be removed and completely dismantled to put things right.*

Note: *The following operations entail the use of Volvo special tool No. 5213, (or a suitable equivalent) to retain the camshaft sprocket(s) and timing chain(s).*

Removal

1 Disconnect the battery negative lead.

2 Drain the cooling system (see Chapter 1).

3 Remove the inlet manifold and associated components (see Chapter 4B).

4 Disconnect the coolant hose(s) from the head(s) to be removed. Also remove the radiator top and/or bottom hoses from the water pump and thermostat housing.

5 When removing the right-hand cylinder head, disconnect or remove the following items:

a) TDC sender and cable lead
b) Distributor (Chapter 5B)
c) Air conditioning compressor (without disconnecting the hoses)
d) Engine oil dipstick and tube

6 When removing the left-hand cylinder head, disconnect or remove the following items:

a) Vacuum pump
b) Hot air trunking

7 Disconnect the exhaust downpipes from both manifolds. Disconnect the exhaust mounting from the transmission and move the exhaust system rearwards so that the downpipes are clear of the manifold studs.

8 Perform the following operations on one head at a time.

9 Unbolt and remove the rocker cover (Section 3).

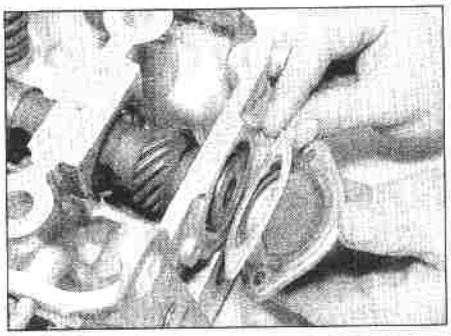
10 Remove the cover plate from the rear of the head **(see illustration)**.

11 Remove the four timing cover bolts which enter the cylinder head.

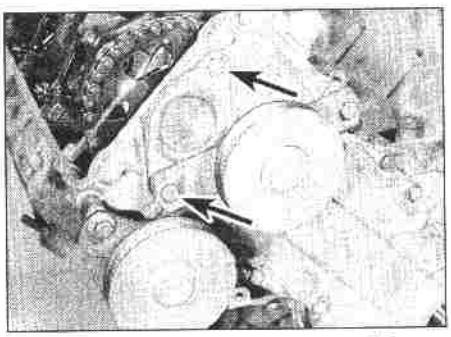
12 Remove the cover plate (RHS) or threaded plug (LHS) which gives access to the camshaft sprocket bolt **(see illustrations)**.

13 Restrain the camshaft sprocket. Slacken the sprocket centre bolt with a 10 mm Allen key.

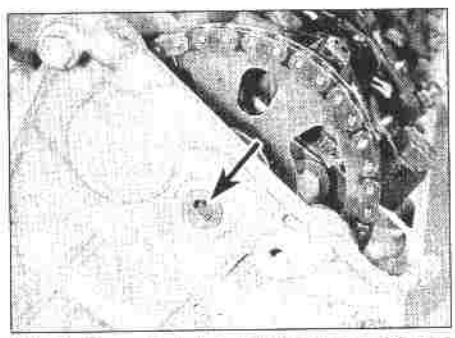
14 Slacken the cylinder head/rocker gear bolts progressively in the correct sequence **(see illustration)**. Remove the bolts and the



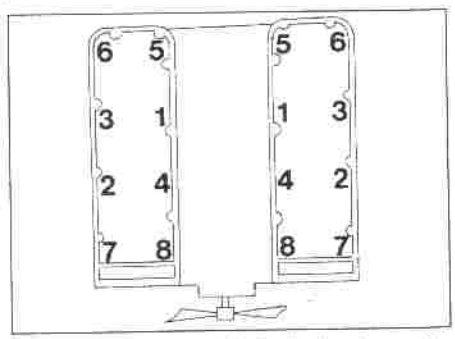
6.10 Removing the cover plate and gasket from the rear of the head



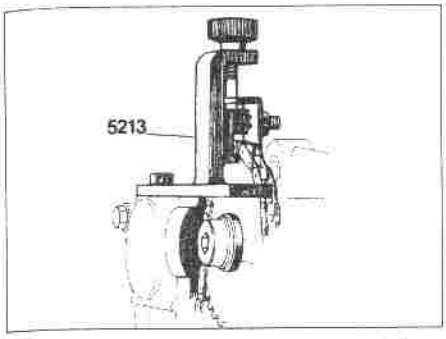
6.12a Cover plate bolts (arrowed) for access to right-hand sprocket bolt. Idler pulley may need to be removed



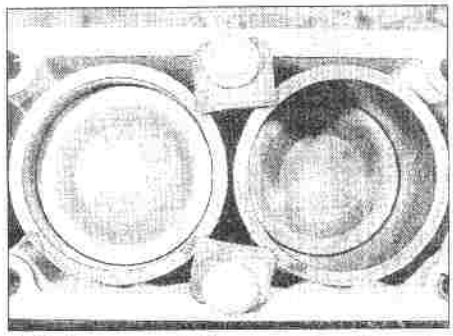
6.12b Threaded plug (arrowed) for access to left-hand sprocket bolt



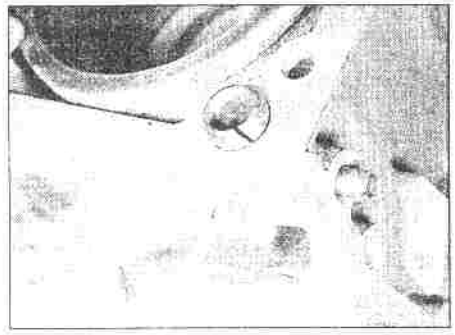
6.14 Cylinder head bolt slackening and tightening sequence



6.16 Volvo tool 5213 for retention of the camshaft sprocket



6.21 Home-made liner retaining clamps in position



6.30 A rivet inserted below the dowel

rocker gear; identify them if both heads are to be removed.

15 Slacken the camshaft thrust plate bolt. Move the thrust plate aside.

16 It is now necessary to fit a tool (Volvo tool No 5213, or equivalent) to retain the camshaft sprocket and to keep the chain taut **(see illustration)**. If the timing chain is allowed to slacken, the timing cover will have to be removed (Section 4) to reset the tensioner. If the tool is not available, proceed by removing the timing chains.

17 With the sprocket securely supported and the chain tension assured, unscrew the camshaft sprocket centre bolt. Remove the bolt from the right-hand camshaft, being careful not to drop it into the timing case. On the left-hand side there is no room to remove the bolt completely.

18 Move the camshaft rearwards so that it is clear of the sprocket.

19 Place a wooden or plastic lever between the head and the water branch pipe. Lever the head away from the block with a rocking motion to release it. Do not try to swivel the head (as it is located by dowels), or lift it straight off, or the cylinder liners will be disturbed. **Note:** *If care is not taken and the liners are moved, there is also a possibility of the bottom seals being disturbed, causing leakage after refitting the head.* When the joint is broken, lift the cylinder head away; seek assistance if possible, as it is a heavy assembly.

20 Remove the gasket from the cylinder head or block. Recover the dowels if they are loose.

21 Fit cylinder liner retaining clamps, using some head bolts, spacers, and large washers or suitable pieces of scrap metal. The precise dimensions of the retainers are not important unless the pistons are to be removed, in which case they must not foul the bores **(see illustration)**.

22 If it is wished to turn the crankshaft whilst the head is removed, or if the other head is to be removed, the camshaft sprocket retaining tool must be changed for one which will allow the sprocket to rotate. Volvo tool No 5105 is suitable.

23 Repeat the operations from paragraph 9 to remove the other cylinder head.

24 If the cylinder head is to be dismantled for overhaul, remove the camshaft as described in Section 7, then refer to Part C of this Chapter.

Preparation for refitting

25 The mating faces of the cylinder head and cylinder block must be perfectly clean before refitting the head. Use a hard plastic or wood scraper to remove all traces of gasket and carbon; also clean the piston crowns. Take particular care during the cleaning operations, as aluminium alloy is easily damaged. Also, make sure that the carbon is not allowed to enter the oil and water passages - this is particularly important for the lubrication system, as carbon could block the oil supply to the engine's components. Using adhesive tape and paper, seal the water, oil and bolt holes in the cylinder block/crankcase. To prevent carbon entering the gap between the pistons and bores, smear a little grease in the gap. After cleaning each piston, use a small brush to remove all traces of grease and carbon from the gap, then wipe away the remainder with a clean rag. Clean all the pistons in the same way.

26 Check the mating surfaces of the cylinder block and the cylinder head for nicks, deep scratches and other damage. If slight, they may be removed carefully with a file, but if excessive, machining may be the only alternative to renewal.

27 If warpage of the cylinder head gasket surface is suspected, use a straight-edge to check it for distortion. Refer to Part C of this Chapter if necessary.

28 Check the condition of the cylinder head bolts, and particularly their threads, whenever they are removed. Wash the bolts in suitable solvent, and wipe them dry. Check each for any sign of visible wear or damage, renewing any bolt if necessary. Measure the length of each bolt, to check for stretching (although this is not a conclusive test, in the event that all ten bolts have stretched by the same amount). It is strongly recommended that the bolts should be renewed as a complete set whenever they are disturbed. Note that if new bolts are to be fitted, the latest Volvo recommendation is that these bolts will not require retorquing after the engine has been run-in. Consult your Volvo dealer for further information.

Refitting

29 Commence refitting by removing the liner retaining clamps. Refit the camshaft sprocket retaining tool, if it was removed, being careful to keep the chain taut.

30 Fit the dowels in the cylinder block and keep them raised by inserting a nail or twist drill (3 mm diameter) in the holes beneath the dowels **(see illustration)**.

31 Make sure that the exposed sections of the timing cover gasket are in good condition. If not, repair them with fragments cut from a new gasket. Apply jointing compound to the gasket sections.

32 With the gasket mating face clean and dry, fit a new head gasket to the block. Make sure that it is the right way round and the right way up.

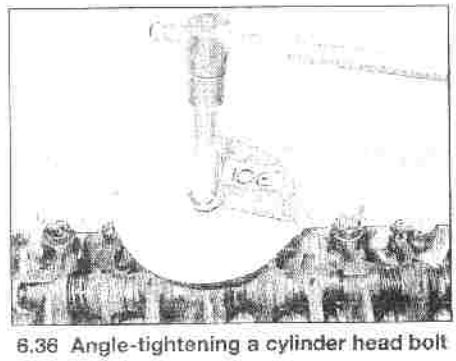
33 Lower the cylinder head and camshaft into position. Turn the camshaft until its hole lines up with the locating pin in the sprocket, then push the camshaft forwards to engage with the sprocket. Insert the sprocket centre bolt and tighten it lightly.

34 Remove the nails or drills from below the dowels. Fit the rocker gear and the cylinder head bolts. The bolts must be clean and have oiled threads.

35 Tighten the cylinder head bolts progressively, in the correct sequence (see illustration 6.14), and to the Stage 1 specified torque.

36 Slacken the first bolt, then retighten it to the Stage 2A specified torque. Tighten the bolt further through the angle specified for Stage 2B. Use an angle measuring gauge for this operation or make up a cardboard template to indicate the angle required **(see illustration)**.

37 Repeat the Stage 2 tightening process on each bolt in turn.



6.36 Angle-tightening a cylinder head bolt

38 Remove the camshaft sprocket retaining tool. Move the camshaft thrust plate into position and tighten its retaining bolt.
39 Restrain the camshaft sprocket and tighten the sprocket centre bolt to the specified torque.
40 Refit the cover plate or access plug to the front of the timing cover. Use a new O-ring under the cover plate.
41 Fit and tighten the four timing cover bolts.
42 Refit the head rear cover plate, using a new gasket.
43 Refit the other cylinder head if it was removed.
44 Check and adjust the valve clearances (Chapter 1).
45 Provisionally fit the rocker covers, using new gaskets (Section 3). Only secure them with a bolt at each corner for the time being, as they will have to come off again soon.
46 Refit the exhaust downpipes to the manifolds and secure the exhaust mounting.
47 Refit the items listed in paragraphs 5 and 6, with the exception of the air conditioning compressor.
48 Refit the coolant hoses. Refill the cooling system (Chapter 1).
49 Refit the inlet manifold and fuel injection equipment (Chapter 4B).
50 Reconnect the battery. Run the engine and bring it up to normal operating temperature.
51 Stop the engine and allow it to cool for two hours.
52 Remove the rocker covers again. Tighten each cylinder head bolt, in the correct sequence, through the angle specified for Stage 3 tightening. **Note:** *If new bolts have been fitted, the latest Volvo recommendation is that these bolts will not require retorquing at this stage. Consult your Volvo dealer for further information.*
53 Refit the rocker covers, this time using all the bolts. Refit any other disturbed components.
54 Refit the air conditioning compressor.
55 Check the ignition timing (Chapter 5B) and the idle speed and mixture (Chapter 1).

7 Camshaft - removal, inspection and refitting

Removal

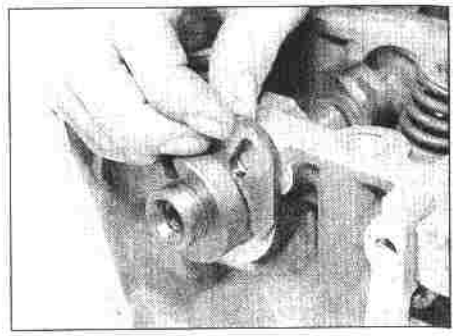
1 Remove the appropriate cylinder head and rocker gear (see Section 6).
2 If not done during removal, unbolt the camshaft thrust plate and remove the cover plate from the rear of the head **(see illustration)**.
3 Withdraw the camshaft through the hole in the rear of the head, being careful not to damage the bearing surfaces (or your fingers) with the sharp edges of the cam lobes **(see illustration)**.

Inspection

4 Inspect the cam lobes and the camshaft bearing journals for scoring, scuffing or other damage. Once the surface hardening of the lobes has been penetrated, wear will progress rapidly.
5 Measure the bearing journals with a micrometer and check them for ovality and taper. To establish the bearing running clearance, an internal micrometer must be used to measure the bearings in the cylinder heads. Excessive wear or damage can only be corrected by renewing the camshaft and/or head.
6 Measure camshaft endfloat with the camshaft installed in the head **(see illustration)**. If endfloat is excessive, renew the thrust plate.

Refitting

7 Refit by reversing the removal operations, applying plenty of oil to the bearing journals and the cam lobes. If special lubricant is supplied with a new camshaft, use it.
8 Run in a new camshaft at moderate engine speeds (in the range 1500 to 2500 rpm) for a few minutes, or as specified by the manufacturer.

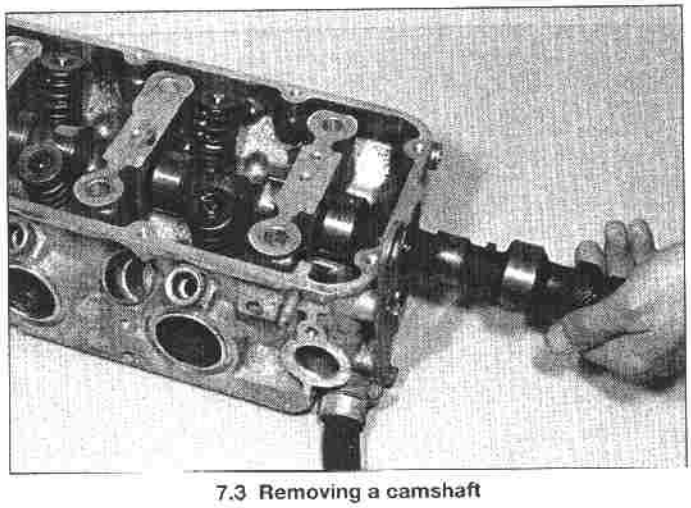


7.2 Removing a camshaft thrust plate

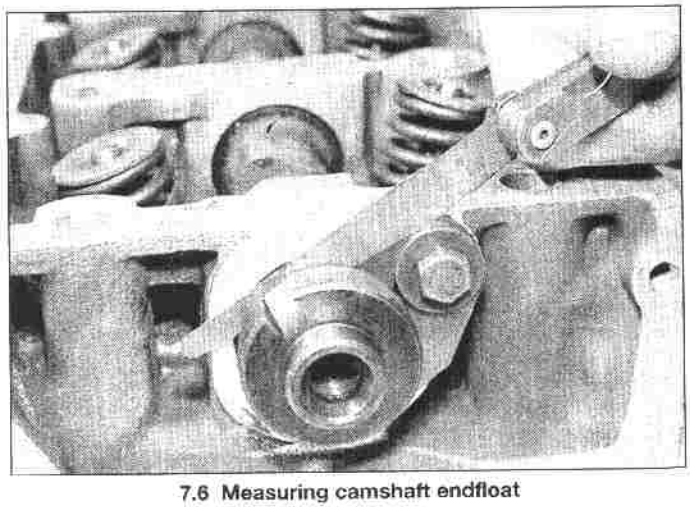
8 Crankshaft oil seals - renewal

Front oil seal

1 Disconnect the battery negative lead.
2 Remove the radiator, fan shroud and fan. When fitted, also remove the ATF auxiliary cooler (see Chapter 3).
3 Remove all the accessory drivebelts (see Chapter 1).
4 Turn the crankshaft until No 1 pulley notch is aligned approximately with the 20° BTDC mark on the timing scale. This will position the keyway correctly.
5 Remove the crankshaft pulley (see Section 4, paragraphs 8 to 10).
6 Carefully prise the oil seal from its location. Do not damage the seal seat. Alternatively, punch or drill two small holes opposite each other in the oil seal. Screw a self-tapping screw into each, and pull on the screws with pliers to extract the seal.
7 Clean the seal seat in the timing cover and inspect the seal rubbing surface on the pulley. If the rubbing surface is damaged, it must be cleaned up or the pulley must be renewed, otherwise the new seal will fail prematurely.



7.3 Removing a camshaft



7.6 Measuring camshaft endfloat

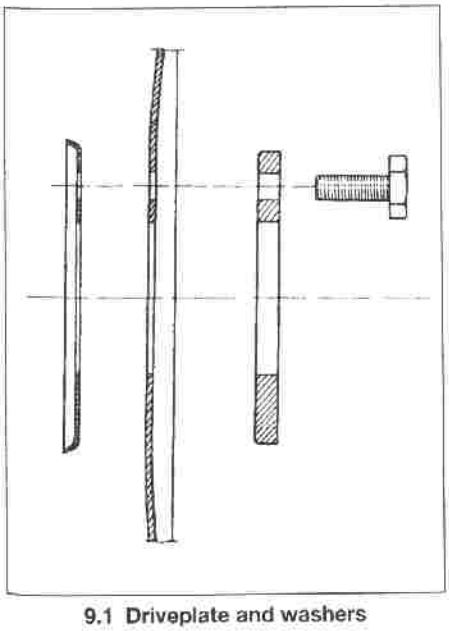
8 Grease the lips of the new seal. Fit the seal, lips inwards, and tap it home using a large socket or a piece of tube.
9 Refit the crankshaft pulley, being careful not to dislodge the Woodruff key.
10 Jam the ring gear and tighten the crankshaft pulley nut to the specified torque. Remove the jamming device.
11 Refit the other components by reversing the removal sequence.

Rear oil seal

12 Remove the flywheel or driveplate (see Section 9).
13 Carefully prise out the old oil seal. Do not damage the carrier or the surface of the crankshaft. Alternatively, punch or drill two small holes opposite each other in the oil seal. Screw a self-tapping screw into each, and pull on the screws with pliers to extract the seal.
14 Clean the oil seal carrier and the crankshaft. Inspect the crankshaft for a wear groove or ridge left by the old seal.
15 Lubricate the carrier, the crankshaft and the new seal. Fit the seal, lips inwards, and use a piece of tube (or the old seal, inverted) to tap it home.
16 Refit the flywheel or driveplate (Section 9).

9 Flywheel/driveplate - removal and refitting

1 Proceed as described in Part A, Section 12, but disregard the references to the ignition system. Note also that the arrangement of the driveplate washers differ **(see illustration)**.



9.1 Driveplate and washers

10 Engine mountings - removal and refitting

B28 Engines

Removal

1 Disconnect the battery negative lead.
2 Raise and support the front of the vehicle. From below, remove the through-bolt and nut and the spigot nuts from the lower part of the mounting to be removed.
3 Fit lifting tackle to the engine, or support it in some other way. Do not jack up directly onto the sump, as damage may result. Raise the engine slightly to unload the mountings and remove the lower part.
4 The upper part of the mounting, complete with rubber block, can now be removed.

Refitting

5 Refit by reversing the removal operations.

B280 engines

Removal

6 Disconnect the battery negative lead.
7 Remove the two securing bolts from the top of the fan shroud and free the shroud from its lower mountings. There is no need to remove the shroud completely.
8 Fit lifting tackle to the engine, or support it in some other way. Do not jack up directly onto the sump, as damage may result. Raise the engine slightly to unload the mountings and remove the lower part.
9 Unbolt the exhaust system flanged joint behind the front silencer.
10 Unbolt the engine dampers at one end of their mountings. Compress the dampers slightly and swing them aside.
11 Remove the sump guard (if not already done). If working on the right-hand side, unbolt the transmission fluid line bracket from the bellhousing.
12 Remove the three nuts and two bolts securing each mounting. One of the nuts is not immediately obvious: it is accessible from the underside of the engine support crossmember.
13 Raise the engine slightly and withdraw the mounting. Recover the spacer.

Refitting

14 Refit by reversing the removal operations.

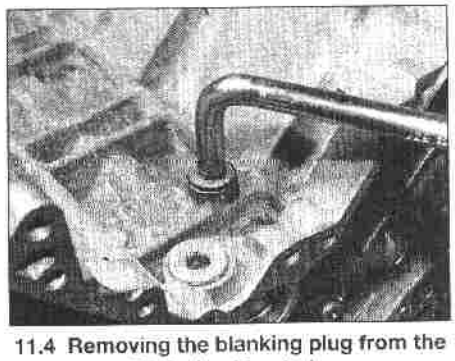
11 Timing scale - checking and adjusting

Checking

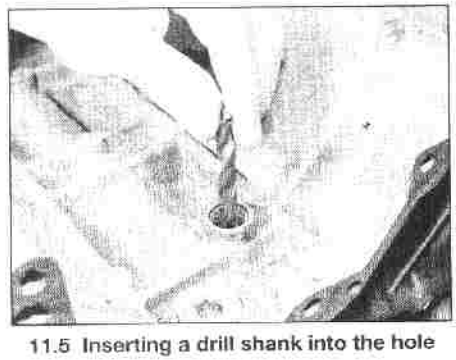
1 The position of the timing scale, fitted to the timing cover above the crankshaft pulley, can be altered within the range provided by the two elongated bolt holes. Although there should normally be no reason to doubt the accuracy of the scale, its position should be checked if it is ever disturbed, or if new components have been fitted (eg a new timing cover).
2 To check the accuracy of the timing scale, the timing cover and crankshaft pulley must be fitted, and the inlet manifold must be removed (see Chapter 4B). It may also be necessary to remove the water pump (Chapter 3).
3 Bring the crankshaft to approximately 20° BTDC with No 1 piston on compression.
4 Remove the blanking plug from the checking hole, using an 8 mm square drive key (the same as for the sump drain plug). Recover the copper washer **(see illustration)**.
5 Insert a drill shank or other rod, 8 mm in diameter, into the hole **(see illustration)**. Slowly turn the crankshaft clockwise until the rod drops into the slot in the crankshaft. This is TDC for No 1 piston.
6 In this position the "O" mark on the timing scale must be aligned exactly with the No 1 notch on the pulley.

Adjusting

7 If the position of the scale is incorrect, slacken the scale securing bolts if necessary and adjust the scale position. Tighten the bolts and seal them with a dab of paint.
8 Remove the drill or rod. Refit the blanking plug, using a new copper washer, and tighten it.
9 Refit the disturbed components with reference to the relevant Chapters of this manual.



11.4 Removing the blanking plug from the TDC checking hole



11.5 Inserting a drill shank into the hole

2B

Chapter 2 Part C:
Engine removal and overhaul procedures

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

2C

Specifications

In-line engines

Cylinder head

Warp limit - acceptable for use:	
Lengthwise	0.50 mm
Across	0.25 mm
Warp limit - acceptable for refinishing:	
Lengthwise	1.00 mm
Across	0.50 mm
Height:	
B23/B200/B230	
New	146.1 mm
Minimum after refinishing	145.6 mm
B234F	
New	103.0 to 104.0 mm
Minimum after refinishing	102.7 mm
Maximum machining	0.3 mm

Inlet valves

B23/B200/B230:	
Head diameter	44 mm
Stem diameter:	
New	7.955 to 7.970 mm
Wear limit	7.935 mm
B234F:	
Stem diameter	6.95 mm min
Stem height (must be correct for hydraulic tappets)	49.0 to 49.8 mm
Stem height, maximum machining allowance	0.4 mm
Stem length, new	122.25 to 122.65 mm
Edge width, new	1.5 mm
Edge width after grinding	1.2 mm min
Valve head angle	44° 30'

Exhaust valves

Head diameter (B23/B200/B230)	35 mm
Stem diameter (B200/B230 E and K):	
New	7.945 to 7.960 mm
Wear limit	7.925 mm
Stem diameter (B23 and B230 ET):	
32 mm (1.26 in) from head	Same as B230 E and K
16 mm (0.63 in) from tip:	
New	7.965 to 7.980 mm
Wear limit	7.945 mm
B234F:	
Stem diameter	6.94 mm min
Stem height (must be correct for hydraulic tappets)	49.0 to 49.8 mm
Stem height, maximum machining allowance	0.4 mm
Stem length, new	122.05 to 122.45 mm
Valve head angle	44° 30'

Valve seat inserts

B23/B200/B230:	
Diameter (standard):	
Inlet	46.00 mm
Exhaust	38.00 mm
Oversizes available	+ 0.25 and 0.50 mm
Valve seat angle	45° 00'
B234F:	
Diameter (standard):	
Inlet	36.14 mm
Exhaust	33.14 mm
Oversizes available	+ 0.50 mm
Valve seat angle	45° 00'
Valve seat upper relief angle	15° 00'
Valve seat lower relief angle	70° 00'
Valve seat width (seating face excluding relief angles):	
Inlet	1.3 to 1.9 mm
Exhaust	1.7 to 2.3 mm
Fit in cylinder head	Interference

Valve guides

B23/B200/B230:	
Length	52 mm
Internal diameter	8.000 to 8.022 mm
Height above cylinder head:	
Inlet	15.4 to 15.6 mm
Exhaust	17.9 to 18.1 mm
Stem-to-guide clearance:	
New (inlet)	0.030 to 0.060 mm
New (exhaust)	0.060 to 0.090 mm
Wear limit (inlet and exhaust)	0.15 mm
External oversizes available	3 (marked by grooves)
B234F:	
Height above cylinder head (inlet and exhaust)	14.8 to 15.2 mm
Stem-to-guide clearance:	
New (inlet)	0.030 to 0.060 mm
New (exhaust)	0.040 to 0.070 mm
Wear limit (inlet and exhaust)	0.15 mm
External diameter	12.0 mm
Oversize (marked by groove)	12.1 mm
Fit in cylinder head	Interference

Valve springs

B23/B200/B230:	
Diameter	32.5 mm
Free length	45.0 mm
Length under load of:	
280 to 320 N	38.0 mm
710 to 790 N	27.0 mm

B234F:	
Diameter	26.2 mm
Free length	43.0 mm
Length under load of:	
212 to 252 N	37.0 mm
600 to 680 N	26.5 mm

Cylinder bores

B23/B230/B234F:	
Standard sizes:	
C	96.00 to 96.01 mm
D	96.01 to 96.02 mm
E	96.02 to 96.03 mm
G	96.04 to 96.05 mm
First oversize	96.30 mm
Second oversize	96.60 mm
Wear limit	0.1 mm
B200:	
Standard sizes:	
C	88.90 to 88.91 mm (3.5000 to 3.5004 in)
D	88.91 to 88.92 mm (3.5004 to 3.5008 in)
E	88.92 to 88.93 mm (3.5008 to 3.5012 in)
G	88.94 to 88.95 mm (3.5016 to 3.5020 in)
First oversize	89.29 mm (3.5154 in)
Second oversize	89.67 mm (3.5303 in)
Wear limit	0.1 mm

Pistons

Height:	
B23	75.4 mm
B200/B230	64.7 mm
B234F	68.7 mm
Weight:	
B23	562 ± 7 g
B200/B230	535 ± 7 g
B234F	530 ± 7 g
Weight variation in same engine:	
B23/B200/B230	12 g max
B234F	14 g max
Running clearance in bore:	
B23	0.05 to 0.07 mm
B200/B230/B234F	0.01 to 0.03 mm
Piston diameter (B234F)	
Standard sizes:	
C	95.98 to 95.99 mm
D	95.99 to 96.00 mm
E	96.00 to 96.01 mm
G	96.02 to 96.03 mm
First oversize	96.28 to 96.29 mm
Second oversize	96.58 to 96.59 mm

Piston rings

Height:	
Top compression (B23/B200/B230)	1.728 to 1.740 mm
Second compression (B23)	1.978 to 1.990 mm
Second compression (B200/B230)	1.728 to 1.740 mm
Oil control (B23)	3.975 to 3.990 mm
Oil control (B200/B230)	3.475 to 3.490 mm
B234F	Not known
Clearance in groove (B23/B230/B234F):	
Top compression	0.060 to 0.092 mm
Second compression	0.040 to 0.072 mm
Oil control	0.030 to 0.065 mm
Clearance in groove (B200):	
Top compression	0.060 to 0.092 mm
Second compression	0.030 to 0.062 mm
Oil control	0.020 to 0.055 mm

Piston rings (continued)

End gap (in 96.00 mm bore):	
Compression rings, B23	0.40 to 0.65 mm
Compression rings, B230/B234F	0.30 to 0.55 mm
Oil control	0.30 to 0.60 mm
End gap (in 88.90 mm bore):	
Top compression	0.30 to 0.50 mm
Second compression	0.30 to 0.55 mm
Oil control	0.25 to 0.50 mm

Gudgeon pins

Diameter, standard:	
B23	24.00 mm
B200/B230/B234F	23.00 mm
Oversize available	+ 0.05 mm
Fit in connecting rod	Light thumb pressure
Fit in piston	Firm thumb pressure

Auxiliary shaft - B23/B200/B230

Bearing journal diameter:	
Front	46.975 to 47.000 mm
Centre	43.025 to 43.050 mm
Rear	42.925 to 42.950 mm
Bearing running clearance	0.020 to 0.075 mm
Endfloat	0.20 to 0.46 mm

Balance shaft - B234F

Endfloat	0.06 to 0.19 mm

Crankshaft - B23

Run-out	0.05 mm max
Endfloat	0.25 mm max
Main bearing journal diameter:	
Standard	63.451 to 63.464 mm
First undersize	63.197 to 63.210 mm
Second undersize	62.943 to 62.956 mm
Main bearing running clearance	0.028 to 0.083 mm
Main bearing out-of-round	0.07 mm max
Main bearing taper	0.05 mm max
Connecting rod bearing journal diameter:	
Standard	53.987 to 54.000 mm
First undersize	53.733 to 53.746 mm
Second undersize	53.479 to 53.492 mm
Connecting rod bearing running clearance	0.024 to 0.070 mm
Connecting rod bearing out-of-round	0.5 mm max
Connecting rod bearing taper	0.05 mm max

Crankshaft - B200/B230

Run-out	0.025 mm max
Endfloat	0.080 to 0.270 mm
Main bearing journal diameter:	
Standard	54.987 to 55.000 mm
First undersize	54.737 to 54.750 mm
Second undersize	54.487 to 54.500 mm
Main bearing running clearance	0.024 to 0.072 mm
Main bearing out-of-round	0.004 mm max
Main bearing taper	0.004 mm max
Connecting rod bearing journal diameter:	
Standard	48.984 to 49.005 mm
First undersize	48.734 to 48.755 mm
Second undersize	48.484 to 48.505 mm
Connecting rod bearing running clearance	0.023 to 0.067 mm
Connecting rod bearing out-of-round	0.004 mm max
Connecting rod bearing taper	0.004 mm max

Crankshaft - B234F

Run-out	0.040 mm max
Endfloat	0.080 to 0.270 mm
Main bearing journal diameter:	
Standard	62.987 to 63.000 mm
First undersize	62.737 to 62.750 mm
Second undersize	62.487 to 62.500 mm
Main bearing running clearance	0.024 to 0.064 mm
Main bearing out-of-round	0.006 mm max
Main bearing taper	0.006 mm max
Connecting rod bearing journal diameter:	
Standard	48.984 to 49.005 mm
First undersize	48.734 to 48.755 mm
Second undersize	48.484 to 48.505 mm
Connecting rod bearing running clearance	0.023 to 0.067 mm
Connecting rod bearing out-of-round	0.025 mm max
Connecting rod bearing taper	0.025 mm max

Connecting rods

Length between centres:	
B23	145 mm
B200/B230	152 mm
B234F	Not known
Endfloat on crankshaft:	
B23	0.15 to 0.35 mm
B200/B230	0.25 to 0.45 mm
B234F	0.25 to 0.45 mm (suggested value)
Weight variation in same engine:	
B23	10 g max
B200/B230/B234F	20 g max

Torque wrench settings

Refer to Chapter 2A Specifications

2C

V-6 engines

Cylinder head

Warp limit - acceptable for use	0.05 mm per 100 mm length
Warp limit - acceptable for refinishing	No refinishing allowed
Height (new)	111.07 mm

Inlet valves (B28E)

Head diameter	44 mm
Stem diameter:	
26.5 mm (1.04 in) from head	7.965 to 7.980 mm
Just below collet groove	7.975 to 7.990 mm
Valve head angle	29° 30'

Inlet valves (B280E)

Head diameter	45.3 mm
Stem diameter:	
26.5 mm (1.04 in) from head	7.958 to 7.980 mm
Just below collet groove	7.973 to 7.995 mm
Valve head angle	44° 30'

Exhaust valves

Head diameter	
B28E	37 mm
B280E	38.5 mm

Stem diameter:

32 mm (1.26 in) from head	7.945 to 7.960 mm
Just below collet groove	7.965 to 7.980 mm
Valve head angle	44° 30'

Valve guides

Internal diameter	8.000 to 8.022 mm
Fit in cylinder head	Interference
External oversizes available	3 (marked by grooves)

Valve seat inserts

Fit in cylinder head	Interference
Oversizes available	3
Valve seat angles:	
B28E:	
Inlet	Compound (60° - 30° - 15°)
Exhaust	45°
B280E:	
Inlet and exhaust	45°

Valve springs

Free length	47.1 mm
Length under load:	
230 to 266 N	40.0 mm
613 to 689 N	30.0 mm

Rocker gear

Rocker arm clearance on shaft	0.012 to 0.054 mm

Cylinder liners

Bore:	
Grade 1 (takes grade A piston)	91.00 to 91.01 mm
Grade 2 (takes grade B piston)	91.01 to 91.02 mm
Grade 3 (takes grade C piston)	91.02 to 91.03 mm
Liner protrusion above block (depends on gasket; consult your dealer):	
Checking value (used seals)	0.14 to 0.23 mm
Setting value (new seals)	0.16 to 0.23 mm
Liner seal thickness (B28E):	
Blue mark	0.070 to 0.105 mm
White mark	0.085 to 0.120 mm
Red mark	0.105 to 0.140 mm
Yellow mark	0.130 to 0.165 mm
Liner seal thickness (B280E):	
Early type:	
1 tab	0.10 ± 0.01 mm
2 tabs	0.12 ± 0.01 mm
3 tabs	0.15 ± 0.02 mm
Later type:	
Orange	0.116 ± 0.018 mm
Clear	0.136 ± 0.018 mm
Blue	0.166 ± 0.028 mm

Pistons

Diameter (matched to liners):	
B28E:	
Grade A	90.970 to 90.980 mm
Grade B	90.980 to 90.990 mm
Grade C	90.990 to 91.000 mm
Clearance in bore	0.020 to 0.040 mm
B280E:	
Grade A	90.920 to 90.930 mm
Grade B	90.930 to 90.940 mm
Grade C	90.940 to 90.950 mm
Clearance in bore	0.070 to 0.090 mm
Height	65.3 mm
Weight	455 ± 39 g
Gudgeon pin bore (B28E):	
Blue mark	23.510 to 23.573 mm
White mark	23.507 to 23.510 mm
Red mark	23.504 to 23.507 mm

Gudgeon pins (B28E)

Diameter:	
Blue mark	23.497 to 23.500 mm
White mark	23.494 to 23.497 mm
Red mark	23.491 to 23.494 mm
Clearance in connecting rod	0.020 to 0.041 mm
Clearance in piston	0.010 to 0.016 mm

Gudgeon pins (B280E)

Number of sizes	One only
Clearance in piston	0.007 to 0.017 mm
Clearance in connecting rod	Nominal (firm push-fit)
Securing method	Circlips

Piston rings

Clearance in groove:	
Top compression	0.045 to 0.074 mm
Second compression	0.025 to 0.054 mm
Oil control	0.009 to 0.233 mm
End gap (in 91.00 mm bore):	
Top and second compression	0.40 to 0.60 mm
Oil control	0.40 to 1.45 mm

Crankshaft

Run-out (measured on centre journals)	0.02 mm
Endfloat	0.070 to 0.270 mm
Main bearing running clearance	0.038 to 0.088 mm
Connecting rod bearing running clearance	0.030 to 0.080 mm
Rear seal diameter:	
Standard	79.926 to 80.000 mm
Undersize	79.726 to 79.800 mm
Main bearing journal diameter:	
B28E:	
Standard	70.043 to 70.062 mm
Undersize	69.743 to 69.762 mm
B280E:	
Standard	70.043 to 70.062 mm
Undersize	Not permitted
Main bearing out-of-round	0.007 mm max
Main bearing taper	0.01 mm max
Main bearing shell thickness:	
Standard	1.961 to 1.967 mm
Oversize	2.111 to 2.117 mm
Rear main bearing journal width:	
Standard	29.20 to 29.25 mm
First oversize	29.40 to 29.45 mm
Second oversize	29.50 to 29.55 mm
Third oversize	29.60 to 29.65 mm
Thrustwasher thickness:	
Standard	2.30 to 2.35 mm
First oversize	2.40 to 2.45 mm
Second oversize	2.45 to 2.50 mm
Third oversize	2.50 to 2.55 mm
Connecting rod bearing journal diameter:	
B28E:	
Standard	52.267 to 52.286 mm
Undersize	51.967 to 51.986 mm
B280E:	
Standard	59.971 to 59.990 mm
Undersize	Not permitted
Connecting rod bearing out-of-round	0.007 mm max
Connecting rod bearing taper	0.01 mm max
Connecting rod bearing shell thickness:	
B28E:	
Standard	1.842 to 1.848 mm
Oversize	1.992 to 1.998 mm
B280E	1.838 to 1.848 mm

Connecting rods

Length between centres	146.15 mm
Endfloat on crankshaft (between each pair of rods)	0.20 to 0.38 mm
Weight variation in same engine	2.5 g max

Torque wrench settings

Refer to Chapter 2B Specifications

1 General information

Included in this Part of Chapter 2 are details of removing the engine/transmission from the car and general overhaul procedures for the cylinder head, cylinder block and all other engine internal components.

The information ranges from advice concerning preparation for an overhaul and the purchase of replacement parts, to detailed step-by-step procedures covering removal, inspection, renovation and refitting of engine internal components.

After Section 8, all instructions are based on the assumption that the engine has been removed from the car. For information concerning in-car engine repair, as well as removal and installation of those external components necessary for full overhaul, refer to Parts A and B of this Chapter (as applicable) and to Section 8. Ignore any preliminary dismantling operations described in Part A or B that are no longer relevant once the engine has been removed from the car.

Apart from torque wrench settings, which are given at the beginning of Part A or B (as applicable), all specifications relating to engine overhaul are at the beginning of this Part of Chapter 2.

2 Engine overhaul - general information

It's not always easy to determine when, or if, an engine should be completely overhauled, as a number of factors must be considered.

High mileage is not necessarily an indication that an overhaul is needed, while low mileage doesn't preclude the need for an overhaul. Frequency of servicing is probably the most important consideration. An engine that's had regular and frequent oil and filter changes, as well as other required maintenance, will most likely give many thousands of miles of reliable service. Conversely, a neglected engine may require an overhaul very early in its life.

Excessive oil consumption is an indication that piston rings, valve seals and/or valve guides are in need of attention. Make sure that oil leaks aren't responsible before deciding that the rings and/or guides are worn. Perform a compression test as described in Part A or B of this Chapter, to determine the likely cause of the problem.

Check the oil pressure with a gauge fitted in place of the oil pressure switch, and compare it with that specified. If it is extremely low, the main and big-end bearings, and/or the oil pump, are probably worn-out.

Loss of power, rough running, knocking or metallic engine noises, excessive valve gear noise and high fuel consumption may also point to the need for an overhaul, especially if they are all present at the same time. If a complete service does not remedy the situation, major mechanical work is the only solution.

An engine overhaul involves restoring all internal parts to the specification of a new engine.

During an overhaul, the cylinder liners (where applicable), the pistons and the piston rings are renewed. New main and big-end bearings are generally fitted and, if necessary, the crankshaft may be reground (or renewed) to restore the journals. The valves are also serviced as well, since they are usually in less-than-perfect condition at this point. While the engine is being overhauled, other components, such as the distributor, starter and alternator, can be overhauled as well. The end result should be an as-new engine that will give many trouble-free miles.

Note: *Critical cooling system components such as the hoses, drivebelt, thermostat and water pump should be renewed when an engine is overhauled. The radiator should be checked carefully, to ensure that it isn't clogged or leaking. Also, it is a good idea to renew the oil pump when an engine is overhauled.*

Before beginning the engine overhaul, read through the entire procedure to familiarise yourself with the scope and requirements of the job. Overhauling an engine is not difficult if you follow carefully all of the instructions, have the necessary tools and equipment, and pay close attention to all specifications. It can, however, be time-consuming. Plan on the vehicle being off the road for a minimum of two weeks, especially if parts must be taken to an engineering works for repair or reconditioning. Check on availability of parts, and make sure that any necessary special tools and equipment are obtained in advance. Most work can be done with typical hand tools, although a number of precision measuring tools are required, for inspecting parts to determine if they must be renewed. Often, the engineering works will handle the inspection of parts, and will offer advice concerning reconditioning and renewal.

Note: *Always wait until the engine has been completely dismantled, and until all components, (especially the cylinder block/crankcase and the crankshaft) have been inspected, before deciding what service and repair operations must be performed by an engineering works. The condition of these components will be the major factor to consider when determining whether to overhaul the original engine or buy a reconditioned unit. Do not, therefore, purchase parts or have overhaul work done on other components until they have been thoroughly inspected.* As a general rule, time is the primary cost of an overhaul, so it doesn't pay to fit worn or sub-standard parts.

As a final note, to ensure maximum life and minimum trouble from a reconditioned engine, everything must be assembled with care, in a spotlessly-clean environment.

3 Engine/transmission removal - methods and precautions

1 If you have decided that an engine must be removed for overhaul or major repair work, several preliminary steps should be taken.

2 Locating a suitable place to work is extremely important. Adequate work space, along with storage space for the car, will be needed. If a workshop or garage is not available, at the very least, a flat, level, clean work surface is required.

3 Cleaning the engine compartment and engine/transmission before beginning the removal procedure will help keep tools clean and organised.

4 An engine hoist or A-frame will also be necessary. Make sure the equipment is rated in excess of the combined weight of the engine and transmission. Safety is of primary importance, considering the potential hazards involved in lifting the engine/transmission from the car.

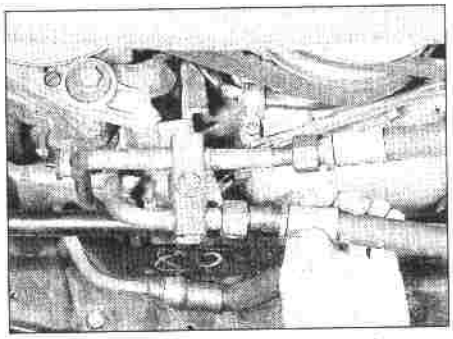
5 If this is the first time you have removed an engine, an assistant should ideally be available. Advice and aid from someone more experienced would also be helpful. There are many instances when one person cannot simultaneously perform all of the operations required when lifting the engine/transmission out of the vehicle.

6 Plan the operation ahead of time. Before starting work, arrange for the hire of or obtain, all of the tools and equipment you will need. Some of the equipment necessary to perform engine/transmission removal and installation safely and with relative ease (in addition to an engine hoist) is as follows: a heavy-duty trolley jack, complete sets of spanners and sockets as described at the end of this manual, wooden blocks, and plenty of rags and cleaning solvent for mopping up spilled oil, coolant and solvent. If the hoist must be hired, make sure that you arrange for it in advance, and perform all of the operations possible without it beforehand. This will save you money and time.

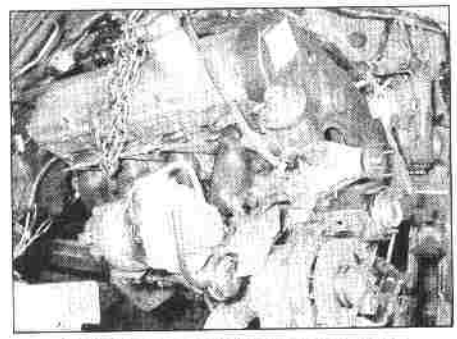
7 Plan for the vehicle to be out of use for quite a while. An engineering works will be required to perform some of the work which the do-it-yourselfer cannot accomplish without special equipment. These places often have a busy schedule, so it would be a good idea to consult them before removing the engine, to accurately estimate the amount of time required to rebuild or repair components that may need work.

8 Always be extremely careful when removing and installing the engine/transmission. Serious injury can result from careless actions. Plan ahead and take your time, and a job of this nature can be accomplished successfully.

4.12 Disconnecting an engine wiring harness multi-plug



4.23 Disconnecting the oil cooler hoses



4.35 Lifting out the in-line engine

4 In-line engine (without transmission) - removal and refitting

Removal

Note: *The in-line engine can be removed from the car either on its own, or as a complete unit with the transmission. Removal of the engine on its own is described in this Section; removal of the unit with the transmission attached is described in Section 5.*

1 Disconnect the battery negative lead.

2 Either remove the bonnet (see Chapter 11), or open it to its widest setting.

3 Remove the radiator (see Chapter 3).

4 On Turbo models, remove the intercooler and associated hoses (see Chapter 4B). Also remove the airflow meter-to-turbo hose.

5 On carburettor models, remove the air cleaner (see Chapter 4).

6 On B234F models, remove the air mass meter and air inlet hose. On all models, remove the air cleaner hot air trunking.

7 On B200/B230/B234F models, remove the distributor cap and HT leads. On B23 models, remove the coil-to-distributor HT lead.

8 Disconnect the throttle cable.

9 Disconnect the brake servo vacuum hose.

10 Disconnect the fuel supply and return pipes. Be prepared for fuel spillage.

11 Disconnect the various crankcase ventilation, vacuum and pressure sensing hoses. Make notes or identifying marks if there is any possibility of confusion later.

12 Disconnect the engine wiring harness multi-plug(s), again making notes if necessary **(see illustration)**.

13 Disconnect the starter motor feed lead, then remove the battery completely.

14 Disconnect the engine earth strap(s).

15 Disconnect the air conditioning compressor clutch lead.

16 Remove the power steering pump without disconnecting the hoses and wire it up out of the way. See Chapter 10 if necessary.

17 Disconnect the heater hoses at the rear of the engine.

18 Remove the starter motor (see Chapter 5A).

19 Disconnect the exhaust downpipe from the manifold or turbo exit.

20 If an oil cooler is fitted, unbolt its mounting bracket.

21 Raise and support the vehicle. Remove the engine undertray, if not already done.

22 Drain the engine oil and remove the oil filter (see Chapter 1).

23 If an oil cooler is fitted, disconnect the flexible hoses at their unions with the rigid pipes **(see illustration)**. The contents of the oil cooler will drain out of the open unions. Remove the oil cooler.

24 Disconnect the hose from the vacuum tank, then unbolt and remove it.

25 Remove those engine-to-transmission nuts and bolts which are accessible from below. Also remove the flywheel/driveplate bottom cover.

26 On automatic transmission models, unbolt the torque converter from the driveplate. Turn the crankshaft as necessary to gain access. Make alignment marks for reference when refitting.

27 Remove the air conditioning compressor drivebelt (see Chapter 1).

28 Remove the nuts which secure the air conditioning compressor bracket to the engine. Move the compressor aside without disconnecting the refrigerant hoses. It will rest in the space vacated by the battery.

29 On models with electronic ignition systems, disconnect the ignition sensor multi-plugs at the bulkhead and identify the plugs for refitting. There may be one or two of them. Disconnect the knock sensor lead.

30 Support the transmission from below, using a trolley jack for preference. Pad the jack head with rags or wood.

31 Attach the lifting tackle to the engine using the lifting eyes provided. Take the weight of the engine.

32 Remove the nuts which secure the engine bearers to the engine mountings.

33 Remove the remaining engine-to-transmission nuts and bolts.

34 Check that no wires, hoses etc have been overlooked. Raise the engine and draw it forwards off the transmission, at the same time raising the jack under the transmission. Do not allow the weight of the transmission to hang on the input shaft.

35 Once the engine is clear of the transmission, carefully lift it out of the engine bay and take it to the bench **(see illustration)**.

Refitting

36 Make sure that the clutch is properly centred, or that the torque converter is fully engaged in the transmission. Put a smear of grease or anti-seize compound on the gearbox input shaft or the torque converter locating spigot.

37 Lower the engine into position; have an assistant watch to see that no pipes, wires etc, are trapped.

38 On manual transmission models, rock the engine from side to side, or rotate the crankshaft slightly, to encourage the input shaft to enter the clutch driven plate. Do not allow the engine to hang on the input shaft.

39 When the bellhousing is engaged on the engine dowels, insert a couple of engine-to-bellhousing nuts and bolts and tighten them up.

40 The remainder of refitting is now a reversal of removal noting the following points:

a) Refill the engine with oil and coolant (Chapter 1).

b) Refer to Section 25 before starting the engine.

5 In-line engine (with transmission) - removal, separation and refitting

Note: *The in-line engine can be removed from the car either on its own, or as a complete unit with the transmission. Removal of the engine on its own is described in Section 4; removal of the unit with the transmission attached is described in this Section.*

Removal

1 Proceed as in Section 4, paragraphs 1 to 17, 19 to 24 and 27 to 29.

2 Disconnect the leads from the starter motor solenoid.

3 Remove the exhaust downpipe completely.

Manual transmission models

4 Remove the clutch slave cylinder (without disconnecting the hydraulic hose) or

disconnect the clutch cable, as applicable (see Chapter 6).
5 Disconnect the gear lever (see Chapter 7A).

Automatic transmission models

6 Disconnect the kickdown and control linkages (see Chapter 7B).

All models

7 Disconnect electrical services from the transmission.
8 Unbolt the propeller shaft from the rear of the transmission.
9 Support the transmission. Unbolt the crossmember from the transmission and from the side rails and remove it.
10 Unbolt the bracing strut from below the bellhousing (when fitted).
11 Attach suitable lifting tackle to the engine using the eyes provided. Take the weight of the engine.
12 Remove the nuts which secure the engine bearers to the engine mountings.
13 Check that no attachments have been overlooked. Raise the engine, at the same time lowering the support under the transmission, until the whole assembly can be lifted from the engine bay.

Separation

14 With the engine/transmission assembly removed, support the assembly on suitable blocks of wood, on a workbench (or failing that, on a clean area of the workshop floor).
15 Remove the starter motor.
16 Remove the bellhousing-to-engine nuts and bolts. Also remove the flywheel/driveplate bottom cover plate (if applicable).

Manual transmission models

17 With the aid of an assistant, draw the transmission off the engine. Once it is clear of the dowels, do not allow it to hang on the input shaft.

Automatic transmission models

18 Unbolt the torque converter from the driveplate, turning the crankshaft to gain access from below or through the starter motor hole. Make alignment marks for reference when refitting.
19 With the aid of an assistant, draw the transmission off the engine. Make sure that the torque converter stays in the bellhousing.

Refitting

Manual transmission models

20 Make sure that the clutch is correctly centred and that the clutch release components are fitted to the bellhousing. Put a smear of grease or anti-seize compound on the input shaft splines.
21 Offer the transmission to the engine. Rotate the crankshaft or the input shaft if necessary to align the input shaft and clutch driven plate splines. Do not allow the weight of the transmission to hang on the input shaft.
22 Engage the transmission on the engine dowels. Fit a couple of bellhousing-to-engine nuts and bolts.

Automatic transmission models

23 Make sure that the torque converter is fully engaged in the transmission. Put a smear of grease or anti-seize compound on the torque converter locating spigot.
24 Offer the transmission to the engine, engaging the locating dowels. Fit a couple of bellhousing-to-engine nuts and bolts.
25 Insert the torque converter-to-driveplate bolts, turning the crankshaft to gain access. Just finger tighten the bolts at first, then tighten them in criss-cross sequence to the specified torque (see Chapter 7B Specifications).

All models

26 Fit the remaining bellhousing nuts and bolts, and (when applicable) the flywheel/driveplate bottom cover plate. Tighten the nuts and bolts progressively.
27 Refit the starter motor.
28 The remainder of refitting is essentially a reversal of removal, noting the following points.

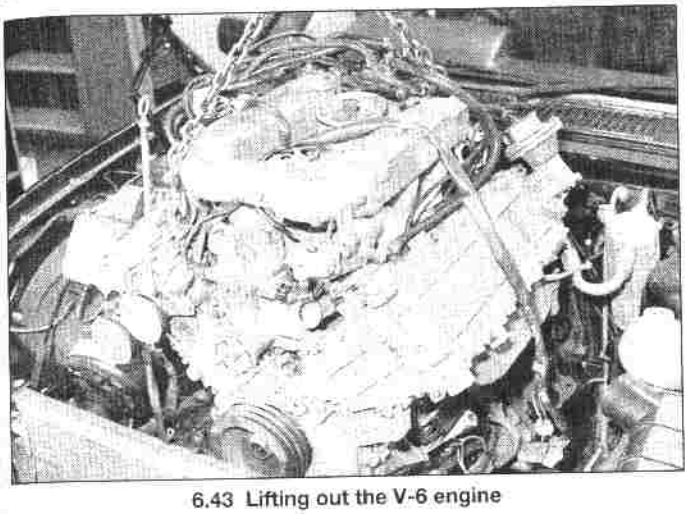
a) On automatic transmission models, adjust the gear selector mechanism (Chapter 7B).
b) Refill the engine with oil and coolant (Chapter 1).
c) Refill the transmission with lubricant if necessary (Chapter 1).
d) Refer to Section 25 before starting the engine.

6 V-6 engine (without transmission) - removal and refitting

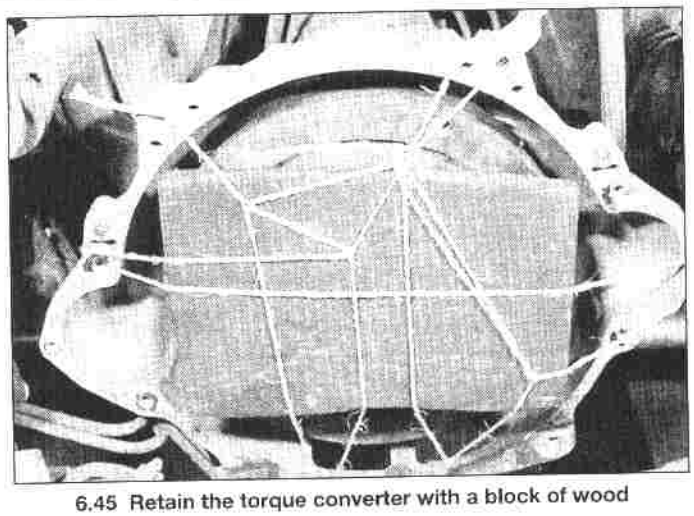
1 The manufacturers recommend that the engine and transmission should be removed together as described in Section 7. This method is preferred if adequate lifting tackle is available.
2 Removal of the engine alone is relatively straightforward on models with automatic transmission. Refitting, however, is difficult because the angle at which the engine is suspended has to be just right in order to mate with the transmission. Thought should be given to this when attaching the lifting tackle: ideally the chains should be attached to a bar running lengthways and pivoted about its centre so that the angle can easily be adjusted.
3 Removal of the engine alone on manual transmission models is not recommended by the manufacturers. This is not to say that it is impossible, but the problems mentioned above will be magnified because of the need to align the clutch with the transmission input shaft.
4 The following procedures are therefore mainly applicable to automatic transmission models. If this work is being attempted on manual transmission models, bear in mind the points mentioned above, read through the entire procedure, and ensure that you have the necessary equipment and facilities available.

Removal

5 Open the bonnet to the vertical position, or remove it completely (see Chapter 11).
6 Remove the battery (see Chapter 5A).
7 Drain the cooling system (see Chapter 1), then remove the radiator, the fan shroud and the viscous coupled fan (see Chapter 3). Remove the radiator top and bottom hoses from the engine.
8 Remove the air intake trunking from the air cleaner and the airflow sensor, together with the oil filler cap and the crankcase ventilation hoses.
9 Disconnect the exhaust downpipes from the manifolds. (If preferred, these can be tackled from below later on.) Recover the gaskets.
10 When fitted, remove the transmission fluid auxiliary cooler (see Chapter 3).
11 Unbolt the crossmember which carries the radiator top mounting brackets. Four of the bonnet lockbolts pass through this crossmember. Disengage the crossmember from the bonnet release cable and remove it.
12 Unbolt the air conditioning condenser bottom mountings. Move the condenser forwards, being careful not to strain the refrigerant pipes. Do not disconnect the pipes.
13 Remove the air conditioning compressor drivebelt (see Chapter 1). Disconnect the wires from the compressor clutch. Unbolt the compressor and its mounting brackets; place the compressor in the battery tray, being careful not to strain the refrigerant hoses. Do not disconnect the hoses.
14 Disconnect the engine and fuel injection wiring harness multiplugs on top of the engine and next to the expansion tank. Unclip the impulse relay from the expansion tank so that it stays with the harness. Place the harness on the engine.
15 Unbolt the air conditioning harness earth tag from the inlet manifold. Move the harness out of the way.
16 Slacken the fuel tank filler cap to release any pressure. Disconnect the fuel feed pipe from the top of the fuel filter. Be prepared for fuel spillage.
17 Disconnect the fuel return pipe from the union on the left-hand inner wing, or from the fuel distributor.
18 Disconnect the throttle, kickdown and cruise control cables (as applicable) and move them aside.
19 Remove the hot air trunking from the air cleaner and the downpipe shroud.
20 Unbolt one end of the earth strap which joins the fuel distributor to the bulkhead.
21 Disconnect the distributor-to-coil HT lead and the distributor LT multi-plug.
22 Disconnect the distributor vacuum advance pipes from the control valve behind the right-hand suspension turret (when fitted). Make identifying marks for reference when refitting.



6.43 Lifting out the V-6 engine



6.45 Retain the torque converter with a block of wood

23 Disconnect the brake servo/heater control vacuum feed from the T-piece near the vacuum pump.
24 Disconnect the heater hoses at the rear of the engine.
25 Remove the oil filter (see Chapter 1).
26 Raise and support the vehicle. Remove the ending undertray (if not already done).
27 Drain the engine oil (see Chapter 1). Refit and tighten the drain plug afterwards for safekeeping.
28 Unbolt the torque converter or clutch cover plate from the bottom of the bellhousing.
29 Remove the starter motor (see Chapter 5A).
30 Remove the steering pump auxiliary drivebelt (see Chapter 1). Unbolt the pump and its brackets - some of the mounting bolts are more easily reached from above - and support the pump below the engine.
31 Unbolt and remove the blanking plate from the unused starter motor aperture.
32 Unbolt the earth strap from behind the engine right-hand mounting.
33 On automatic transmission models, make alignment marks between the torque converter and driveplate. Working through the cover plate or starter motor aperture, remove the torque converter-to-driveplate bolts, turning the crankshaft to gain access. Lever the torque converter rearwards to check that it is free from the driveplate.
34 On all models, remove the bellhousing-to-engine bolts which are accessible from below.
35 Slacken the exhaust mounting bracket at the rear of the transmission.
36 Remove the through-bolt from each engine mounting, and the single nut from each mounting which secures it to the front crossmember.
37 Lower the vehicle. Remove the alternator and its drivebelts (see Chapter 5A). Recover the water pump pulley, which is now free.
38 Free the remaining bellhousing nuts and bolts. On automatic transmission models, one of these bolts also secures the transmission dipstick/filler tube.
39 Attach the lifting tackle to the engine, using the eyes provided.
40 Support the transmission with a trolley jack under the bellhousing.
41 Check that no attachments have been overlooked.
42 Lift the engine until the mounting studs are clear of the crossmember. Raise the trolley jack so that the transmission is still supported, then draw the engine forwards and off the transmission. With a manual gearbox, do not allow the weight to be taken by the input shaft.
43 Lift the engine out of the bay **(see illustration)**. An assistant should guide it out and make sure that items such as the air conditioning compressor are not snagged. Be careful not to damage the air conditioning condenser, which will be punctured by the water pump pulley studs if the engine lurches forwards.
44 Set the engine down on the bench or on blocks of wood, making sure it is securely supported.
45 On automatic transmission models, secure a bar or a block of wood across the mouth of the bellhousing to keep the torque converter in place **(see illustration)**.

Refitting

46 Make sure that the clutch is properly centred, or that the torque converter is fully engaged in the transmission. Put a smear of grease or anti-seize compound on the gearbox input shaft or the torque converter locating spigot.
47 Lower the engine into position; have an assistant watch to see that no pipes, wires etc, are trapped.
48 On manual transmission models, rock the engine from side to side, or rotate the crankshaft slightly, to encourage the input shaft to enter the clutch driven plate. Do not allow the engine to hang on the input shaft.
49 When the bellhousing is engaged on the engine dowels, insert a couple of engine-to-bellhousing nuts and bolts and nip them up.
50 The remainder of refitting is now a reversal of removal noting the following points:

a) Refill the engine with oil and coolant (Chapter 1).
b) Refer to Section 25 before starting the engine.

7 V-6 engine (with transmission) - removal, separation and refitting

2C

Removal

1 Proceed as described in Section 6, paragraphs 5 to 8 and 10 to 24.
2 Raise and support the vehicle. Remove the engine undertray.
3 Remove the steering pump auxiliary drivebelt (see Chapter 1). Unbolt the pump and its brackets - some of the mounting bolts are more easily reached from above - and support the pump below the engine.
4 Unbolt the earth strap from behind the engine right-hand mounting.
5 On manual transmission models, disconnect the clutch cable or remove the clutch slave cylinder (without disconnecting the hydraulic hose) and remove the gear lever (see Chapters 6 and 7A).
6 On automatic transmission models, unbolt the selector linkage from below at the shift lever end, and separate the wiring connectors.
7 On all models, disconnect the exhaust downpipe from the rest of the system.
8 Disconnect the propeller shaft from the transmission flange, making alignment marks for reference when refitting.
9 Support the rear of the engine from above, or use a trolley jack and a piece of wood from below, then remove the transmission rear mounting crossmember and associated components.

10 Remove the through-bolt for each engine mounting, and the single nut from each mounting which secures it to the front crossmember.
11 Lower the vehicle. Support the transmission with a trolley jack and a piece of wood (if not already done).
12 Attach the lifting tackle to the four engine lifting eyes.
13 Take the weight of the engine/transmission unit. Check that no attachments have been overlooked, then lift the unit out of the engine bay, lowering the jack under the transmission as the lifting commences. Have an assistant guide the unit and check that nothing is trapped.
14 Set the unit down on the bench or on blocks of wood, making sure it is securely supported.

Separation

15 Refer to the procedures contained in Section 5, noting the following additional points:

a) It will be necessary to remove the oil filter before the starter motor can be removed.
b) Remove the blanking plate from the unused starter motor aperture.
c) Remove the exhaust downpipes.

Refitting

Manual transmission models

16 Make sure that the clutch is correctly centred and that the clutch release components are fitted to the bellhousing. Put a smear of grease or anti-seize compound on the input shaft splines.
17 Offer the transmission to the engine. Rotate the crankshaft or the input shaft if necessary to align the input shaft and clutch driven plate splines. Do not allow the weight of the transmission to hang on the input shaft.
18 Engage the transmission on the engine dowels. Fit a couple of bellhousing-to-engine nuts and bolts.

Automatic transmission models

19 Make sure that the torque converter is fully engaged in the transmission. Put a smear of grease or anti-seize compound on the torque converter locating spigot.
20 Offer the transmission to the engine, engaging the locating dowels. Fit a couple of bellhousing-to-engine nuts and bolts.
21 Insert the torque converter-to-driveplate bolts, turning the crankshaft to gain access. Just nip the bolts up at first, then tighten them in cross-cross sequence to the specified torque (see Chapter 7B Specifications).

All models

22 Fit the remaining bellhousing nuts and bolts, and (when applicable) the flywheel/driveplate bottom cover plate. Tighten the nuts and bolts progressively.
23 Refit the starter motor.
24 Refit the exhaust downpipes.
25 Refit the starter motor blanking plate.
26 Fit a new oil filter (Chapter 1).
27 The remainder of refitting is essentially a reversal of removal, noting the following points.

a) On automatic transmission models, adjust the gear selector mechanism (Chapter 7B).
b) Refill the engine with oil and coolant (Chapter 1).
c) Refill the transmission with lubricant if necessary (Chapter 1).
d) Refer to Section 25 before starting the engine.

8 Engine overhaul - dismantling sequence

1 It is much easier to dismantle and work on the engine if it is mounted on a portable engine stand. These stands can be hired from a tool hire shop. Before the engine is mounted on a stand, the flywheel/driveplate should be removed , so that the stand bolts can be tightened into the end of the cylinder block/crankcase.
2 If a stand is not available, it is possible to dismantle the engine with it suitably supported on a sturdy, workbench or on the floor. Be careful not to tip or drop the engine when working without a stand.
3 If you are going to obtain a reconditioned engine, all the external components must be removed first to be transferred to the replacement engine (just as they will if you are doing a complete engine overhaul yourself). These components include the following, according to engine type.

In-line engine

a) Engine mountings (Chapter 2A).
b) Alternator and brackets (Chapter 5A).
c) Exhaust manifold, with turbocharger if fitted (Chapter 4).
d) Fan and water pump (Chapter 3).
e) Distributor (Chapter 5B).
f) Inlet manifold and carburettor or injection components (Chapter 4).
g) Turbo bypass valve (Chapter 4).
h) Spark plugs (Chapter 1).
i) Clutch pressure and driven plates (Chapter 6).
j) Ignition sensors and bracket (Chapter 5B).
k) Auxiliary air valve or air control valve (not carburettor models) (Chapter 4).
l) Flywheel/driveplate (Chapter 2A).
m) Oil filter (Chapter 1).
n) Oil cooler and pipework (Chapter 3).
o) Water pump with hoses and distribution pipe (Chapter 3).
p) Dipstick, tube and bracket.
q) Oil trap and flame trap (Chapter 4C).

V-6 engine

a) Engine mountings (Chapter 2B).
b) Exhaust manifolds (Chapter 4).
c) Dipstick tube and dipstick.
d) Clutch pressure and driven plates (Chapter 6).
e) Alternator, accessory drivebelts and pulleys (Chapters 1 and 5).
f) Inlet manifold with injection components (Chapter 4).
g) Distributor (Chapter 5B).
h) Spark plugs (Chapter 1).
i) Water pump with hoses and distribution pipe (Chapter 3).
j) Ignition sensors and brackets (Chapter 5B).
k) Vacuum pump (Chapter 9).
l) Flywheel/driveplate (Chapter 2B).
m) Oil filter (Chapter 1).
n) Sensors, brackets and sender units (Chapters 3 and 5).

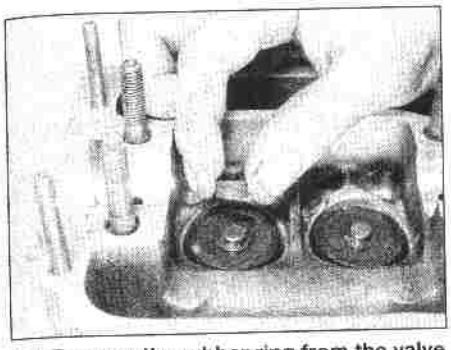
Note: *When removing the external components from the engine, pay close attention to details that may be helpful or important during refitting. Note the fitting positions of gaskets, seals, washers, bolts and other small items.*
4 If you are obtaining a "short" engine (cylinder block/crankcase, crankshaft, pistons and connecting rods all assembled), then the cylinder head(s), sump, oil pump and camshaft drivebelt/timing chains will also have to be removed.
5 If a complete overhaul is planned, the engine can be dismantled and the internal components removed in the following order.

a) Camshaft drivebelt, tensioner and sprockets (in-line engine).
b) Timing chains, sprockets and tensioners (V-6 engine).
c) Cylinder head(s).
d) Flywheel/driveplate.
e) Auxiliary shaft (in-line engine, except B234F).
f) Sump.
g) Oil pump.
h) Pistons/connecting rods.
i) Crankshaft.

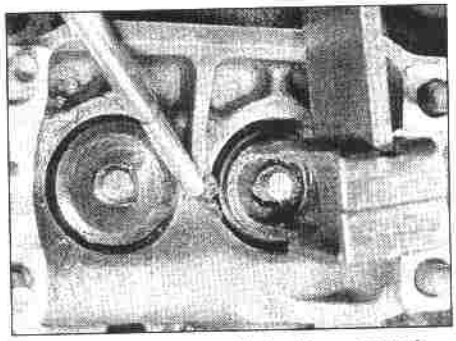
Note: *On B234F in-line engines, the oil pump is mounted outside the engine block, behind the timing cover, and is accessible without removing the sump.*
6 Before beginning the dismantling and overhaul procedures, make sure that you have all of the correct tools necessary. Refer to *"Tools and working facilities"* for further information.

9 Cylinder head - dismantling

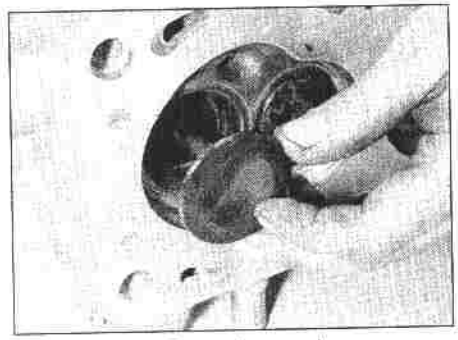
1 Remove the cylinder head(s) as described in Part A or B of this Chapter (as applicable).
2 Remove the camshaft, tappets and shims as described in Part A or B of this Chapter (as applicable). **Note:** *On B234F engines, the two camshafts are mounted on a camshaft carrier which is bolted on top of the cylinder head. You have to remove the camshafts first, then the hydraulic tappets, then the camshaft*



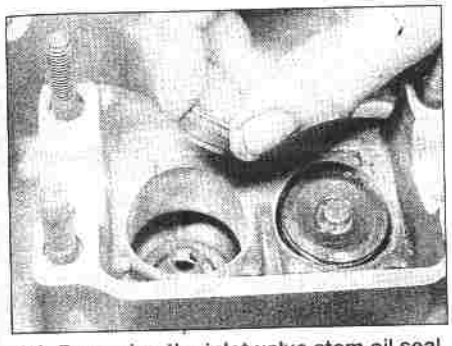
9.4 Recover the rubber ring from the valve stem tips



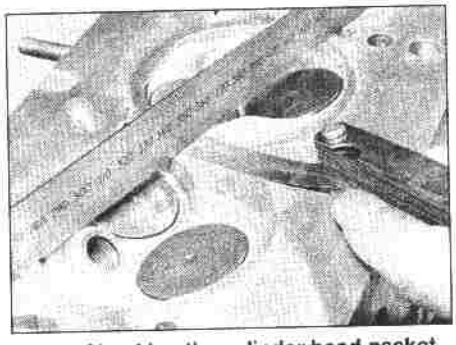
9.6 Extracting a collet with a magnet



9.7 Removing a valve



9.8 Removing the inlet valve stem oil seal



10.6 Checking the cylinder head gasket surface for distortion

carrier, then you can remove the cylinder head.

3 According to engine type, and components still in place, remove the inlet and exhaust manifolds (Chapter 4), the thermostat housing (Chapter 3), the spark plugs (Chapter 1) and any other unions, pipes, sensors or brackets as necessary.

4 On in-line engines recover the rubber rings, if fitted, from the valve stem tips **(see illustration)**.

5 Tap each valve stem smartly, using a light hammer and drift, to free the spring and associated items.

6 Fit a valve spring compressor to each valve in turn and compress each spring until the collets are exposed. Lift out the collets - a small screwdriver, a magnet or a pair of tweezers may be useful **(see illustration)**. Carefully release the spring compressor and remove it.

7 Remove the valve spring upper seat and the valve spring. Pull the valve out of its guide **(see illustration)**.

8 Pull off the valve stem oil seal with a pair of long-nosed pliers. Recover the seal **(see illustration)**. Note that on in-line engines, except B234F, valve stem oil seals are only fitted to the inlet valves; on V-6 engines and B234F in-line engines, they are fitted to the inlet and exhaust valves.

9 Recover the valve spring lower seat. If there is much carbon build-up round the outside of the valve guide, this will have to be scraped off before the seat can be removed.

10 It is essential that each valve is stored together with its collets, spring and seats. The valves should also be kept in their correct sequence, unless they are so badly worn or burnt that they are to be renewed. If they are going to be kept and used again, place each valve assembly in a labelled polythene bag or similar container. If dismantling both cylinder heads on V-6 engines, remember to identify each bag as left-hand or right-hand, as well as with a number.

10 Cylinder head and valves - cleaning and inspection

1 Thorough cleaning of the cylinder head and valve components, followed by a detailed inspection, will enable you to decide how much valve service work must be carried out during the engine overhaul. **Note:** *If the engine has been severely overheated, it is best to assume that the cylinder head is warped, and to check carefully for signs of this.*

Cleaning

2 Scrape away all traces of old gasket material from the cylinder head.

3 Scrape away the carbon from the combustion chambers and ports, then wash the cylinder head thoroughly with paraffin or a suitable solvent.

4 Scrape off any heavy carbon deposits that may have formed on the valves, then use a power-operated wire brush to remove deposits from the valve heads and stems.

Inspection

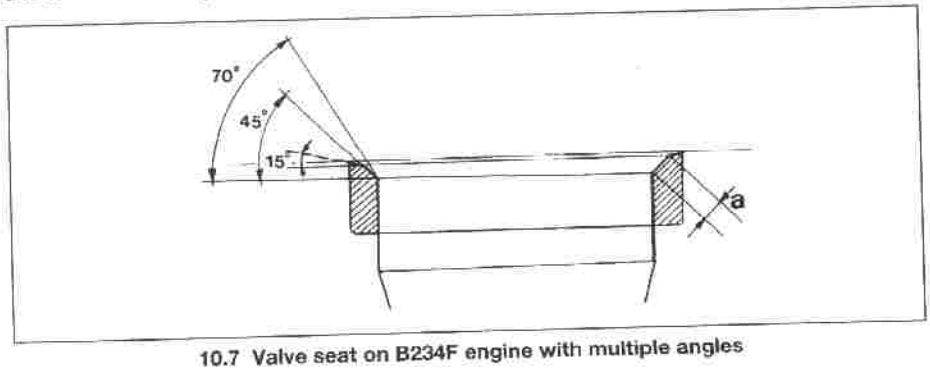
Note: *Be sure to perform all the following inspection procedures before concluding the services of an engineering works are required. Make a list of all items that require attention.*

Cylinder head

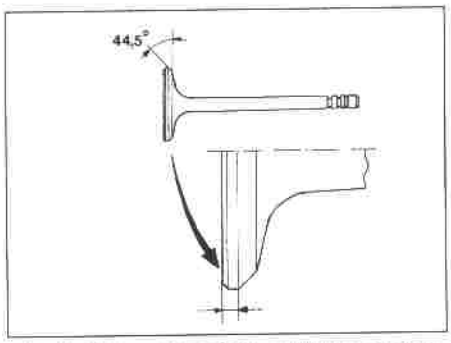
5 Inspect the head very carefully for cracks, evidence of coolant leakage, and other damage. If cracks are found, a new cylinder head should be obtained.

6 Use a straight edge and feeler blade to check that the cylinder head gasket surface is not distorted. If it is, it may be possible to re-surface it **(see illustration)**.

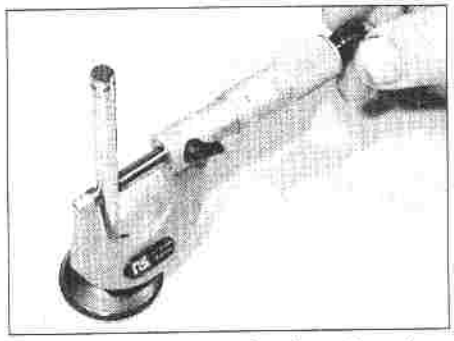
7 Examine the valve seats in each of the combustion chambers. If they are severely pitted, cracked or burned, then they will need to be renewed or re-cut by an engine overhaul specialist. If they are only slightly pitted, this can be removed by grinding-in the valve heads and seats with fine valve-grinding compound, as described below. **Note:** *On B234F engines, the valve seats have multiple angles and the seat width (a) must be within the specified limits* ***(see illustration)***.



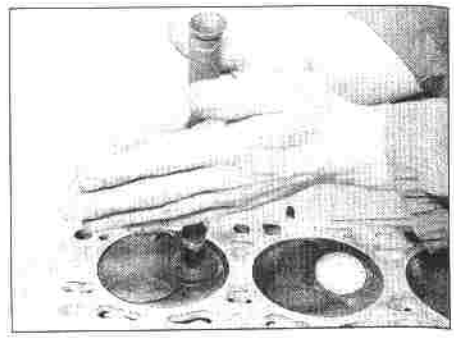
10.7 Valve seat on B234F engine with multiple angles



10.11 Valve edge width on B234F engine



10.12 Measuring a valve stem diameter



10.15 Grinding in a valve

8 If the valve guides are worn, indicated by a side-to-side motion of the valve, new guides must be fitted. Measure the diameter of the existing valve stems (see below) and the bore of the guides, then calculate the clearance, and compare the result with the specified value; if the clearance is excessive, renew the valves or guides as necessary.

9 The renewal of valve guides is best carried out by an engine overhaul specialist.

10 If the valve seats are to be re-cut, this must be done *only after* the guides have been renewed.

Valves

11 Examine the head of each valve for pitting, burning, cracks and general wear, and check the valve stem for scoring and wear ridges. Rotate the valve, and check for any obvious indication that it is bent. Look for pits and excessive wear on the tip of each valve stem. Renew any valve that shows any such signs of wear or damage.

Caution: Exhaust valves on Turbo engines contain sodium and must not be mixed with other scrap metal. Consult a Volvo dealer for safe disposal of these valves.

Note: *On B234F engines, the inlet valves can be machine ground and the edge width* ***(see illustration)*** *must be within the specified limits. The exhaust valves are stellite-coated and must be ground only with grinding paste.*

12 If the valve appears satisfactory at this stage, measure the valve stem diameter at several points, using a micrometer **(see illustration)**. Any significant difference in the readings obtained indicates wear of the valve stem. Should any of these conditions be apparent, the valve(s) must be renewed.

13 If the valves are in satisfactory condition, they should be ground (lapped) into their respective seats, to ensure a smooth gas-tight seal. If the seat is only lightly pitted, or if it has been re-cut, fine grinding compound *only* should be used to produce the required finish. Coarse valve-grinding compound should *not* be used unless a seat is badly burned or deeply pitted; if this is the case, the cylinder head and valves should be inspected by an expert, to decide whether seat re-cutting, or even the renewal of the valve or seat insert, is required.

14 Valve grinding is carried out as follows. Place the cylinder head upside-down on a bench, with a block of wood at each end to give clearance for the valve stems.

15 Smear a trace of (the appropriate grade of) valve-grinding compound on the seat face, and press a suction grinding tool onto the valve head. With a semi-rotary action, grind the valve head to its seat, lifting the valve occasionally to redistribute the grinding compound **(see illustration)**. A light spring placed under the valve head will greatly ease this operation.

16 If coarse grinding compound is being used, work only until a dull, matt even surface is produced on both the valve seat and the valve, then wipe off the used compound, and repeat the process with fine compound. When a smooth unbroken ring of light grey matt finish is produced on both the valve and seat, the grinding operation is complete. *Do not* grind in the valves any further than absolutely necessary, or the seat will be prematurely sunk into the cylinder head.

17 When all the valves have been ground-in, carefully wash off *all* traces of grinding compound, using paraffin or a suitable solvent, before reassembly of the cylinder head.

Valve components

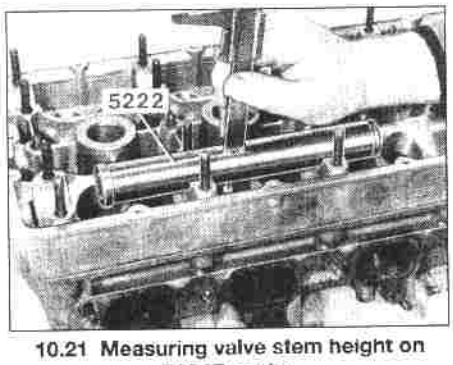
18 Examine the valve springs for signs of damage and discoloration, and also measure their free length by comparing each of the existing springs with a new component.

19 Stand each spring on a flat surface, and check it for squareness. If any of the springs are damaged, distorted, or have lost their tension, obtain a complete set of new springs. It is normal to fit new springs as a matter of course if a major overhaul is being carried out.

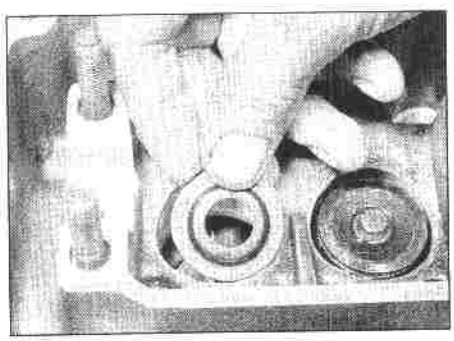
20 Renew the valve stem oil seals regardless of their apparent condition.

Valve stem height - B234F engines

21 On B234F engines, the correct valve stem height is essential to the satisfactory operation of the hydraulic tappets. The valve stem height is the distance between the camshaft bearing and the top of the valve stem, measured with a special tool. Place the camshaft carrier on the cylinder head and place the gauge 5222 across the camshaft bearing seats **(see illustration)**. Measure the valve stem heights by inserting the calipers through the hole in the gauge. If necessary, grind the end of the valve stem, but not beyond the maximum machining allowance.



10.21 Measuring valve stem height on B234F engine



11.1 Fitting a valve spring lower seat

11 Cylinder head - reassembly

1 Oil the stem of one valve and insert it into its guide. Fit the spring lower seat (dished side up on in-line engines) **(see illustration)**.

2 On the inlet valves only (in-line engines except B234F) or on all the valves (V-6 engines and B234F in-line engines), fit the valve stem oil seal, pushing it onto the valve

guide with a piece of tube. Be careful not to damage the seal lips on the valve stem: if a protective sleeve is supplied with the seals, cover the collet grooves with it when fitting the seal.

3 Fit the valve spring and upper seat **(see illustrations)**. Compress the spring and fit the two collets in the recesses in the valve stem. Carefully release the compressor.

> **HAYNES HiNT** ***Use a little dab of grease to hold the collets in position on the valve stem while the spring compressor is released.***

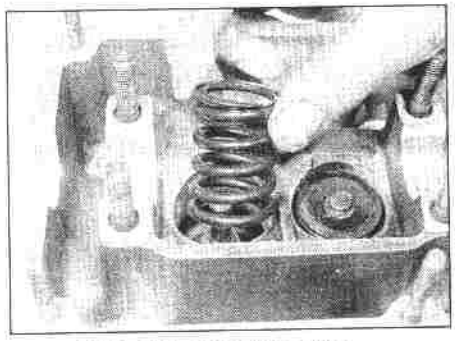
4 Cover the valve stem with a cloth and tap it smartly with a light hammer to verify that the collets are properly seated.

5 Repeat these procedures on the other valves.

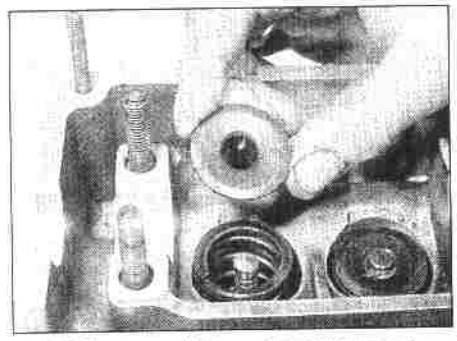
6 On in-line engines, fit new rubber rings to the valve stem tips.

7 Refit the camshaft, tappets and shims as described in Part A or B of this Chapter (as applicable).

8 Refit the remainder of the disturbed components then refit the cylinder head(s) as described in Part A or B of this Chapter.



11.3a Fitting a valve spring . . .



11.3b . . . and the spring upper seat

12 Rocker gear (V-6 engine) - dismantling, inspection and reassembly

Dismantling

1 Remove the bolt from the pedestal furthest from the circlip. Hold the pedestal against spring pressure as the bolt is removed.

2 Slide the pedestals, rocker arms, springs and spacers off the shaft, being careful to keep them all in order and the right way round **(see illustration)**. Remove the circlip from the end of the shaft.

Inspection

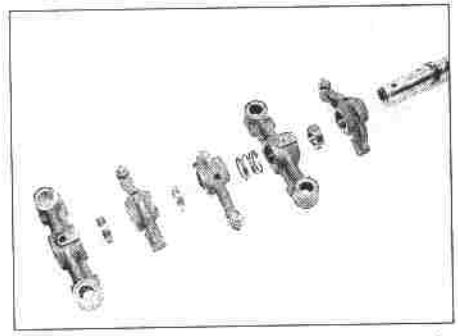
3 Examine the rocker arm bearing surfaces which contact the camshaft lobes for wear ridges and scoring. Renew any rocker arms on which these conditions are apparent. If a rocker arm bearing surface is badly scored, also examine the corresponding lobe on the camshaft for wear, as it is likely that both will be worn. Renew worn components as necessary.

4 Inspect the ends of the (valve clearance) adjusting screws for signs of wear or damage, and renew as required.

5 Examine the rocker arm and shaft bearing surfaces for wear ridges and scoring. If there are obvious signs of wear, the relevant rocker arm(s) and/or the shaft must be renewed.

Reassembly

6 Reassemble in the reverse order to dismantling, oiling all components liberally. Note that the flat faces of the pedestals face the circlip end of the shaft, and that the shaft oilways face downwards.



12.2 Rocker shaft components removed

13 Auxiliary shaft (in-line engine) - removal, inspection and refitting

Note: *On B234F engines, there is no auxiliary shaft protruding into the engine block. Instead, the oil pump is outside the block, behind the timing cover, and the oil pump pulley fits directly onto the pump.*

Removal

1 Remove the camshaft drivebelt, sprockets, tensioner and backplate, the sump, the oil pump, the distributor and any additional external components necessary for access.

2 Unbolt the crankcase ventilation system oil trap and pull out the long drain hose. Working through that hole, lift up the oil pump drivegear/shaft and remove it **(see illustration)**.

3 Unbolt and remove the front oil seal housing **(see illustration)**. Note the cable clips attached to the bottom studs. Recover the gasket.

4 Withdraw the auxiliary shaft, being careful not to damage the bearings in the block **(see illustration)**.

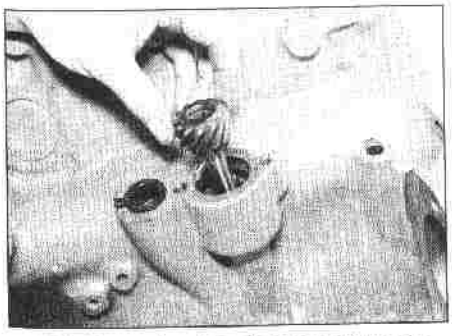
Inspection

5 Inspect the shaft bearing journals and gears for wear or damage. Measure the journals with a micrometer. Renew the shaft if it is worn or damaged.

6 If the auxiliary shaft bearings in the block are damaged, have them renewed by a Volvo dealer or other specialist.

Refitting

7 Lubricate the auxiliary shaft bearing surfaces and feed the shaft into the block, being careful not to damage the bearings.



13.2 Removing the oil pump drivegear

13.3 Removing the front oil seal housing

13.4 Removing the auxiliary shaft

8 Fit the front oil seal housing, using a new gasket. Trim the ends of the gasket level with the sump mating face. Some of the housing bolts cannot be fitted yet because they also secure the camshaft drivebelt backplate.
9 Fit new oil seals in the front oil seal housing, lips inwards and lubricated. Use a piece of tube to seat the seals.
10 Refit the oil pump drivegear/shaft, making sure it engages with the auxiliary shaft.
11 Refit the oil trap drain hose, making sure that it is inserted fully into its hole and secured towards its lower end by the guide.
12 Fit a new O-ring to the crankcase ventilation system oil trap, refit and secure the trap.
13 Refit the previously removed components with reference to the relevant Chapters of this manual.

14 Sump (V-6 engine) - removal and refitting

Removal

1 Remove the 23 bolts and washers which secure the sump.
2 Remove the sump, tapping or levering it gently if need be to free it. Recover the gasket.
3 The oil baffle and oil pump pick-up strainer are now accessible. If the strainer is removed, renew its O-ring.

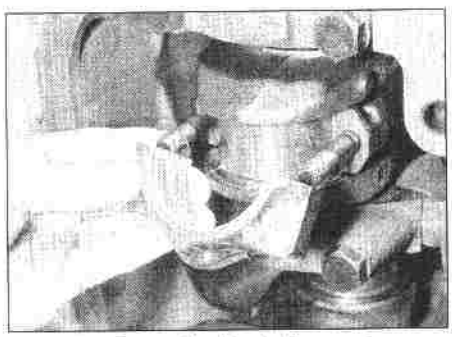
Refitting

4 Clean the sump thoroughly, inside and out using a suitable solvent and dry thoroughly. Clean off all traces of old gasket.
5 Refit by reversing the removal operations, using a new gasket. Tighten the sump bolts evenly.

15 Piston/connecting rod assemblies - removal

In-line engines

1 Remove the cylinder head and sump. On all engines except B234F remove the oil pump. See Part A of this Chapter.

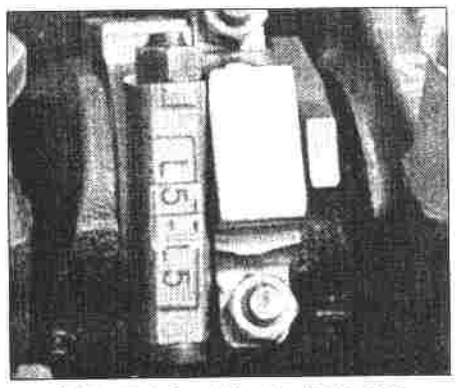


15.4 Removing the in-line engine connecting rod cap

2 Feel inside the tops of the bores for a pronounced wear ridge. Some authorities recommend that such a ridge be removed (with a scraper or ridge reamer) before attempting to remove the pistons. However, a ridge big enough to damage the pistons will almost certainly mean that a rebore and new pistons are needed anyway.
3 Turn the crankshaft to bring a pair of connecting rod caps into an accessible position. Check that there are identification numbers or marks on each connecting rod and cap; paint or punch suitable marks if necessary, so that each rod can be refitted in the same position and the same way round.
4 Remove two connecting rod nuts or bolts. Tap the cap with a soft-faced hammer to free it. Remove the cap and bearing shell **(see illustration)**.
5 Push the connecting rod and piston up and out of the bore. Recover the other half bearing shell if it is loose.
6 Refit the cap to the connecting rod so that they do not get mixed up. Keep the bearing shells in their original positions if there is any chance that they will be re-used.
7 Repeat the operations on the remaining connecting rods and pistons, turning the crankshaft as necessary to gain access to the connecting rod caps.

V-6 engines

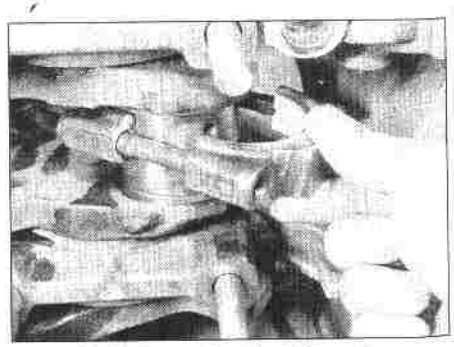
8 Remove the cylinder heads, sump, oil baffle and the oil pump pick-up strainer. Recover the O-ring.
9 Remove the 14 small bolts and the eight main bearing nuts which secure the lower crankcase. Lift off the lower crankcase; recover the oil pick-up tube O-ring. Note that on the B280E engine there are two additional bolts on each side of the cylinder block which secure the No 2 and 3 main bearing caps. Slacken these bolts first before removing the main bearing nuts.
10 Fit spacers to the main bearing cap studs and then refit the main bearing nuts so that the main bearings and crankshaft are secured for subsequent operations. This is particularly important if the main bearings are not to be disturbed. In any event it is undesirable to have the crankshaft fall out unexpectedly.
11 If it is hoped to re-use the existing cylinder liners, make sure that they are securely clamped.
12 Position the engine, so that both top and bottom are accessible and the crankshaft can be turned.
13 Inspect the connecting rods and caps to see that they carry identification marks or numbers. Note that the numbering system used here by the makers does not correspond to the cylinder numbering **(see illustration)**.
14 Check the endfloat between each pair of connecting rods. If it is outside the specified limits, all six connecting rods must be renewed.
15 Remove the nuts from one connecting rod cap, tapping it with a soft-faced hammer if it is stiff. Recover the bearing shell if it is loose and keep it with the cap **(see illustration)**.
16 Push the piston and rod up the bore and out of the top. Have an assistant catch the piston in a rag as it emerges. Tap the rod with a hammer handle if it is stiff. Recover the bearing shell if it is loose and keep it with the cap.
17 Fit the rod and cap back together and secure them with the nuts. Keep the bearing shells identified if they are to be re-used.
18 Repeat the process to remove the other five pistons and rods, turning the crankshaft as necessary to gain access.



15.13 Relationship of cylinder and connecting rod numbering. Letter ("L" shown here on rod and cap) is arbitrary

16 Crankshaft - removal

1 Remove the pistons and connecting rods, the oil pump (V-6 engines), and the front and rear oil seal housings (if not already done).
2 Before the crankshaft is removed, check the endfloat. Mount a DTI (Dial Test Indicator, or dial gauge) with the stem in line with the crankshaft and just touching the crankshaft.
3 Push the crankshaft fully away from the gauge, and zero it. Next, lever the crankshaft towards the gauge as far as possible, and check the reading obtained. The distance that the crankshaft moved is its endfloat; if it is



15.15 Removing the V-6 engine connecting rod cap

16.6 Removing the rear main bearing cap with thrustwashers

greater than specified, check the crankshaft thrust surfaces for wear. If no wear is evident, new thrustwashers should correct the endfloat.

4 If no dial gauge is available, feeler blades can be used. Gently lever or push the crankshaft all the way towards the right-hand end of the engine. Slip feeler blades between the crankshaft and the main bearing incorporating the thrustwashers to determine the clearance.

5 Inspect the main bearing caps for identifying numbers or marks. Paint or punch marks if necessary.

6 Remove the main bearing cap bolts (in-line engines) or nuts and spacers (V-6 engines). Lift off the main bearing caps, tapping them with a soft-faced hammer if necessary to free them. Keep the bearing shells with their caps if they may be re-used. On V-6 engines recover the two half thrustwashers from each side of the rear cap **(see illustration)**.

7 Lift out the crankshaft. Do not drop it, it is heavy.

8 On B200/B230 in-line engines, recover the two half thrustwashers from each side of the centre main bearing. (On B23 and B234F in-line engines, No 5 bearing shells have integral thrust flanges.) On V-6 engines recover the upper halves of the thrustwashers from each side of the rear bearing seat.

9 Remove the upper half main bearing shells from their seats in the crankcase by pressing the end of the shell furthest from the locating tab. Again, keep the shells in order if they are to be re-used.

17 Cylinder block/crankcase - cleaning and inspection

Cleaning

1 Prior to cleaning, remove all external components and senders, and any gallery plugs or caps that may be fitted.

2 On V-6 engines, remove the cylinder liners - see paragraphs 20 and 21.

3 If any of the castings are extremely dirty, all should be steam-cleaned.

4 After the castings are returned from steam-cleaning, clean all oil holes and oil galleries one more time. Flush all internal passages with warm water until the water runs clear, then dry thoroughly, and apply a light film of oil to all machined surfaces, to prevent rusting. If you have access to compressed air, use it to speed the drying process, and to blow out all the oil holes and galleries.

Warning: Wear eye protection when using compressed air!

5 If the castings are not very dirty, you can do an adequate cleaning job with hot soapy water (as hot as you can stand!) and a stiff brush. Take plenty of time, and do a thorough job. Regardless of the cleaning method used, be sure to clean all oil holes and galleries very thoroughly, and to dry all components completely; protect the machined surfaces as described above, to prevent rusting.

6 All threaded holes must be clean and dry, to ensure accurate torque readings during reassembly. To clean the threads, run the correct-size tap into each of the holes to remove rust, corrosion, thread sealant or sludge, and to restore damaged threads **(see illustration)**. If possible, use compressed air to clear the holes of debris caused by this operation.

HAYNES HiNT ***A good alternative is to inject aerosol-applied water dispersant lubricant into each hole, using the long spout usually supplied.***

Warning: Wear eye protection when using compressed air!

7 If the engine is not going to be reassembled right away, cover it with a large plastic bag to keep it clean; protect the machined surfaces as described above, to prevent rusting.

Inspection

In-line engines

8 Visually check the castings for cracks and corrosion. Look for stripped threads in the threaded holes. If there has been any history of internal coolant leakage, it may be worthwhile having an engine overhaul specialist check the cylinder block/crankcase for cracks with special equipment. If defects are found, have them repaired, if possible, or renew the assembly.

17.6 Cleaning a cylinder block threaded hole using a suitable tap

9 Check each cylinder bore for scuffing and scoring. Check for signs of a wear ridge at the top of the cylinder, indicating that the bore is excessively worn.

10 If the necessary measuring equipment is available, measure the diameter of each cylinder at the top (just under the ridge area), centre and bottom of the cylinder bore, parallel to the crankshaft axis. Next, measure the bore diameter at the same three locations across the crankshaft axis. Note the measurements obtained.

11 Measure the piston diameter at right-angles to the gudgeon pin axis, just above the bottom of the skirt; again, note the results.

12 If it is wished to obtain the piston-to-bore clearance, measure the bore and piston skirt as described above, and subtract the skirt diameter from the bore measurement. If the precision measuring tools shown are not available, the condition of the pistons and bores can be assessed, though not quite as accurately, by using feeler blades as follows. Select a feeler blade of thickness equal to the specified piston-to-bore clearance, and slip it into the cylinder along with the matching piston. The piston must be positioned exactly as it normally would be. The feeler blade must be between the piston and the cylinder on one of the thrust faces (at right-angles to the gudgeon pin bore). The piston should slip through the cylinder (with the feeler blade in place) with moderate pressure; if it falls through or slides through easily, the clearance is excessive, and a new piston will be required. If the piston binds at the lower end of the cylinder, and is loose toward the top, the cylinder is tapered. If tight spots are encountered as the piston/feeler blade is rotated in the cylinder, the cylinder is out-of-round (oval).

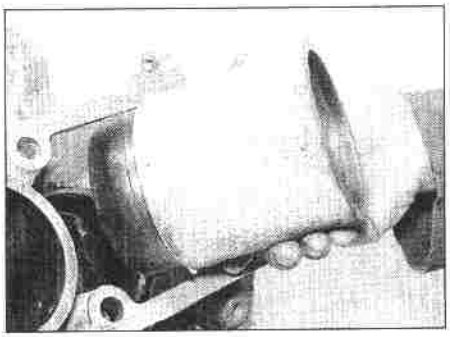
13 Repeat these procedures for the remaining pistons and cylinder bores.

14 Compare the results with the Specifications at the beginning of this Chapter; if any measurement is beyond the dimensions specified for that class, or if any bore measurement is significantly different from the others (indicating that the bore is tapered or oval), the piston or bore is excessively-worn.

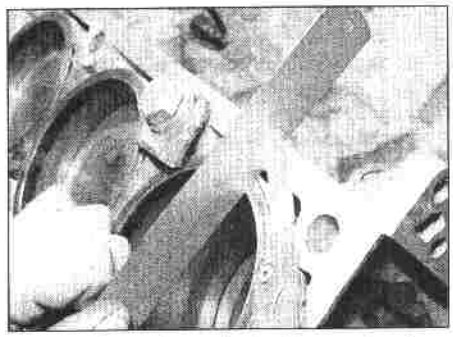
15 If any of the cylinder bores are badly scuffed or scored, or if they are excessively-worn, out-of-round or tapered, the usual course of action would be to have the cylinder block/crankcase rebored, and to fit new, oversized pistons on reassembly. Consult a dealer or engine reconditioning specialist for advice.

16 If the bores are in reasonably good condition and not excessively-worn, then it may only be necessary to renew the piston rings.

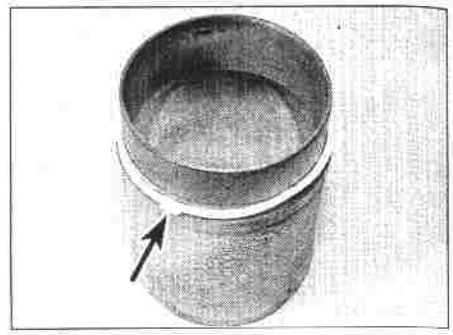
17 If this is the case, the bores should be honed, to allow the new rings to bed in



17.21 Removing the liner from the block



17.31 Measuring cylinder liner protrusion



17.36 Liner with base seal fitted. Identification tab is arrowed

correctly and provide the best possible seal. Honing is an operation that will be carried out for you by an engine reconditioning specialist.

18 After all machining operations are completed, the entire block/crankcase must be washed very thoroughly with warm soapy water to remove all traces of abrasive grit produced during the machining operations. When the cylinder block/crankcase is completely clean, rinse it thoroughly and dry it, then lightly oil all exposed machined surfaces, to prevent rusting.

19 The cylinder block/crankcase should now be completely clean and dry, with all components checked for wear or damage, and repaired or overhauled as necessary. Refit as many ancillary components as possible, for safekeeping. If reassembly is not to start immediately, cover the block with a large plastic bag to keep it clean, and protect the machined surfaces as described above to prevent rusting.

V-6 engines

20 Mark the position of each liner relative to the block. Also mark the cylinder number on each liner.

21 Remove the liner retaining clamps (if fitted), then lift the liners out of the block **(see illustration)**.

22 Clean the sealing lip on the outside of the liner and the sealing surface in the block.

23 Remove the various blanking plugs from the cylinder block. Clean the block inside and out, not forgetting the oil and water channels. Blow through the channels with compressed air.

24 Inspect the block for cracks, distortion of mating faces or other damage. Seek professional advice if damage is found. Also check the condition of threaded holes.

25 Refit the blanking plugs to the block using new seals or copper washers.

26 Inspect the liners for cracks, internal scoring or other visible damage.

27 Check the liners for wear and ovality as described above for the in-line engine (paragraphs 9 to 14). Liners cannot be rebored and must be renewed, complete with pistons and in sets of six, if excessively worn.

28 The protrusion of the cylinder liners above the top of the block must be accurately set to ensure good sealing of the head gaskets and liner bases. Base seals are available in various thicknesses; a selection should be obtained for this procedure. **Note:** *Some cylinder gaskets require a different liner protrusion; consult your dealer.*

29 Make sure that the liners and their seats are perfectly clean.

30 Fit one liner to the block without a seal. Observe position and alignment marks if re-using the old liners. Clamp the liner lightly using cylinder head bolts, spacers and large washers.

31 Using a straight-edge and feeler blades, or (preferably) a dial test indicator and a suitable bracket, measure the protrusion of the top of the liner relative to the top of the block **(see illustration)**. Measure in three different places and record the results.

32 The difference between the three measurements must not exceed 0.05 mm. If it does, remove the liner and check for dirt on the liner or seat. If the difference is within limits, use the largest of the three measurements as the basis for calculation. For example:

Measurement 1	=	0.10 mm
Measurement 2	=	0.06 mm
Measurement 3	=	0.07 mm
Maximum difference	=	0.04 mm
Largest measurement	=	0.10 mm

33 Select a base seal of thickness such that the final protrusion of the liner will be within the specified range. Aim for the maximum allowable protrusion. For example:

Desired protrusion	=	0.23 mm (max)
Measurement 1 (above)	=	0.10 mm
Difference (seal thickness required)	=	0.13 mm

34 Liner seal thicknesses are indicated either by colour coding or by a series of tabs, according to engine type (see Specifications). If for example the B28E engine is being worked on, the seal closest in thickness to that required, carries a red mark. It might prove marginally too thick, in which case a white marked seal would have to be used.

35 Remove the liner from the block.

36 Fit the thickness of seal just calculated to all the liners. The coloured identification tab should be positioned so that it will be visible when the liner is fitted. The tongues round the inside of the seal must fit into the liner base groove **(see illustration)**.

37 Fit all the liners to the block, again observing position and alignment marks if applicable. Clamp the liners.

38 Working on one cylinder bank at a time, measure the protrusion of each liner relative to the block and relative to the adjacent liner(s). The protrusion relative to the block must be as specified, and the difference between adjacent liners must not exceed 0.04 mm.

39 Fit different thickness seals to individual liners if necessary to achieve the desired result. (No more than one seal may be used per liner.) New liners may be rotated or swapped around if wished. Clamp the liners securely on completion.

18 Piston/connecting rod assemblies - inspection

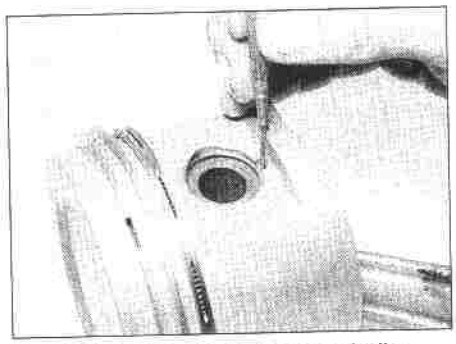
1 Before the inspection process can be carried out, the piston/connecting rod assemblies must be cleaned, and the original piston rings removed from the pistons.

2 Carefully expand the old rings over the top of the pistons. The use of two or three old feeler blades will be helpful in preventing the rings dropping into empty grooves. Be careful not to scratch the pistons with the ends of the ring. The rings are brittle and will snap if they are spread too far. They are also very sharp - protect your hands and fingers. Note that the third ring incorporates an expander. Always remove the rings from the top of the piston. Keep each set of rings with its piston if the old rings are to be re-used, and mark or label each ring so that its original top surface can be identified on reassembly, and so that it can be returned to its original groove.

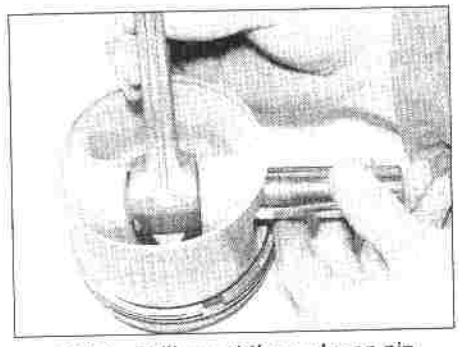
3 Scrape all traces of carbon from the top of the piston. A hand-held wire brush (or a piece of fine emery cloth) can be used, once the majority of the deposits have been scraped away.

4 Remove the carbon from the ring grooves in the piston, using an old ring. Break the ring in half to do this (be careful not to cut your fingers - piston rings are sharp). Be careful to

18.4 Cleaning a piston ring groove



18.14a Removing a piston circlip



18.14b Pulling out the gudgeon pin

remove only the carbon deposits - do not remove any metal, and do not nick or scratch the sides of the ring grooves **(see illustration)**.

5 Once the deposits have been removed, clean the piston/rod assemblies with paraffin or a suitable solvent, and dry thoroughly. Make sure the oil return holes in the ring grooves, are clear.

6 If the pistons and cylinder (or liner) bores are not damaged or worn excessively, and if the cylinder block does not need to be rebored (where applicable), the original pistons can be refitted. Normal piston wear appears as even vertical wear on the piston thrust surfaces, and slight looseness of the top ring in its groove. New piston rings should always be used when the engine is reassembled.

7 Carefully inspect each piston for cracks around the skirt, around the gudgeon pin holes, and at the ring "lands" (between the ring grooves).

8 Look for scoring and scuffing on the piston skirt, holes in the piston crown, and burned areas at the edge of the crown. If the skirt is scored or scuffed, the engine may have been suffering from overheating and/or abnormal combustion, which caused excessively-high operating temperatures. The cooling and lubrication systems should be checked thoroughly. Scorch marks on the sides of the piston show that blow-by has occurred. A hole in the piston crown or burned areas at the edge of the piston crown, indicates that abnormal combustion (pre-ignition, knocking, or detonation) has been occurring. If any of the above problems exist, the causes must be investigated and corrected, or the damage will occur again. The causes may include intake air leaks, incorrect fuel/air mixture or incorrect ignition timing.

9 Corrosion of the piston, in the form of pitting, indicates that coolant has been leaking into the combustion chamber and/or the crankcase. Again, the cause must be corrected, or the problem may persist in the rebuilt engine.

10 On V-6 engines it is not possible to renew just the pistons separately; pistons are only supplied with piston rings, a gudgeon pin and a liner as part of a matched assembly. On in-line engines, pistons can be purchased separately from a Volvo dealer or motor factor.

11 Examine each connecting rod carefully for signs of damage, such as cracks around the big-end and small end bearings. Check that the rod is not bent or distorted. Damage is highly unlikely, unless the engine has been seized or badly overheated. Detailed checking of the connecting rod assembly can only be carried out by an engine overhaul specialist with the necessary equipment.

12 On the B28E, V-6 engine, the gudgeon pin is an interference fit in the connecting rod small end bearing. Therefore piston/connecting rod renewal should be entrusted to a Volvo dealer or engine reconditioning specialist who will have the necessary tooling to remove and install the gudgeon pins. On all in-line engines, and the B280E V-6 engine, the gudgeon pins are of the floating type, secured in position by two circlips. On these engines, the pistons and connecting rods can be separated as follows.

13 Check that each piston and connecting rod carry identification and orientation marks, for correct reassembly. If in doubt, examine the connecting rod and piston and note any markings which can be used as a guide to fitting the new pistons.

14 Remove one of the circlips which secure the gudgeon pin. Push the gudgeon pin out of the piston and connecting rod **(see illustrations)**.

15 If new pistons of standard size are required, note that three grades are available - see Specifications. The grade letter is stamped on the piston crown and adjacent to each bore.

16 Check the fit of the gudgeon pin in the connecting rod bush and in the piston. If there is perceptible play, a new bush or an oversize gudgeon pin must be fitted. Consult a Volvo dealer or engine reconditioning specialist.

17 Examine all components and obtain any new parts required. If new pistons are purchased, they will be supplied complete with gudgeon pins and circlips. Circlips can also be purchased separately.

18 Oil the gudgeon pin. Reassemble the connecting rod and piston, making sure the rod is the right way round, and secure the gudgeon pin with the circlip.

19 Crankshaft - inspection

1 Clean the crankshaft using paraffin or a suitable solvent, and dry it, preferably with compressed air if available. Be sure to clean the oil holes with a pipe cleaner or similar probe to ensure that they are not obstructed.

Warning: Wear eye protection when using compressed air!

2 Check the main and big-end bearing journals for uneven wear, scoring, pitting and cracking.

3 Big-end bearing wear is accompanied by distinct metallic knocking when the engine is running (particularly noticeable when the engine is pulling from low speed) and some loss of oil pressure.

4 Main bearing wear is accompanied by severe engine vibration and rumble - getting progressively worse as engine speed increases - and again by loss of oil pressure.

5 Check the bearing journal for roughness by running a finger lightly over the bearing surface. Any roughness (which will be accompanied by obvious bearing wear) indicates that the crankshaft requires regrinding (where possible) or renewal.

6 If the crankshaft has been reground, check for burrs around the crankshaft oil holes (the holes are usually chamfered so burrs should not be a problem unless regrinding has been carried out carelessly). Remove any burrs with a fine file or scraper.

7 Using a micrometer, measure the diameter of the main and big-end journals, and compare the results with the Specifications. By measuring the diameter at a number of points around each journal's circumference, you will be able to determine whether or not the journal is out-of-round. Take the measurement at each end of the journal, near the webs, to determine if the journal is tapered. Compare the results obtained with those given in the Specifications.

8 Check the oil seal contact surfaces at each

end of the crankshaft for wear and damage. If either seal has worn a deep groove in the surface of the crankshaft, consult an engine overhaul specialist; repair may be possible, otherwise a new crankshaft will be required.

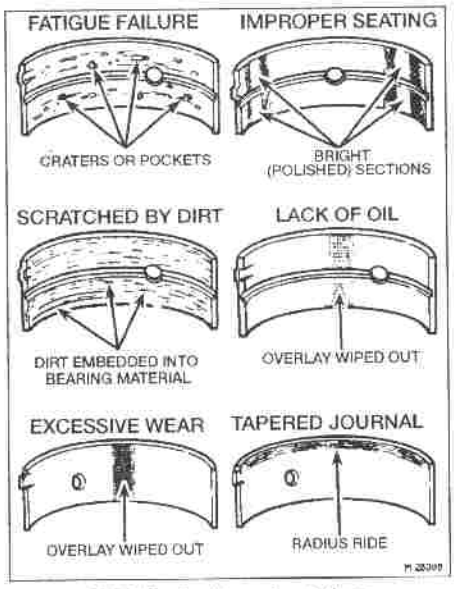
20 Main and big-end bearings - inspection

1 Even though the main and big-end bearing shells should be renewed during the engine overhaul, the old shells should be retained for close examination, as they may reveal valuable information about the condition of the engine.

2 Bearing failure occurs because of lack of lubrication, the presence of dirt or other foreign particles, overloading the engine, and corrosion **(see illustration)**. Regardless of the cause of bearing failure, the cause must be corrected (where applicable) before the engine is reassembled, to prevent it from happening again.

3 When examining the bearing shells, remove them from the cylinder block/crankcase and main bearing caps, and from the connecting rods and the big-end bearing caps, then lay them out on a clean surface in the same general position as their location in the engine. This will enable you to match any bearing problems with the corresponding crankshaft journal. *Do not* touch any shell's bearing surface with your fingers while checking it, or the delicate surface may be scratched.

4 Dirt or other foreign matter gets into the engine in a variety of ways. It may be left in the engine during assembly, or it may pass through filters or the crankcase ventilation system. It may get into the oil, and from there into the bearings. Metal chips from machining operations and normal engine wear are often present. Abrasives are sometimes left in engine components after reconditioning, especially when parts are not thoroughly cleaned using the proper cleaning methods. Whatever the source, these foreign objects often end up embedded in the soft bearing material, and are easily recognised. Large particles will not embed in the material, and will score or gouge the shell and journal. The best prevention for this cause of bearing failure is to clean all parts thoroughly, and to keep everything spotlessly-clean during engine assembly. Frequent and regular engine oil and filter changes are also recommended.



20.2 Typical bearing failure

5 Lack of lubrication (or lubrication breakdown) has a number of inter-related causes. Excessive heat (which thins the oil), overloading (which squeezes the oil from the bearing face) and oil leakage (from excessive bearing clearances, worn oil pump or high engine speeds) all contribute to lubrication breakdown. Blocked oil passages, which usually are the result of misaligned oil holes in a bearing shell, will also starve a bearing of oil, and destroy it. When lack of lubrication is the cause of bearing failure, the bearing material is wiped or extruded from the shell's steel backing. Temperatures may increase to the point where the steel backing turns blue from overheating.

6 Driving habits can have a definite effect on bearing life. Full-throttle, low-speed operation (labouring the engine) puts very high loads on bearings, which tends to squeeze out the oil film. These loads cause the shells to flex, which produces fine cracks in the bearing face (fatigue failure). Eventually, the bearing material will loosen in pieces, and tear away from the steel backing.

7 Short-distance driving leads to corrosion of bearings, because insufficient engine heat is produced to drive off condensed water and corrosive gases. These products collect in the engine oil, forming acid and sludge. As the oil is carried to the engine bearings, the acid attacks and corrodes the bearing material.

8 Incorrect shell refitting during engine assembly will lead to bearing failure as well. Tight-fitting shells leave insufficient bearing running clearance, and will result in oil starvation. Dirt or foreign particles trapped behind a bearing shell result in high spots on the bearing, which lead to failure.

9 *Do not* touch any shell's bearing surface with your fingers during reassembly; there is a risk of scratching the delicate surface, or of depositing particles of dirt on it.

21 Engine overhaul - reassembly sequence

1 Before reassembly begins ensure that all new parts have been obtained and that all necessary tools are available. Read through the entire procedure to familiarise yourself with the work involved, and to ensure that all items necessary for reassembly of the engine are at hand. In addition to all normal tools and materials, jointing and thread locking compound will be needed in some areas during engine reassembly. In all other cases, provided the relevant mating surfaces are clean and flat, new gaskets will be sufficient to ensure joints are oil-tight.

2 In order to save time and avoid problems, engine reassembly can be carried out in the following order (as applicable).

a) Crankshaft (see Section 23).
b) Pistons/connecting rods (see Section 24).
c) Oil pump (see Part A or B as applicable).
d) Auxiliary shaft - in-line engine, except B234F (see Section 13).
e) Sump (see Part A or Section 14 as applicable).
f) Flywheel/driveplate (see Part A or B as applicable).
g) Cylinder head(s) (see Part A or B as applicable).
h) Timing chains, sprockets and tensioners - V-6 engine (see Part B).
i) Camshaft drivebelt, tensioner and sprockets - in-line engine (see Part A).
j) Engine external components.

Note: *On B234F engines the oil pump is mounted outside the engine block, behind the timing cover, and can be refitted after fitting the sump.*

3 At this stage, all engine components should be absolutely clean and dry, with all faults repaired. The components should be laid out (or in individual containers) on a completely clean work surface.

22 Piston rings - refitting

1 Before installing new piston rings, the ring end gaps must be checked as follows.

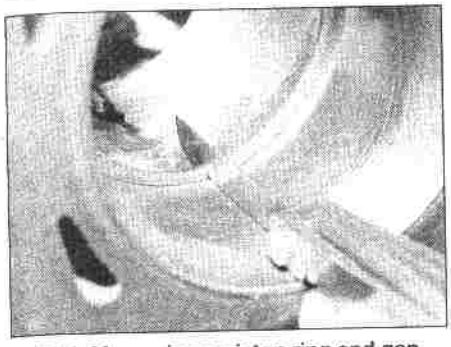
2 Lay out the piston/connecting rod assemblies and the new piston ring sets, so that the ring sets will be matched with the same piston and cylinder during the end gap measurement and subsequent engine reassembly

3 Insert the top ring into the first cylinder, and push it down the bore using the top of the piston. This will ensure that the ring remains square with the cylinder walls. Position the ring near the bottom of the cylinder bore, at the lower limit of ring travel. Note that the top and second compression rings are different. The second ring is easily identified by the step on its lower surface or by the fact that its outer face is tapered.

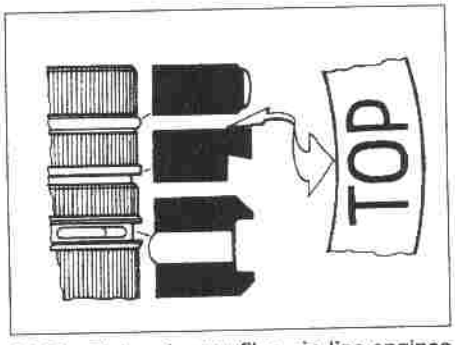
4 Measure the ring gap using feeler blades **(see illustration)**.

5 Repeat the procedure with the ring at the top of the cylinder bore, at the upper limit of its travel and compare the measurements with the figures given in the Specifications.

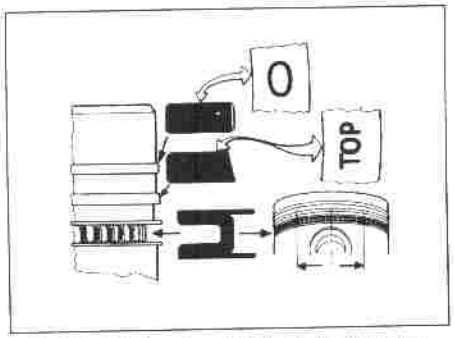
6 If the gap is still too small, it must be enlarged or the ring ends may contact each



22.4 Measuring a piston ring end gap



22.10a Piston ring profiles - in-line engines



22.10b Piston ring profiles - V-6 engine. Stagger oil control rail gaps as shown

other during engine operation, causing serious damage. Ideally, new piston rings providing the correct end gap should be fitted. As a last resort the end gaps can be increased by filing the ring ends very carefully with a fine file. Mount the ring in a vice equipped with soft jaws, slip the ring over the file with the ends contacting the file face, and slowly move the ring to remove material from the ends. Take care as piston rings are sharp and are easily broken.

7 With new piston rings, it is unlikely that the end gap will be too large. If the gaps are too large, check that you have the correct rings for your engine and for the cylinder bore size.

8 Repeat the checking procedure for each ring in the first cylinder, and then for the rings in the remaining cylinders. Remember to keep rings, pistons and cylinders matched up.

9 Once the ring end gaps have been checked and if necessary corrected, the rings can be fitted to the pistons.

10 Fit the piston rings using the same technique as for removal. Fit the bottom (oil control) ring first, and work up. Observe the "TOP" marking on the second compression ring. The other rings can be fitted either way up, unless the top ring is stepped, in which case the step must be uppermost **(see illustrations)**. Do not expand the compression rings too far or they will break.

Note: *Always follow any instructions supplied with the new piston ring sets - different manufacturers may specify different procedures. Do not mix up the top and second compression rings, as they have different cross-sections.*

23 Crankshaft - refitting and main bearing running clearance check

1 It is assumed at this point that the cylinder block/crankcase and crankshaft have been cleaned, inspected and repaired or reconditioned as necessary. Position the engine upside-down.

2 Remove the main bearing cap nuts or bolts, and lift out the caps. Lay the caps out in the proper order, to ensure correct installation.

3 If they're still in place, remove the old bearing shells from the block and the main bearing caps. Wipe the bearing recesses of the block and caps with a clean, lint-free cloth. They must be kept spotlessly-clean!

Main bearing running clearance check

In-line engines

4 Wipe clean the main bearing shell seats in the crankcase and clean the backs of the bearing shells. Insert the respective upper shells (dry) into position in the crankcase and the lower shells into their respective caps. Fit the bearing shells to the same locations as previously occupied if they are being re-used. Press the shells home so that the tangs engage in the recesses provided. All the shells are the same, except for No 5 shells on the B23 and B234F engines which have thrust flanges.

5 The most accurate method of checking the main bearing running clearance is to use an American product known as "Plastigage". This consists of a fine thread of perfectly-round plastic, which is compressed between the bearing shell and the journal. When the shell is removed, the plastic is deformed, and can be measured with a special card gauge supplied with the kit. The running clearance is determined from this gauge. Plastigage should be available from your Volvo dealer, otherwise enquiries at one of the larger specialist motor factors should produce the name of a stockist in your area. The procedures for using Plastigage are as follows.

6 Clean the bearing surfaces of the shells in the block, and the crankshaft main bearing journals with a clean, lint-free cloth. Check or clean the oil holes in the crankshaft, as any dirt here can go only one way - straight through the new bearings.

7 Once you are certain the crankshaft is clean, carefully lay it in position in the main bearings. Trim several pieces of the appropriate-size Plastigage (they must be slightly shorter than the width of the main bearings), and place one piece on each crankshaft main bearing journal, parallel with the crankshaft centre-line **(see illustration)**.

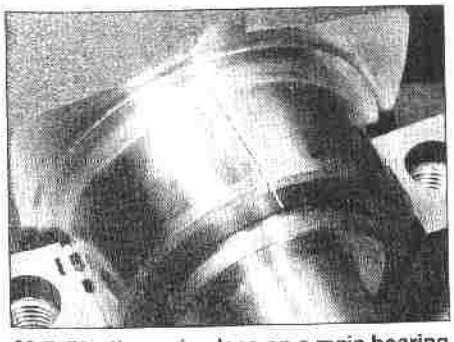
8 Clean the bearing surfaces of the cap shells, and install the caps in their respective positions. Take care not to disturb the Plastigage, and *do not* rotate the crankshaft at any time during this operation.

9 Working on one cap at a time, from the centre main bearing outwards (and ensuring that each cap is tightened down squarely and evenly onto the block), tighten the main bearing cap bolts to the specified torque wrench setting.

10 Remove the bolts, and carefully lift off the main bearing caps, keeping them in order. Again, take care not to disturb the Plastigage or rotate the crankshaft.

11 Compare the width of the crushed Plastigage on each journal with the scale printed on the Plastigage envelope to obtain the main bearing running clearance **(see illustration)**. Check the Specifications to make sure that the clearance is correct.

12 If the clearance is significantly different from that expected, the bearing shells may be the wrong size (or excessively worn, if the original shells are being re-used).



23.7 Plastigage in place on a main bearing journal

23.11 Measure the width of the deformed Plastigage using the scale on the card

Before deciding that different-size shells are required, make sure that no dirt or oil was trapped between the bearing shells and the caps or block when the clearance was measured. If the Plastigage is noticeably wider at one end than the other, the journal may be tapered.

13 Carefully scrape all traces of the Plastigage material off the main bearing journals and the bearing surfaces. Be very careful not to scratch the bearing - use your fingernail or a wooden or plastic scraper which is unlikely to score the bearing surfaces.

V-6 engines

14 The procedure is similar to that described above for in-line engines, except that it will be necessary to use spacers underneath the bearing cap retaining nuts to allow the nuts to be tightened.

15 When locating the bearing shells, note that the shells fitted to the block have lubrication holes; the shells fitted to the bearing caps are plain.

Final crankshaft refitting

In-line engines

16 Carefully lift the crankshaft out of the engine, then clean the bearing surfaces of the shells in the block.

17 On the B200/B230 engine, smear some grease on the smooth sides of the half thrustwashers. Place the washers in position on each side of the centre bearing in the crankcase. The slotted sides of the washers face outwards. On the B23 and B234F engine, smear some grease on the sides of the thrust flanges of No 5 bearing shells.

18 Liberally lubricate the bearing shells in the crankcase with clean engine oil.

19 Wipe clean the crankshaft journals, then lower the crankshaft into position. Make sure that the shells (and thrustwashers, when applicable) are not displaced.

20 Inject oil into the crankshaft oilways. Oil the shells in the main bearing caps and fit the caps, each to its correct position and the right way round.

21 Fit the main bearing cap bolts and tighten them progressively to the specified torque.

22 Rotate the crankshaft. Some stiffness is to be expected with new components, but there must be no tight spots or binding.

23 It is a good idea at this stage, to once again check the crankshaft endfloat as described in Section 16.

24 Fit the rear oil seal carrier, using a new gasket. Trim the protruding ends of the gasket level with the sump mating face.

25 Fit a new rear oil seal to the carrier as described in Part A.

26 Refit the piston/connecting rod assemblies to the crankshaft as described in Section 24.

V-6 engines

27 Carefully lift the crankshaft out of the engine, then clean the bearing surfaces of the shells in the block.

28 Fit the upper half thrustwashers to each side of the rear bearing seat in the block. The grooves must face outwards. Use a smear of grease to hold them in position.

29 Oil the bearing shells in the block. Lower the crankshaft into position, being careful not to dislodge the thrustwashers.

30 Inject oil into the crankshaft oilways. Oil the shells in the main bearing caps and fit the thrustwashers to the rear cap, grooves outwards. Fit the caps to their locations and the right way round. Tap them home if necessary.

31 Secure each cap with a spacer and a nut. Fit two spacers to the rear cap and tighten its nuts to 40 Nm (30 lbf ft).

32 Check that the crankshaft is free to rotate. Some stiffness is to be expected with new components, but there must be no tight spots or binding.

33 It is a good idea at this stage, to once again check the crankshaft endfloat as described in Section 16.

34 Refit the rear oil seal housing, using a new gasket. Make sure that the flat edge of the housing is flush with the block, then tighten the five Allen screws to secure it. Trim the gasket flush.

35 Fit a new rear oil seal to the carrier as described in Part B.

36 Refit the piston/connecting rod assemblies to the crankshaft as described in Section 24.

24 Piston/connecting rod assemblies - refitting and big-end bearing clearance check

1 Before refitting the piston/connecting rod assemblies, the cylinder bores must be perfectly clean, the top edge of each cylinder must be chamfered, and the crankshaft must be in place.

2 Remove the big-end bearing cap from No 1 cylinder connecting rod (refer to the marks noted or made on removal). Remove the original bearing shells, and wipe the bearing recesses of the connecting rod and cap with a clean, lint-free cloth. They must be kept spotlessly-clean!

Big-end bearing running clearance check

3 Note that the following procedure assumes that the cylinder liners (V-6 engines) are in position in the cylinder block/crankcase, and that the crankshaft and main bearing caps are in place.

4 Clean the back of the new upper bearing shell, fit it to No 1 connecting rod, then fit the other shell of the bearing set to the big-end bearing cap. Make sure the tab on each shell fits into the notch in the rod or cap recess.

5 It is critically important that all mating surfaces of the bearing components are perfectly clean and oil-free when they're assembled.

6 Position the piston ring gaps evenly around the piston, lubricate the piston and rings with clean engine oil, and attach a piston ring compressor to the piston. Leave the skirt protruding slightly, to guide the piston into the cylinder bore. The rings must be compressed until they're flush with the piston.

7 Rotate the crankshaft until No 1 big-end journal is at BDC (Bottom Dead Centre), and apply a coat of engine oil to the cylinder walls.

8 Arrange the No 1 piston/connecting rod assembly so that the arrow on the piston crown points to the camshaft drivebelt/timing chain end of the engine. Gently insert the assembly into the No 1 cylinder bore, and rest the bottom edge of the ring compressor on the engine block.

9 Tap the top edge of the ring compressor to make sure it's contacting the block around its entire circumference.

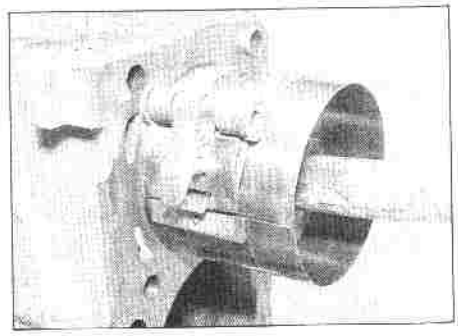
10 Gently tap on the top of the piston with the end of a wooden hammer handle **(see illustration)**, while guiding the connecting rod big-end onto the crankpin. The piston rings may try to pop out of the ring compressor just before entering the cylinder bore, so keep some pressure on the ring compressor. Work slowly, and if any resistance is felt as the piston enters the cylinder, stop immediately. Find out what is binding, and fix it before proceeding. *Do not*, for any reason, force the piston into the cylinder - you might break a ring and/or the piston.

11 The most accurate method of checking the big-end bearing running clearance is to use Plastigage (see Section 23).

12 Cut a piece of the appropriate-size Plastigage slightly shorter than the width of the connecting rod bearing, and lay it in place on the No 1 big-end journal, parallel with the crankshaft centre-line.

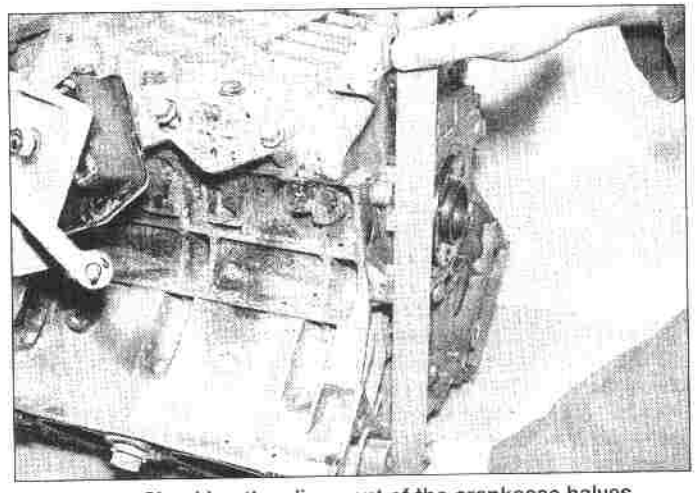
13 Clean the connecting rod-to-cap mating surfaces, and refit the big-end bearing cap. Tighten the cap bolts to the specified torque. Do not rotate the crankshaft at any time during this operation!

14 Unscrew the bolts and detach the cap, being very careful not to disturb the Plastigage.



24.10 Fitting a piston to the bore

24.28 Oil pick-up tube O-ring (arrowed)



24.31 Checking the alignment of the crankcase halves

15 Compare the width of the crushed Plastigage to the scale printed on the Plastigage envelope, to obtain the running clearance. Compare it to the Specifications, to make sure the clearance is correct.

16 If the clearance is significantly different from that expected, the bearing shells may be the wrong size (or excessively worn, if the original shells are being re-used). Before deciding that different-size shells are required, make sure that no dirt or oil was trapped between the bearing shells and the cap or rod when the clearance was measured. If the Plastigage is noticeably wider at one end than the other, the journal may be tapered.

17 Carefully scrape all traces of the Plastigage material off the big-end bearing journal and the bearing surface. Be very careful not to scratch the bearing - use your fingernail or a wooden or plastic scraper which is unlikely to score the bearing surfaces.

Final piston/connecting rod refitting

In-line engines

18 Make sure the bearing surfaces are perfectly clean, then apply a uniform layer of clean engine oil to both of them. You will have to push the piston into the cylinder to expose the bearing surface of the shell in the connecting rod.

19 Slide the connecting rod back into place on the big-end journal, refit the big-end bearing cap, and then tighten the nuts as described above.

20 Repeat the entire procedure for the remaining piston/connecting rod assemblies.

21 The important points to remember are:

a) Keep the backs of the bearing shells and the recesses of the connecting rods and caps perfectly clean when assembling them.

b) Make sure you have the correct piston/rod assembly for each cylinder.

c) The arrow on the piston crown must face the camshaft drivebelt end of the engine.

d) Lubricate the cylinder bores with clean engine oil.

e) Lubricate the bearing surfaces when refitting the big-end bearing caps after the running clearance has been checked.

22 After all the piston/connecting rod assemblies have been properly installed, rotate the crankshaft a number of times by hand, to check for any obvious binding.

23 Continue with engine reassembly in the sequence given in Section 21.

V-6 engines

24 Make sure the bearing surfaces are perfectly clean, then apply a uniform layer of clean engine oil to both of them. You will have to push the piston into the cylinder to expose the bearing surface of the shell in the connecting rod.

25 Slide the connecting rod back into place on the big-end journal, refit the big-end bearing cap, but do not fully tighten the nuts yet.

26 Repeat the entire procedure on the other five pistons, bearing in mind the information contained in paragraph 21. Tighten the bearing cap nuts to the specified torque when each pair of rods is fitted to a crankpin. (If the nuts are tightened when only one rod is fitted, the twisting of the rod may produce a false result.)

27 Check that the crankshaft is still free to rotate.

28 Remove the main bearing cap nuts and spacers. Make sure that the oil pick-up tube is in place and fit a new O-ring to it **(see illustration)**.

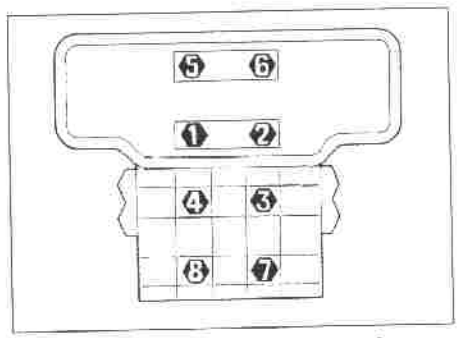
29 Clean the upper and lower crankcase mating faces, then apply sealant to one face, including the areas round the main bearing studs.

30 Fit the lower crankcase. Fit the main bearing nuts and the 14 small bolts, but only tighten them lightly at this stage. On the B280E engines, fit the two additional main bearing cap bolts each side, and tighten these finger tight as well.

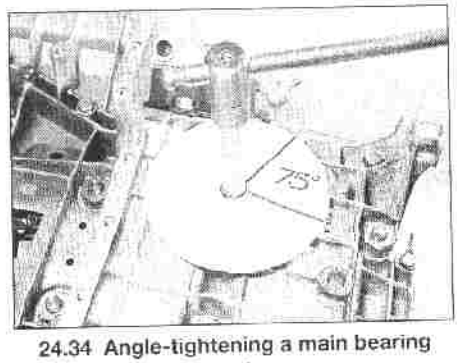
31 Use a straight-edge to check that the rear edges of the crankcase halves are aligned **(see illustration)**. Reposition the lower crankcase if necessary, first slackening the nuts and bolts.

32 Tighten the main bearing nuts in the sequence shown to the Stage 1 specified torque **(see illustration)**.

33 Recheck the alignment of the crankcase halves. Slacken the nuts if necessary and start again.



24.32 Main bearing nut tightening sequence



24.34 Angle-tightening a main bearing nut

34 Slacken the first nut and retighten it to the Stage 2A specified torque. Tighten the nut further through the angle specified for Stage 2B. Use an angle measuring gauge or a cardboard template to indicate the angle required **(see illustration on previous page)**.
35 Repeat the slackening and retightening process on each nut in turn.
36 Check that the crankshaft is still free to rotate.
37 Tighten the 14 small bolts in the lower crankcase, then, on B280E engines, tighten the four main bearing cap side bolts.
38 Refit the oil pump pick-up strainer, using a new O-ring, and the oil baffle.
39 Continue with engine reassembly in the sequence given in Section 21.

25 Engine - initial start-up after overhaul

1 With the engine refitted in the vehicle, double-check the engine oil and coolant levels. Make a final check that everything has been reconnected, and that there are no tools or rags left in the engine compartment.
2 Refit the spark plugs, and connect all the spark plug (HT) leads (Chapter 1).
3 Start the engine, noting that this also may take a little longer than usual, due to the fuel system components being empty.
4 While the engine is idling, check for fuel, coolant and oil leaks. Don't be alarmed if there are some odd smells and smoke from parts getting hot and burning off oil deposits.
5 Keep the engine idling until hot water is felt circulating through the top hose, check that it idles reasonably smoothly and at the usual speed, then switch it off.
6 After a few minutes, recheck the oil and coolant levels, and top-up as necessary (see "*Weekly checks*").
7 If new components such as pistons, rings or crankshaft bearings have been fitted, the engine must be run-in for the first 500 miles (800 km). Do not operate the engine at full-throttle, or allow it to labour in any gear during this period. It is recommended that the oil and filter be changed at the end of this period.

Chapter 3
Cooling, heating and air conditioning systems

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

General

System type	Water-based coolant, pump-assisted circulation, thermostatically controlled

Thermostat

Opening commences:	
B23/B230 (type 1), B234F and B280E	86 to 88°C
B23/B230 (type 2) and B28	91 to 93°C
Fully open at:	
B23/B230 (type 1), B234F and B280E	97°C
B23/B230 (type 2) and B28	102°C
Models with thermostat on cylinder head:	
Clearance between thermostat hose and alternator drivebelt	25 mm min

Torque wrench settings

	Nm	lbf ft
Water pump bolts:		
B28	15 to 20	11 to 15
All other engines	Not specified	

1 General information and precautions

General information

The cooling system is conventional in operation. Water-based coolant is circulated around the cylinder block and head(s) by a belt-driven pump. A thermostat restricts circulation to the engine and heater matrix until operating temperature is achieved. When the thermostat opens, coolant circulates through the radiator at the front of the engine bay.

Cooling airflow through the radiator is provided by the forward motion of the vehicle, and by a viscous coupled fan on the water pump pulley. The design of the viscous coupling is such that fan speed remains low at low air temperatures, increasing as the temperature of the air coming through the radiator rises. In this way overcooling, unnecessary power loss and noise are minimised. On some models an electric cooling fan is placed in front of the air conditioning condenser, itself in front of the radiator, to supplement the airflow.

The cooling system is pressurised, which increases the efficiency of the system by raising the boiling point of the coolant. An expansion tank accommodates variations in coolant volume with temperature.

Because the system is sealed, evaporative losses are minimal.

Heat from the coolant is used in the vehicle's heating system. The heating and air conditioning systems are described in Sections 11 and 13.

Precautions

Warning: Do not attempt to remove the expansion tank filler cap, or to disturb any part of the cooling system, while it or the engine is hot, as there is a very great risk of scalding. If the expansion tank filler cap must be removed before the engine and radiator have fully cooled down (even though this is not recommended) the pressure in the cooling system must first be released. Cover the cap with a thick layer of cloth, to avoid scalding, and slowly unscrew the filler cap until a hissing sound can be heard. When the hissing has stopped, showing that pressure is released, slowly unscrew the filler cap further until it can be removed; if more hissing sounds are heard, wait until they have stopped before unscrewing the cap completely. At all times, keep well away from the filler opening.

Warning: Do not allow antifreeze to come in contact with your skin, or with the painted surfaces of the vehicle. Rinse off spills immediately with plenty of water. Never leave antifreeze lying around in an open container, or in a puddle in the driveway or on the garage floor. Children and pets are attracted by its sweet smell, but antifreeze is fatal if ingested.

Warning: Refer to Section 13 for precautions to be observed when working on vehicles equipped with air conditioning.

2 Cooling system hoses - disconnection and renewal

Note: *Refer to the warnings given in Section 1 of this Chapter before proceeding. Hoses should only be disconnected once the engine has cooled sufficiently to avoid scalding.*

1 If the checks described in Chapter 1 reveal a faulty hose, it must be renewed as follows.

2 First drain the cooling system (see Chapter 1); if the antifreeze is not due for renewal, the drained coolant may be re-used, if it is collected in a clean container.

3 To disconnect any hose, use a pair of pliers to release the spring clamps (or a screwdriver to slacken screw-type clamps), then move them along the hose clear of the union. Carefully work the hose off its stubs. The hoses can be removed with relative ease when new - on an older vehicle, they may have stuck.

4 If a hose proves stubborn, try to release it by rotating it on its unions before attempting to work it off. Gently prise the end of the hose with a blunt instrument (such as a flat-bladed screwdriver), but do not apply too much force, and take care not to damage the pipe stubs or hoses. Note in particular that the radiator hose unions are fragile; do not use excessive force when attempting to remove the hoses. If all else fails, cut the hose with a sharp knife, then slit it so that it can be peeled off in two pieces. While expensive, this is preferable to buying a new radiator. Check first, however, that a new hose is readily available.

5 When refitting a hose, first slide the clamps onto the hose, then engage the hose with its unions. Work the hose into position, then check that the hose is settled correctly and is properly routed. Slide each clip along the hose until it is behind the union flared end, before tightening it securely.

> **HAYNES HiNT** ***If the hose is stiff, use a little soapy water as a lubricant, or soften the hose by soaking it in hot water. Do not use oil or grease, which may attack the rubber.***

6 Refill the system with coolant (see Chapter 1).

7 Check carefully for leaks as soon as possible after disturbing any part of the cooling system.

3 Antifreeze - general information

Note: *Refer to the warnings given in Section 1 of this Chapter before proceeding.*

1 The cooling system should be filled with a water/ethylene glycol-based antifreeze solution, of a strength which will prevent freezing down to at least -25°C, or lower if the local climate requires it. Antifreeze also provides protection against corrosion, and increases the coolant boiling point.

2 The cooling system should be maintained according to the schedule described in Chapter 1. If antifreeze is used that is not to Volvo's specification, old or contaminated coolant mixtures are likely to cause damage, and encourage the formation of corrosion and scale in the system. Use distilled water with the antifreeze, if available - if not, be sure to use only soft water. Clean rainwater is suitable.

3 Before adding antifreeze, check all hoses and hose connections, because antifreeze tends to leak through very small openings. Engines don't normally consume coolant, so if the level goes down, find the cause and correct it.

4 The specified mixture is 50% antifreeze and 50% clean soft water (by volume). Mix the required quantity in a clean container and then fill the system as described in Chapter 1, and "*Weekly checks*". Save any surplus mixture for topping-up.

4 Radiator - removal and refitting

Note: *Refer to the warnings given in Section 1 of this Chapter before proceeding. If leakage is the reason for removing the radiator, bear in mind that minor leaks can often be cured using a radiator sealant with the radiator in situ.*

Removal

1 Drain the cooling system (see Chapter 1).

2 Disconnect the top hose, expansion tank hose and vent hose from the radiator.

3 On automatic transmission models, disconnect the fluid cooler lines from the radiator. Be prepared for fluid spillage. Plug or cap the lines to keep dirt out.

4 Disconnect the leads from any thermal switches, sensors etc, in the radiator.

5 Unbolt the power steering fluid reservoir (when located on the radiator) and move it aside.

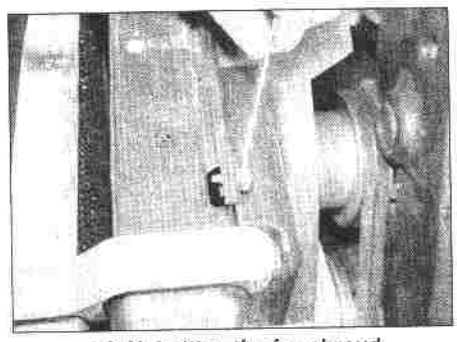
6 Unbolt the fan shroud and move it rearwards **(see illustration)**.

7 Unbolt the radiator top mounting brackets **(see illustration)**.

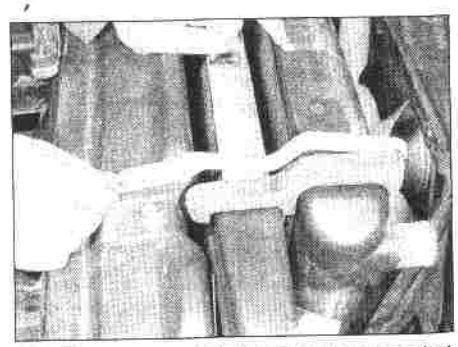
8 Lift out the radiator. Recover the bottom mountings if they are loose.

Refitting

9 Refit by reversing the removal operations. Refill the cooling system on completion. On automatic transmission models check, and if necessary top-up, the transmission fluid level. Both these operations are described in Chapter 1.



4.6 Unbolting the fan shroud



4.7 Removing a radiator mounting bracket

5 Viscous coupled fan - removal and refitting

Removal

1 Remove the nuts which secure the viscous coupling to the water pump pulley studs.
2 Pull the fan and coupling off the studs **(see illustration)**. Manipulate the assembly past the fan shroud and remove it. It may be necessary to release the shroud.
3 The fan and viscous coupling may now be separated if required.

Refitting

4 Refit by reversing the removal operations.

5.2 Removing the fan and viscous coupling

6 Electric fan - removal and refitting

Removal

1 Remove the front radiator grille panel (see Chapter 11).
2 Remove the four screws which secure the fan mounting bars. Disconnect the wiring multi-plug.
3 Remove the fan complete with mounting bars. The motor can be unbolted from the bars if wished.

Refitting

4 Refit by reversing the removal operations.

7 Cooling system electrical switches and sensors - testing, removal and refitting

Electric fan thermoswitch

Removal

1 Partially drain the cooling system (see Chapter 1) to below the level of the thermoswitch. The switch is located in the radiator side tank or in a hose adapter adjacent to the radiator **(see illustration)**.

7.1 Fan thermoswitch in a hose adapter. It may also be located in the radiator side tank

2 Disconnect the thermoswitch leads, unscrew it and remove it.

Testing

3 To test the switch, connect a battery and test light to its terminals. Heat the switch in hot water. The switch should close (test light comes on) at approximately the temperature stamped on it, and open again (test light goes off) as it cools down. If not, renew it.

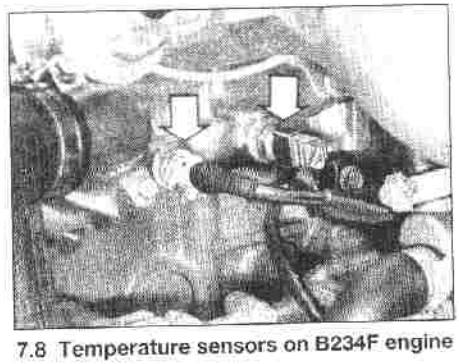
Refitting

4 Refit the thermoswitch, using sealant on the threads, and reconnect its leads.
5 Refill the cooling system (Chapter 1).

Coolant temperature gauge sender

Testing

6 If the temperature gauge indicates Hot at any time, consult the *"Fault finding"* section at the rear of this manual, to assist in tracing possible cooling system faults. If both the fuel gauge and the temperature gauge are inaccurate, the fault is probably in the instrument voltage stabiliser on the instrument panel printed circuit (see Chapter 12).
7 If the temperature gauge readings are suspect, or the gauge does not work at all, test the gauge and sender unit as follows.
8 Disconnect the electrical lead from the sender unit which is located either in the cylinder head or water pump. On B234F engines, there are two temperature sensors on the cylinder head under the intake manifold. The front sensor supplies a signal to the ignition and fuel injection systems, and the rear sensor is the temperature gauge sender unit **(see illustration)**.



7.8 Temperature sensors on B234F engine

Note: *If the front sensor on the B234F engine is faulty, it will produce a fault code on the self-diagnostic system. See Chapters 4B and 5B.*
9 Connect a resistor, value approximately 68 Ω, between the lead and earth (vehicle metal). Switch on the ignition: the gauge should rise to roughly 75% of full scale deflection. If not, either the lead is broken or the gauge is defective. Switch off the ignition.
10 Remove the sender then measure its resistance with it immersed in a water bath of known temperature. The resistance should vary as follows:

Pre-1987 models

Temperature	Resistance
60°C	217 ± 35 Ω
90°C	87 ± 15 Ω
100°C	67 ± 11 Ω

1987 models onward

Temperature	Resistance
60°C	560 Ω
90°C	206 Ω
100°C	153 Ω

11 If either the gauge or the sender does not behave as described, they should be renewed. If the sender is satisfactory, refit it or reconnect its lead accordingly.

Removal

12 Partially drain the cooling system (see Chapter 1) to below the level of the sender unit.
13 Disconnect the lead from the sender unit and unscrew it from its location.

Refitting

14 Screw in the new sender unit, using a smear of sealant on the threads. Reconnect the leads.
15 Top-up the coolant level (see *"Weekly checks"*).

Coolant level sensor

Testing

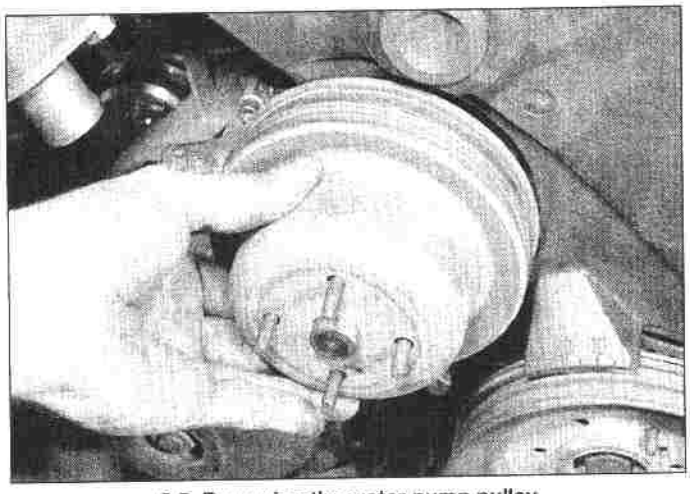
16 A coolant level sensor is fitted in the expansion tank on later models. It consists of a float-operated switch connected to an instrument panel warning light.
17 If the sensor operation is suspect, unscrew it from the expansion tank and submerge the float in a jar of water. With the ignition switched on, the warning light on the instrument panel should not be illuminated. Withdraw the sensor from the jar and check that the warning light illuminates when the float is clear of the water. Renew the sensor if it does not perform as described.

Removal

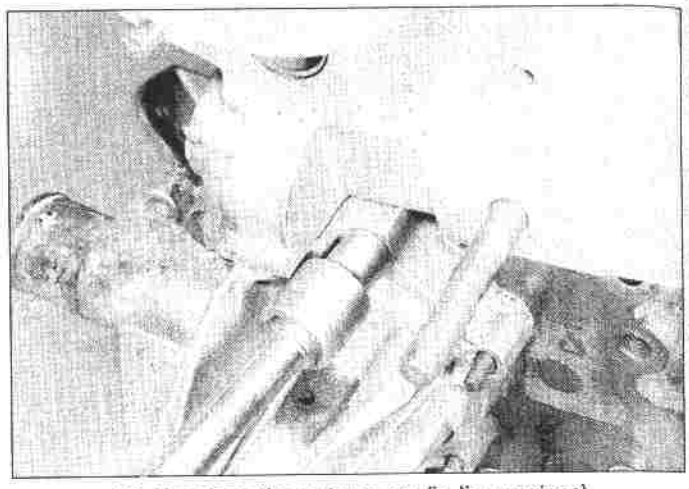
18 Disconnect the switch wiring and unscrew the sensor from the expansion tank.

Refitting

19 Refit by reversing the removal operations.



8.5 Removing the water pump pulley



8.7 Unbolting the water pump (in-line engines)

8 Water pump removal and refitting

Note: *Refer to the warnings given in Section 1 of this Chapter before proceeding.*

Removal

1 Disconnect the battery negative lead.
2 Remove the accessory drivebelts, as necessary, for access to the water pump pulley (see Chapter 1).
3 Drain the cooling system (see Chapter 1).
4 Remove the radiator and the fan shroud (see Section 4).
5 Remove the fan from the water pump (see Section 5), then remove the water pump pulley **(see illustration)**.

In-line engine

6 Disconnect the radiator bottom hose and the heater pipe from the pump.
7 Unbolt the water pump, slide it downwards and remove it **(see illustration)**.

V6 engine

8 Remove the inlet manifold (see Chapter 4B).
9 Remove the two hoses which connect the pump to the cylinder heads. Disconnect the remaining hoses from the pump and thermostat housing. Also disconnect the sensor and switch at the sides of the pump **(see illustrations)**.
10 Remove the three bolts which secure the pump to the block. Lift off the pump **(see illustration)**.

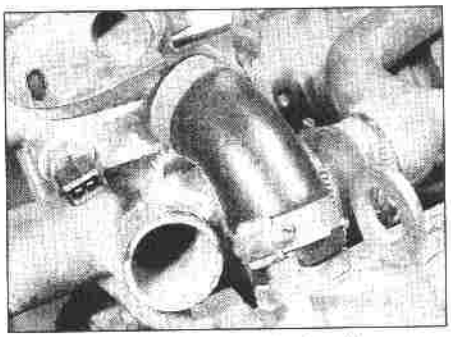
Refitting

In-line engine

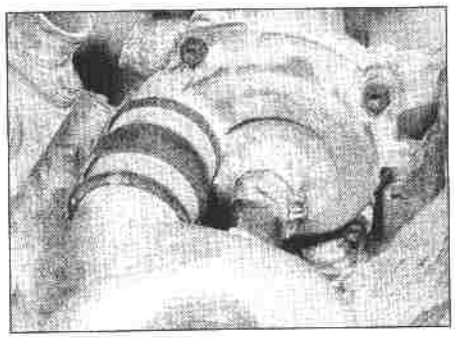
11 Renew the pump top sealing ring and body gasket **(see illustration)**. When refitting, keep the pump pressed up against the cylinder head whilst tightening the nuts and bolts. Use a new seal on the heater pipe.
12 The remainder of refitting is a reversal of the removal procedure. Refit and tension the accessory drivebelt(s) and refill the cooling system (Chapter 1) to complete.

V6 engine

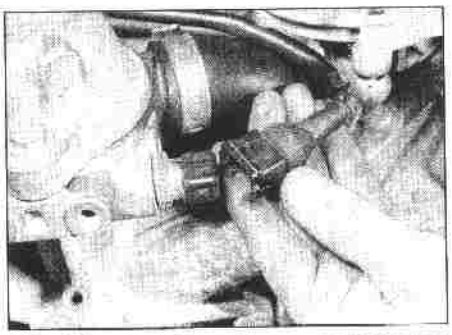
13 If a new pump is to be fitted, transfer the rear housing, thermostat and housing, sender unit, blanking plugs etc. from the old pump to the new. Use new gaskets and seals. Also renew the pump hoses unless they are in perfect condition.
14 Fit the pump to the block and secure it with the three bolts.



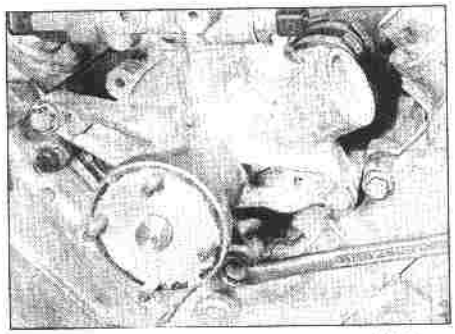
8.9a One of the pump-to-head hoses



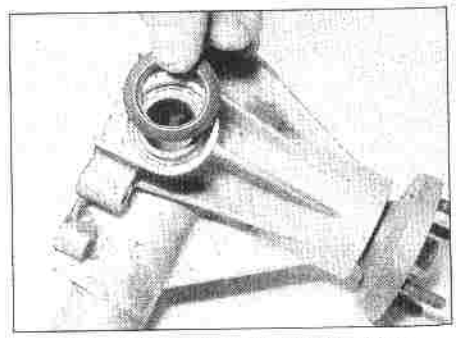
8.9b Two hoses at the rear of the pump



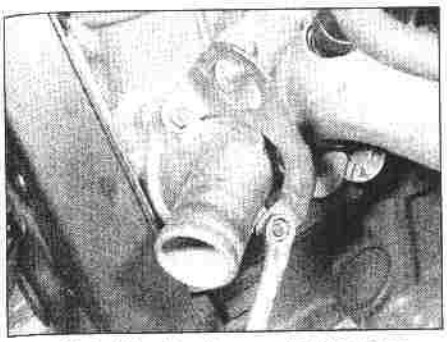
8.9c Disconnecting a temperature sensor



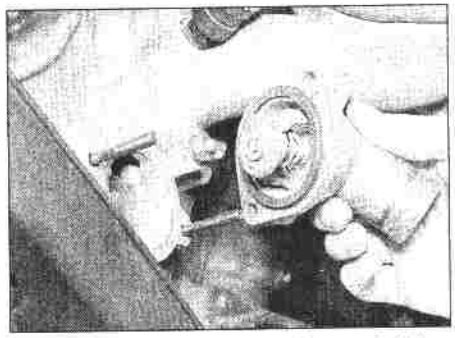
8.10 Unbolting the water pump (V-6 engines)



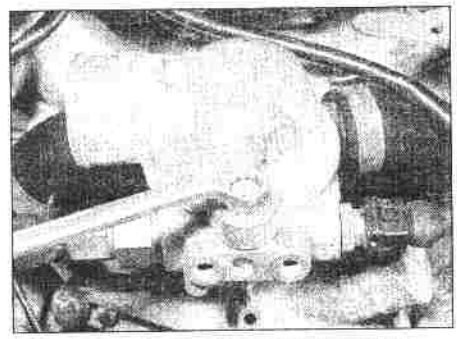
8.11 Fitting a new top sealing ring



9.2a Unbolting the thermostat housing . . .



9.2b . . . and removing the thermostat (in-line engine)



9.2c Unbolting the thermostat housing . . .

15 The remainder of refitting is a reversal of the removal procedure. Refit and tension the accessory drivebelt(s) and refill the cooling system (Chapter 1) to complete.

9 Thermostat - removal, testing and refitting

Note: *Refer to the warnings given in Section 1 of this Chapter before proceeding.*

Removal

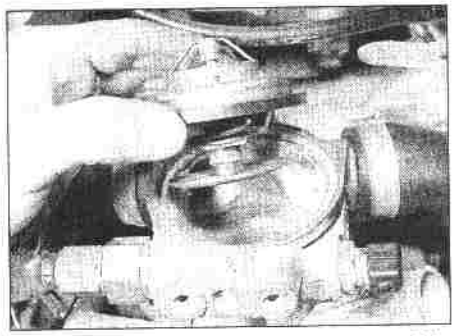
1 Drain the cooling system (see Chapter 1). Remove the radiator hose from the thermostat housing.

2 Unbolt the thermostat housing from the cylinder head or water pump. On some models an engine lifting eye may also be attached here; on V6 engines it will be necessary to unbolt a throttle cable bracket. Lift out the thermostat **(see illustrations)**.

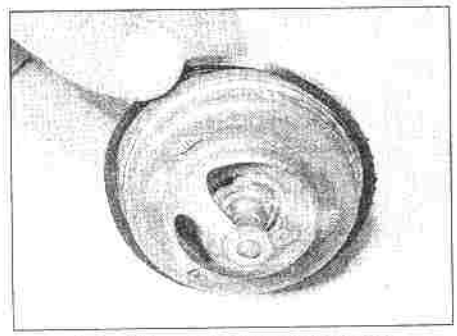
Testing

3 Suspend the (closed) thermostat on a length of string in a container of cold water, with a thermometer beside it; ensure that neither touches the side or bottom of the container.

4 Heat the water, and check the temperature at which the thermostat begins to open, or is fully open. Compare this value with the figures given in the Specifications, then remove the thermostat and allow it to cool down; check that it closes fully.



9.2d . . . and removing the thermostat (V6 engine)



9.6 Fitting a thermostat sealing ring

5 If the thermostat does not open and close as described, if it sticks in either position, or if it does not open at the specified temperature, it must be renewed.

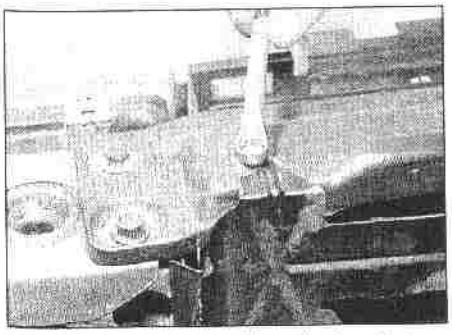
Refitting

6 Fit a new sealing ring to the thermostat **(see illustration)**.

7 Refit the thermostat and housing (and the engine lifting eye, when applicable). Fit and tighten the housing nuts.

8 Refit the radiator hose to the thermostat housing. On models with the thermostat fitted to the cylinder head, check the clearance between the hose and the normally adjusted alternator drivebelt, according to the Specifications.

9 Refill the cooling system (Chapter 1).



10.3 Unbolting an oil cooler bracket

10 Oil coolers - removal and refitting

Engine oil cooler (all engines except B280)

Removal

1 When fitted, the engine oil cooler is mounted behind and to one side of the radiator.

2 Disconnect the oil cooler unions, either at the cooler itself or at the flexible hoses. Be prepared for oil spillage.

3 Unbolt the oil cooler brackets and remove it **(see illustration)**. The oil cooler can then be separated from the brackets if required.

4 If the oil cooler is to be re-used, flush it internally with solvent and then blow compressed air through it. Also clean it externally.

Refitting

5 Refit by reversing the removal operations, then run the engine and check for oil leaks. Switch off the engine and check the oil level as described in *"Weekly checks"*.

Engine oil cooler (B280 engines)

Removal

6 The oil cooler is located between the oil filter and the left-hand side of the cylinder block.

7 Disconnect the battery negative lead.

8 Drain the engine oil and remove the oil filter (see Chapter 1).

9 Remove the engine undertray.

10 Drain the cooling system (see Chapter 1).

11 Remove the air cleaner unit (see Chapter 4B).

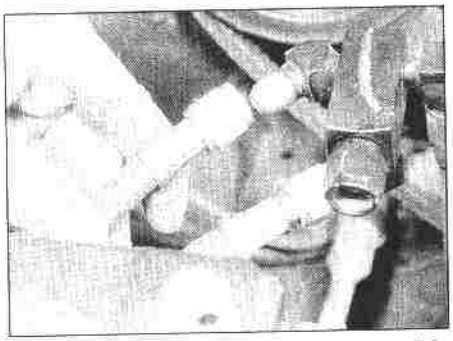
12 Remove the centre bolt from the oil cooler.

13 Disconnect the coolant hoses from the oil cooler.

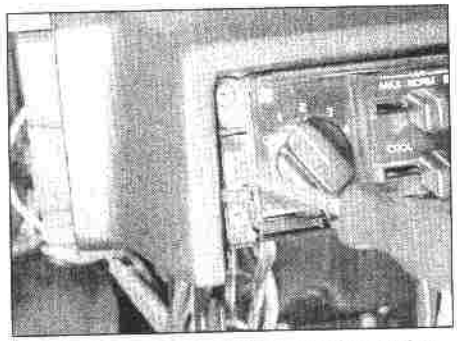
14 Remove the oil cooler, being prepared for some spillage of oil and coolant.

Refitting

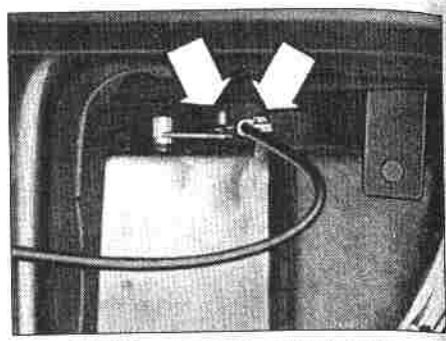
15 Refit by reversing the removal operations, using a new oil filter. Run the engine and check for oil leaks. Switch off the engine and check the oil level as described in *"Weekly checks"*.



10.17 Disconnecting an ATF cooler flexible hose



12.2 Removing a control panel securing screw



12.5 Temperature control cable connections (arrowed) at shutter lever

ATF auxiliary cooler

Removal

16 When fitted, the ATF auxiliary cooler is mounted between the radiator and the air conditioning condenser.

17 Disconnect the flexible hoses from the union on the radiator **(see illustration)**. Be prepared for fluid spillage. Cap open unions to keep dirt out.

18 Remove the radiator (see Section 4).

19 Unbolt the cooler. Feed the hoses through the side panel grommets and remove the cooler and hoses together.

20 Clean the cooler fins and flush it internally with clean ATF. Renew the hoses if necessary.

Refitting

21 Refit by reversing the removal operations. Refill the cooling system (Chapter 1), then run the engine and check the transmission fluid level as described in Chapter 1.

11 Heating and ventilation system - general information

1 Depending on model and options selected, the heater may be fitted alone or in conjunction with an air conditioning unit. The same housings and heater components are used in all cases. The air conditioning system is described in Section 13.

2 The heater is of the fresh air type. Air enters through a grille in front of the windscreen. On its way to the various vents a variable proportion of the air passes through the heater matrix, where it is warmed by engine coolant flowing through the matrix.

3 Distribution of air to the vents, and through or around the matrix, is controlled by flaps or shutters. These are operated by vacuum motors (except for the air mix shutter on heater-only models, which is operated by cable). A vacuum tank is fitted under the vehicle on some models.

4 A four-speed electric blower is fitted to boost the airflow through the heater. On early models the blower is always running at low speed when the ignition is on.

12 Heater/ventilation system components - removal and refitting

Heater/air conditioning control panel

Removal

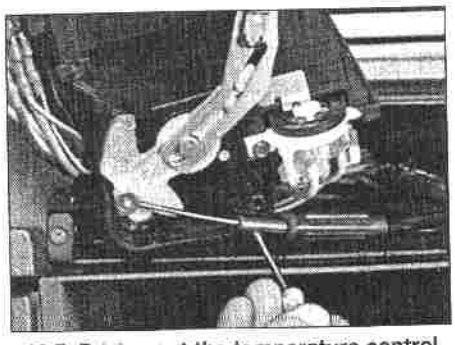
1 For best access, remove the centre console side panels (see Chapter 11, Section 33).

2 Remove the trim from around the control panel, if not already done. Remove the panel securing screws **(see illustration)**.

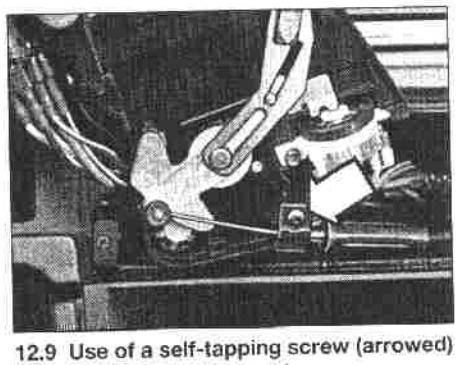
3 Withdraw the panel and disconnect the control cables, multi-plugs and vacuum unions from it. Make notes or identifying marks if necessary for reference when refitting.

Refitting

4 Refit by reversing the removal operations. Where a mechanical temperature control cable is fitted, adjust it as described below.



12.7 Prising out the temperature control cable sleeve



12.9 Use of a self-tapping screw (arrowed) to secure the sleeve

Heater temperature control cable

Note: *A mechanical temperature control cable is only fitted to vehicles without air conditioning.*

Removal

5 With the temperature control in the "WARM" position, disconnect the far end of the cable from the air mix shutter lever **(see illustration)**.

6 Remove the trim from around the heater control panel. Remove the screws which hold the panel to the centre console.

7 Ease the heater control panel away from the centre console until the cable is accessible. Disconnect the cable from the control panel, using a screwdriver to prise free the cable sleeve **(see illustration)**.

8 The cable can now be removed.

Refitting

9 Refit by reversing the removal operations, noting the following points:

a) If the cable sleeve was damaged during removal, use a self-tapping screw to secure it ***(see illustration)****.*

b) Adjust the position of the cable sleeve so that the air mix shutter travels over its full range of movement when the temperature control is operated.

Heater matrix

Removal

Note: *Refer to the warnings given in Section 1 of this Chapter before proceeding.*

10 Disconnect the battery negative lead.

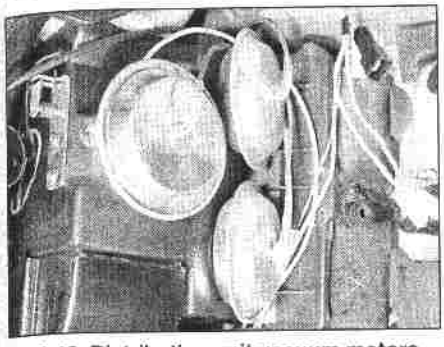
11 Depressurise the cooling system by removing the expansion tank cap. Take precautions against scalding if the coolant is hot.

12 Clamp the coolant hoses which lead to the heater matrix stubs on the bulkhead. Release the hose clips and disconnect the hoses from the stubs. Be prepared for coolant spillage.

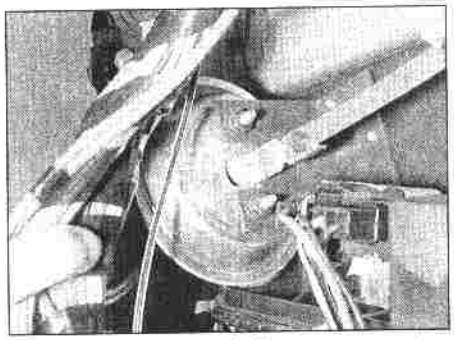
13 Remove the glovebox, centre console and rear console (see Chapter 11 Sections, 32 to 34).

14 Unclip the central electrical unit and move it aside.

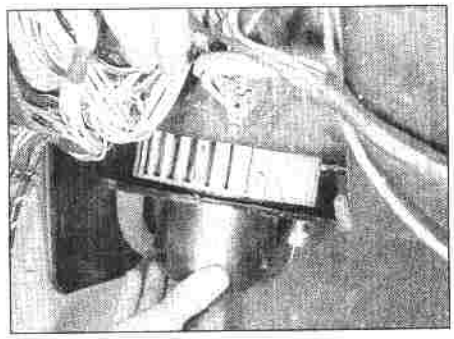
15 Remove the centre panel vent. Remove the screw from the distribution unit and



12.16 Distribution unit vacuum motors



12.25 Recirculation shutter vacuum motor



12.30 Removing the heater blower motor

disconnect all the air ducts from the unit. Also remove the rear vent distribution ducts.

16 Disconnect the vacuum hoses from the vacuum motors **(see illustration)**. On models with automatic climate control, also remove the hose which leads to the inner sensor (the aspirator hose).

17 Remove the distribution unit.

18 Remove the heater matrix clips. Pull the matrix out and remove it; be prepared for coolant spillage.

Refitting

19 Refit by reversing the removal operations ensuring that the vacuum hoses are connected correctly.

20 Top-up the cooling system on completion (see *"Weekly checks"*). Run the engine and check that there are no coolant leaks, then allow it to cool and recheck the coolant level.

Heater vacuum motors in distribution unit

Removal

21 Remove the distribution unit as described in the previous sub-Section, but do not disconnect the coolant pipes from the matrix.

22 Remove the appropriate panel from the distribution unit for access to the motors. Remove the motors as necessary.

Refitting

23 Refit by reversing the removal operations.

Air recirculation shutter motor

Removal

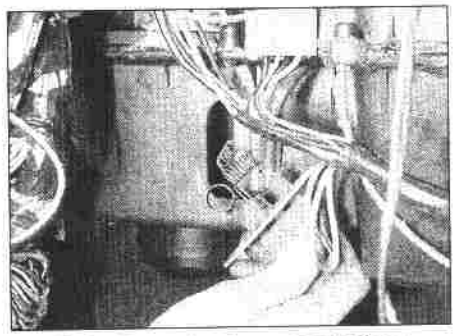
24 Remove the glovebox (see Chapter 11, Section 32). Also remove the outer panel vent and air duct.

25 Unbolt the control rod from the motor. Undo the two securing nuts, withdraw the motor and disconnect the vacuum hose **(see illustration)**.

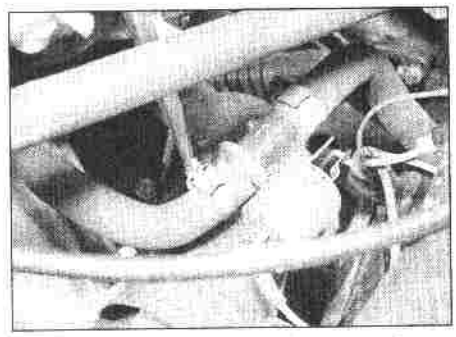
Refitting

26 When refitting, make sure that both the shutter and the vacuum motor are in the resting position before tightening the control rod bolt.

27 The remainder of refitting is a reversal of the removal procedure.



12.37 Removing the motor resistor



12.41 Disconnecting the heater water valve

Heater blower motor

Removal

28 Remove the trim panel from below the glovebox.

29 Remove the screws which secure the motor to the housing.

30 Lower the motor and disconnect the cooling hose. Disconnect the wiring and remove the motor complete with centrifugal fan **(see illustration)**.

31 Do not disturb any steel clips on the fan blades. They have been fitted for balancing purposes.

Refitting

32 When refitting, apply sealant between the motor flange and housing. Connect the wiring and secure the motor.

33 Refit the motor cooling hose - this is important if premature failure is to be avoided.

34 Check for correct operation of the motor, then refit the trim panel.

Heater blower motor resistor

Removal

35 Remove the glovebox (see Chapter 11, Section 32).

36 Disconnect the multi-plug from the resistor.

37 Remove the two screws from the resistor and withdraw it **(see illustration)**. Be careful not to damage the coils of resistance wire.

Refitting

38 Refit by reversing the removal operations, but check the operation of the blower on all four speeds before refitting the glovebox.

Heater water valve

Removal

Note: *Refer to the warnings given in Section 1 of this Chapter before proceeding.*

39 Depressurise the cooling system by removing the expansion tank cap. Take precautions against scalding if the coolant is hot.

40 Clamp the coolant hoses on each side of the valve.

41 Disconnect the vacuum and coolant hoses from the valve and remove it **(see illustration)**.

Refitting

42 Refit by reversing the removal operations. Top-up the coolant if much was lost (see *"Weekly checks"*).

3

13 Air conditioning system - general information and precautions

General information

Air conditioning system

1 Air conditioning is fitted as standard on most models and is optionally available on others. In conjunction with the heater, the system enables any reasonable air temperature to be achieved inside the car. It also reduces the humidity of the incoming air, aiding demisting even when cooling is not required.

2 The refrigeration side of the air conditioning system functions in a similar way to a

domestic refrigerator. A compressor, belt-driven from the crankshaft pulley, draws refrigerant in its gaseous phase from an evaporator. The compound refrigerant passes through a condenser where it loses heat and enters its liquid phase. After dehydration the refrigerant returns to the evaporator where it absorbs heat from air passing over the evaporator fins. The refrigerant becomes a gas again and the cycle is repeated.

3 Various subsidiary controls and sensors protect the system against excessive temperature and pressures. Additionally, engine idle speed is increased when the system is in use to compensate for the additional load imposed by the compressor.

Automatic Climate Control system

4 On models with Automatic Climate Control (ACC), the temperature of the incoming air is automatically regulated to maintain the cabin temperature at the level selected by the operator. An electromechanical programmer controls heater, air conditioner and blower functions to achieve this.

5 The four sensors peculiar to the ACC are the control panel sensor, the coolant thermal switch, the inner sensor and the outer sensor.

6 The control panel sensor operates in conjunction with the coolant thermal switch. If cabin temperature is below 18°C and coolant temperature is below 35°C, the blower is prevented from operating (unless "defrost" is selected). This prevents the ACC from blowing cold air into the cabin whilst the coolant warms up.

7 The inner sensor is located above the glovebox. It reads cabin air temperature.

8 The outer sensor is located in the blower housing and reads the temperature of the incoming air.

9 Acting on information received from the inner and outer sensors, the programmer applies the appropriate heating/cooling and blower speed settings to achieve the selected temperature.

Electronic Climate Control system

10 The Electronic Climate Control (ECC), fitted to 760 models from 1988 onwards, is a development of the Automatic Climate Control (ACC) described earlier. The main difference is in the control system, which now incorporates a microprocessor, solenoid valves and a servo motor. Less use is made of vacuum than in the ACC system, with a consequent increase in reliability.

11 From the driver's point of view the two systems are very similar. When the automatic function is engaged, the selected temperature is maintained in the cabin by mixing of hot and cold air, using the heating and air conditioning systems as necessary.

12 The microprocessor control unit, mounted on the back of the control panel, incorporates a built-in fault diagnosis facility. A fault is signalled to the driver by the flashing of the air conditioner control button. If the fault is serious, the button will flash continuously while the engine is running. If the fault is less serious, the button will flash for about 20 seconds after the engine is started. The four sensors peculiar to the ECC are the solar sensor, the water temperature sensor, the interior air temperature sensor and the exterior air temperature sensor.

13 The solar system is mounted on top of the dashboard, in the left-hand loudspeaker grille. Its function is to reduce cabin air temperature by up to 3°C in bright sunlight.

14 The interior air temperature sensor is located inside the interior light. It measures cabin air temperature. A hose running from the sensor to the inlet manifold maintains a flow of air through the sensor when the engine is running.

15 The water temperature sensor is located next to the heater matrix. This sensor in fact measures air temperature adjacent to the matrix. When the automatic function is selected, this sensor prevents the fan running at maximum speed before the matrix has heated up.

16 The exterior air temperature sensor is mounted on the blower motor casing. It measures the temperature of the air passing through the blower; when the recirculation function is selected, this air comes from inside the car, but otherwise it comes from outside.

Precautions

17 When an air conditioning system is fitted, it is necessary to observe special precautions whenever dealing with any part of the system, or its associated components. If for any reason the system must be discharged, entrust this task to your Volvo dealer or a refrigeration engineer.

⚠ ***Warning: The refrigeration circuit may contain a liquid refrigerant (Freon), and it is therefore dangerous to disconnect any part of the system without specialised knowledge and equipment.***

18 The refrigerant is potentially dangerous, and should only be handled by qualified persons. If it is splashed onto the skin, it can cause frostbite. It is not itself poisonous, but in the presence of a naked flame (including a cigarette) it forms a poisonous gas. Uncontrolled discharging of the refrigerant is dangerous, and potentially damaging to the environment.

19 In view of the above points, removal and refitting of any air conditioning system components, except for the sensors and other peripheral items covered in this Chapter, must be left to a specialist.

14 Air conditioning system components - testing, removal and refitting

1 The contents of this Section is limited to those operations which can be carried out without discharging the refrigerant. Renewal of the compressor drivebelt is described in Chapter 1, but all other operations must be entrusted to a Volvo dealer or air conditioning specialist. If necessary, the compressor can be unbolted and moved aside, without disconnecting the refrigerant unions, after removing the compressor drivebelt.

ACC control panel sensor

Removal

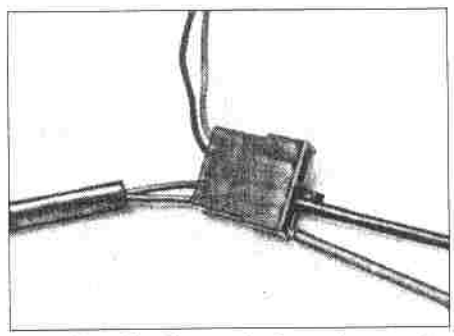
2 Remove the trim from around the control panel. Remove the control panel securing screws and pull the panel out.

3 Disconnect the sensor multi-plug. Use an ohmmeter to check the sensor for continuity **(see illustration)**. Continuity should be displayed above 18°C, and no continuity (open-circuit) at lower temperatures. Cool the sensor with some ice cubes, or warm it in the hands, to check that it behaves as described.

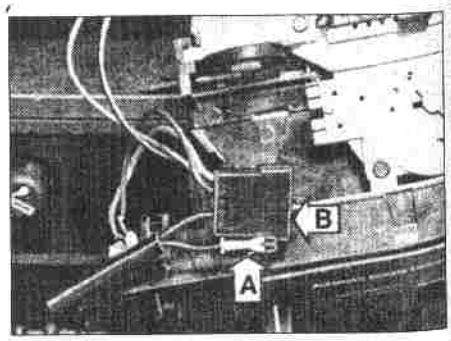
4 To remove the sensor, insert a thin screwdriver or a stiff wire into the multi-plug and prise out the sensor terminals **(see illustration)**.

Refitting

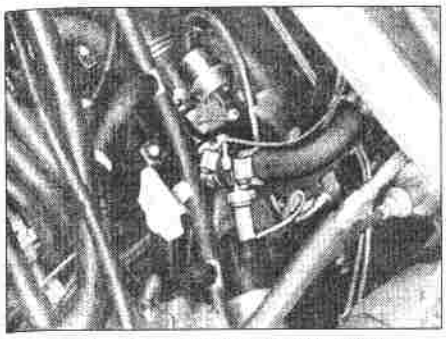
5 Fit the new sensor by pressing its terminals into the multi-plug. Refit the control panel and trim.



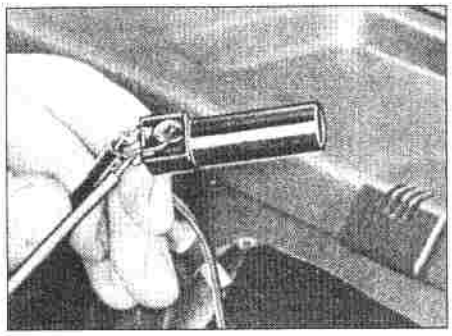
14.3 Checking the control panel sensor for continuity



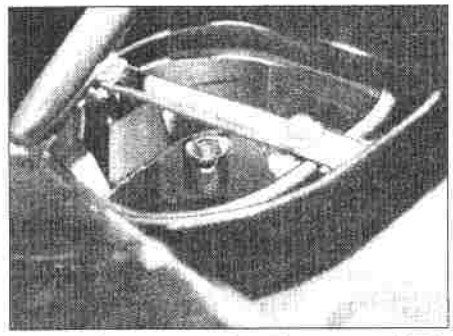
14.4 Prising out the control panel sensor terminals (A) by inserting a stiff wire (B)



14.6 The coolant thermal switch



14.13 Checking the inner sensor for continuity



14.15 Outer sensor location on pre-1985 models

ACC coolant thermal switch

Removal

6 The coolant thermal switch is located under the bonnet. It is screwed into a T-piece inserted in the heater supply hose **(see illustration)**.

7 Unplug the electrical connector and unscrew the thermal switch from the T-piece.

8 Test the thermal switch using an ohmmeter, or a battery and test lamp, immersing the switch in a heated water bath. The switch should show continuity at temperatures of 30 to 40°C. As the water cools, continuity should be broken before the temperature reaches 10°C.

9 Note that if the lead to the thermal switch is accidentally disconnected, the heater blower will not work at cabin temperatures below 18°C, regardless of coolant temperature.

Refitting

10 Refit by reversing the removal operations.

ACC inner sensor

Removal

11 Remove the glovebox (see Chapter 11, Section 32).

12 Pull the air hose off the sensor, unclip the sensor and remove it.

13 The only test specified for this sensor is that it should display continuity. No resistance values are given **(see illustration)**.

Refitting

14 Refit by reversing the removal operations.

ACC outer sensor

General

15 Access to the sensor for testing can be gained by removing the windscreen wiper arms, the scuttle panel and the air inlet cover **(see illustration)**.

16 Measure the resistance of the sensor. At 20 to 23°C, the resistance should be 30 to 40 Ω. The higher the temperature, the lower the resistance.

17 For removal and refitting of the sensor, proceed by removing the air recirculation shutter motor (see Section 12). The sensor can then be removed and a new one fitted.

18 On 1985 and later models, the sensor is mounted lower down in the fan housing. Access for testing and removal should therefore be possible without much dismantling **(see illustration)**.

ACC programmer

Removal

19 Remove the glovebox (see Chapter 11, Section 32). Also remove the outer panel vent and duct.

20 Disconnect the air mix shutter control rod, the electrical multi-plug and the vacuum pipe cluster from the programmer.

21 Remove the three screws which secure the programmer and remove it **(see illustration)**.

Refitting

22 When refitting, secure the programmer with the three screws **(see illustration)**, then connect the vacuum cluster and the multi-plug. The vacuum pipe connections must not be pushed right home, or an apparent loss of vacuum can result. The connection is correct when the spigot on the programmer enters the connector only as far as the entry of the vacuum line on the side of the connector.

23 Adjust the shutter control rod as follows. Run the engine to provide vacuum. Select maximum heat on the temperature control dial. Pull the control rod until it reaches its stop and secure it to the programmer arm.

24 Refit the duct, vent and glovebox.

ECC control pump and control unit

Removal

25 Disconnect the battery negative lead.

26 Remove the switch panel and ECC panel surround.

27 Remove the four screws now exposed and draw the ECC panel and control unit into the car. (This will give sufficient access for bulb renewal if this is the reason for removal.)

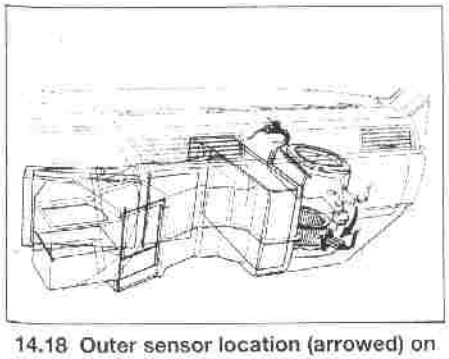
28 Disconnect the multi-plugs from the rear of the unit and remove it.

29 Do not attempt to dismantle the control unit, unless out of curiosity. There are no serviceable parts inside.

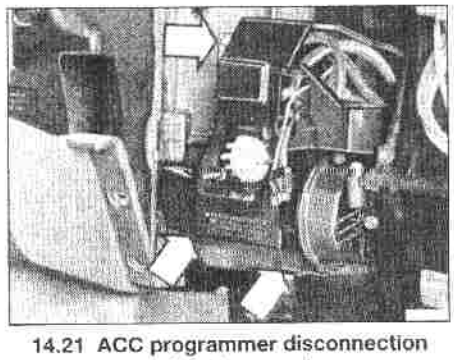
Refitting

30 Refit by reversing the removal operations.

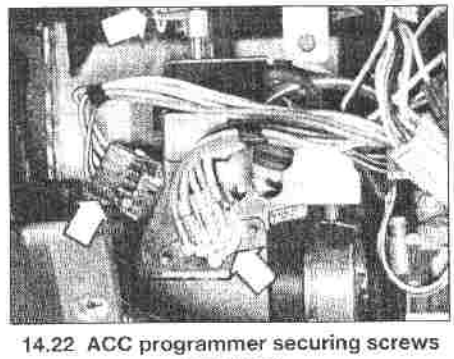
3



14.18 Outer sensor location (arrowed) on later models



14.21 ACC programmer disconnection points (arrowed)



14.22 ACC programmer securing screws (arrowed)

Chapter 4 Part A:
Fuel/exhaust systems - carburettor engines

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

Carburettor

General

Type:	
Pre-1987 models	Pierburg 2B5
1987 models onward	Pierburg 2B7
Choke type	Automatic
Idle speed:	
Manual transmission models	800 rpm
Automatic transmission models	900 rpm
Idle mixture CO content::	
Pierburg 2B5 carburettor:	
Setting value	1.0%
Checking value	0.5 to 2.0%
Pierburg 2B7 carburettor:	
Setting value	1.0%
Checking value	0.5 to 1.5%

Calibration	Primary	Secondary
Air correction jet	140	65
Idle (air/fuel) jet:		
2B5 carburettor	47.5/120	-
2B7 carburettor	47.5/115	-
Auxiliary (air/fuel) jet:		
2B5 carburettor	45/145	-
2B7 carburettor	45/130	-
Enrichment jet	85	-
Main jet:		
2B5 carburettor	X 112.5	X 137.5
2B7 carburettor	115	142.5
Air bypass jet	-	140
Fuel bypass jet	-	100
Float height	See text	
Accelerator pump delivery	10 to 14 ml per 10 strokes	

Overhaul data

Fast idle gap:	
2B5 carburettor	4.0 mm
2B7 carburettor:	
Manual transmission	5.0 mm
Automatic transmission	5.6 mm
Throttle linkage clearance (see text):	
Gap "A"	0.10 to 0.50 mm
Gap "B"	0.15 to 0.85 mm
Choke flap opening under vacuum:	
Upper connection blocked (see text)	3.35 to 3.65 mm
Upper connection open	1.35 to 1.65 mm
Choke flap opening at full throttle	5.2 to 6.2 mm
Choke flap opening at 20°C (68°F)	0.55 to 2.05 mm
Clearance between choke flap and full load enrichment tube	0.5 mm

Recommended fuel

Models without green fuel filler cap	98 RON leaded
Models with green fuel filler cap	95 RON unleaded (UK unleaded premium)

1 General information and precautions

The fuel system consists of one or two rear-mounted fuel tanks, electric fuel tank pump, mechanical main fuel pump and a Pierburg carburettor. Certain later models are also equipped with an exhaust gas recirculation (EGR) system, and a Pulsair system as part of an emissions control package. Further details of these systems will be found in Part C of this Chapter.

The Pierburg 2B5 or 2B7 carburettor is a twin barrel, fixed jet, downdraught unit utilising an automatic choke for cold starting. Further details of the carburettor will be found in Section 11.

The exhaust system consists of multiple sections, the number varying according to model, suspended from under the car on rubber mountings. A catalytic converter is fitted to the exhaust system of later models.

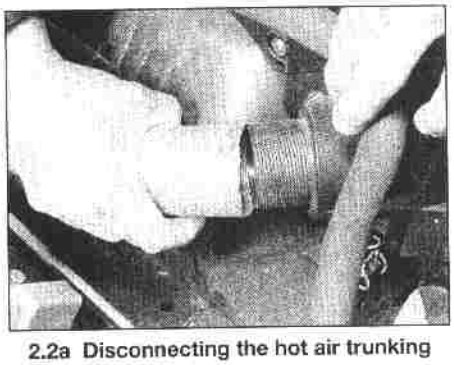
Warning: Many of the procedures in this Chapter require the removal of fuel lines and connections, which may result in some fuel spillage. Before carrying out any operation on the fuel system, refer to the precautions given in "Safety first!" at the beginning of this manual, and follow them implicitly. Petrol is a highly dangerous and volatile liquid, and the precautions necessary when handling it cannot be overstressed.

2 Air cleaner assembly - removal and refitting

Removal

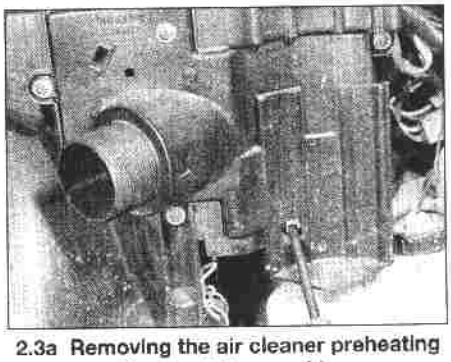
1 Remove the air cleaner element (see Chapter 1).

2 Disconnect the hot air inlet trunking from the housing. Also disconnect the crankcase ventilation hose **(see illustrations)**.

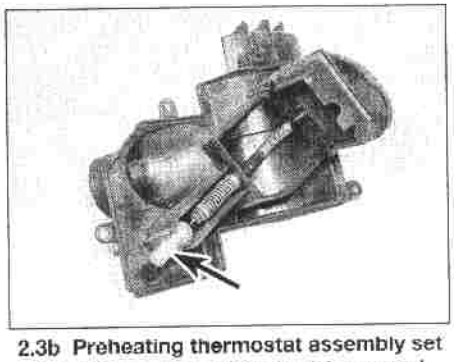


2.2a Disconnecting the hot air trunking

2.2b An air cleaner crankcase ventilation hose



2.3a Removing the air cleaner preheating thermostat assembly



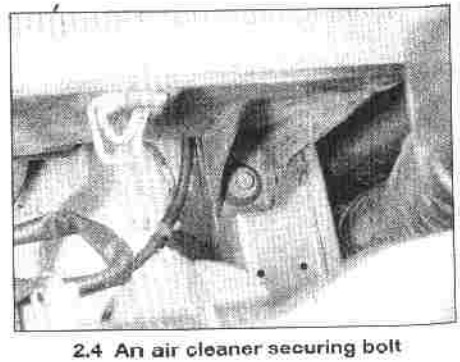
2.3b Preheating thermostat assembly set to take in hot air. Thermostat arrowed

3 The preheating thermostat and shutter may now be removed if wished. The operation of the thermostat may be checked using a refrigerator or a hair dryer. The marking on the thermostat gives the approximate temperature at which it will be in the "half-way" position **(see illustrations)**.

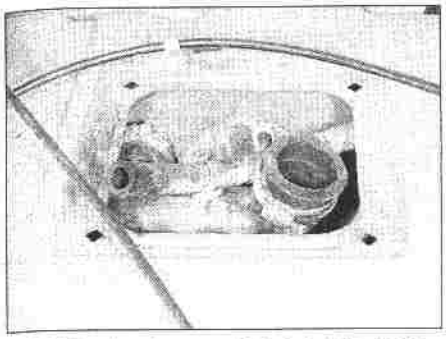
4 To remove the complete air cleaner housing, release the securing bolt or clip **(see illustration)**. Lift out the housing, disengaging the cold air intake from the grommet in the inner wing.

Refitting

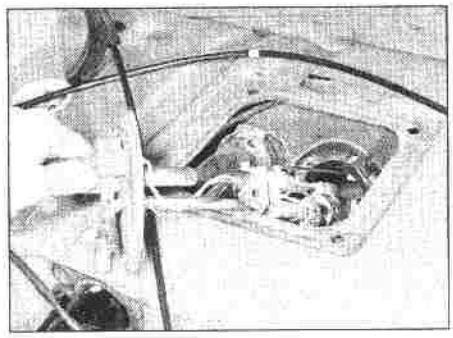
5 Refit by reversing the removal operations.



2.4 An air cleaner securing bolt



4.9 The two hoses which joint the main and auxiliary tanks



5.7 Removing the tank pump

3 Main fuel tank - removal and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

Removal

1 Disconnect the battery negative lead.
2 Drain the tank, storing the fuel in suitable sealed containers.
3 On models with an auxiliary tank, remove it (see Section 4). On models without an auxiliary tank, remove the access hatch from the luggage area floor.
4 Disconnect the fuel hoses, filler and breather hoses (when applicable) and the tank pump connector (See Section 5, paragraph 5).
5 Raise and support the rear of the vehicle. Support the fuel tank, remove the securing nuts, bolts and reinforcing plates and lower the tank.
6 Repair of a leaking tank must only be undertaken by professionals. Even when the tank is empty, it may still contain explosive vapours. Do not attempt to weld or solder the tank. "Cold" repair compounds are available and these are suitable for DIY use.

Refitting

7 If a new tank is to be fitted, apply rustproofing compound to it beforehand.
8 Refit by reversing the removal operations, using new hoses and clips as necessary.

4 Auxiliary fuel tank - removal and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

Removal

1 The auxiliary tank is empty when there is less than 60 litres of fuel remaining. Drain some fuel from the main tank if necessary to empty the auxiliary tank.
2 Disconnect the battery negative lead.
3 Unclip and remove the boot lining.
4 Unbolt and remove the tank cover plate and the filler pipe cover plate.
5 Disconnect the wires from the fuel gauge auxiliary sender unit.
6 Disconnect the breather hose from the auxiliary tank.
7 Remove the four bolts which secure the auxiliary tank.
8 Carefully lift the tank as far as possible, without straining the connecting hoses beneath it. Prop the tank in the raised position with a couple of wooden blocks.
9 Working under the left-hand end of the auxiliary tank, disconnect the two hoses which join it to the main tank **(see illustration)**.
10 Lift out the auxiliary tank, unclipping the thin breather pipe from its forward edge.

Refitting

11 Refit by reversing the removal operations. Renew hoses and clips as necessary.

5 Fuel tank pump - removal and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

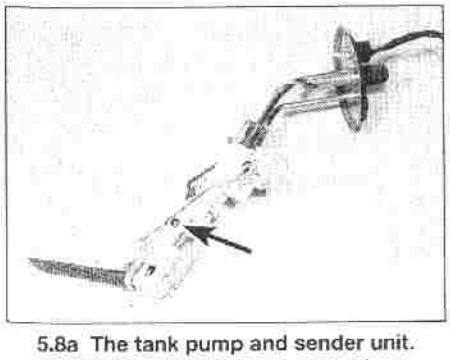
Removal

1 Disconnect the battery earth lead.
2 Gain access to the top of the main fuel tank, either by removing the auxiliary tank (see Section 4), or by removing the access hatch when no auxiliary tank is fitted.
3 Clean around the tank pump/sender unit cover plate.
4 Disconnect and plug the fuel supply and return hoses. Also disconnect the breather hose (when applicable).
5 Follow the electrical lead back to the nearest multi-plug and disconnect it. If the plug will not pass through the holes in the bodywork *en route* to the tank, prise the connectors out of the plug. Unbolt the earth tag and pull the lead into the same compartment as the tank.
6 Remove the nuts which secure the cover plate to the tank. On later models the pump/sender unit is secured by a large plastic ring nut; unscrew the nut using a "soft" tool such as a strap wrench.
7 The tank pump/sender unit can now be removed from the tank. Some manipulation will be needed. Do not force the unit out, it is delicate **(see illustration)**.
8 Unclip the pick-up screen and tube from the pump. Remove the clamp screw, disconnect the electrical leads and remove the pump **(see illustrations)**.
9 If the pump is defective it must be renewed.

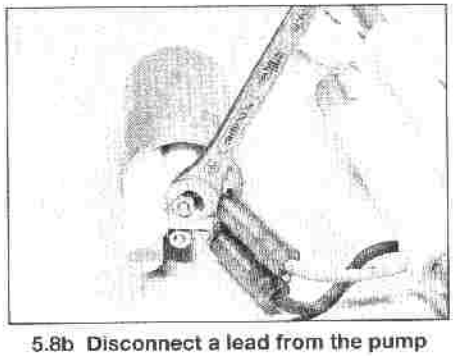
Refitting

10 Fit the pump to the sender unit and secure the pick-up components. Make sure that the O-ring is in good condition and that the pick-up screen is clean **(see illustration)**. Connect the electrical leads and tighten the clamp screw.
11 The pump is spring-loaded against the cover plate to ensure that the pick-up screen

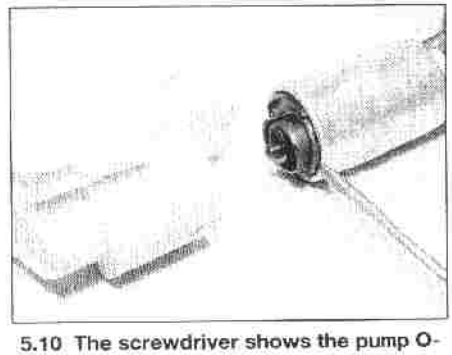
4A



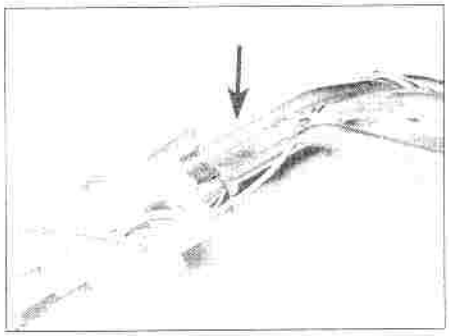
5.8a The tank pump and sender unit. Pump clamp screw arrowed



5.8b Disconnect a lead from the pump



5.10 The screwdriver shows the pump O-ring



5.11 Matchstick (arrowed) wedging pump in raised position. String goes through breather tube

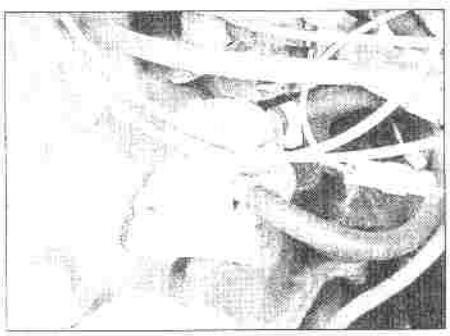
sits at the very bottom of its well. Temporarily defeat the spring by pressing the pump towards the plate and wedging it in this position with a length of matchstick on a piece of string. Feed the string out through the breather hole **(see illustration)**.

12 Check the condition of the sealing ring on the tank and renew it if necessary.

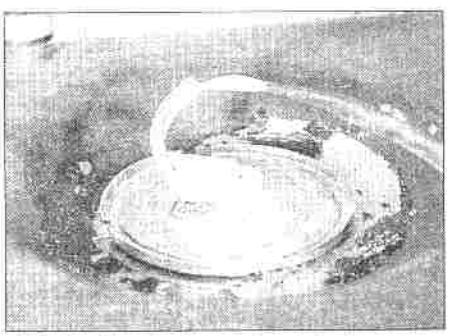
13 Offer the pump/sender unit to the tank and work it into position. Fit and tighten the securing nuts. On later models align the arrows on each side of the unit with seams of the fuel tank, then fit and tighten the ring nut.

14 Pull the piece of string to release the matchstick. The spring will force the pick-up screen to the bottom of the tank. Withdraw the string and matchstick through the breather hole. (No harm will result if the matchstick is lost.)

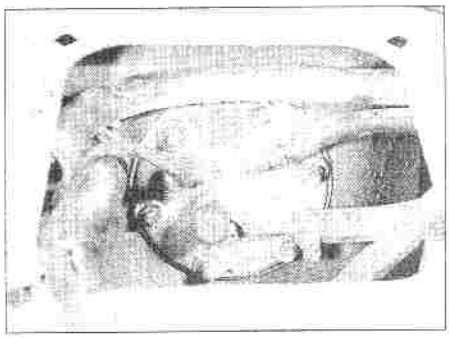
15 On models with an auxiliary tank, refit and secure the blanking strut to the breather pipe.



6.2 Mechanical fuel pump with hoses connected



7.6 Auxiliary tank sender unit with wires connected



5.17 Fuel hoses and breather blanking stub reconnected

16 Reconnect the electrical lead, not forgetting the earth tag.

17 Reconnect the fuel hoses and (when applicable) the breather hose **(see illustration)**.

18 Refit the auxiliary tank or the access hatch.

19 Reconnect the battery.

6 Main fuel pump - removal and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

Removal

1 Disconnect the battery negative lead.

2 Clean around the hose unions on the pump, then slacken the hose clamps and disconnect the hoses **(see illustration)**. Be prepared for fuel spillage. Plug the tank hose with a bolt or metal rod.

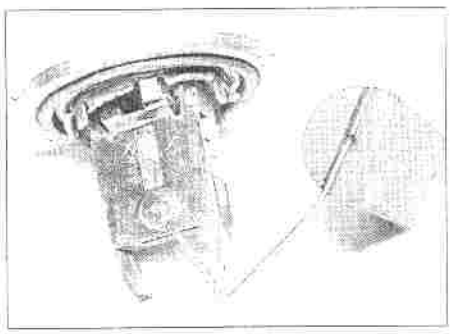
3 Unbolt the fuel pump from the block and remove it. Recover the gasket and any spacers.

4 The pump cover may be removed for cleaning of the filter screen if wished. Further dismantling should not be attempted unless a repair kit can be obtained. Various makes of pump may be fitted.

Refitting

5 Refit by reversing the removal operations, using a new gasket.

6 Run the engine and check for leakage.



7.7 Auxiliary tank sender unit removed

7 Fuel gauge senders - removal, testing and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

Main tank sender unit

Removal and refitting

1 The removal and refitting procedure is as given in Section 5 for the fuel tank pump.

Testing

2 To test the sender unit, connect an ohmmeter between the black and the grey/white wires. Move the float up and down and verify that the resistance changes with float position.

3 A defective sender unit must be renewed.

Auxiliary tank sender unit

Removal

4 Disconnect the battery negative lead.

5 Unclip and remove the boot lining.

6 Disconnect the leads from the top of the sender unit **(see illustration)**.

7 Using a large screwdriver or tyre lever, release the sender unit from the auxiliary tank by twisting it anti-clockwise. Remove the sender unit **(see illustration)**.

Testing

8 Connect an ohmmeter across the sender unit terminals and check that the resistance varies smoothly with float movement.

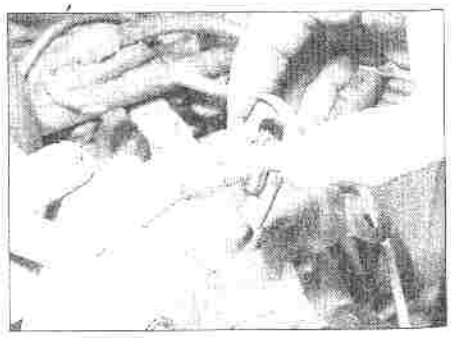
Refitting

9 Refit by reversing the removal operations, using a new sealing ring if necessary.

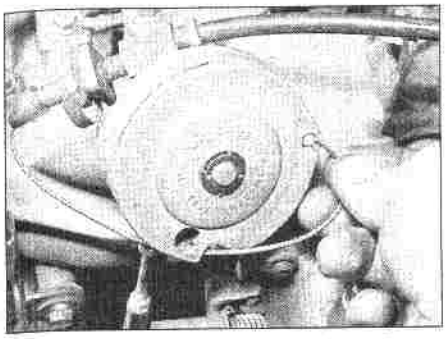
8 Throttle cable - removal, refitting and adjustment

Removal

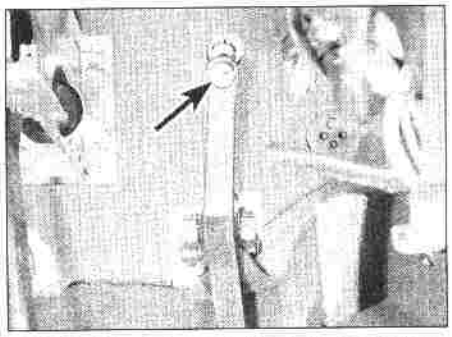
1 Release the cable outer by extracting the spring clip and unhook the inner from the drum **(see illustrations)**.



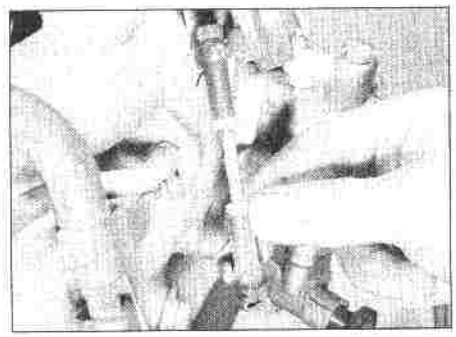
8.1a Remove the spring clip . . .



8.1b . . . and unhook the cable inner from the drum



8.2 Split bush (arrowed) secures cable at pedal end



8.5 Disconnecting the throttle link rod

2 Inside the vehicle, remove the trim from below the steering column. Pull the cable inner through the end of the pedal and slide the split bush off the end of the cable **(see illustration)**.
3 Release the cable grommet from the bulkhead and pull the cable into the engine bay. Note the routing of the cable, release it from any clips or ties and remove it.

Refitting and adjustment

4 Refit by reversing the removal operations, then adjust the cable as follows.
5 Disconnect the link rod which joins the cable down to the throttle valve(s) by levering off a balljoint **(see illustration)**.
6 With the throttle pedal released, the cable inner should be just taut, and the cable drum must be resting against the idle stop. With the pedal fully depressed the drum must contact the full throttle stop. Adjust if necessary by means of the threaded sleeve.
7 On automatic transmission models, first check the adjustment of the kickdown cable (see Chapter 7B).
8 Reconnect the link rod, adjusting its length if necessary as follows.
9 Make sure that the fast idle screw is on the lowest part of the cam (in the normal idling position). In this position the throttle valve lever should contact the stop screw.
10 Reconnect the link rod: the cable drum should be held off the idle stop by 0.5 to 1.0 mm. Adjust the link rod if necessary to achieve this.

9 Throttle pedal - removal and refitting

Removal

1 Remove the trim from below the steering column.
2 Depress the pedal fully. Grip the cable inner with pliers and release the pedal. Separate the cable inner from the split bush.
3 Remove the pedal bracket bolts and remove the pedal and bracket.

Refitting

4 Refit by reversing the removal operations. Check the throttle cable adjustment on completion (see Section 8).

10 Unleaded petrol - general information and usage

Note: *The information given in this Chapter is correct at the time of writing. If updated information is thought to be required, check with a Volvo dealer. If travelling abroad, consult one of the motoring organisations (or a similar authority) for advice on the fuel available.*

The fuel recommended by Volvo is given in the Specifications Section of this Chapter, followed by the equivalent petrol currently on sale in the UK.

From 1988 model year, a green fuel filler cap is fitted to those models which may be run on unleaded fuel without making any adjustment. The green filler cap indicates a smaller tank filler tube which will only accept the unleaded fuel hose nozzle.

Use of unleaded fuel is not essential except on models fitted with a catalytic converter.

Owners of models not having a green filler cap who wish to use unleaded fuel should consult a Volvo dealer.

11 Carburettor - general information

The Pierburg 2B5 carburettor fitted to the early B230K engine is a twin barrel, fixed jet, downdraught instrument. The choke (cold start device) is semi-automatic, being brought into operation by depressing and releasing the throttle pedal before starting.

Operation of the two barrels is sequential. At idle and light running only the primary barrel is used. Opening of the throttle valve in the secondary barrel is controlled by vacuum developed in the primary barrel, with a mechanical interlock preventing opening of the secondary throttle valve until the primary valve is at least half open. This system gives better performance from low speeds than a simple mechanical linkage.

Choke operation after start-up is controlled by a bi-metallic spring, which gradually opens the choke flap as it is heated by an electric element and by circulated coolant. Vacuum and mechanical devices influence the degree of opening of the flap during the warm-up phase to avoid over-enrichment of the mixture.

When the engine is running, the float chamber is vented into the carburettor air inlet. This ensures that restriction of the air intake (due for instance to a blocked air cleaner element) affects both the air and the fuel systems equally and does not cause over-enrichment. When the ignition is switched off, a hot start valve vents the float chamber to atmosphere, so avoiding a build-up of fumes in the air inlet which could make hot starting difficult.

A fuel shut-off system improves fuel economy by cutting off the fuel supply when the throttle is released, the engine is warm and engine speed exceeds 1610 rpm. The system uses a vacuum valve, a solenoid valve and a throttle switch, with overall control from the ignition control unit. The solenoid and vacuum valves are also used to prevent run-on (dieseling) after switching off the ignition.

Twin floats and float chambers maintain a more or less constant fuel level, even on gradients or when cornering hard. A fuel return system is used to keep fuel temperature steady and avoid vapour locks.

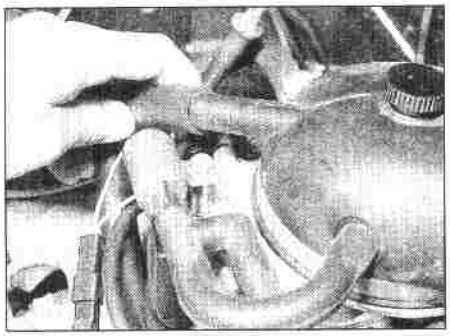
The carburettor seen in the photographs in this Chapter is in fact a development of the 2B5 known as a 2B7. This unit was fitted to later B230K engines. Apart from a three-stage choke vacuum unit and the absence of a fuel return connection, it is the same as the 2B5.

12 Carburettor - removal and refitting

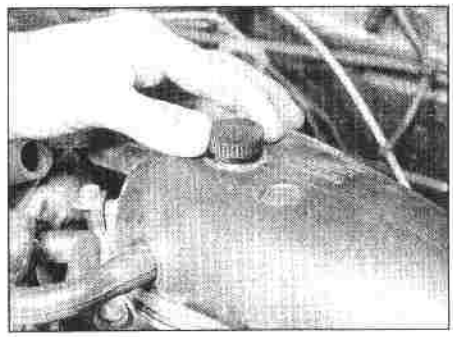
Note: *Refer to the warning note in Section 1 before proceeding.*

Removal

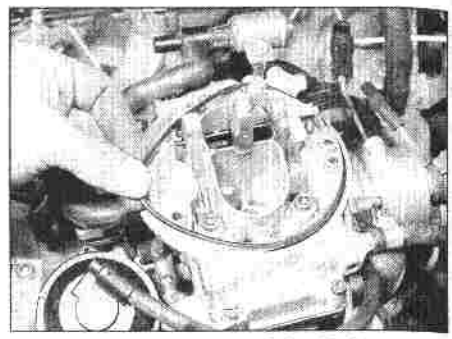
1 Disconnect the battery negative lead.
2 Remove the air inlet trunking from the top of the carburettor by undoing the knurled nut and disconnecting the breather and vacuum pipes. Recover the O-ring **(see illustrations)**.
3 Disconnect the throttle link rod.



12.2a Disconnecting a carburettor breather pipe



12.2b Undoing the knurled nut



12.2c Carburettor inlet O-ring

4 Disconnect the carburettor electrical feed **(see illustration)**.

5 Disconnect the vacuum hoses from the carburettor, making identifying marks if necessary. (Coloured washers, corresponding to the vacuum hose colours, may be found on the connecting stubs.)

6 Slacken the expansion tank cap to release residual pressure, taking precautions against scalding if the coolant is hot. Clamp the coolant hoses which feed the choke and disconnect them. Be prepared for coolant spillage.

7 Disconnect the fuel supply and return hoses. Be prepared for fuel spillage. Plug the hoses to keep dirt out.

8 Remove the four Allen screws which secure the carburettor to the manifold **(see illustration)**. Lift off the carburettor and recover the spacer and gaskets.

Refitting

9 Refit by reversing the removal operations, using new gaskets and (if necessary) a new inlet trunking O-ring.

10 Check the fast idle adjustment (see Section 15) and adjust the idle speed and mixture (see Chapter 1).

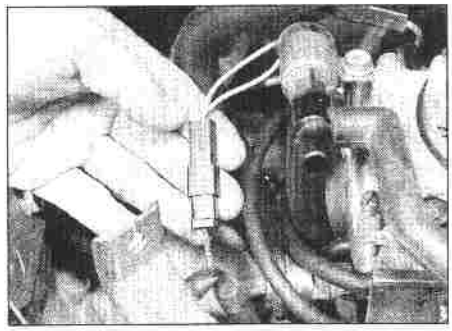
11 Top-up the cooling system if necessary.

13 Carburettor - fault diagnosis, overhaul and reassembly

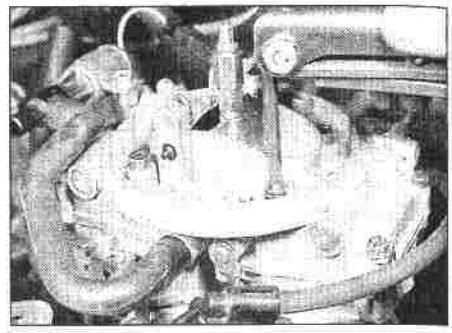
Fault diagnosis

1 If a carburettor fault is suspected, always check first that the ignition timing is correctly set, that the spark plugs are in good condition and correctly gapped, that the throttle cable is correctly adjusted, and that the air cleaner filter element is clean; refer to the relevant Sections of Chapter 1, Chapter 5 or this Chapter. If the engine is running very roughly, first check the valve clearances as described in Chapter 1, then check the compression pressures as described in Chapter 2.

2 If careful checking of all the above produces no improvement, the carburettor must be removed for cleaning and overhaul.



12.4 Carburettor electrical connector



12.8 Removing a carburettor securing screw

3 Prior to overhaul, check the availability of component parts before starting work; note that most sealing washers, screws and gaskets are available in kits, as are some of the major sub-assemblies. In most cases it will be sufficient to dismantle the carburettor and to clean the jets and passages.

Overhaul

Note: *Refer to the warning note in Section 1 before proceeding.*

Note: *The operations described here should be regarded as the limit of possible overhaul. It may be more satisfactory to renew a well worn carburettor.*

4 With the carburettor removed from the vehicle, empty the petrol from it. Clean the carburettor externally using paraffin and an old toothbrush, then wipe it dry.

5 Operate the throttle linkage and inspect the throttle spindles and valves. Renew the carburettor if they are worn or damaged. (The throttle housing cannot be renewed separately because special equipment is needed to match it to the rest of the carburettor.)

Top cover

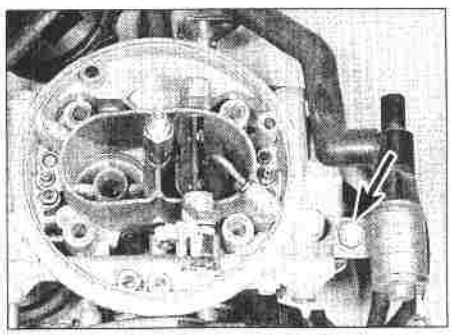
6 Unbolt the hot start valve. Disconnect its hoses and electrical connector and remove it **(see illustration)**.

7 Disconnect the secondary throttle vacuum unit hose, noting where it is fitted **(see illustration)**.

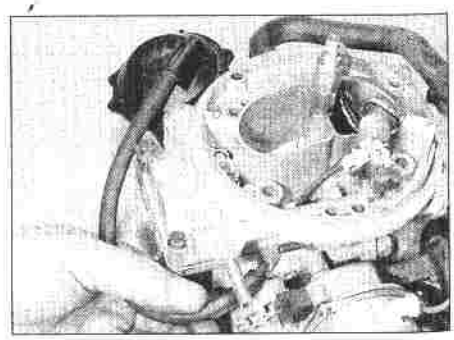
8 Disconnect the accelerator pump link at the bottom end by prising it out **(see illustration)**.

9 Disconnect the choke link at the top end by unclipping it from the plastic lever.

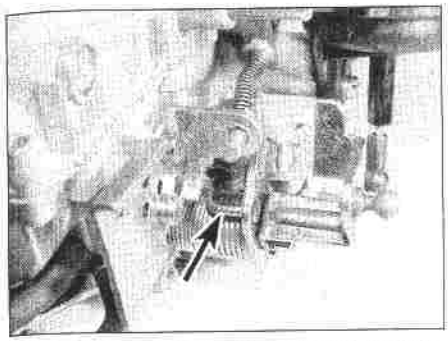
10 Remove the central stud and the four screws which secure the top cover **(see illustration)**.



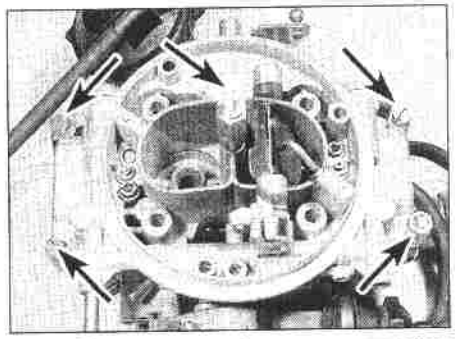
13.6 Hot start valve securing bolt (arrowed)



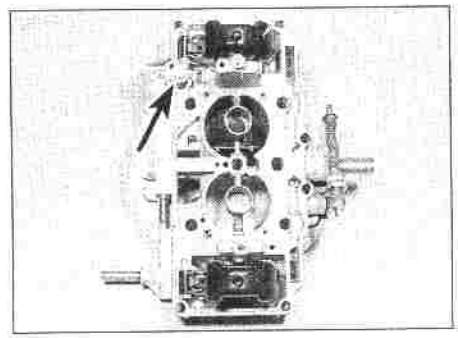
13.7 Disconnecting the secondary throttle vacuum unit hose



13.8 Prise out the accelerator pump link rod (arrowed)



13.10 Top cover securing screws and stud (arrowed)



13.12 Part load enrichment valve (arrowed)

11 Lift off the top cover and recover the gasket.
12 Check the part load enrichment valve spring and piston for freedom of movement in the cover **(see illustration)**. If the piston sticks, renew the carburettor.
13 Inspect the choke and accelerator pump linkages and renew worn components.
14 Invert the top cover so that the floats are uppermost. Cover the fuel return connection and blow into the fuel supply connection: the valves must not leak. Lift the floats and the valves must open.
15 Still with the cover inverted, measure the float heights **(see illustration)**. The gasket must be removed and the spring-loaded pins in the needle valves must not be depressed.
16 If a needle valve leaks or a float height is incorrect, renew the valve and float together. They are removed by tapping out the float pivot pin.

Secondary throttle vacuum unit

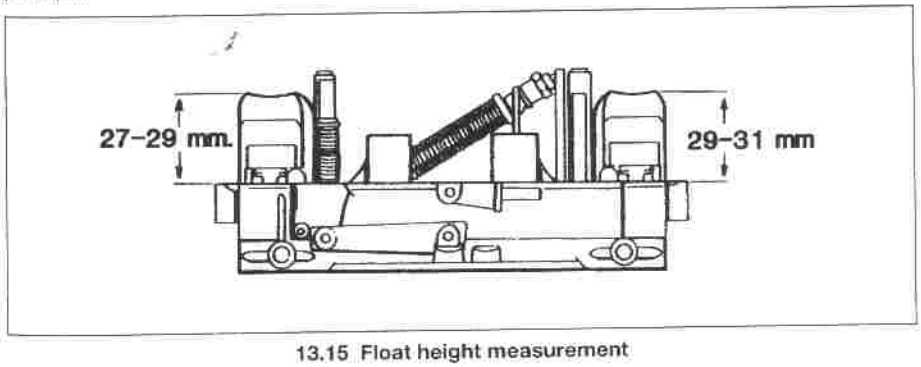
17 Connect a vacuum pump to the secondary throttle vacuum unit.
18 Open the primary throttle wide and apply vacuum. The secondary throttle must open. Hold the vacuum to see that the unit does not leak, then release it.
19 Renew the vacuum unit if necessary. Separate its link rod from the balljoint in any case.

Throttle housing and linkage

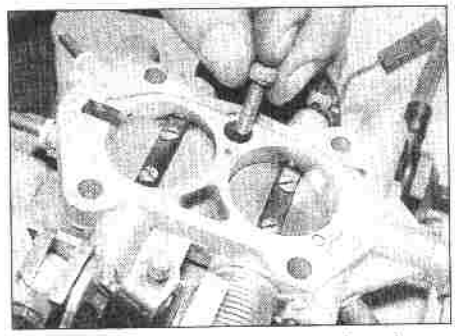
20 Disconnect the remaining hose from the choke vacuum unit, noting where it is connected.
21 Remove the screw from the underside of the throttle housing. Separate the carburettor body from the housing and recover the thick gasket **(see illustrations)**.
22 Inspect the throttle linkage on the side of the housing. Renew parts as necessary. Do not disturb the throttle stop screws.
23 Check the throttle linkage clearance between the base of the plastic lever and the metal fork, pushing the lever one way and then the other to measure gaps "A" and "B" **(see illustration)**. Bend the fork if the gaps are not as specified.
24 Apply vacuum to the fuel shut-off vacuum valve and check that the valve plunger moves in to block the idle mixture passage. Dismantle the valve for inspection if necessary.

Choke components

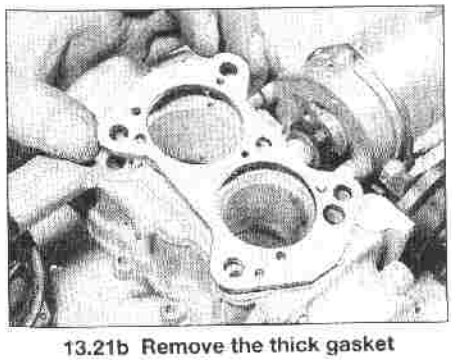
25 Check for alignment marks between the bi-metallic spring housing and the choke carrier **(see illustration)**. Make marks if necessary, then remove the three screws which secure the clamp ring. Remove the clamp ring, water jacket and spring housing together. Recover the gasket.



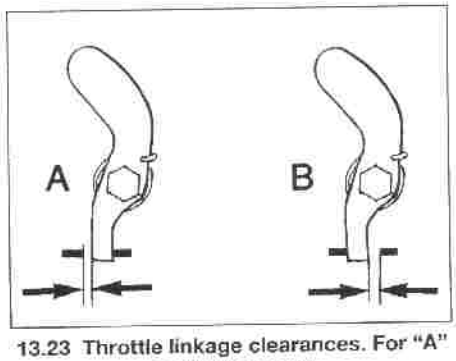
13.15 Float height measurement



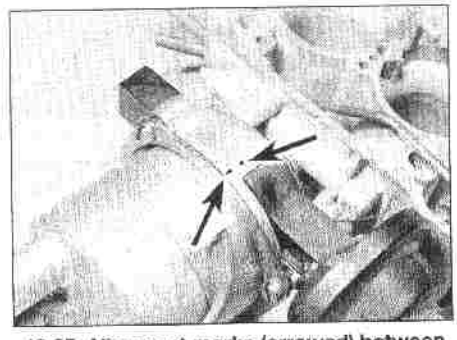
13.21a Removing the throttle housing screw



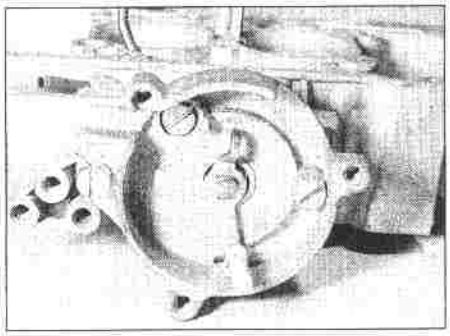
13.21b Remove the thick gasket



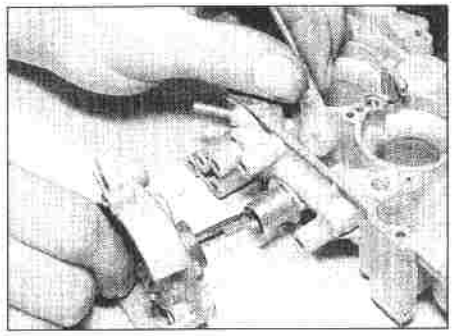
13.23 Throttle linkage clearances. For "A" and "B" see text



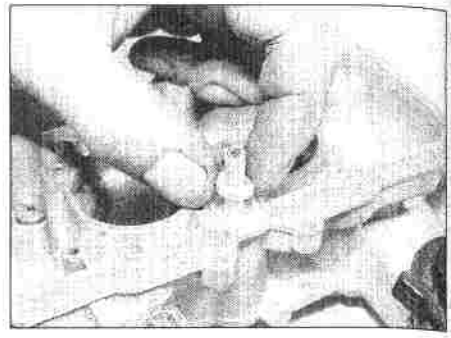
13.25 Alignment marks (arrowed) between bi-metallic spring housing and choke carrier



13.28a Choke carrier showing the three securing screws



13.28b Removing the choke carrier



13.30 Accelerator pump felt washer

26 The water jacket can be separated from the spring housing if wished after removing the central bolt. Recover the O-ring.

27 Apply vacuum to the lower connection on the choke vacuum unit. Cover the upper connection and apply vacuum until the pullrod contacts the far stop. Hold the vacuum to check for leakage, then release it.

28 Slide the vacuum unit and cover off the choke carrier. Remove the three screws which secure the carrier, noting that the short screw goes behind the vacuum unit pullrod. Prise off the inner plastic link and withdraw the choke carrier with shaft, spring, etc **(see illustrations)**.

29 Examine the choke components and renew worn or damaged items.

Accelerator pump

30 Remove the felt washer from the pump piston rod **(see illustration)**.

31 Prise up the piston retainer.

32 Lift out the piston and spring **(see illustrations)**.

33 Examine the components and renew as necessary.

Jets

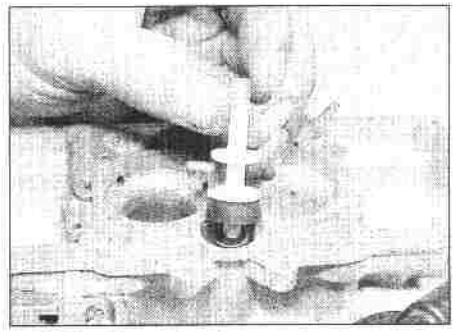
34 Remove the jets and blow through them with compressed air **(see illustration)**. **Do not** probe them with wire or their calibration will be upset. The air correction jets are pressed in place and cannot be removed.

Warning: Wear eye protection when using compressed air!

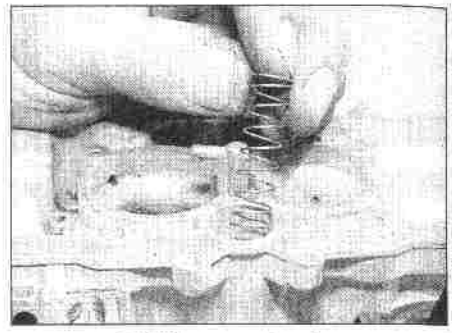
35 Remove the idle speed and mixture adjustment screws.

36 Blow compressed air through the various channels and orifices, then refit the jets and adjustment screws. Screw the adjustment screws fully home, then back out the speed adjustment screw 2½ turns and the mixture adjustment screw 3½ turns. Final adjustment will be made after refitting.

HAYNES HiNT ***Aerosol cans of carburettor cleaner are widely available and can prove very useful in helping to clear internal passages of stubborn obstructions.***



13.32a Removing the accelerator pump piston . . .



13.32b . . . and spring

Reassembly

37 Obtain a repair kit containing new gaskets, seals and other renewable items.

38 Refit the accelerator pump spring, plunger, retainer and felt washer.

39 Refit the throttle housing to the carburettor body, using a new thick gasket. Secure them with the screw.

40 Refit the secondary throttle unit (if removed) and reconnect the vacuum hose and link rod. Set the link rod as short as possible without actually opening the throttle.

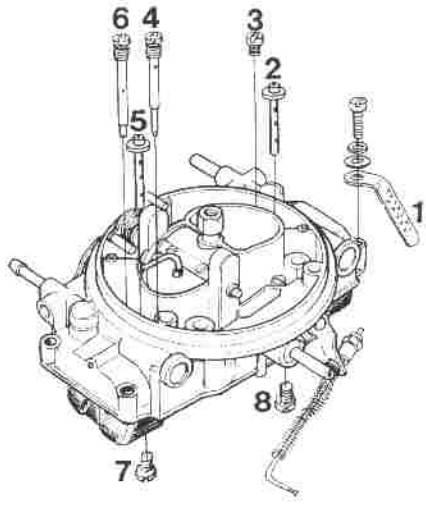
41 Refit the choke carrier, shaft and associated components. Slide the choke vacuum unit and cover into place.

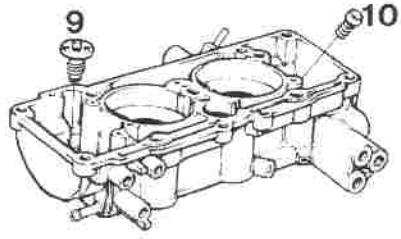
42 Refit the top cover, using a new gasket, and reconnect the choke and accelerator pump links.

43 Perform the automatic choke adjustments (Section 14, paragraph 3 onwards), then adjust the accelerator pump as follows.

Accelerator pump delivery

44 Fill the float chambers with petrol via the feed pipe until it starts to emerge from the return pipe.





13.34 Carburettor jet identification

1 Identification plate
2 Air correction jet /emulsion tube
3 Air bypass jet
4 Idle air/fuel jet
5 Air correction jet/emulsion tube
6 Auxiliary air/fuel jet
7 Primary main jet
8 Secondary main jet
9 Enrichment jet
10 Bypass jet

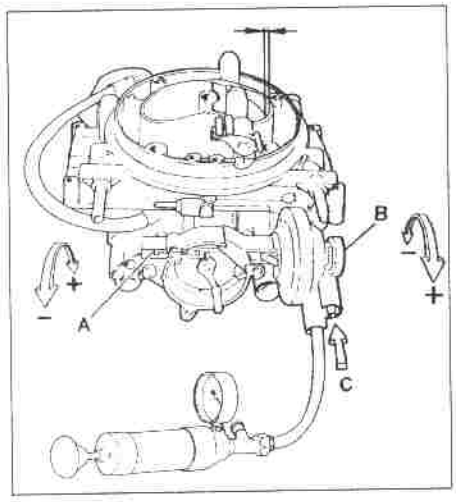
45 Position the base of the carburettor over a funnel leading to a measuring cylinder. Holding the fast idle cam out of the way, open and close the throttle fully ten times, taking about one second per opening and allowing three seconds between openings. Measure the quantity of fuel delivered.
46 If the quantity of fuel is not as specified, turn the link rod adjusting nut in the appropriate direction and repeat the test.

Final assembly

47 Refit the hot start valve and hoses, and the fuel shut-off valve if it was removed.
48 Lubricate the linkages whilst they are accessible.
49 Reconnect any remaining vacuum hoses and wires.

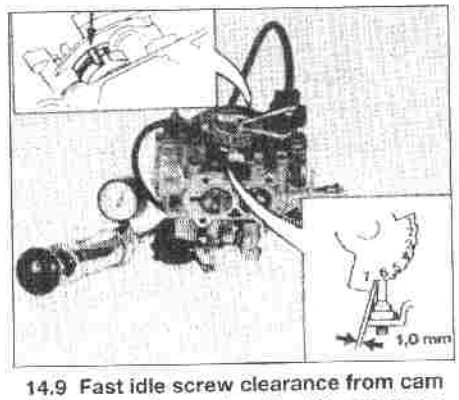
14 Carburettor - automatic choke adjustment

1 Remove the carburettor (see Section 12).
2 Make alignment marks if necessary, then remove the three screws which secure the bi-metallic spring housing clamp ring. Remove the clamp ring, spring housing with water jacket and gasket.
3 If not already done, set the fast idle gap (see Section 15).
4 Subsequent adjustments must be done in the order given.
5 Close the choke flap by hooking a rubber band round the choke link and the choke vacuum unit.
6 Open and close the throttle. The fast idle adjustment screw should come to rest on the seventh (highest) step of the fast idle cam. There should be a small clearance (0.5 to 1.0 mm) between the choke link and the vacuum unit rod. Bend the tag on the link rod if necessary to achieve this.
7 Connect a vacuum pump to the lower connection on the choke vacuum unit. Cover the upper connection. Apply vacuum and measure the choke flap opening: it should correspond to gap "A" (see Specifications). Adjust if necessary at screw "A" **(see illustration)**.
8 Expose the upper connection, maintaining vacuum on the lower. Gap "B" must now be measured, and if necessary adjusted at screw "B".
9 Release the vacuum but leave the pump connected. Set the throttle so that the fast idle screw is again on the seventh cam step. Cover the choke vacuum upper connection and apply vacuum to the lower. Open and close the throttle: the fast idle screw should return to the sixth stop and be at least 1.0 mm clear of the seventh step. Adjust if necessary by bending the link **(see illustration)**.
10 Uncover the choke vacuum upper connection and remove the vacuum pump.



14.7 Choke flap opening under vacuum. For A and B see text
C Vacuum unit upper connection

11 Move the choke link clockwise so that the choke flap is fully open and hold it in this position. Open and close the throttle: the fast idle adjustment screw should return to a position clear of all the cam steps, clearing the first (lowest) step by at least 0.5 mm. Bend the tag on the choke flap spindle if necessary to adjust.
12 Release the choke link so that the rubber band closes the flap again. Open the throttle wide and measure the choke flap opening. If it is not as specified, slacken the throttle spindle nut and reposition the cam, then tighten the nut. Remove the rubber band.
13 Refit the bi-metallic spring housing and associated components, engaging the eye of the spring with the end of the link and observing the alignment marks. Insert the three screws into the clamp ring and just nip them up.
14 Check the choke flap opening at 20°C - assuming this to be the ambient temperature - and adjust to within specification if necessary by turning the bi-metallic spring housing. Tighten the three screws when adjustment is correct.



14.9 Fast idle screw clearance from cam stop (inset, bottom) - adjust if necessary by bending link (inset, top)

15 With the choke flap still in the 20°C position, check the clearance between the end of the full load enrichment tube and the flap. Bend the tube if the clearance is not as specified. Too low a setting will cause high fuel consumption, too high will cause cold starting problems.

15 Carburettor - fast idle adjustment

1 Disconnect the air inlet trunking from the top of the carburettor.
2 Separate the cable drum-to-carburettor link rod by prising off its balljoint.
3 Open the primary throttle valve fully by hand. Turn the choke flap so that the fast idle adjustment screw is resting on the sixth (highest but one) step of the fast idle cam. Release the throttle valve.
4 In this position measure the fast idle gap between the throttle valve lever and the stop screw. If the gap is not as specified, turn the fast idle adjustment screw to correct it.
5 When the gap is correct, refit the link rod and the air trunking.
6 Check the idle speed and mixture (see Chapter 1).

16 Hot start valve - testing

1 Inspect the valve hoses to see that they are not kinked or perished. If the hoses between the valve and the carburettor are defective, rough running and poor fuel consumption may result.
2 Check that the breather hose is unobstructed. Its lower end is near the transmission crossmember. If this hose is blocked, difficult hot starting may result.
3 Check the valve by blowing through the hoses with the ignition on and off. With the ignition on, the valve must be closed (breather hose and carburettor hoses not connected). With the ignition off, the valve must open the breather hose to the carburettor. If not, either the valve or the power supply is at fault.

17 Inlet manifold - removal and refitting

Removal

1 Disconnect the battery negative lead.
2 Remove the carburettor (see Section 12), or disconnect all services from it but leave it attached to the manifold.
3 Disconnect the vacuum hoses from the manifold, making identifying marks if necessary. Clamp and disconnect coolant hoses also.

4 Unbolt and remove the manifold. Recover the gasket.

Refitting

5 Refit by reversing the removal operations, using new gaskets or O-rings. It may be necessary to cut the gasket to clear adjacent components.
6 Adjust the throttle drum cable(s), run the engine and check the idle speed and mixture on completion (see Chapter 1).
7 Top-up the cooling system if necessary.

18 Exhaust manifold - removal and refitting

Removal

1 Remove the hot air trunking (when so equipped).
2 Disconnect the exhaust downpipe from the manifold.
3 Unbolt the manifold from the cylinder head and remove it. Recover the gaskets.

Refitting

4 When refitting, use new gaskets. The marking "UT" must face away from the cylinder head.
5 Apply anti-seize compound to the threads. Fit the manifold to the head and tighten the nuts evenly.
6 Reconnect the exhaust downpipe and the hot air trunking.
7 Run the engine and check for leaks.

19 Exhaust system - general information, removal and refitting

General information

1 The exhaust system consists of front, intermediate and rear sections, the number varying according to model. The system is suspended from the underbody on rubber mountings, and bolted to a cast iron manifold at the front. Flanged joints incorporating gasket seals or U-type pipe clamps are used to secure the sections. On later models (1988 onward) a catalytic converter is fitted - refer to Part C of this Chapter for further information.
2 The exhaust system should be examined for leaks, damage and security at regular intervals (see Chapter 1). To do this, apply the handbrake, and allow the engine to idle in a well-ventilated area. Lie down on each side of the car in turn, and check the full length of the system for leaks, while an assistant temporarily places a wad of cloth over the end of the tailpipe. If a leak is evident, stop the engine and use a proprietary repair kit to seal it. If the leak is excessive, or damage is evident, renew the section. Check the rubber mountings for deterioration, and renew them if necessary.

Removal

3 Details of exhaust system routing and mounting will vary with model and year, but the principles of removal and refitting remain the same.
4 In many cases it will be found easier to remove the complete system from the downpipe(s) rearwards and then to renew individual sections on the bench. One exception is on models where the system passes over the rear axle; here it is better to separate the joints, or to cut the pipe if it is rusty anyway.
5 To remove the complete system, raise and support the vehicle at a convenient working height. Apply penetrating oil to the nuts, bolts and clamps which will have to be undone.
6 Unbolt the flanged joint at the union of the exhaust system with the downpipe(s).
7 If the system passes over the rear axle, remove one of the U-pipe clamps and separate the system there.
8 With the aid of an assistant, unhook the system from its mountings and remove it.
9 To remove the downpipe(s), release the mounting clamp from the bellhousing and separate the joints from the manifold(s). Also disconnect the hot air trunking; and if necessary unbolt the hot air shroud.

Refitting

10 Commence refitting with the downpipe(s), using new gaskets. Apply anti-seize compound to the threads. Fit the bellhousing mounting clamp bolt but do not tighten it yet.
11 Sling the rest of the system on its mountings and couple it up, using a new sealing ring at the flanged joint. Apply exhaust jointing compound to the sliding joints and anti-seize compound to all threads.
12 Tighten all the joints from the front rearwards, but leave the bellhousing clamp loose until everything else has been tightened. Twist the sliding joints slightly if necessary so that the system hangs easily and without touching the body.
13 Run the engine for a few minutes and check the system for leaks. Allow it to cool and retighten the joints.
14 Lower the vehicle.

Chapter 4 Part B:
Fuel/exhaust systems - fuel-injected engines

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

4B

System type

B28E, B200E and B230E engines	Continuous fuel injection, normally-aspirated
B23ET and B230ET engines	Motronic fuel injection, turbocharged
B280E engines	LH2.2-Jetronic fuel injection, normally-aspirated
B234F engines	LH2.4-Jetronic fuel injection, normally-aspirated

Fuel system data

Idle speed:		
B200/230E engines	900 rpm	
B23ET engines	900 rpm	
B280E engines	700 rpm (basic idle speed)	
Idle speed controlled by constant idle speed system:		
B28E engines	900 rpm (adjust to 850 rpm)	
B230ET engines	900 rpm (adjust to 850 rpm)	
B234F engines	850 rpm (not adjustable)	
Idle speed for LH2.4-Jetronic system in limp-home mode	480 to 520 rpm	
Idle mixture CO content:	**Setting value**	**Checking value**
B28E engines	2.0%	1.0 to 3.0%
B200E engines	1.0%	0.5 to 2.0%
B230E engines	1.0%	0.5 to 2.0%
B23ET engines	1.5%	1.0 to 2.5%
B230ET engines	1.0%	0.5 to 2.0%
B234F engines	0.6% (not adjustable)	0.2 to 1.0% (with Lambdasond disconnected)

Recommended fuel

Models without green fuel filler cap	98 RON leaded
Models with green fuel filler cap	95 RON unleaded (UK unleaded premium)
B234F	91-95 RON unleaded

Torque wrench settings	Nm	lbf ft
Exhaust downpipe to turbo wastegate housing	25	18
Wastegate housing to turbocharger	20	15
Turbocharger to exhaust manifold:		
Stage 1	1	0.7
Stage 2	45	33
Stage 3	Angle-tighten 45° further	
Oxygen sensor (Lambdasond)	55	40
Throttle link rod locknut	0.45 to 0.75	0.34 to 0.56

1 General information and precautions

The fuel system on fuel-injected engines consists of one or two rear-mounted fuel tanks, one or two electric fuel pumps, and either an electro-mechanical, or fully electronic fuel injection system. The B200E, B230E and B28E engines have a fuel injection system of the continuous injection type; B23ET and B230ET engines have a turbocharger and electronically controlled (Motronic) fuel injection system; while the B280E and B234F engines have different versions of the electronically controlled (LH Jetronic) fuel injection system. Further details of these systems will be found in Section 11.

The exhaust system consists of multiple sections, the number varying according to model, suspended from under the car on rubber mountings. A catalytic converter is fitted to the exhaust system of later models.

Warning: Many of the procedures in this Chapter require the removal of fuel lines and connections, which may result in some fuel spillage. Before carrying out any operation on the fuel system, refer to the precautions given in "Safety first!" at the beginning of this manual, and follow them implicitly. Petrol is a highly dangerous and volatile liquid, and the precautions necessary when handling it cannot be overstressed.

2 Air cleaner assembly - removal and refitting

1 For all engines except the B280E and B234F, refer to Chapter 4A, Section 2. For the B280E and B234F, proceed as follows.

Removal

2 Remove the air cleaner element as described in Chapter 1.

3 Disconnect the air trunking, including the air mass meter if still attached.

4 Release the air cleaner unit from its rubber mountings by tugging firmly. If the mountings come away with the air cleaner, remove them and refit them to their locations on the inner ring and mounting bracket.

Refitting

5 Refit by reversing the removal operations, pushing the air cleaner firmly onto the rubber mountings.

3 Main fuel tank - removal and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

1 For all models except 760 Saloon (1988 onwards) with independent rear suspension, refer to Chapter 4A, Section 3. For 760 Saloon models with independent rear suspension, proceed as follows.

Removal

2 Disconnect the battery negative lead.

3 Inside the boot, remove the spare wheel. Peel back the carpet around the fuel filler tube. Remove the left-hand drain tube and the cover from around the filler tube.

4 Remove the cover plate to expose the tank pump/fuel gauge sender unit. Disconnect the fuel hoses and the electrical connector from the unit.

5 Syphon or pump the fuel from the tank into suitable sealed containers, working through the hole in the pump/gauge sender.

6 Raise and support the vehicle. Remove the three screws which secure the protective shield at the front of the tank. Remove the shield.

7 Remove the two inner bolts from the tank front mounting bracket. Slacken the outer bolts by about 10 mm but do not remove them yet. Release the straps from the front mounting bracket and let them hang down.

8 Unbolt the bracing strap from the base of the tank. Also remove the nut on the right-hand side of the tank (up near the silencer).

9 Free the tank and lower it so that it is resting on the front mounting bracket and the rear suspension members.

10 Remove the rear half of the propeller shaft, making identification marks for reassembly.

11 Have an assistant support the tank, or make up a cradle to support it on a trolley jack. Be careful not to damage the tank; it is only made of plastic.

12 Remove the remaining bolts from the front mounting bracket and remove the bracket. Lower the tank and draw it forwards, at the same time disconnecting the breather hose on top of the tank. Remove the tank from under the vehicle.

13 If a new tank is to be fitted, transfer the pump/gauge unit, heat shields, bump stops etc from the old tank.

Refitting

14 Refit by reversing the removal operations.

4 Auxiliary fuel tank - removal and refitting

Refer to Chapter 4A, Section 4.

5 Fuel tank pump - removal and refitting

Refer to Chapter 4A, Section 5.

6 Main fuel pump - removal and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

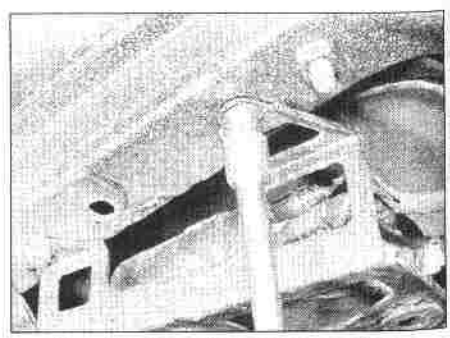
Removal

1 Raise the vehicle on ramps or drive it over a pit.

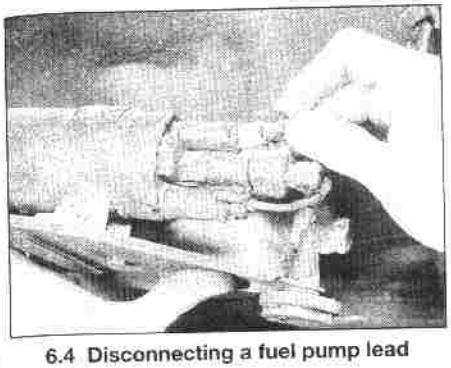
2 Disconnect the battery negative lead.

3 Unbolt the fuel pump cradle from the underside of the vehicle **(see illustration)**. Pull the cradle off the grommets.

4 Disconnect the electrical leads from the



6.3 Unbolting the fuel pump cradle



6.4 Disconnecting a fuel pump lead

pump, noting the colours of the wires and the corresponding terminals **(see illustration)**.
5 Disconnect the fuel supply and outlet pipes from the pump. Be prepared for fuel spillage. Plug or cap the open pipe unions.
6 Unbolt the pump brackets and remove the pump.

Refitting

7 Refit by reversing the removal operations, using new sealing washers as necessary.
8 Run the engine and check for leakage before lowering the vehicle.

7 Fuel gauge senders - removal, testing and refitting

Refer to Chapter 4A, Section 7.

8 Throttle cable - removal, refitting and adjustment

Removal

1 Release the cable outer by extracting the spring clip and unhook the inner from the drum.
2 Inside the vehicle, remove the trim from below the steering column. Pull the cable inner through the end of the pedal and slide the split bush off the end of the cable.
3 Release the cable grommet from the bulkhead and pull the cable into the engine bay. Note the routing of the cable, release it from any clips or ties and remove it.

Refitting and adjustment

4 Refit by reversing the removal operations, then adjust the cable as follows.
5 Disconnect the link rod which joins the cable down to the throttle valve(s) by levering off a balljoint.
6 With the throttle pedal released, the cable inner should be just taut, and the cable drum must be resting against the idle stop. With the pedal fully depressed the drum must contact the full throttle stop. Adjust if necessary by means of the threaded sleeve.
7 On automatic transmission models, first check the adjustment of the kickdown cable (see Chapter 7B).
8 Reconnect the link rod, adjusting its length if necessary as follows.

B28/280E engines

9 The length of the link rod should be such that neither the cable drum nor the throttle valves are disturbed from their idle positions.

B23/200/230E/ET engines

10 Reconnect the link rod and place a 1.0 mm feeler blade between the cable drum and the idle stop. In this position the clearance between the throttle lever and the adjustment screw must be 0.1 mm. Adjust the link rod **(not** the adjustment screw) if necessary to achieve this.

B234F engines

11 Reconnect the link rod and place a feeler blade between the cable drum and the idle stop. The feeler blade should be 3.3mm for manual transmission models and for automatics with 1989 engine version numbers 1289321 and 1289407. For automatics with other engine version numbers, use a feeler blade of 1.6mm.
12 Turn the link rod until the lever leaves the adjustment screw and the throttle switch clicks. Turn the link rod in the opposite direction until the return click is heard, then tighten the locknut to the recommended torque. Repeat this process until you achieve a clearance of 0.1 to 0.5 mm between the throttle lever and the adjustment screw.

9 Throttle pedal - removal and refitting

Refer to Chapter 4A, Section 9.

10 Unleaded petrol - general information and usage

Refer to Chapter 4A, Section 10.

11 Fuel injection systems - general information

Continuous injection system

The continuous fuel injection system is found on the B28E, B200E and B230E engines. It is a well-proven system, with little to go wrong and no "black boxes" to worry about. As the name implies, fuel injection takes place continuously whilst the engine is running. The rate of injection is varied to suit the prevailing speed and load.

Fuel is drawn from the tank by the tank pump. It passes to the main fuel pump where the line pressure of around 5 bar is established. An accumulator next to the pump provides a reservoir of pressure to improve hot starting. From the accumulator the fuel passes through a filter and then to the fuel distributor on top of the inlet manifold.

The fuel distributor looks a little like an ignition distributor, but it has fuel lines instead of HT leads. There is one fuel line per injector, with additional lines for the start injector and the control pressure regulator. The fuel distributor's main function is to regulate the fuel supply to the injectors in proportion to the incoming airflow. Incoming air deflects the airflow sensor plate, which moves the control plunger in the fuel distributor and so varies the supply to the injectors. The airflow sensor and the fuel distributor together are sometimes called the fuel control unit.

The control pressure regulator reduces the control pressure during warm-up and under conditions of low manifold vacuum, and so enriches the mixture. (A lower control pressure means that the airflow sensor plate is deflected further, and the quantity of fuel injected is increased.)

An electrically-controlled start injector provides extra fuel during engine starting. A thermal time switch controls the duration of start injector operation when the engine is cold; on a hot engine an impulse relay provides a smaller quantity of extra fuel to be injected. An auxiliary air valve provides the extra air needed to maintain idle speed when the engine is cold. On models with the constant idle speed system, an air control valve takes the place of the auxiliary air valve.

Most of the information in the following Sections relates to the continuous injection system as fitted to the B28E engine, since there is a lack of information for the B200E and B230E. Differences will be found to relate mainly to component access, besides the obvious difference of the number of cylinders.

Motronic system

The Motronic system used on B23ET and B230ET engines is basically Bosch L-Jetronic fuel injection with integrated ignition system control. Fuel injection and ignition functions are both controlled by the same unit in order to achieve optimum efficiency, driveability and power.

The control unit receives information of engine speed and crankshaft position, air flow into the induction system, coolant temperature and throttle position. The temperature of the inducted air after it has passed through the turbocharger and the intercooler is also measured. A signal relay informs the control unit if the air conditioning is in operation, necessitating a rise in idle speed. The unit also compensates for the effects of fluctuations in battery voltage, and provides extra enrichment via the start injector when the starter motor is operating. A thermal timer controls the duration of start injection.

Control unit outputs are to the fuel pump relay, the fuel injectors and the ignition

system. The fuel pump is only allowed to run when the engine is running or when the starter motor is operating.

The fuel injectors are electrically controlled. Injection quantity is determined by the length of time for which the injectors are open. The quantity is increased in proportion to air flow, and also in response to sudden opening of the throttle and during warm-up.

Idle speed is raised during the warm-up phase by an auxiliary air valve, similar to that used in the continuous injection system, which allows a small quantity of air to bypass the throttle valve.

Fuel pressure regulation is in proportion to manifold vacuum or boost pressure, and is achieved by varying the amount of fuel allowed out of the injector rail into the return line. The constant circulation of fuel makes for a steady fuel temperature and avoids vapour locks.

Besides regulating normal driving functions, the Motronic control unit also protects against over-revving by cutting out alternate injector pulses at speeds in excess of 6200 rpm.

In the event of a sensor failure or other malfunction, the control unit imposes preset values on injection and ignition systems to provide a limp home facility.

Ignition-related aspects of the Motronic system are covered in Chapter 5.

LH-Jetronic system

Two different versions of the LH-Jetronic system are used in the engines covered in this manual. Version 2.2 is fitted to the B280E engine and the more advanced version 2.4, described at the end of this Section, is fitted to the B234F engine.

The LH-Jetronic system is similar to the Motronic system described above. The main differences are the use of an air mass meter in the inlet system and an oxygen sensor (Lambdasond) in the exhaust system.

The ignition side of the system is controlled by a separate unit, though both fuel injection and ignition control units communicate with each other and are interdependent.

The air mass meter measures the mass of the inducted air instead of its volume. Air mass is measured by observing the cooling effect of the air on a hot wire. This elegant method avoids the need to use cumbersome and potentially unreliable moving flaps to measure airflow.

The air mass meter is located in the air inlet trunking between the air cleaner and the throttle housing. It incorporates a platinum wire which, when the system is operating, is heated to 100°C above the temperature of the incoming air. The current needed to maintain this temperature is used by the control unit to calculate air mass. Each time the engine is switched off, the control unit briefly heats the wire to 1000°C to burn off any deposits.

The hot wire in the air mass meter is the most vulnerable component in the system. Should the wire break, the control unit provides a limp home signal to the injectors, enabling the car to be driven at low speed until a new air mass meter can be fitted.

The oxygen sensor (Lambdasond) is fitted to the catalytic converter and measures the oxygen content of the exhaust gases. The result is processed by the electronic control unit and is used to adjust the fuel/air mixture strength in the inlet manifold by altering the injector opening times. If there is too much oxygen in the exhaust gases, the mixture is weak and needs to be enriched. If there is too little oxygen in the exhaust, the mixture is too strong, causing incomplete combustion, and needs to be reduced. The change in mixture strength affects the oxygen content of the exhaust gases, creating a closed-loop system. The ECU maintains the mixture strength at the chemically-correct ratio for complete combustion of petrol - 14.7 parts by weight of air to 1 part of fuel, known as the "stoichiometric" ratio. At this point, peak conversion efficiency of all major pollutants is achieved.

The oxygen sensor has a zirconium oxide tube, coated with platinum, which sends a voltage signal to the ECU representing the oxygen content in the exhaust. It operates at a temperature of approximately 285°C and is electrically heated to achieve this temperature, heating up quickly when the ignition is switched on.

There are slight variations in the use of the oxygen sensor on different models:

a) On some early models, before 1990, the oxygen sensor was placed in the exhaust pipe, 15cm upstream of the catalytic converter.

b) On turbo models, the oxygen sensor is placed immediately downstream of the turbocharger.

c) On models without catalytic converters, produced for markets where lead-free petrol is not generally available, a different type of oxygen sensor is used which has a limited life and needs to be renewed at regular intervals.

The oxygen sensor is an essential component of the LH-Jetronic system, but is also more generally fitted to any system that uses fuel injection and has a catalytic converter. Although it is part of the fuel injection system, it is also important for emission control, discussed in more detail in Part C.

Other functions of the LH-Jetronic control unit include enrichment during starting, warm-up, acceleration and full-load conditions; fuel cut-off during overrun; idle speed control; fuel pump cut-off when the engine is stopped, and injection cut-off at excessive engine speed.

LH2.4-Jetronic system

The LH2.4-Jetronic system, fitted to B234F engines, is an enhancement of the earlier LH2.2-Jetronic system and works in combination with the EZ116K electronic ignition system (See Chapter 5B). It has the following additional features:

a) Built-in diagnostic unit for fault tracing. This unit is shared between the fuel and ignition systems. See Section 24.

b) Adaptive system control. The ECU maintains a history of the conditions experienced and adapts itself accordingly.

c) Constant idling system under adaptive control of the ECU. See Section 16.

d) CO adjustment not necessary because of the adaptive functions (not applicable to B204E).

e) EVAP function, to recover fuel vapours produced in the fuel tank. See Part C.

f) Cold start valve upstream of injectors on some models not covered by this manual.

12 Fuel injection system - testing and adjustment

Note: *If you have the LH2.4-Jetronic system with the built-in diagnostic unit, go to Section 24. The diagnostic unit provides the easiest way of testing for faults.*

Testing

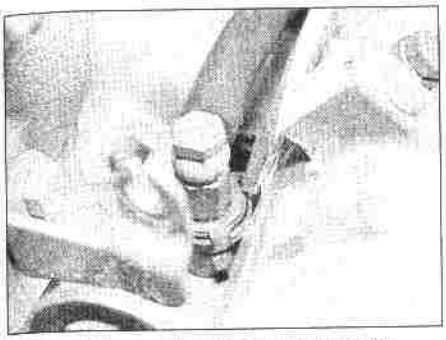
1 If a fault appears in the fuel injection system, first ensure that all the system wiring connectors are securely connected and free of corrosion. Ensure that the fault is not due to poor maintenance; ie, check that the air cleaner filter element is clean, the spark plugs are in good condition and correctly gapped, the valve clearances are correctly adjusted, the cylinder compression pressures are correct, the ignition timing is correct, and that the engine breather hoses are clear and undamaged, referring to Chapters 1, 2 and 5 for further information.

2 If these checks fail to reveal the cause of the problem, the vehicle should be taken to a suitably equipped Volvo dealer for testing. A special diagnostic connector is incorporated into the fuel injection system electronic circuitry into which a special electronic diagnostic tester can be plugged. This equipment will locate the fault quickly and simply, alleviating the need to test all the system components individually, which is a time-consuming operation that carries an element of risk of damaging the ECU.

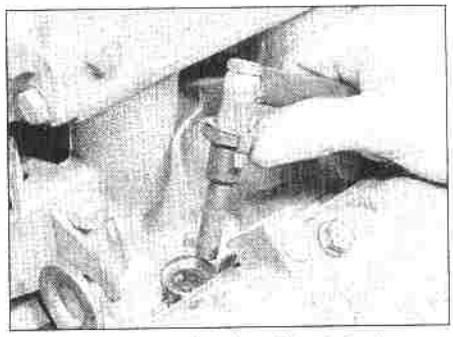
Adjustment

3 Experienced home mechanics with a considerable amount of skill and equipment (including a tachometer and an accurately calibrated exhaust gas analyser) may be able to check the exhaust CO level and the idle speed. In practice, however, these systems rarely need adjustment and only go "out of tune" through lack of regular maintenance (see paragraph 1 above).

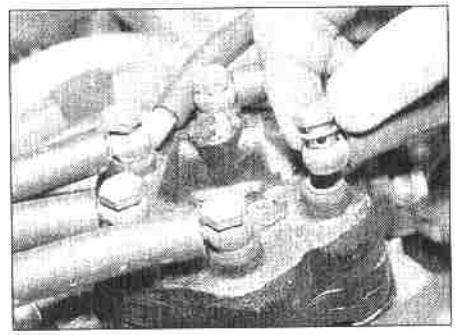
4 If it is felt that the exhaust CO level and idle speed require adjustment, ideally the car should be taken to a dealer for this work to be done. For those with the necessary



13.4a Prise up the injector spring clip . . .



13.4b . . . and pull out the injector



13.9a Disconnecting an injector union - note sealing washers

experience and equipment, the adjustment procedures will be found in Chapter 1.

Note: *On LH2.4-Jetronic systems, the idling speed and CO level are subject to adaptive control, based on data accumulated from previous driving conditions and no adjustment is possible. If the idling speed or the CO level are not correct, use the diagnostic unit to test for faults (See Section 24).*

13 Continuous injection system components - removal and refitting

1 Disconnect the battery negative lead.

Fuel accumulator

Note: *Refer to the warning note in Section 1 before proceeding.*

2 This is removed in the same way as the main fuel pump (Section 6), except that there are no electrical connections to attend to.

3 In practice it is probably easier to remove the pump, accumulator and cradle all together. The accumulator can then be removed under relatively clean conditions on the bench.

Injectors

Note: *Refer to the warning note in Section 1 before proceeding.*

4 Release the spring clip and pull the injector from its recess **(see illustrations)**.

5 Disconnect the fuel line union from the injector.

6 Refit by reversing the removal operations, using a new seal and union washers if necessary.

7 Note that new injectors are filled with a preservative wax before storage. This wax must be flushed out of the injector before it is fitted. Take advice from the seller of the injectors.

Fuel control unit

Note: *Refer to the warning note in Section 1 before proceeding.*

8 Slacken the fuel filler cap to release residual pressure.

9 Disconnect the various fuel unions from the fuel distributor, making identifying marks if necessary **(see illustrations)**. Be prepared for fuel spillage.

10 Remove the air inlet trunking from the top of the airflow sensor.

11 Disconnect the electrical leads from the constant idle system throttle switch (when so equipped).

12 Remove the twelve Allen screws which secure the upper half of the control unit. Note the location of the earth tags **(see illustration)**.

13 Lift off the upper half of the control unit and recover the gasket. Further dismantling is not recommended.

14 When refitting, use a new gasket. If necessary use new sealing washers on the fuel unions.

15 On completion of refitting, have the line, control and testing pressures checked by a dealer, together with the exhaust CO level and idle speed.

Start injector

Note: *Refer to the warning note in Section 1 before proceeding.*

16 Disconnect the fuel and electrical feeds from the injector. Be prepared for fuel spillage.

17 Remove the two Allen screws and withdraw the injector.

18 Refit by reversing the removal operations.

Air control/auxiliary air valve

19 Disconnect the electrical plug from the valve.

20 Disconnect the air hoses from the valve.

21 Remove the valve securing screws and remove the valve.

22 Refit by reversing the removal operations.

Control pressure regulator

Note: *Refer to the warning note in Section 1 before proceeding.*

23 Disconnect the electrical and vacuum feeds from the regulator **(see illustration)**.

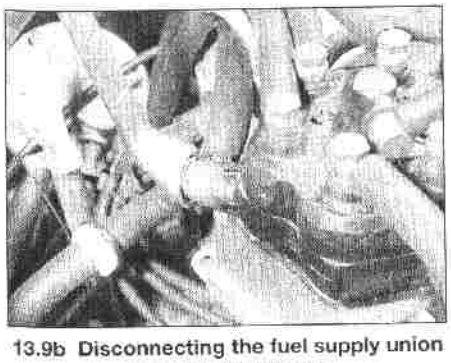
24 Disconnect the fuel unions from the regulator. They are different sizes so they cannot be confused. Be prepared for fuel spillage.

25 Unbolt the regulator and remove it.

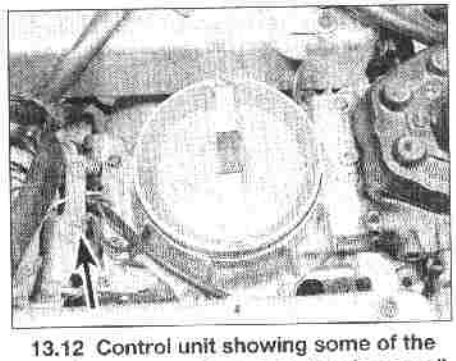
26 Refit by reversing the removal operations. Use new union sealing washers if necessary.

Thermal timer

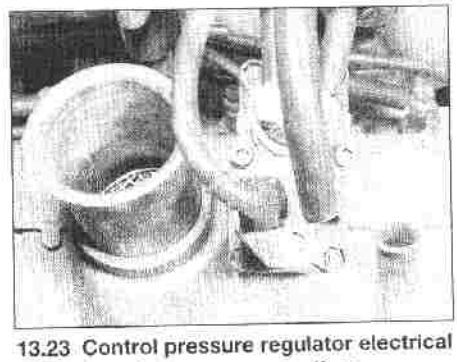
27 Unscrew the expansion tank filler cap to release any pressure in the cooling system. Take precautions against scalding if the coolant is hot.



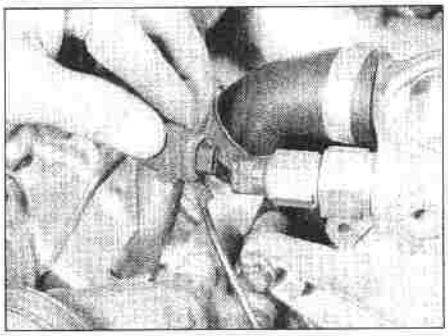
13.9b Disconnecting the fuel supply union from the distributor



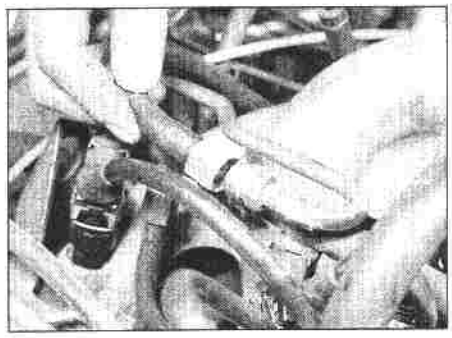
13.12 Control unit showing some of the securing screws. Note earth tag (arrowed)



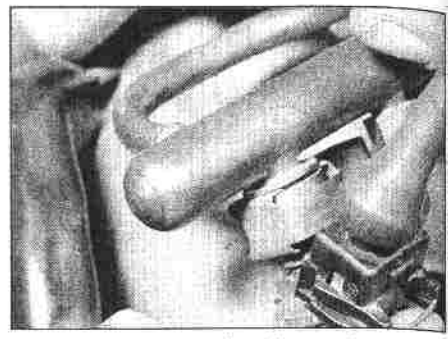
13.23 Control pressure regulator electrical and vacuum connections



13.28 Disconnecting the thermal timer multi-plug



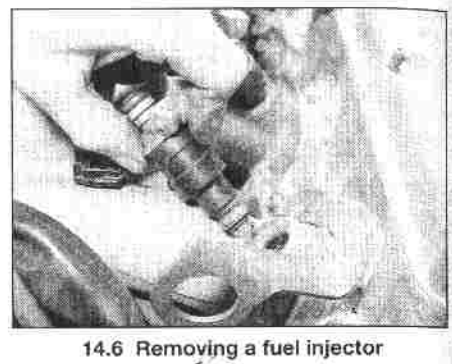
14.2 Fuel rail supply union



14.3 Prise out the wire clip to release the multi-plug

14.4 Prise out the injector securing clip

14.5 Removing the fuel rail



14.6 Removing a fuel injector

28 Disconnect the electrical plug from the thermal timer **(see illustration)**.
29 Unscrew the thermal timer and remove it. Plug the hole with a tapered wooden plug to minimise coolant loss.
30 When refitting, apply sealant to the timer threads and screw it into position. Reconnect the electrical plug.
31 Top-up the cooling system if necessary.

Fuel pump relay

32 This relay is located in position "E" of the central electrical unit - See Chapter 12.

14 Motronic injection system components - removal and refitting

1 Disconnect the battery negative lead.

Fuel injectors

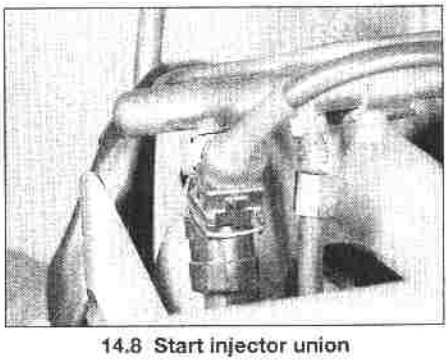
Note: *Refer to the warning note in Section 1 before proceeding.*
2 Disconnect the fuel rail unions from the supply pipe, the start injector and the pressure regulator **(see illustration)**. Be prepared for fuel spillage.
3 Disconnect the multi-plugs from the injectors. Prise out the wire clips to release the multi-plugs **(see illustration)**.
4 Remove the injector securing clips by prising them out **(see illustration)**.
5 Unbolt the fuel rail from the manifold, noting the location of any earth tags. Pull the rail off the injectors **(see illustration)**.
6 Pull the injectors out of their locations in the manifold **(see illustration)**.
7 Refit by reversing the removal operations. Use new sealing rings on the injectors and smear them with silicone grease. Renew the securing clips as well.

Start injector

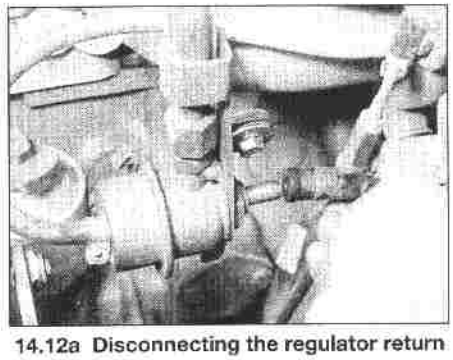
Note: *Refer to the warning note in Section 1 before proceeding.*
8 Disconnect the start injector union from the fuel rail **(see illustration)**. Be prepared for fuel spillage.
9 Disconnect the start injector multi-plug.
10 Unbolt the start injector from underneath the inlet manifold and remove it.
11 Refit by reversing the removal operations.

Fuel pressure regulator

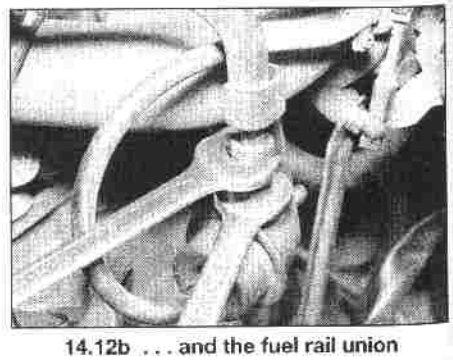
Note: *Refer to the warning note in Section 1 before proceeding.*
12 Disconnect the fuel return pipe and the fuel rail union from the regulator **(see illustrations)**. Be prepared for fuel spillage.



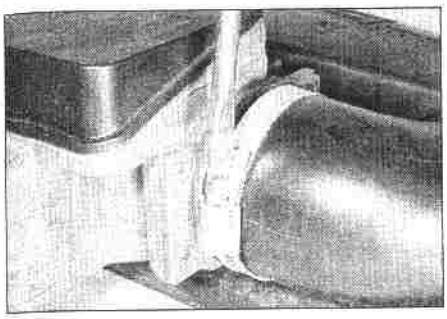
14.8 Start injector union



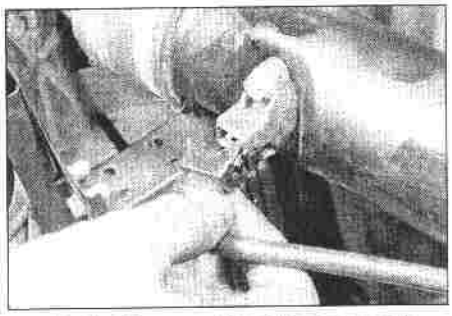
14.12a Disconnecting the regulator return pipe . . .



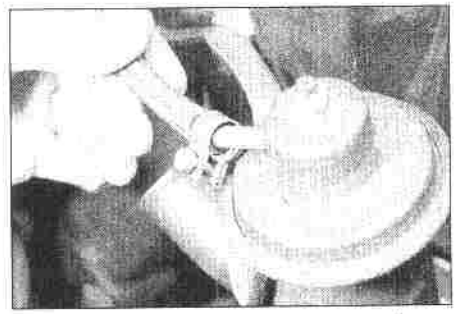
14.12b . . . and the fuel rail union



14.23 Releasing the airflow meter connecting hose



14.30 Disconnecting the charge air temperature sensor



14.34 Disconnecting a hose from the bypass valve

13 Disconnect the vacuum pipe from the regulator.
14 Undo the regulator securing nut and remove the regulator from its bracket.
15 Refit by reversing the removal operations.

Auxiliary air valve

16 Disconnect the multi-plug from the valve.
17 Disconnect the air hoses from the valve.
18 Unbolt the valve from the camshaft cover and remove it.
19 Refit by reversing the removal operations.

Airflow meter

20 Release the clips which secure the air cleaner lid.
21 Disconnect the airflow meter multi-plug and the meter-to-turbo trunking. The multi-plug is released by levering out the wire clip.
22 Lift off the lid, complete with the airflow meter.
23 Release the connecting hose, unbolt the airflow meter from the lid and remove it **(see illustration)**. Do not drop it, it is fragile.
24 Refit by reversing the removal operations. If a new meter has been fitted, the idle speed and mixture must be adjusted on completion (see Chapter 1).

Thermal timer

25 Unscrew the expansion tank filler cap to release any pressure in the cooling system. Take precautions against scalding if the coolant is hot.
26 Disconnect the electrical plug from the thermal timer which is screwed into the cylinder head below the manifold, at the rear of the engine.
27 Unscrew the thermal timer and remove it. Plug the hole with a tapered wooden plug to minimise coolant loss.
28 When refitting, apply sealant to the timer threads and screw it into position. Reconnect the electrical plug.
29 Top-up the cooling system if necessary.

Charge air temperature sensor

30 Disconnect the multi-plug from the temperature sensor **(see illustration)**.
31 Unbolt the sensor from the induction pipe and remove it.
32 Refit by reversing the removal operations.

Electronic control unit (ECU)

33 Refer to Chapter 5B.

Bypass valve

34 Disconnect the hoses from the valve, making identifying marks if necessary **(see illustration)**.
35 Unbolt the valve from its bracket and remove it.
36 Refit by reversing the removal operations. Do not disturb the adjustment screw on top of the valve, which is factory set.

15 LH-Jetronic injection system components - removal and refitting

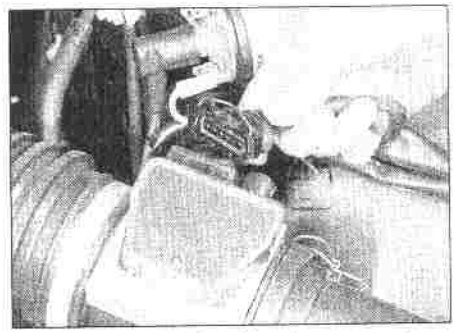
1 Disconnect the battery negative lead.

Air mass meter

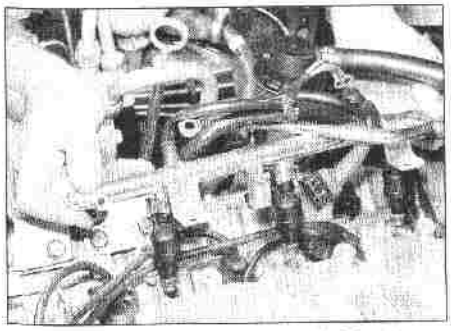
2 Disconnect the multi-plug from the air mass meter **(see illustration)**.
3 Release the two clips which secure the air mass meter to the air cleaner, and the hose clip which secures it to the trunking. Remove the air mass meter.
4 Refit by reversing the removal operations. The exhaust CO level must be checked on completion if a new meter has been fitted (except for LH2.4-Jetronic systems with no adjusting screw on the air mass meter).

Injectors

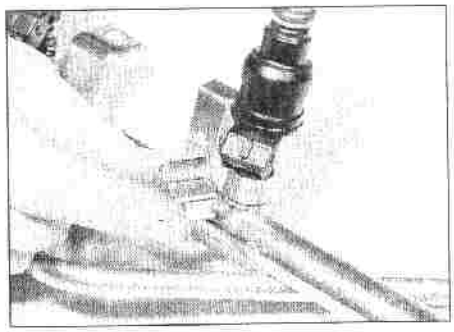
Note: *Refer to the warning note in Section 1 before proceeding.*
5 Disconnect the wiring plug from each injector. Free the wiring harness from the fuel rails, cutting cable-ties where necessary.
6 Uncouple the fuel supply and return pipes from the rails, counterholding the unions when slackening them. Be prepared for fuel spillage.
7 Remove the two bolts which secure each fuel rail to the inlet manifold. Pull each rail upwards to release the injectors from the manifold and remove the rails complete with the injectors **(see illustration)**.
8 Individual injectors may now be removed from the rails by removing the securing clips and pulling them out **(see illustrations)**.



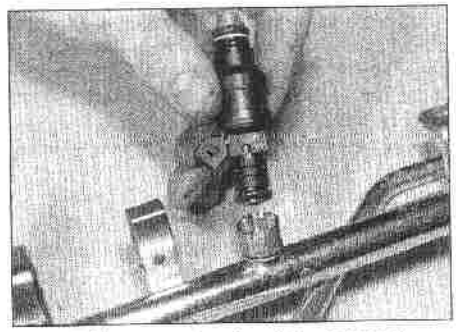
15.2 Disconnecting the air mass meter multi-plug



15.7 Removing a fuel rail with injectors

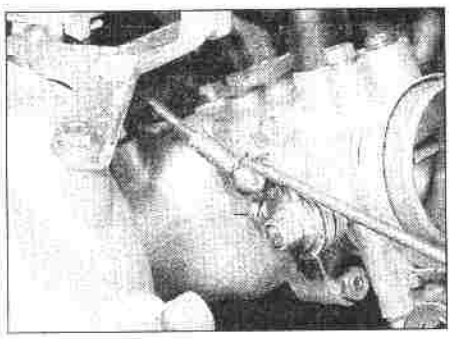


15.8a Remove the clip . . .

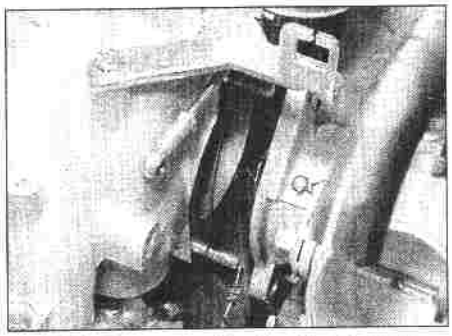


15.8b . . . and pull out the injector

4B



15.19 Releasing the throttle linkage balljoint spring clip



15.20 Removing the throttle housing

9 Refit by reversing the removal operations. Check that the injector O-rings are in good condition and renew them if necessary; smear them with petroleum jelly or silicone grease as an assembly lubricant.

Note: *Some engines, not covered in this manual, have a cold start valve which is operated by the ECU and comes off complete with the injector rail.*

Fuel pressure regulator

Note: *Refer to the warning note in Section 1 before proceeding.*

10 Disconnect the vacuum and fuel hoses from the regulator. Be prepared for fuel spillage. Counterhold the unions when slackening the nuts.

11 Remove the regulator from its bracket, being prepared for further spillage.

12 Refit by reversing the removal operations.

Air control (idle) valve

13 Disconnect the multi-plug from the valve.

14 Carefully pull the valve air hoses off the stubs on the inlet trunking and throttle housing.

15 Remove the valve and hoses. Slacken the hose clips and remove the hoses if required.

16 Refit by reversing the removal operations, using new hoses and clips if necessary.

Throttle housing

17 Disconnect the throttle position switch multi-plug.

18 Disconnect the air control (idle) valve hose, the vacuum hose and the air inlet trunking from the housing.

19 Prise out the spring clip and disconnect the throttle linkage balljoint from the operating lever **(see illustration)**.

20 Make alignment marks between the housing and the inlet manifold. Remove the three nuts which secure the housing and withdraw it **(see illustration)**. Recover the gasket.

21 When refitting, observe the alignment marks if refitting the old components. Use a new gasket.

22 The basic idle speed must be checked on completion and adjusted if necessary (except for the LH2.4-Jetronic system which has no idle speed adjustment). If basic idle speed cannot be brought low enough, adjust the throttle butterfly setting as follows.

23 Slacken the butterfly adjuster locknut. Undo the adjuster until the throttle is completely closed. Screw the adjuster back in until it just contacts the operating lever, then from this position screw it in a further quarter turn (half a turn on B234F engines). Hold the adjuster and tighten the locknut.

24 Check the operation of the throttle position switch.

Throttle position switch

25 Disconnect the multi-plug from the switch.

26 Make alignment marks between the switch and the throttle housing. Remove the two Allen screws which secure the switch and withdraw the switch.

27 Refit by reversing the removal operations. Check that a click is heard from the switch as soon as the throttle is opened. If there is no click, adjust as follows.

28 Slacken the switch screws. Turn the switch clockwise (viewed from behind) within its limits of travel, then turn it slowly anti-clockwise until a click is heard. On all models except B234F which has the LH2.4 Jetronic system, hold the switch in this position and tighten the screws. On B234F models the anti-clockwise movement depends on whether the throttle switch is BOSCH or VDO. On models with a BOSCH switch, turn it anticlockwise until a click is heard and then continue turning it until the stop is reached but no further, then tighten the screws. On models with a VDO switch, place a 0.25mm feeler gauge between the throttle lever and adjusting screw, then turn the switch anticlockwise until the click is heard and tighten the screws.

29 Check again that the click is heard when the throttle is opened and repeat the adjustment if necessary. On B234F models, open the throttle so that it clicks, place a feeler gauge between the throttle lever and adjusting screw, then close the throttle and listen for the return click. With a 0.15 mm gauge there should be a click, but with a 0.45 mm gauge there should be no click.

Coolant temperature sensor

30 Partially drain the cooling system (see Chapter 1) to below the level of the sender unit.

31 Disconnect the lead from the sender unit and unscrew it from its location.

32 Screw in the new sender unit, using a smear of sealant on the threads. Reconnect the leads.

33 Top-up the coolant level (see *"Weekly checks"*).

Oxygen sensor (Lambdasond)

34 The oxygen sensor is fitted to the catalytic converter, or to the exhaust pipe immediately upstream of the converter on some earlier models. On turbo models, it is fitted to the exhaust downpipe, immediately downstream of the turbocharger. If the engine has been running, allow it to cool down.

35 Disconnect the signal and electrical heating connections from the oxygen sensor.

36 Remove and replace the oxygen sensor, using a new one if required. Apply anti-seize compound to the entire threaded section and tighten it to the recommended torque.

Electronic control unit (ECU)

37 Remove the trim from around the driver's footwell.

38 Where more than one control unit are located together, identify the injection control unit which is labelled "Jetronic".

39 Free the control unit from its mountings and disconnect the multi-plug.

40 Refit in reverse order of removal

Note: *If you are removing an LH2.4-Jetronic ECU because it is faulty and fitting a new one, all the stored self-adaptive values will be lost. When you first start the car, it might seem as if it is not running so well, but performance will soon improve as new adaptive values are accumulated.*

16 Constant idle speed system - general information

All B230ET, B234F and most B28E engines are equipped with a constant idle speed system. The system operates to keep idle speed more or less constant regardless of varying accessory loads (air conditioning, alternator, etc). On B234F engines it also supplies air to the engine during braking to maintain the correct negative pressure at the inlet manifold.

The components of the system are a control unit, an air control valve, a throttle switch and a temperature sensor. Additionally the system receives an input from the ignition coil (B28E) and the Motronic control unit (B230ET). On B234F engines there is no separate control unit for the constant idle speed system, and the air control valve is operated directly from the LH2.4-Jetronic fuel control unit.

The control valve allows a certain amount of air to bypass the throttle butterfly. The amount is affected by the engine speed, throttle position, coolant temperature, and in the case of the B234F engine, the air mass meter.

As with the other fuel injection systems discussed previously, adjustment of the constant idle speed system can only be done accurately with specialist knowledge and equipment. Should it be thought that adjustment is necessary, or a fault occurs on the system, consult a Volvo dealer or other specialist.

The LH2.4-Jetronic system fitted to B234F engines applies adaptive control to the idle speed, using data from previous driving conditions. No adjustment of the idling speed is possible except during limp-home mode (See Chapter 1). If the idling speed is not correct, there is likely to be a fault with one of the idling system components or the control system, and you will need to check for fault codes using the diagnostic unit (see Section 24).

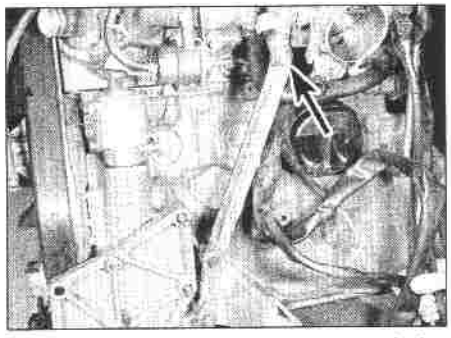
17 Cruise control - general information

When fitted, the cruise control allows the vehicle to maintain a steady speed selected by the driver, regardless of gradients or prevailing winds.

The main components of the system are a control unit, a control switch, a vacuum servo and a vacuum pump. Brake and (when applicable) clutch pedal switches protect the engine against excessive speeds or loads should a pedal be depressed whilst the system is in use.

In operation, the driver accelerates to the desired speed and then brings the system into use by means of the switch. The control unit then monitors vehicle speed (from the speedometer pulses) and opens or closes the throttle by means of the servo to maintain the set speed. If the switch is moved to "OFF", or the brake or clutch pedal is depressed, the servo immediately closes the throttle. The set speed is stored in the control unit memory and the system can be reactivated by moving the switch to "RESUME", provided that vehicle speed has not dropped below 25 mph.

The driver can override the cruise control for overtaking simply by depressing the throttle pedal. When the pedal is released, the set speed will be resumed.



18.9a Remove the bracing strut top bolt (arrowed) . . .

The cruise control cannot be engaged at speeds below 25 mph, and should not be used in slippery or congested conditions.

No specific removal, refitting or adjustment procedures were available at the time of writing. Problems should be referred to a Volvo dealer or other specialist.

18 Inlet manifold - removal and refitting

Note: *Refer to the warning note in Section 1 before proceeding.*

Removal

1 Disconnect the battery negative lead.

B23/200/230E/ET/B234F engines

2 If the manifold is coolant-heated, drain the cooling system.

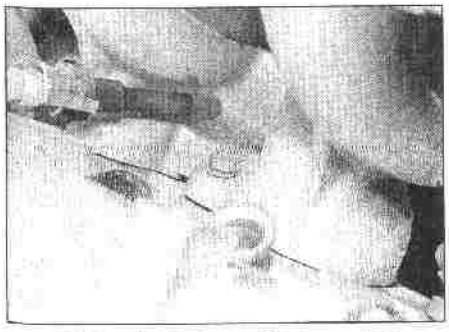
3 Disconnect the air inlet trunking from the throttle housing. On B234F engines, remove the air mass meter.

4 Disconnect the control cable(s) from the throttle drum.

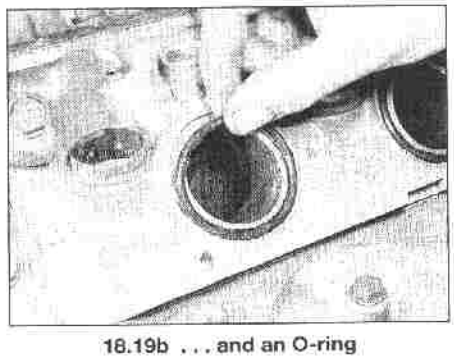
5 Disconnect the injector multi-plugs (Turbo models) and any other electrical services obstructing removal.

6 Disconnect the vacuum, pressure, breather and coolant hoses from the manifold, making identifying marks if necessary.

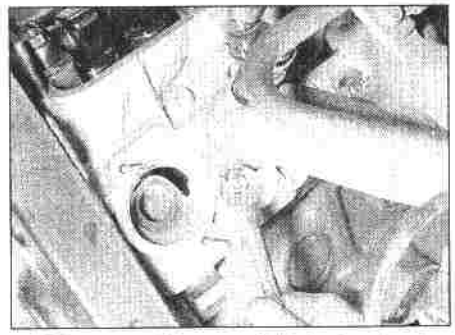
7 Disconnect the fuel feed and return pipes from the fuel rail or pressure regulator. Be prepared for fuel spillage.



18.19a An inlet manifold securing bolt . . .



18.19b . . . and an O-ring



18.9b . . . and the manifold-to-head nuts

8 Disconnect or move aside the cold start injector and the auxiliary air valve (as applicable).

9 Check that nothing has been overlooked, then unbolt and remove the manifold complete with throttle housing and (on Turbo models) injection equipment **(see illustrations)**. Recover the gasket.

B28E engines

10 Slacken the fuel tank cap to release any residual pressure.

11 Remove the oil filler cap, the crankcase ventilation hoses and the air inlet trunking.

12 Disconnect the control cables attached to the throttle drum and move them out of the way.

13 Disconnect the injection wiring harness at the multi-plugs next to the expansion tank, and from the injection system components on and around the manifold. Move the harness out of the way.

14 Disconnect the vacuum hoses from the manifold, making identifying marks if necessary.

15 Disconnect the HT leads from the spark plugs, unclip the leads and move them aside.

16 Release the fuel injector retaining clips and remove the injectors from their bores.

17 Disconnect the fuel feed line from the top of the fuel filter, and the fuel return line from the union on the left-hand inner wing. Be prepared for fuel spillage; plug or cap open lines.

18 Unbolt the control pressure regulator and place it on the manifold.

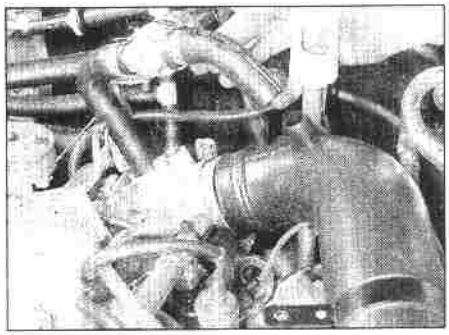
19 Remove the four bolts which secure the manifold. Lift off the manifold complete with the throttle housing and fuel injection components. Recover the O-rings **(see illustrations)**.

B280E engines

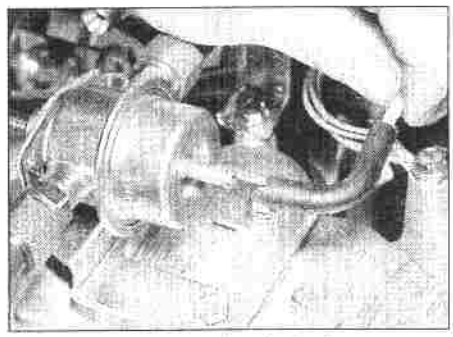
20 Slacken the fuel filler cap to release any pressure in the tank.

21 Cut the cable-ties which secure the electrical and vacuum lines to the injector rails. Also cut the tie which secures the fuel supply line to the air inlet trunking. Obtain new ties for reassembly.

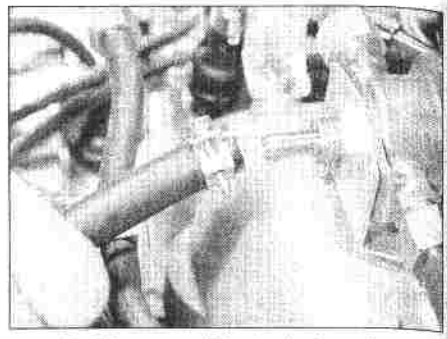
22 Disconnect the throttle and kickdown cables from the throttle drum and from their brackets.



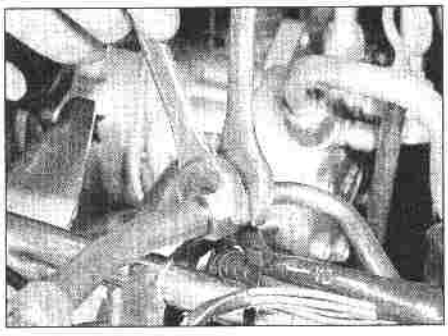
18.23 Disconnecting the air control valve hose from the air inlet trunking



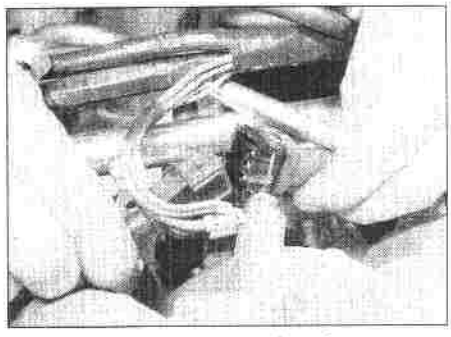
18.25a Disconnecting the fuel pressure regulator vacuum hose . . .



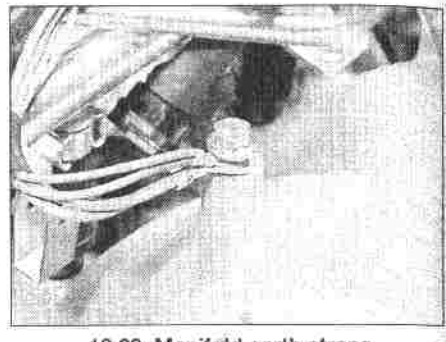
18.25b . . . and the fuel return line



18.26 Disconnecting the fuel pressure regulator from an injector rail



18.28 Disconnecting a knock sensor multiplug



18.29 Manifold earth straps

23 Remove the air mass meter and the trunking which connects it to the throttle body housing. It will be necessary to disconnect the air control valve and the crankcase ventilation hose from the trunking **(see illustration)**.

24 Disconnect the vacuum hose and the crankcase ventilation hose from the throttle body housing.

25 Disconnect the vacuum hose and the fuel return line from the fuel pressure regulator **(see illustrations)**. Be prepared for fuel spillage.

26 Disconnect the fuel pressure regulator from one or other injector rail, counterholding the union **(see illustration)**. Remove the fuel pressure regulator bracket bolts.

27 Disconnect the wiring plugs from the fuel injectors. Also disconnect the throttle switch plug at the throttle body housing.

28 Disconnect the two knock sensor multiplugs **(see illustration)**. Note how the sensor wires pass through the manifold branches; they will have to be fed back through when refitting.

29 Unbolt the earth straps from the manifold **(see illustration)**.

30 Disconnect the fuel supply lines from the front of the injector rails. Be prepared for fuel spillage.

31 Unbolt the injector rails and remove them, pulling the injectors from their locations. Move the injector wiring harness aside.

32 Disconnect the temperature sensor multiplug at the water pump **(see illustration)**.

33 Disconnect the air control valve multiplug. Also disconnect the valve hose from the throttle body housing.

34 Move aside any remaining wires, pipes or hoses which will obstruct removal. Remove the four bolts which secure the manifold and lift off the manifold complete with throttle body housing and throttle drum **(see illustration)**.

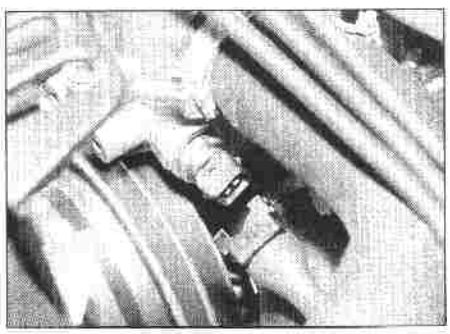
Refitting

All models

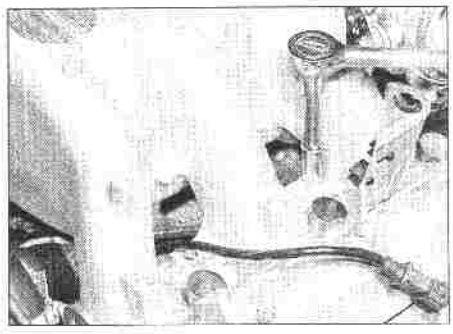
35 Refit by reversing the removal operations, using new gaskets or O-rings. It may be necessary to cut the gasket to clear adjacent components **(see illustration)**.

36 Adjust the throttle drum cable(s), and automatic transmission kickdown cable (Chapter 7B). Run the engine and check the idle speed and mixture on completion (Chapter 1).

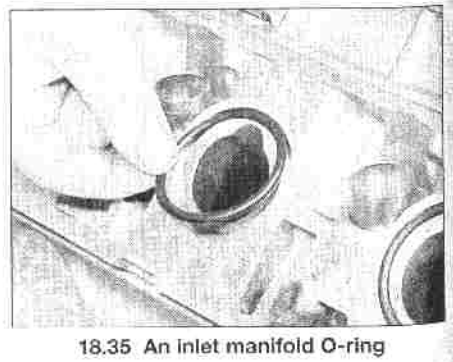
37 Top-up the cooling system if necessary.



18.32 Disconnecting the temperature sensor multiplug



18.34 Removing a manifold securing bolt



18.35 An inlet manifold O-ring

19 Exhaust manifold - removal and refitting

B200/230E/B234F engines

Removal

1 Remove the hot air trunking (when so equipped).
2 Disconnect the exhaust downpipe from the manifold.
3 Unbolt the manifold from the cylinder head and remove it. Recover the gaskets.

Refitting

4 When refitting, use new gaskets. The marking "UT" must face away from the cylinder head.
5 Apply anti-seize compound to the threads. Fit the manifold to the head and tighten the nuts evenly.
6 Reconnect the exhaust downpipe and the hot air trunking.
7 Run the engine and check for leaks.

B23/230ET engines

8 On these engines, the exhaust manifold and turbocharger are removed as a unit - refer to Section 21 for details.

B28/280E engines

Removal

9 Raise and support the front of the vehicle.
10 Disconnect the battery negative lead.
11 Disconnect the exhaust downpipes from the manifold flanges. (Both must be disconnected even if only one manifold is to be removed.)
12 Disconnect the hot air trunking if it is in the way.
13 Disconnect the exhaust system front mounting from the transmission. Move the exhaust system rearwards until the pipes are clear of the manifolds. Support the exhaust system if necessary so that it is not strained.
14 Remove the securing nuts and take off the manifolds. Recover the gaskets; obtain new ones for use when refitting.

Refitting

15 Manifold gaskets are supplied in packets of three. Separate the gasket sections by cutting, not by folding or tearing.
16 Fit the gasket sections over the cylinder head studs, with the reinforced metallic edge facing the head.
17 Fit the manifolds over the studs. Secure them with the nuts; use a little anti-seize compound on the threads. Tighten the nuts evenly.
18 Fit the exhaust pipes to the manifold, using new gaskets, metallic edges facing the manifolds. Fit and tighten the nuts, again using anti-seize compound.
19 Refit the exhaust system front mounting.
20 Refit the hot air trunking.
21 Lower the vehicle and reconnect the battery.
22 Run the engine and check for leaks.

20 Turbocharger - general information and precautions

General information

The turbocharger increases the efficiency of the engine by raising the pressure in the inlet manifold above atmospheric pressure. Instead of the air/fuel mixture being simply sucked into the cylinders it is actively forced in.

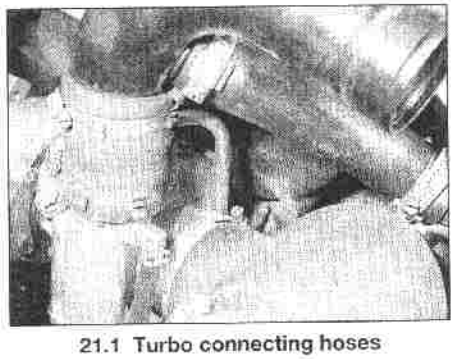
Energy for the operation of the turbocharger comes from the exhaust gas. The gas flows through a specially-shaped housing (the turbine housing) and in so doing spins the turbine wheel. The turbine wheel is attached to a shaft, at the other end of which is another vaned wheel known as the compressor wheel. The compressor wheel spins in its own housing and compresses the inducted air on the way to the inlet manifold.

After leaving the turbocharger, the compressed air passes through an intercooler, which is an air-to-air heat exchanger mounted in front of the radiator. Here the air gives up heat which it acquired when being compressed. This temperature reduction improves engine efficiency and reduces the risk of detonation.

Boost pressure (the pressure in the inlet manifold) is limited by a wastegate, which diverts the exhaust gas away from the turbine wheel in response to a pressure-sensitive actuator. As a further precaution, a pressure-sensitive switch cuts out the fuel pump if boost pressure becomes excessive. Boost pressure is displayed to the driver by a gauge on the instrument panel.

The turbo shaft is pressure-lubricated by means of a feed pipe from the engine's main oil gallery. The shaft "floats" on a cushion of oil. A drain pipe returns the oil to the sump.

From the 1987 model year, the turbocharger is of the water-cooled type. Water cooling keeps the operating temperature of the turbo bearings lower than previously. Water continues to circulate by convection after the engine has stopped, so cooling the turbocharger if it is hot after a long run. A service kit is available for installing the water-cooled unit to earlier models.



21.1 Turbo connecting hoses

Precautions

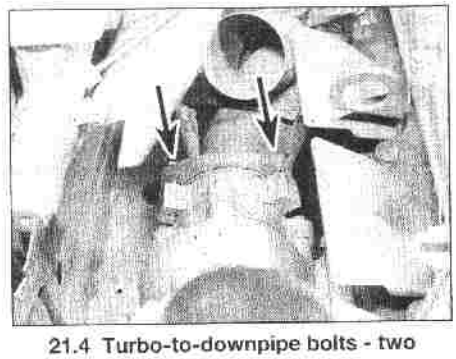
The turbocharger operates at extremely high speeds and temperatures. Certain precautions must be observed to avoid premature failure of the turbo or injury to the operator.

a) Do not operate the turbo with any parts exposed. Foreign objects falling onto the rotating vanes could cause extensive damage and (if ejected) personal injury.
b) Do not race the engine immediately after start-up, especially if it is cold. Give the oil a few seconds to circulate.
c) Always allow the engine to return to idle speed before switching it off - do not blip the throttle and switch off, as this will leave the turbo spinning without lubrication.
d) Allow the engine to idle for several minutes before switching off after a high-speed run.
e) Observe the recommended intervals for oil and filter changing, and use a reputable oil of the specified quality. Neglect of oil changing, or use of inferior oil, can cause carbon formation on the turbo shaft and subsequent failure.

21 Turbocharger - removal and refitting

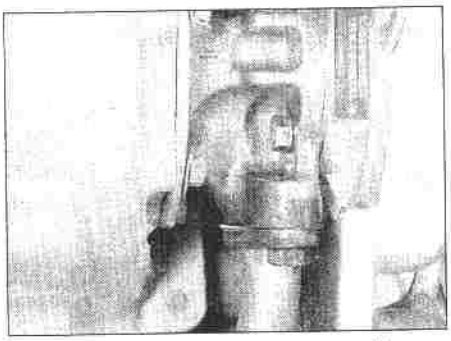
Removal

1 The turbocharger and exhaust manifold are removed together. Begin by removing the turbo-to-intercooler and the airflow meter-to-turbo hoses. The airflow meter hose is also connected to the bypass valve **(see illustration)**.
2 Remove the air cleaner hot air trunking.
3 If a water-cooled turbocharger is fitted, drain the cooling system (see Chapter 1), and disconnect the water pipe connections at the turbocharger.
4 Disconnect the exhaust downpipe from the turbo outlet. Remove the heat shield **(see illustration)**.

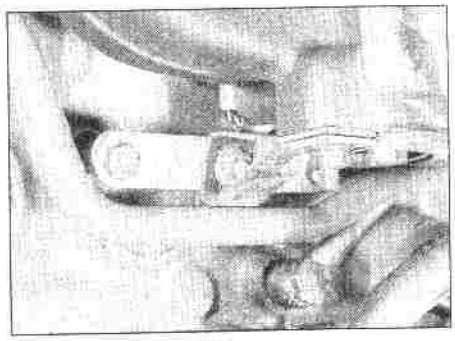


21.4 Turbo-to-downpipe bolts - two arrowed, third is hidden

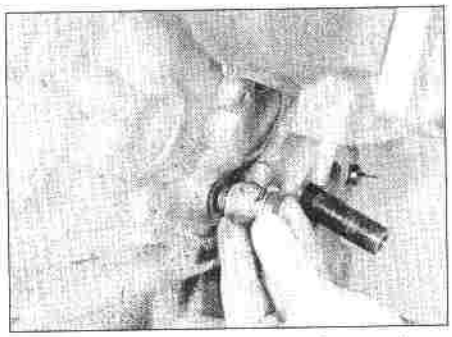
4B



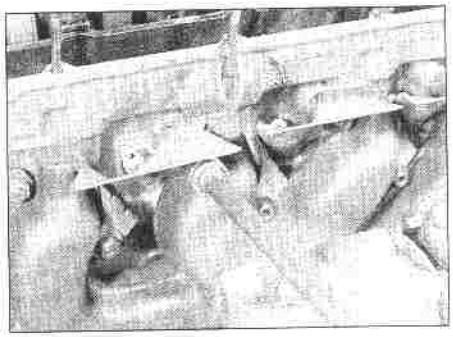
21.5 Turbo oil drain pipe connection



21.6 Exhaust manifold stiffener plate



21.7 Turbo oil feed connection - note sealing washers



21.8 Removing an exhaust manifold nut

5 Disconnect the oil drain pipe from the turbo. Be prepared for some oil spillage **(see illustration)**.
6 Unbolt and remove the stiffener plate from below the manifold **(see illustration)**.
7 Unbolt the oil feed pipe from the block **(see illustration)**.
8 Remove the eight nuts which secure the exhaust manifold to the cylinder head. Note that one of the nuts secures a lifting eye **(see illustration)**.
9 Lift off the manifold and turbocharger. Recover the exhaust port gaskets.
10 Remove the oil feed pipe and recover the gasket.
11 Remove the locking plates from the four bolts which secure the turbocharger to the manifold. Bend up the plate tabs with a chisel and prise or drive them off the bolts. New plates will be needed for reassembly.
12 Clamp the manifold in a vice and remove the four bolts. Lift the turbo off the manifold. Recover the other halves of the locking plates.
13 Measure the length of the bolts and renew them if they have stretched to longer than 89 mm.

Refitting

14 Fit the turbo to the manifold and secure it with the four bolts, applying anti-seize compound to their threads. Remember to fit the new locking plate sections.
15 Tighten the bolts to the specified torque, following the sequence shown. Use an angle-tightening gauge or make up a template for the final angular tightening **(see illustrations)**.
16 Fit the outer halves of the locking plates. Drive them over the bolt heads with a hammer and a tube, crimp the tabs with pliers and finally knock the tabs down with a mallet.
17 The remainder of refitting is a reversal of the removal procedure. Use new gaskets, oil pipe sealing washers, etc.
18 Where a water-cooled turbocharger is fitted, refill the cooling system (Chapter 1).
19 Before starting the engine, disconnect the ignition coil LT feed and crank the engine on the starter for six 10-second bursts. This will prime the turbocharger with oil.
20 Reconnect the ignition coil, run the engine and check that there are no oil or water leaks.

22 Intercooler - removal and refitting

Removal

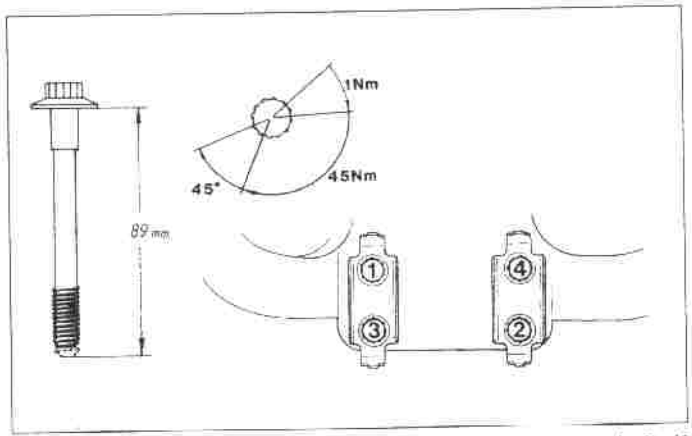
1 Remove the radiator top mountings and carefully move the radiator rearwards.
2 Disconnect the hoses from the intercooler and lift it out.
3 If turbocharger failure has occurred, the intercooler may contain a substantial quantity of oil. A drain plug is provided.

Refitting

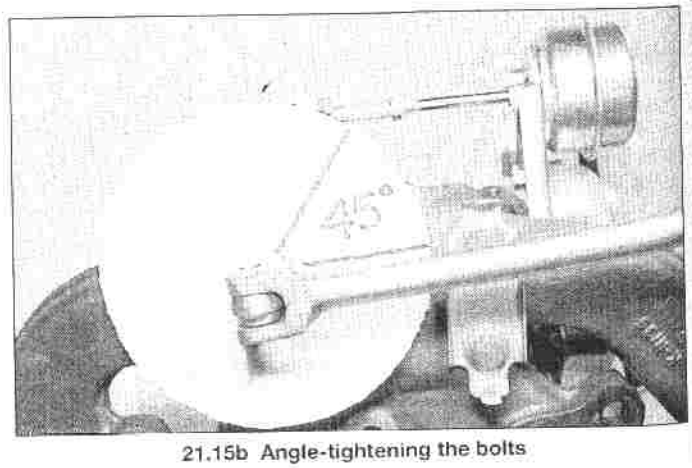
4 Refit by reversing the removal operations.

23 Exhaust system - general information, removal and refitting

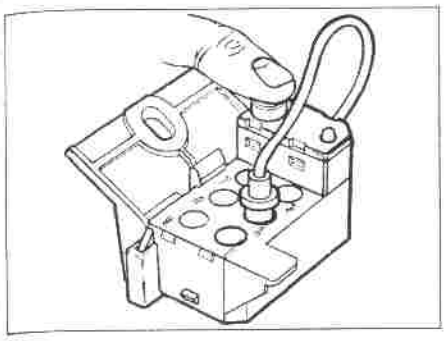
1 Disconnect the signal and electrical heating connections from the oxygen sensor (Lambdasond), if fitted. The oxygen sensor is fitted to the catalytic converter, or to the exhaust pipe immediately upstream of the converter on some earlier models. On turbo



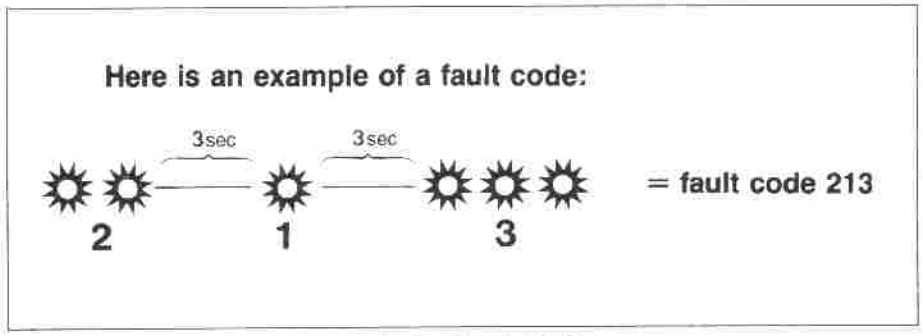
21.15a Turbo bolt tightening sequence and stages. Renew bolts if they are longer than shown



21.15b Angle-tightening the bolts



24.1a Diagnostic unit with plug in socket 2



24.1b Fault code 2-1-3

models, it is fitted to the exhaust downpipe, immediately downstream of the turbocharger.
2 Remove and refit the exhaust system according to the instructions in Chapter 4A, Section 19. Remember to reconnect the oxygen sensor when finished.

24 Fuel system testing with diagnostic unit - LH2.4-Jetronic systems

1 The LH2.4-Jetronic system fitted to B234F engines includes a diagnostic unit which is shared between the fuel and ignition systems. The diagnostic unit is mounted on the left-hand suspension strut housing in the engine compartment and has a plug which can be inserted into different sockets for system testing. Socket number 2 is used for testing the fuel system **(see illustration)**. A variety of tests can be performed by pressing the button, depending on how many times it is pressed.

a) If the button is pressed once, the light will flash, giving a fault code. Any faults that have occurred while the engine has been running are stored in memory, up to a maximum of three faults.

b) If the button is pressed twice, the system will perform functional tests on the throttle switch, speed sensor and the air conditioning control and compressor. The light will flash during each functional test, giving an acknowledgement code.

c) If the button is pressed three times, the system will perform control tests on the injectors, idling control valve, EVAP valve, and the cold start valve if fitted. These components will begin to operate and you can observe them, but there are no acknowledgement codes.

Each code consists of three numbers, represented by three series of flashes. Each flash lasts for about 0.5 seconds and the interval between flashes within a series is also about 0.5 seconds. When a series has finished, the system waits for about 3 seconds, and then starts the next series. For example, the fault code 2-1-3 is represented by two flashes separated by an interval of 0.5 seconds, then an interval of 3 seconds, then one flash, then another interval of 3 seconds, then three flashes separated by 0.5 seconds **(see illustration)**.

Fault Testing

2 Open the cover of the diagnostic unit and insert the plug into socket 2.
3 Turn on the ignition without starting the engine.
4 Press the button once and hold it down for more than 1 second, but not more than 3 seconds.
5 Observe the flashing light and identify the fault code. The available codes are as follows:

1-1-1 No fault.
1-1-2 Control unit fault. Install new unit.
1-1-3 Injector cable break or blocked injector.
1-2-1 No signal to or from air mass meter. Engine runs in limp home mode.
1-2-3 No signal from coolant temperature sensor, or short to ground. Engine behaves as though hot.
1-3-1 No ignition system rpm signal.
1-3-2 Battery voltage too low or too high.
1-3-3 Throttle switch idle position incorrectly adjusted or shorted to ground.
2-1-2 No Lambdasond signal.
2-1-3 Throttle switch in full load position, shorted to ground.
2-2-1 Adaptive Lambda control, lean, part load.
2-2-3 No signal to or from idle control valve
2-3-1 Adaptive Lambda control, lean or rich, part load.
2-3-2 Adaptive Lambda control, lean or rich, idle.
2-3-3 Idle control valve, closed or leaking.
3-1-1 No signal from speedometer.
3-1-2 No knock enrichment signal from ignition system.
3-2-2 Air mass meter platinum wire burn-off function, defective.

6 If the code 1-1-1 is displayed, there are no faults in the system memory. If any other code is displayed, press the button again to see if there is a second fault. Then press it a third time to see if there is a third fault. The system can store a maximum of three faults. When you have observed all the recorded faults, the system will cycle back to the first fault next time you press the button.
7 Take whatever action is necessary to rectify the faults.
8 Press the button again and hold it down for at least 5 seconds, then release it. The light will come on after 3 to 4 seconds. Press the button a second time for at least 5 seconds. This will erase the system memory so that it becomes available for recording new faults.
9 Remove the plug from socket 2, place it in its holder and then test drive the vehicle. Then repeat these instructions to see if any new faults are recorded. If there are no more faults, the code will be 1-1-1.

Functional Testing

10 Open the cover of the diagnostic unit and insert the plug into socket 2.
11 Turn on the ignition without starting the engine.
12 Press the button twice. On each occasion hold it down for more than 1 second, but not more than 3 seconds. The light will begin to flash continuously. You can now perform a series of tests, and on each occasion the light should first go out and then display an acknowledgement code. Wait until the light has returned to continuous flashing before the next test.
13 Open the throttle fully. The acknowledgement code 3-3-3 should appear, confirming the operation of the full-load contacts (not applicable to turbo engines that have no full-load contacts).
14 Release the throttle. The acknowledgement code 3-3-2 should appear, confirming the operation of the idling switch.
15 Start the engine. The acknowledgement code 3-3-1 should appear, confirming the speed signal. Leave the engine idling.
16 Switch on the air conditioning. The acknowledgement code 1-1-4 should appear, confirming that the AC switch functions are correct.
17 Adjust the air conditioning, if necessary, so that the compressor comes on. The acknowledgement code 1-3-4 should appear, confirming that the compressor coupling is connected.

18 On cars with automatic gear boxes, apply the footbrake and set the gear selector to position D, then back to position N. The acknowledgement code 1-2-4 should appear. If the code does not appear, see your Volvo dealer.

19 Switch off the engine. Remove the plug from socket 2 and place it in its holder.

Control Testing

20 Open the cover of the diagnostic unit and insert the plug into socket 2.

21 Turn on the ignition without starting the engine.

22 Press the button three times. On each occasion hold it down for more than 1 second, but not more than 3 seconds. A number of components will begin to operate in sequence at a given frequency, for approximately 10 seconds each, with an interval of 5 seconds between each component. The light will flash at the frequency of the operating component. You can observe the components by placing a hand on them or listening to the noises they make. The cycle is as follows:

a) The injectors will operate at 13 Hz.
b) The idling control valve will operate at 1 Hz.
c) The EVAP valve will operate at 2 Hz. (B234F engines only)
d) The cold start valve, if fitted, will operate at an unspecified frequency.

The cycle will be repeated until another system is selected or the ignition is switched off. If the light flashes at the given frequency of a component, but the component does not operate, then the component is faulty.

23 Switch off the ignition. Remove the plug from socket 2 and place it in its holder.

Chapter 4 Part C:
Emission control systems

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

1 General information

Many of the models covered by this manual have various features built into the fuel system to help minimise harmful emissions. All models are equipped with the crankcase emission control system described below. Later vehicles also feature a catalytic converter to reduce exhaust emissions, and carburettor equipped models have an exhaust gas recirculation (EGR) system as well as a Pulsair system to reduce emissions still further.

The emission control systems function as follows.

Crankcase emission control

To reduce the emissions of unburned hydrocarbons from the crankcase into the atmosphere, a Positive Crankcase Ventilation (PCV) system is used whereby the engine is sealed and the blow-by gases and oil vapour are drawn from inside the crankcase, through an oil separator, into the inlet tract to be burned by the engine during normal combustion.

Under conditions of high manifold depression (idling, deceleration) the gases will be sucked positively out of the crankcase. Under conditions of low manifold depression (acceleration, full-throttle running) the gases are forced out of the crankcase by the (relatively) higher crankcase pressure; if the engine is worn, the raised crankcase pressure (due to increased blow-by) will cause some of the flow to return under all manifold conditions.

Exhaust emission control

To minimise the amount of pollutants which escape into the atmosphere, some models are fitted with a catalytic converter in the exhaust system. In general, on electronically controlled fuel-injection systems where a catalytic converter is fitted, there is an oxygen sensor (Lambdasond) which measures the amount of oxygen in the exhaust system and uses the result to maintain the correct air/fuel ratio for complete combustion of petrol - 14.7 parts (by weight) of air to 1 part of fuel. Under these conditions, peak conversion of all major pollutants occurs. The oxygen sensor, where fitted, is an essential component of the fuel injection system (see Part B) but it is also important for exhaust emission control.

On carburettor models, accurate control of the fuel/air mixture under all driving conditions is not possible due to the relatively unsophisticated nature of carburettor induction. On these engines, a single-stage (open-loop) catalytic converter is fitted, in conjunction with the additional emission control systems described below.

Exhaust gas recirculation system

The EGR system is part of the emission control package fitted to B230K engines from 1987 onwards. Its function is to introduce a controlled quantity of exhaust gas into the inlet manifold at part load conditions. This has the effect of reducing the emission of oxides of nitrogen.

The components of the system are a control valve, a vacuum amplifier, a thermostatic valve and the associated pipework. The control valve receives a signal from the vacuum amplifier, causing the valve to open or close and so allow more or less exhaust gas to pass. The vacuum amplifier receives signals from the air cleaner-to-carburettor ducting, from the carburettor venturi and from the inlet manifold itself. The manifold vacuum signal arrives via the thermostatic valve, which is closed at low temperatures and so stops the system operating during warm-up.

When the system is operating correctly, exhaust gas recirculation does not take place at idle nor at full load. Malfunction at idle will cause rough running and stalling. Malfunction at full load will cause loss of power.

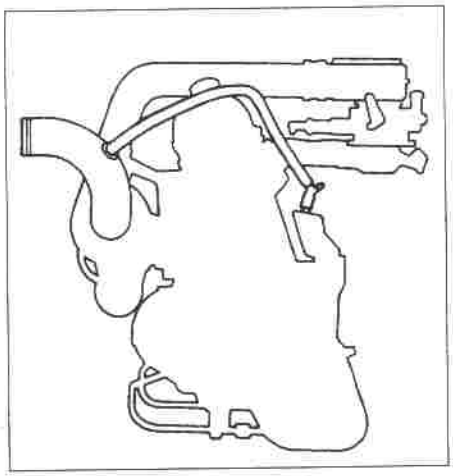
Pulsair system

The Pulsair system is also part of the emission control package fitted to later B230K engines. It uses fluctuations in pressure in the exhaust manifold to draw in pulses of air from the air cleaner housing. The air provides oxygen which combines with unburnt hydrocarbons to reduce exhaust pollution.

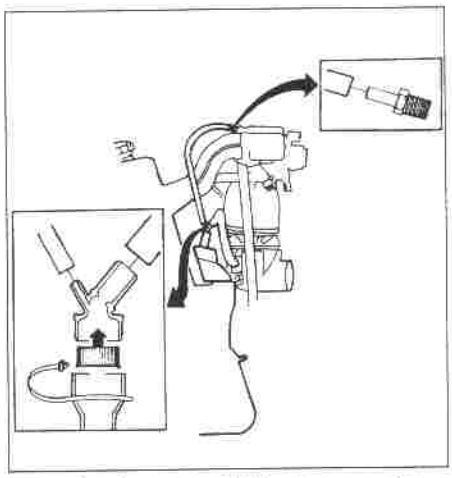
The components of the system are an air distribution manifold, two non-return valves, a shut-off valve and associated pipework. The shut-off valve is controlled by inlet manifold vacuum and stops air flowing to the exhaust manifold for a couple of seconds at the beginning of deceleration, so preventing backfiring. The non-return valves prevent exhaust gas from arriving in the air cleaner.

Evaporative emission control system

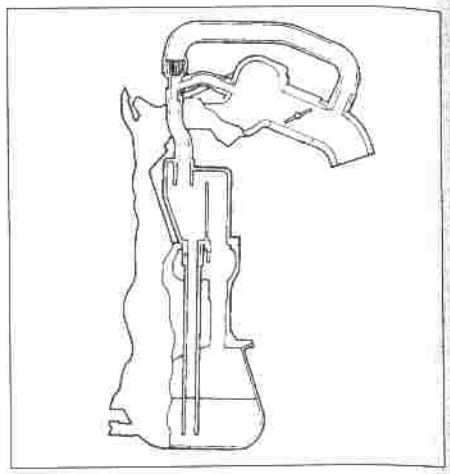
The Evaporative Emission Control system, known as EVAP, is fitted to B234F models and recovers fuel vapours from the tank to



2.1a Typical crankcase ventilation hose routing - Turbo models



2.1b Crankcase ventilation hose routing - B200/B230 normally aspirated models



2.1c Crankcase ventilation hose routing - B234F engine

prevent them from being released to the atmosphere. Fuel vapours, up to a maximum of about 90 gm, are absorbed by a canister of active carbon and then passed through an EVAP valve to the inlet manifold. When the engine is at rest or running at idling speed, the EVAP valve is closed and vapours are absorbed by the active carbon filter. When the engine is running above idling speed, the EVAP valve is energised and vapours are released to the inlet manifold. The EVAP valve is operated by the fuel system control unit, and while energised it opens for seven minutes and closes for two minutes on a cyclic basis. During the 'open' period, it operates at a frequency of 6 Hz so that it opens and closes six times per second. Under normal running conditions, the canister is emptied of fuel in about 15-20 minutes.

There is a roll-over valve between the fuel tank and the active carbon filter, to prevent fuel from leaking in the event of an accident. If the car tilts sideways by more than 45°, the roll-over valve closes.

2 Emission control systems - testing and component renewal

Crankcase emission control

1 The components of this system require no attention other than to check that the hoses are clear and undamaged at regular intervals **(see illustrations)**.

Exhaust emission control

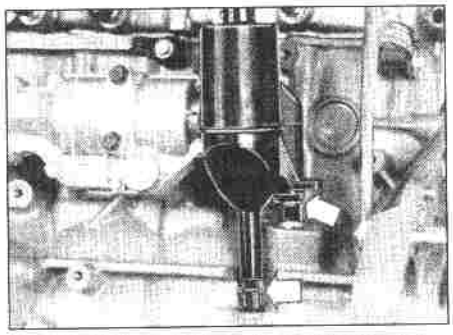
Testing

2 The performance of the catalytic converter can be checked only by measuring the exhaust gases using a good-quality, carefully calibrated exhaust gas analyser.

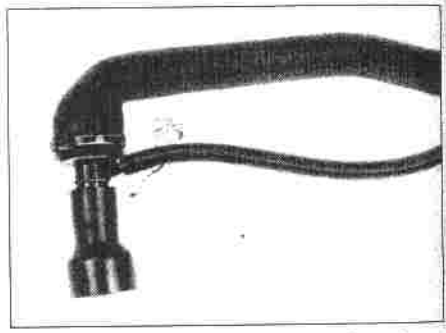
3 If the CO level at the tailpipe is too high, the vehicle should be taken to a Volvo dealer so that the complete fuel and ignition system can be thoroughly checked using the special diagnostic equipment. On B234F models the self-diagnostic unit is available (see Chapters 4B and 5B). If the fuel and ignition systems are known to be free from faults, the fault must be in the catalytic converter which will need to be renewed.

Catalytic converter - renewal

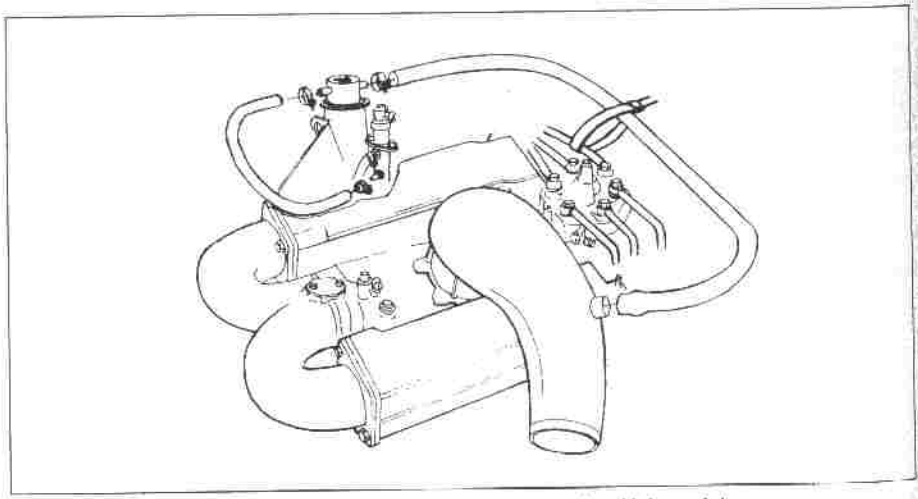
4 The catalytic converter is located between the exhaust system front sections and is removed and refitted in the same way as the other sections. Disconnect the signal and electrical heating connections from the oxygen sensor (Lambdasond), then remove the appropriate sections of the exhaust system (see Chapter 4A, Section 19). In some



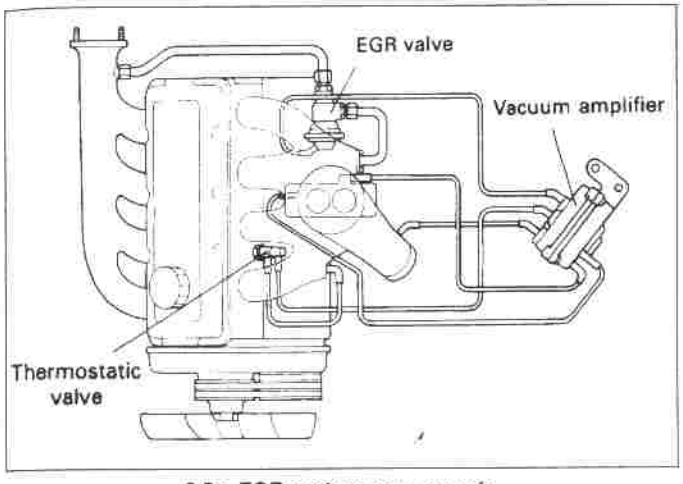
2.1d Oil trap and seals - B234F engine



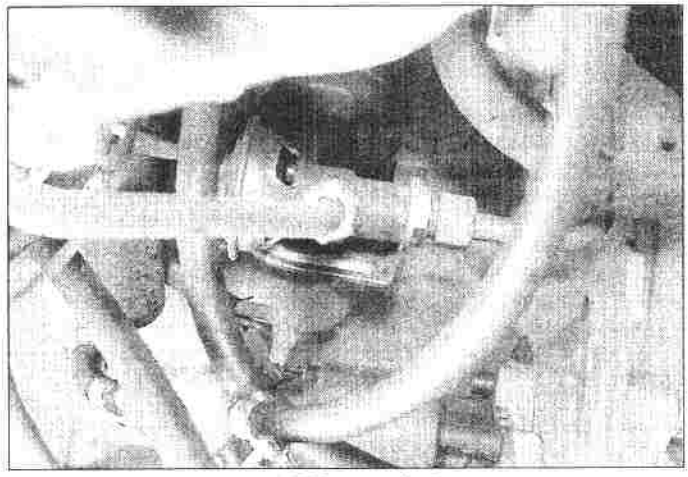
2.1e Flame trap T-piece - mounts on top of oil trap - B234F engine



2.1f Crankcase ventilation components - V-6 models



2.5a EGR system components



2.5b EGR control valve

cases it is easier to remove the complete exhaust system from the downpipe(s) rearwards and then dismantle it on the bench. Remove the catalytic converter and replace it with a new one of the same type, making sure it is the right way round. The converter has a plate giving the part number and other details, and is marked with an arrow giving the direction of flow. Renew the converter flange seals and ensure that all retaining nuts are securely tightened. Remove and refit the oxygen sensor, if it was fitted to the old converter (see Chapter 4B, Section 15). Reassemble the exhaust system and reconnect the oxygen sensor.

Note: *See Section 3 for general information about the catalytic converter.*

Exhaust gas recirculation system

Testing

5 Open the bonnet and locate the EGR valve. Shine a light on it so that the movement of the valve rod may be observed **(see illustrations)**. Start the engine from cold and warm it up. No movement of the valve rod should take place, regardless of throttle opening, at coolant temperatures below 55°C. If the valve operates at low coolant temperatures, the thermostatic valve is defective.

6 With the engine warm, verify that the EGR valve rod moves at part throttle and closes again at idle. If not, the valve or the vacuum amplifier (or their connections) must be at fault. The EGR valve and the vacuum amplifier are matched in production and must be renewed as a pair.

Component renewal

7 At the time of writing no specific information was available regarding removal and refitting of the system components.

Pulsair system

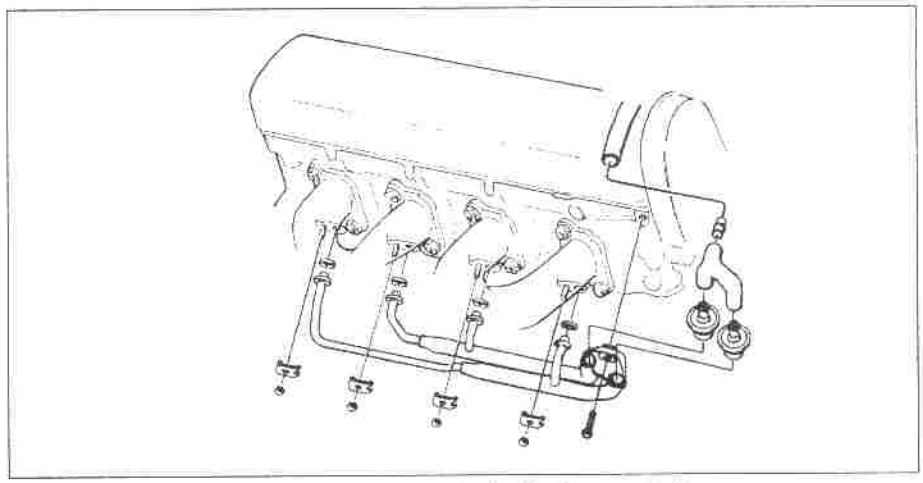
Testing

8 Initially check that all hoses and connections in the system are in good condition.

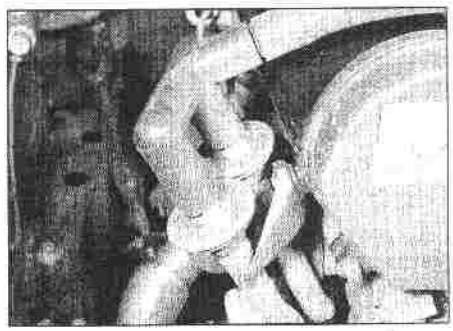
9 Disconnect the non-return valves from the air cleaner hose. Run the engine and feel the openings of the valves. Air should be sucked in and exhaust gas must not be emitted. If this is not the case the valves are defective. Reconnect the hose **(see illustrations)**.

10 If the shut-off valve is not closing as it should, backfiring on the overrun will have been noticed. To verify that the valve is open at idle, measure the exhaust gas CO level first with the system blocked off (clamp the hose between the air cleaner and the non-return valves), then with the system unblocked. The CO level must fall when the system is unblocked: if not, the shut-off valve is probably defective **(see illustration)**.

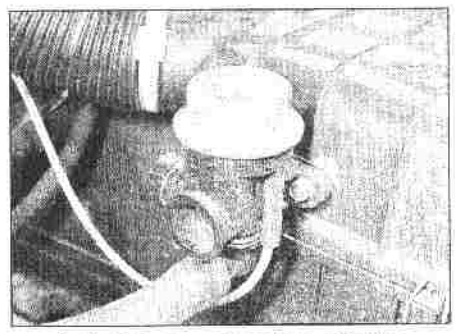
11 Before condemning a shut-off valve which is apparently not opening, check that the ignition timing and the engine valve clearances are correct. Retarded timing or excessive valve clearances can both be causes of excessive inlet manifold vacuum.



2.9a Pulsair system air distribution manifold



2.9b Pulsair system non-return valves



2.10 Pulsair system shut-off valve

Component renewal

12 At the time of writing no specific information was available regarding removal and refitting of the system components.

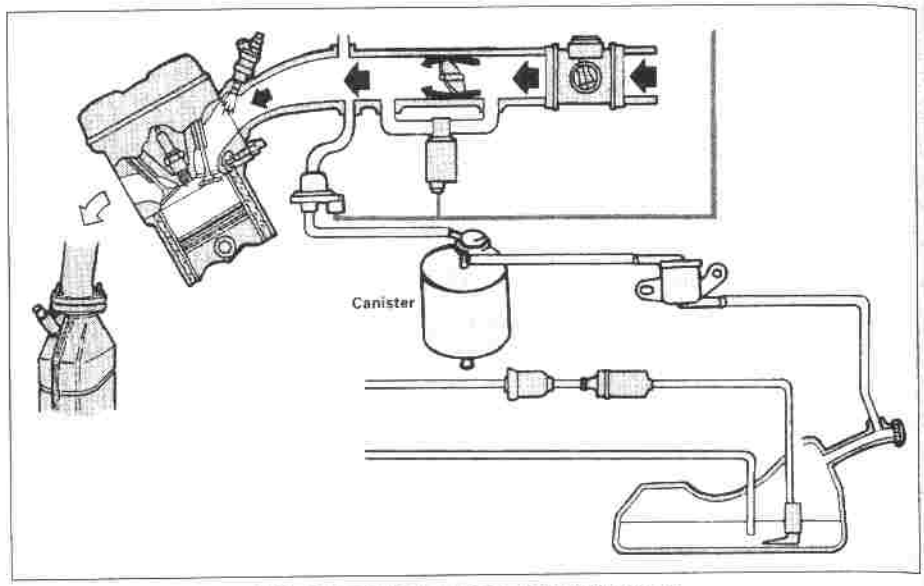
Evaporative emission control system

Testing

13 The EVAP system releases accumulated vapours from the active carbon filter to the inlet manifold under the control of the EVAP valve **(see illustration)**. To test this component, use the built-in diagnostic unit to perform a control test on the fuel system (see Chapter 4B). A number of components will begin to operate in sequence at a given frequency, including the EVAP valve. If it does not operate correctly, it needs to be renewed.

Component renewal

14 At the time of writing no specific information was available regarding removal and refitting of the system components.



2.13 Evaporative emission control system

3 Catalytic converter - general information and precautions

The catalytic converter is a reliable and simple device, which needs no maintenance in itself, but there are some facts of which an owner should be aware if the converter is to function properly for its full service life.

a) DO NOT use leaded petrol in a vehicle equipped with a catalytic converter - the lead will coat the precious metals, reducing their converting efficiency, and will eventually destroy the converter.

b) Always keep the ignition and fuel systems well-maintained in accordance with the manufacturer's schedule (see Chapter 1).

c) If the engine develops a misfire, do not drive the vehicle at all (or at least as little as possible) until the fault is cured.

d) DO NOT push - or tow-start the vehicle - this will soak the catalytic converter in unburned fuel, causing it to overheat when the engine does start.

e) DO NOT switch off the ignition at high engine speeds, ie do not "blip" the throttle immediately before switching off.

f) DO NOT use fuel or engine oil additives - these may contain substances harmful to the catalytic converter.

g) DO NOT continue to use the vehicle if the engine burns oil to the extent of leaving a visible trail of blue smoke.

h) Remember that the catalytic converter operates at very high temperatures. DO NOT, therefore, park the vehicle in dry undergrowth, over long grass or piles of dead leaves, after a long run.

i) Remember that the catalytic converter is FRAGILE. Do not strike it with tools during servicing work.

j) In some cases, a sulphurous smell (like that of rotten eggs) may be noticed from the exhaust. This is common to many catalytic converter-equipped vehicles. Once the vehicle has covered a few thousand miles, the problem should disappear - in the meantime, try changing the brand of petrol used.

k) The catalytic converter used on a well-maintained and well-driven vehicle should last for between 50,000 and 100,000 miles. If the converter is no longer effective, it must be renewed.

See Section 2 for details of how to renew the catalytic converter.

Chapter 5 Part A:
Starting and charging systems

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

System type	12 volt, negative earth
Battery	
Type	Lead acid
Charge condition:	
Poor	12.5 volts
Normal	12.6 volts
Good	12.7 volts
Alternator	
Type	Bosch K1 or N1
Starter motor	
Type	Bosch GF or DW, or Hitachi

5A

1 General information and precautions

General information

The engine electrical system consists mainly of the charging and starting systems. Because of their engine-related functions, these components are covered separately from the body electrical devices such as the lights, instruments, etc (which are covered in Chapter 12). Information on the ignition system will be found in Part B of this Chapter.

The electrical system is of the 12-volt negative earth type.

The battery is charged by the alternator which is belt driven from the crankshaft pulley.

The starter motor is of the pre-engaged type incorporating an integral solenoid. On starting, the solenoid moves the drive pinion into engagement with the flywheel/driveplate ring gear teeth before the starter motor is energised. Once the engine is started, a one-way clutch prevents the motor armature being turned by the engine until the pinion disengages from the ring gear.

Precautions

Further details of the various systems are given in the relevant Sections of this Chapter. While some repair procedures are given, the usual course of action is to renew the component concerned. The owner whose interest extends beyond mere component renewal should obtain a copy of the *"Automobile Electrical & Electronic Systems Manual"* from the publishers of this manual.

It is necessary to take extra care when working on the electrical system to avoid damage to semi-conductor devices (diodes and transistors), and to avoid the risk of personal injury. In addition to the precautions given in "Safety First!" at the beginning of this manual, observe the following when working on the electrical system:

Always remove rings, watches, etc before working on the electrical system. Even with the battery disconnected, capacitive discharge could occur if a component's live terminal is earthed through a metal object. This could cause a shock or nasty burn.

Do not reverse the battery connections. Components such as the alternator, or any other components having semi-conductor circuitry could be irreparably damaged.

If the engine is being started using jump leads and a slave battery, connect the batteries positive-to-positive and negative-to-negative (see "Booster battery (jump) starting"). This also applies when connecting a battery charger.

Never disconnect the battery terminals, the alternator, or any electrical wiring or any test instruments when the engine is running.

Do not allow the engine to turn the alternator when the alternator is not connected.

Never "test" for alternator output by "flashing" the output lead to earth.

Never use an ohmmeter of the type incorporating a hand-cranked generator for circuit or continuity testing.

Always ensure that the battery negative lead is disconnected when working on the electrical system.

Before using electric-arc welding equipment on the vehicle, disconnect the battery and alternator to protect them from the risk of damage.

Certain later radio/cassette units fitted as standard equipment by Volvo are equipped with built-in security codes to deter thieves. If the power source to the unit is interrupted, the anti-theft system will activate. Even if the power source is immediately reconnected, the radio/cassette unit will not function until the correct security code has been entered. Therefore, if you do not know the correct security code for the radio/cassette unit, do not disconnect the negative terminal of the battery or remove the radio/cassette unit from the vehicle. Refer to "Radio/cassette anti-theft system -precaution" Section for further information.

2 Electrical fault finding - general information

Refer to Chapter 12.

3 Battery - testing and charging

Note: *On B234F models you can test the battery condition using the self-diagnostic unit. If the battery voltage is too high or too low, a fault code will be displayed during a fuel system test. See Chapter 4B.*

Standard and low maintenance battery - testing

1 If the vehicle covers a small annual mileage, it is worthwhile checking the specific gravity of the electrolyte every three months to determine the state of charge of the battery. Use a hydrometer to make the check and compare the results with the following table. Note that the specific gravity readings assume an electrolyte temperature of 15°C; for every 10°C below 15°C subtract 0.007. For every 10°C above 15°C add 0.007.

	Above 25°C	Below 25°C
Fully charged	*1.210 to 1.230*	*1.270 to 1.290*
70% charged	*1.170 to 1.190*	*1.230 to 1.250*
Discharged	*1.050 to 1.070*	*1.110 to 1.130*

2 If the battery condition is suspect, first check the specific gravity of electrolyte in each cell. A variation of 0.040 or more between any cells indicates loss of electrolyte or deterioration of the internal plates.

3 If the specific gravity variation is 0.040 or more, the battery should be renewed. If the cell variation is satisfactory but the battery is discharged, it should be charged as described later in this Section.

Maintenance-free battery - testing

4 In cases where a "sealed for life" maintenance-free battery is fitted, topping-up and testing of the electrolyte in each cell is not possible. The condition of the battery can therefore only be tested using a battery condition indicator or a voltmeter.

5 If testing the battery using a voltmeter, connect the voltmeter across the battery and compare the results with those given in the Specifications under "charge condition". The test is only accurate if the battery has not been subjected to any kind of charge for the previous six hours. If this is not the case, switch on the headlights for 30 seconds, then wait four to five minutes before testing the battery after switching off the headlights. All other electrical circuits must be switched off, so check that the doors, boot and/or tailgate are fully shut when making the test.

6 If the voltage reading is less than 12.2 volts, then the battery is discharged, whilst a reading of 12.2 to 12.4 volts indicates a partially discharged condition.

7 If the battery is to be charged, remove it from the vehicle (Section 4) and charge it as described later in this Section.

Standard and low-maintenance battery - charging

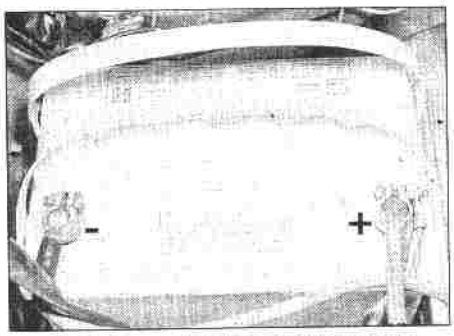
Note: *The following is intended as a guide only. Always refer to the manufacturer's recommendations (often printed on a label attached to the battery) before charging a battery.*

8 Charge the battery at a rate of 3.5 to 4 amps and continue to charge the battery at this rate until no further rise in specific gravity is noted over a four hour period.

9 Alternatively a trickle charger charging at the rate of 1.5 amps can safely be used overnight.

10 Specially rapid "boost" charges which are claimed to restore the power of the battery in 1 to 2 hours are not recommended, as they can cause serious damage to the battery plates through overheating.

11 While charging the battery, note that the temperature of the electrolyte should never exceed 37.8°C.



4.1 Battery, showing positive (+) and negative (-) terminals

Maintenance-free battery - charging

Note: *The following is intended as a guide only. Always refer to the manufacturer's recommendations (often printed on a label attached to the battery) before charging a battery.*

12 This battery type takes considerably longer to fully recharge than the standard type, the time taken being dependent on the extent of discharge, but it can take anything up to three days.

13 A constant voltage type charger is required, to be set, when connected, to 13.9 to 14.9 volts with a charger current below 25 amps. Using this method, the battery should be usable within three hours, giving a voltage reading of 12.5 volts, but this is for a partially discharged battery and, as mentioned, full charging can take considerably longer.

14 If the battery is to be charged from a fully discharged state (condition reading less than 12.2 volts), have it recharged by your Volvo dealer or local automotive electrician, as the charge rate is higher and constant supervision during charging is necessary.

4 Battery - removal and refitting

Note: *If a radio/cassette unit with built-in security code is fitted, refer to "Radio/cassette unit anti-theft system precaution".*

Removal

1 Disconnect the battery negative (earth) lead **(see illustration)**.

2 Disconnect the battery positive leads. These may be protected by a plastic cover. Do not allow the spanner to bridge the positive and negative terminals.

3 Release the battery hold-down clamps. Lift out the battery. Keep it upright and be careful not to drop it - it is heavy.

Refitting

4 Commence refitting by placing the battery in its tray, making sure it is the right way round. Secure it with the hold-down clamp.

5 Clean the battery terminals if necessary, then reconnect them. Connect the positive lead first, and the negative lead last.

5 Charging system - testing

Note: *Refer to the warnings given in "Safety First!" and in Section 1 of this Chapter before starting work.*

1 If the ignition warning light fails to illuminate when the ignition is switched on, first check the alternator wiring connections for security. If satisfactory, check that the warning light bulb has not blown and that the bulbholder is secure in its location in the instrument panel. If the light still fails to illuminate, check the continuity of the warning light feed wire from the alternator to the bulbholder. If all is satisfactory, the alternator is at fault and should be renewed or taken to an auto-electrician for testing and repair.

2 If the ignition warning light illuminates when the engine is running, stop the engine and check that the drivebelt is correctly tensioned (see Chapter 1) and that the alternator connections are secure. If all is so far satisfactory, have the alternator checked by an auto-electrician.

3 If the alternator output is suspect even though the warning light functions correctly, the regulated voltage may be checked as follows.

4 Connect a voltmeter across the battery terminals and start the engine.

5 Increase the engine speed until the voltmeter reading remains steady; the reading should be approximately 12 to 13 volts, and no more than 14 volts.

6 Switch on as many electrical accessories (eg, the headlights, heated rear window, heater blower) as possible and check that the alternator maintains the regulated voltage at around 13 to 14 volts.

7 If the regulated voltage is not as stated, the fault may be due to worn brushes, weak brush springs, a faulty voltage regulator, a faulty diode, a severed phase winding or worn or damaged slip rings. The alternator should be renewed or taken to an auto-electrician for testing and repair.

6 Alternator drivebelt - removal, refitting and tensioning

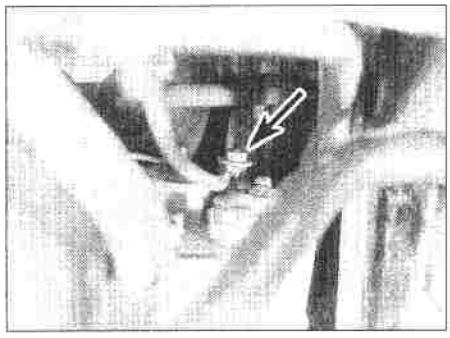
Refer to the procedure given for the accessory drivebelts in Chapter 1.

7 Alternator - removal and refitting

Note: *On some models, access to the alternator is easiest from below. Remove the undertray if necessary.*

Removal

1 Disconnect the battery negative lead.



7.3 Alternator output terminal (arrowed) seen from below

2 Slacken the alternator drivebelt(s) and slip them off the pulley (Refer to Chapter 1).

3 Disconnect the electrical wiring from the rear of the alternator - this may be a multi-plug or separate screw terminals. Make notes for reconnection if necessary **(see illustration)**.

4 Support the alternator. Remove the pivot and adjusting strap nuts, bolts and washers, noting the fitted positions of the washers. Lift out the alternator. Do not drop it, it is fragile.

Refitting

5 Refit by reversing the removal operations. Tension the drivebelt(s) (Chapter 1) before reconnecting the battery.

8 Alternator - testing and overhaul

If the alternator is thought to be suspect, it should be removed from the vehicle and taken to an auto-electrician for testing. Most auto-electricians will be able to supply and fit brushes at a reasonable cost. However, check on the cost of repairs before proceeding as it may prove more economical to obtain a new or exchange alternator.

9 Starting system - testing

Note: *Refer to the warnings given in "Safety First!" and in Section 1 of this Chapter before starting work.*

1 If the starter motor fails to operate when the ignition key is turned to the appropriate position, the following possible causes may be to blame:

a) The battery is faulty.
b) The electrical connections between the switch, solenoid, battery and starter motor are somewhere failing to pass the necessary current from the battery through the starter to earth.
c) The solenoid is faulty.
d) The starter motor is mechanically or electrically defective.

2 To check the battery, switch on the headlights. If they dim after a few seconds, this indicates that the battery is discharged - recharge (see Section 3) or renew the battery. If the headlights glow brightly, operate the ignition switch and observe the lights. If they dim, then this indicates that current is reaching the starter motor, therefore the fault must lie in the starter motor. If the lights continue to glow brightly (and no clicking sound can be heard from the starter motor solenoid), this indicates that there is a fault in the circuit or solenoid - see following paragraphs. If the starter motor turns slowly when operated, but the battery is in good condition, then this shows that either the starter motor is faulty, or there is considerable resistance in the circuit.

3 If a fault in the circuit is suspected, disconnect the battery leads (including the earth connection to the body), the starter/solenoid wiring and the engine/transmission earth strap. Thoroughly clean the connections, and reconnect the leads and wiring, then use a voltmeter or test lamp to check that full battery voltage is available at the battery positive lead connection to the solenoid, and that the earth is sound. Smear petroleum jelly around the battery terminals to prevent corrosion - corroded connections are amongst the most frequent causes of electrical system faults.

4 If the battery and all connections are in good condition, check the circuit by disconnecting the wire from the solenoid blade terminal. Connect a voltmeter or test lamp between the wire and a good earth (such as the battery negative terminal), and check that the wire is live when the ignition switch is turned to the "start" position. If it is, then the circuit is sound - if not, the circuit wiring can be checked as described in Chapter 12.

5 The solenoid contacts can be checked by connecting a voltmeter or test lamp between the battery positive feed connection on the starter side of the solenoid, and earth. When the ignition switch is turned to the "start" position, there should be a reading or lighted bulb, as applicable. If there is no reading or lighted bulb, the solenoid is faulty and should be renewed.

6 If the circuit and solenoid are proved sound, the fault must lie in the starter motor. In this event, it may be possible to have the starter motor overhauled by a specialist, but check on the cost of spares before proceeding, as it may prove more economical to obtain a new or exchange motor.

10 Starter motor - removal and refitting

Removal

1 On some models, access to the starter motor is easier from below. Raise the front of the vehicle on ramps if necessary, and remove the undertray.

2 Disconnect the battery negative lead.
3 On the V6 engine, remove the oil filter (see Chapter 1).
4 Disconnect the wires from the starter motor solenoid. Make notes or identifying marks if necessary **(see illustration)**.
5 Support the starter motor and remove its securing bolts. If a tail bracket is fitted, unbolt it first **(see illustration)**.
6 Remove the starter motor. When fitted, recover the adapter plate **(see illustration)**.

Refitting

7 Refit by reversing the removal operations.

11 Starter motor - testing and overhaul

If the starter motor is thought to be suspect, it should be removed from the vehicle and taken to an auto-electrician for testing. Most auto-electricians will be able to supply and fit brushes at a reasonable cost. However, check on the cost of repairs before proceeding as it may prove more economical to obtain a new or exchange motor.

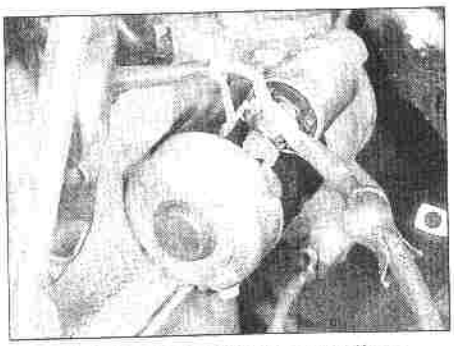
12 Oil level sensor - removal and refitting

Removal

1 When fitted, the oil level sensor is screwed into the right-hand side of the engine lower crankcase. The sensor protrudes into the sump.
2 To remove the sensor, unscrew it from its hole. Be careful with it, it is fragile.

Refitting

3 When refitting the sensor, apply some sealant to its threads. Screw the sensor home, reconnect the multi-plug and check for correct operation **(see illustration)**.



10.4 Starter solenoid connections

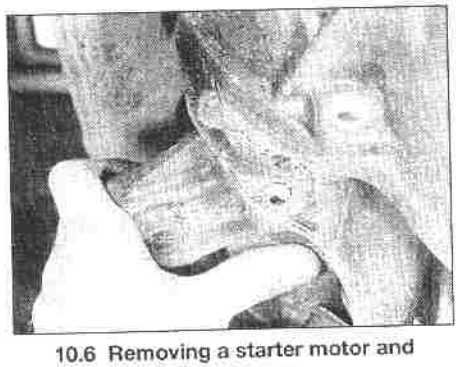
10.5 Starter motor securing bolts

4 The oil level warning control unit is located under the rear console armrest/storage box.

13 Oil pressure warning light switch - removal and refitting

Removal

1 On in-line engines, the oil pressure switch is located on the right-hand side of the cylinder block, between the oil filter and the alternator; on V-6 engines it is located on the right-hand side of the cylinder block at the front of the engine. Depending on model and equipment, access may be easier from below.

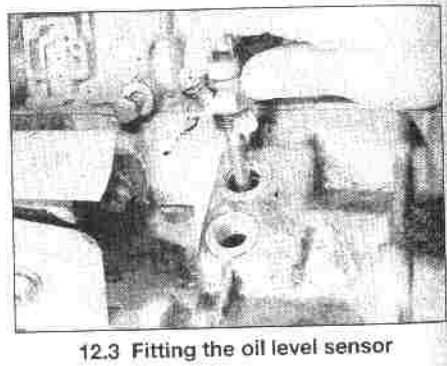


10.6 Removing a starter motor and adapter plate

2 Disconnect the electrical lead from the switch. Wipe clean around the switch, unscrew it from the block and remove it. Recover the sealing washer (if fitted). Note that on V-6 engines, several different types and lengths of switch have been fitted over the years. If the switch is to be renewed, it is important that the correct type is fitted, otherwise loss of oil pressure may result.

Refitting

3 Refit by reversing the removal operations. Put a smear of sealant on the switch threads and renew the sealing washer if necessary.
4 Run the engine and check for correct operation of the oil pressure warning light. Inspect the switch to see that there are no leaks.



12.3 Fitting the oil level sensor

Chapter 5 Part B:
Ignition system

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

General

System type	Breakerless electronic ignition system
Application:	
B23ET and B230ET engines	Motronic
B200E, B230E, B230K	EZ118K
B234F	EZ116K
B280E	EZ115K
B28E	TSZ-4

Firing order

In-line engines	1-3-4-2 (No. 1 cylinder at front of engine)
V-6 engines	1-6-3-5-2-4 (No. 1 cylinder at left-hand rear of engine)

Spark plugs

See Chapter 1 Specifications

Ignition timing*

B23ET	10° BTDC @ 750 rpm (not adjustable)
B200E	12° BTDC @ 900 rpm
B230E	12° BTDC @ 900 rpm
B230ET	10° BTDC @ 900 rpm (not adjustable)
B230K	15° BTDC @ 800 rpm
B234F	15° BTDC @ 850 rpm (not adjustable)
B28E	10° BTDC @ 900 rpm
B280E	10° BTDC @ 750 rpm (not adjustable)

Vacuum unit disconnected (when applicable)

Ignition coil

Primary resistance (typical)	0.5 to 1.0 Ω
Secondary resistance (typical)	6000 to 9000 Ω

1 Ignition system - general information

The ignition system is responsible for igniting the compressed fuel/air charge in each cylinder in turn. This must be done at precisely the right moment for the prevailing engine speed and load. The various engines have slightly different systems, but the principles of operation are the same.

Low tension (LT) pulses are no longer produced by a contact breaker, but by the rotation of a toothed wheel in a magnetic field, or by sensors mounted near the rim of the flywheel. These pulses are received by a control unit where they are amplified to the level necessary to drive the ignition coil. The ignition coil converts the LT pulses into the high tension (HT) pulses needed to fire the spark plugs. HT pulses are conveyed to the appropriate spark plugs via the HT leads, distributor cap and rotor arm.

Ignition timing (the moment when the spark occurs) is varied according to engine speed and load. The faster the engine is turning, the earlier must the spark occur (more advance) in order to allow enough time for combustion. On V6 engines, ignition advance is controlled mechanically by centrifugal weights and springs in the distributor. A vacuum unit provides additional advance under conditions of high inlet manifold vacuum (denoting a light load). On the in-line engines, the ignition advance is determined by the control unit,

which receives information on engine temperature, throttle position and (on Turbo models) charge air temperature, as well as engine speed. The control unit fitted to B230E/K engines also receives a manifold vacuum signal.

The EZ115/116/118K ignition control systems are variants of a family known as EZ-K. The systems fitted to B200/B230E/K and B234F engines incorporate a knock sensor mounted under the inlet manifold. This sensor causes the control unit to retard ignition timing if pre-ignition occurs, so protecting the engine from damage caused by over-advanced timing or poor quality fuel.

The Motronic system fitted to Turbo models controls the fuel injection and ignition systems as an integrated engine management package. A more detailed description of the system is given in Chapter 4B.

The EZ115K system fitted to B280 engines, and the EZ116K system fitted to B234F engines are developments of earlier EZ-K systems, with the ignition timing determined by a flywheel sensor which cannot be adjusted.

Minor changes have also been made in order to accommodate features peculiar to the V-6 engine. There are two knock sensors, one for each cylinder bank. Since the flywheel sensor cannot indicate which bank is firing when a knock occurs, an inductive transducer is fitted to No 1 spark plug lead to supply this information to the control unit.

2 Ignition system - testing

Warning: Voltages produced by an electronic ignition system are considerably higher than those produced by conventional ignition systems. Extreme care must be taken when working on the system if the ignition is switched on. Persons with surgically-implanted cardiac pacemaker devices should keep well clear of the ignition circuits, components and test equipment.

Note: *On B234F models fitted with the EZ116K ignition system, the self-diagnostic unit is available for testing ignition system faults. See Section 8.*

General

1 The components of the electronic ignition system are normally very reliable; most faults are far more likely to be due to loose or dirty connections, or to "tracking" of HT voltage due to dirt, dampness or damaged insulation, than to the failure of any of the system's components. **Always** check all wiring thoroughly before condemning an electrical component, and work methodically to eliminate all other possibilities before deciding that a particular component is faulty.

2 The old practice of checking for a spark by holding the live end of an HT lead a short distance away from the engine is not recommended; not only is there a high risk of a powerful electric shock, but the HT coil, ECU or amplifier unit may be damaged. Similarly, never try to "diagnose" misfires by pulling off one HT lead at a time.

Engine will not start

3 If the engine either will not turn over at all, or only turns very slowly, check the battery and starter motor. Connect a voltmeter across the battery terminals (meter positive probe to battery positive terminal) then note the voltage reading obtained while turning the engine over on the starter for (no more than) ten seconds. If the reading obtained is less than approximately 9.5 volts, first check the battery, starter motor and charging system as described in Part A of this Chapter.

4 If the engine turns over at normal speed but will not start, check the HT circuit by connecting a timing light (following its manufacturer's instructions) and turning the engine over on the starter motor; if the light flashes, voltage is reaching the spark plugs, so these should be checked first. If the light does not flash, check the HT leads themselves, followed by the distributor cap, carbon brush and rotor arm, using the information given in Chapter 1.

5 If there is a spark, check the fuel system for faults, referring to the relevant part of Chapter 4 for further information.

6 If there is still no spark, check the voltage at the ignition coil "+" terminal; it should be the same as the battery voltage (ie, at least 11.7 volts). If the voltage at the coil is more than 1 volt less than that at the battery, check the condition of all the circuit wiring, referring to the wiring diagrams at the end of this manual.

7 If the feed to the coil is sound, check the coil's primary and secondary winding resistance as described later in this Chapter. If faulty, a new coil should be fitted. However, check carefully the condition of the LT connections themselves before doing so, to ensure that the fault is not due to dirty or poorly-fastened connectors.

8 If the coil is in good condition, the fault is probably within the amplifier unit, one of the system sensors, or the ECU and its related components (as applicable). Testing of these components should be entrusted to a Volvo dealer.

Engine misfires

9 An irregular misfire suggests either a loose connection or intermittent fault on the primary circuit, or an HT fault on the coil side of the rotor arm.

10 With the ignition switched off, check carefully through the system, ensuring that all connections are clean and securely fastened. If the equipment is available, check the LT circuit as described above.

11 Check that the ignition coil, the distributor cap and the HT leads are clean and dry. Check the leads themselves and the spark plugs (by substitution if necessary), then check the distributor cap, carbon brush and rotor arm as described in Chapter 1.

12 Regular misfiring is almost certainly due to a fault in the distributor cap, HT leads or spark plugs. Use a timing light (paragraph 4 above) to check whether HT voltage is present at all leads.

13 If HT voltage is not present on any particular lead, the fault will be in that lead, or in the distributor cap. If HT is present on all leads, the fault will be in the spark plugs; check and renew them if there is any doubt about their condition.

14 If no HT is present, check the ignition coil; its secondary windings may be breaking down under load.

15 Any further checking of the system components should be carried out by a Volvo dealer.

3 Ignition HT coil - removal, testing and refitting

Removal

1 Disconnect the battery negative terminal.

2 Disconnect the wires from the coil, identifying their locations for refitting, and release the clamp bracket **(see illustration)**. Slide the coil out of the bracket.

3 Inspect the coil visually for cracks, leakage of insulating oil or other obvious damage. Renew it if such damage is evident.

Testing

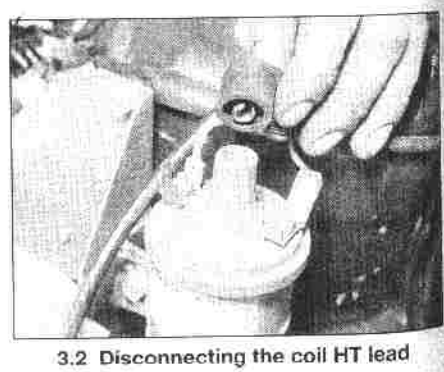
4 Use a multi-meter to measure the primary resistance (between the LT terminals). The desired value is given in the Specifications.

5 Measure the secondary resistance (between one of the LT terminals and the HT terminal) and compare it with that specified.

6 Renew the coil if the resistance of either winding differs widely from the correct value.

Refitting

7 Refit by reversing the removal operations.



3.2 Disconnecting the coil HT lead

4 Distributor - removal and refitting

B23 engines

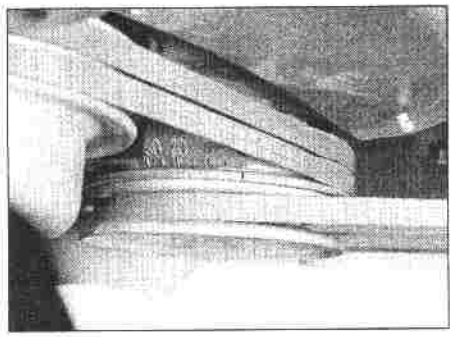
Removal

1 Unclip the distributor cap, or remove its securing screws, and move it aside.

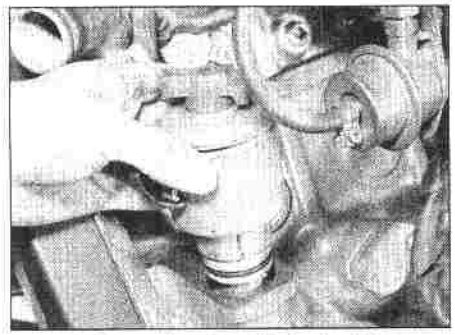
2 Bring the engine to TDC, No 1 firing. Turn the engine with a spanner on the crankshaft pulley bolt until the notch on the pulley is aligned with the "0" (TDC) mark on the timing scale, and the distributor rotor arm tip is pointing to the quarter corresponding to No 1 spark plug lead **(see illustration)**.

3 Make alignment marks between the rotor arm tip and the rim of the distributor body, and between the base of the distributor body and the engine block.

4 Unbolt the clamp plate and lift out the distributor **(see illustration)**. Notice how the rotor arm turns as the distributor is withdrawn.



4.2 Timing marks on the in-line engine - pulley notch is at "0" (TDC)



4.4 Removing the distributor (B23)

Refitting

5 When refitting, set the rotor arm in roughly the same position as it assumed after withdrawal. Insert the distributor so that the distributor-to-block marks are aligned. As the distributor is pushed home, the rotor arm will turn and should end up in the previously marked position for No 1 firing. If not, withdraw the distributor and try again.

6 Refit and secure the distributor clamp plate.

B200/B230/B234 engines

Removal

7 Identify the spark plug leads and disconnect them from the cap.

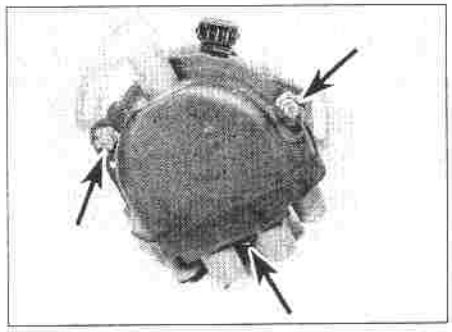
8 Undo the three screws which secure the distributor cap. Access is restricted. The screws are captive, so do not attempt to remove them from the cap **(see illustration)**.

9 Lift off the distributor cap with the coil HT lead still attached.

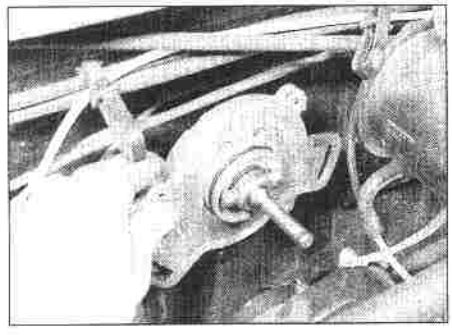
10 Pull off the rotor arm and remove the dust shield.

11 Make alignment marks between the distributor flange and the cylinder head.

12 Remove the two bolts which secure the distributor.



4.8 Distributor cap securing screws (arrowed) - distributor removed



4.14 Removing the distributor (B230)

13 Disconnect the LT connector from the distributor (when applicable).

14 Remove the distributor from the cylinder head **(see illustration)**.

15 Renew the distributor O-rings if necessary.

Refitting

16 When refitting, offer the distributor to the head, observing the alignment marks, and turn the shaft to align the drive dogs with the slots in the camshaft. The drive is offset, so there is no possibility of incorrect fitting.

17 The remainder of refitting is a reversal of the removal procedure. On B234F engines, remember to refit the ignition lead clip beside the left-hand bolt when fitting the distributor housing.

18 On B230E and B230K engines, check the ignition timing (see Section 7).

B28 engines

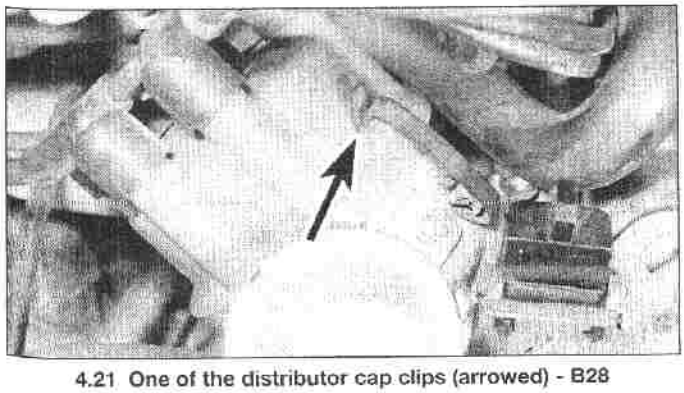
Removal

19 Remove the air inlet trunking from the airflow sensor.

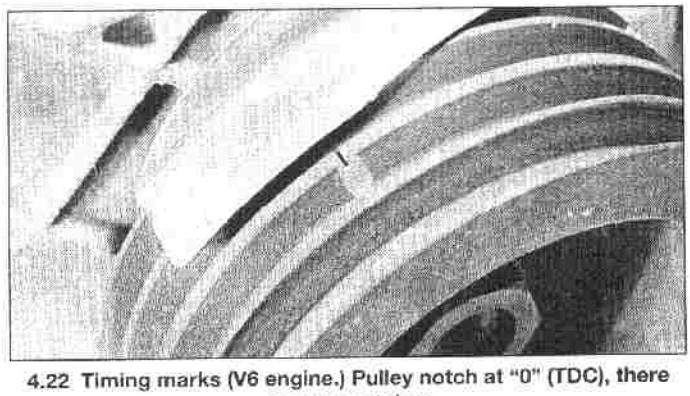
20 Remove the twelve Allen screws which secure the fuel control unit top section. (If it is only wished to remove the distributor cap and rotor arm, this can just about be done without disturbing the fuel control unit. Some of the HT leads will have to be disconnected from the cap *in situ*.)

21 Identify the HT leads. Unclip the distributor cap and remove it, disconnecting HT leads as necessary **(see illustration)**. Lift the fuel control unit up, without straining the fuel lines, to provide clearance for the cap.

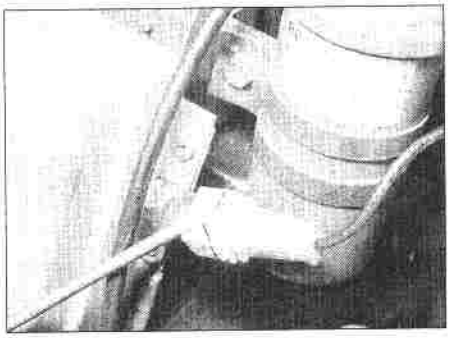
22 Bring the engine to TDC, No 1 firing **(see illustration)**. (See paragraph 2 and illustration 7.2).



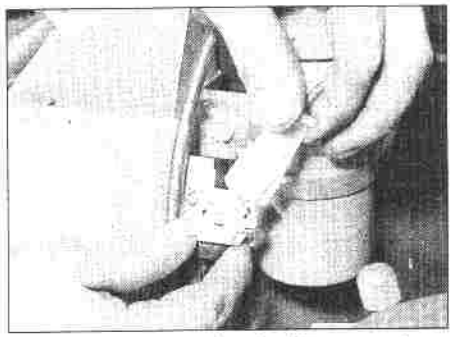
4.21 One of the distributor cap clips (arrowed) - B28



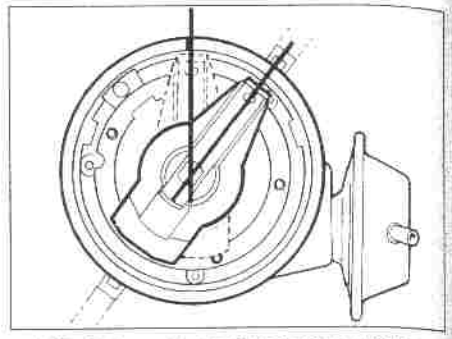
4.22 Timing marks (V6 engine.) Pulley notch at "0" (TDC), there are two notches



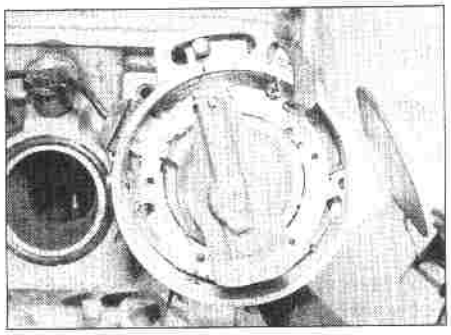
4.23a Prise up the spring clip . . .



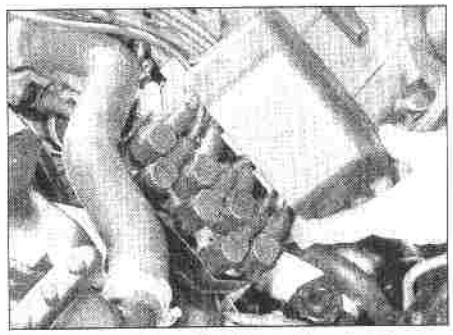
4.23b . . . and unplug the LT connector



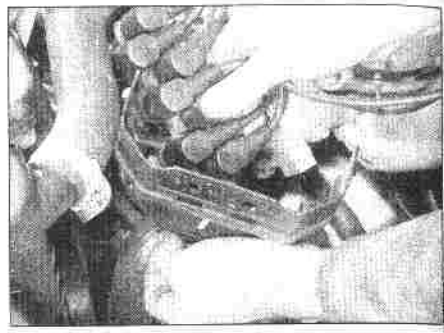
4.25 Rotor arm position before refitting (shown solid) and after refitting (dotted)



4.26 Rotor arm tip aligned with No 1 cylinder notch in distributor rim (B28) - dust shield removed



4.32 Unclip the shield from the distributor



4.33 Removing the distributor cover and cap

23 Disconnect the LT connector between the distributor and the ignition control unit. Also disconnect the vacuum advance pipe **(see illustrations)**.

24 Make alignment marks between the distributor flange and the cylinder head. Remove the clamp nut and lift out the distributor, again lifting the fuel control unit to provide clearance.

Refitting

25 Commence refitting by positioning the rotor arm approximately 30° clockwise of the No 1 reference notch in the rim of the distributor **(see illustration)**.

26 Insert the distributor, observing the previously made alignment marks. The rotor arm should turn to align with the reference notch as the distributor is pushed home **(see illustration)**. Fit the clamp nut and tighten it lightly.

27 Reconnect the LT connector.

28 Refit the distributor cap and HT leads.

29 Secure the fuel control unit and refit the air trunking.

30 Check the ignition timing and adjust if necessary (see Section 7), then fully tighten the clamp nut.

B280 engines

Removal

31 Disconnect the battery negative lead.

32 Unclip the shield from the top of the distributor **(see illustration)**.

33 Remove the 3 bolts which secure the distributor cover and cap. Remove the cover and withdraw the cap **(see illustration)**.

34 Undo the 3 Allen screws which secure the rotor arm. Lift off the arm and screws. The screws are captive in the arm **(see illustration)**.

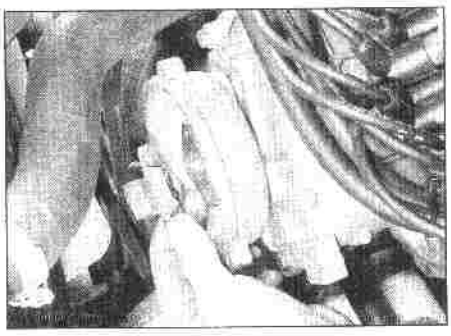
35 Lift out the flash shield with its O-ring.

36 Remove the 10 mm Allen screw which secures the distributor shaft. Remove the shaft if it is loose; if not, leave it for now **(see illustration)**.

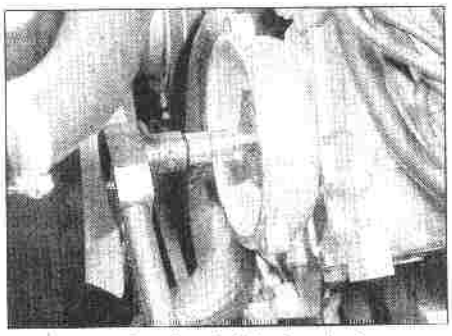
37 Remove the two bolts which secure the distributor body. If the shaft is still in place, pull the body forwards against the shaft and tap the body with a mallet to release the shaft. Remove the body and shaft **(see illustration)**.

Refitting

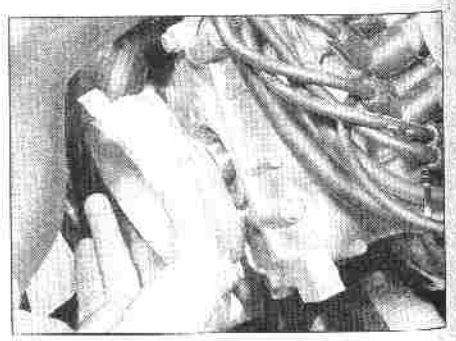
38 Refit by reversing the removal operations, engaging the hole in the distributor shaft with the peg on the drive. Use a new flash shield O-ring if necessary.



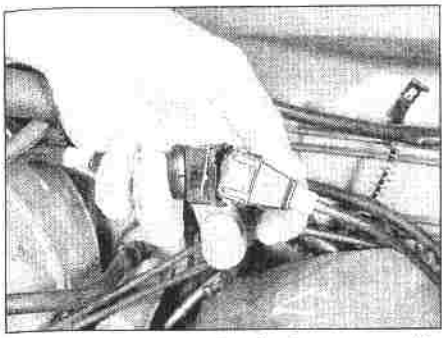
4.34 Removing the rotor arm



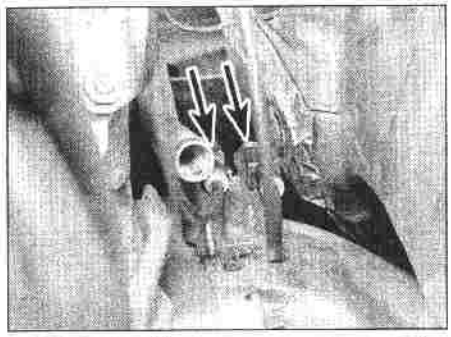
4.36 Undoing the distributor shaft screw



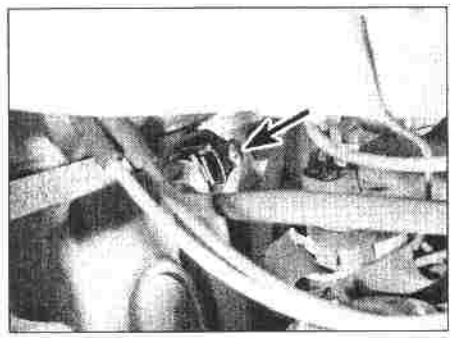
4.37 Removing the distributor body



5.1 Disconnecting a flywheel sensor multi-plug



5.2 The two flywheel sensors (arrowed)



5.7 Knock sensor securing bolt (arrowed)

5 Ignition system sensors - removal and refitting

Flywheel sensors

Removal

1 Disconnect the sensor multi-plug near the bulkhead. Identify the plugs if both sensors are to be removed **(see illustration)**.

2 Remove the Allen screw which secures the sensor to the bracket. Access is restricted **(see illustration)**. On some models there are two separate sensors for RPM and TDC. On other models there is a single sensor that takes both measurements.

3 Withdraw the sensor from the bracket and remove it.

Refitting

4 Refit by reversing the removal operations.

Knock sensors

Removal

5 To remove a sensor from the B280 engines, first carry out the following preliminary work:

a) Remove the inlet manifold (see Chapter 4).

b) Drain the cooling system (see Chapter 1), and remove the Y-pipe.

6 Disconnect the multi-plug from the knock sensor.

7 Remove the sensor securing bolt and the sensor itself. It is located under the inlet manifold **(see illustration)**.

Refitting

8 Refit by reversing the removal operations. Apply thread locking compound to the bolt and tighten it securely.

6 Ignition system electronic control unit - removal and refitting

B28E engines

Removal

1 Disconnect the battery negative lead.

2 The control unit is located on the right-hand inner wing, next to the coil. Disconnect the multi-plug from the base of the unit **(see illustration)**.

3 Undo the securing screws and remove the control unit.

Refitting

4 Refit by reversing the removal operations.

B200E/B230E/K/B234F engines

Removal

5 Remove the trim from below the steering column.

6 Remove the four screws which secure the control unit to the right-hand end of the pedal bracket. Depress the throttle pedal for access to two of the screws **(see illustration)**.

7 Disconnect the multi-plug and the vacuum pipe. Remove the control unit **(see illustration)**.

Refitting

8 Refit by reversing the removal operations.

B23ET/B230ET engines

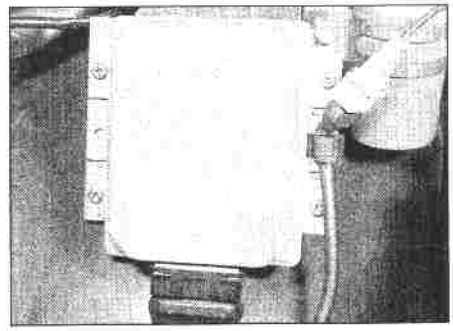
Removal

9 Remove the steering column/pedal lower trim panel.

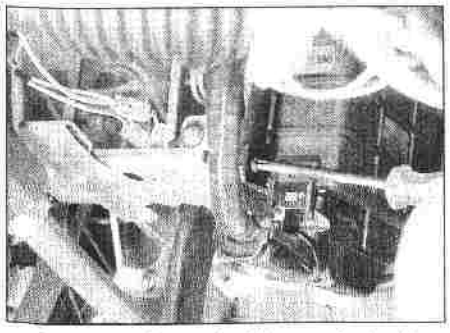
10 Release the forward end of the sill/seat belt reel trim by removing the screws securing it. These screws are concealed by covers.

11 Unclip the right-hand footwell trim panel and remove it.

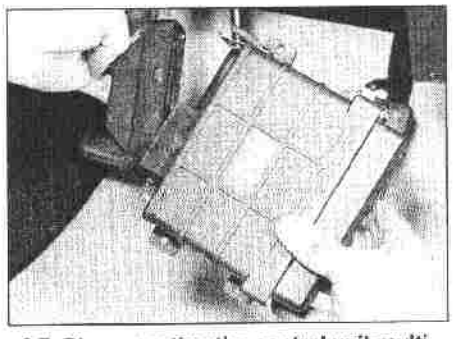
12 Make sure the ignition is switched off, then disconnect the multi-plug from the control unit **(see illustration)**.



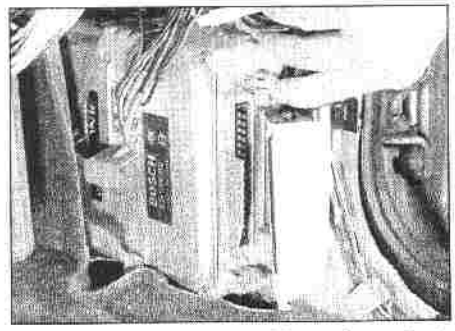
6.2 Ignition control unit - B28E



6.6 Removing an ignition control unit screw - B200E/B230E/K



6.7 Disconnecting the control unit multi-plug - B200E/B230E/K



6.12 Disconnecting the Motronic control unit multi-plug - B23ET/B230ET

5B

6.19 Ignition control unit - B280E

13 Remove the two securing screws and slide the unit out of its bracket.

Refitting

14 Refit by reversing the removal operations.
15 On some later models the power stage of the control unit is mounted separately under the bonnet, forward of the left-hand suspension turret.

B280E engines

Removal

16 Disconnect the battery negative lead.
17 Remove the trim from around the driver's footwell.
18 Where more than one control unit are located together, identify the ignition control unit. It is distinguished by being nearly square and black, as opposed to the Jetronic control unit which is silver (and labelled "Jetronic"), or the ABS control unit (1988 on) which is silver and longer than it is deep.
19 Free the control unit from its mountings and disconnect the multi-plug from it **(see illustration)**.

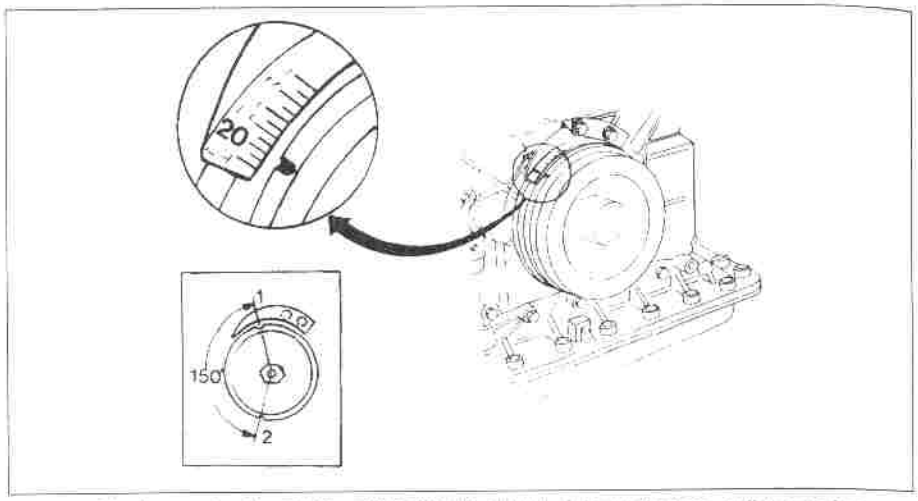
Refitting

20 Refit by reversing the removal operations.

7 Ignition timing - checking and adjustment

Note: *This is not a routine operation, since there is normally no reason why the timing should vary. On B23ET/B230ET Turbo engines (with the Motronic system), B234F and B280E engines, the timing cannot be adjusted; although it can be checked if wished.*

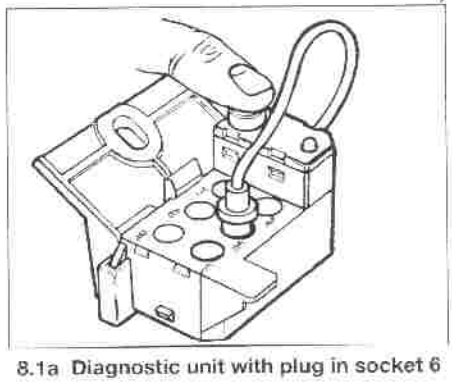
1 Bring the engine to operating temperature with the air conditioning switched off. With the engine stopped, connect a timing light (stroboscope) and a tachometer as instructed by the manufacturers.
2 Highlight the notch on the crankshaft pulley and the desired marks on the timing scale with white paint or typist's correction fluid (see Specifications for the desired values). Be sure to use the correct pulley notch on the B28E engine **(see illustration)**.
3 On B28E and B230E/K engines, disconnect and plug the distributor or control unit vacuum advance pipe.



7.2 Timing marks for B28E - 20° BTDC highlighted. Note the two pulley notches

1 No 1 cylinder notch *2 No 6 cylinder notch*

4 Run the engine at the specified idle speed and shine the timing light on the timing scale. ***Caution: Do not get electrical leads, clothing, long hair etc, caught in the drivebelts or the fan.*** The pulley notch will appear stationary and (if the timing is correct) in alignment with the appropriate mark on the timing scale.
5 If adjustment is necessary, stop the engine. Slacken the distributor mountings and turn the distributor a small amount. Turning the distributor against the direction of shaft rotation advances the timing, and vice versa. Tighten the distributor mountings after each adjustment, restart the engine and recheck the timing. (Do not attempt to turn the Motronic system distributor. It will not affect the timing.)
6 When the timing at idle is correct, check the advance on non-Turbo models by observing the timing at the higher specified speed. If this is incorrect on B28E engines, it is caused by a defective mechanical advance mechanism; on other models it must be due to a fault in the control unit or its inputs. (Normal operation of the knock sensor, when applicable, will also retard the timing.)



8.1a Diagnostic unit with plug in socket 6

7 If a vacuum pump is available, apply vacuum to the advance unit (when so equipped) and verify that the timing is advanced.
8 Stop the engine, disconnect the test gear and remake the original electrical and vacuum connections.

8 Ignition system testing with diagnostic unit - EZ116K ignition systems

1 The EZ116K electronic ignition system fitted to B234F engines includes a diagnostic unit which is shared between the ignition and fuel systems. The diagnostic unit is mounted on the left-hand suspension strut housing in the engine compartment and has a plug which can be inserted into different sockets for system testing. Socket number 6 is used for testing the ignition system **(see illustration)**. A variety of tests can be performed by pressing the button, depending on how many times it is pressed.

a) If the button is pressed once, the light will flash, giving a fault code. Any faults that have occurred while the engine has been running are stored in memory, up to a maximum of three faults.
b) If the button is pressed twice, the system will perform functional tests on the throttle switch and speed sensor. The light will flash during each functional test, giving an acknowledgement code.

Each code consists of three numbers, represented by three series of flashes. Each flash lasts for about 0.5 seconds and the interval between flashes within a series is also about 0.5 seconds. When a series has finished, the system waits for about 3 seconds, and then starts the next series. For example, the fault code 2-1-4 is represented by two flashes separated by an interval of 0.5 seconds, then an interval of 3 seconds, then one flash, then another interval of 3 seconds,

then four flashes separated by 0.5 seconds **(see illustration)**.

Fault Testing

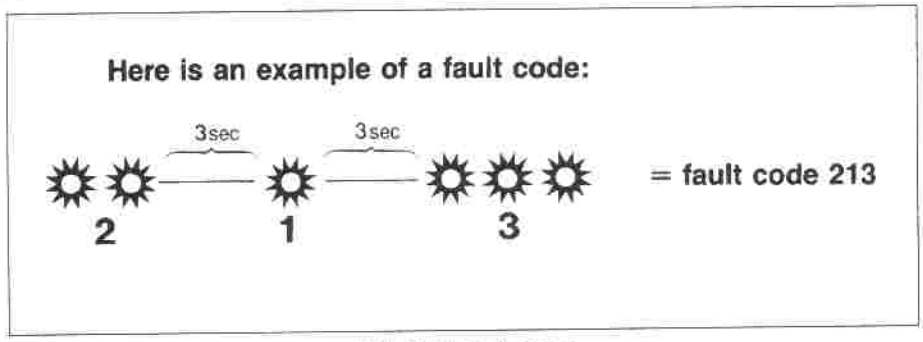
2 Open the cover of the diagnostic unit and insert the plug into socket 6.

3 Turn on the ignition without starting the engine.

4 Press the button once and hold it down for more than 1 second, but not more than 3 seconds.

5 Observe the flashing light and identify the fault code. The available codes are as follows:

1-1-1 No fault.
1-4-2 Control unit fault. Engine running in limp-home mode with safety-retarded ignition (10°).
1-4-3 Knock sensor faulty. Engine running in limp-home mode with safety-retarded ignition (10°).
1-4-4 Load signal absent (supplied by air mass meter in fuel injection system). Control unit selects full-load timing and runs in limp-home mode.
2-1-4 Speed sensor faulty.
2-2-4 Coolant temperature sensor faulty. Engine behaves as though hot and runs in limp-home mode.
2-3-4 Throttle switch (idling) faulty. Engine running with safety-retarded ignition (10°).
2-4-1 Exhaust gas recirculation (EGR) system malfunction (not applicable to B234F).
4-1-3 EGR temperature sensor signal missing or incorrect (not applicable to B234F).



8.1b Fault code 2-1-4

6 If the code 1-1-1 is displayed, there are no faults in the system memory. If any other code is displayed, press the button again to see if there is a second fault. Then press it a third time to see if there is a third fault. The system can store a maximum of three faults. When you have observed all the recorded faults, the system will cycle back to the first fault next time you press the button.

7 Take whatever action is necessary to rectify the faults.

8 Press the button again and hold it down for at least 5 seconds, then release it. The light will come on after 3 to 4 seconds. Press the button a second time for at least 5 seconds. This will erase the system memory so that it becomes available for recording new faults.

9 Remove the plug from socket 6, place it in its holder and then test drive the vehicle. Then repeat these instructions to see if any new faults are recorded. If there are no more faults, the code will be 1-1-1.

Functional Testing

10 Open the cover of the diagnostic unit and insert the plug into socket 6.

11 Turn on the ignition without starting the engine.

12 Press the button twice. On each occasion hold it down for more than 1 second, but not more than 3 seconds. The light will begin to flash continuously.

13 Open the throttle partially. The light should go out and then display the acknowledgement code 3-3-4, confirming the operation of the idling switch.

14 Wait until the light flashes continuously, then turn the starter motor. The light should go out and then display the acknowledgement code 1-4-1, confirming the operation of the speed sensor.

15 Switch off the ignition. Remove the plug from socket 6 and place it in its holder.

Chapter 6
Clutch

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

General

Clutch type	Single dry plate, diaphragm spring
Actuation	Hydraulic or cable, according to model and market

Driven plate

Plate diameter (nominal):	
B230E	216 mm
All other models	229 mm
B234F	Not known at time of writing

Pressure plate

Warp limit	0.2 mm

1 General information

A single dry plate diaphragm spring clutch is fitted. Operation may be hydraulic or mechanical, according to model and market.

The main components of the clutch are the pressure plate, the driven plate (sometimes called the friction plate or disc) and the release bearing. The pressure plate is bolted to the flywheel, with the driven plate sandwiched between them. The centre of the driven plate carries female splines which mate with the splines on the transmission input shaft. The release bearing is attached to the release fork and acts on the diaphragm spring fingers of the pressure plate.

When the engine is running and the clutch pedal is released, the diaphragm spring clamps the pressure plate, driven plate and flywheel firmly together. Drive is transmitted through the friction surfaces of the flywheel and pressure plate to the linings of the driven plate and thus to the transmission input shaft.

When the clutch pedal is depressed, the pedal movement is transmitted (hydraulically or by cable) to the release fork. The fork moves the bearing to press on the diaphragm spring fingers. Spring pressure on the pressure plate is relieved, and the flywheel and pressure plate spin without moving the driven plate. As the pedal is released, spring pressure is restored and the drive is gradually taken up.

The clutch hydraulic system consists of a master cylinder, a slave cylinder and the associated pipes and hoses. The fluid reservoir is shared with the brake master cylinder.

Wear in the driven plate linings is compensated for automatically by the hydraulic system components. The cable needs periodic adjustment to compensate for wear and stretch.

2 Clutch cable - adjustment, removal and refitting

Removal

1 At the transmission end, slacken the outer cable locknut and threaded adjuster as far as possible. Disconnect the return spring (if fitted) from the release fork and unhook the cable inner. If a rubber buffer is fitted at the end of the inner, note which way round it goes **(see illustration).**

2 Remove the trim panel below the steering column for access to the pedals. Remove the retainer which secures the cable inner to the pedal.

3 Pull the cable into the engine bay and remove it.

Refitting

4 Refit by reversing the removal operations, making sure the cable is correctly routed. Adjust the cable as described in Chapter 1 on completion.

3 Clutch pedal - removal and refitting

Removal

1 Disconnect the battery negative lead.

2 Remove the steering column (Chapter 10).

3 Disconnect the brake pedal from the servo pushrod by removing the clevis pin.

4 Similarly disconnect the clutch pedal from the master cylinder pushrod, or (when applicable) disconnect the clutch cable.

5 Remove the three bolts which secure the top of the pedal box to the scuttle.

6 Remove the six nuts which secure the pedal box to the bulkhead. (These nuts also secure the clutch master cylinder and the brake servo.)

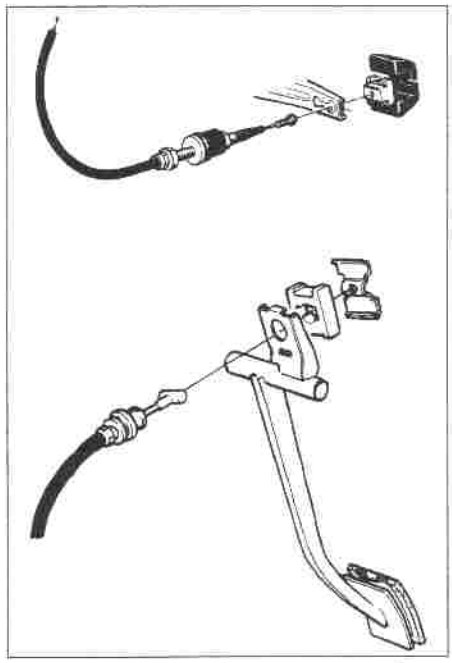
7 Disconnect the wiring from the stop-light switch. Also disconnect electrical and vacuum/pressure feeds from turbo boost and cruise control switches, or the ignition control unit (as applicable).

8 Remove the pedal box and pedals from the vehicle. Note how the brake pedal return spring bears against the scuttle.

9 Disengage the clutch pedal return spring. Remove the pivot nut and bolt, remove the clutch pedal and recover the bushes.

Refitting

10 Refit by reversing the removal operations. Apply grease to the pedal bushes and to the pivot bolt.



2.1 Clutch cable attachment details

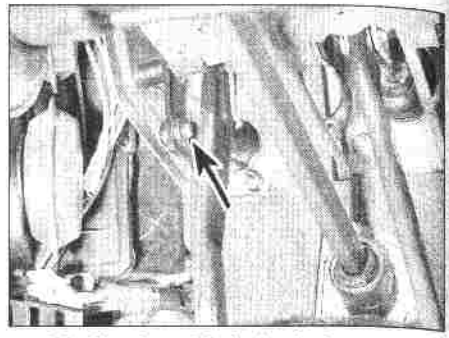
4 Clutch master cylinder - removal and refitting

Warning: Hydraulic fluid is poisonous; wash off immediately and thoroughly in the case of skin contact, and seek immediate medical advice if any fluid is swallowed or gets into the eyes. Certain types of hydraulic fluid are inflammable, and may ignite when allowed into contact with hot components; when servicing any hydraulic system, it is safest to assume that the fluid IS inflammable, and to take precautions against the risk of fire as though it is petrol that is being handled. Hydraulic fluid is also an effective paint stripper, and will attack plastics; if any is spilt, it should be washed off immediately, using copious quantities of clean water. Finally, it is hygroscopic (it absorbs moisture from the air) - old fluid may be contaminated and unfit for further use. When topping-up or renewing the fluid, always use the recommended type, and ensure that it comes from a freshly-opened sealed container.

Removal

1 Disconnect the fluid supply hose from the master cylinder. Have ready a container to catch the fluid which will spill.

2 Disconnect the pressure pipe union from the end of the cylinder. Be prepared for further fluid spillage. Cover the open pipe union with a piece of polythene and a rubber band to keep dirt out.



4.4 Clutch pedal clevis pin (arrowed)

3 Remove the trim panel below the steering column.

4 Remove the clevis pin which secures the clutch pedal to the master cylinder pushrod **(see illustration).**

5 Remove the two nuts which secure the master cylinder to the bulkhead.

6 Remove the master cylinder, being careful not to drip fluid onto the paintwork.

Refitting

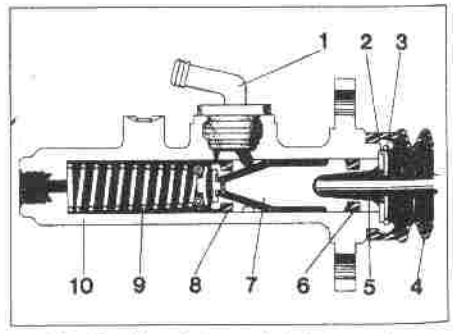
7 Refit by reversing the removal operations, noting the following points:

a) With the pedal released there should be 1 mm clearance between the pushrod and the piston. Adjust if necessary by screwing the clevis up or down the pushrod.

b) Bleed the hydraulic system on completion (Section 8).

5 Clutch master cylinder - overhaul

1 Refer to Section 7. Overhaul of the master cylinder is basically the same, except that there is a washer under the piston retaining circlip, and the piston has two seals **(see illustration).**



5.1 Sectional view of clutch master cylinder

1 Fluid inlet
2 Washer
3 Circlip
4 Dust boot
5 Pushrod
6 Outer seal
7 Piston
8 Inner seal
9 Spring
10 Cylinder body

6 Clutch slave cylinder - removal and refitting

Note: *Refer to the warning at the beginning of Section 4 before proceeding.*

Removal

1 Raise the vehicle on ramps, or drive it over a pit.
2 Slacken the flexible hose union on the slave cylinder **(see illustration)**.
3 Unbolt the slave cylinder or remove its securing circlip, according to type **(see illustration)**.
4 Withdraw the slave cylinder with pushrod. Unscrew the cylinder from the flexible hose. Plug or cap the open end of the hose to minimise fluid loss. Recover the sealing washer.

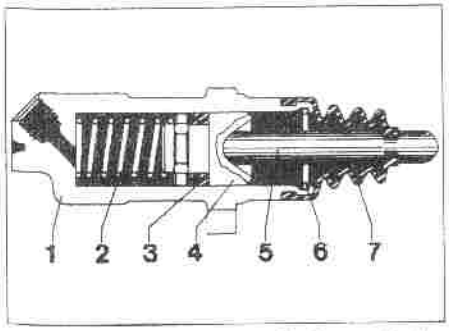
Refitting

5 Refit by reversing the removal operations. Check the "set" of the flexible hose after tightening; correct it if necessary by repositioning the hose-to-pipe union in the bracket.
6 Bleed the clutch hydraulic system (Section 8).

7 Clutch slave cylinder - overhaul

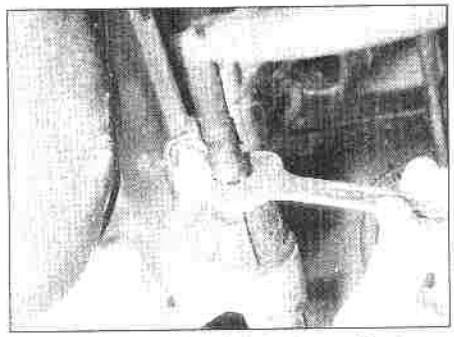
Note: *Refer to the warning at the beginning of Section 4 before proceeding.*

1 Empty the fluid out of the cylinder and clean it externally.
2 Remove the dust boot and pushrod **(see illustration)**.
3 Remove the circlip (if fitted) from the mouth of the cylinder.
4 Shake or tap out the piston and spring. If the piston is stuck, carefully blow it out with **low** air pressure (eg from a foot pump).
5 Remove the seal from the piston.



7.2 Sectional view of clutch slave cylinder

1 Cylinder body
2 Spring
3 Seal
4 Piston
5 Pushrod
6 Circlip
7 Dust boot



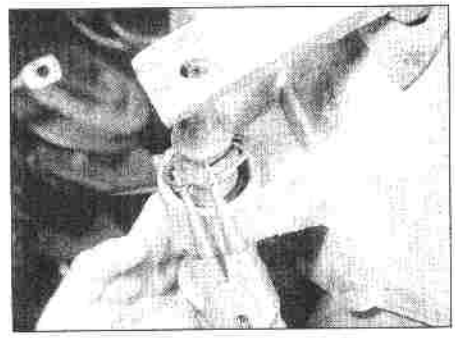
6.2 Undoing the clutch slave cylinder hydraulic union

6 Clean the piston and bore with wire wool and methylated spirit. If either is badly rusted or scored, renew the complete cylinder. Otherwise, obtain a repair kit containing a new seal and dust boot.
7 Dip the new seal in clean hydraulic fluid and fit it to the piston, using the fingers only. Make sure it is the right way round.
8 Lubricate the piston and bore with clean hydraulic fluid. Insert the spring and the piston into the bore.
9 When applicable, refit the circlip to the open end.
10 Fit the new dust boot over the pushrod. Place the pushrod in the cup of the piston and seat the dust boot on the cylinder.

8 Clutch hydraulic system - bleeding

Note: *Refer to the warning at the beginning of Section 4 before proceeding.*

1 Top-up the hydraulic fluid reservoir with fresh clean fluid of the specified type.
2 Slacken the bleed screw on the slave cylinder. Fit a length of clear hose over the screw. Place the other end of the hose in a jar containing an inch or so of hydraulic fluid.
3 Have an assistant depress the clutch pedal. Tighten the bleed screw when the pedal is depressed. Have the assistant release the pedal, then slacken the bleed screw again.
4 Repeat the process until clean fluid, free of air bubbles, emerges from the bleed screw.



6.3 Removing the slave cylinder circlip

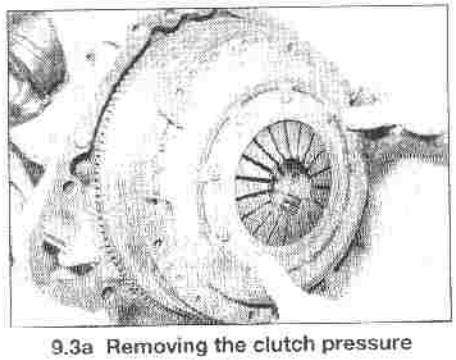
Tighten the screw at the end of a pedal downstroke and remove the hose and jar.
5 Top-up the hydraulic fluid reservoir.
6 Pressure bleeding equipment may be used if preferred - see Chapter 9.

9 Clutch assembly - removal, inspection and refitting

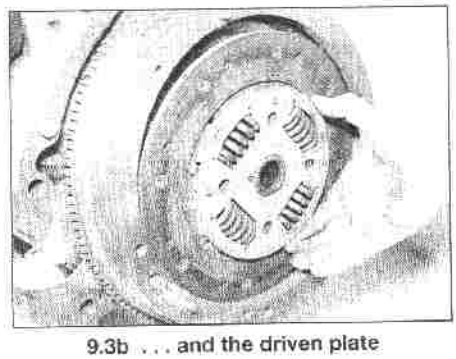
Warning: Dust created by clutch wear and deposited on the clutch components may contain asbestos which is a health hazard. DO NOT blow it out with compressed air or inhale any of it. DO NOT use petrol or petroleum-based solvents to clean off the dust. Brake system cleaner or methylated spirit should be used to flush the dust into a suitable receptacle. After the clutch components are wiped clean with rags, dispose of the contaminated rags and cleaner in a sealed, marked container.

Removal

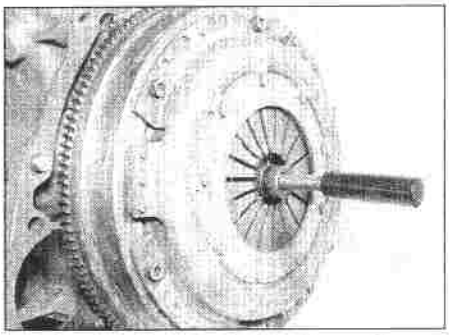
1 Remove the engine or transmission, as wished.
2 Make alignment marks between the pressure plate and the flywheel.
3 Slacken the pressure plate bolts half a turn at a time until the spring pressure is released. Remove the bolts, the pressure plate and the driven plate **(see illustrations)**. Note which way round the driven plate is fitted.



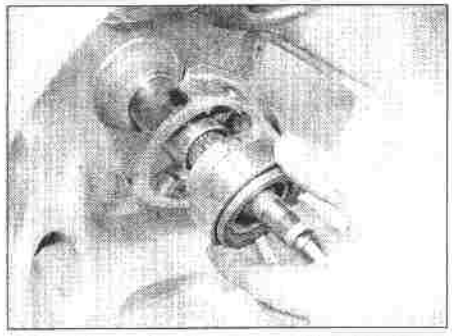
9.3a Removing the clutch pressure plate . . .



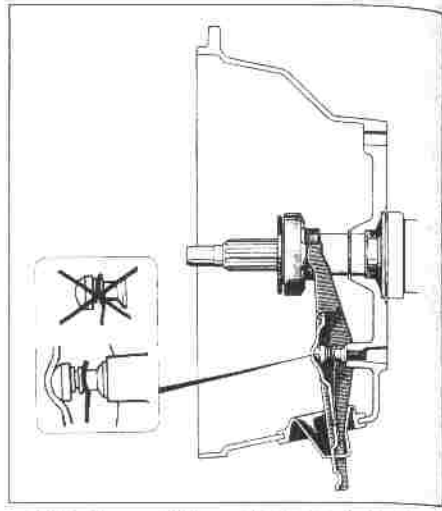
9.3b . . . and the driven plate



9.14 Clutch centering tool in position



10.4 Removing the release bearing and fork



10.6 Correct fitting of release fork clip below ball-stud groove

Inspection

4 Examine the friction surfaces of the flywheel and the pressure plate for scoring or cracks. Light scoring may be ignored. Excessive scoring or cracks can sometimes be machined off the flywheel face - consult a specialist. The pressure plate must be renewed if it is badly scored or warped.

5 Inspect the pressure plate cover and the diaphragm spring for damage, or blue discoloration suggesting overheating. Pay attention to the tips of the spring fingers where the release bearing operates. Renew the pressure plate if in doubt.

6 Renew the driven plate if the friction linings are worn down to, or approaching, the rivets. If the linings are oil-soaked or have a hard black glaze, the source of oil contamination - the crankshaft rear oil seal or transmission input shaft oil seal - must be dealt with before the plate is renewed. Also inspect the driven plate springs, hub and splines.

7 Note that if the driven plate only is renewed, problems may be experienced related to the bedding-in of the driven plate and old pressure plate. It is certainly better practise to renew the driven plate and pressure plate together, if finances permit.

8 Try the fit of the driven plate (whether new or used) on the transmission input shaft splines. It must neither bind nor be slack.

9 Spin the release bearing in the clutch bellhousing and feel for roughness or shake. The bearing should be renewed without question unless it is known to be in perfect condition.

10 Renewal of the crankshaft spigot bearing should also be considered at this stage. See Chapter 1.

Refitting

11 Commence refitting by cleaning the friction surfaces of the flywheel and pressure plate with a non-greasy solvent, followed by a wipe with a clean cloth. Clean oil or grease off the hands before handling the clutch.

12 Offer the driven plate to the flywheel, making sure it is the right way round. It is probably marked "SCHWUNGRAD" or "FLYWHEEL SIDE".

13 Hold the driven plate in position using a proprietary centering tool and fit the pressure plate over it. Observe the alignment marks if the original plate is being refitted.

> **HAYNES HINT** ***An alternative centering tool can be made from a length of wooden dowel which is a snug fit in the crankshaft spigot bearing. Build up the dowel with masking tape so that it just fits through the driven plate splines.***

14 Fit the pressure plate bolts and tighten them evenly until the driven plate is being gripped but can still be moved. Insert the centering tool, if it is not already in position, and tighten the pressure plate bolts progressively **(see illustration)**.

15 Remove the centering tool and check visually that the driven plate is central relative to the crankshaft spigot bearing. If the plate is not central, it will be impossible for the transmission input shaft to enter it.

16 Refit the engine or transmission.

10 Clutch release bearing - removal and refitting

Removal

1 Remove the engine or transmission as wished.

2 Free the release fork dust boot from the bellhousing.

3 Disconnect the release fork from the pivot ball-stud. There may be a spring clip securing the fork to the stud, or there may be nothing.

4 Slide the bearing and fork off the guide sleeve and separate them **(see illustration)**.

5 Clean the guide sleeve and smear a little grease on it lightly around the fork pivot and tips too.

Refitting

6 Refit by reversing the removal operations. When the release fork is secured by a spring clip, note that the clip should pass below the groove in the ball-stud **(see illustration)**.

Chapter 7 Part A:
Manual transmission and overdrive

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

General

Transmission type:	
M46	4 forward gears, overdrive and one reverse. Synchro on all forward gears
M47, M47 II	5 forward gears and one reverse. Synchro on all forward gears
Overdrive type	Laycock J, P, or J/P Hybrid

Ratios

1st	4.03 : 1
2nd	2.16 : 1
3rd	1.37 : 1
4th	1.00 : 1
Overdrive (M46)	0.79 : 1
5th (M47):	
Up to 1985	0.83 : 1
1986 onwards	0.82 : 1
Reverse	3.68 : 1

Torque wrench settings

	Nm	lbf ft
Bellhousing nuts and bolts	35 to 50	26 to 37
Gear lever mounting bracket bolts	35 to 50	26 to 37
Drive flange nut:		
M46	175	129
M47, size M16	70 to 90	52 to 66
M47, size M20	90 to 110	66 to 87
Overdrive-to-intermediate case nuts	12	9
Overdrive solenoid	50	37

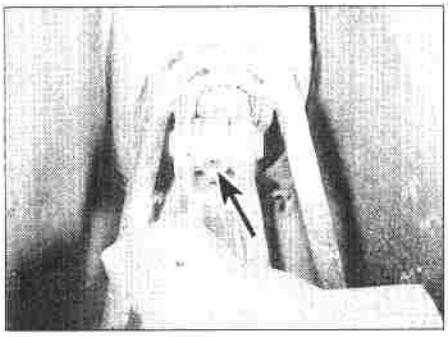
1 General information

Depending on model and year, the manual transmission will be four-speed with overdrive (type M46) or five-speed (type M47). The two transmissions are very similar. They are conventional in design and very sturdy.

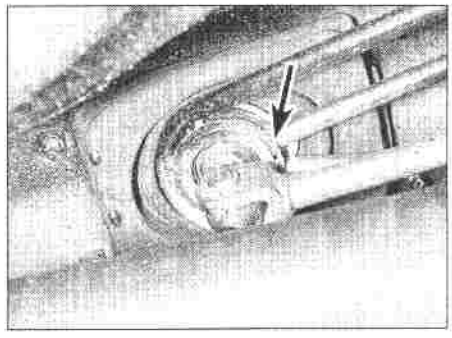
Drive from the engine is transmitted to the input shaft by the clutch. The gear on the input shaft is permanently meshed with the front gear on the layshaft; the remaining layshaft gears (except reverse) are permanently meshed with their counterparts on the mainshaft. Only one mainshaft gear at a time is actually locked to the shaft, the others are freewheeling. The selection of gears is by sliding synchro units: movement of the gear lever is transmitted to selector forks, which slide the appropriate synchro unit towards the gear to be engaged and lock it to the mainshaft. In 4th gear the input shaft is locked to the mainshaft. In neutral, none of the mainshaft gears are locked.

Reverse gear is obtained by sliding an idler gear into mesh with the layshaft and mainshaft reverse gears. The introduction of the idler gear reverses the direction of rotation of the mainshaft.

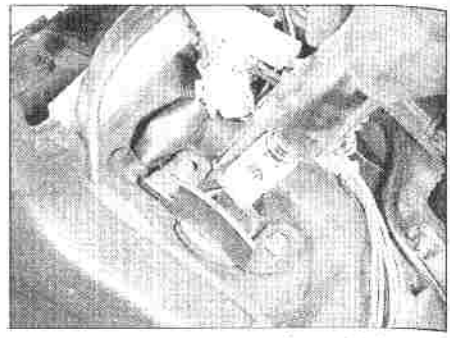
A gear ratio higher than 4th is provided by the overdrive or by 5th gear. The 5th gear components are mounted at the rear of the transmission, in a housing separate from the main gearcase.



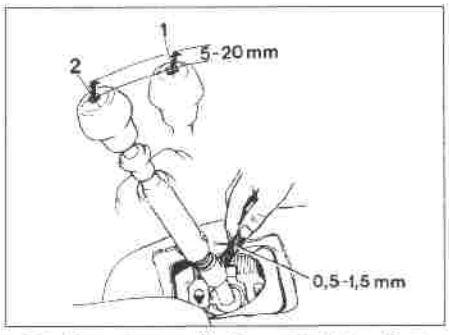
2.2 Allen screw (arrowed) securing gear lever pin



2.3 Circlip (arrowed) at base of gear lever on later models



2.6 Removing the gear lever circlip - earlier models



2.8 Gear lever adjustment in 1st or 2nd gear positions (1 and 2)

2 Gear lever - removal and refitting

Removal

1 Raise and support the vehicle for access to the underside of the gear lever.
2 Remove the Allen screw which secures the pin at the end of the gear lever **(see illustration)**. Press out the pin from the gear lever and the selector rod **(see illustration)**.
3 On 1986 and later models, remove the large circlip from the base of the gear lever **(see illustration)**.
4 Inside the vehicle, remove the console section from around the gear lever.
5 Remove the outer gaiter. Undo the four screws which secure the inner gaiter clamp plate. Remove the clamp plate, noting which way round it is fitted, and peel the inner gaiter up the gear lever.
6 On pre-1986 models, remove the large circlip from the base of the gear lever **(see illustration)**.
7 Pull the gear lever upwards and withdraw it. Disconnect the overdrive switch wires (when applicable). Do not disturb the reverse detent plate bolts.

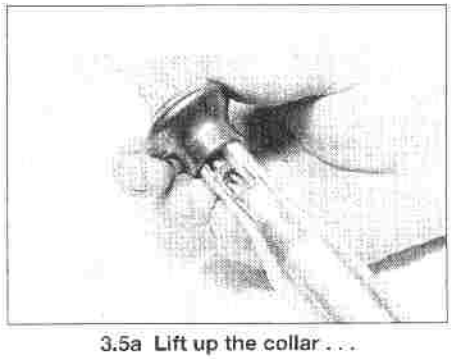
Refitting

8 Refit by reversing the removal operations. Check the clearance between the reverse detent plate and finger with 1st gear engaged: it should be between 0.5 and 1.5 mm **(see illustration)**. Adjust if necessary by slackening the detent plate bolts. When adjustment is correct, side-to-side play of the gear lever knob in 1st or 2nd gear should be 5 to 20 mm.

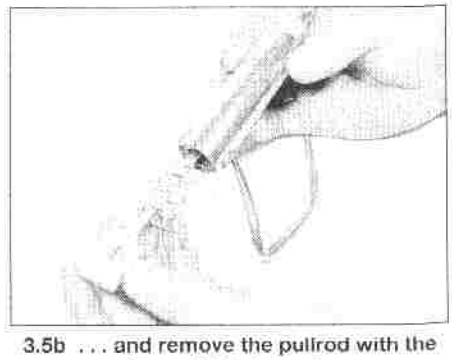
3 Gear lever pullrod - renewal

1 The gear lever pullrod transmits the motion from the collar under the gear knob to the interlock sleeve at the base of the gear lever. If it breaks, it will not be possible to engage reverse gear. Proceed as follows.
2 On models with overdrive, remove the trim panel from the right-hand side of the centre console. Separate the overdrive wiring connector there and tie a piece of string to the wire leading to the gear lever.
3 On all models, remove the gear lever boot. Drive out the roll pin which secures the lever to the stub. Lift off the gear lever, at the same time pulling the overdrive wire and string through, when applicable. Untie the string.
4 Remove the overdrive switch, when applicable. Remove the gear lever knob by gripping the lever in a soft-jawed vice and tapping the knob with a soft hammer and an open-ended spanner **(see illustration)**. The knob is glued onto splines and may not come off undamaged. Clean off the old glue.
5 Remove the old pullrod. It may be plastic or metal. The metal rod is removed by undoing the grub screw at the top of the lever, then withdrawing the pullrod, spring and interlock sleeve downwards. To remove the plastic rod, release the catch at the base and (on overdrive models) lift up the collar slightly to free the top of the rod **(see illustrations)**.
6 Soak the new pullrod in water for one hour before fitting it. Fit the new rod from below on overdrive models, being careful not to displace the rubber bushes and wiring. Make sure it engages with the collar. On models without overdrive, fit the pullrod to the collar and then insert them both from above. On all models, position the pullrod bottom lug to receive the interlock sleeve.
7 Fit the spring and interlock sleeve, engaging the pullrod lug in the catch on the sleeve.
8 Refit the gear lever over the splines, using a little glue if wished. Do not use powerful glue, or there will be a problem with any subsequent removal.
9 Refit the gear lever to the stub and secure it with the roll pin. On overdrive models, reattach the string to the wiring and draw the wire back to the centre console. Reconnect the wires and refit the trim panel.

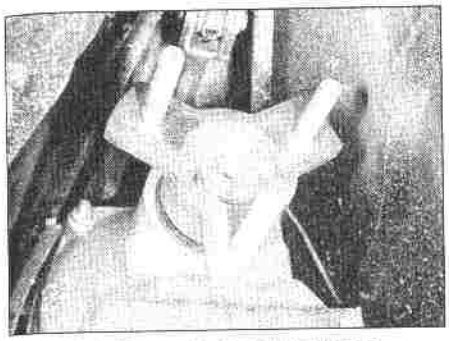
3.4 Removing the gear lever knob



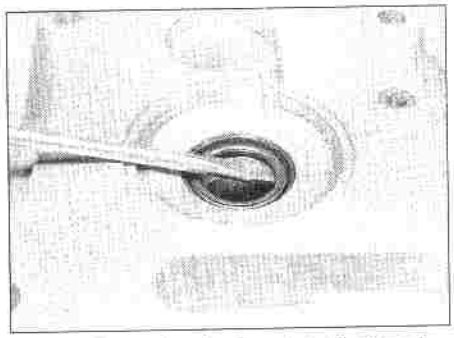
3.5a Lift up the collar . . .



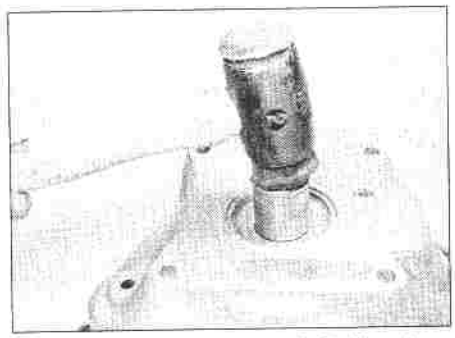
3.5b . . . and remove the pullrod with the spring and interlock sleeve



4.3 Transmission drive flange



4.15 Removing the input shaft oil seal



4.17 Seating the input shaft oil seal

10 Check the selection of all gears, including reverse. If adjustment is necessary, see Section 2, paragraph 8.
11 When adjustment is satisfactory, refit the gear lever boot, the overdrive switch and any other disturbed items.

4 Oil seals - renewal

Drive flange oil seal

1 Raise and support the vehicle.
2 Unbolt the propeller shaft from the drive flange and move it aside.
3 Counterhold the flange and undo its central nut **(see illustration)**.
4 Draw off the flange, using a puller if necessary. Do not try to hammer it off. Be prepared for oil spillage.
5 Prise out the old oil seal and clean up its seat. Inspect the seal rubbing surface on the flange: clean it, or renew the flange if necessary, to avoid premature failure of the new seal.
6 Lubricate the new seal and fit it, lips inwards, using a piece of tube to tap it home. On the M47 transmission the seal should be recessed by 2.5 mm.
7 On the M46 transmission, apply locking compound to the output shaft splines. Be careful not to contaminate the seal.
8 Refit the flange and secure it with the nut, tightened to the specified torque.
9 Refit the propeller shaft.
10 Top-up the transmission oil as described in Chapter 1.
11 Lower the vehicle. Check for leaks after the next run.

Input shaft oil seal

12 Remove the transmission (see Section 6).
13 Remove the clutch release components from the bellhousing.
14 Unbolt the bellhousing and remove it. Recover the input shaft bearing shim and clean off the old gasket.
15 Lever the old oil seal out of the bellhousing and clean out its seat **(see illustration)**.
16 Inspect the seal rubbing face of the input shaft. If it is damaged, a new shaft may be required.
17 Lubricate the new seal and fit it to the bellhousing, lips pointing to the gearcase side. Use a piece of tube to seat it **(see illustration)**.
18 Refit the bellhousing to the gearcase, using a new gasket. Remember to refit the input shaft bearing shim; use a smear of grease to hold it in position if necessary.
19 Fit the bellhousing bolts and tighten them to the specified torque.
20 Refit the clutch release components.
21 Refit the transmission.

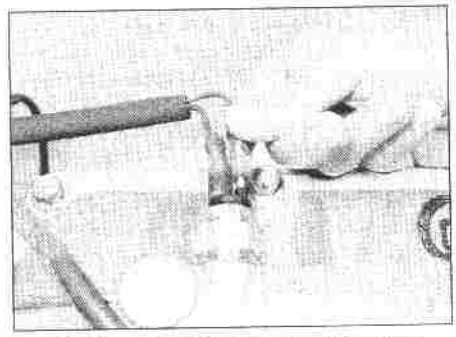
5 Reversing light switch - removal and refitting

Removal

1 Gain access to the transmission top cover (Section 9, paragraphs 3 and 4).
2 Clean around the switch, disconnect the wires and unscrew it **(see illustration)**.

Refitting

3 Refit by reversing the removal operations.



5.2 Disconnecting the reversing light switch

6 Manual transmission - removal and refitting

Note: *The transmission can be removed as a unit with the engine as described in Chapter 2B, then separated from the engine on the bench. However, if work is only necessary on the transmission or clutch unit, it is better to remove the transmission on its own from underneath the vehicle. The latter method is described in this Section. A trolley jack will be required, and the aid of an assistant during the actual removal (and refitting) procedures.*

Removal

1 On overdrive transmissions, if the overdrive is to be dismantled it should first be relieved as described in Section 10, paragraph 1.
2 Disconnect the battery negative lead.
3 On B200/B230/B234F engines, arrangements must be made to support the engine from above to prevent damage to the distributor due to engine movement. The best way to support the engine is with a bar resting in the bonnet channels with an adjustable hook appropriately placed.
4 Raise and support the vehicle.
5 Unbolt the propeller shaft from the transmission output flange **(see illustration)**.
6 Remove the Allen screw which secures the gear lever to the selector rod. Push out the pin and separate the rod from the lever.
7 Slacken the exhaust downpipe-to-silencer joint so that some movement of the pipe is possible.
8 Unbolt the transmission mounting crossmember from the transmission and from the side rails. Remove the crossmember.
9 On B200/B230/B234F engines, adjust the engine support so that the distributor cap is 10 mm from the bulkhead.
10 Disconnect the transmission wiring harness multi-plugs.
11 Remove the gear lever (Section 2). Alternatively, the gear lever carrier can be unbolted now and left on the vehicle.
12 Remove the starter motor (Chapter 5). On B28 engines, also remove the cover plate from the unused starter motor mounting.
13 Remove the clutch slave cylinder without disconnecting the hydraulic pipe, or disconnect the clutch cable, as applicable. See Chapter 6.
14 Remove all but two of the engine-to-transmission nuts and bolts. Note the position of cable clips, exhaust brackets, etc.

15 Support the transmission, preferably with a cradle and trolley jack, or else with the aid of an assistant. It is too heavy for one person to remove alone.

16 Remove the remaining engine-to-transmission nuts and bolts. Draw the transmission off the engine. Do not allow the weight of the transmission to hang on the input shaft.

17 Remove the transmission from under the vehicle.

Refitting

18 Refit by reversing the removal operations, noting the following points:

a) Apply a smear of molybdenum-based grease to the input shaft splines.

b) Make sure that the clutch driven plate is properly centred, and that the clutch release components have been fitted in the bellhousing (Chapter 6).

c) Adjust the clutch cable (when applicable) (Chapter 1).

d) Refill or top-up the transmission oil (Chapter 1).

19 Check for correct operation on completion.

7 Manual transmission overhaul - general information

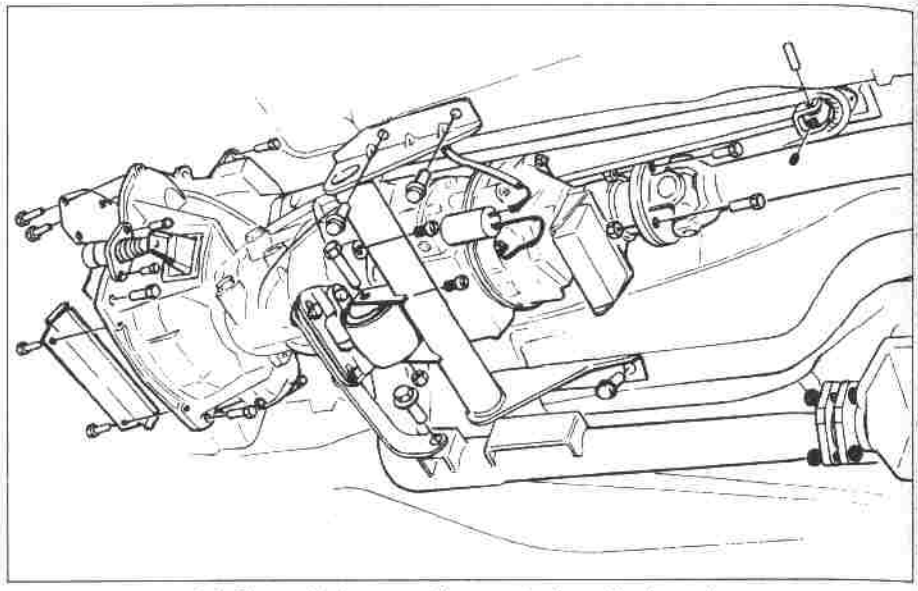
Overhauling a manual transmission is a difficult job for the do-it-yourselfer. It involves the dismantling and reassembly of many small parts. Numerous clearances must be precisely measured and, if necessary, changed with selected spacers and circlips. As a result, if transmission problems arise, while the unit can be removed and refitted by a competent do-it-yourselfer, overhaul should be left to a transmission specialist. Rebuilt transmissions may be available - check with your dealer parts department, motor factors, or transmission specialists. At any rate, the time and money involved in an overhaul is almost sure to exceed the cost of a rebuilt unit.

Nevertheless, it's not impossible for an inexperienced mechanic to rebuild a transmission, providing the special tools are available, and the job is done in a deliberate step-by-step manner so nothing is overlooked.

The tools necessary for an overhaul include: internal and external circlip pliers, a bearing puller, a slide hammer, a set of pin punches, a dial test indicator, and possibly a hydraulic press. In addition, a large, sturdy workbench and a vice or transmission stand will be required.

During dismantling of the transmission, make careful notes of how each part comes off, where it fits in relation to other parts, and what holds it in place.

Before taking the transmission apart for repair, it will help if you have some idea what area of the transmission is malfunctioning.



6.5 Transmission mountings and other attachments. M 46 transmission with B 28 engine shown

Certain problems can be closely tied to specific areas in the transmission, which can make component examination and replacement easier. Refer to the "Fault finding" section at the back of this manual for information regarding possible sources of trouble.

8 Overdrive unit - general information

The overdrive is essentially an extra transmission, driven by the output shaft of the main transmission and producing on its own output shaft a step-up ratio of 0.797 : 1. The unit is attached to the rear of the transmission and takes the form of a hydraulically operated epicyclic gear. Overdrive operates on fourth gear to provide fast cruising at lower engine revolutions. The overdrive is engaged or disengaged by a driver operated switch which controls an electrical solenoid mounted on the overdrive unit. A further switch (inhibitor switch) is included in the electrical circuit to prevent accidental engagement of overdrive in reverse, first, second or third gears.

Satisfactory fault diagnosis, repair and/or overhaul of the overdrive unit requires specialist knowledge, factory tools and environmentally clean working conditions. For these reasons, it is recommended that the advice of a Volvo dealer is sought in the event of any unsatisfactory performance or suspected fault on the unit.

9 Overdrive switches - removal and refitting

Removal

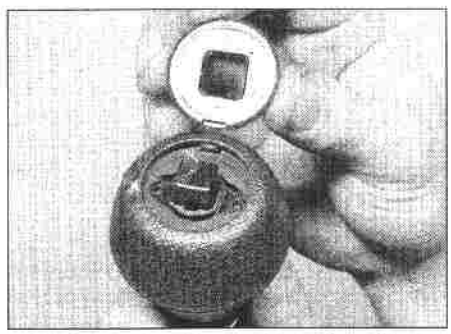
Control switch

1 Prise off the trim plate from the top of the gear lever knob **(see illustration)**.

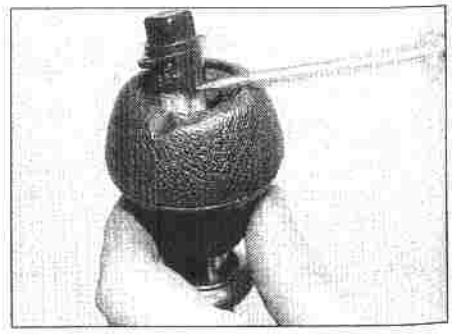
2 Prise out the switch and disconnect it **(see illustrations)**.

Inhibitor (transmission) switch

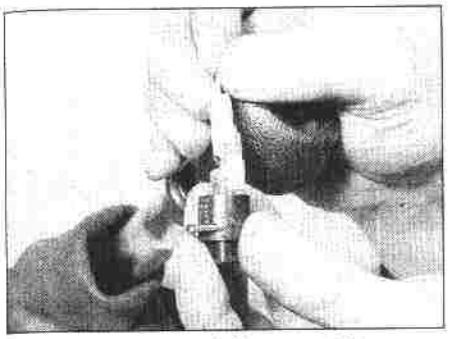
3 Raise and support the vehicle.



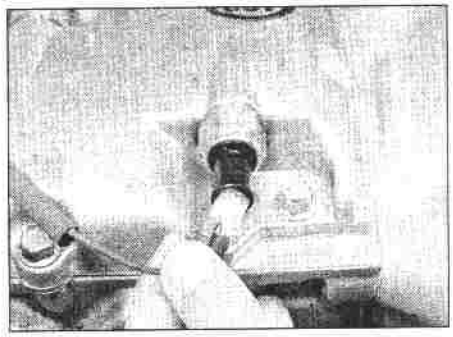
9.1 Removing the gear lever knob trim plate



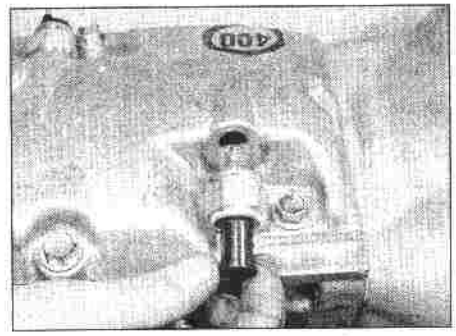
9.2a Prise out the overdrive switch . . .



9.2b . . . and disconnect it



9.5a Disconnect the inhibitor switch . . .



9.5b . . . and unscrew it from the cover

4 Except on V6 models, support the transmission, remove the crossmember and slacken the exhaust flanged joint. Lower the rear of the transmission slightly for access to the top cover.

5 Clean around the switch, disconnect the wires and unscrew it **(see illustrations)**.

Pressure switch (Turbo only)

6 Raise and support the vehicle.

7 The switch is located in front of the overdrive solenoid. Clean around the switch, disconnect the wiring and unscrew it. Be prepared for oil spillage.

8 Refit by reversing the removal operations. Top-up the transmission oil if necessary.

Refitting

9 In all cases, refit the switches by reversing the removal operations. Top-up the transmission oil as described in Chapter 1 where necessary.

10 Overdrive unit - removal and refitting

Removal

1 Relieve the pressure in the overdrive by driving the vehicle with overdrive engaged, then disengaging the overdrive with the clutch pedal depressed.

2 Raise and support the vehicle.

3 Unbolt the propeller shaft from the drive flange.

4 Support the transmission and remove the crossmember. Lower the rear of the transmission, being careful not to damage the distributor on the B200/B230/B234F engines.

5 Disconnect the wiring from the overdrive solenoid and (when applicable) the pressure switch **(see illustration)**.

6 Remove the eight nuts which secure the overdrive to the transmission intermediate section. Lift off the overdrive **(see illustrations)**; be prepared for oil spillage. If the overdrive will not come off, use a slide hammer on the drive flange; do not lever between the transmission and overdrive casings.

Refitting

7 Refit by reversing the removal operations, noting the following points:

a) Use a new gasket between the transmission and the overdrive.

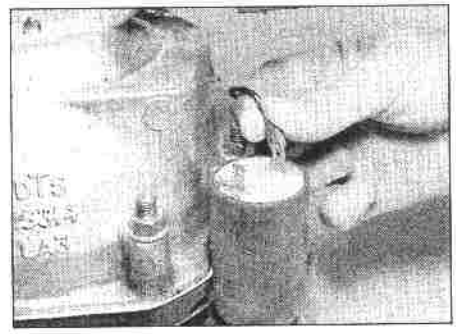
b) Tighten the nuts progressively to the specified torque.

c) Top-up the transmission oil (Chapter 1), road test the vehicle, then check the oil level again.

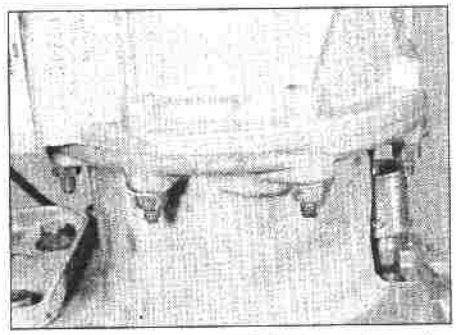
11 Overdrive unit overhaul - general information

In the event of a fault occurring on the overdrive unit, it is first necessary to determine whether it is of an electrical, mechanical or hydraulic nature, and to do this special test equipment is required. It is therefore essential to have the work carried out by a Volvo dealer if an overdrive fault is suspected.

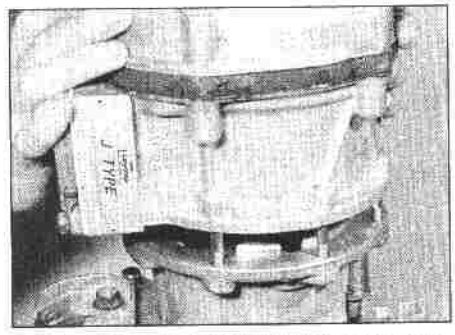
Do not remove the overdrive unit from the vehicle for possible repair before professional fault diagnosis has been carried out, since most tests require the unit to be in the vehicle.



10.5 Disconnecting the overdrive solenoid



10.6a Four of the overdrive securing nuts



106b Lifting off the overdrive (gearbox on bench)

7A

Chapter 7 Part B:
Automatic transmission

Contents

Degrees of difficulty

Easy, suitable for novice with little experience 

Fairly easy, suitable for beginner with some experience 

Fairly difficult, suitable for competent DIY mechanic 

Difficult, suitable for experienced DIY mechanic 

Very difficult, suitable for expert DIY or professional 

Specifications

General

Type	4 forward speeds and one reverse. Torque converter, with high-speed lock-up on some models
Designation	AW70, AW71, AW72 or ZF4HP22

Ratios

	AW70/AW71	AW72	ZF4HP22
1st	2.45 : 1	2.83:1	2.48 : 1
2nd	1.45 :1	1.49:1	1.48 : 1
3rd	1.0 : 1	1.0:1	1.0 : 1
4th (overdrive)	0.69 : 1	0.73:1	0.73 : 1
Reverse	2.21 : 1	2.70:1	2.09 : 1
Torque converter	1.0 to 2.0 : 1	1.0 to 2.0:1	1.0 to 2.3 : 1

Stall speed

AW70:	
B200E	2100 rpm
AW71:	
B230K	2500 rpm
B28E	2100 rpm
B280E	2100 rpm
AW72:	
B234F	
Plate no. 1 208 638, colour black	1800 rpm
Plate no. 1 208 667, colour green, with kick-down inhibitor	2450 rpm
ZF4HP22:	
B230E	2150 rpm
B230ET	2000 to 2450 rpm

Throttle cable setting

Stop-to-sleeve distance:	
Idling	0.25 to 1.00 mm
Kickdown	50.4 to 52.6 mm

Torque wrench settings	Nm	lbf ft
AW70/AW71		
Converter housing to engine:		
M10	35 to 50	26 to 37
M12	55 to 90	41 to 66
Driveplate to torque converter	41 to 50	30 to 37
Centre support to gearcase (in steps of 5 Nm / 4 lbf ft)	24 to 28	18 to 21
Oil pan	4 to 5	3 to 4
Oil cooler union	20 to 30	15 to 22
Dipstick tube nut	65 to 70	48 to 52
Drain plug	18 to 23	13 to 17
Drive flange nut	45	33
AW72		
Not known		
ZF4HP22		
Converter housing to engine:		
M10	35 to 50	26 to 37
M12	55 to 90	41 to 66
Driveplate to torque converter:		
M8	17 to 27	13 to 20
M10	41 to 50	30 to 37
Oil pan	7 to 9	5 to 7
Filler tube nut	85 to 115	63 to 85
Drive flange nut	100	74

1 General information

The automatic transmission has four forward speeds and one reverse. Gear changing between forward speeds is normally fully automatic, responding to speed and load, although the driver can prevent the selection of higher ratios. On the AW70/AW71/AW72 transmission the highest (4th) gear is provided by an overdrive unit fitted between the torque converter and the rest of the transmission. The ZF4HP transmission is an integrated four-speed unit.

Drive is taken from the engine to the transmission by a torque converter. This is a type of fluid coupling which under certain conditions has a torque multiplying effect. On later models the torque converter is mechanically locked at high speeds in 3rd and 4th gear, so eliminating losses due to slip and improving fuel economy.

The gear selector has six or seven positions: P, R, N, D, 3 (on some models), 2 and 1. The engine can only be started in positions P and N. In position P the transmission is mechanically locked: this position must only be engaged when the vehicle is stationary. In position R reverse is engaged, in N neutral. In position D gear changing is automatic throughout the range; positions 3, 2 and 1 prevent the selection of higher ratios when this is desired. These lower positions must not be selected at speeds so high as to cause engine overrevving.

When position 3 is missing from the selector, a button on the side of the selector knob serves to inhibit the engagement of 4th (overdrive) gear. A dashboard warning light reminds the driver when this has been done.

A "kickdown" facility causes the transmission to shift down a gear (subject to engine speed) when the throttle is fully depressed. This is useful when extra acceleration is required. Kickdown is controlled by a cable linkage from the throttle cable drum.

The transmission fluid is cooled by a heat exchanger built into one of the radiator side tanks, and (on some models) by an auxiliary cooler mounted in front of the radiator.

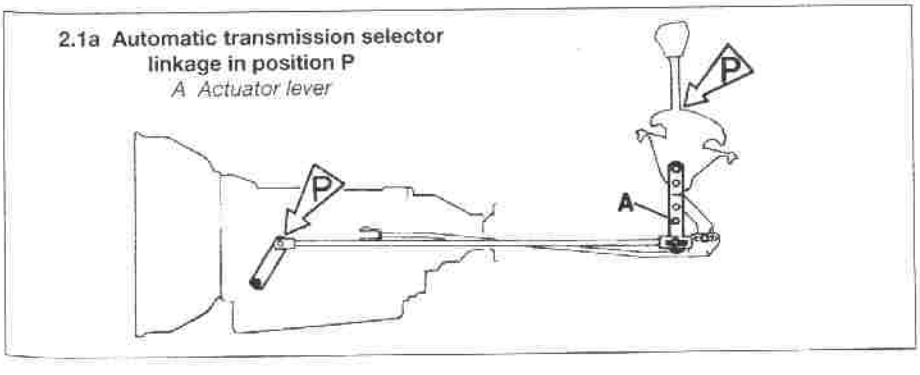
The automatic transmission is a complex unit, but if it is not abused it is reliable and long-lasting. Repair or overhaul operations are beyond the scope of many dealers, let alone the home mechanic; specialist advice should be sought if problems arise which cannot be solved by the procedures given in this Chapter.

2 Gear selector - checking and adjustment

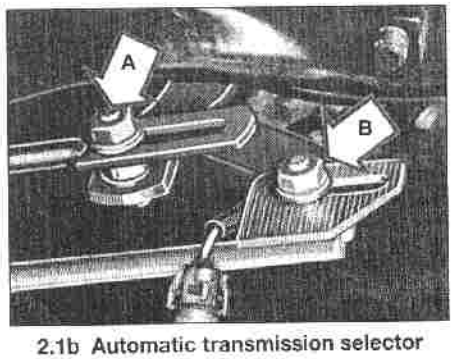
Note: *On B234F models the self-diagnostic unit can be used to perform a functional test on an automatic gearbox. See Chapter 4B.*

Checking

1 Check that the gear lever is vertical in position P (not touching the centre console). Adjust from below if necessary by slackening the actuator lever nut **(see illustrations)**.

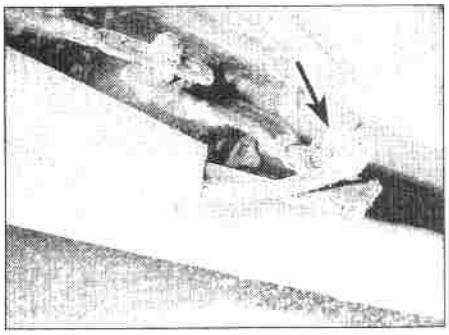


2.1a Automatic transmission selector linkage in position P
A Actuator lever



2.1b Automatic transmission selector linkage adjustment nuts
A Actuator lever *B Reaction lever*

7B

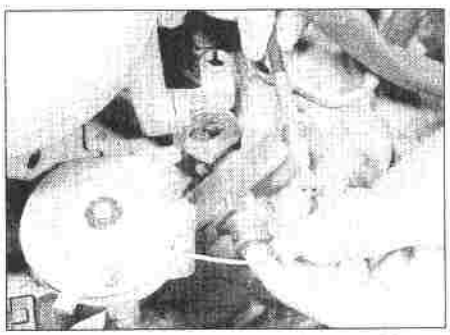


2.4 Gear selector reaction lever nut (arrowed, under cable)

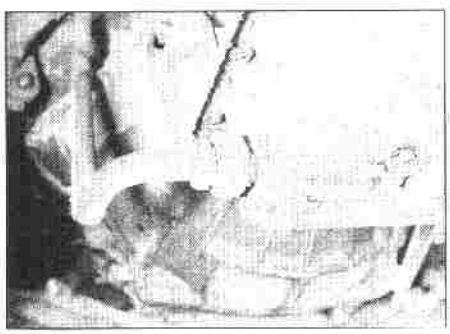
2 Check that the engine will only start in positions P and N, and that the reversing lights only come on in position R (ignition on).
3 Check that the free play from D to N is the same as, or less than, the play from 2 to 1 (AW70/AW71/AW72) or from 3 to 2 (ZF4HP22).

Adjustment

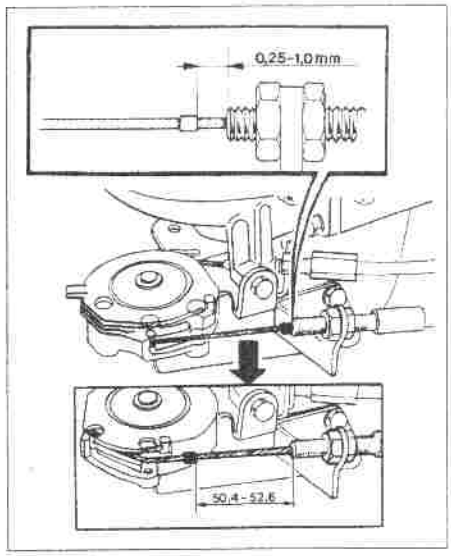
4 If there is insufficient play in D, slacken the reaction lever nut (beneath the vehicle) and move the lever approximately 2 mm rearwards **(see illustration)**.
5 If there is insufficient play in 3 or 2, slacken the nut and move the lever approximately 3 mm forwards.
6 Tighten the nut and recheck the adjustment.



4.1 Disconnecting the kickdown cable at the throttle end



4.2 Transmission dipstick/filler tube nut



3.1 Kickdown cable adjustment at idle (inset, top) and at full throttle (below)

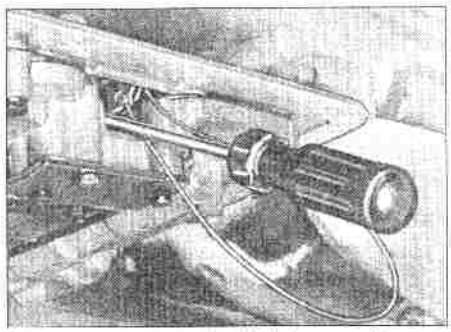
3 Kickdown cable - checking and adjustment

Checking

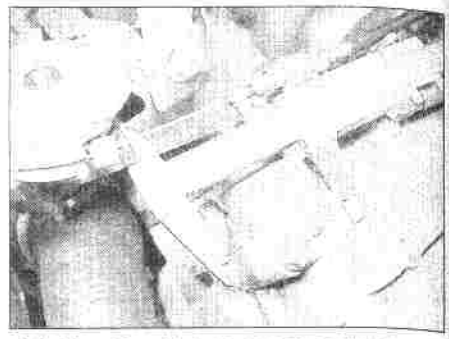
1 With the throttle linkage in the idle position, the distance from the crimped stop on the kickdown cable to the adjuster sleeve should be 0.25 to 1.0 mm **(see illustration)**. The cable should be taut.
2 Have an assistant depress the throttle pedal fully. Measure the distance from the stop to the adjuster again **(see illustration)**. It should be 50.4 to 52.6 mm. From this position it should be possible to pull the cable out by 2 mm.

Adjustment

3 Adjust if necessary by slackening the locknuts, turning the adjuster sleeve and tightening the locknuts.
4 If correct adjustment cannot be achieved, either the throttle linkage adjustment is incorrect (Chapter 4) or the cable crimped stop is incorrectly positioned (Section 4).



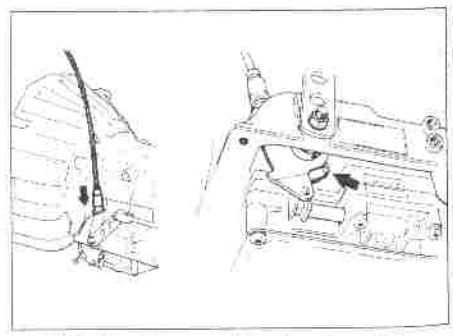
4.4a Removing the kickdown cable - AW transmission



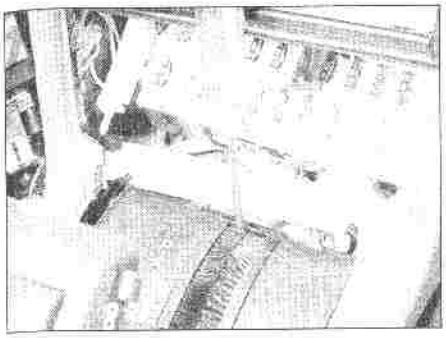
3.2 Checking kickdown cable adjustment at full throttle

4 Kickdown cable - renewal

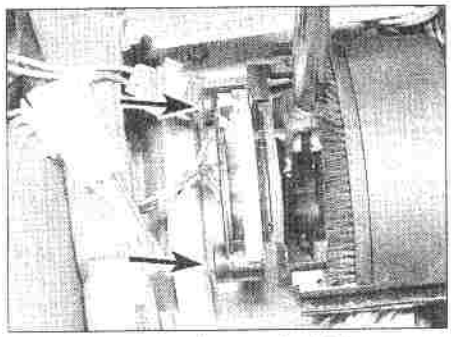
1 Slacken the cable adjuster at the throttle end. Disconnect the cable inner from the drum and the outer from the bracket **(see illustration)**.
2 Raise and support the vehicle. Drain the transmission oil pan by removing the drain plug (when fitted) and the dipstick/filler tube nut **(see illustration)**. ***Caution: The fluid may be very hot.***
3 Clean the oil pan, then unbolt and remove it. Be prepared for fluid spillage. Recover the gasket.
4 Clean around the cable outer where it enters the transmission. Unhook the cable inner from the cam, using a screwdriver to turn the cam **(see illustrations)**. Cut the cable inner below the stop at the throttle end if there is not enough slack in the inner. Release the cable outer and remove the cable.
5 Fit the new cable to the transmission, attaching the inner to the cam and securing the outer to the transmission case. Use a new O-ring and grease the cable outer where it enters the transmission.
6 Attach the cable outer at the throttle end. Pull the cable inner until light resistance is felt, and in this position crimp the inner stop 0.25 to 1.0 mm from the adjuster.
7 Reconnect the cable inner to the throttle drum. Adjust the cable as described in Section 3.



4.4b Kickdown cable attachments - ZF transmission



6.2 Removing a selector cover screw



6.3 Two screws (arrowed) which secure the starter inhibitor switch

8 Clean the inside of the oil pan, including the magnets when fitted.
9 Refit the oil pan, using a new gasket. Reconnect the dipstick/filler tube.
10 Top-up the transmission fluid (see Chapter 1).
11 Lower the vehicle. Road test the transmission, then recheck the fluid level and inspect the oil pan for leaks.

5 Kickdown marker - adjustment

Early models (marker in floor)

1 Release the retainer and screw the marker in towards the floor as far as possible.
2 Depress the throttle pedal by hand to the start of the kickdown position (beginning of resistance). Hold the pedal in this position and screw the marker upwards to meet it.
3 Refit the retainer.

Later models (marker in pedal)

4 Screw the marker into the pedal as far as possible.
5 Depress the throttle pedal by hand to the start of the kickdown position. Hold the pedal in this position and screw the marker down to meet the floor.

6 Starter inhibitor/reversing light switch - removal and refitting

Removal

1 Remove the ashtray and the centre console panel in front of the selector.

Models up to 1984

2 Remove the two screws which secure the left-hand half of the selector cover - one screw at each end of the brush **(see illustration)**. Lift off the half of the cover.
3 Undo the switch securing screws, disconnect the multi-plug and remove it **(see illustration)**.
4 If a new switch is being fitted, transfer the lens to it.

Models from 1985

5 Proceed as above, but note the different selector cover fittings **(see illustration)**.

Refitting

6 Refit by reversing the removal operations. Make sure that the stud on the lever enters the slot in the switch.

7 Overdrive switch (AW70/AW71/AW72 transmission) - removal and refitting

Removal

1 Prise the switch out of the side of the selector lever and disconnect it **(see illustration)**.

Refitting

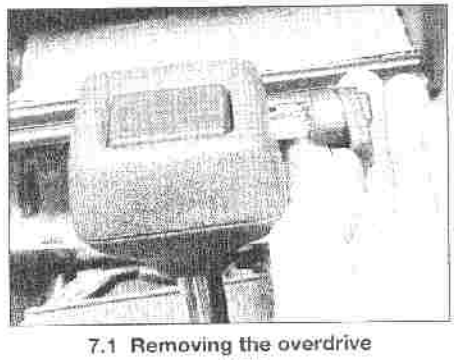
2 Refit by reversing the removal operations.

8 Transmission oil seals - renewal

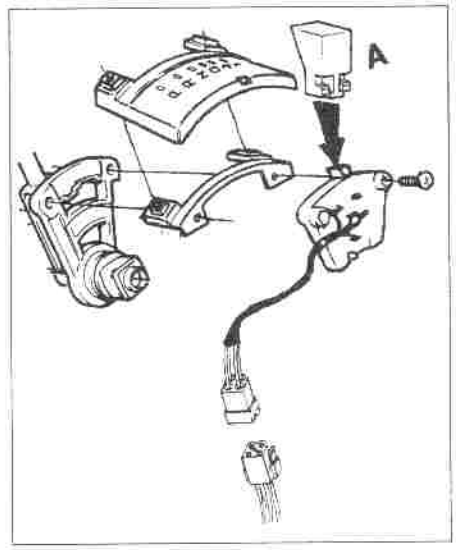
Note: *It is important not to introduce dirt into the transmission when working on it.*

Drive flange oil seal

1 The procedure is the same as that described for the manual transmission in Part A, Section 4, except that the flange central nut may be secured by a lockwasher.



7.1 Removing the overdrive switch



6.5 Later type automatic transmission selector cover and associated components
A Lens

Input shaft/torque converter oil seal

2 Remove the transmission (Section 9).
3 Lift the torque converter out of its housing. Be careful, it is full of fluid.
4 Pull or lever out the old seal. Clean the seat and inspect the seal rubbing surface on the torque converter.
5 Lubricate the new seal with ATF and fit it, lips inwards. Seat it with a piece of tube.
6 Refit the torque converter and the transmission.

Selector shaft oil seal

7 Remove the selector arm nut and pull the arm off the shaft.
8 Prise the seal out with a small screwdriver. Clean the seat.
9 Grease the new seal and fit it, lips inwards. Seat the seal with a tube or socket.
10 Refit the selector arm and tighten the nut.

All seals

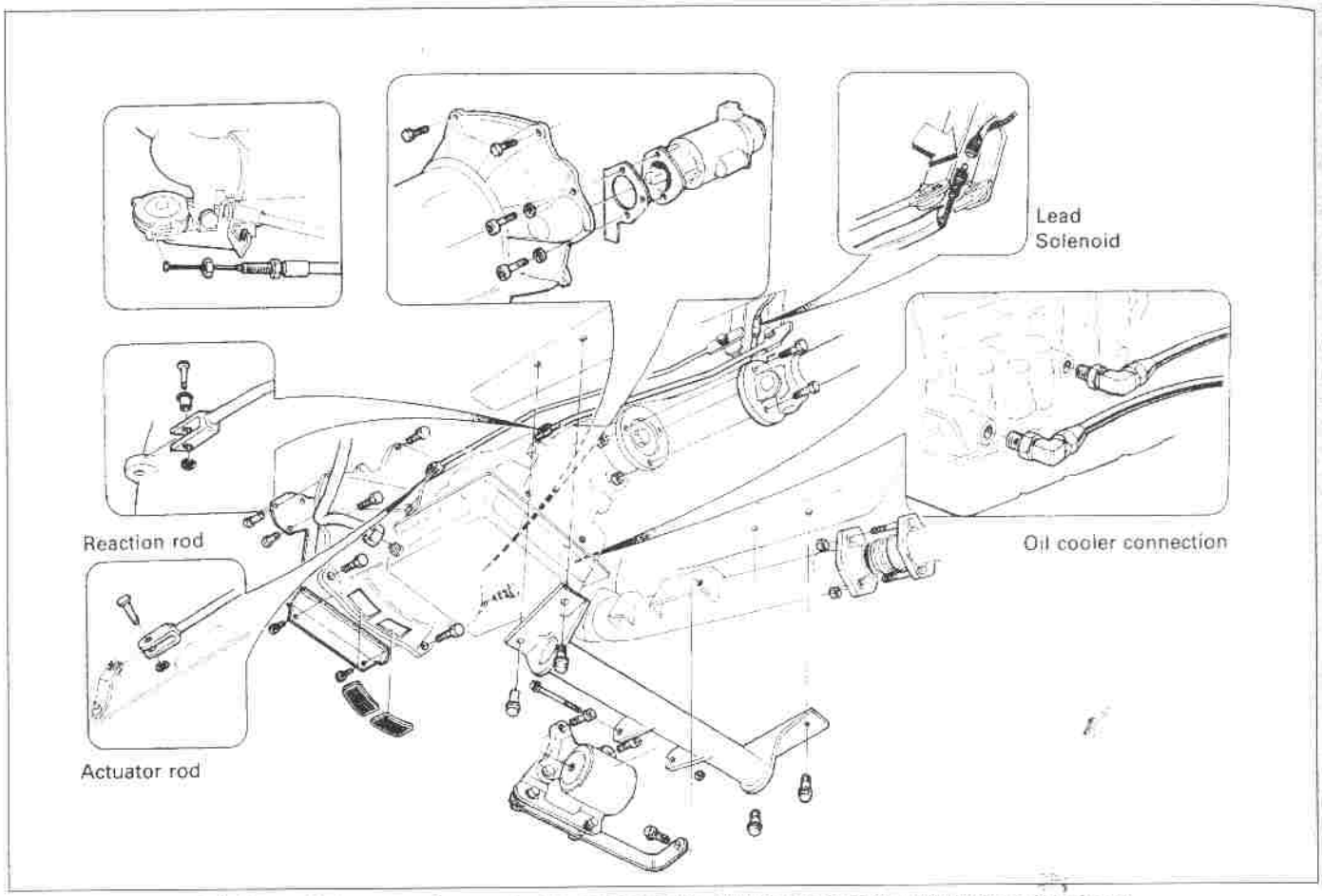
11 Check the transmission fluid level as described in Chapter 1 on completion.

9 Automatic transmission - removal and refitting

Note: *If the transmission is being removed for repair, check first that the repairer does not need to test it in the vehicle.*

Removal

1 Select P (AW70/AW71/AW72 transmissions) or N (ZF transmission).
2 Disconnect the battery negative lead.
3 Disconnect the kickdown cable at the throttle end.
4 Raise and support the vehicle. Drain the transmission fluid by removing the



9.5 Transmission mountings and other attachments. AW71 transmission with B28 engine shown

dipstick/filler tube nut. ***Caution: The fluid may be very hot.***

5 Disconnect the selector linkage and (when applicable) the overdrive wiring connector from the side of the transmission **(see illustration)**.

6 Remove the starter motor (Chapter 5). On B28 engines, also remove the other starter motor aperture blanking plate.

7 Remove the dipstick/filler tube.

8 Disconnect the fluid cooler unions at the transmission. Be prepared for spillage. Cap the open unions to keep dirt out.

9 Disconnect the exhaust downpipe and unbolt the exhaust support bracket from the transmission crossmember. Support the exhaust system if necessary.

10 Unbolt the propeller shaft flange.

11 When fitted, remove the cover plate from the bottom of the torque converter housing. Also remove the cooling grilles.

12 Jam the driveplate and remove the bolts which hold the torque converter to the driveplate. Turn the crankshaft to bring the bolts into view. It is possible to work through the starter motor aperture on some models.

13 Support the transmission, preferably with a properly designed cradle. Unbolt and remove the transmission crossmember.

14 Lower the transmission until it takes up a stable position. On the B200/B230/B234F engine, make sure that the distributor is not crushed against the bulkhead.

15 Remove the converter housing-to-engine nuts and bolts.

16 With the aid of an assistant, draw the transmission off the engine, at the same time levering the torque converter away from the driveplate. Keep the transmission tilted rearwards and lower it from the vehicle. It is heavy.

Refitting

17 Refit by reversing the removal operations, noting the following points:

a) Put a smear of grease on the torque converter spigot.

b) Tighten the torque converter-to-driveplate bolts progressively to the specified torque.

c) Do not fully tighten the dipstick tube nut until the tube bracket has been secured.

d) Adjust the selector mechanism (Section 2) and the kickdown cable (Section 3).

e) Refill the transmission with fluid. If a new transmission has been fitted, flush the oil cooler(s) - (see "Automatic transmission fluid renewal" in Chapter 1). Additionally, flush the auxiliary cooler (when fitted) using a hand pump. The auxiliary cooler is thermostatically controlled and will not be flushed during the fluid renewal procedure.

Chapter 8
Propeller shaft and rear axle

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

Propeller shaft

Type	Tubular, two-section, with centre support bearing
Number of universal joints	Two or three (plus rubber coupling on some models)

Rear axle

Type:	
Models without independent rear suspension	Solid axle with hypoid final drive gears; limited slip differential on some models
Models with independent rear suspension	Discrete hypoid final drive unit feeding twin driveshafts
Final drive ratio (depending on model and year)	3.31, 3.54, 3.73 or 3.91:1

Pinion bearing preload

Turning torque at pinion (wheels free):	
Models without independent rear suspension:	
New bearing	2.5 to 3.5 Nm
Used bearing	1.8 to 3.4 Nm
Models with independent rear suspension:	
New bearing	1.2 to 2.8 Nm
Used bearing	1.0 to 2.5 Nm

Torque wrench settings

	Nm	lbf ft
Propeller shaft		
Rubber coupling nuts and bolts	80	60
Plain flange coupling nuts and bolts:		
M10	50	37
M8	35	26
Rear axle (models without independent rear suspension)		
Pinion flange nut:		
Solid spacer	200 to 250	148 to 185
Collapsible spacer (see text)	180 to 280	133 to 207
Speedometer sensor locknut	25 to 40	18 to 30
Halfshaft retaining plate bolts	40	30
Trailing arm bracket bolts	45	33
Trailing arm bracket nuts	85	63
Trailing arm to axle	45	33
Panhard rod	85	63
Shock absorber lower mountings	85	63
Torque rods	140	103

Torque wrench settings (continued)	Nm	lbf ft
Rear axle (models with independent rear suspension)		
Pinion flange nut (see text)	120 to 280	89 to 207
ABS/speedo sensor bolt	8 to 12	6 to 9
Final drive unit to axle member	160	118
Rear casing bolts	20 to 28	15 to 21
Side bracket bolts	40 to 56	30 to 41
Lockplate bolts	40 to 56	30 to 41
Driveshaft Allen screws:*		
Stage 1	30	22
Stage 2	Angle tighten 90° further	
Driveshaft nut:*		
Stage 1	190	140
Stage 2	Angle tighten 60° further	

**Fastenings which are angle tightened should be renewed every time*

1 General information

The information in this Chapter deals with the driveline components from the transmission to the rear wheels. For the purposes of this Chapter, these components are grouped into the two categories, propeller shaft and rear axle. Separate Sections within this Chapter offer general descriptions and repair procedures for each group.

Since many of the procedures covered in this Chapter involve working under the car, make sure that it is securely supported on axle stands placed on firm level ground.

2 Propeller shaft - description

A two-section tubular propeller shaft is fitted. Two or three universal joints are used, and on some models a rubber coupling is fitted between the transmission output flange and the propeller shaft flange. A centre bearing supports the shaft at the junction of the two sections.

The universal joints are secured with circlips instead of by staking, which makes them relatively easy to overhaul.

3 Rubber coupling - removal and refitting

Removal

1 Raise and securely support the vehicle.
2 Make alignment marks between the shaft and the transmission output flange.
3 Remove the six nuts and bolts which hold the flanges to the coupling **(see illustration)**. (It may not be possible actually to remove the forward-facing bolts, which will stay on the flange.)
4 Pull the shaft rearwards and lower the front section. Remove the rubber coupling, the centre sleeve and the locating plate.

Refitting

5 Refit by reversing the removal operations, observing the alignment marks. Apply a little anti-seize compound to the locating plate pin.

4 Propeller shaft - removal and refitting

Removal

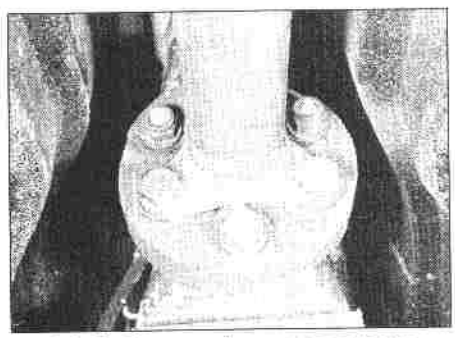
1 Raise the vehicle on ramps or drive it over a pit.
2 Make alignment marks between the shaft flanges and the gearbox and axle flanges, and between the two sections of the shaft.
3 Remove all the flange nuts and bolts except one at each end **(see illustration)**. Leave these last ones loose.
4 Have an assistant support the shaft. Remove the bolts which secure the centre bearing carrier.
5 On later models with a saddle type fuel tank, remove the bracing strap from the bottom of the fuel tank.
6 With the aid of the assistant, remove the remaining flange bolts. Remove the shaft and bearing from under the vehicle. Recover the rubber coupling (when fitted).
7 In the absence of an assistant, the shaft may be removed in two sections (rear section first). The two sections simply pull apart. Release the rubber boot from the rear of the centre bearing carrier as this is done.

Refitting

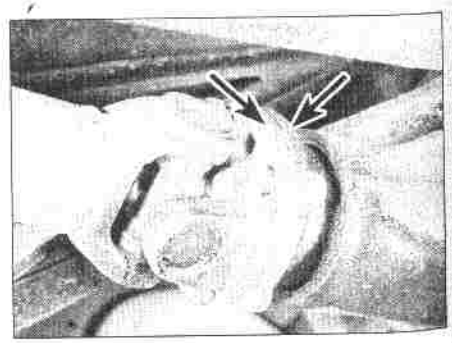
8 Refit by reversing the removal operations, observing the flange alignment marks. Note that if a new propeller shaft is being fitted to models with independent rear suspension, the new shaft may have a balance mark on it, in the form of a pink dot near the final drive flange end. This dot must be aligned with a similar mark on the final drive flange.
9 Do not tighten the bearing carrier bolts until the flange bolts have been tightened; the carrier fixings are slotted to allow the bearing to take up an unstrained position.

5 Universal joints - overhaul

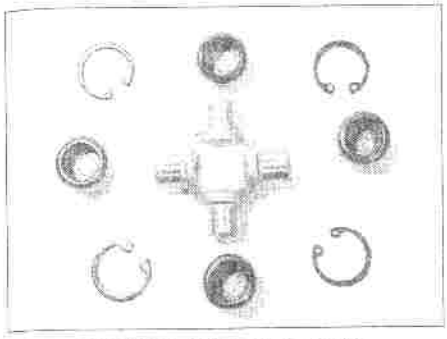
1 The joints may need to be overhauled because of excess play; a joint which is stiff will cause vibration and must also be overhauled.
2 Obtain an overhaul kit (spider, bearing cups and circlips) for each joint **(see illustration)**.
3 Clean the joint and apply penetrating oil or releasing fluid to the circlips.



3.3 Rubber coupling nuts and bolts



4.3 Propeller shaft rear flange - note alignment marks (arrowed)



5.2 Universal joint repair kit

4 Remove the circlips. If they are stuck, tap them with a punch.
5 Rest the yoke of the joint on the open jaws of a vice. Tap the flange with a plastic or copper hammer, or place a piece of tube over the bearing cup and strike that, until the cup protrudes a little way. Do not hit too hard, or clamp the shaft too firmly in the vice - if it is distorted it will be scrap.
6 Grasp the bearing cup with self-locking pliers and withdraw it. Recover any loose rollers.
7 Repeat this process until the spider can be removed from the yoke and all the bearing cups have been removed.
8 Clean the cup seats in the shaft and flange.
9 Carefully remove the cups from the new spider. Check that each cup contains its complement of rollers and that the seals are securely attached. The rollers should already be packed with grease.
10 Offer the spider to the yoke. Fit a cup to the spider, making sure that the rollers are not displaced.
11 Tap the cup lightly to seat it, then press it in using the vice and a tube or socket. The cup should be recessed by 3 to 4 mm.
12 Fit the circlip to secure the cup.
13 Similarly fit and secure the opposite cup, then assemble the rest of the joint in the same way.
14 Check the joint for freedom of movement. If it is stiff, tap it lightly with a plastic or copper hammer.
15 If vibration persists after overhauling the joints, it may be that the shaft needs to be balanced. This must be done by a specialist.

6 Centre bearing - renewal

Note: *Several different patterns of centre bearing and rubber boot have been fitted. If buying new components in advance, be careful to obtain the correct ones.*

1 Remove the propeller shaft (Section 4) and separate the two sections.
2 Support the front of the bearing and cage on V-blocks or with a piece of split tubing. Press or drive the shaft out of the bearing. Recover the protective rings from both sides of the bearing.
3 If the bearing cage is undamaged, the old bearing can be driven out and a new one pressed in. Otherwise, renew the bearing and cage complete.
4 Fit a new front protective ring to the shaft and tap it home with a wooden or plastic mallet.
5 Fit the new bearing and cage. Seat them with a piece of tube pressing on the bearing inner race.
6 Fit the rear protective ring, keeping it square as it is tapped home.
7 Check that the bearing spins freely, then reassemble the two sections of the shaft, observing the previously made alignment marks. Use a new rubber boot and/or retaining rings if necessary.
8 Refit the shaft to the vehicle.

7 Rear axle - description

Models without independent rear suspension

On these models the rear axle is conventional in design. A rigid casing encloses the final drive unit and two halfshafts. The casing is located by two torque rods bolted to a central subframe, by the two trailing arms and the Panhard rod.

The final drive unit is mounted centrally in the casing. It consists of the differential unit, the crownwheel and pinion. Drive from the propeller shaft is transmitted to the crownwheel by the pinion. The differential unit is bolted to the crownwheel and transmits the drive to the halfshafts. The differential gears and pinions allow the halfshafts to turn at different speeds when necessary, for example when cornering.

On some models the differential is of the "limited slip" type. Here the difference in speed between the two halfshafts is limited by means of friction clutches. This improves traction on slippery surfaces.

Work on the rear axle should be limited to the operations described in this Chapter. If overhaul of the final drive unit is necessary, consult a Volvo dealer or other specialist.

Models with independent rear suspension

On IRS models the solid rear axle has been replaced by a separate final drive unit and twin open driveshafts.

The final drive unit contains a differential unit, a crownwheel and a pinion. Drive from the propeller shaft is transmitted by a flanged coupling, as before. Two side flanges transmit the drive to the driveshafts. A sensor on the rear of the final drive casing provides speed information for the speedometer and for the ABS.

The driveshafts each have two constant velocity joints to permit movement with the suspension. They transmit drive to stub shafts in the rear hub carriers by means of splines.

8 Pinion oil seal - renewal

Caution: If the axle has a collapsible spacer in front of the pinion bearing (all models with IRS, and all non-IRS models having a letter "S" preceding the serial number), care must be taken not to overtighten the pinion flange nut. If the nut is overtightened, it may be necessary to take the axle to a Volvo dealer for a new spacer to be fitted.

1 Raise and support the rear of the vehicle on ramps, or drive it over a pit.
2 Unbolt the propeller shaft flange from the pinion flange. Make alignment marks between the flanges.
3 Paint or scribe alignment marks between the pinion flange and the flange nut.
4 Restrain the pinion flange with a bar and a couple of bolts. Unscrew the flange nut, counting the number of turns needed to remove it.
5 Pull off the pinion flange. If it is tight, strike it from behind with a copper mallet. Be prepared for oil spillage.
6 Lever out the old oil seal. Clean the seal seat and tap in the new seal, lips inwards.
7 Inspect the seal rubbing surface of the pinion flange. Clean it, or renew the flange, as necessary.
8 Oil the seal lips, then refit the flange.
9 Refit the flange nut. If the original flange and nut are being used, tighten the nut through the number of turns noted and align the marks made before dismantling. With new components, proceed as follows:
   a) *Axle with solid spacer - tighten the nut to the specified torque.*
   b) *Axle with collapsible spacer - tighten the nut to the lowest specified torque, then use a spring balance to determine the pinion bearing preload (wheels free, handbrake off). If the preload is lower than specified, carry on tightening the nut until it is correct. Do not exceed the maximum specified preload or tightening torque.*
10 Refit the propeller shaft and lower the vehicle.
11 Check the axle oil level and top-up if necessary.

9 Halfshaft, bearing and seals - removal and refitting

Note: *This procedure is only applicable to those models that do not have independent rear suspension.*

8

Removal

1 Remove the handbrake shoes (Chapter 9).
2 Remove the four bolts which secure the halfshaft retaining plate **(see illustration)**. Recover the handbrake shoe clips.
3 Refit the brake disc the wrong way round (drum facing outwards) and secure it with the wheel nuts, flat faces inwards. Pull on the brake disc to withdraw the halfshaft. Be prepared for oil spillage.
4 With the halfshaft removed, the inner (axle oil) seal may be removed by prising it out of the axle tube. Clean the seal seat and tap the new seal into position using a mallet and a piece of tube.
5 Renewal of the outer (grease) seal and bearing should be left to a Volvo dealer or other specialist, as press tools are required.

Refitting

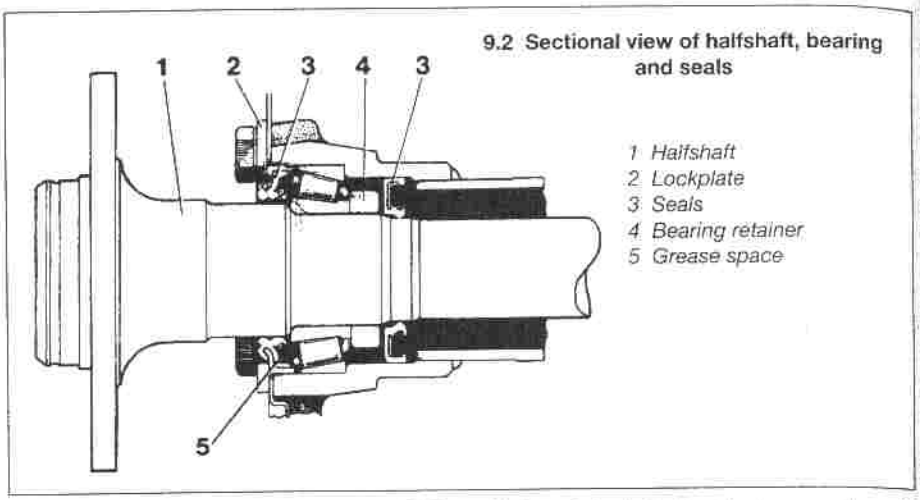
6 Before refitting, make sure that the bearing and seal lips are packed with grease.
7 Clean the axle tube and retaining plate mating faces and apply sealant to them.
8 Fit the halfshaft into the axle tube, being careful not to damage the inner seal. Secure it with the retaining plate and the four bolts, tightened to the specified torque. Remember to fit the handbrake shoe clips.
9 Remove the brake disc (if not already done) and refit the handbrake shoes.
10 Check the rear axle oil level as described in Chapter 1 and top-up if necessary.

10 Rear axle - removal and refitting

Note: *This procedure is only applicable to those models that do not have independent rear suspension.*

Removal

1 Slacken the rear wheel nuts. Raise and support the vehicle with the rear wheels free (see *"Jacking and vehicle support"*).
Caution: If raising the front of the vehicle as well, place the supports under the front control arm brackets, not under the jacking points. If the front jacking points are used, the vehicle may become nose-heavy.
2 Remove the rear wheels.
3 Remove the rear brake calipers (without disconnecting them), the brake discs and the handbrake shoes. Refer to Chapter 9 for full details.
4 Disconnect the handbrake cables from the brake backplates and from the brackets on the axle.
5 Unbolt the axle torque rods from the subframe, and the lower torque rod from the axle **(see illustration)**.
6 Support the axle with a cradle and a jack. Take the weight of the axle on the jack.
7 If the exhaust system runs below the axle, remove it.
8 Remove the Panhard rod.



9.2 Sectional view of halfshaft, bearing and seals

1 Halfshaft
2 Lockplate
3 Seals
4 Bearing retainer
5 Grease space

9 Disconnect the speedometer sender/ETC multi-plug(s) (as applicable). The speedometer sender multi-plug may be secured by a locking wire and seal, which must be broken.
10 Unbolt the propeller shaft/axle flange joint.
11 Unbolt the upper torque rod from the axle.
12 Unbolt the rear shock absorber lower mountings.
13 Remove the trailing arm front mounting bracket nuts and bolts.
14 Lower the axle, at the same time freeing the trailing arm front mountings, and remove it from under the vehicle.
15 The anti-roll bar (if fitted) and the trailing arms may now be removed if wished. The trailing arms are handed: do not mix them up.

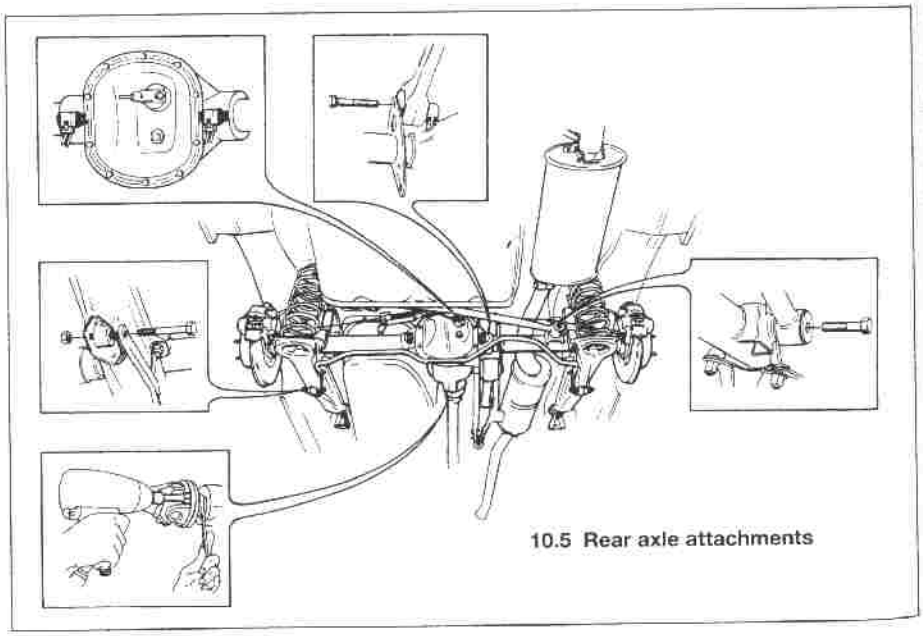
Refitting

16 Refit by reversing the removal operations, noting the following points:
a) When refitting the trailing arms to the axle, tighten the nuts progressively and in diagonal sequence to the specified torque.
b) Do not finally tighten the torque rods until the weight of the vehicle is back on the wheels (or jack the axle up to simulate this condition).
c) Check the axle oil level as described in Chapter 1 on completion.

11 Final drive unit (models with independent rear suspension) - removal and refitting

Removal

1 Remove the rear axle member lower section (Chapter 10).
2 Disconnect the driveshafts and the propeller shaft from the final drive unit. Mark the propeller shaft alignment if necessary.
3 Take the weight of the final drive unit on a jack. Remove the three bolts which hold the unit to the rear axle member upper section.
4 Lower the final drive unit. Disconnect or



10.5 Rear axle attachments

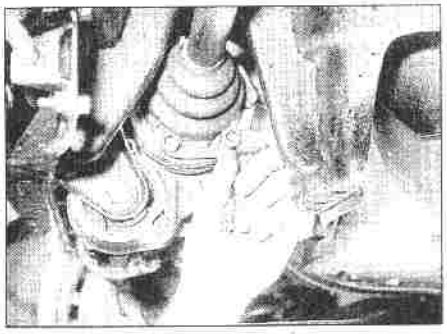
remove the speedometer/ABS sender as it becomes accessible.
5 Remove the final drive unit from under the vehicle.

Refitting

6 Refit by reversing the removal operations. Check the oil level in the final drive as described in Chapter 1 on completion.

12 Final drive side oil seals (models with independent rear suspension) - renewal

This is not a DIY job, since it involves disturbing the differential carrier side bearings. Remove the final drive unit and have the seals renewed by a Volvo dealer.

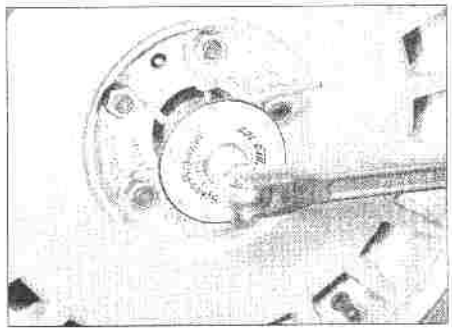


13.5 Removing a driveshaft flange screw

13 Driveshaft (models with independent rear suspension) - removal and refitting

Removal

1 Remove the wheel trim from the rear wheel on the side concerned. Apply the handbrake, engage 1st gear (or "P" on automatic transmission models) and chock the wheels.
2 Slacken the driveshaft nut. This nut is extremely tight. A 3/4-inch drive 36 mm socket will be required. Remove the nut.
3 Slacken the wheel nuts, raise and support the rear of the vehicle and remove the rear wheel. Make sure that the vehicle supports do not obstruct the driveshaft or the rear axle member lower section.



13.8 Angle-tightening the driveshaft nut

4 Remove the eight nuts and bolts which secure the axle member upper and lower sections together. Note the handbrake cable guide under one of the rear bolts. Pull the axle member lower section downwards as far as it will comfortably go without straining the linkages.
5 Undo and remove the six Allen screws which secure the driveshaft inboard flange. Recover the three double washers **(see illustration)**. An assistant should be available to apply and release the handbrake, disengage gear etc.
6 Lower the driveshaft and withdraw the outboard end from the hub. Tap it out if it is tight. Withdraw the driveshaft from under the vehicle.
7 Overhaul of a worn driveshaft is unlikely to be possible. Repair kits (including rubber gaiters) may be available; if so, follow the instructions in the kit.

Refitting

8 Refit by reversing the removal operations, noting the following points:

a) Use new Allen screws and a new driveshaft nut.
b) Align the axle members with a couple of bolts or drifts when reassembling - see Chapter 10.
c) Do not attempt final tightening of the driveshaft nut until the weight of the car is back on its wheels ***(see illustration).***

Chapter 9
Braking system

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

General

System type:	
Footbrake	Dual-circuit hydraulic with servo assistance. Anti-lock braking (ABS) on some models
Handbrake	Mechanical to drums on rear wheels
Hydraulic system split:	
Without ABS	Double triangular
With ABS	Front-rear

Front brakes

Type	Disc, with twin piston sliding calipers
Brake pad minimum lining thickness	3.0 mm
Disc diameter:	
Solid	280 mm
Ventilated	262 or 287 mm
Disc thickness - solid:	
New	14.0 mm
Wear limit	11.0 mm
Disc thickness - ventilated:	
New	22.0 mm
Wear limit	20.0 mm
Disc thickness - ABS models (1991 onwards):	
New	26 mm
Wear limit	23 mm
Maximum disc run out:	
Pre-1988 models	0.08 mm
1988 models onward	0.06 mm

Rear brakes

Type	Disc, with twin piston fixed, or single piston sliding, calipers
Brake pad minimum lining thickness:	
Models without independent rear suspension	2.0 mm
Models with independent rear suspension	3.0 mm
Disc diameter	281 mm
Disc thickness:	
New	9.6 mm
Wear limit	8.4 mm
Maximum disc run-out	0.10 mm

Handbrake

Drum diameter	160.45 mm (maximum)
Maximum drum run-out	0.15 mm
Maximum drum out-of-round	0.20 mm

Torque wrench settings

	Nm	lbf ft
Front caliper bracket screws	100	74
Rear caliper mounting bolts or bracket bolts*	58	43
Upper guide pin to caliper bracket	25	18
Caliper guide pin bolts	34	25
Front dust shield	24	18
Rear dust shield	40	30
Master cylinder nuts	30	22
Rigid pipe unions	14	10
Flexible hose unions	17	13

**Use new bolts every time*

1 General information

The brake pedal operates disc brakes on all four wheels by means of a dual circuit hydraulic system with servo assistance. The handbrake operates separate drum brakes on the rear wheels only by means of cables. An anti-lock braking system (ABS) is fitted to some models, and is described in detail in Section 18.

The hydraulic system is split into two circuits, so that in the event of failure of one circuit, the other will still provide adequate braking power (although pedal travel and effort may increase). Except on models with ABS, the split is "triangular", ie each circuit serves one rear caliper and half of both front ones.

The brake servo is of the direct-acting type, being interposed between the brake pedal and the master cylinder. The servo magnifies the effort applied by the driver. It is vacuum-operated, the vacuum being derived from the inlet manifold or (on some models) a mechanical vacuum pump.

Instrument panel warning lights alert the driver to hydraulic circuit failure (by means of a pressure differential valve) and on some models to low fluid level. Another warning light reminds when the handbrake is applied. The stop-lights are covered by the bulb failure warning system.

Note: *When servicing any part of the system, work carefully and methodically; also observe scrupulous cleanliness when overhauling any part of the hydraulic system. Always renew components (in axle sets, where applicable) if in doubt about their condition, and use only genuine Volvo replacement parts, or at least those of known good quality. Note the warnings given in "Safety first" and at relevant points in this Chapter concerning the dangers of asbestos dust and hydraulic fluid.*

2 Hydraulic system - bleeding

Warning: Hydraulic fluid is poisonous; wash off immediately and thoroughly in the case of skin contact, and seek immediate medical advice if any fluid is swallowed or gets into the eyes. Certain types of hydraulic fluid are inflammable, and may ignite when allowed into contact with hot components; when servicing any hydraulic system, it is safest to assume that the fluid IS inflammable, and to take precautions against the risk of fire as though it is petrol that is being handled. Hydraulic fluid is also an effective paint stripper, and will attack plastics; if any is spilt, it should be washed off immediately, using copious quantities of clean water. Finally, it is hygroscopic (it absorbs moisture from the air). The more moisture is absorbed by the fluid, the lower its boiling point becomes, leading to a dangerous loss of braking under hard use. Old fluid may be contaminated and unfit for further use. When topping-up or renewing the fluid, always use the recommended type, and ensure that it comes from a freshly-opened sealed container.

General

1 The correct functioning of the brake hydraulic system is only possible after removing all air from the components and circuit; this is achieved by bleeding the system.

2 During the bleeding procedure, add only clean, fresh hydraulic fluid of the specified type; never re-use fluid that has already been bled from the system. Ensure that sufficient fluid is available before starting work.

3 If there is any possibility of incorrect fluid being used in the system, the brake lines and components must be completely flushed with uncontaminated fluid and new seals fitted to the components.

4 If brake fluid has been lost from the master cylinder due to a leak in the system, ensure that the cause is traced and rectified before proceeding further.

5 Park the vehicle on level ground, switch off the ignition and select first gear (manual transmission) or Park (automatic transmission) then chock the wheels and release the handbrake.

6 Check that all pipes and hoses are secure, unions tight, and bleed screws closed. Remove the dust caps and clean any dirt from around the bleed screws.

7 Unscrew the master cylinder reservoir cap, and top-up the reservoir to the "MAX" level line. Refit the cap loosely, and remember to maintain the fluid level at least above the "MIN" level line throughout the procedure, otherwise there is a risk of further air entering the system.

8 There are a number of one-man, do-it-yourself, brake bleeding kits currently available from motor accessory shops. It is recommended that one of these kits is used

wherever possible, as they greatly simplify the bleeding operation, and also reduce the risk of expelled air and fluid being drawn back into the system. If such a kit is not available, the basic (two-man) method must be used, which is described in detail below.

9 If a kit is to be used, prepare the vehicle as described previously, and follow the kit manufacturer's instructions, as the procedure may vary slightly according to the type being used; generally, they are as outlined below in the relevant sub-section.

10 Whichever method is used, the correct sequence must be followed (paragraphs 11 to 13) to ensure the removal of all air from the system.

Bleeding sequence

11 If the hydraulic system has only been partially disconnected and suitable precautions were taken to minimise fluid loss, it should only be necessary to bleed that part of the system (ie the primary or secondary circuit).

12 If the complete system is to be bled, then it should be done in the following sequence:

Non-ABS models

a) Right-hand rear
b) Left-hand rear
c) Right-hand front
d) Left-hand front

ABS models (pre-1988)

a) Left-hand front
b) Right-hand front
c) Left-hand rear
d) Right-hand rear

ABS models (1988 onwards)

a) Rear brakes (in either order)
b) Front brakes (in either order)

13 On non-ABS models there are two bleed screws on each front caliper, and one on each rear caliper. On ABS models there are two bleed screws on each front caliper, one on each rear caliper on models without independent rear suspension, and two on each rear caliper on models with independent rear suspension. When bleeding the front brakes, start with the upper bleed screw on each caliper; when bleeding the rear brakes on calipers with twin bleed screws, only the upper bleed screw is used.

Bleeding - basic (two-man) method

14 Collect a clean glass jar and a suitable length of plastic or rubber tubing, which is a tight fit over the bleed screw, and a ring spanner to fit the screws. The help of an assistant will also be required.

15 If not already done, remove the dust cap(s) from the bleed screw(s) of the first wheel to be bled and fit the bleed tube(s) to the screw(s).

16 Immerse the other end of the bleed tube(s) in the jar, which should contain enough fluid to cover the end of the tube.

17 Ensure that the master cylinder reservoir fluid level is maintained at least above the "MIN" level line throughout the procedure.

18 Open the bleed screw(s) approximately half a turn, and have your assistant depress the brake pedal with a smooth steady stroke down to the floor, and then hold it there. When the flow of fluid through the tube stops, tighten the bleed screw(s) and have your assistant release the pedal slowly.

19 Repeat this operation (paragraph 18) until clean brake fluid, free from air bubbles, can be seen flowing from the end of the tube(s).

20 When no more air bubbles appear, tighten the bleed screw(s), remove the bleed tube(s) and refit the dust cap(s). Repeat these procedures on the remaining calipers in sequence until all air is removed from the system and the brake pedal feels firm again.

Bleeding - using a one-way valve kit

21 As their name implies, these kits consist of a length of tubing with a one-way valve fitted, to prevent expelled air and fluid being drawn back into the system; some kits incorporate a translucent container, which can be positioned so that the air bubbles can be more easily seen flowing from the end of the tube.

22 The kit is connected to the bleed screw, which is then opened **(see illustration)**. The user returns to the driver's seat, depresses the brake pedal with a smooth steady stroke, and slowly releases it; this is repeated until the expelled fluid is clear of air bubbles.

23 Note that these kits simplify work so much that it is easy to forget the master cylinder fluid level; ensure that this is maintained at least above the "MIN" level line at all times.

Bleeding - using a pressure-bleeding kit

24 These kits are usually operated by the reserve of pressurised air contained in the spare tyre. However, note that it will probably be necessary to reduce the pressure to a lower level than normal; refer to the instructions supplied with the kit.

25 By connecting a pressurised, fluid-filled container to the master cylinder reservoir, bleeding is then carried out by simply opening each bleed screw in turn (in the specified sequence) and allowing the fluid to run out, rather like turning on a tap, until no air bubbles can be seen in the expelled fluid.

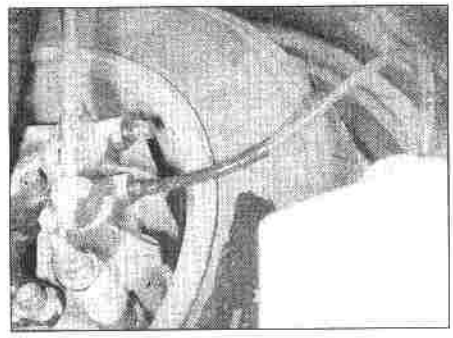
26 This method has the advantage that the large reservoir of fluid provides an additional safeguard against air being drawn into the system during bleeding.

27 Pressure bleeding is particularly effective when bleeding "difficult" systems, or when bleeding the complete system at the time of routine fluid renewal.

All methods

28 When bleeding is completed, check and top-up the fluid level in the master cylinder reservoir.

29 Check the feel of the brake pedal. If it feels at all spongy, air must still be present in the system, and further bleeding is indicated. Failure to bleed satisfactorily after a reasonable repetition of the bleeding operations may be due to worn master cylinder seals.



2.22 One-way valve bleeder connected to a front bleed screw

30 Discard brake fluid which has been bled from the system; it will not be fit for re-use.

3 Hydraulic pipes and hoses - inspection and renewal

Note: *Before starting work, refer to the warning at the beginning of Section 2 concerning the dangers of hydraulic fluid.*

Inspection

1 Raise and securely support the car at the front and rear so that the pipes and hoses under the wheel arches and on the suspension assemblies can be inspected.

2 Inspect the rigid pipes for security in their mountings. The pipes must be free from rust or impact damage.

3 Inspect the flexible hoses for cracks, splits and bulges. Bend the hoses between finger and thumb to show up small cracks. Renew any hoses whose condition is at all dubious. It is worth considering the renewal of the hoses on a precautionary basis at the time of fluid renewal.

Renewal

4 Details of pipe and hose renewal will vary according to the location of the item in question, but the basic steps are the same.

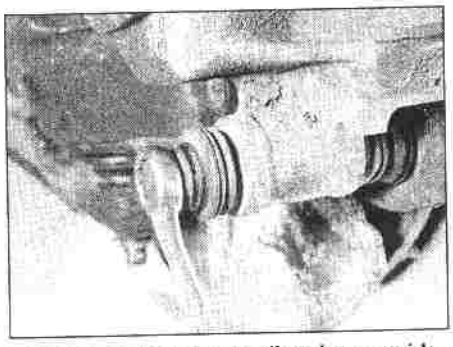
5 Minimise hydraulic fluid loss by removing the master cylinder reservoir cap, placing a piece of plastic film over the reservoir and tightening the cap over it.

6 Clean around the unions which are to be disconnected. Undo the unions - with a flexible hose, release it at the rigid pipe first, then from the caliper. Free the pipe or hose from any mounting clips and remove.

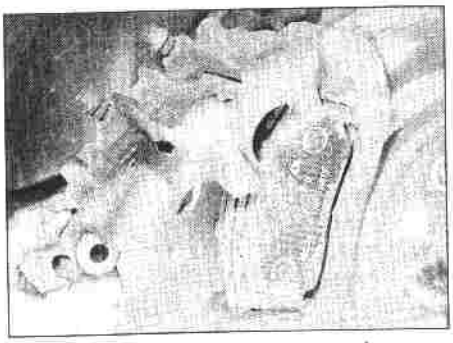
7 Before refitting, blow through the new pipe or hose with dry compressed air. Any bending needed for a rigid pipe should take place before the unions are connected. If genuine Volvo parts are used, the pipes should fit without bending.

8 When satisfied that the pipe or hose is correctly routed and will not foul adjacent components, refit and tighten the unions.

9 Bleed the hydraulic system (Section 2).



4.2 Removing a front caliper lower guide pin bolt



4.3 Pivot the caliper upwards

4 Front brake pads - renewal

Warning: Disc brake pads must be renewed on both front wheels at the same time - never renew the pads on only one wheel as uneven braking may result. Dust created by wear of the pads may contain asbestos, which is a health hazard. Never blow it out with compressed air and do not inhale any of it. DO NOT use petroleum-based solvents to clean brake parts. Use brake cleaner or methylated spirit only. DO NOT allow any brake fluid, oil or grease to contact the brake pads or disc. Also refer to the warning at the start of Section 2 concerning the dangers of hydraulic fluid.

1 Slacken the front wheel nuts, raise and support the front of the car and remove the front roadwheels.

2 Remove the caliper lower guide pin bolt, if necessary counterholding the guide pin with an open-ended spanner **(see illustration)**. On Girling calipers, also slacken the upper guide pin bolt.

3 Pivot the caliper upwards, free the bellows and slide it off the guide pin **(see illustration)**. Support the caliper so that the hose(s) are not strained. Do not press the brake pedal whilst the caliper is removed.

4 Recover the pads from the caliper bracket, noting their positions if they are to be re-used. Recover the anti-squeal shims (if fitted) from the backs of the pads.

5 Measure the thickness of the pad friction linings. If any one pad lining has worn down to the specified minimum, all four front pads must be renewed. Do not interchange pads in an attempt to even out wear. (Uneven pad wear may be due to the caliper sticking on the guide pins).

6 Clean the caliper and bracket with a damp rag or an old paintbrush. Inspect the caliper piston and dust boots for signs of fluid leakage. Also inspect the rubber bellows which cover the guide pins. Repair or renew as necessary (Section 8).

7 Remove any scale or rust from the outer rim of the brake disc with a wire brush or file. Inspect the disc visually; if brake judder has been a problem, carry out a more thorough inspection (Section 6).

8 If new pads are to be fitted, press the caliper pistons back into their bores with a pair of pliers, being careful not to damage the dust boots. Remove some fluid from the master cylinder reservoir to prevent overflowing as the pistons are pressed back.

> **HAYNES HINT** *An ideal way to remove fluid from the master cylinder reservoir is to use a clean syringe or an old poultry baster.*

9 Apply anti-seize compound or disc brake lubricant to the backs of the pads and to the caliper guide pins. Do not allow lubricant to contact the disc or pad friction surfaces. Also lubricate both sides of the anti-squeal shims (when fitted) and fit them to the pads.

10 Slide the caliper onto the upper guide pin and engage the bellows. Position the pads with the friction surfaces towards the disc and swing the caliper down over the pads. Make sure that the anti-rattle spring in the caliper is sitting correctly on the pads.

11 Apply thread locking compound to the guide pin bolt, insert it and tighten it to the specified torque. On Girling calipers, also tighten the upper guide pin bolt.

12 Press the brake pedal several times to bring the pads up to the disc.

5.2 Driving out a pad retaining pin

13 Repeat the operations on the other front brake.

14 Refit the roadwheels, lower the vehicle and tighten the wheel nuts.

15 Check the brake fluid level and top-up if necessary.

16 If new pads have been fitted, avoid hard braking as far as possible for the first few hundred miles to allow the linings to bed in.

5 Rear brake pads - renewal

Warning: Disc brake pads must be renewed on both rear wheels at the same time - never renew the pads on only one wheel as uneven braking may result. Dust created by wear of the pads may contain asbestos, which is a health hazard. Never blow it out with compressed air and do not inhale any of it. DO NOT use petroleum-based solvents to clean brake parts. Use brake cleaner or methylated spirit only. DO NOT allow any brake fluid, oil or grease to contact the brake pads or disc. Also refer to the warning at the start of Section 2 concerning the dangers of hydraulic fluid.

Models without independent rear suspension

1 Slacken the rear wheel nuts, raise and support the rear of the car and remove the rear wheels.

2 Drive the two retaining pins out of the caliper using a hammer and punch **(see illustration)**. Recover the anti-rattle spring. Obtain a new spring for reassembly.

3 Press each pad away from the disc, using pliers. Do not lever between the pads and the disc.

4 Pull the pads out of the caliper, along with the anti-squeal shims (if fitted). Identify their position if they are to be re-used. Do not press the brake pedal with the pads removed.

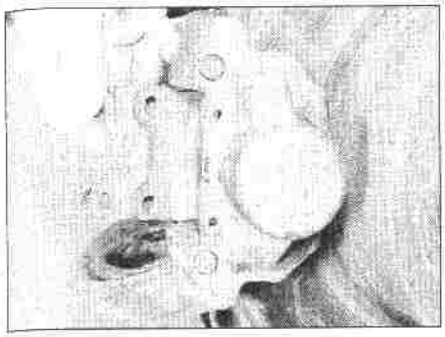
5 Measure the thickness of the pad friction linings. If any one pad lining has worn down to the specified minimum, all four rear pads must be renewed. Do not interchange pads in an attempt to even out wear.

6 Clean the caliper with a damp rag or an old paintbrush. Inspect the caliper pistons and dust boots for signs of fluid leakage. Repair or renew as necessary (Section 9).

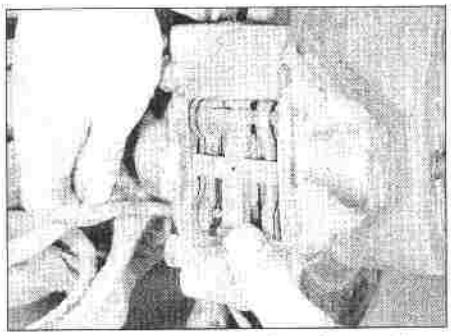
7 Inspect the visible surface of the brake disc. If deep scoring, cracks or grooves are evident, or if brake judder or snatch has been a problem, carry out a more thorough inspection (Section 7). Remove the caliper if necessary for access to the inboard face of the disc.

8 Anti-squeal shims may be fitted if wished, even if none were fitted before.

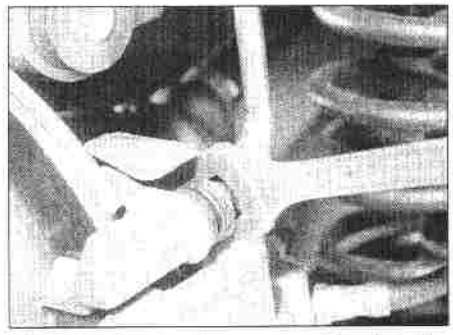
9 If new pads are to be fitted, press the caliper pistons back into their bores. Remove some fluid from the master cylinder reservoir to prevent overflowing as the pistons are pressed back.



5.11 Refitting a rear pad and anti-squeal shim



5.12 Fitting a pad retaining pin over the spring tongue



5.15 Slackening the upper guide pin bolt

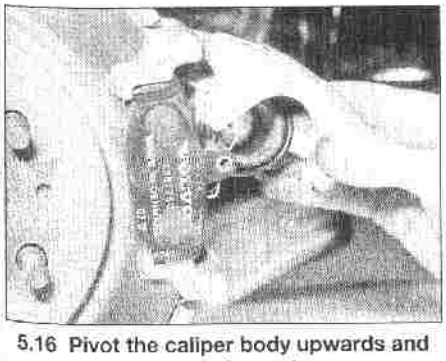
> **HAYNES HiNT** *An ideal way to remove fluid from the master cylinder reservoir is to use a clean syringe or an old poultry baster.*

10 Smear the backs of the pads and both sides of the anti-squeal shims (if used) with anti-seize compound or disc brake lubricant. Keep this off the friction surfaces of the pads.
11 Fit the pads and shims into the jaws of the caliper with the friction surfaces towards the disc **(see illustration)**.
12 Insert one of the pad retaining pins and tap it home. Fit a new anti-rattle spring and the other pad retaining pin, making sure that the pins pass over the tongues of the spring **(see illustration)**.

Models with independent rear suspension

13 Slacken the rear wheel nuts, raise and support the rear of the car and remove the rear wheels.
14 Press the caliper piston back into its bore by levering between the back of the outboard pad and the caliper body. The brake fluid level in the master cylinder will rise when this is done, so remove a little fluid if necessary to prevent overflow.

> **HAYNES HiNT** *An ideal way to remove fluid from the master cylinder reservoir is to use a clean syringe or an old poultry baster.*



5.16 Pivot the caliper body upwards and remove the pads

15 Remove the lower guide pin bolt, counter-holding the pin with an open-ended spanner. Slacken, but do not remove, the upper guide pin bolt **(see illustration)**.
16 Pivot the caliper body upwards and remove the brake pads **(see illustration)**. Do not press the brake pedal whilst the pads are removed.
17 Clean and inspect the caliper and disc as described in paragraphs 6 and 7 above. Also check that the rubber bellows on the guide pins are in good condition.
18 Fit the new pads, friction surface towards the disc, and swing the caliper body down over them.
19 Refit the lower guide pin bolt. Tighten both guide pin bolts to the specified torque, counterholding the guide pins if necessary.

All models

20 Pump the brake pedal several times to bring the new pads up to the discs.
21 Repeat the operations on the other rear brake.
22 Refit the roadwheels, lower the vehicle and tighten the wheel nuts.
23 Check the brake fluid level and top-up if necessary.
24 If new pads have been fitted, avoid harsh braking as far as possible for the first few hundred miles to allow the linings to bed in.

6 Front brake disc - inspection, removal and refitting

Note: *Before starting work, refer to the warning at the beginning of Section 4 concerning the dangers of asbestos dust.*

Inspection

Note: *If either disc requires renewal, BOTH should be renewed at the same time, to ensure even and consistent braking. New brake pads should also be fitted.*
1 Slacken the front wheel nuts, raise and support the front of the car and remove the front roadwheels.
2 Inspect the friction surfaces for cracks or deep scoring (light grooving is normal and may be ignored). A cracked disc must be renewed; a scored disc can be reclaimed by machining provided that the thickness is not reduced below the specified minimum.
3 Check the disc run-out using a dial test indicator with its probe positioned near the outer edge of the disc. If the run-out exceeds the figures given in the Specifications, ensure that the front wheel bearing adjustment is correct (Chapter 10). If the run-out is still excessive, renew the disc.

> **HAYNES HiNT** *If a dial test indicator is not available, check the run-out by positioning a fixed pointer near the outer edge, in contact with the disc face. Rotate the disc and measure the maximum displacement of the pointer with feeler blades.*

4 Disc thickness variation in excess of 0.015 mm can also cause judder. Check this using a micrometer.

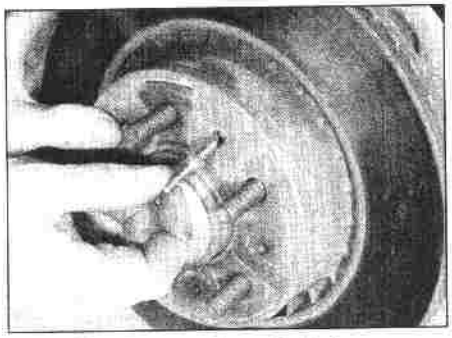
Removal

Pre-1988 models with integral disc/hub assembly

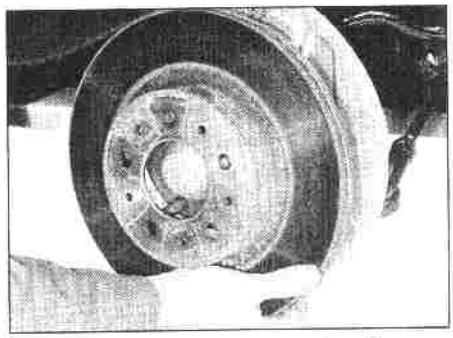
5 On pre-1988 models, the front brake disc itself is an integral part of the front hub unit and cannot be removed separately. Removal procedures for the disc/hub assembly are contained in Chapter 10.
6 If the disc/hub assembly is to be renewed, it may not be possible to obtain the original type of brake disc with integral hub. A service kit is available, consisting of separate disc and hub units so that the car can be converted to the later arrangement. After initial fitting and adjustment, the disc can subsequently be removed and refitted independently of the hub.

1988 models onward with separate disc/hub assembly

7 Remove the brake caliper and bracket (Section 8), but do not disconnect the hydraulic hoses. Tie the caliper up so that the hoses are not strained.
8 Remove the spigot pin which holds the disc to the hub and lift off the disc **(see illustrations)**.



6.8a Remove the spigot pin . . .



6.8b . . . and lift off the brake disc

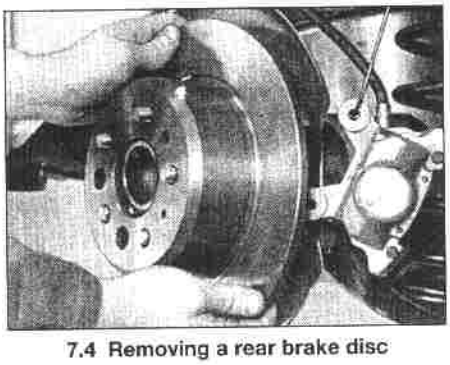
Refitting

Pre-1988 models with integral disc/hub assembly

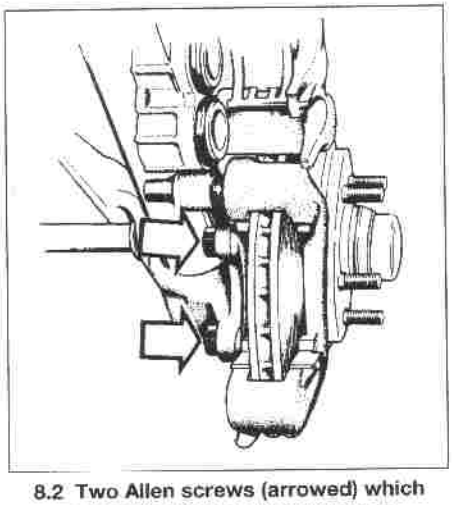
9 Refer to Chapter 10 for the disc/hub assembly refitting procedures. If a new disc is to be fitted, transfer the bearing tracks to it if they are in good condition, or fit new ones. Renew the oil seal in any case. Clean rustproofing compound off a new disc with methylated spirit and a rag.

1988 models onward with separate disc/hub assembly

10 Ensure that the hub and disc mating faces are clean. Clean rustproofing compound off a new disc with methylated spirit and a rag.



7.4 Removing a rear brake disc



8.2 Two Allen screws (arrowed) which secure the front caliper bracket

11 Locate the disc on the hub and refit the retaining spigot pin.

12 Refit the brake caliper and bracket (Section 8).

7 Rear brake disc - inspection, removal and refitting

Note: *Before starting work, refer to the warning at the beginning of Section 5 concerning the dangers of asbestos dust.*

Inspection

1 The inspection procedures are the same as for the front brake disc, and reference should be made to Section 6, paragraphs 1 to 4 inclusive. Additionally, after removal, check the condition of the handbrake drums. Refinishing, run-out and out-of-round limits are given in the Specifications. The drums are unlikely to wear unless the handbrake is habitually used to stop the vehicle.

Removal

2 Remove the rear brake caliper without disconnecting the hydraulic hose (Section 9). Tie the caliper up out of the way.

3 If a wheel locating spigot is fitted, unscrew it from the disc.

4 Make sure that the handbrake is released, then pull off the disc. Tap it with a soft-faced mallet if necessary to free it **(see illustration)**.

Refitting

5 Refit by reversing the removal procedure. If a new disc is being fitted, remove the traces of rustproofing compound from it.

8.7a Remove a piston dust boot . . .

8 Front brake caliper - removal, overhaul and refitting

Note: *Before starting work, refer to the warning at the beginning of Section 2 concerning the dangers of hydraulic fluid, and to the warning at the beginning of Section 4 concerning the dangers of asbestos dust.*

Removal

Non-ABS models

1 Proceed as for brake pad removal (Section 4), but additionally disconnect the caliper hoses from the hydraulic pipes at the bracket on the inner wing. Identify the hoses so that they can be refitted to the same pipes; be prepared for hydraulic fluid spillage. Keep dirt out of the open unions.

2 If it is wished to remove the caliper bracket, undo the two Allen screws which secure it to the steering knuckle **(see illustration)**. Obtain new screws for reassembly.

ABS models

3 Proceed as above, but note that as there is only one hydraulic hose per caliper, the hose-to-pipe union can be left undisturbed. Slacken the hose union at the caliper, remove the caliper from the guide pins and unscrew it from the hose.

Overhaul

4 With the brake caliper removed, clean it externally with methylated spirit and a soft brush.

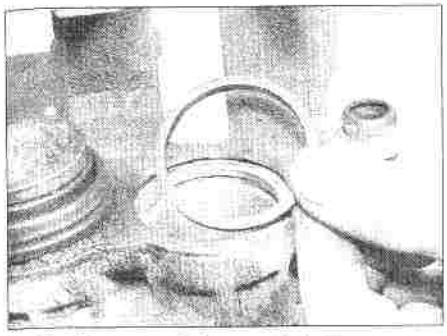
5 Remove the hydraulic hose(s) and the bleed screws. Empty any remaining hydraulic fluid out of the caliper.

6 Remove the anti-rattle spring.

7 Remove one of the piston dust boots and pull the piston out of its bore **(see illustrations)**.

HAYNES HiNT ***If the caliper piston is reluctant to move, refit the bleed screws and apply low air pressure (eg from a foot pump) to the fluid inlet, but note that the piston may be ejected with some force.***

8.7b . . . and the piston itself



8.13 Fit a new piston seal into the groove

8 Hook out the piston seal from the bore using a blunt instrument.
9 Repeat the above operations on the other piston. Identify the pistons if they are to be re-used.
10 Clean the pistons and bores with a lint-free rag and some clean brake fluid or methylated spirit. Slight imperfections may be polished out with steel wool. Pitting, scoring or wear ridging of bores or pistons mean that the whole caliper must be renewed.
11 Renew all rubber components (seals, dust boots and bellows) as a matter of course. Blow through the fluid inlet and bleed screw holes with compressed air.
12 Check that the guide pins slide easily in their housings. Clean or renew them as necessary, and lubricate them with a copper-based anti-seize compound.
13 Lubricate a new piston seal with clean brake fluid. Insert the seal into the groove in the bore, using the fingers only to seat it **(see illustration)**.
14 Fit a new dust boot to the piston at the end furthest from the piston groove. Extend the dust boot ready for fitting.
15 Lubricate the piston and bore with clean brake fluid, or with assembly lubricant if this is supplied with the repair kit.
16 Offer the piston and dust boot to the caliper. Engage the dust boot with the groove in the piston housing, then push the piston through the dust boot into the caliper bore. Engage the dust boot with the groove on the piston.
17 Repeat the above operations on the other piston and bore.
18 Refit the bleed screws, hydraulic hoses and other disturbed components.

Refitting

19 When refitting the caliper bracket, apply thread locking compound to the Allen screws and tighten them to the specified torque.
20 Refit the caliper as described in Section 4 and reconnect the hydraulic hoses. Check the "set" of the hoses ensuring that they aren't twisted or kinked.
21 Bleed the hydraulic system on completion (Section 2).

9 Rear brake caliper - removal, overhaul and refitting

Note: *Before starting work, refer to the warning at the beginning of Section 2 concerning the dangers of hydraulic fluid, and to the warning at the beginning of Section 5 concerning the dangers of asbestos dust.*

Removal

Models without independent rear suspension

1 Remove the rear brake pads (Section 5).
2 Clean around the hydraulic union on the caliper. Slacken the union half a turn **(see illustration)**.
3 Remove the two bolts which secure the caliper. Of the four bolts on the caliper, these are the two nearest the hub. Do not remove the other two bolts, which hold the caliper halves together. Obtain new bolts for refitting.
4 Remove the caliper from the disc and unscrew it from the hydraulic hose. Be prepared for fluid spillage. Plug or cap open unions.

Models with independent rear suspension

5 Slacken the rear wheel nuts, raise and support the vehicle and remove the rear wheel.
6 If the caliper is to be removed completely, slacken the hydraulic hose union half a turn.
7 Remove the two bolts which secure the caliper bracket to the rear hub carrier. Obtain new bolts for refitting.
8 Withdraw the caliper, bracket and pads from the disc. Unscrew the caliper from the hydraulic hose if wished, being prepared for fluid spillage. If the caliper is not to be removed completely, tie it up so that the hose is not strained.

Overhaul

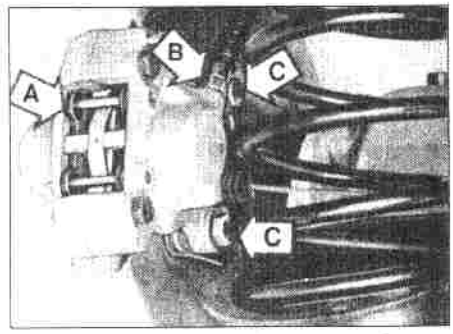
All models

9 This is essentially the same procedure as that described for the front caliper (Section 8). In addition, note the following points.
10 Do not attempt to separate the caliper halves.
11 Pay attention to the position of the step on the piston. It should be at a 20° angle to the lower surface of the caliper.
12 Single piston calipers are fitted to certain later models but the overhaul procedures are essentially the same.

Refitting

All models

13 Commence refitting by screwing the caliper onto the flexible hose. Do not tighten the union fully yet.
14 Fit the caliper over the disc and secure it to the axle bracket with two new bolts. Tighten the bolts to the specified torque.



9.2 Rear brake caliper removal

A Rear pads
B Hydraulic union
C Caliper securing bolts

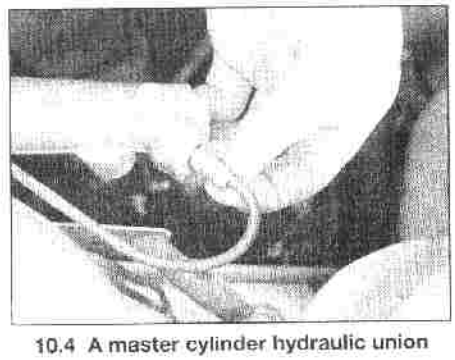
15 Tighten the flexible hose union at the caliper. Check that the routing and "set" of the hose are such that it does not contact adjacent components. Correct if necessary by releasing the hose union at the brake pipe bracket, repositioning the hose and tightening the union.
16 Refit the brake pads (Section 5).
17 Bleed the appropriate hydraulic circuit (Section 2).

10 Brake master cylinder - removal, overhaul and refitting

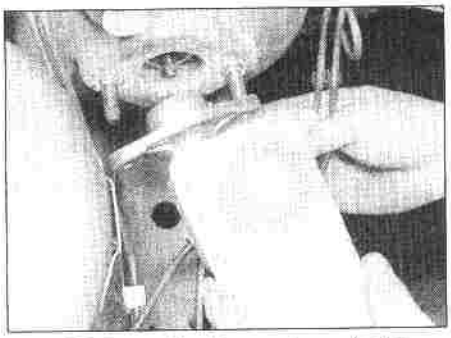
Note: *Before starting work, refer to the warning at the beginning of Section 2 concerning the dangers of hydraulic fluid.*

Removal

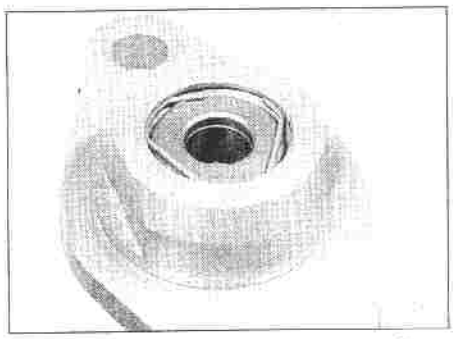
1 Syphon as much fluid as possible from the master cylinder reservoir, using a hydrometer or old poultry baster.
Caution: Do not syphon the fluid by mouth, it is poisonous.
2 Unbolt the heat shield (when fitted) from around the master cylinder.
3 Disconnect the clutch master cylinder feed pipe from the side of the reservoir (when applicable). Be prepared for fluid spillage. Plug the open end of the pipe.
4 Disconnect the hydraulic unions from the master cylinder. Be prepared for fluid spillage. Cap the open unions to keep dirt out **(see illustration)**.



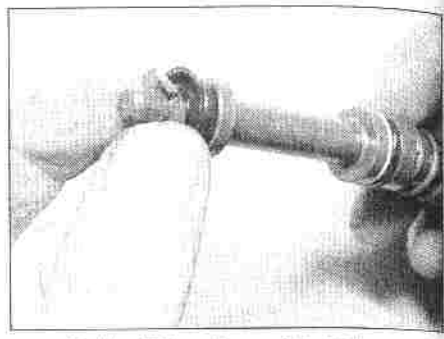
10.4 A master cylinder hydraulic union



10.5 Removing the master cylinder



10.8 Remove the circlip to release the pistons



10.14a Fitting the spring seat . . .

5 Remove the nuts which secure the master cylinder to the servo. Pull the master cylinder off the servo studs and remove it **(see illustration)**. Be careful not to spill hydraulic fluid on the paintwork.

Overhaul

6 Empty the fluid out of the master cylinder by pumping the pistons with a screwdriver. Clean the cylinder externally.

7 Pull the reservoir off the master cylinder and recover the seals.

Non-ABS models

8 Depress the pistons and extract the circlip from the mouth of the cylinder **(see illustration)**.

9 Shake the pistons, spring seat and spring out of the cylinder.

10 Inspect the master cylinder bore. If it is badly corroded or scratched, renew the cylinder complete. Light scoring or surface rust may be removed with steel wool and methylated spirit.

11 Obtain a repair kit, which will contain new pistons with seals already fitted.

12 Clean all parts not being renewed with methylated spirit. Blow through fluid passages with an air line or foot pump.

13 Lubricate the cylinder bore with clean hydraulic fluid. Apply more fluid to the pistons and seals, or smear them with assembly lubricant if this is supplied in the kit.

14 Assemble the spring, spring seat and pistons. Make sure that all components are perfectly clean, then insert the spring and pistons into the master cylinder. Depress the pistons and insert the circlip **(see illustrations)**.

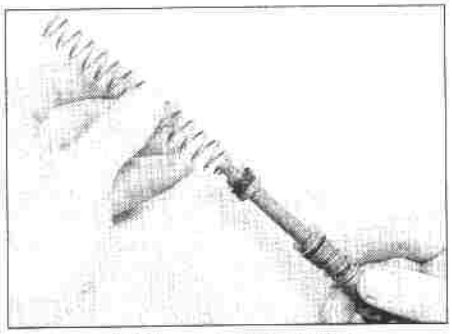
15 Refit the reservoir and seals; renew the seals if necessary. Make sure that the reservoir cap breather hole is clear.

ABS models

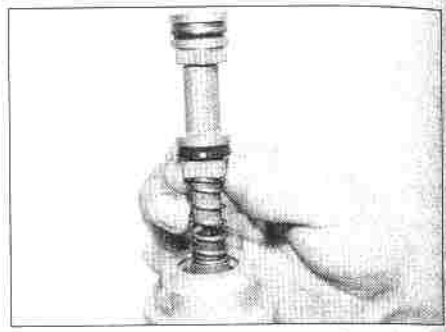
16 The procedure is similar to that just described, but the pistons are retained by a roll pin as well as by a circlip.

Refitting

17 Refit by reversing the removal operations. Bleed the complete brake hydraulic system (Section 2), and if necessary the clutch hydraulic system (Chapter 6), on completion.



10.14b . . . and the spring



10.14c Fitting the pistons into the master cylinder

11 Pressure differential warning valve - removal, overhaul and refitting

Note: *On certain later models the pressure differential warning valve is not used, its function being replaced by a float operated switch in the master cylinder reservoir filler cap.*

Removal

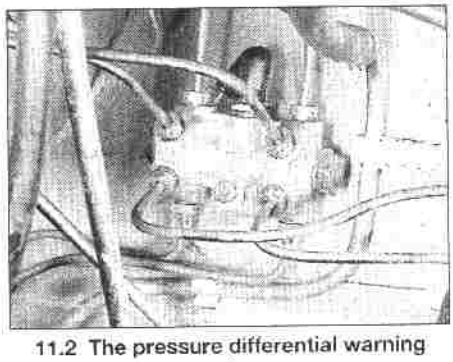
1 Seal the master cylinder reservoir by blocking the cap vent, or by tightening the cap over a piece of thin plastic film.

2 Clean the valve and its unions. It is located on the left-hand inner wing; access is not good **(see illustration)**.

3 Disconnect the eight hydraulic unions for the valve, making notes for refitting if there is any possibility of confusion. Be prepared for fluid spillage; cap open unions.

4 Disconnect the electrical lead from the valve.

5 Remove the single securing bolt and remove the valve. Do not drip fluid on the bodywork.



11.2 The pressure differential warning valve

Overhaul

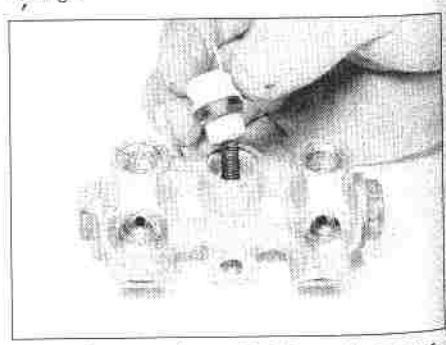
6 Thoroughly clean the outside of the valve.

7 Unscrew the switch from the top of the valve. Recover the spring and contact pin **(see illustration)**.

8 Unscrew the two end plugs from the valve. Recover the O-rings.

9 Remove the piston, spring, plungers and O-rings. Note their fitted order.

10 Clean all parts with methylated spirit and inspect them. If the valve bore is badly worn, rusty or scored, renew the valve complete. Otherwise, obtain a repair kit containing new O-rings.



11.7 Unscrew the switch from the top of the valve

11 Fit one end plug, using a new O-ring, and tighten it.
12 Assemble the piston, plungers and spring. Lubricate the piston and the new O-rings with clean hydraulic fluid. Fit one of the O-rings to a plunger and insert the assembly into the valve bore, O-ring first.
13 Fit the other O-ring into the bore and press it home with a small tube or other suitable tool.
14 Fit the other end plug and O-ring.

Refitting

15 Refit by reversing the removal operations. Bleed the complete hydraulic system (Section 2), then check the success of the overhaul as follows.
16 Have an assistant depress the brake pedal hard for one minute. Watch the valve: if fluid emerges from the switch hole, renew the valve. If no fluid emerges, refit the contact pin, spring and switch. Reconnect the switch.

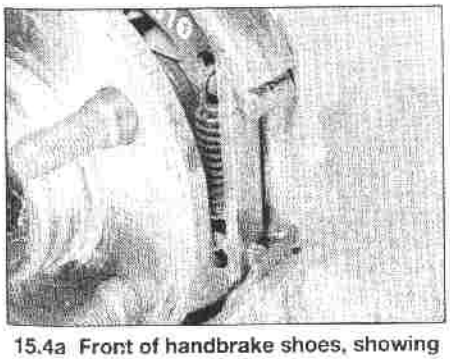
12 Brake pedal - removal and refitting

The procedure for removal and refitting of the brake pedal is the same as for the clutch pedal. Refer to Chapter 6, Section 3

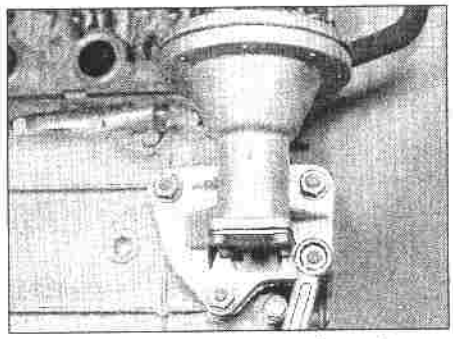
13 Brake servo - removal and refitting

Removal

1 Remove the brake master cylinder (Section 10). If care is taken, the master cylinder can be moved away from the servo without disconnecting the hydraulic unions. It will be necessary to disconnect the clutch master cylinder feed pipe, however.
2 Disconnect the servo vacuum feed, either by disconnecting the hose or by levering out the check valve.
3 Inside the vehicle, remove the steering column/pedal trim. Disconnect the servo clevis from the brake pedal.
4 Remove the four nuts which secure the servo.



15.4a Front of handbrake shoes, showing strut



14.2 Vacuum pump securing nuts

5 Withdraw the servo from the engine bay.

Refitting

6 Refit by reversing the removal operations. If a new servo is being fitted, adjust the pushrod if necessary to give small clearance between the servo pushrod and the master cylinder piston in the resting position.
7 Bleed the hydraulic system on completion if necessary (Section 2).

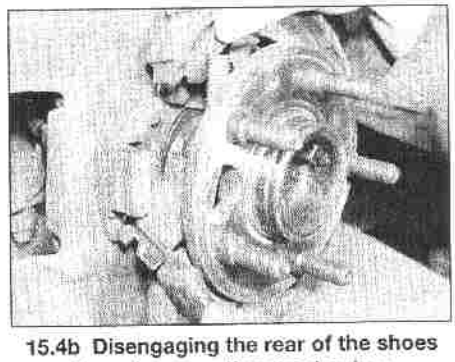
14 Vacuum pump - removal, overhaul and refitting

Removal

1 Disconnect the hose from the vacuum pump.
2 Undo the four securing nuts and lift off the pump **(see illustration)**. Recover the gasket.

Overhaul

3 Remove the pump top cover, which is secured by two screws. Recover the gasket, valve springs, valves and seals. Note which way round the valves are fitted.
4 Make alignment marks between the two halves of the pump. Remove the eight screws and separate the pump halves.
5 Remove the central screw which secures the diaphragm. Remove the diaphragm, washers and spring. Note the fitted sequence of the washers.
6 Undo the four securing screws and remove the bottom cover.



15.4b Disengaging the rear of the shoes from the operating mechanism

7 Insert feeler blades between the operating lever and the lever bearing arm to support the bearing arm. Drive out the lever pivot pin, then withdraw the feeler blades.
8 Remove the operating rod and lever.
9 Clean all parts and renew as necessary. New gaskets and seals should be used as a matter of course.
10 Commence reassembly by fitting the operating rod and lever to the pump body. Support the bearing arm with feeler blades and drive in the pivot pin; apply a drop of locking fluid to the exposed ends of the pin. Withdraw the feeler blades.
11 Refit the bottom cover, using a new gasket, and secure with the four screws.
12 Assemble the diaphragm, spring, washers and screw. Hold the pump upside down and fit the diaphragm assembly. Secure it with the screw.
13 Refit the top half of the pump, observing the alignment marks made when dismantling. Secure it with the eight screws.
14 Refit the valves, using new seals. Make sure that the valves are fitted the right way round. Refit the springs and the top cover, using a new gasket, and secure it with the two screws.

Refitting

15 Refit by reversing the removal operations, using a new gasket if necessary.

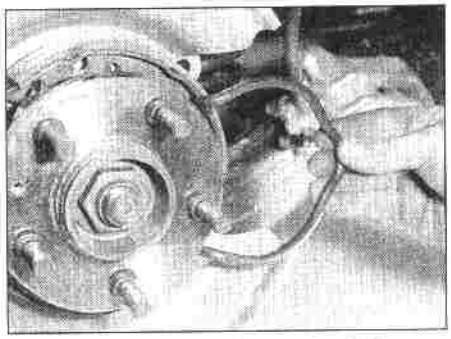
15 Handbrake shoes - inspection and renewal

Inspection

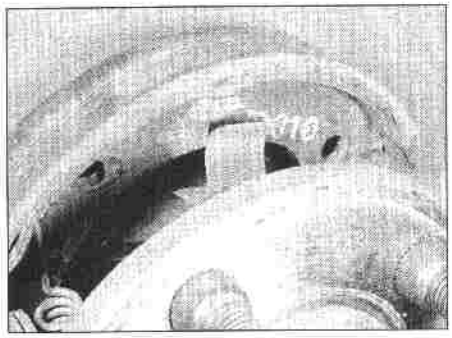
1 Slacken the handbrake cable adjuster (Chapter 1).
2 Remove the rear brake disc (Section 7).
3 Inspect the shoes for wear, damage or oil contamination. Renew them if necessary and rectify the source of any contamination. As with the brake pads, the shoes must be renewed in axle sets.

Renewal

4 Prise the shoes apart and displace the operating mechanism from them at the rear end, and the strut from them at the front **(see illustrations)**.
5 On early models, unhook one of the coil return springs from one of the shoes, working through the hole in the halfshaft flange. On later models a horseshoe shaped return spring is used. The open ends of the spring engage in holes in the shoes, and the closed end is secured by a clip **(see illustration)**. The spring is removed by levering the open ends out of their holes using a large screwdriver.
6 Free the shoes from the U-clips on the backplate and remove them (complete with springs on early models) **(see illustration)**.



15.5 Handbrake shoe spring being removed on later models



15.6 Handbrake shoe engaged in U-clip

7 Refit the shoes by reversing the removal operations. Adjust the handbrake on completion (Chapter 1).

16 Handbrake cables (without independent rear suspension) - removal and refitting

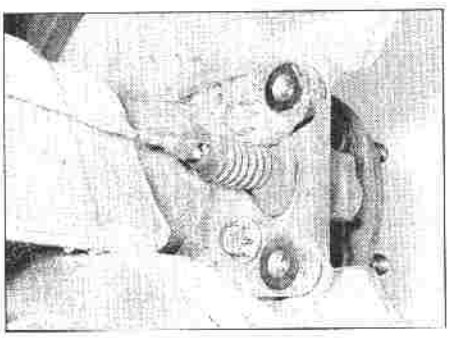
Removal

Short (right-hand) cable

1 Remove the handbrake shoes on the right-hand side (Section 15).
2 Free the cable from the operating mechanism by pushing out the clevis pin.
3 Remove the clevis pin from the other end of the cable. Free the cable from the guides or retaining clips and remove it.
4 Check the condition of the rubber gaiter and renew it if necessary **(see illustration)**.

Long (left-hand) cable

5 Inside the vehicle, slacken off the handbrake adjustment as far as possible (Chapter 1). Release the cable from the lever.
6 Remove the handbrake shoes on the left-hand side (Section 15).
7 Free the cable from the operating mechanism by pressing out the clevis pin.
8 Release the cable from the brake backplate and from the rear axle.
9 Release the cable from the under-floor clamps and grommets and remove it. Transfer the grommets etc to the new cable. Renew the rubber gaiter if necessary.



16.4 Handbrake cable showing rubber gaiter

Refitting

Both cables

10 Refit by reversing the removal procedure, noting the following points:
a) Apply brake anti-seize compound to the operating mechanism and backplate rubbing surfaces. Keep the compound off brake friction surfaces.
b) Fit the operating mechanism with the arrow visible and pointing upwards ***(see illustration).***
c) Adjust the handbrake on completion (Chapter 1).

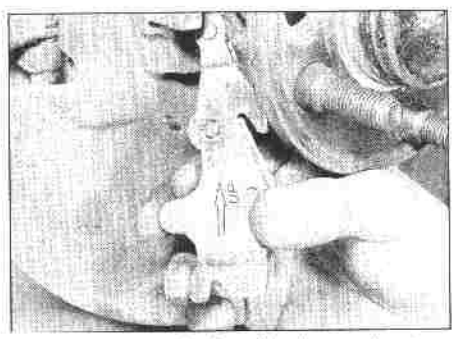
17 Handbrake cables (with independent rear suspension) - removal and refitting

Removal

1 On models with independent rear suspension, three handbrake cables are used. A long cable runs from the handbrake lever to the rear suspension members. Two short cables, one on each side, transmit the movement of the long cable to the brake shoe assemblies.

Long cable

2 Remove the rear console, slacken the cable adjustment right off and disconnect the cable from the handbrake lever.
3 Remove the rear seat cushion and pull back the carpet. Free the cable grommet from the floor.



16.10 Refitting the handbrake mechanism - note arrow and "UP" marking

4 Raise and support the vehicle. Slacken, but do not remove, the fuel tank retaining bolts (see Chapter 4) so that the tank is lowered by 10 to 15 mm.
5 Unbolt the clamp which secures the cable to the underside of the floor.
6 Disconnect the long cable from its junctions with the small cables. Remove the long cable, drawing it over the petrol tank.

Short cable

7 Remove the rear console (Chapter 11), and slacken the cable adjuster.
8 Remove the handbrake shoes on the side concerned (Section 15).
9 Disconnect the short cable at its junction with the long cable. (It may be easier if both short cables are disconnected.)
10 Withdraw the cable clip from the brake backplate.
11 Withdraw the operating mechanism from the backplate and disconnect the cable inner from it, noting which way the arrow on the mechanism faces. Remove the cable.

Refitting

All cables

12 Refit by reversing the removal procedure, noting the following points:
a) Apply brake anti-seize compound to the operating mechanism and backplate rubbing surfaces. Keep the compound off brake friction surfaces.
b) Fit the operating mechanism with the arrow pointing in the direction noted on removal.
c) On the long cable, the correct position of the floor clamp on the new cable is shown by a paint mark.
d) Adjust the handbrake (Chapter 1) before refitting the console.

18 Anti-lock braking system (ABS) - general information

1 When fitted, the anti-lock braking system monitors the rotational speed of the wheels under braking. Sudden deceleration of one wheel, indicating that lock-up is occurring, causes the hydraulic pressure to that wheel's brake to be reduced or interrupted momentarily. Monitoring and correction take place several times per second, giving rise to a "pulsing" effect at the brake pedal when correction is taking place. The system gives even inexperienced drivers a good chance of retaining control when braking hard on slippery surfaces.
2 The main components of the system are the sensors, the control unit and the hydraulic modulator. (Some of the ABS components are shared with the Electronic Traction Control system (ETC), when fitted).
3 One sensor is fitted to each front wheel, picking up speed information from a pulse wheel carried on the brake disc. Rear wheel

speed information is picked up from the speedometer sensor in the differential housing. For ABS purposes the rear wheels are treated as one unit.

4 Information from the sensors is fed to the control unit which is located in the boot on early models, or in the driver's footwell area on later models. The control unit operates solenoid valves in the hydraulic modulator, (also in the boot on early models, or engine compartment on later models), to restrict if necessary the supply to either front caliper or both rear calipers. The control unit also illuminates a warning light in the event of system malfunction.

5 The hydraulic modulator contains a pump as well as solenoid valves. It is a semi-active device, increasing the effort applied at the brake pedal. If the modulator fails, adequate braking effort will still be available from the master cylinder and servo, though the anti-lock function will be lost.

6 On models with ABS, the hydraulic circuits are split front to rear instead of triangularly.

7 To avoid damage to the ABS control unit, do not subject it to voltage surges in excess of 16V, nor to temperatures in excess of 80°C.

19 Anti-lock braking system (ABS) components - removal and refitting

Removal

Front wheel sensor

1 Follow the sensor wiring back to the suspension turret. Separate the connector, push the wires out of it and feed them back into the wheel arch.

2 Remove the Allen screw which secures the sensor to the steering knuckle. Withdraw the sensor and its wiring.

Front disc pulse wheel

Note: *Removal and refitting of the front disc pulse wheels can only be carried out on early models with integral hub/disc assembly.*

3 Remove the front brake disc/hub assembly (see Chapter 10).

4 Remove the pulse wheel from the disc with a two-legged puller. Be careful not to damage the hub oil seal.

Rear wheel sensor (models without independent rear suspension)

5 This is the same as the speedometer sender (Chapter 12, Section 7), but may be secured by an Allen screw instead of a ring nut. The running clearance for this sender is 0.35 to 0.75 mm with a target value of 0.60 mm.

Rear wheel sensor (models with independent rear suspension)

6 As on earlier models, the ABS sensor doubles as the speedometer sender. Access is as follows.

7 Inside the boot, remove the spare wheel and fold back the carpet. Remove the protective cover from around the fuel filler pipe to expose the ABS sensor connector box.

8 Open the box, break the seal and disconnect the connector. Free the ABS sensor cable where it passes through a grommet in the boot floor.

9 Raise and support the rear of the vehicle. Support the rear axle lower member with a jack.

10 Remove the four bolts which secure the rear axle upper member to the body. Carefully lower the axle members/final drive assembly until the ABS sensor is accessible. Be careful that the driveshafts do not foul the fuel tank.

11 Break the seal on the ABS sensor, undo the Allen screw and withdraw the sensor. Unclip the cable, noting how it is routed. Access may be improved by disconnecting the handbrake right-hand short cable.

Control unit (pre-1988 models)

12 Make sure that the ignition is switched off.

13 Remove the cover from the right-hand well in the boot.

14 Lift the control unit out of its bracket, disconnect the multi-plug and remove it.

Control unit (1988 models onward)

15 Disconnect the battery negative lead.

16 Remove the trim from below the instrument panel and around the right-hand side of the driver's footwell.

17 Identify the control unit, free it from its strap and withdraw it **(see illustration)**. Disconnect the wiring plug from the unit and remove it.

Hydraulic modulator (pre-1988 models)

Note: *Before starting work, refer to the warning at the beginning of Section 2 concerning the dangers of hydraulic fluid.*

18 Remove the cover from the right-hand well in the boot.

19 Remove the modulator cover. Unplug the two relays and the electrical connector from the modulator. Release the earth wire.

20 Clean around the modulator hydraulic unions. Make identifying marks or notes.

21 Remove the three nuts from the modulator mountings.

22 Place some rags under the unit. Disconnect the hydraulic unions, being prepared for fluid spillage. Lift out the modulator. Plug or cap open unions.

23 If a new modulator is being fitted, transfer the pipe connectors and the rubber mountings to it.

Hydraulic modulator (1988 models onward)

24 Disconnect the battery negative lead. Remove the securing screw and lift the cover off the hydraulic modulator.

25 Remove both relays from the modulator. Undo the cable clamp screw and disconnect the multi-plug. Also disconnect the earth strap.

26 Inspect the hydraulic pipes for identification marks. Mark the pipes if necessary, following the identification letters on the modulator:

a) V Inlet, front (vorn) circuit
b) H Inlet, rear (hintern) circuit
c) l outlet, left front
d) r outlet, right front
e) h outlet, rear

27 Place rags under the modulator to catch spilt fluid. Disconnect the hydraulic unions.

28 Remove the two nuts and one bolt which secure the modulator. Remove the modulator, being careful not to spill hydraulic fluid on the paintwork.

Refitting

29 In all cases, refit by reversing the removal operations but noting the following points:

a) When refitting the front wheel sensor, apply a little grease (Volvo No 1 161 037-5, or equivalent) to the body of the sensor.
b) Use a piece of tube to seat the front disc pulse wheel then refit the disc/hub assembly (see Chapter 10).
c) When refitting the rear wheel sensor on models with independent rear suspension, use new bolts to secure the axle upper member and tighten them as specified.
d) Bleed the complete hydraulic system after refitting the hydraulic modulator.

19.17 ABS control unit as fitted to later models

Chapter 10
Suspension and steering

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

Steering

Power steering fluid type	See *"Weekly checks"*

Wheel alignment and steering angles

Front wheel toe setting:	
All models except 760 Saloon, 1988 onwards	2.0 ± 0.5 mm toe-in
760 Saloon, 1988 onwards	2.5 ± 0.5 mm toe-in
Rear wheel toe setting (models with independant rear suspension)	2.5 ± 0.5 mm toe-in

Roadwheels

Lateral run-out:	
Aluminium	0.8 mm maximum
Steel	1.0 mm maximum
Radial run-out:	
Aluminium	0.6 mm maximum
Steel	0.8 mm maximum

Torque wrench settings

	Nm	lbf ft
Front suspension		
Front wheel hub nut (1988 models onward with angular contact ball-bearings):		
Stage 1	100	74
Stage 2	Angle tighten 45° further	
Control arm ballpin nut	60	44
Balljoint to strut:		
Stage 1	30	22
Stage 2	Angle tighten 90° further	
Track rod end ballpin nut	60	44
Control arm to crossmember*	85	63
Radius rod to control arm*	95	70
Radius rod to subframe*		
M12	85	63
M14	140	103
Strut top mounting (to body)	40	30
Strut piston rod nut:		
Up to 1984	150	111
1985 onwards	70	52
Crossmember to body	95	70
**Use new fastenings every time*		
Rear suspension (non-independent)		
Trailing arm to axle	45	33
Trailing arm bracket bolts	45	33
Trailing arm bracket nuts	85	63
Rear spring upper mounting	48	35
Shock absorber mountings	85	63
Panhard rod bolts	85	63
Torque rods	140	103
Subframe front mounting	85	63
Subframe rear bush bracket	48	35
Rear suspension (independent)		
Driveshaft nut:*		
Stage 1	190	140
Stage 2	Angle tighten 60° further	
Support arm front mounting to body:		
Bolts	48	35
Nut, stage 1*	70	52
Nut, stage 2*	Angle tighten 60° further	
Upper link to hub carrier	115	85
Upper link to axle member:		
Front, stage 1*	70	50
Front, stage 2*	Angle tighten 60° further	
Rear	85	63
Track rod to hub carrier	85	63
Track rod to axle member	70	52
Shock absorber to support arm	56	41
Shock absorber to body	85	63
Support arm to hub carrier:*		
Stage 1	60	44
Stage 2	Angle tighten 90° further	
Support arm to mounting:*		
Stage 1	125	92
Stage 2	Angle tighten 120° further	
Lower link to hub carrier or axle member:*		
Stage 1	50	37
Stage 2	Angle tighten 90° further	
Rear axle member to body:*		
Stage 1	70	52
Stage 2	Angle tighten 60° further	
Rear axle member upper to lower sections:*		
Stage 1	70	52
Stage 2	Angle tighten 30° further	
**Fastenings which are angle tightened should be renewed every time*		

Torque wrench settings (continued)	Nm	lbf ft
Steering		
Steering wheel bolt	32	24
Steering column bearing bolts (760 models, 1988 onwards)	24	18
Steering intermediate shaft joint clamp bolts (760 models, 1988 onwards)	24	18
Steering column universal joints	21	16
Steering gear to crossmember	44	33
Track rod end balljoint nut	60	44
Track rod end locknut	70	52
Hydraulic union banjo bolts	42	31
Roadwheels		
Wheel nuts	85	63

1 General information

The independent front suspension is of the MacPherson strut type incorporating coil springs and integral telescopic shock absorbers. The struts are located at their lower ends by control arms, each carrying a balljoint. The control arms are attached to the front crossmember, to a radius rod each, and to the front anti-roll bar.

On most models, rear suspension is of the non-independent live rear axle type. The axle is supported by two trailing arms, two torque rods and a Panhard rod. The torque rods are attached to a central subframe, and a coil spring and a telescopic shock absorber are attached to each trailing arm. An anti-roll bar may also be fitted. Some top range Estate models also feature self-levelling rear suspension.

Independent "Multi-link" rear suspension is fitted to 760 Saloon models from the 1988 model year onwards. The system uses upper and lower links, track rods and support arms, with coil springs and telescopic shock absorbers. The final drive unit and driveshafts, which are new components associated with the independent rear suspension, are dealt with in Chapter 8.

Steering is by power-assisted rack and pinion on all models. Power assistance is derived from a hydraulic pump, belt-driven from the crankshaft pulley.

2 Front wheel bearings - checking and adjustment

Checking

1 Raise and support the front of the vehicle with the wheels free.

2 Hold the wheel at top and bottom and try to rock it. Spin the wheel and listen for rumbling or grinding noises. Play should be barely perceptible and noise should be absent.

3 Two types of wheel bearings are fitted to models covered by this manual. Pre-1988 models are equipped with adjustable taper-roller bearings (identified by the use of a split pin to secure the hub nut); later models utilise non-adjustable angular contact ball-bearings (identified by the absence of a split pin to secure the hub nut).

4 If play or noise is evident, the taper-roller bearings fitted to pre-1988 models may be adjusted as follows. If adjustment does not improve matters, the bearings must be renewed (see Section 3). No adjustment is possible on models equipped with ball-bearings, and if play or noise is evident, renewal is the only course of action (see Section 3).

Adjustment (pre-1988 models with taper-roller bearings only)

5 Slacken the front wheel nuts. Raise and support the front of the vehicle and remove the front wheel.

6 Prise or tap off the hub nut grease cap. Obtain a new cap if the old one is damaged **(see illustration)**.

7 Straighten the legs of the hub nut split pin. Remove the split pin; obtain a new one for reassembly.

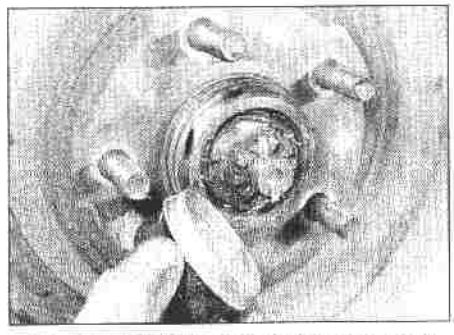
8 Slacken the hub nut slightly, then tighten it to 57 Nm (42 lbf ft), at the same time rotating the brake disc.

9 Slacken the nut half a turn, then retighten it using the fingers only (nominal torque 1.5 Nm/1.1 lbf ft).

10 Insert a new split pin to secure the hub nut. Tighten the nut if necessary to align the next split pin hole. Spread the legs of the split pin to secure it.

11 Half fill the grease cap with grease. Refit it and tap it home.

12 Refit the wheel, lower the vehicle and tighten the wheel nuts.



2.6 Removing the front hub grease cap

3 Front wheel bearings - renewal

Note: *Two types of front wheel bearings are fitted to Volvo models covered by this manual. Pre-1988 models are equipped with taper-roller bearings (identified by the use of a split pin to secure the hub nut); later models utilise angular contact ball-bearings (identified by the absence of a split pin to secure the hub nut). Identify the arrangement fitted, then proceed as follows according to type.*

Pre-1988 models with taper-roller bearings

1 Remove the front brake caliper and bracket (see Chapter 9, Section 8), but do not disconnect the hydraulic hoses. Tie the caliper up so that the hoses are not strained.

2 Prise or tap off the hub nut grease cap. Obtain a new cap if the old one is damaged during removal.

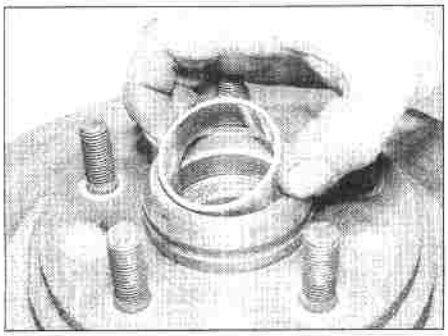
3 Remove the split pin from the hub unit. Unscrew and remove the nut.

4 Pull the hub and brake disc outwards to displace the bearing outboard race. Recover the race, then pull the assembly off the stub axle.

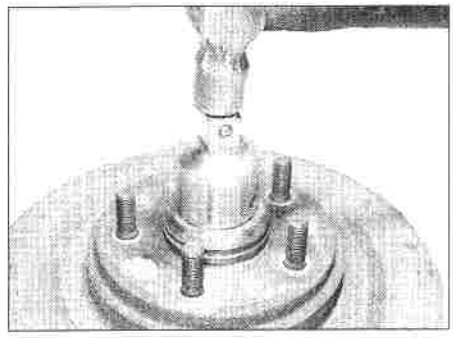
5 Prise out the oil seal and withdraw the bearing inboard race. If the inboard race has stayed on the stub axle, pull or lever it off.

6 To remove the bearing tracks, tap them out of the hub using a hammer and a brass or copper drift **(see illustration)**.

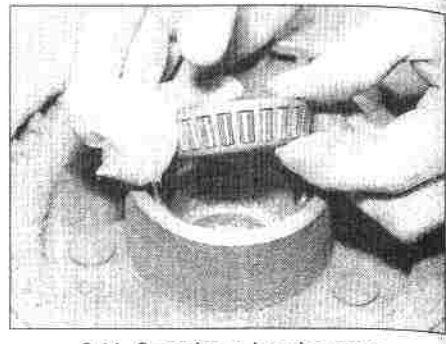
3.6 Driving out a bearing track



3.10a Fitting a bearing track . . .



3.10b . . . and driving it home



3.11 Greasing a bearing race

7 Clean the bearing races and the tracks in the hub with paraffin. Inspect them for roughness, blueing or other signs of damage. Renew the bearings as a set if any are found to be unsatisfactory.

8 When renewing bearings, note that the outboard bearing may be made by SKF or by Koyo. Races and tracks of different manufacture must not be mixed.

9 Clean the bearing track seats in the hub.

10 Tap the tracks into position in the hub, being careful to keep them square **(see illustrations)**. Use a socket or tube, or the old tracks, to drive them in.

11 Pack the bearing races with grease, working it well into the rollers by hand. Also put a few fingerfuls of grease into the space between the bearing tracks **(see illustration)**.

12 Fit the inboard race to the hub. Grease the lips of a new oil seal and fit it so that it is flush with the hub **(see illustration)**.

13 Fit the hub/disc assembly to the stub axle, which should be well greased. Push the assembly home, then fit the outboard race and the castellated nut **(see illustration)**.

14 Adjust the bearings as described in Section 2.

15 Refit the brake caliper and bracket (see Chapter 9, Section 8).

1988 models onward with angular contact ball-bearings

Note: *A new hub retaining nut will be required for refitting.*

16 On models with angular contact ball-bearings the hub and bearings are a single assembly. If the bearings are worn, the complete hub must be renewed.

17 Remove the front brake caliper and bracket (see Chapter 9, Section 8), but do not disconnect the hydraulic hoses. Tie the caliper up so that the hoses are not strained.

18 Remove the spigot pin which holds the disc to the hub. Lift off the disc **(see illustrations)**.

19 Prise or chisel off the bearing dust cap. Obtain a new cap for reassembly.

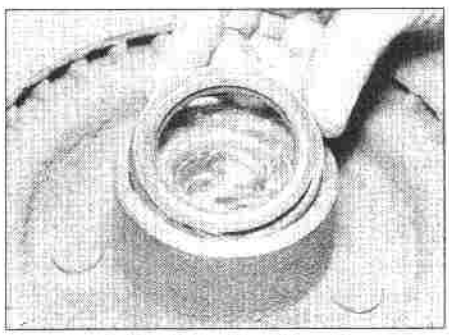
20 Undo the hub nut now exposed. This nut is very tight so make sure the car is well supported. Use a new nut on reassembly.

21 Pull the hub and bearings off the stub axle **(see illustration)**. The inner race of the inboard bearing may remain on the stub axle; if so pull it off.

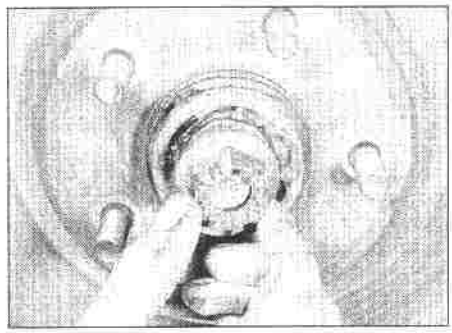
22 Clean the stub axle and lightly grease it before fitting the new hub and bearing assembly.

23 Fit the nut and tighten it to the stage one specified torque. Tighten the nut further through the angle specified for stage two **(see illustration)**.

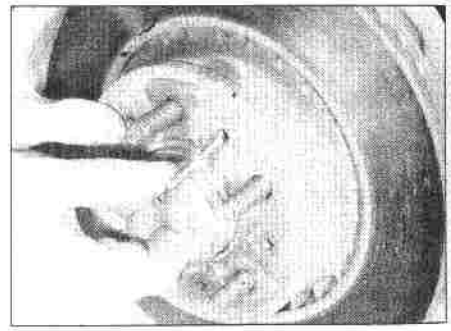
24 Refit the remaining components in the reverse order to removal.



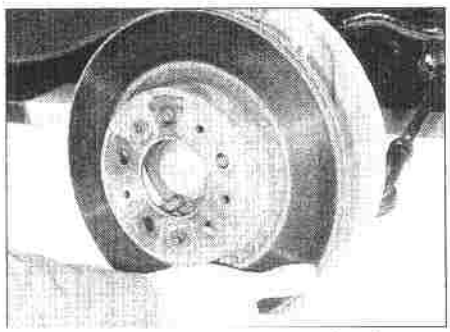
3.12 Fitting the oil seal



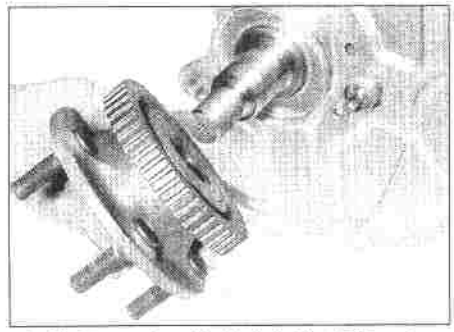
3.13 Fitting the castellated nut



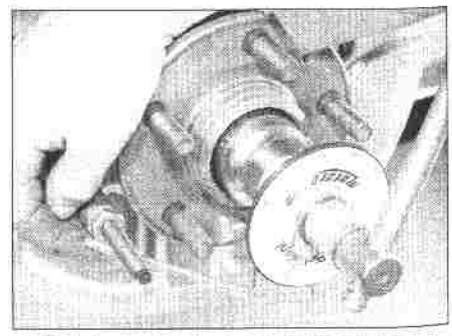
3.18a Remove the spigot pin . . .



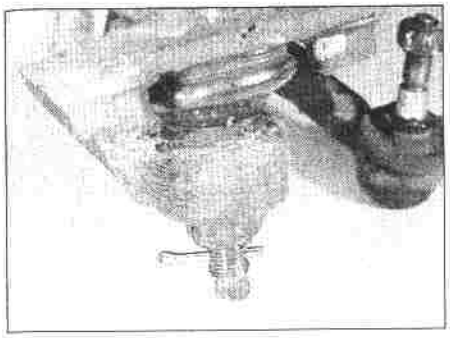
3.18b . . . and lift off the brake disc



3.21 Removing the hub (with ABS pulse wheel) from the stub axle



3.23 Angle-tightening the front hub nut



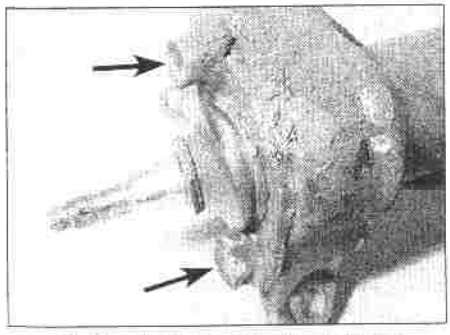
4.2 Control arm balljoint - split pin partly withdrawn

4 Front control arm - removal and refitting

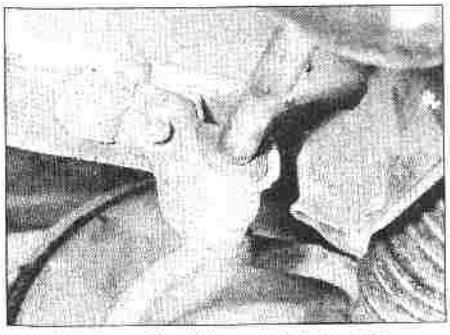
Note: *Some 1987, 740 models are fitted with aluminium front control arms instead of steel ones. The two types of arm are not interchangeable. If renewal is necessary, the same type of arm must be fitted as was already present.*
Note: *All nuts and bolts which are angled tightened on reassembly (see Specifications) must be renewed.*

Removal

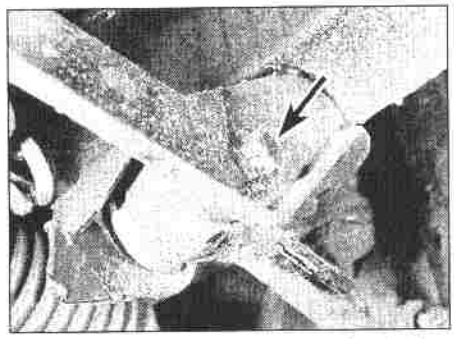
1 Slacken the front wheel nuts, raise and support the front of the vehicle and remove the front wheel.
2 Remove the split pin and nut from the ballpin nut **(see illustration)**. Obtain a new split pin for reassembly.



5.2 Two bolts (arrowed) secure the balljoint to the strut (strut removed)



7.2 An anti-roll bar saddle bracket



4.5 Control arm-to-crossmember bolt (arrowed)

3 Unbolt the anti-roll bar link and the radius rod from the control arm. Obtain a new bolt for reassembly.
4 Separate the control arm from the balljoint, using a balljoint separator if necessary. Be careful not to damage the balljoint.
5 Remove the control arm-to-crossmember nut and bolt **(see illustration)**. Remove the control arm from the crossmember. Obtain a new nut and bolt for reassembly.

Refitting

6 Refit by reversing the removal operations, but do not fully tighten the control arm-to-crossmember nut and bolt until the weight of the vehicle is back on its wheels. Rock the vehicle to settle the suspension, then tighten the nut and bolt to the specified torque.

5 Front control arm balljoint - removal and refitting

Removal

Note: *All nuts and bolts which are angled tightened on reassembly must be renewed.*
1 Proceed as for control arm removal (Section 4, paragraphs 1 to 4) but without unbolting the radius rod.
2 Remove the two bolts which secure the balljoint to the strut **(see illustration)**. Remove the balljoint.

Refitting

3 When refitting, use new bolts to secure the balljoint and apply thread locking compound to them. Tighten the bolts in the specified stages, making sure that the balljoint is properly seated.
4 The remainder of refitting is a reversal of the removal procedure.

7.3 An anti-roll bar link

6 Front radius rod - removal and refitting

Removal

Note: *All nuts and bolts which are angled tightened on reassembly (see Specifications) must be renewed.*
1 Slacken the front wheel nuts, raise and support the vehicle and remove the front wheel.
2 Unbolt the radius rod from the control arm and from the subframe. Remove the radius rod.

Refitting

3 Refit by reversing the removal operations, using new nuts and bolts to secure the radius rod. Do not fully tighten the radius rod-to-subframe nut and bolt until the weight of the vehicle is back on its wheels and it has been rocked a few times.

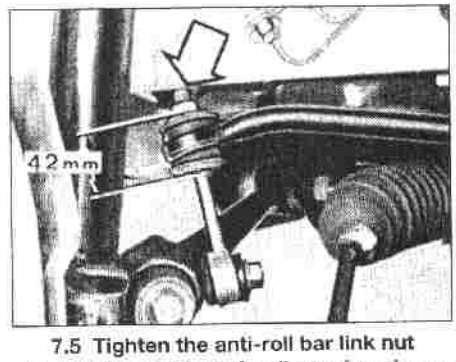
7 Front anti-roll bar - removal and refitting

Removal

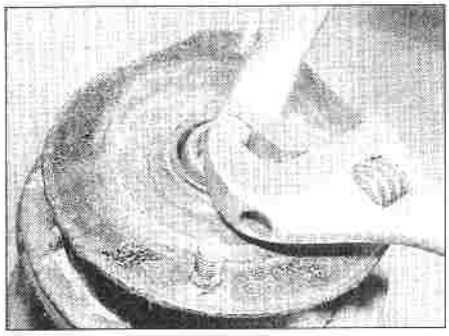
1 Raise the front of the vehicle on ramps, or drive it over a pit.
2 Unbolt the two saddle brackets which secure the anti-roll bar **(see illustration)**.
3 Unbolt the anti-roll bar from its end links, or unbolt the end links from the control arms, as preferred **(see illustration)**.

Refitting

4 Refit by reversing the removal operations. Renew the mounting rubbers as necessary. (The saddle bracket rubbers are split and may be renewed without removing the anti-roll bar.)
5 Tighten the link upper nuts to achieve the correct dimension between the washers **(see illustration)**.



7.5 Tighten the anti-roll bar link nut (arrowed) to achieve the dimension shown



8.9 Releasing the piston rod nut (strut removed)

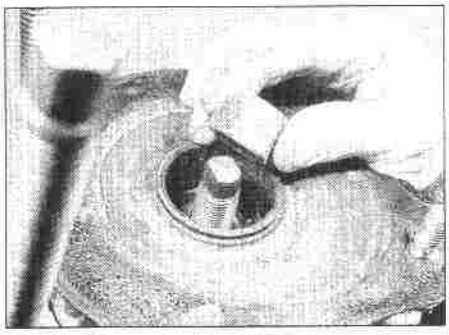
8 Front suspension strut - removal and refitting

Removal

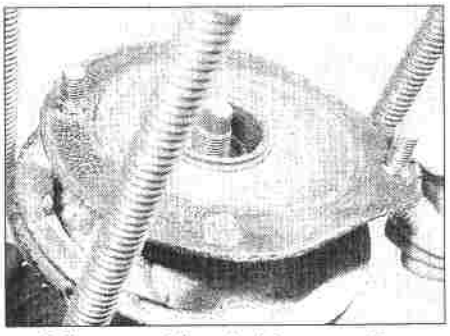
1 Slacken the front wheel nuts, raise and support the front of the vehicle and remove the front wheel.
2 Remove the brake caliper (see Chapter 9, Section 8), but do not disconnect the hydraulic hoses. Tie the caliper up so that the hoses are not strained.
3 On models with ABS, disconnect or remove the wheel sensor.
4 If the strut is to be renewed, remove the front hub assembly (see Section 3) then remove the brake backplate.
5 Remove the split pin from the suspension bottom balljoint nut. Unscrew the nut to the end of the threads. Free the ballpin from the control arm using a proprietary balljoint separator, then remove the nut.
6 Similarly separate the track rod end balljoint from the steering arm.
7 Lever the control arm downwards and free it from the bottom balljoint. If there is not enough movement to allow this, unbolt the anti-roll bar link.
8 Remove the cover from the strut top mounting. Note which way round the mounting is fitted: it is not symmetrical.
9 If the strut is to be dismantled, slacken the piston rod nut, at the same time counter-holding the piston rod **(see illustration)**. ***Caution: Do not remove the nut, just slacken it a turn or two.***
10 Have an assistant support the strut. Check that all attachments have been removed, then remove the two top mounting nuts. Remove the strut through the wheel arch.

Refitting

11 Refit by reversing the removal operations, noting the following points:
a) Observe the correct fitted direction of the top mounting ***(see illustration)****.*
b) Tighten all fastenings to their specified torques.



9.3a Removing the piston rod nut . . .



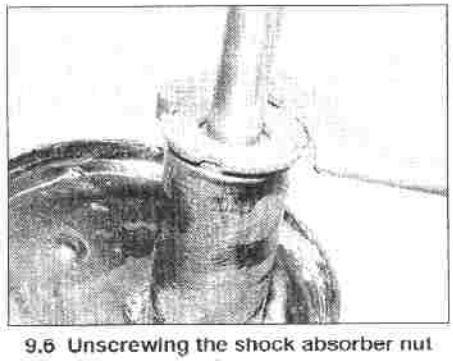
9.3b . . . and the strut top mounting

9 Front suspension strut - dismantling and reassembly

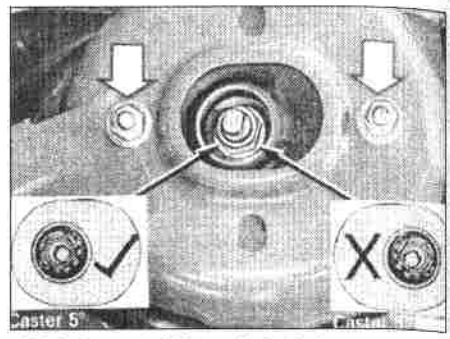
Warning: Before attempting to dismantle the shock absorber and coil spring assembly, a suitable tool to hold the spring in compression must be obtained. Adjustable coil spring compressors are readily available, and are recommended for this operation. Any attempt at dismantling without such a tool is likely to result in damage or personal injury.

Dismantling

1 Remove the strut from the vehicle (see Section 8).



9.6 Unscrewing the shock absorber nut with a C-spanner

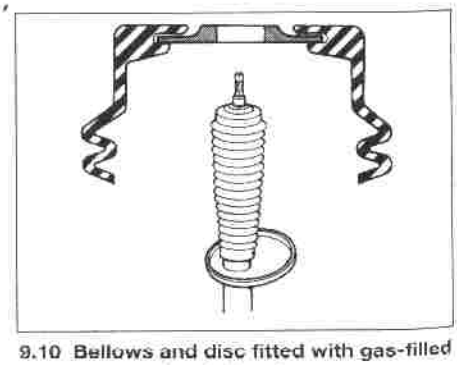


8.11 Correct fitting of strut gives correct castor (inset, left). Top mounting nuts arrowed; right-hand strut shown

2 Fit spring compressors to catch at least three coils of the spring. Tighten the compressors until the load is taken off the spring seats. Make sure that the compressors are secure.
3 Remove the piston rod nut (which should already have been slackened) and the strut top mounting. Note the position of any washers **(see illustrations)**.
4 Remove the spring upper seat, the spring itself, the washer, bump stop and bellows. (With gas-filled shock absorbers there is no bump stop.) Do not drop or jar the compressed spring.
5 Recover the rubber ring (when fitted) from the spring lower seat.
6 Using a C-spanner or similar tool, unscrew the shock absorber retaining nut **(see illustration)**.
7 Pull the shock absorber out of its tube.
8 Dismantling of the strut is now complete. Renew components as necessary, remembering that it is good practice to renew springs and shock absorbers in pairs.
9 If the spring is to be renewed, carefully remove the compressors from the old spring and fit them to the new one.

Reassembly

10 Reassemble by reversing the dismantling operations. Note the relationship of the disc to the bellows on models with gas-filled shock absorbers **(see illustration)**. Do not fully tighten the piston rod nut until the top mounting has been secured to the vehicle.



9.10 Bellows and disc fitted with gas-filled shock absorbers

11 If the top mounting is of the type incorporating an axial ball-bearing (1985 models onward) ensure that the bearing is fitted with the yellow side up, and the grey or orange side down. Incorrect fitting will result in the bearing being too tightly clamped, with consequent problems of stiff steering and noise.

10 Suspension rubber bushes - renewal

1 The principle of bush renewal is simple enough: the old bush is pressed out and the new one is pressed in. The reality is slightly more difficult.
2 Various special tools are specified by the makers for bush renewal. They are basically mandrels and tubes of different sizes which are used with a suitable press and sometimes with V-blocks. The amateur may experiment with a bench vice and socket spanners or pieces of tubing, using liquid soap or petroleum jelly as a lubricant. If this is unsuccessful it will be necessary to have the bush renewed by a workshop having press facilities.
3 Bush renewal *in situ* is not recommended.

11 Rear torque rods - removal and refitting

Note: *This procedure is only for those models that do NOT have independent rear suspension.*

Removal

1 Raise and support the rear of the vehicle.
2 Remove the front mounting bolts from both torque rods, even if only one is to be removed.
3 Unbolt and remove the torque rods. Recover the X-link.

Refitting

4 When refitting, unbolt the subframe front mounting to allow movement of the subframe. Fit the torque rods to the rear axle first without tightening the mountings, then attach them and the X-link to the subframe.
5 Tighten the torque rod-to-subframe mountings to the specified torque.
6 Tighten the subframe front mounting to the specified torque.
7 With the weight of the vehicle back on the rear wheels, tighten the torque rod-to-axle mountings to the specified torque.

12 Rear subframe and mountings - removal and refitting

Note: *This procedure is only for those models that do NOT have independent rear suspension.*

Removal

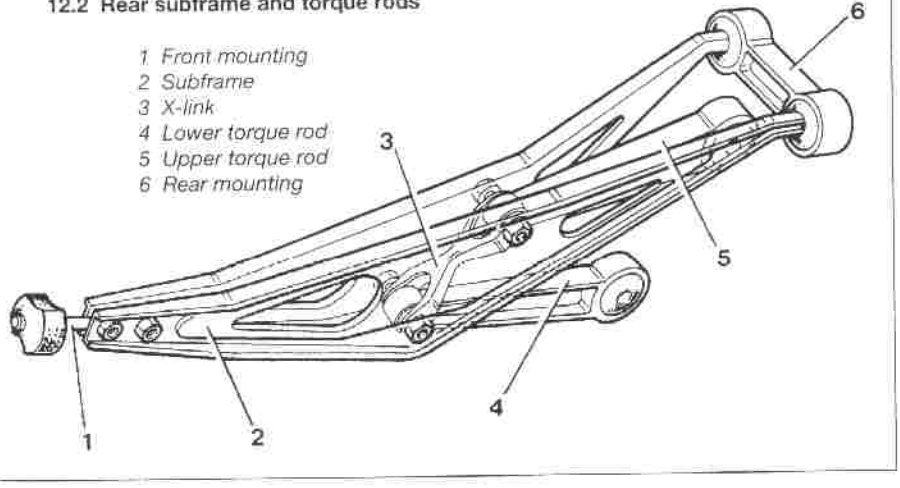
1 Raise and support the rear of the vehicle.
2 Remove the subframe front mounting nuts and bolts **(see illustration)**.
3 The front mounting rubber and mounting bracket may now be removed if wished, using a chisel and some lubricant around the rubber. Note the orientation of the rubber.
4 To remove the subframe completely, unbolt the torque rods and X-link from it. Also release the handbrake cable from the subframe bracket.
5 Refit one of the front mounting bolts. Hook a G-clamp behind the bolt and use the clamp to pull the subframe out of the rear mountings.
6 The rear mounting bracket can now be unbolted if required.

Refitting

7 Refit by reversing the removal operations, noting the following points:
a) Use petroleum jelly as a lubricant for the mounting rubbers.
b) Carry out the final tightening of the front mounting before that of the torque rods.

12.2 Rear subframe and torque rods

1 Front mounting
2 Subframe
3 X-link
4 Lower torque rod
5 Upper torque rod
6 Rear mounting



13 Rear trailing arm - removal and refitting

Note: *This procedure is only for those models that do NOT have independent rear suspension.*

Removal

1 Proceed as if for rear spring removal (see Section 14, paragraphs 1 to 3).
2 Disconnect the propeller shaft from the rear axle flange, making alignment marks for reference when refitting.
3 Support the trailing arm below the spring pan with a jack.
4 Unbolt the anti-roll bar (when fitted) from both trailing arms. If no anti-roll bar is fitted, remove the shock absorber lower mounting bolt on the side concerned. Slacken the lower mounting on the other side.
5 Lower the jack to release the spring tension.
6 Slacken the trailing arm-to-axle nuts crosswise. Remove the nuts, axle clamp and mounting rubbers. Recover the anti-roll bar bracket, if fitted.
7 Remove the trailing arm bracket nuts and bolts. Prise the front mounting out of the body and remove the trailing arm.

Refitting

8 Refit by reversing the removal operations, tightening the various fastenings to their specified torques.

14 Rear spring - removal and refitting

Note: *This procedure is only for those models that do NOT have independent rear suspension.*

Removal

Note: *New rear brake caliper retaining bolts will be required for refitting.*
1 Slacken the rear wheel nuts on the side concerned. Raise and support the rear of the vehicle so that both rear wheels hang free. Remove the rear wheel.
2 Remove the two bolts which secure the rear brake caliper. Slide the caliper off the disc and tie it up so that the flexible hose is not strained. Obtain new bolts for reassembly.
3 If the exhaust system will be in the way, unhook it from its mountings and lower it or move it aside.
4 Jack up the trailing arm slightly to take the load off the shock absorber. Remove the shock absorber lower mounting nut and bolt. Lower the jack.
5 Remove the nut which secures the spring upper seat **(see illustration)**.
6 Pull the trailing arm downwards as far as possible. Pull the top of the spring

downwards until the upper seat is clear of the mounting stud, then remove the spring and seat rearwards. If difficulty is experienced, either use spring compressors to unload the spring, or disconnect the rear anti-roll bar to allow the trailing arm more downward movement **(see illustration)**.
7 Inspect the spring seat rubbers and renew them if necessary.

Refitting

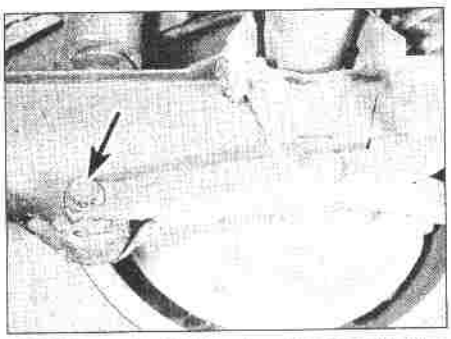
8 Refit by reversing the removal operations, tightening the fastenings to their specified torques. Use new bolts to secure the brake caliper.
9 Refit the roadwheel, lower the vehicle and tighten the wheel nuts.

15 Rear shock absorber - removal and refitting

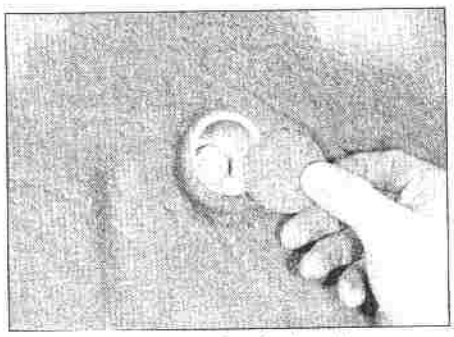
Note: *This procedure is only for those models that do NOT have independent rear suspension.*

Removal

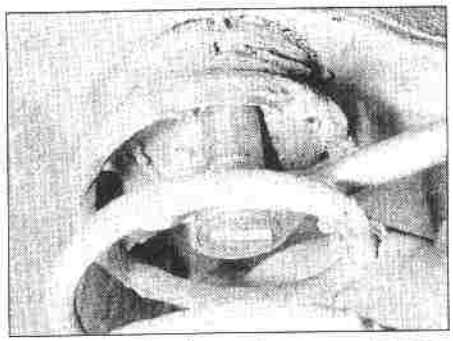
1 Slacken the rear wheel nuts on the side concerned. Raise and support the rear of the vehicle and remove the rear wheel.
2 Jack up the trailing arm slightly to take the load off the shock absorber. Remove the shock absorber lower mounting nut and bolt **(see illustration)**. Lower the jack.
3 Remove the rubber bung in the wheel arch covering the shock absorber upper mounting bolt **(see illustration)**. Remove the bolt.



15.2 Rear shock absorber lower mounting bolt (arrowed)



15.3 Exposing the shock absorber upper mounting bolt



14.5 Removing the spring upper seat nut

4 Pull the shock absorber downwards and remove it.

Refitting

5 Refit by reversing the removal operations. Tighten the shock absorber mounting and the wheel nuts to the specified torque.

16 Rear anti-roll bar - removal and refitting

Note: *This procedure is only for those models that do NOT have independent rear suspension.*

Removal

1 Raise the rear of the vehicle on ramps or drive it over a pit.
2 Remove the two nuts and bolts on each side which secure the anti-roll bar. The forward bolts also secure the rear shock absorber lower mountings: it may be necessary to jack up under the trailing arms to take the load off these bolts.
3 Remove the anti-roll bar.

Refitting

4 Refit by reversing the removal operations.

17 Panhard rod - removal and refitting

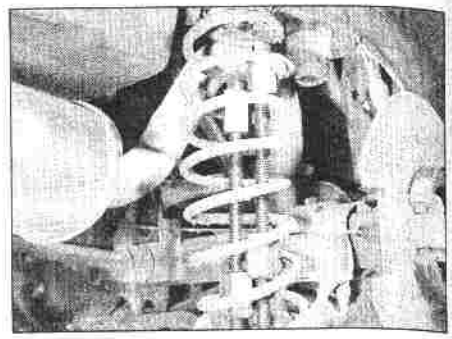
Note: *This procedure is only for those models that do NOT have independent rear suspension.*

Removal

1 Raise and support the vehicle with the rear wheels free.
2 Unbolt the Panhard rod from the body, then from the rear axle **(see illustration)**. Remove the rod.
3 If the rod bushes need renewing, have the old ones pressed out and new ones pressed in by a Volvo dealer or other specialist.

Refitting

4 Refit the rod and tighten the bolts to the specified torque, axle end first. Lower the vehicle.



14.6 Using spring compressors to unload the rear spring

18 Lower link - removal and refitting

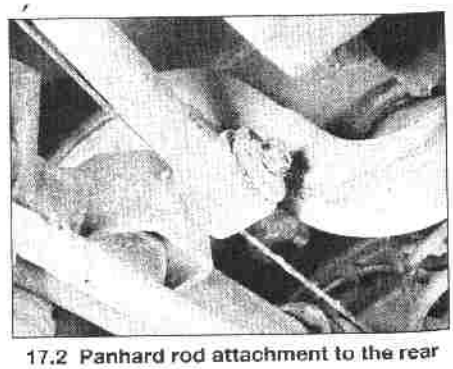
Note: *This procedure is only for those models that have independent rear suspension.*

Removal

Note: *All nuts and bolts which are angled tightened on reassembly (see Specifications) must be renewed.*
1 Slacken the rear wheel nuts on the side concerned. Raise and support the vehicle with the suspension support arm free. Remove the rear wheel.
2 Mark the position of the lower link eccentric mounting on the axle member to provide an approximately correct setting for reassembly **(see illustrations)**.
3 Remove the nuts and bolts which secure the lower link ends to the axle member and hub carrier **(see illustration)**. Remove the lower link.

Refitting

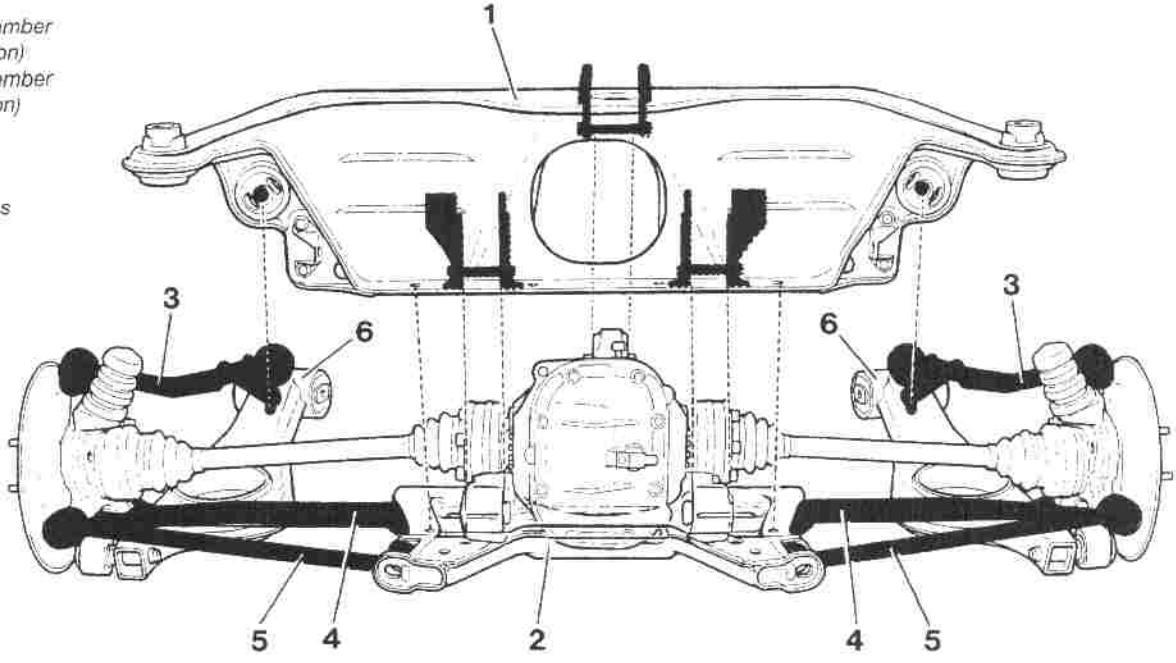
4 Refit by reversing the removal operations, using new nuts and bolts at the lower link mountings. Tighten the lower link mountings to the specified torque and have the rear wheel alignment checked on completion (see Section 34).



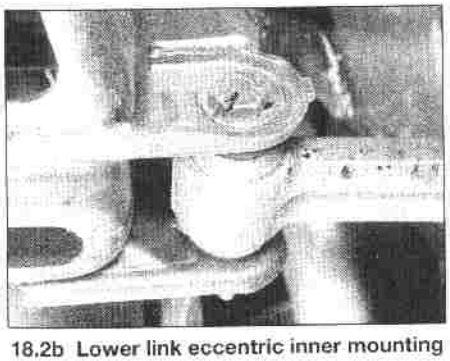
17.2 Panhard rod attachment to the rear axle

18.2a Independent rear suspension components

1 Rear axle member (upper Section)
2 Rear axle member (lower Section)
3 Upper links
4 Lower links
5 Track rods
6 Support arms



19 Track rod - removal and refitting



18.2b Lower link eccentric inner mounting

Note: *This procedure is only for those models that have independent rear suspension.*

Removal

1 Slacken the rear wheel nuts on the side concerned. Raise and support the vehicle with the suspension support arm free. Remove the rear wheel.

2 Mark the position of the track rod eccentric mounting on the axle member to provide an approximately correct setting for reassembly **(see illustration)**.

3 Remove the nuts and bolts which secure the track rod ends to the axle member and hub carrier **(see illustration)**. Remove the track rod.

Refitting

4 Refit by reversing the removal operations. Tighten the track rod mountings to the specified torque and have the rear wheel alignment checked on completion (see Section 34).

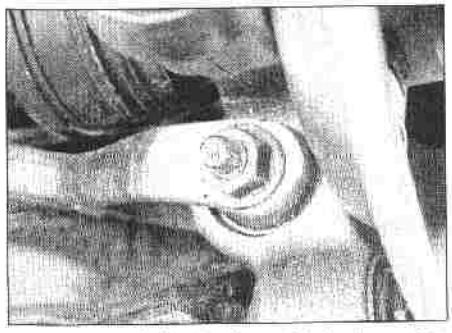
20 Support arm - removal and refitting

Note: *This procedure is only for those models that have independent rear suspension.*

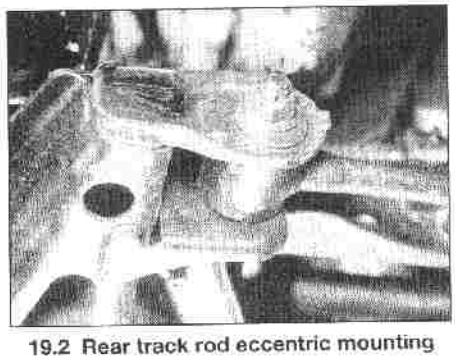
Removal

Note: *All nuts and bolts which are angled tightened on reassembly (see Specifications) must be renewed.*

1 Slacken the rear wheel nuts on the side concerned. Raise and support the vehicle with the support arm free. Remove the wheel.

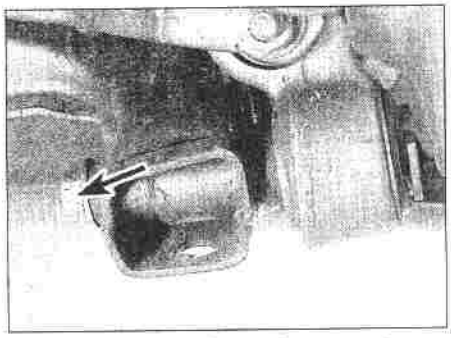


18.3 Lower link attachment to hub carrier

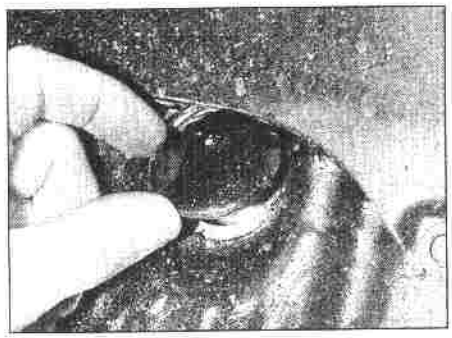


19.2 Rear track rod eccentric mounting

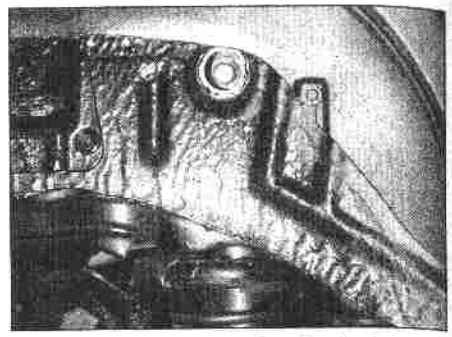
19.3 Rear track rod attachment to hub carrier



20.2 Bolt (arrowed) securing support arm to hub carrier



20.5a Remove the blanking plug . . .



20.5b . . . for access to the shock absorber top mounting

2 Remove the bolt which secures the support arm to the hub carrier **(see illustration)**, and the nuts and bolts which secure the arm front mounting to the body. Also unbolt the guard plate from the arm.
3 Separate the support arm from the hub carrier by levering it off. Note the mating flats on the bush and support arm spigot.
4 Take the weight of the support arm, using a jack and a piece of wood.
5 Unbolt the shock absorber top mounting **(see illustrations)**. Lower the jack and remove the support arm complete with spring and shock absorber.
6 The spring and shock absorber may now be removed if wished. The shock absorber is secured to the support arm by two bolts.

Refitting

7 Refit by reversing the removal operations, tightening all fastenings to the specified torque and using new nuts and bolts when these are subjected to angle tightening.

21 Rear axle member lower section - removal and refitting

Note: *This procedure is only for those models that have independent rear suspension.*

Removal

Note: *All nuts and bolts which are angled tightened on reassembly (see Specifications) must be renewed.*
1 The rear axle member lower section is removed complete with lower links and track rods. In this way the wheel alignment is not disturbed.
2 Slacken the rear wheel nuts on both sides. Raise and support the vehicle with the support arms free. Remove the rear wheels.
3 Unbolt the lower link mountings from the hub carriers.
4 Unbolt the support arms from the hub carriers. Separate the arms from the carriers by levering.
5 Unbolt the track rods from the hub carriers. Pull off the track rods, either by hand or with the aid of a small puller.
6 Remove the eight nuts and bolts which hold the axle member upper and lower sections together. Note the handbrake cable guide under one of the rear bolts.
7 Support the axle member lower section. Swing the hub carriers outwards and free the lower links and track rods from them. Remove the axle member section with links and track rods.

Refitting

8 Commence refitting by roughly positioning the axle member lower section. Insert a couple of the new nuts and bolts to secure it to the upper section, but do not tighten them yet.
9 Insert two bolts, dowels or similar items, 12 mm in diameter, into the two centering holes on the front edge of the axle members **(see illustration)**.
10 Fit all the new axle member nuts and bolts (not forgetting the handbrake cable guide) and tighten them to the specified torque. Remove the centering bolts.
11 Reconnect the lower links to the hub carriers. Tighten their fastenings to the specified torque, at the same time pulling the hub carrier inwards.
12 Reconnect and tighten the support arms and the track rods.
13 Refit the wheels, lower the vehicle and tighten the wheel nuts.

22 Upper link - removal and refitting

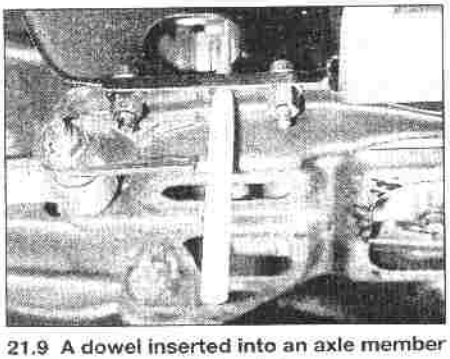
Note: *This procedure is only for those models that have independent rear suspension.*

Removal

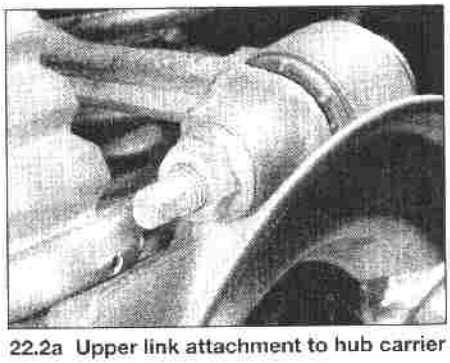
Note: *All nuts and bolts which are angled tightened on reassembly (see Specifications) must be renewed.*
1 Proceed as if preparing for axle member lower section removal (see Section 21, paragraphs 2 to 5). Also unbolt the brake caliper and support it out of the way.
2 Unbolt the upper link from the hub carrier. Separate the link from the carrier, collecting any spacers **(see illustrations)**.
3 Unbolt the upper link from the axle member. Remove the link.

Refitting

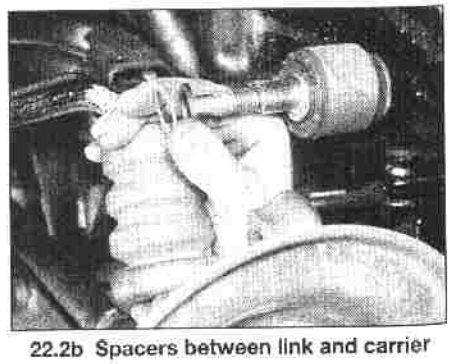
4 Refit by reversing the removal operations, noting the following points:
a) Use new nuts and bolts on all fastenings subjected to angle tightening.
b) Pull the top of the hub carrier outwards when tightening the upper link mounting.



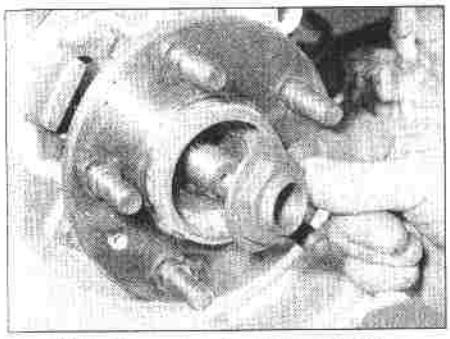
21.9 A dowel inserted into an axle member centering hole



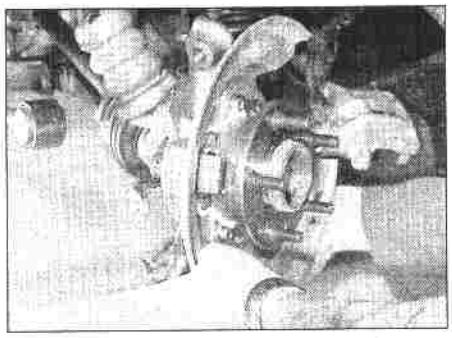
22.2a Upper link attachment to hub carrier



22.2b Spacers between link and carrier



23.5 Removing the driveshaft nut



23.7 Removing the rear hub carrier

c) Pull the bottom of the hub carrier inwards when tightening the lower link mounting.

23 Rear hub carrier - removal and refitting

Note: *This procedure is only for those models that have independent rear suspension.*

Removal

Note: *All nuts and bolts which are angled tightened on reassembly (see Specifications) must be renewed.*

1 Remove the wheel trim from the rear wheel on the side concerned. Apply the handbrake, engage 1st gear (or "P" on automatic transmission models) and chock the wheels.

2 Slacken the driveshaft nut. This nut is extremely tight. A 3/4-inch drive 36 mm socket will be required. Remove the nut.

3 Raise and support the rear of the vehicle and remove the rear wheel. Make sure the supports do not obstruct the suspension components.

4 Referring to Chapter 9, remove the brake caliper (without disconnecting the hydraulic hoses), the brake disc and the handbrake shoes. Disconnect the handbrake cable.

5 Remove the driveshaft nut **(see illustration)**.

6 Remove the nuts and bolts which secure the upper link, the lower link, the track rod and the support arm to the hub carrier. Separate the carrier from the links and arms, recovering and noting any spacers on the upper link mounting. The support arm mounting may be stiff: lever the carrier off it if necessary.

7 Support the driveshaft and remove the hub carrier, tapping the end of the driveshaft to free it if necessary **(see illustration)**.

Refitting

8 Refit by reversing the removal operations, using new nuts and bolts if the specified tightening procedure includes angle tightening.

9 If new bushes, link rods etc have been fitted, have the rear wheel alignment checked on completion (see Section 34).

24 Rear wheel bearing - renewal

Note: *This procedure is only for those models that have independent rear suspension.*

1 Remove the rear hub carrier (see Section 23).

2 Support the hub carrier and drive or press the stub shaft out of the bearing. The inner race will probably stay on the shaft; if so, pull it off **(see illustration)**.

3 Remove the circlip from the outboard side of the carrier.

4 Remove the brake backplate and the bump stop for ease of handling. Press or drive out the bearing from the hub carrier, pressing from the inboard side.

5 Clean and lightly grease the bearing seat in the hub carrier. Also clean and grease the stub shaft.

6 Offer the new bearing to the carrier (it is symmetrical so it can be fitted either way round). Press the bearing in from the outboard side. Use the old bearing outer race to press with: it will not get jammed because the lead-in in the carrier is chamfered.

7 Refit the circlip **(see illustration)**.

8 Refit the brake backplate, applying silicone sealant to the joint between the hub carrier and the backplate **(see illustration)**.

9 Support the bearing inner race and press in the stub shaft.

10 Refit the hub carrier (Section 23).

25 Rear spring and shock absorber - removal and refitting

Note: *This procedure is only for those models that have independent rear suspension.*

1 The procedures are basically as described in Sections 14 and 15, but note the following points:

a) The spring can only be removed after the shock absorber.

b) There is no spring upper seat nut.

c) If sufficient clearance cannot be gained by disconnecting the support arm from the hub carrier, remove the support arm completely.

26 Steering wheel - removal and refitting

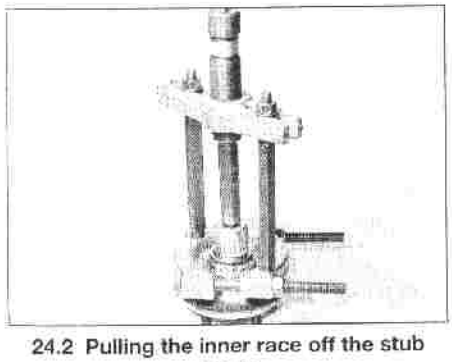
Warning: On vehicles equipped with an air bag, DO NOT attempt to remove the steering wheel. Have any work involving steering wheel removal carried out by a Volvo dealer.

Removal

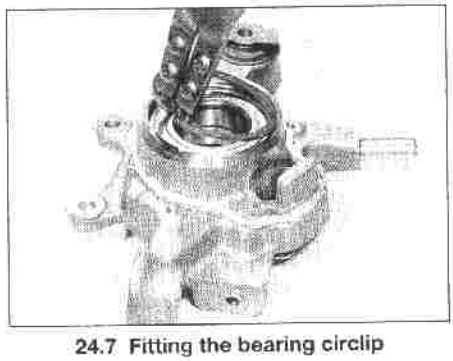
1 Disconnect the battery negative lead.

2 Bring the steering wheel to the straight-ahead position.

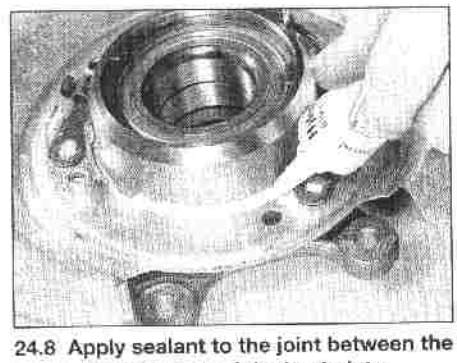
3 Prise off the steering wheel centre pad **(see illustration)**.



24.2 Pulling the inner race off the stub shaft



24.7 Fitting the bearing circlip



24.8 Apply sealant to the joint between the hub carrier and the backplate

4 Undo the steering wheel centre bolt **(see illustration)**.
5 Make alignment marks between the steering wheel and column then pull the steering wheel off its splines.

> **HAYNES HiNT** ***If the wheel is tight, tap it up near the centre, using the palm of your hand, or twist it from side to side whilst pulling, to release it from the column splines.***

Refitting

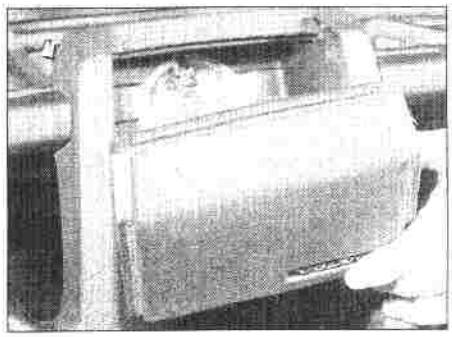
6 Refit by reversing the removal operations, observing the alignment marks or the straight-ahead position of the wheel.

27 Steering column - removal and refitting

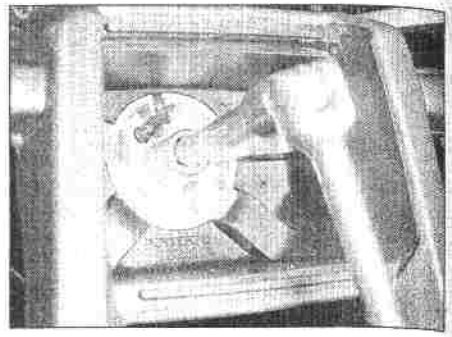
Warning: On vehicles equipped with an air bag, DO NOT attempt to remove the steering column. Have any work involving steering column removal carried out by a Volvo dealer.

Removal

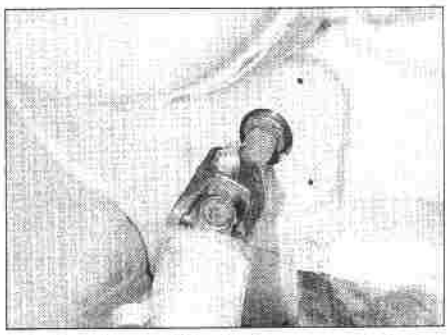
1 Disconnect the battery negative lead.
2 Still under the bonnet, remove the clamp nut and bolt from the top universal joint of the intermediate steering shaft. The nut is secured by a spring clip **(see illustration)**.
3 Remove the steering wheel (see Section 26) and the steering column switches, complete with baseplate and horn contact ring **(see illustration)**.
4 Remove the trim panel from below the steering column. It is secured by two screws and two clips. Disconnect the heater duct as the panel is withdrawn.
5 Remove the switch panel to the right of the steering lock.
6 Disconnect the multi-plug from the ignition/starter switch.
7 Remove the three screws which secure the column bottom bearing plate to the bulkhead **(see illustration)**.
8 Remove the two bolts which secure the column top bearing to the support crossmember **(see illustration)**. In some markets shear-head bolts will be found here: remove them by drilling and inserting a stud extractor, or by driving their heads round with a punch.
9 Remove the third bolt securing the top bearing. Recover the spacer tube **(see illustration)**.
10 Remove the three bolts which secure the column support crossmember. To gain access to the right-hand bolts it will be necessary to remove the right-hand lower trim panel, disconnect the Motronic ECU (where applicable) and move the wiring harnesses aside.
11 Remove the steering lock and ignition/starter switch (see Section 28).
12 Free the column and withdraw it into the vehicle. Recover the washer from the top bearing spigot.
13 The column bearings may now be removed if necessary. Be careful not to collapse the coupling in the upper section. The overall length of the column must be 727.2 ± 1 mm.



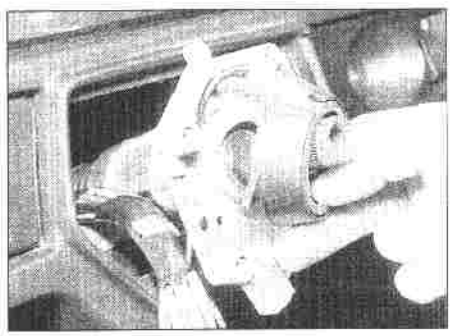
26.3 Removing the steering wheel centre pad



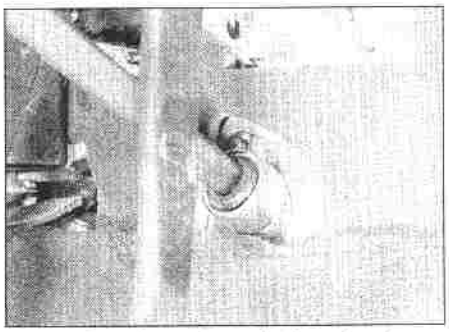
26.4 Undoing the steering wheel centre bolt



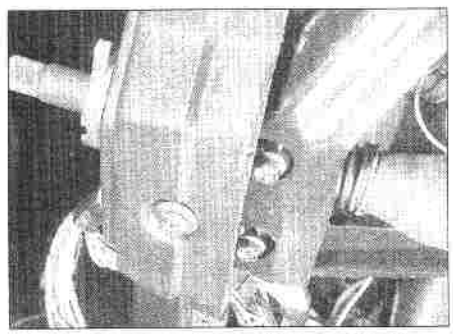
27.2 Intermediate shaft upper universal joint



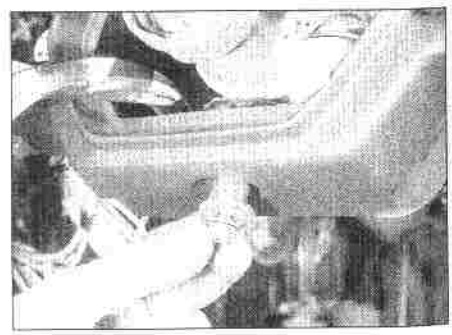
27.3 Removing the horn contact ring



27.7 Steering column bottom bearing plate



27.8 The three bolts which secure the column top bearing to the crossmember

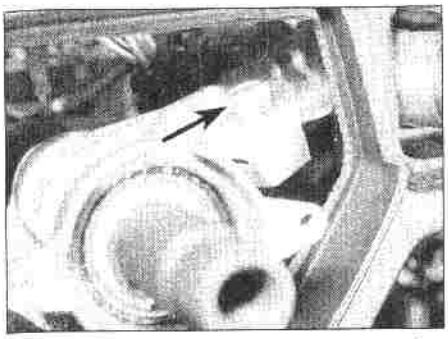


27.9 Removing the third bolt and spacer tube

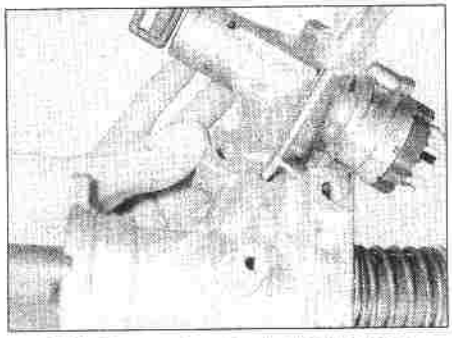
Refitting

14 Refit by reversing the removal operations, noting the following points:

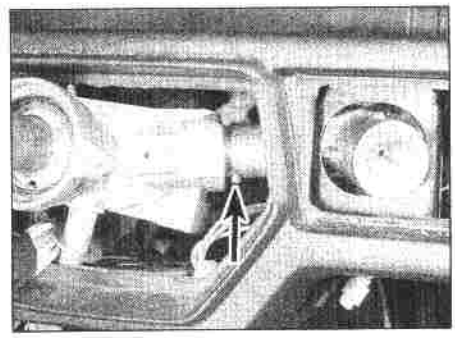
a) Tighten nuts and bolts to the specified torque (where given).
b) When shear-head bolts are used, only tighten them lightly at first. When satisfied that installation is correct tighten the bolts until their heads break off.



28.3 Steering lock pinch-bolt (arrowed)



28.4 Depressing the locking button (column removed)



28.5 Withdrawing the steering lock - column fitted. Locking button (arrowed) has just emerged

28 Steering column lock/ignition switch - removal and refitting

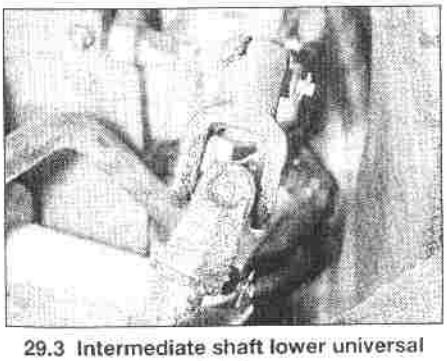
Warning: On vehicles equipped with an air bag, DO NOT attempt to remove the steering column lock/ignition switch. Have any work involving steering column lock/ignition switch removal carried out by a Volvo dealer.

Removal

1 Disconnect the battery negative lead.
2 Carry out the operations described in Section 27, paragraphs 3 to 10.
3 Remove the lock pinch-bolt from the top bearing housing **(see illustration)**.
4 Insert the ignition key and turn it to position II. Depress the locking button and begin to withdraw the lock from the bearing housing **(see illustration)**.
5 The ignition key and lock barrel will obstruct removal by fouling the surrounding trim. Therefore remove the key and free the top bearing housing from the crossmember; do not lose the washer from the spigot. By moving the bearing housing enough clearance can be gained to withdraw the steering lock complete with ignition/starter switch **(see illustration)**.
6 Remove the switch from the lock by undoing the two screws.

Refitting

7 Refit by reversing the removal operations.



29.3 Intermediate shaft lower universal joint

29 Power steering gear - removal and refitting

Removal

Note: *New copper sealing washers must be used on the fluid unions when refitting.*
1 Raise and support the front of the vehicle. Remove the engine undertray.
2 Remove the cover panel from the middle of the front crossmember.
3 Remove the spring clips and slacken the pinch-bolts and nuts on the lower universal joint **(see illustration)**. Slide the universal joint up the intermediate shaft to free it from the pinion.
4 Disconnect the track rod ends from the steering arms (See Section 33).
5 Clean around the fluid supply and return unions, then disconnect them **(see illustration)**. Be prepared for fluid spillage. Plug or cap open unions to keep dirt out.
6 Remove the two mounting bolts and nuts. Remove the steering gear from the crossmember **(see illustration)**. It may be necessary to displace the front anti-roll bar.

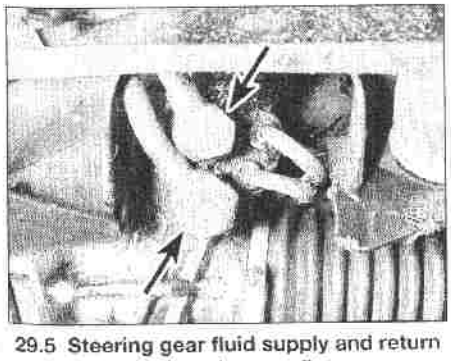
Refitting

7 Refit by reversing the removal operations, noting the following points:
a) Tighten all fastenings to the specified torque.
b) Use new copper washers on the fluid unions.
c) Bleed the power steering system (Section 31).
d) Check the front wheel toe setting (Section 34).

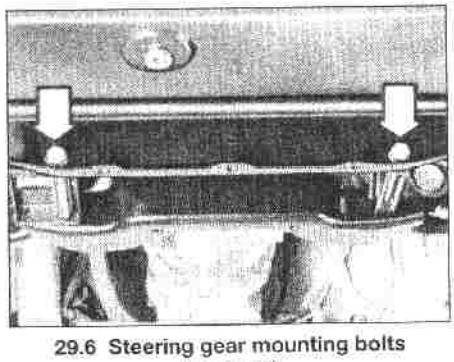
30 Steering rack bellows - renewal

Removal

1 Remove the track rod end on the side concerned (see Section 33). Also remove the rod end locknut.
2 Release the two clips which secure the bellows. Peel off the bellows **(see illustrations)**.

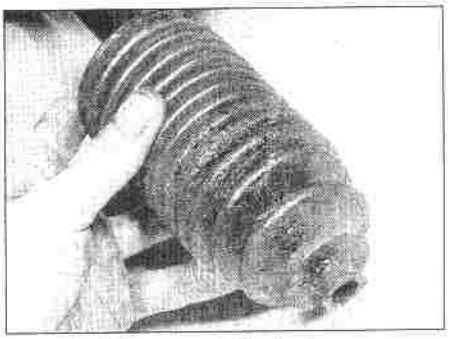


29.5 Steering gear fluid supply and return unions (arrowed)



29.6 Steering gear mounting bolts (arrowed)

30.2a Removing a steering rack bellows clip . . .



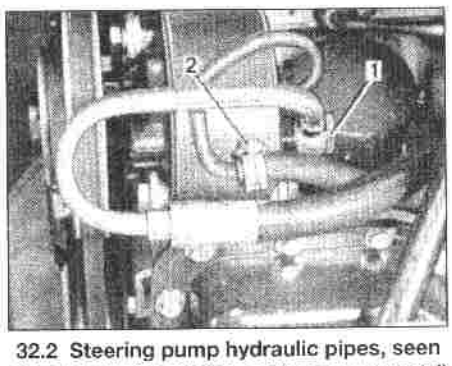
30.2b . . . and the bellows

Refitting

3 Clean out any dirt and grit from the inner end of the track rod and (when accessible) the rack. Apply fresh grease to these components.
4 Fit and secure the new bellows, then refit the track rod end.

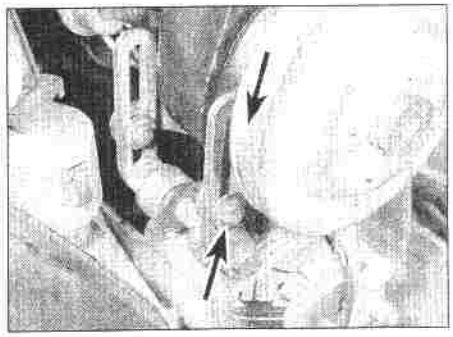
31 Power steering system - bleeding

1 The steering fluid reservoir may be mounted on the pump, or remotely mounted on the radiator or inner wing. It may have a dipstick, or there may simply be level markings on a translucent container.
2 Fluid level should not exceed the "MAX" mark, nor drop below the "LOW" or "ADD" mark. Some dipsticks are calibrated both for hot and for cold fluid: use the correct markings.
3 If topping-up is necessary, use clean fluid of the specified type (see *"Weekly checks"*). Check for leaks if frequent topping-up is required. Do not run the pump without fluid in it - remove the drivebelt if necessary.
4 After component renewal, or if the fluid level has been allowed to fall so low that air has entered the hydraulic system, bleeding must be carried out as follows.
5 Referring to *"Weekly checks"*, fill the reservoir to the "MAX" mark. Start the engine and allow it to idle.



32.2 Steering pump hydraulic pipes, seen from below (V6 engine, undertray removed)

1 Supply *2 Return*



32.1a Steering pump mounting strap - in-line engine

6 Turn the steering wheel from lock to lock a couple of times. Do not hold it on full lock.
7 Top-up the fluid if necessary.
8 Repeat paragraphs 6 and 7 until the fluid level ceases to fall. Stop the engine and refit the reservoir cap.

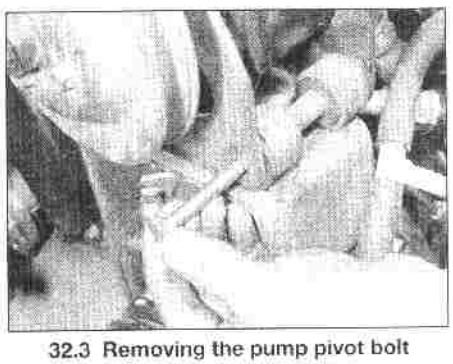
32 Power steering pump - removal and refitting

Removal

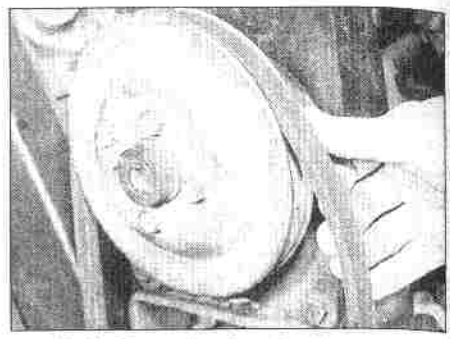
Note: *New copper sealing washers must be used on the fluid unions when refitting.*
1 Slacken the pump pivot and mounting strap nuts and bolts. Push the pump towards the engine and slip the drivebelt off the pulley **(see illustrations)**.
2 Disconnect the pump hydraulic pipes, either from below (remove the undertray) or from the back of the pump **(see illustration)**. Be prepared for fluid spillage.
3 Remove the pivot and strap nuts and bolts **(see illustration)**.
4 Lift away the pump. On versions with a remote reservoir, either remove it with the pump or disconnect the hose from the pump.
5 If a new pump is to be fitted, transfer the pulley and mounting brackets to it.

Refitting

6 Refit by reversing the removal operations, using new copper washers on disturbed banjo unions.
7 Tension the drivebelt (Chapter 1).



32.3 Removing the pump pivot bolt



32.1b Removing the steering pump drivebelt

8 Refill the pump reservoir and bleed the system (Section 31).

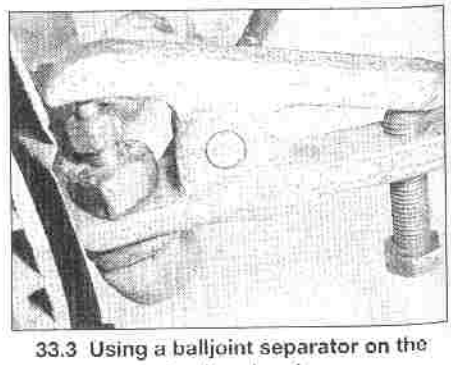
33 Track rod end - removal and refitting

Removal

1 Raise and support the front of the vehicle. Remove the front wheel on the side concerned.
2 Counterhold the track rod and slacken the rod end locknut by half a turn.
3 Unscrew the rod end ballpin nut to the end of its threads. Separate the ballpin from the steering arm with a proprietary balljoint separator, then remove the nut and disengage the ballpin from the arm **(see illustration)**.
4 Unscrew the track rod end from the track rod, counting the number of turns needed to remove it. Record this number.

Refitting

5 Screw the track rod end onto the track rod by the same number of turns noted during removal.
6 Engage the ballpin in the steering arm. Fit the nut and tighten it to the specified torque.
7 Counterhold the track rod and tighten the locknut.
8 Refit the front wheel, lower the vehicle and tighten the wheel nuts.
9 Have the front wheel toe setting checked at the first opportunity (Section 34), especially if new components have been fitted.



33.3 Using a balljoint separator on the track rod end

34 Wheel alignment and steering angles - general information

General

1 A car's steering and suspension geometry is defined in four basic settings - all angles are expressed in degrees (toe settings are also expressed as a measurement); the relevant settings are camber, castor, steering axis inclination, and toe setting. With the exception of vehicles with independent rear suspension, only the front wheel toe setting is adjustable. On vehicles with independent rear suspension, the rear suspension geometry is fully adjustable.

Front wheel toe setting - checking and adjustment

2 Due to the special measuring equipment necessary to accurately check the wheel alignment, and the skill required to use it properly, checking and adjustment is best left to a Volvo dealer or similar expert. Note that most tyre fitting shops now possess sophisticated checking equipment. The following is provided as a guide should the owner decide to carry out a DIY check.

3 The front wheel toe setting is checked by measuring the distance between the front and rear inside edges of the roadwheel rims. Proprietary toe measuring gauges are available from accessory shops. Adjustment is made by screwing the track rod ends in or out of their track rods to alter the effective length of the track rod assemblies.

4 For accurate checking, the vehicle must be at kerb weight, ie unladen and with a full tank of fuel.

5 Before starting work, check first that the tyre sizes and types are as specified, then check the tyre pressures and tread wear, the roadwheel run-out, the condition of the wheel bearings, the steering wheel free play, and the condition of the front suspension components (see Chapter 1 and *"Weekly checks"*). Correct any faults found.

6 Park the vehicle on level ground, check that the front roadwheels are in the straight-ahead position, then rock the rear and front ends to settle the suspension. Release the handbrake and roll the vehicle backwards 1 metre, then forwards again, to relieve any stresses in the steering and suspension components.

7 Measure the distance between the front edges of the wheel rims and the rear edges of the rims. Subtract the front measurement from the rear measurement, and check that the result is within the specified range.

8 If adjustment is necessary, apply the handbrake, then jack up and securely support the front of the car. Turn the steering wheel onto full-left lock and record the number of exposed threads on the right-hand track rod. Now turn the steering onto full-right lock, and record the number of threads on the left-hand side. If there are the same number of threads visible on both sides, then subsequent adjustment should be made equally on both sides. If there are more threads visible on one side than the other, it will be necessary to compensate for this during adjustment. **Note:** *It is most important that after adjustment, the same number of threads are visible on each track rod.*

9 First clean the track rod threads; if they are corroded, apply penetrating fluid before starting adjustment. Release the steering rack bellows outer retaining clips and peel back the bellows; apply a smear of grease to the inside of the bellows, so that both are free and will not be twisted or strained as their respective track rods are rotated.

10 Use a straight-edge and a scriber or similar to mark the relationship of each track rod to its track rod end then, holding each track rod in turn, unscrew its locknut.

11 Alter the lengths of the track rods, bearing in mind the note made in paragraph 8. Screw them into or out of the track rod ends, rotating the track rods with grips or a similar tool. Shortening the track rods (screwing them into their track rod ends) will increase toe-in/reduce toe-out.

12 When the setting is correct, hold the track rods and securely tighten the track rod end locknuts. Count the number of exposed threads to check the length of both track rods. If they are not the same, then the adjustment has not been made equally, and problems will be encountered with tyre scrubbing in turns; also, the steering wheel spokes will no longer be horizontal when the wheels are in the straight-ahead position.

13 If the track rod lengths are the same, lower the vehicle to the ground and re-check the toe setting; re-adjust if necessary. When the setting is correct, securely tighten the track rod end locknuts. Ensure that the rubber bellows are seated correctly, and are not twisted or strained, and secure them in position with their retaining clips.

Rear wheel toe setting and rear suspension geometry - checking and adjustment

14 To accurately check and adjust the rear wheel toe-setting and camber angles on models with independent rear suspension, sophisticated optical alignment equipment must be used. Therefore these checks and adjustments should only be carried out by a Volvo dealer or other specialist.

Chapter 11
Bodywork and fittings

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

1 General information

Body styles available are 4-door Saloon and 5-door Estate. The body and floorpan are of welded steel construction and form a very strong unit, with crumple zones at front and rear which will deform progressively in case of accident. The doors are also reinforced against side impacts. The tailgate on Estate models is made of aluminium.

Stout bumpers are fitted front and rear, with energy-absorbing buffers to protect against damage in low-speed collisions.

The front wings bolt on for easy renewal. The bonnet has two opening positions: partly open for normal work, and fully open for major work.

Interior trim and fittings are of the high standard expected in a vehicle of this class.

2 Maintenance - bodywork and underframe

The general condition of a vehicle's bodywork is the one thing that significantly affects its value. Maintenance is easy but needs to be regular. Neglect, particularly after minor damage, can lead quickly to further deterioration and costly repair bills. It is important also to keep watch on those parts of the vehicle not immediately visible, for instance the underside, inside all the wheel arches and the lower part of the engine compartment.

The basic maintenance routine for the bodywork is washing preferably with a lot of water, from a hose. This will remove all the loose solids which may have stuck to the vehicle. It is important to flush these off in such a way as to prevent grit from scratching the finish. The wheel arches and underframe need washing in the same way to remove any accumulated mud which will retain moisture and tend to encourage rust. Paradoxically enough, the best time to clean the underframe and wheel arches is in wet weather when the mud is thoroughly wet and soft. In very wet weather the underframe is usually cleaned of large accumulations automatically and this is a good time for inspection.

Periodically, except on vehicles with a wax-based underbody protective coating, it is a good idea to have the whole of the underframe of the vehicle steam cleaned, engine compartment included, so that a thorough inspection can be carried out to see what minor repairs and renovations are necessary. Steam cleaning is available at many garages and is necessary for removal of the accumulation of oily grime which sometimes is allowed to become thick in certain areas. If steam cleaning facilities are

not available, there are one or two excellent grease solvents available which can be brush applied. The dirt can then be simply hosed off. Note that these methods should not be used on vehicles with wax-based underbody protective coating or the coating will be removed. Such vehicles should be inspected annually, preferably just prior to winter, when the underbody should be washed down and any damage to the wax coating repaired. Ideally, a completely fresh coat should be applied. It would also be worth considering the use of wax-based protection for injection into door panels, sills, box sections, etc, as an additional safeguard against rust damage where such protection is not provided by the vehicle manufacturer.

After washing paintwork, wipe off with a chamois leather to give an unspotted clear finish. A coat of clear protective wax polish will give added protection against chemical pollutants in the air. If the paintwork sheen has dulled or oxidised, use a cleaner/polisher combination to restore the brilliance of the shine. This requires a little effort, but such dulling is usually caused because regular washing has been neglected. Care needs to be taken with metallic paintwork as special non-abrasive cleaner/polisher is required to avoid damage to the finish.

Always check that the door and ventilator opening drain holes and pipes are completely clear so that water can be drained out. Bright work should be treated in the same way as paint work. Windscreens and windows can be kept clear of the smeary film which often appears by the use of a proprietary glass cleaner. Never use any form of wax or other body or chromium polish on glass.

3 Maintenance - upholstery and carpets

Mats and carpets should be brushed or vacuum cleaned regularly to keep them free of grit. If they are badly stained remove them from the vehicle for scrubbing or sponging and make quite sure they are dry before refitting. Seats and interior trim panels can be kept clean by wiping with a damp cloth. If they do become stained (which can be more apparent on light coloured upholstery) use a little liquid detergent and a soft nail brush to scour the grime out of the grain of the material. Do not forget to keep the headlining clean in the same way as the upholstery. When using liquid cleaners inside the vehicle do not over-wet the surfaces being cleaned. Excessive damp could get into the seams and padded interior causing stains, offensive odours or even rot. If the inside of the vehicle gets wet accidentally it is worthwhile taking some trouble to dry it out properly, particularly where carpets are involved. Do not leave oil or electric heaters inside the vehicle for this purpose.

4 Minor body damage - repair

Repair of minor scratches in bodywork

If the scratch is very superficial, and does not penetrate to the metal of the bodywork, repair is very simple. Lightly rub the area of the scratch with a paintwork renovator or a very fine cutting paste to remove loose paint from the scratch and to clear the surrounding bodywork of wax polish. Rinse the area with clean water.

Apply touch-up paint to the scratch using a fine paint brush; continue to apply fine layers of paint until the surface of the paint in the scratch is level with the surrounding paintwork. Allow the new paint at least two weeks to harden: then blend it into the surrounding paintwork by rubbing the scratch area with a paintwork renovator or a very fine cutting paste. Finally, apply wax polish.

Where the scratch has penetrated right through to the metal of the bodywork, causing the metal to rust, a different repair technique is required. Remove any loose rust from the bottom of the scratch with a penknife, then apply rust inhibiting paint to prevent the formation of rust in the future. Using a rubber or nylon applicator, fill the scratch with bodystopper paste. If required, this paste can be mixed with cellulose thinners to provide a very thin paste which is ideal for filling narrow scratches. Before the stopper-paste in the scratch hardens, wrap a piece of smooth cotton rag around the top of a finger. Dip the finger in cellulose thinners and then quickly sweep it across the surface of the stopper-paste in the scratch; this will ensure that the surface of the stopper-paste is slightly hollowed. The scratch can now be painted over as described earlier in this Section.

Repair of dents in bodywork

When deep denting of the vehicle's bodywork has taken place, the first task is to pull the dent out, until the affected bodywork almost attains its original shape. There is little point in trying to restore the original shape completely, as the metal in the damaged area will have stretched on impact and cannot be reshaped fully to its original contour. It is better to bring the level of the dent up to a point which is about 3 mm below the level of the surrounding bodywork. In cases where the dent is very shallow anyway, it is not worth trying to pull it out at all. If the underside of the dent is accessible, it can be hammered out gently from behind, using a mallet with a wooden or plastic head. Whilst doing this, hold a suitable block of wood firmly against the outside of the panel to absorb the impact from the hammer blows and thus prevent a large area of the bodywork from being "belled-out".

Should the dent be in a section of the bodywork which has a double skin or some other factor making it inaccessible from behind, a different technique is called for. Drill several small holes through the metal inside the area - particularly in the deeper section. Then screw long self-tapping screws into the holes just sufficiently for them to gain a good purchase in the metal. Now the dent can be pulled out by pulling on the protruding heads of the screws with a pair of pliers.

The next stage of the repair is the removal of the paint from the damaged area, and from an inch or so of the surrounding "sound" bodywork. This is accomplished most easily by using a wire brush or abrasive pad on a power drill, although it can be done just as effectively by hand using sheets of abrasive paper. To complete the preparation for filling, score the surface of the bare metal with a screwdriver or the tang of a file, or alternatively, drill small holes in the affected area. This will provide a really good "key" for the filler paste.

To complete the repair see the Section on filling and re-spraying.

Repair of rust holes or gashes in bodywork

Remove all paint from the affected area and from an inch or so of the surrounding "sound" bodywork, using an abrasive pad or a wire brush on a power drill. If these are not available a few sheets of abrasive paper will do the job just as effectively. With the paint removed you will be able to gauge the severity of the corrosion and therefore decide whether to renew the whole panel (if this is possible) or to repair the affected area. New body panels are not as expensive as most people think and it is often quicker and more satisfactory to fit a new panel than to attempt to repair large areas of corrosion.

Remove all fittings from the affected area except those which will act as a guide to the original shape of the damaged bodywork (eg headlamp shells etc). Then, using tin snips or a hacksaw blade, remove all loose metal and any other metal badly affected by corrosion. Hammer the edges of the hole inwards in order to create a slight depression for the filler paste.

Wire brush the affected area to remove the powdery rust from the surface of the remaining metal. Paint the affected area with rust inhibiting paint; if the back of the rusted area is accessible treat this also.

Before filling can take place it will be necessary to block the hole in some way. This can be achieved by the use of aluminium or plastic mesh, or aluminium tape.

Aluminium or plastic mesh or glass fibre matting is probably the best material to use for a large hole. Cut a piece to the approximate size and shape of the hole to be filled, then position it in the hole so that its edges are below the level of the surrounding bodywork. It can be retained in position by several blobs of filler paste around its periphery.

Aluminium tape should be used for small or very narrow holes. Pull a piece off the roll and trim it to the approximate size and shape required, then pull off the backing paper (if used) and stick the tape over the hole; it can be overlapped if the thickness of one piece is insufficient. Burnish down the edges of the tape with the handle of a screwdriver or similar, to ensure that the tape is securely attached to the metal underneath.

Bodywork repairs - filling and re-spraying

Before using this Section, see the Sections on dent, minor scratch, rust holes and gash repairs.

Many types of bodyfiller are available, but generally speaking those proprietary kits which contain a tin of filler paste and a tube of resin hardener are best for this type of repair. A wide, flexible plastic or nylon applicator will be found invaluable for imparting a smooth and well contoured finish to the surface of the filler.

Mix up a little filler on a clean piece of card or board - measure the hardener carefully (follow the maker's instructions on the pack) otherwise the filler will set too rapidly or too slowly. Using the applicator, apply the filler paste to the prepared area; draw the applicator across the surface of the filler to achieve the correct contour and to level the filler surface. As soon as a contour that approximates to the correct one is achieved, stop working the paste - if you carry on too long the paste will become sticky and begin to "pick up" on the applicator. Continue to add thin layers of filler paste at twenty-minute intervals until the level of the filler is just proud of the surrounding bodywork.

Once the filler has hardened, excess can be removed using a metal plane or file. From then on, progressively finer grades of abrasive paper should be used, starting with a 40-grade production paper and finishing with 400-grade wet-and-dry paper. Always wrap the abrasive paper around a flat rubber, cork, or wooden block - otherwise the surface of the filler will not be completely flat. During the smoothing of the filler surface the wet-and-dry paper should be periodically rinsed in water. This will ensure that a very smooth finish is imparted to the filler at the final stage.

At this stage the "dent" should be surrounded by a ring of bare metal, which in turn should be encircled by the finely "feathered" edge of the good paintwork. Rinse the repair area with clean water, until all of the dust produced by the rubbing-down operation has gone.

Spray the whole repair area with a light coat of primer - this will show up any imperfections in the surface of the filler. Repair these imperfections with fresh filler paste or bodystopper, and once more smooth the surface with abrasive paper. If bodystopper is used, it can be mixed with cellulose thinners to form a really thin paste which is ideal for filling small holes. Repeat this spray and repair procedure until you are satisfied that the surface of the filler, and the feathered edge of the paintwork are perfect. Clean the repair area with clean water and allow to dry fully.

The repair area is now ready for final spraying. Paint spraying must be carried out in a warm, dry, windless and dust free atmosphere. This condition can be created artificially if you have access to a large indoor working area, but if you are forced to work in the open, you will have to pick your day very carefully. If you are working indoors, dousing the floor in the work area with water will help to settle the dust which would otherwise be in the atmosphere. If the repair area is confined to one body panel, mask off the surrounding panels; this will help to minimise the effects of a slight mismatch in paint colours. Bodywork fittings (eg chrome strips, door handles etc) will also need to be masked off. Use genuine masking tape and several thicknesses of newspaper for the masking operations.

Before commencing to spray, agitate the aerosol can thoroughly, then spray a test area (an old tin, or similar) until the technique is mastered. Cover the repair area with a thick coat of primer; the thickness should be built up using several thin layers of paint rather than one thick one. Using 400 grade wet-and-dry paper, rub down the surface of the primer until it is really smooth. While doing this, the work area should be thoroughly doused with water, and the wet-and-dry paper periodically rinsed in water. Allow to dry before spraying on more paint.

Spray on the top coat, again building up the thickness by using several thin layers of paint. Start spraying in the centre of the repair area and then, with a single side-to-side motion, work outwards until the whole repair area and about 50 mm of the surrounding original paintwork is covered. Remove all masking material 10 to 15 minutes after spraying on the final coat of paint.

Allow the new paint at least two weeks to harden, then, using a paintwork renovator or a very fine cutting paste blend the edges of the paint into the existing paintwork. Finally, apply wax polish.

Plastic components

With the use of more and more plastic body components by the vehicle manufacturers (eg bumpers, spoilers, and in some cases major body panels), rectification of more serious damage to such items has become a matter of either entrusting repair work to a specialist in this field, or renewing complete components. Repair of such damage by the DIY owner is not really feasible owing to the cost of the equipment and materials required for effecting such repairs. The basic technique involves making a groove along the line of the crack in the plastic using a rotary burr in a power drill. The damaged part is then welded back together by using a hot air gun to heat up and fuse a plastic filler rod into the groove. Any excess plastic is then removed and the area rubbed down to a smooth finish. It is important that a filler rod of the correct plastic is used, as body components can be made of a variety of different types (eg polycarbonate, ABS, polypropylene).

Damage of a less serious nature (abrasions, minor cracks etc) can be repaired by the DIY owner using a two-part epoxy filler repair material. Once mixed in equal proportions, this is used in similar fashion to the bodywork filler used on metal panels. The filler is usually cured in twenty to thirty minutes, ready for sanding and painting.

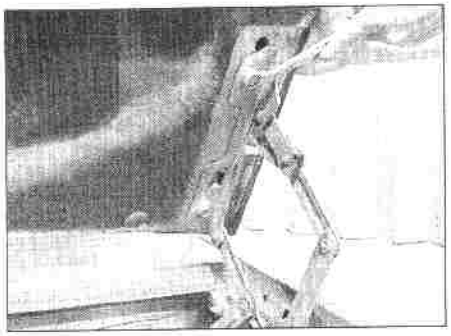
If the owner is renewing a complete component himself, or if he has repaired it with epoxy filler, he will be left with the problem of finding a suitable paint for finishing which is compatible with the type of plastic used. At one time the use of a universal paint was not possible owing to the complex range of plastics encountered in body component applications. Standard paints, generally speaking, will not bond to plastic or rubber satisfactorily. However, it is now possible to obtain a plastic body parts finishing kit which consists of a pre-primer treatment, a primer and coloured top coat. Full instructions are normally supplied with a kit, but basically the method of use is to first apply the pre-primer to the component concerned and allow it to dry for up to 30 minutes. Then the primer is applied and left to dry for about an hour before finally applying the special coloured top coat. The result is a correctly coloured component where the paint will flex with the plastic or rubber, a property that standard paint does not normally possess.

Aluminium components

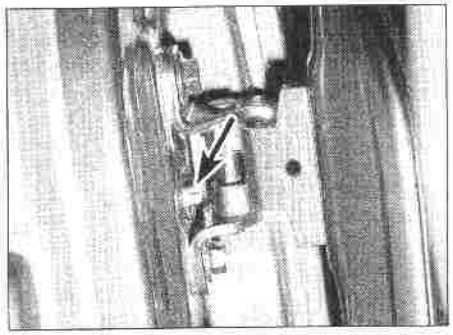
The tailgate on Estate models (and the bonnet on later 760 models) is made of aluminium. Be careful when hammering out dents in an aluminium panel as the material is easily work-hardened and may crack. Abrasives should be used with great caution on aluminium as it is much softer than steel.

5 Major body damage - repair

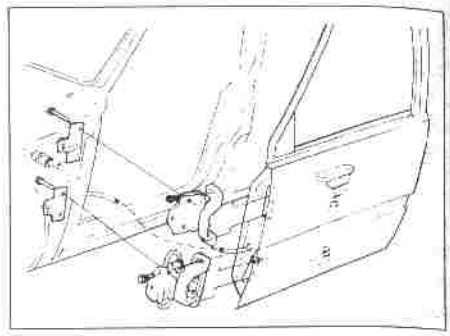
Where serious damage has occurred or large areas need renewal due to neglect, completely new sections or panels will need welding in - this is best left to professionals. If the damage is due to impact, it will also be necessary to check completely the alignment of the body shell structure. Due to the principle of construction, the strength and shape of the whole can be affected by damage to a part. In such instances, the services of a Volvo agent with specialist checking jigs are essential. If a body is left misaligned, it is first of all dangerous as the car will not handle properly and secondly uneven stresses will be imposed on the steering, engine and transmission, causing abnormal wear or complete failure. Tyre wear may also be excessive.



6.6 Undoing a bonnet hinge bolt



7.3a Guide pin (arrowed) determines hinge position on later models



7.3b Door hinge details

6 Bonnet - removal and refitting

Removal

1 Disconnect the battery negative lead.
2 Disconnect the washer tube from the bonnet at the T-piece. Unclip the tube from the bulkhead.
3 Remove the under-bonnet light (when fitted) and disconnect the wire from it. Tie a piece of string to the wire, draw the wire through the bonnet cavity into the engine bay, then untie the string and leave it in the bonnet. This will make refitting easier.
4 Where gas struts are used to retain the bonnet in the open position, support the bonnet then disconnect the struts at their upper ends.
5 Mark around the hinge bolts with a soft lead pencil for reference when refitting.
6 With the aid of an assistant, support the bonnet and remove the hinge bolts **(see illustration)**. Lift off the bonnet.

Refitting

7 Before refitting, place pads of rags under the corners of the bonnet near the hinges to protect the paintwork from damage.
8 Fit the bonnet and insert the hinge bolts. Just nip the bolts up in their previously marked positions. Where applicable, reconnect the gas struts.
9 Draw the light lead through with the string. Reconnect and refit the light.
10 Reconnect the washer tube and clip it to the bulkhead.
11 Shut the bonnet and check its fit. The hinge-to-bonnet bolt holes control the fore-and-aft and left-right adjustment. Front height is adjusted by screwing the rubber buffers in or out. Rear height is adjusted at the hinge mounting bolts near the wheel arch.
12 Tighten the hinge bolts when adjustment is correct, and reconnect the battery.

7 Doors - removal and refitting

Removal

1 Open the door. Support it with a jack or axle stand, using rags to protect the paintwork.
2 Disconnect the door electrical wiring, either by removing the door trim panel or the adjacent pillar trim. Feed the wiring through so that it hangs free.
3 Mark around the hinge bolts for reference when refitting. (Note that on later models, a guide pin in the hinge is used to ensure correct alignment). With the aid of an assistant, remove the hinge bolts and lift away the door **(see illustrations)**. Recover any hinge shims.

Refitting

4 Refit by reversing the removal operations. On early models, adjust the fit of the door if necessary, using shims and/or the slotted hinge bolt holes. Do not try to adjust the position of the door lock striker for a good fit.

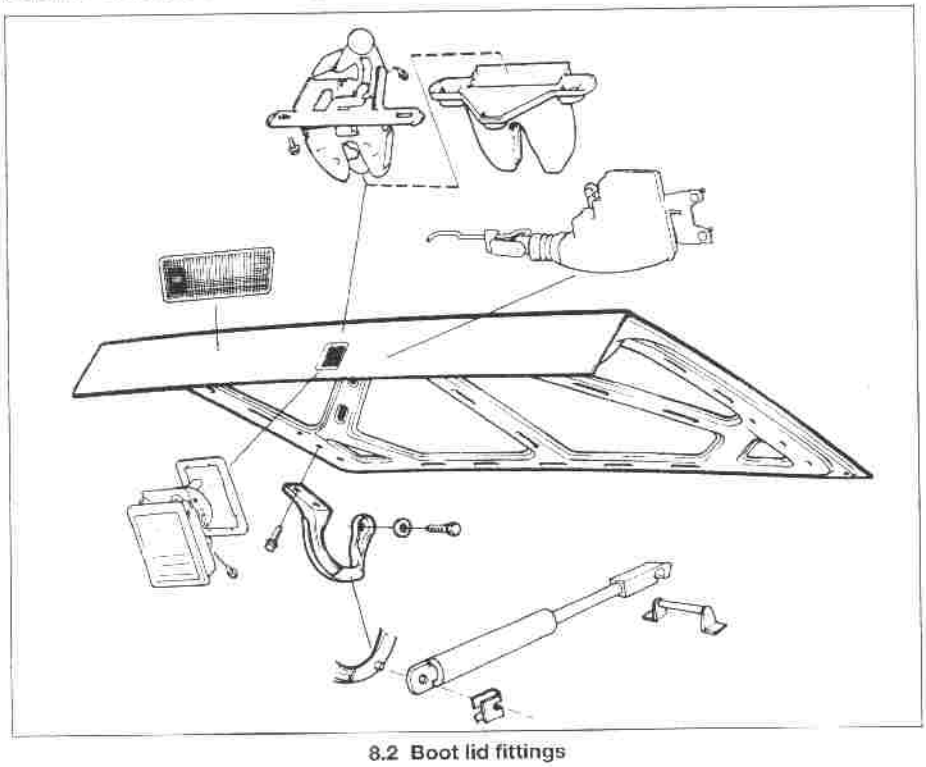
8 Boot lid - removal and refitting

Removal

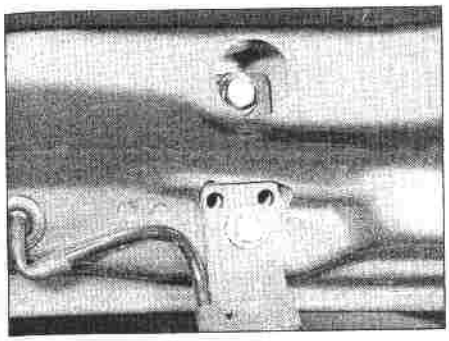
1 Open the boot. Disconnect the central locking system and/or boot light wiring so that the boot lid is free to be removed.
2 Mark around the hinge bolts. With the aid of an assistant, disconnect the boot lid strut at the hinge end, remove the hinge bolts and lift away the lid **(see illustration)**.

Refitting

3 Refit by reversing the removal operations. If height adjustment is necessary, this is carried out at the rear by adjusting the lock bracket, and at the front by adjusting the hinges. Access to the hinge front bolts is via the covers in the rear window pillar trim.



8.2 Boot lid fittings



9.3 Tailgate hinge bolts

9 Tailgate - removal and refitting

Removal

1 Disconnect the battery negative lead.
2 Open the tailgate. Disconnect the washer tube at the junction next to the right-hand hinge.
3 Prise out the bungs which conceal two hinge bolts. Slacken the hinge bolts but do not remove them yet **(see illustration)**.
4 Remove the trim panel from around the load area light. Besides the visible fasteners, there is one concealed behind the light itself **(see illustration)**.
5 Separate the wiring connectors exposed by removal of the trim panel, making notes for refitting if necessary. Feed the wiring through to the tailgate.
6 Have an assistant support the tailgate. Disconnect the gas struts by removing the wire clips and separating the balljoints.
7 Remove the hinge bolts and lift away the tailgate.

Refitting

8 Refit by reversing the removal operations. Only provisionally tighten the hinge bolts until satisfied with the fit of the tailgate. Adjust the lock striker and side guide pieces if necessary for a good fit.

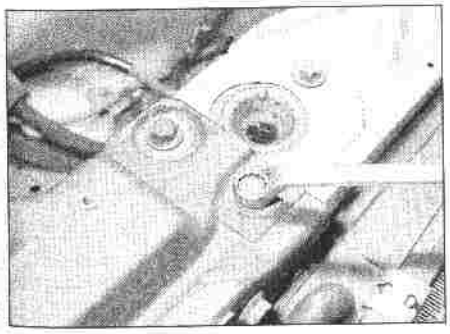
10 Bonnet release cable - removal and refitting

Removal

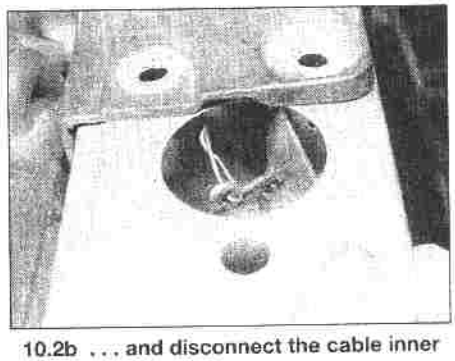
1 Open the bonnet. If the cable is broken, the catches must be released from below, or access can be gained by the destructive removal of the headlights.
2 Unbolt the release catch which is furthest from the release handle. Disconnect the cable inner from it **(see illustrations)**.
3 Release the cable outer from the other catch. Pull the cable free of the catches.
4 Inside the vehicle, release the cable from the lever by unhooking the inner and removing the slide clip from the outer.
5 Feed the cable into the engine bay and remove it.

Refitting

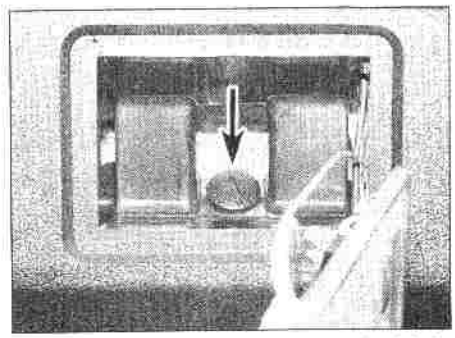
6 Refit by reversing the removal operations.



10.2a Unbolt the bonnet release catch . . .



10.2b . . . and disconnect the cable inner



9.4 Trim panel fastener (arrowed) behind load area light

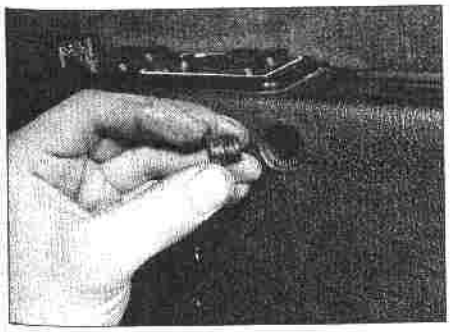
Adjust the threaded section of the cable at the release lever end to take most of the slack out of the inner in the resting position.

11 Front door interior trim - removal and refitting

Removal

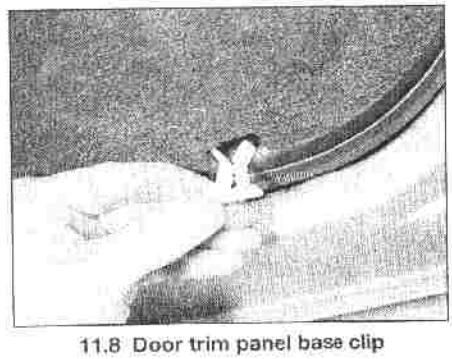
Pre-1985 models

1 Disconnect the battery negative lead.
2 Prise out the three screw plugs from the armrest. Remove the three screws **(see illustration)**.
3 Unclip the door edge marker light lens, noting that the arrow points outwards.
4 Unclip the loudspeaker grille. Remove the four screws which secure the speaker, pull it out of its cavity and disconnect the wires from it. Also remove the fourth armrest screw now exposed.
5 If working on the passenger's door, prise out the facing and remove the two door pull securing screws behind. Remove the door pull.
6 Free the armrest from its clips by tugging firmly. Remove the switch panel from the armrest. Disconnect the edge marker light multi-plug and remove the armrest **(see illustration)**.
7 Unscrew the interior lock button.
8 Prise out the two clips at the base of the main trim panel **(see illustration)**. Free the panel from the door clips by tugging or prising and remove it.

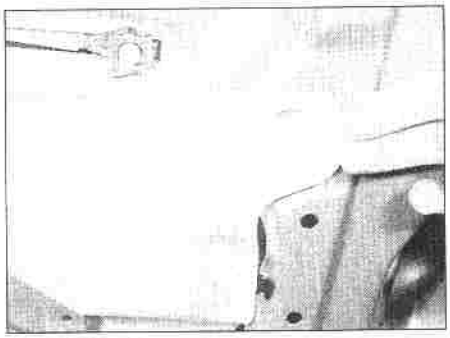


11.2 Removing an armrest screw plug

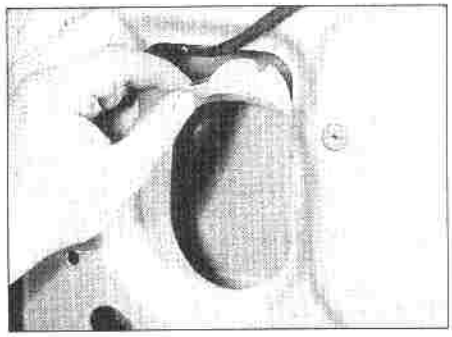
11.6 Removing the armrest



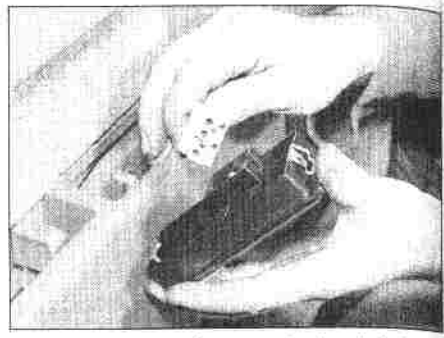
11.8 Door trim panel base clip



11.9a Removing the large water deflector . . .



11.9b . . . and the small one



11.20 Disconnecting a control switch from the armrest

9 Remove the large and small water deflectors **(see illustrations)**.

1985 to 1989 models

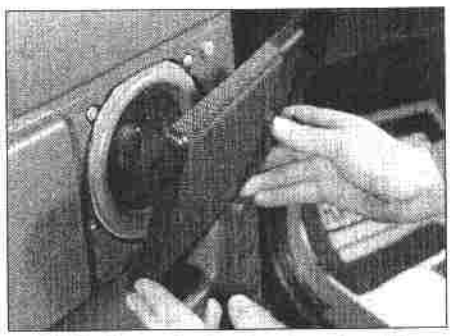
10 Disconnect the battery negative lead.
11 Carefully prise off the speaker grille. On the passenger side, carefully prise off the door pull trim then remove the door pull (two screws).
12 Remove the four screws which secure the speaker, and the single door panel retaining screw which is now exposed. As the speaker is removed, detach the two leads.
13 Unscrew the interior lock button, then remove the interior release handle (one retaining screw after prising out the rubber blanking plug).
14 On models with manually-operated windows, remove the winder handle.
15 On all models, rotate the blanking plug in the door panel well (adjacent to the interior release handle) through 90°, and prise the panel well assembly upwards and away from the door panel. Where appropriate, lift up the electrically-operated window switch assembly.
16 Carefully prise off the door edge marker light lens, then pull out the door panel retaining clip which is now visible.
17 Carefully prise the two plastic clips at the base of the door panel downwards, then pull the door panel away from the door at the two sides and the bottom edge.
18 Lift the panel upwards and away from the door, detaching the electrical connector from the door edge marker light.

1989 models onwards

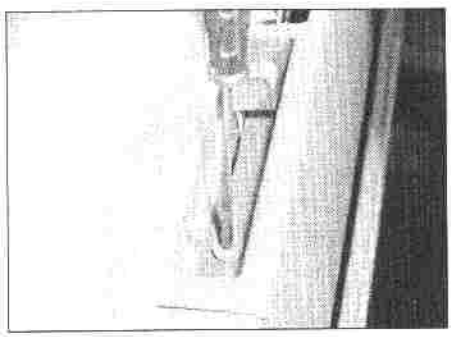
19 Disconnect the battery negative lead.
20 Prise out the control switches from the armrest and disconnect them **(see illustration)**.
21 Remove the loudspeaker trim by sliding it forwards **(see illustration)**.
22 Remove the clip from the well behind the interior handle by turning the clip a quarter-turn with a screwdriver **(see illustration)**.
23 Unclip the edge marker light lens.
24 Prise out the three clips from the bottom edge of the trim panel.
25 Unclip the panel by tugging it firmly. Disconnect the loudspeaker and edge marker light connectors and remove it.
26 To remove the armrest frame, first prise the plug out of the end of the interior handle cap **(see illustration)**. Remove the exposed screw and remove the cap.
27 Unclip any wiring from the armrest frame. Remove the two securing screws and lift off the frame **(see illustration)**.

Refitting

28 In all cases, refit by reversing the removal operations.



11.21 Removing the loudspeaker trim



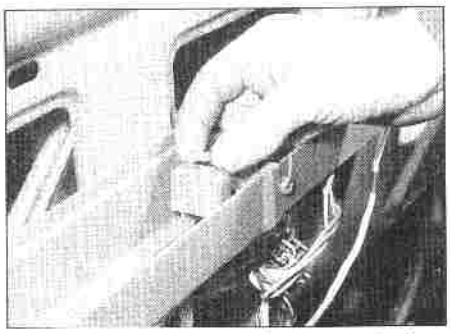
11.22 Turn the clip through a quarter turn to release it

12 Rear door interior trim - removal and refitting

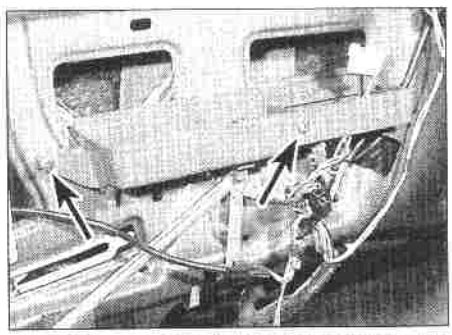
Removal

Pre-1985 models

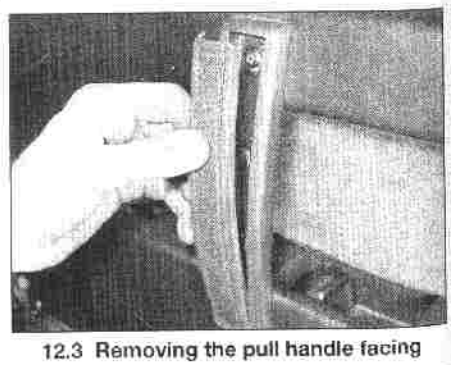
1 Disconnect the battery negative lead.
2 Prise out the two screw plugs from the armrest. Remove the screws.
3 Carefully prise the facing out of the pull handle to reveal two screws. Remove these screws and the pull handle **(see illustration)**.



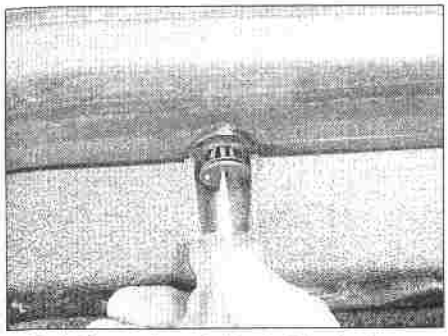
11.26 Remove the plug for access to the screw



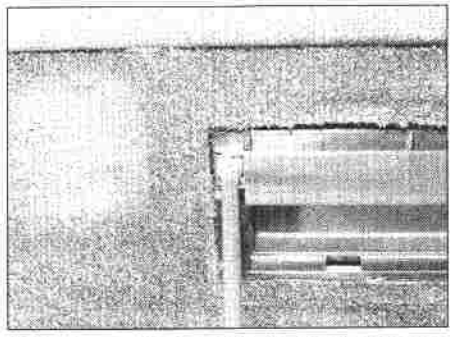
11.27 Two screws (arrowed) securing the armrest



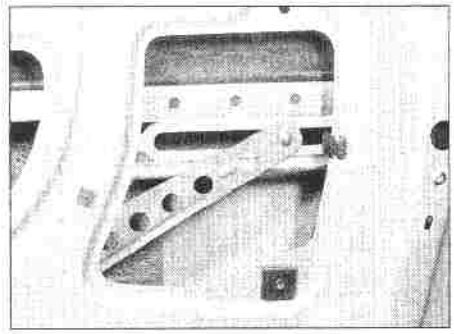
12.3 Removing the pull handle facing



13.1 Removing a tailgate trim fastener



13.2 Removing the tailgate interior handle trim



15.2 Window lift arm in the channel. Clip is behind the end of the arm

4 Unclip the loudspeaker grille. Remove the speaker (if fitted) and two more armrest screws now exposed.
5 Pull the armrest off the door. Disconnect the window switch and the edge marker light multi-plug (as applicable) and remove the armrest.
6 Unscrew the interior lock button.
7 Release the trim panel clips by tugging firmly, or by prising with a palette knife or scraper. Lift and remove the trim panel.
8 The waterproof sheet may now be peeled off the door in the area to which access is desired.

1985 and later models

9 The removal procedures are virtually identical to those for the later front door (Section 11, paragraph 10 onwards) except that both doors have a pull handle, and there are no clips securing the door panel base.

Refitting

10 In all cases, refit by reversing the removal operations.

13 Tailgate interior trim - removal and refitting

Removal

1 Open the tailgate. From the bottom of the trim panel remove the four fasteners by turning them through 90° **(see illustration)**.
2 Unclip the plastic surround from the interior handle. Remove the two screws now exposed, and the handle trim piece which they also secure **(see illustration)**.
3 Slide the trim upwards (relative to the closed position of the tailgate) to free the "keyhole" fasteners along the top edge. Remove the trim panel.

Refitting

4 Refit by reversing the removal operations.

14 Windscreen and other fixed glass - removal and refitting

Special equipment and techniques are needed for successful removal and refitting of the windscreen, rear window and rear quarter windows. Have the work carried out by a Volvo dealer or a windscreen specialist.

15 Front door window - removal and refitting

Removal

1 Remove the door interior trim (Section 11).
2 Raise or lower the window so that the lift arms are accessible. Remove the clip which secures each lift arm to the lift channel **(see illustration)**.
3 Have an assistant support the window, or wedge it in position. Disengage the lift arms from the channel and lift the glass out of the door.
4 If new glass is being fitted, check whether or not it is supplied with the lift channel attached. If not, it will be necessary to transfer the old channel. Where possible, note the fitted position of the channel relative to the trailing edge of the glass. The channel is removed by judicious use of a rubber mallet. If the fitted position of the channel is not known, position it as shown **(see illustration)**.

Refitting

5 Refit by reversing the removal operations.

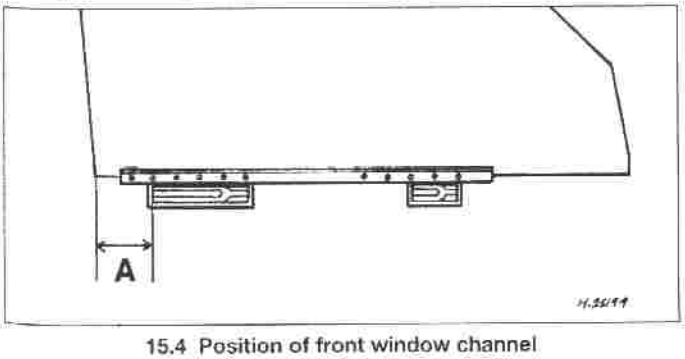
16 Rear door windows - removal and refitting

Removal

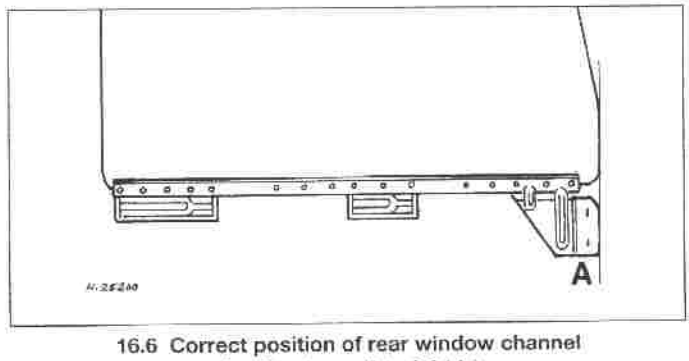
1 Remove the door interior trim (Section 12).
2 Remove the drop glass as described for the front window (Section 15).
3 The fixed glass may now be removed after drilling out the blind rivets which secure the guide channel. Remove the guide channel and slide out the glass.
4 When refitting the fixed glass, lubricate the surround with liquid soap.
5 Press the glass home and refit the guide channel, securing it with new blind rivets.
6 If fitting a lift channel to the drop glass, position it as shown **(see illustration)**.

Refitting

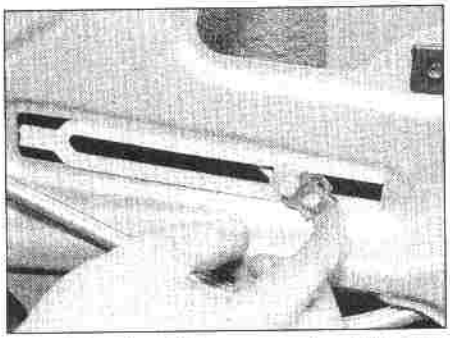
7 Refit the drop glass and the interior trim.



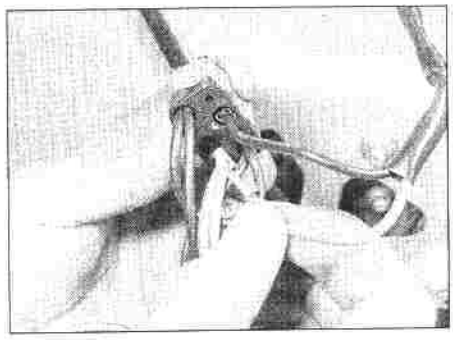
15.4 Position of front window channel
A = 70 mm (2.75 in) approx



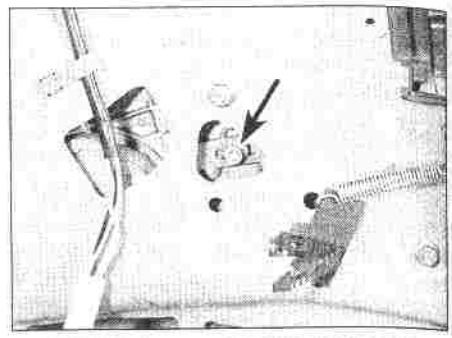
16.6 Correct position of rear window channel
A = 0 to 1 mm (0 to 0.04 in)



17.2 The clip which secures the slide arm in the channel



17.3 Removing the window motor connectors from the multi-plug



17.7 Window mechanism stop screw (arrowed)

17 Window lift mechanism - removal and refitting

Removal

1 Proceed as for door window glass removal (Section 15 or 16), but do not remove the glass completely. Tape or wedge it in the fully raised position.

2 Remove the clip which secures the slide arm in its channel **(see illustration)**.

3 In the case of electrically-operated windows, remove the motor connectors from the multi-plug, prising them out with a small screwdriver or scriber **(see illustration)**. It is difficult to do this without damaging the connectors, but if a new motor is to be fitted this does not matter. On later models an additional multi-plug is fitted in the harness which simplifies disconnection.

4 Remove the nuts which secure the mechanism to the door skin.

5 Push the mechanism into the door cavity and remove it through the large hole at the bottom. It may be necessary to alter the position of the mechanism to allow it to pass through the hole; with electrically-operated windows, do this by carefully connecting a battery to the connectors using jump leads. Do not allow the connectors or the jump lead clips to touch.

6 The motor may be unbolted from the mechanism if wished. Take great care that as the motor is removed, spring pressure does not cause a sudden movement of the toothed quadrant, which could result in injury.

Refitting

7 Refit by reversing the removal operations. Before refitting the door trim, adjust the stop screw as follows **(see illustration)**.

8 Slacken the stop screw and press it forwards. Wind the window fully up, press the stop screw rearwards and tighten it.

18 Door handles, locks and latches - removal and refitting

Removal

1 Remove the door interior trim (Section 11 or 12).

Lock barrel

2 On early models, release the central locking switch from the barrel by undoing the retaining clip.

3 Remove the two screws in the door shut face which secure the lock barrel clip **(see illustration)**.

4 Unhook the lock-to-latch rod, noting which way round it is fitted. Slide the clip off the lock and remove the lock and clip **(see illustration)**.

Exterior handle

5 Remove the two screws which secure the handle. Unhook the link rod and remove the handle.

Latch mechanism

6 Disconnect the lock barrel and exterior handle link rods from the latch.

7 Remove the catch from the door. It is secured by two Allen screws.

8 Remove the single securing screw exposed by removal of the catch.

9 Unclip the interior handle link and remove the latch mechanism **(see illustration)**.

Refitting

10 In all cases, refit by reversing the removal operations. Check for correct operation before refitting the door trim.

11 Note that the exterior handle link rod contains an adjustable section. The length of the rod should be set so that the latch stop contacts its base, and the handle tongue protrudes at least 22 mm.

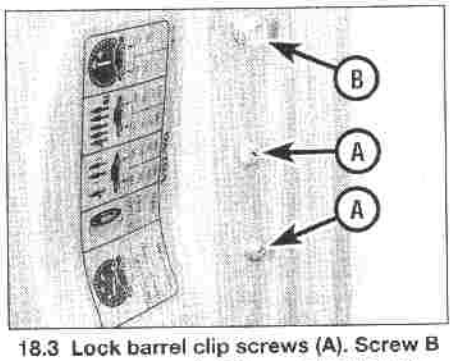
19 Boot lock - removal and refitting

Removal

1 Remove the latch, and unhook the lock motor link rod from the latch driver **(see illustration)**.

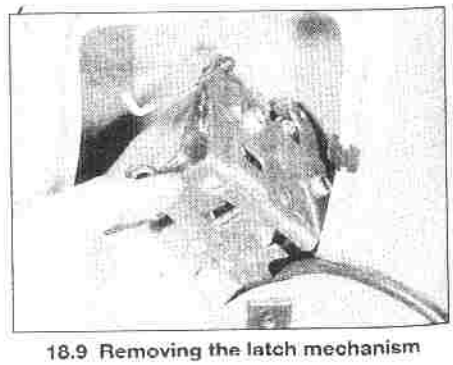
2 Remove the shear-head bolt which secures the lock, using a stud extractor or a hammer and punch.

3 Remove the lock from the boot lid.

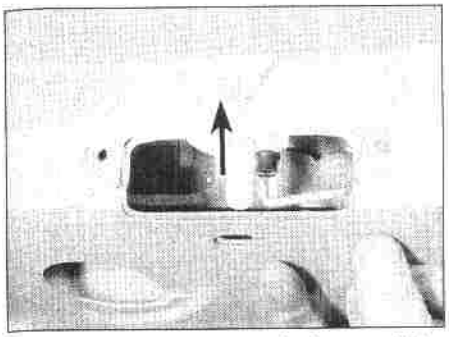


18.3 Lock barrel clip screws (A). Screw B secures one end of the exterior handle

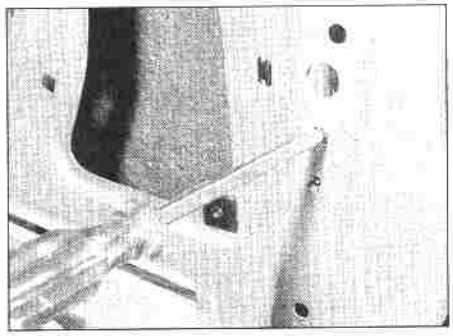
18.4 Door lock barrel removed



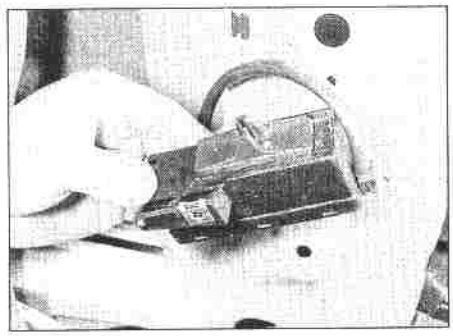
18.9 Removing the latch mechanism



19.1 Unhooking the boot lock motor link rod. Shear-head bolt is arrowed



21.3a Remove the securing screw . . .



21.3b . . . and lift out the switch

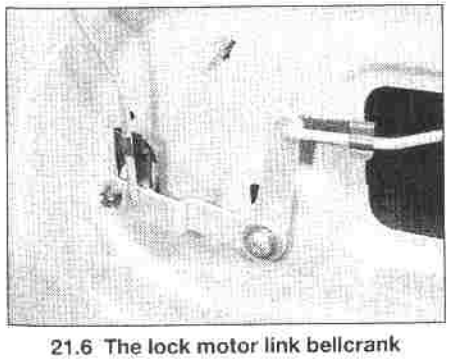
Refitting

4 When refitting, use a new shear-head bolt. Only tighten the bolt lightly until satisfied with the operation of the lock, then tighten the bolt until its head shears off.

20 Tailgate lock - removal and refitting

Removal

1 Remove the tailgate interior trim panel (Section 13).
2 Disconnect the link rods from the exterior handle, the lock cylinder and (when applicable) the lock motor.
3 Remove the exterior handle/number plate light assembly, which is secured by two screws and two nuts. Disconnect the wiring.



21.6 The lock motor link bellcrank

4 The lock cylinder and levers can now be removed after releasing the E-clip and locking plate.

Refitting

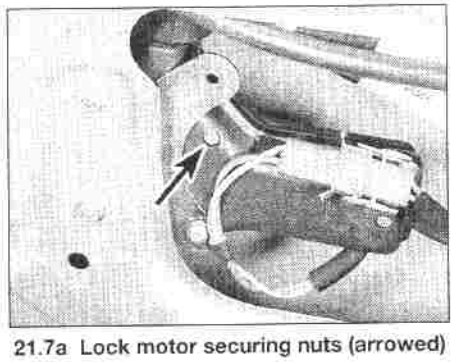
5 Refit by reversing the removal operation. Adjust the exterior handle link rod if necessary to give the handle approximately 3 mm.

21 Central locking components - removal and refitting

Removal

Driver's door switch

1 Remove the interior trim from the door (Section 11).
2 On early models, unclip the switch from around the lock barrel and remove it. Note how the switch groove engages with the lug on the lock.
3 On later models, the switch is located next to the latch mechanism. Remove the single securing screw and lift out the switch. Note how the switch tongue engages with the latch rod **(see illustrations)**.
4 Disconnect the switch multi-plug. If other services share the same plug, prise out the appropriate connectors. On later models, an additional multi-plug is fitted in the harness which simplifies disconnection.



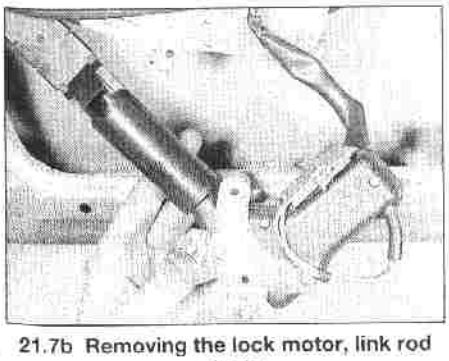
21.7a Lock motor securing nuts (arrowed)

Door lock motors (pre-1989 models)

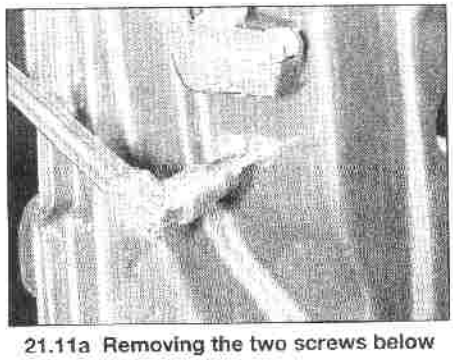
5 Remove the interior trim from the door (Section 11 or 12).
6 Unclip the motor link rod from the bellcrank (front door) or lock button link rod (rear door) **(see illustration)**.
7 Undo the motor securing nuts. Remove the motor and link rod from the door. On some models the link rod is enclosed in a plastic tube **(see illustrations)**.
8 Disconnect the multi-plug - see paragraph 4.
9 If a new motor is being fitted, transfer the link rod, mounting plate and any other components to it.

Door lock motors (1989 models onward)

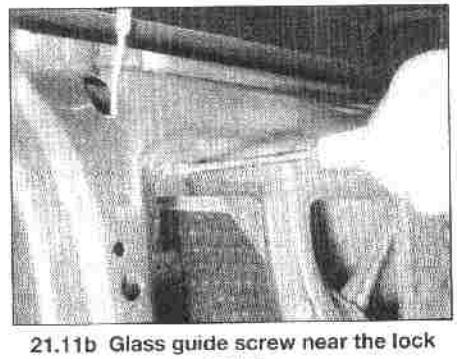
10 Remove the interior trim from the door (Section 11 or 12).
11 Remove the two screws from below the catch, and the single screw near the interior lock button, to release the glass rear guide **(see illustrations)**.



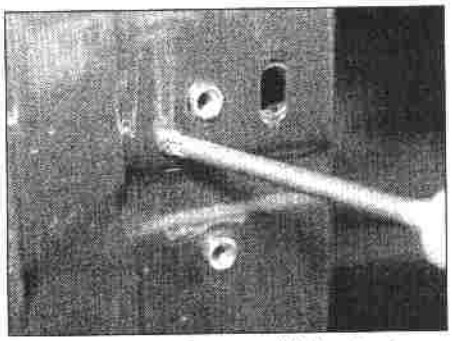
21.7b Removing the lock motor, link rod and tube



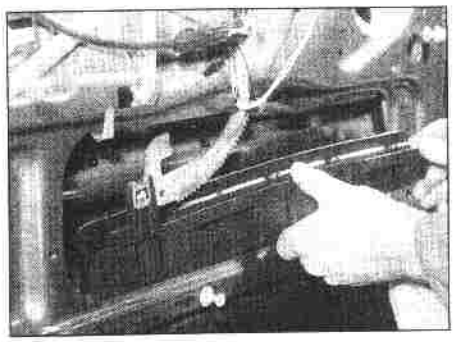
21.11a Removing the two screws below the catch



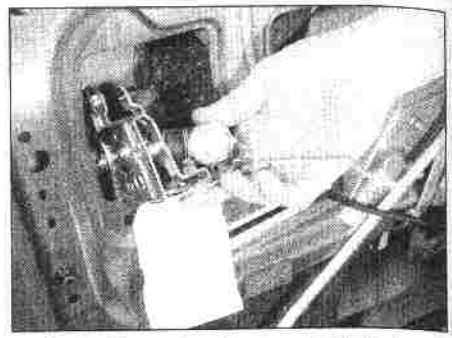
21.11b Glass guide screw near the lock button



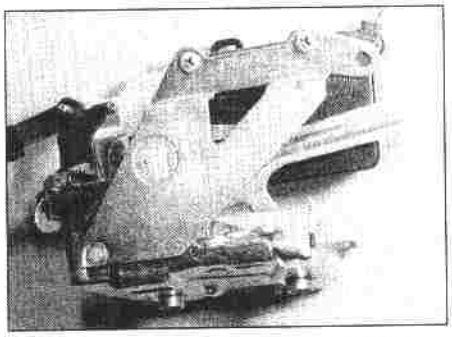
21.12 The single screw hidden by the catch



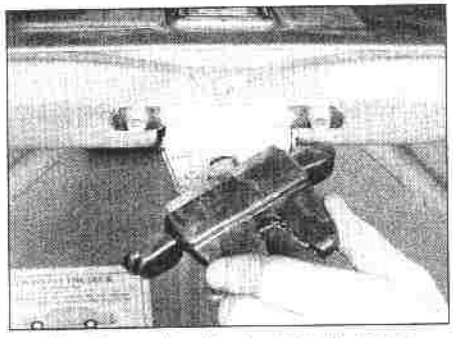
21.13 Removing the glass rear guide



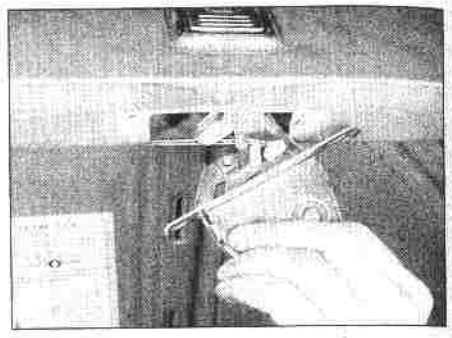
21.14 Removing the door lock motor



21.15 Lock motor showing securing screws



21.16a Removing the boot latch cover . . .



21.16b . . . and the latch

12 Remove the two Torx screws which secure the catch. Remove the catch, and the single screw thus exposed **(see illustration)**.
13 Remove the glass rear guide **(see illustration)**.
14 Unclip the handle operating levers. Unhook the motor and remove it complete with interior lock button rod **(see illustration)**.
15 The motor itself can be removed from the locking mechanism by undoing the two securing screws **(see illustration)**.

Boot lock motor

16 Remove the latch cover. Unbolt and remove the latch **(see illustrations)**.
17 Unhook the lock motor link rod from the latch driver.
18 Remove the three securing nuts, disconnect the motor wiring and remove it **(see illustration)**.

Tailgate lock motor

19 Remove the tailgate interior trim (Section 13).
20 The lock motor may now be removed in a similar way to the boot lock motor.

Relays

21 On 1982 and 1983 models, two relays in the central electrical unit control the locking and unlocking functions. See Chapter 12 for further information.
22 On later models no relays are used in the central locking system.

Refitting

23 In all cases, refit by reversing the removal operations.

22 Door mirror - removal and refitting

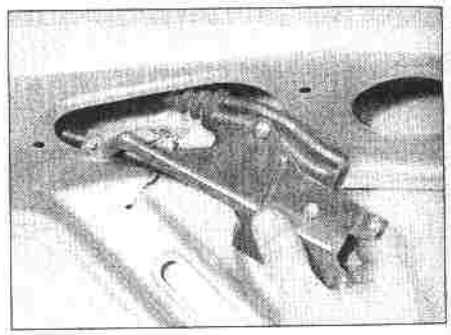
Removal

Electrically-operated

1 Remove the door interior trim (Section 11).
2 Prise free the trim plate which covers the mirror mounting **(see illustration)**.
3 Disconnect the mirror wiring multi-plug. Free the wiring harness from the door **(see illustration)**.
4 Support the mirror and remove the mounting screw. Lift the mirror off its mountings.

Manually-operated

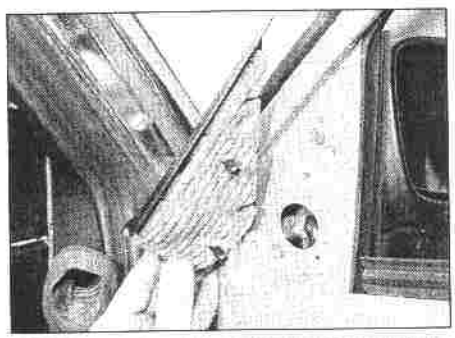
5 The operations are similar to those just described, but since there are no wires to disconnect there should be no need to remove the door interior trim panel. No specific information is available.



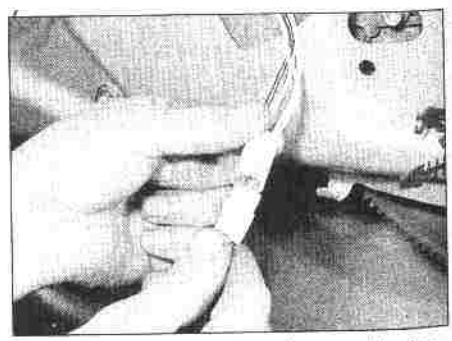
21.18 Removing the boot lock motor

Refitting

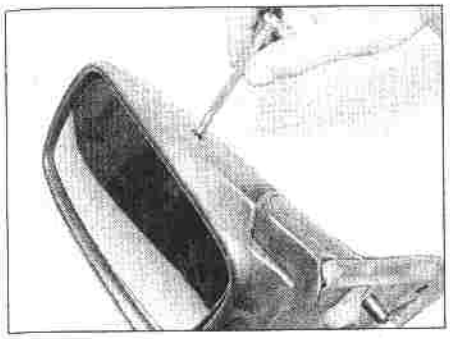
6 Refit by reversing the removal operations.



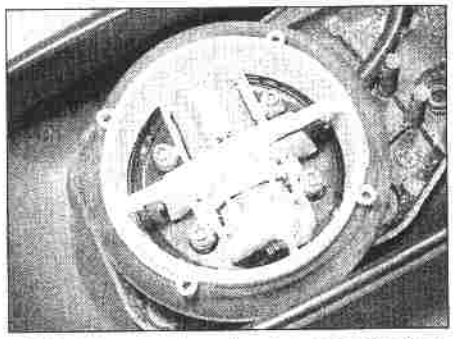
22.2 Removing the door mirror mounting trim plate



22.3 Disconnecting the mirror multi-plug



23.2 Releasing the mirror glass retaining ring



23.3 Mirror motor, showing the retaining screws

23 Door mirror glass and motor - removal and refitting

Note: *There is no need to remove the mirror from the door for the following operations.*

Removal

1 Press the mirror glass inwards at the bottom until the retaining ring teeth are visible through the access hole.

2 Prise the teeth with a screwdriver to move the ring in an anti-clockwise direction (looking at the glass). This will release the retaining ring from the mounting plate **(see illustration)**. Remove the glass and retaining ring. When applicable, disconnect the heating element wires.

3 The motor may now be removed after undoing the four retaining screws and disconnecting the wires from it. If the wires cannot be separated from the motor, remove the door interior trim and disconnect the mirror multi-plug **(see illustration)**.

Refitting

4 Refit by reversing the removal operations. Observe the "TOP" marking on the motor, and the "UNTEN" (bottom) marking on the mirror glass **(see illustrations)**.

24 Door surround weatherstrip - removal and refitting

Removal

1 Remove the kick panel from the door sill **(see illustration)**.

2 Prise the weatherstrip free, starting at the bottom. Use a wide-bladed screwdriver and protect the paintwork by prising against a piece of wood.

Refitting

3 Refit the weatherstrip starting at the uppermost corner. Tap it home with a rubber mallet.

4 Refit the kick panel.

25 Front seat - removal and refitting

Removal

1 Remove the trim or storage pocket from the outboard side of the seat base. Unbolt the seat belt anchorage thus exposed **(see illustration)**.

2 Move the seat forwards. Remove the single screw from the rear of each track - these may be concealed by trim covers **(see illustration)**.

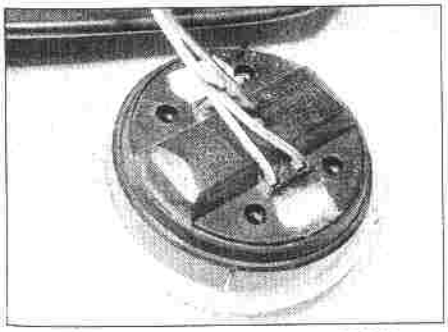
3 Move the seat rearwards. Remove any trim covers, then remove the single screw from the front of each track **(see illustration)**.

4 Disconnect the seat heater, seatbelt switch and adjustment motor multi-plugs (as applicable).

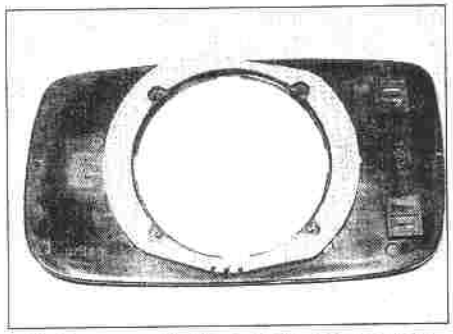
5 Lift the front of the seat, pushing it rearwards at the same time, to free the tracks from their "keyhole" fixings in the floor. Remove the seat and tracks together.

Refitting

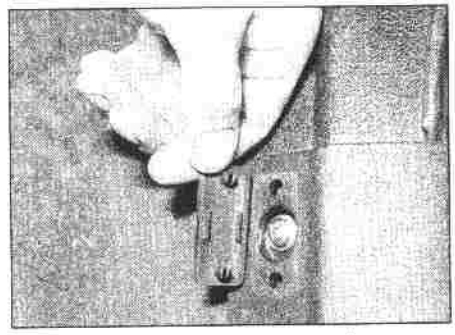
6 Refit by reversing the removal operations.



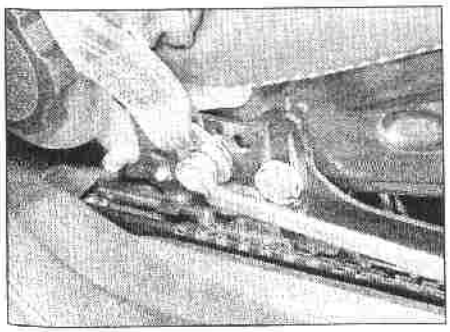
23.4a Mirror motor is marked "TOP" . . .



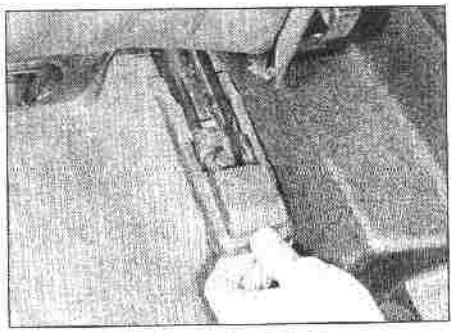
23.4b . . . and bottom of glass is marked "UNTEN"



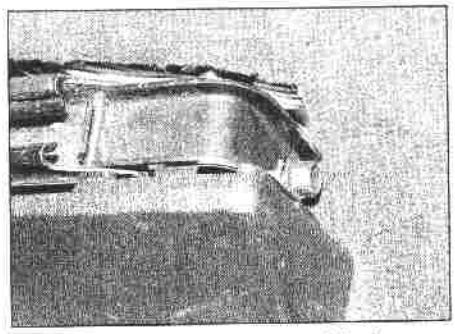
24.1 Sill kick panel screw and cover



25.1 Unbolting the belt anchorage from the seat



25.2 A rear track bolt . . .



25.3 . . . and a front track bolt

26 Rear seat - removal and refitting

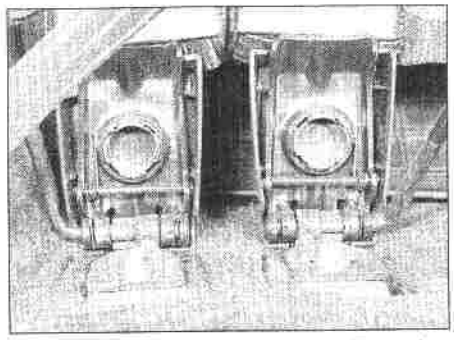
Removal

Saloon models

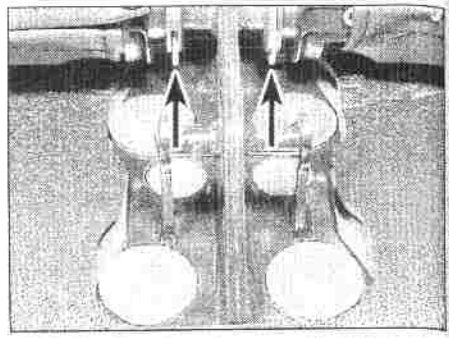
1 Free the seat cushion from its retaining clips by pushing the front edge down and pulling it rearwards. Lift out the cushion.
2 Straighten the tongues of the clips which secure the base of the seat back. Thump the seat back upwards to free it from the top clips and remove it.
3 The armrest may now be unbolted and removed if wished.

Estate models

4 Fold the seat cushions forwards. Remove the hinge retaining nuts and lift out the cushions **(see illustration)**.
5 Fold down the seat backs. Pull the pins out of the centre mounting **(see illustration)** and release the side mounting pins by turning them with pliers. Lift out the seat backs.



26.4 Two seat cushion hinges (Estate)



26.5 Seat back centre mounting (Estate) - pins arrowed

Refitting

6 Refit by reversing the removal operations.

27 Head restraints - removal and refitting

Removal

1 Press the front of the seat backrest about 90 mm below the top edge, at the same time pulling the head restraint upwards to free it.
2 Pull the head restraint out of the guides and remove it.

Refitting

3 Refit by pushing the head restraint firmly into place until it latches.

28 Front seat position adjusters - removal and refitting

Removal

1 Remove the seat and cushion (Sections 25 and 29).

Mechanical height adjusters

2 Raise the adjuster to its highest position. Remove the Allen screws which secure it to the seat.
3 Press the height adjuster lever towards the front of the seat and push downwards on the seat. Separate the seat from the rods.
4 The height adjuster components may now be renewed as necessary.

Mechanical reclining adjuster

5 Proceed as for backrest heater renewal (Section 29), but also unbolt the reclining mechanism from the seat base frame. The complete backrest frame and reclining mechanism must be renewed together.

Fore-and-aft and height adjuster motor

6 Invert the seat on a clean bench or floor so that the base is accessible.
7 Remove the four small bolts which secure the motor mounting plate.
8 Ease the mounting plate away from the seat. Remove the four bolts which secure the motor in question; note the spacers fitted to the front height adjuster motor.
9 Remove the motor from the bracket and withdraw the cable from it.
10 Disconnect the motor multi-plug. This plug is shared by all three motors; to remove one motor it will be necessary to prise its connectors out of the plug, or to cut the wires and make new connections for a new motor.

Backrest motor

11 Remove the lumbar support adjustment knob. Also remove the covers at the base of the backrest on both sides.
12 Recline the backrest as far as possible, using a screwdriver or similar tool inserted in the hole in the reclining gear mechanism at the base of the backrest.
13 On the underside of the seat disconnect the multi-plugs which feed the heater pads and the backrest motor. It will also be necessary to free or cut the black wire from the three-pole connector. Cut cable-ties as necessary.
14 Remove the four bolts which secure the backrest. Lift the backrest off the seat base.
15 Cut the rings which secure the upholstery to the base of the backrest. Peel back the upholstery and unhook the clips inside to gain access to the motor.
16 Remove the nut which secures the motor bracket to the backrest frame. Withdraw the motor with cables and bracket still attached.
17 Unbolt the bracket from the motor and free it from the cables. Disconnect its wiring plug and remove it.

Seat adjuster motor control panel

18 Cut the cable-tie which secures the wiring harness to the motor mounting plate.
19 Disconnect the motor multi-plugs.
20 Remove the two screws which secure the control panel.
21 Withdraw the control panel, feeding the cables and connectors through the side of the seat.

Refitting

22 In all cases, refit by reversing the removal operations using new cable-ties, upholstery rings etc, as necessary.

29 Seat heating elements - removal and refitting

Removal

1 Remove the front seat (Section 25).
2 Recline the backrest as far as it will go. Invert the seat and free the wiring from the cable-ties.

Backrest heater

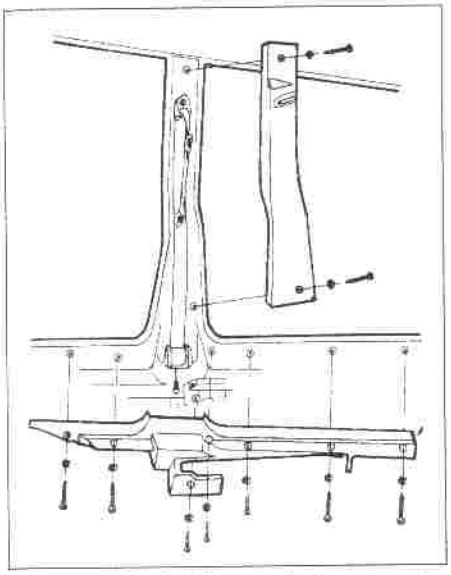
3 Remove the head restraint (Section 27).
4 Remove the backrest adjuster knob, and the lumbar support adjuster knob and guide.
5 Remove the upholstery retaining rod. Cut the clamp rings which secure the bottom edge of the upholstery. Peel off the upholstery, freeing the centre attachment clamps.
6 The heating element can now be removed.

Cushion heater

7 Remove the upholstery retaining rods. Unhook the side springs and remove the cushion.
8 Cut the clamp rings which secure the upholstery. Peel off the upholstery, unhooking the centre attachments.
9 The heating element and thermostat can now be removed.

Seat heater control unit

10 Up to 1988, seat heating was controlled simply by a thermostat and a switch. From 1988, seats have control units (one for each front seat) which vary the seat heater output according to temperature. Maximum output is only provided at under-seat temperatures below 10°C. Low output is provided at temperatures between 10 and 18°C. No output is provided at higher temperatures, apart from a burst of a few seconds when the ignition is first switched on.



30.2 Remove the trim panels for access to the front seat belt

11 If the seat heater does not behave as described, the control unit may be at fault. Access is obtained by removing the seat, cutting the mounting strap and unplugging the control unit.
12 Testing of the control unit is by substitution of a known good unit. Assuming that only one control unit will fail at a time, a good unit may be borrowed from the other seat to confirm the fault.

Refitting

13 In all cases, refit by reversing the removal operations, using new clamp rings when necessary.

30 Seat belts - removal and refitting

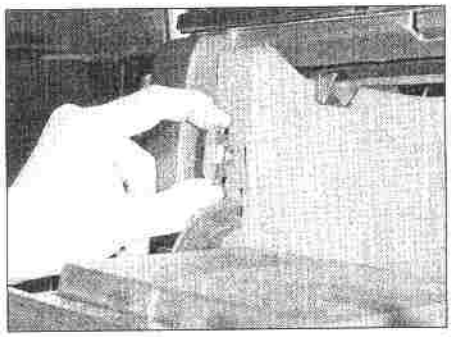
Removal

Front seat belts

1 Move the front seat forwards. Remove the trim or storage pocket from the outboard side of the seat base. Unbolt the seat belt anchorage.
2 Remove the B-pillar trim panel, which is secured by two screws concealed by plugs **(see illustration)**. Free the belt guide from the slot in the trim.
3 Remove the reel cover/sill trim panel, which is secured by seven concealed screws.
4 Unbolt the belt upper guide and the inertia reel unit, noting the location of any washers and spacers. Remove the belt and reel.
5 To remove the buckle, it is first necessary to remove the seat (Section 25).

Rear seat belts - Saloon models

6 Remove the rear seat (Section 26).
7 The buckles and floor anchorages can now be unbolted from the seat pan.



32.1 Removing a glovebox screw trim pad

8 To gain access to the inertia reels it will first be necessary to remove the parcel shelf loudspeakers (when fitted). Access to their connectors and fastenings is from inside the boot.
9 Remove the parcel shelf securing clips and the parcel shelf itself.
10 Remove the reel cover clips and the reel covers.
11 Unbolt and remove the inertia reels, noting the position of any spacers.

Rear seat belts - Estate models

12 Access to the buckles and floor anchorages is gained by tipping the seat cushion forwards.
13 The inertia reels are accessible after removing the C-pillar trim. This is attached by a screw at the top, by the seat back stop at the bottom and by a clip at the rear.

Refitting

14 In all cases, refit by reversing the removal operations.

31 Steering column/pedal trim panel - removal and refitting

Removal

1 The large trim panel below the steering column is secured by two screws and two clips. Remove the screws and turn the clips 90° to release them.
2 Lower the trim panel and disconnect the heater duct from it. Remove the panel.

Refitting

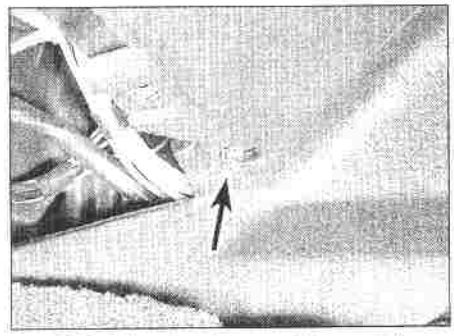
3 Refit by reversing the removal operations.

32 Glovebox - removal and refitting

Removal

All models except 760, 1988-onwards

1 Open the glovebox. Prise out the two trim pads from the edges of the glovebox and remove the two screws so exposed **(see illustration)**.



32.3 Glovebox base nut (arrowed)

2 Remove the trim panel from below the glovebox. This is secured by three clips which must be turned 90°.
3 Remove the nut at the base of the glovebox (towards the centre of the vehicle) **(see illustration)**.
4 Lower the glovebox, disconnect the wires from it and remove it.

760 models, 1988 onwards

5 Remove the panel from below the glovebox. This is secured by clips at the top (turn through 90° to release) and screws at the bottom.
6 Remove the two screws at the base of the glovebox lid, one at each end.
7 Open the glovebox. Remove the plastic covers from above the lid straps and remove the screws thus exposed.
8 Free the glovebox from its mounting clips and remove it.

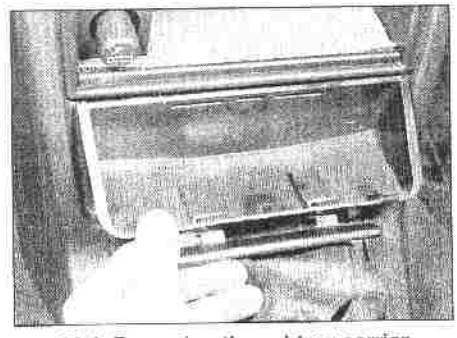
Refitting

9 Refit by reversing the removal operations.

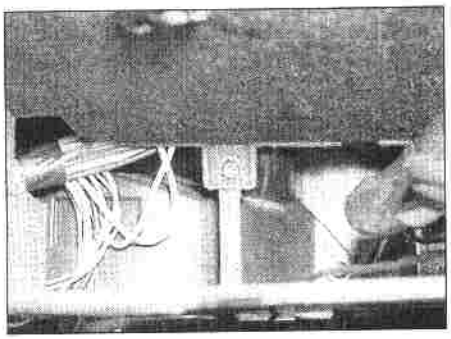
33 Centre console - removal and refitting

Removal

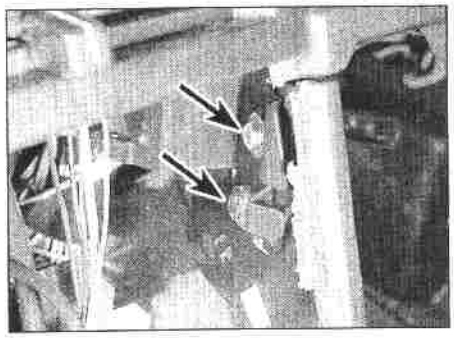
1 Disconnect the battery negative lead.
2 Remove the steering column/pedal trim (Section 31) and the glovebox (Section 32). This may not be essential but will improve access.
3 Remove the radio (Chapter 12).
4 Remove the ashtray and its carrier **(see illustration)**.



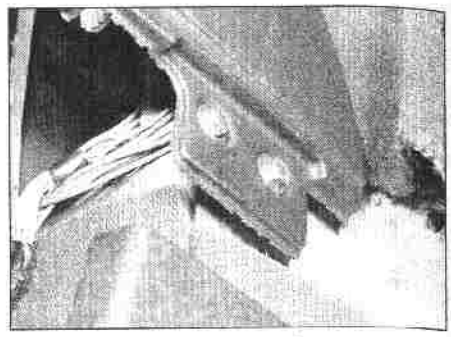
33.4 Removing the ashtray carrier



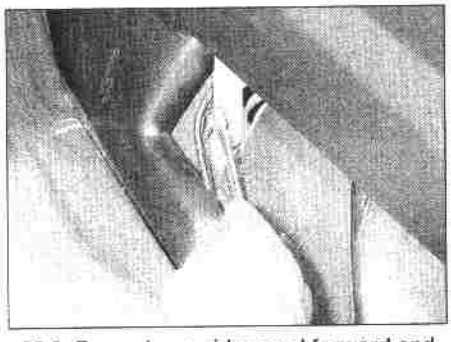
33.6 Radio tray securing screw



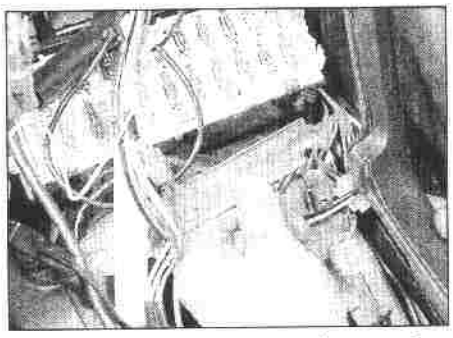
33.7 Side panel screws (arrowed) below the heater controls



33.8 Side panel rear edge screws



33.9 Removing a side panel forward end screw



33.10 Removing the side panel connecting strut

5 Remove the cigarette lighter tray. This is secured by one or two screws, exposed by removing the lighter element and cover plate. Disconnect the lighter feed and withdraw the bulb holder as the tray is withdrawn. (On some models the tray may contain audio equipment.)
6 Remove the radio tray, which is secured by a single screw at the back **(see illustration)**.
7 Remove the side panel screws from below the heater controls **(see illustration)**.
8 Remove the screws (two on each side) which secure the rear edge of the centre console side panels. It will be necessary to release the rear console and move it rearwards to gain access to these screws **(see illustration)**.
9 Peel back the carpet from the forward end of the transmission tunnel and remove the two screws (one each side) which secure the forward ends of the side panels **(see illustration)**.

10 Slacken the screws which secure the side panel connecting strut. Release the strut, which has slotted fixing holes **(see illustration)**.
11 Remove the centre console side panels.

Refitting

12 Refit by reversing the removal operations.

34 Rear console - removal and refitting

Removal

1 Lift the armrest, empty the storage box and prise out the cover plate from the bottom of the box. Remove the two screws thus exposed **(see illustration)**.

2 On manual transmission models, remove the gear lever/handbrake trim. This is retained by two screws. Disconnect any switches.
3 On automatic transmission models, remove the selector lever trim.
4 Lift the rear console. Separate the rear ashtray/cigarette lighter/seat belt warning light panel from the console. Remove the console, leaving the panel behind.

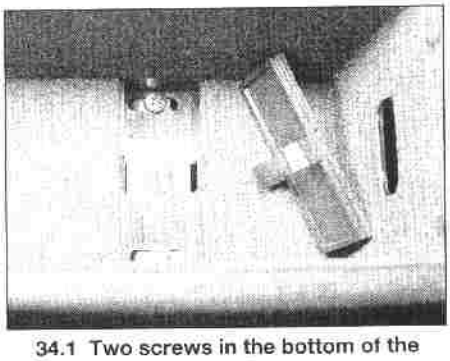
Refitting

5 Refit by reversing the removal operations.

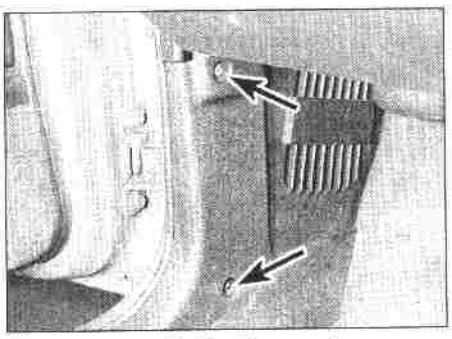
35 Facia - removal and refitting

Removal

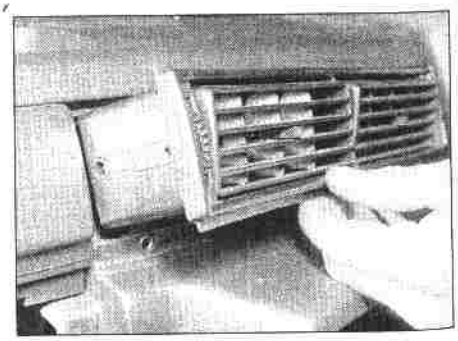
1 Disconnect the battery negative lead.
2 Remove the steering wheel, the steering column switches and the instrument panel. See Chapters 10 and 12.
3 Remove the steering column/pedal trim, the glovebox, the centre console and the rear console. See Sections 31 to 34.
4 Remove the footwell side trim panels **(see illustration)**. Also remove the A-pillar trim.
5 Disconnect the switch and lighting multi-plugs.
6 Remove the screw which secures the steering column top bearing to the facia. Recover the spacer tube.
7 Remove the central air vents **(see illustration)**. Remove the air mix box retaining screw and disconnect the air ducts.



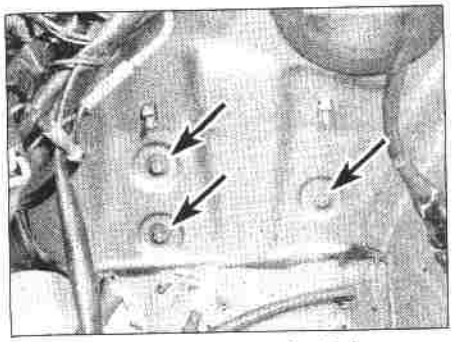
34.1 Two screws in the bottom of the storage box



35.4 Footwell side trim panel screws (arrowed)



35.7 Removing the central air vent



37.1a Three nuts (arrowed) which secure the bumper side section. Air cleaner has been removed for access

8 Unclip the wiring harness from the facia.
9 On vehicles with automatic climate control, remove the inner temperature sensor.
10 Remove the facia panel complete with switchgear, demister vents etc. Transfer components as necessary if a new panel is to be fitted.

Refitting

11 Refit by reversing the removal operations.

36 Front spoiler - removal and refitting

Removal

1 Have an assistant support the spoiler. Remove the six bolts and D-shaped washers which secure it to the bumper.
2 Free the spoiler from the bumper side section and remove it.

Refitting

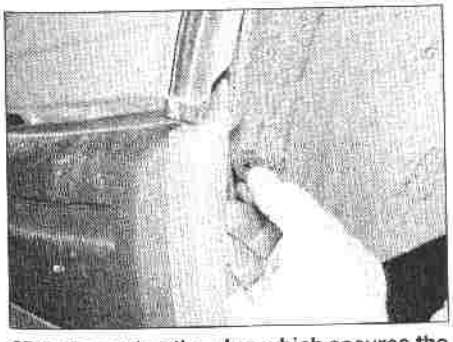
3 Refit by reversing the removal operations.

37 Bumpers - removal and refitting

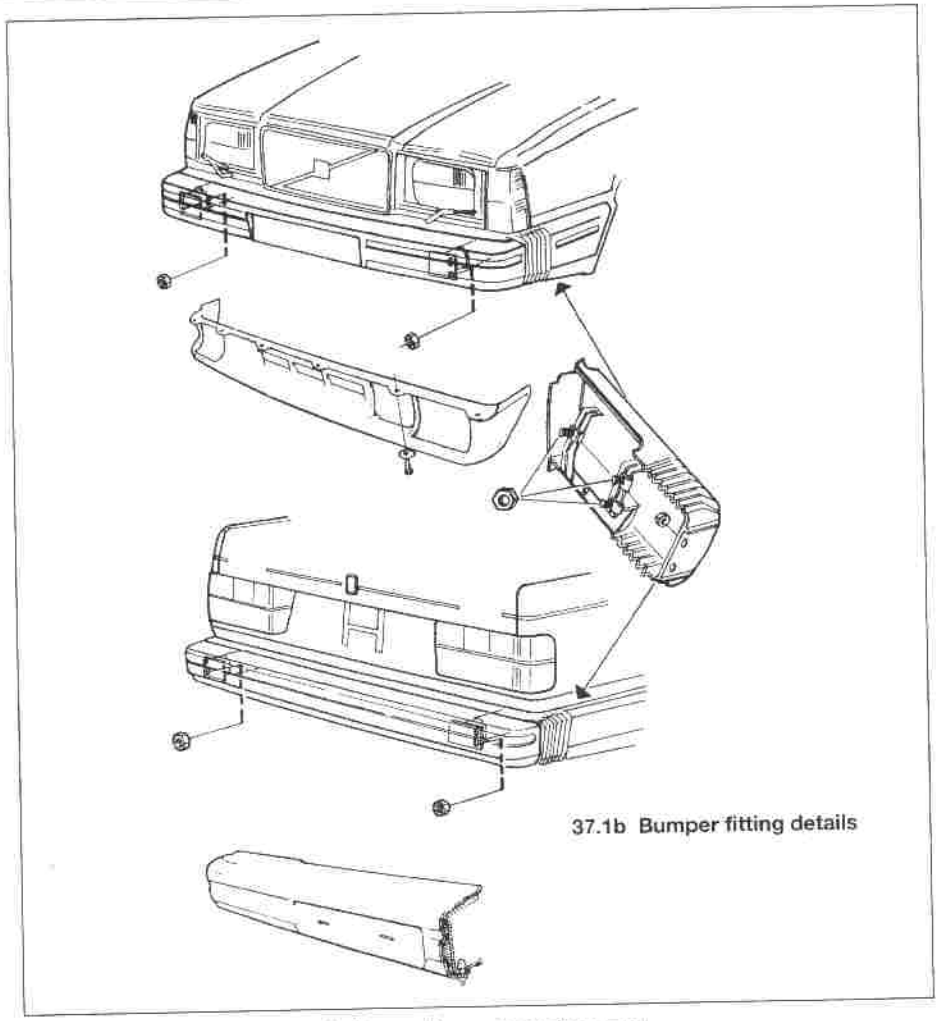
Removal

Front bumper

1 Remove the three nuts which secure each side section **(see illustrations)**. (Depending on equipment and model, it may be necessary to remove the battery, washer reservoir and/or air cleaner for access.)
2 Remove the single plug securing the rear edge of each side section **(see illustration)**.
3 Remove the front spoiler (Section 36).
4 Disconnect or remove the auxiliary lights (when fitted).
5 From inside the bumper remove the four nuts which secure it to the buffers. Remove the bumper.



37.2 Removing the plug which secures the rear of the bumper side section



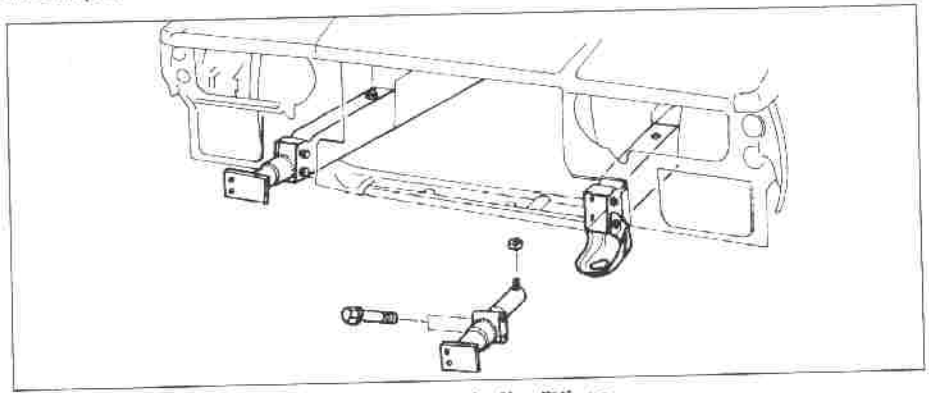
37.1b Bumper fitting details

Rear bumper

6 This is removed in a similar way to the front bumper, but access to the side section nuts is gained from within the boot or load area wells.

Bumper buffers

7 Remove the front or rear bumper, as appropriate.
8 Remove the two nuts and bolts and the single nut securing the buffer. The single nut is reached from the engine bay (front buffers) or from inside the boot or load area **(see illustration)**.



37.8 Bumper buffer fittings

9 Pull the buffer out of its bracket.
10 Do not puncture the buffers, or perform welding on or near them. They contain gas under pressure which could cause injury if suddenly released.

Refitting

11 Refit by reversing the removal operations.

38 Front grille panel - removal and refitting

Removal

1 Open the bonnet. Squeeze the grille panel top retaining clips and remove them **(see illustration)**.

2 Release the panel from its bottom mountings and remove it **(see illustration)**.

Refitting

3 Refit by reversing the removal operations.

39 Engine undertray - removal and refitting

Removal

1 Raise and support the front of the vehicle.
2 Remove the undertray securing screws and free it from the lugs. When a vacuum tank is fitted in this area, it may share some of the undertray screws.

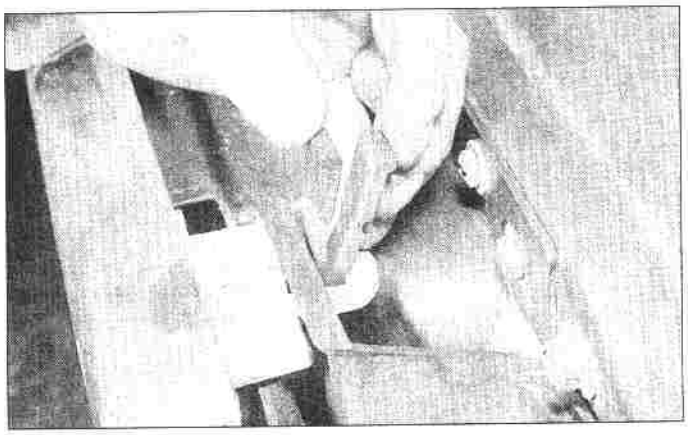
Refitting

3 Refit by reversing the removal operations.

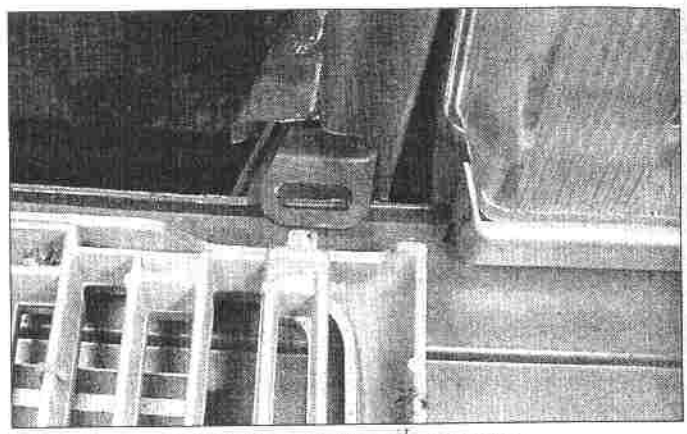
40 Sunroof - general information

A mechanically or electrically operated sunroof is available as standard or optional equipment according to model.

The sunroof is maintenance-free, but any adjustment or removal and refitting of the component parts should be entrusted to a dealer, due to the complexity of the unit and the need to remove much of the interior trim and headlining to gain access. The latter operation is involved, and requires care and specialist knowledge to avoid damage.



38.1 Removing a grille panel clip



38.2 Grille panel bottom mounting

Chapter 12
Body electrical systems

Contents

Degrees of difficulty

Easy, suitable for novice with little experience

Fairly easy, suitable for beginner with some experience

Fairly difficult, suitable for competent DIY mechanic

Difficult, suitable for experienced DIY mechanic

Very difficult, suitable for expert DIY or professional

Specifications

Fuses - 1982/83 models

No	Rating (amps)	Circuit(s) protected
F1 (or 2)	25	Fuel pump (main)
F2 (or 1)	25	Hazard warning, headlight flasher, central locking
F3	15	Front foglights/spotlights
F4	15	Stop-lights
F5	15	Clock, interior lighting, power aerial, radio (full-time), door edge marker lights
F6	25	Cooling fan
F7	30	Window motors
F8	15	Direction indicators, constant idle system, overdrive relay
F9	30	Heated rear window, sunroof motor
F10	15	Instruments, reversing lights, seat heaters, seat belt reminder, fuel pump relay, window motor relay, cooling fan relay, air conditioning delay valve, oil level sensor, bulb failure warning
F11	25	Day running lights, cruise control, heater blower (low speed), automatic climate control
F12	25	Cigarette lighter, radio (ignition-controlled), mirror motors, seat motors
F13	25	Horn, windscreen wash/wipe, headlight wash/wipe
F14	30	Heater blower (high speeds)
F15	15	Fuel pump (auxiliary)
F16	15	Rear foglights and relay
F17	15	Main beam (LH) and main beam pilot light
F18	15	Main beam (RH), front spotlight relay
F19	15	Dipped beam (LH)
F20	15	Dipped beam (RH)
F21	15	Instrument and control lighting, tail/parking lights (LH), number plate light, warning buzzer, front ashtray
F22	15	Rear ashtray light, transmission tunnel switch lighting, tail/parking lights (RH), front foglight relay

Fuses - 1984 models

No	Rating (amps)	Circuit(s) protected
F1	25	Fuel pump (main), fuel injection system
F2	25	Hazard warning, headlight flasher, ABS, central locking
F3	15	Front foglights/spotlights
F4	15	Stop-lights
F5	15	Clock, interior lighting, power aerial, radio (full-time), door edge marker lights
F6	25	Cooling fan, seat belt reminder, seat heaters
F7	30	Window motors
F8	15	Day running lights, bulb failure warning, window motor relay, cooling fan relay
F9	25	Heated rear window, sunroof motor, air conditioning
F10	15 or 25	Instruments, reversing lights, ignition system, cruise control, oil level sensor, ABS
F11	15 or 25	Direction indicators, overdrive relay, constant idle system, inlet heater relay
F12	15	Cigarette lighter, radio (ignition-controlled), mirror motors, seat motors
F13	25	Horn, windscreen wash/wipe, headlight wash/wipe
F14	30	Heater blower, air conditioning
F15	15	Fuel pump (auxiliary)
F16	15	Rear foglights and relay
F17	15	Main beam (LH) and main beam pilot light
F18	15	Main beam (RH), front spotlight relay
F19	15	Dipped beam (LH)
F20	15	Dipped beam (RH)
F21	15	Instrument and control lighting, tail/parking lights (LH), number plate light
F22	15	Rear ashtray light, transmission tunnel switch lighting, tail/parking lights (RH), front foglight relay

Fuses - 1985/86 models

No	Rating (amps)	Circuit(s) protected
F1	25	Fuel pump (main), fuel injection system
F2	25	Hazard warning, headlight flasher, ABS, central locking
F3	15	Front foglights/spotlight relay, rear foglight relay
F4	15	Stop-lights
F5	15	Clock, interior lighting, power aerial, radio (full-time), door edge marker lights
F6	15	Seat heaters
F7	25	Cooling fan
F8	30	Window motors
F9	15	Direction indicators, seat belt reminder, seat heater relay, window motor relay, air conditioning relay, cooling fan relay
F10	30	Heated rear window, sunroof motor, heated mirrors
F11	15	Fuel pump (auxiliary)
F12	15	Reversing lights, oil level sensor, overdrive, ignition system, cruise control, ABS
F13	15	Fuel injection systems
F14	15	Mirror motors, cigarette lighter, radio (ignition-controlled), rear window wiper
F15	25	Horn, windscreen wash/wipe, headlight wash/wipe
F16	30	Heater blower, air conditioning
F17	15	Main beam (LH) and main beam pilot light
F18	15	Main beam (RH), front spotlights
F19	15	Dipped beam (LH)
F20	15	Dipped beam (RH)
F21	15	Instrument lighting, tail/parking lights (LH), number plate lights
F22	15	Rear ashtray light, transmission tunnel switch light, tail/parking lights (RH)
F23	15	Seat motor relay
F24	-	Spare
F25	15	Day running lights
F26	30	Seat motors

Fuses - 760 models, 1988 onwards

No	Rating (amps)	Circuit(s) protected
F1	10	Tail/parking lights (LH), number plate lights
F2	10	Tail/parking lights (RH)
F3	15	Main beam (LH)
F4	15	Main beam (RH)
F5	-	Spare
F6	15	Dipped beam (LH)
F7	15	Dipped beam (RH)
F8	15	Foglights (front)
F9	10	Foglights (rear)
F10	5	Instrument and control lighting
F11	15	Reversing lights, turn signals, cruise control
F12	15	Dim-dip system
F13	25	Heated rear window, heated mirrors
F14	10	Bulb failure warning, overdrive relay, power window relay, sunroof motor relay, seat belt warning
F15	-	Spare
F16	-	Spare
F17	-	Spare
F18	5	Radio
F19	15	Electronic climate control, mirror motors, rear window wiper, seat motor relay, cigarette lighter
F20	25	Horn, windscreen wipers, headlight wipers
F21	5	Electronic traction control, constant idle speed system
F22	5	ABS
F23	-	Spare
F24	-	Spare
F25	25	Hazard warning lights, central locking
F26	10	Clock, interior lights, door markers
F27	15	Stop-lights
F28	30	Heater blower, electronic climate control
F29	30	Radio aerial, trailer lighting
F30	10	Auxiliary fuel pump
F31	25	Main fuel pump, fuel injection system
F32	10	Radio amplifier
F33	10	Radio
F34*	30	Window motors, sunroof motor
F35*	30	Seat heaters, seat motors
-	10	ABS (on transient surge protector relay)

**Circuit breakers*

Light bulbs (typical)

	Wattage	Pattern
Headlights	60/55	P45t-38 (H4)
Day running/parking lights	21/5	BA7 15d
Direction indicators	21	BA 15s
Direction indicator side repeaters	5	W2.1x9.5d
Front foglights/spotlights	55	PK 22s (H3)
Tail lights	5	BA 15s
Stop-lights	21	BA 15s
High-level stop-light:		
1986 models	20	BA 9s
1987 models onward	21	BA 15s
Combined stop and tail	21/5	BA7 15d
Rear foglights/reversing lights	21	BA 15s
Number plate light	5	BA 9s
Interior (courtesy) lights	10	SV 8.5
Reading lights	5	W 2.1x9.5d
Engine bay/load area lights	10	SV 8.5
Glovebox light	2	BA 9s
Vanity mirror light	3	SV 7
Door edge marker light	3	W 2.1x9.5d
Indicator and warning lights	1.2	Integral holder
Instrument illumination	3	W 2.1x9.5d
Control illumination	1.2	W 2x4.6d

1 General information and precautions

General information

The electrical system is of 12-volt negative earth type. Power for the lights and all electrical accessories is supplied by a lead/acid battery which is charged by the alternator.

This Chapter covers repair and service procedures for the various electrical components and systems not associated with the engine. Information on the battery, ignition system, alternator, and starter motor can be found in Chapter 5.

Precautions

Warning: Before carrying out any work on the electrical system, read through the precautions given in "Safety first!" at the beginning of this manual and in Chapter 5.

Warning: Prior to working on any component in the electrical system, the battery negative lead should first be disconnected, to prevent the possibility of electrical short-circuits and/or fires. If a radio/cassette player with anti-theft security code is fitted, refer to the information given in the reference Sections of this manual before disconnecting the battery.

2 Electrical fault finding - general information

Warning: Refer to the precautions given in "Safety first!" and in Section 1 of this Chapter before starting work. The following tests relate to testing of the main electrical circuits, and should not be used to test delicate electronic circuits, particularly where an electronic control module is used.

General

1 A typical electrical circuit consists of an electrical component, any switches, relays, motors, fuses, fusible links or circuit breakers related to that component, and the wiring and connectors which link the component to both the battery and the chassis. To help to pinpoint a problem in an electrical circuit, wiring diagrams are included at the end of this manual.

2 Before attempting to diagnose an electrical fault, first study the appropriate wiring diagram, to obtain a complete understanding of the components included in the particular circuit concerned. The possible sources of a fault can be narrowed down by noting if other components related to the circuit are operating properly. If several components or circuits fail at one time, the problem is likely to be related to a shared fuse or earth connection.

3 Electrical problems usually stem from simple causes, such as loose or corroded connections, a faulty earth connection, a blown fuse, a melted fusible link, or a faulty relay. Visually inspect the condition of all fuses, wires and connections in a problem circuit before testing the components. Use the wiring diagrams to determine which terminal connections will need to be checked in order to pinpoint the trouble-spot.

4 The basic tools required for electrical fault-finding include a circuit tester or voltmeter (a 12-volt bulb with a set of test leads can also be used for certain tests); an ohmmeter (to measure resistance and check for continuity); a battery and set of test leads; and a jumper wire, preferably with a circuit breaker or fuse incorporated, which can be used to bypass suspect wires or electrical components. Before attempting to locate a problem with test instruments, use the wiring diagram to determine where to make the connections.

5 To find the source of an intermittent wiring fault (usually due to a poor or dirty connection, or damaged wiring insulation), a "wiggle" test can be performed on the wiring. This involves wiggling the wiring by hand to see if the fault occurs as the wiring is moved. It should be possible to narrow down the source of the fault to a particular section of wiring. This method of testing can be used in conjunction with any of the tests described in the following sub-Sections.

6 Apart from problems due to poor connections, two basic types of fault can occur in an electrical circuit - open-circuit, or short-circuit.

7 Open-circuit faults are caused by a break somewhere in the circuit, which prevents current from flowing. An open-circuit fault will prevent a component from working.

8 Short-circuit faults are caused by a "short" somewhere in the circuit, which allows the current flowing in the circuit to "escape" along an alternative route, usually to earth. Short-circuit faults are normally caused by a breakdown in wiring insulation, which allows a feed wire to touch either another wire, or an earthed component such as the bodyshell. A short-circuit fault will normally cause the relevant circuit fuse to blow.

Finding an open-circuit

9 To check for an open-circuit, connect one lead of a circuit tester or the negative lead of a voltmeter either to the battery negative terminal or to a known good earth.

10 Connect the other lead to a connector in the circuit being tested, preferably nearest to the battery or fuse. At this point, battery voltage should be present, unless the lead from the battery or the fuse itself is faulty (bearing in mind that some circuits are live only when the ignition switch is moved to a particular position).

11 Switch on the circuit, then connect the tester lead to the connector nearest the circuit switch on the component side.

12 If voltage is present (indicated either by the tester bulb lighting or a voltmeter reading, as applicable), this means that the section of the circuit between the relevant connector and the switch is problem-free.

13 Continue to check the remainder of the circuit in the same fashion.

14 When a point is reached at which no voltage is present, the problem must lie between that point and the previous test point with voltage. Most problems can be traced to a broken, corroded or loose connection.

Finding a short-circuit

15 To check for a short-circuit, first disconnect the load(s) from the circuit (loads are the components which draw current from a circuit, such as bulbs, motors, heating elements, etc).

16 Remove the relevant fuse from the circuit, and connect a circuit tester or voltmeter to the fuse connections.

17 Switch on the circuit, bearing in mind that some circuits are live only when the ignition switch is moved to a particular position.

18 If voltage is present (indicated either by the tester bulb lighting or a voltmeter reading, as applicable), this means that there is a short-circuit.

19 If no voltage is present during this test, but the fuse still blows with the load(s) reconnected, this indicates an internal fault in the load(s).

Finding an earth fault

20 The battery negative terminal is connected to "earth" - the metal of the engine/transmission and the vehicle body - and many systems are wired so that they only receive a positive feed, the current returning via the metal of the car body. This means that the component mounting and the body form part of that circuit. Loose or corroded mountings can therefore cause a range of electrical faults, ranging from total failure of a circuit, to a puzzling partial failure. In particular, lights may shine dimly (especially when another circuit sharing the same earth point is in operation), motors (eg wiper motors or the radiator cooling fan motor) may run slowly, and the operation of one circuit may have an apparently-unrelated effect on another. Note that on many vehicles, earth straps are used between certain components, such as the engine/transmission and the body, usually where there is no metal-to-metal contact between components, due to flexible rubber mountings, etc.

21 To check whether a component is properly earthed, disconnect the battery and connect one lead of an ohmmeter to a known good earth point. Connect the other lead to

the wire or earth connection being tested. The resistance reading should be zero; if not, check the connection as follows.

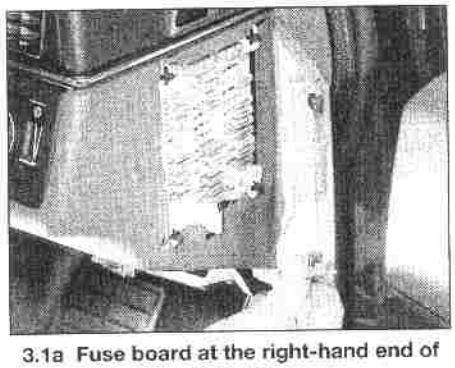
22 If an earth connection is thought to be faulty, dismantle the connection, and clean both the bodyshell and the wire terminal (or the component earth connection mating surface) back to bare metal. Be careful to remove all traces of dirt and corrosion, then use a knife to trim away any paint, so that a clean metal-to-metal joint is made. On reassembly, tighten the joint fasteners securely; if a wire terminal is being refitted, use serrated washers between the terminal and the bodyshell, to ensure a clean and secure connection. When the connection is remade, prevent the onset of corrosion in the future by applying a coat of petroleum jelly or silicone-based grease, or by spraying on (at regular intervals) a proprietary ignition sealer or a water-dispersant lubricant.

3 Fuses and relays - general information

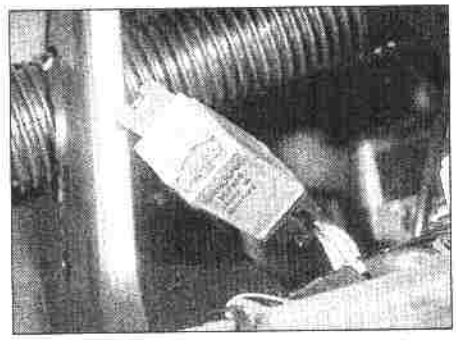
Fuses

1 The fuses are located on the sloping face of the central electric unit, behind the front ashtray. Access is gained by removing the ashtray, then unclipping the ashtray carrier by pressing up the section marked "electrical fuses - press". On 760 models from 1988 onwards, the fuses are housed at the right-hand end of the facia. For access, open the driver's door, then unclip the fuse cover panel **(see illustration)**. A separate fuse protects the ABS circuits. This fuse is mounted on a relay, known as the ABS Transient Surge Protector, located to the right of the instrument panel **(see illustration)**.

2 If a fuse blows, the electrical circuit(s) protected by that fuse will cease to operate. Lists of the circuits protected are given in the Specifications; a sticker behind the ashtray gives details for the particular vehicle. On 760 models from 1988 onwards, fuses No 34 and 35 are in fact circuit breakers. If a circuit breaker trips, it should reset itself after about 20 seconds. If it fails to reset, renew it, first rectifying the cause of any overload.



3.1a Fuse board at the right-hand end of the facia



3.1b ABS fuse mounted on the transient surge protector

3 To check for a blown fuse, either remove the fuse and inspect its wire link, or (with the power on) connect a 12-volt test light between earth and each of the fuse pegs. If the test light comes on at both pegs, the fuse is OK; if it comes on at one peg only, the fuse is blown.

4 To renew a blown fuse, pull out the old fuse either with the fingers or with the special tool provided. Press in a new fuse of the correct rating (indicated by colour and by a number on the fuse). Spare fuses are provided at each side of the central electrical unit or, on later 760 models, in a drawer at the base of the fuse board.

5 Never fit a fuse of a higher rating than that specified, nor bypass a blown fuse with wire or metal foil. Serious damage or fire could result.

6 Persistent blowing of a particular fuse indicates a fault in the circuit(s) protected. Where more than one circuit is involved, switch on one item at a time until the fuse blows, so showing in which circuit the fault lies.

7 Besides a fault in the electrical component concerned, a blown fuse can also be caused by a short-circuit in the wiring to the component. Look for trapped or frayed wires allowing a live wire to touch vehicle metal, and for loose or damaged connectors.

Relays - general

8 A relay is an electrically-operated switch, which is used for the following reasons:

a) A relay can switch a heavy current remotely from the circuit in which the current is flowing, allowing the use of lighter gauge wiring and switch contacts.

b) A relay can receive more than one control input, unlike a mechanical switch.

c) A relay can have a timer function - for example an intermittent wiper delay.

9 If a circuit which includes a relay develops a fault, remember that the relay itself could be faulty. Testing is by substitution of a known good relay. Do not assume that relays which look similar are necessarily identical for purposes of substitution.

Relays - identification and location

All models except 760 - 1988 onwards

10 Most relays are located on the central electrical unit, in front of the fuses. For access, remove the ashtray and ashtray holder, then release the clips and draw the unit into the vehicle **(see illustrations)**.

11 Additional relays relating to the fuel and ignition systems are located in the engine compartment, and two air conditioning system relays are located behind the facia panel.

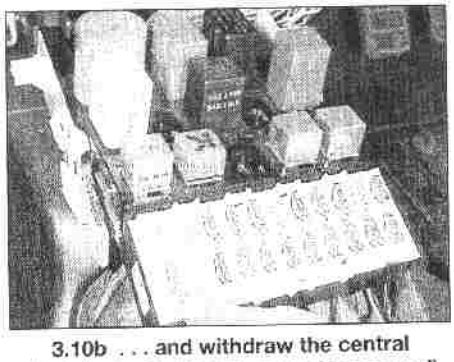
760 models - 1988 onwards

12 From the 1988 model year, the relays may be located on the right-hand side of the centre console. Remove the side trim for access **(see illustration)**.

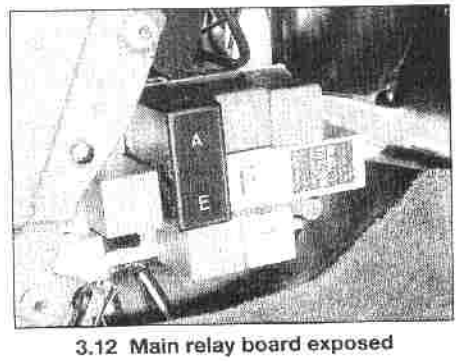
13 Relay identification is as follows:

A Main lighting relay (part)
B Motronic/Jetronic relay
C Central locking relay
D Foglamp relay
E Main lighting relay (part)

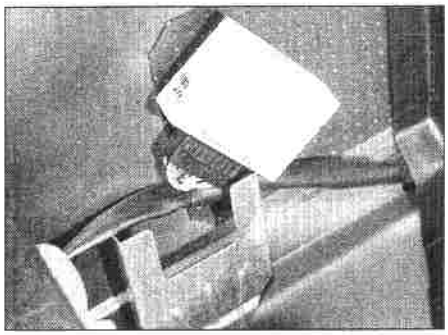
3.10a Release the clips . . .



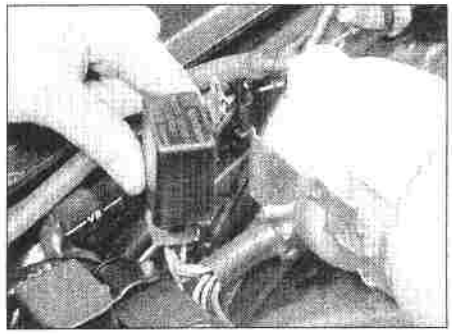
3.10b . . . and withdraw the central electrical unit. (Centre console removed)



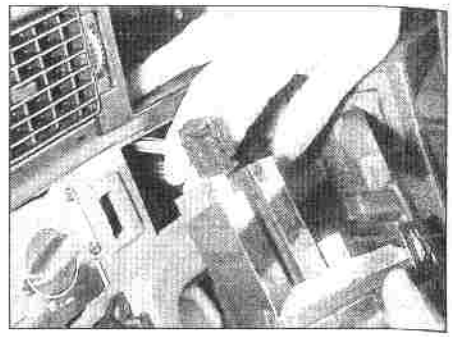
3.12 Main relay board exposed



3.15 The rear bulb failure warning unit



3.16 The electric cooling fan relay



3.19 Removing the heated rear window switch/relay and the hazard warning switch/flasher unit

F Bulb failure warning relay (front)
G Overdrive relay
J Power boost relay
K Rear wiper delay relay
L Windscreen wiper delay relay
M Seat belt warning relay

14 Relays in positions A, B, F, J, L and M are permanently attached to the board. Depending on equipment, not all the relays listed are fitted to all models.

15 Bulb failure warning for the rear lights on 760 models is controlled by a relay mounted behind the trim on the left-hand side of the boot or luggage area **(see illustration)**.

16 The electric cooling fan relay on 760 models is located in the engine compartment, in front of one or other suspension strut housing **(see illustration)**.

17 The heated rear window relay is now incorporated in the heated rear window control switch.

18 The direction indicator/hazard warning flasher unit is incorporated in the hazard warning switch.

19 Access to the switch-incorporated units is by unclipping the switch panel, disconnecting the multi-plugs and unclipping the switch from its location **(see illustration)**.

4 Switches - removal and refitting

Steering column switches

All models except 760 - 1988 onwards

1 Disconnect the battery negative lead.

2 Remove the steering wheel (Chapter 10).

3 Remove the column shrouds, which are secured by two screws each **(see illustration)**.

4 Remove the switch in question. Each switch is secured by two screws. Remove the screws, pull the switch out and disconnect the multi-plug **(see illustrations)**.

5 Refit by reversing the removal operations.

760 models - 1988 onwards

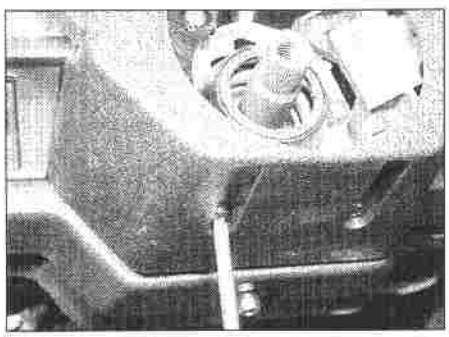
6 Disconnect the battery negative lead.

7 Remove the Allen screw which secures the column adjuster control knob **(see illustration)**. Remove the knob.

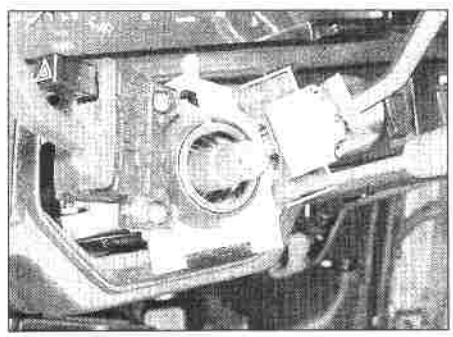
8 Remove the column shrouds, which are secured by six screws.

9 Remove the two screws which secure each switch. Withdraw the switches and disconnect their wiring plugs **(see illustration)**.

10 Refit by reversing the removal operations.

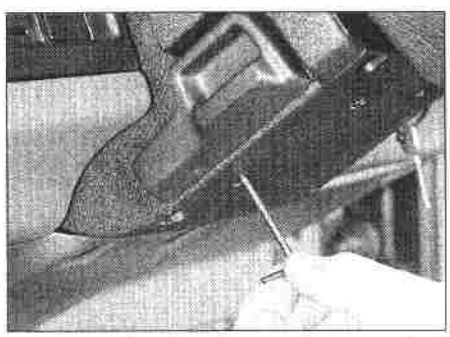


4.3 Removing a column shroud screw

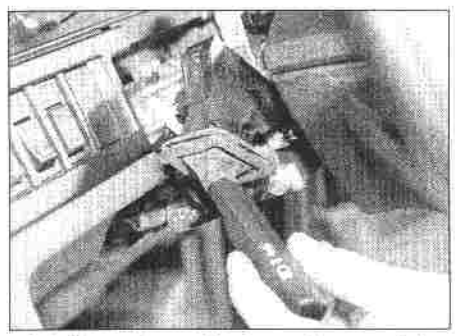


4.4a Removing a column switch screw

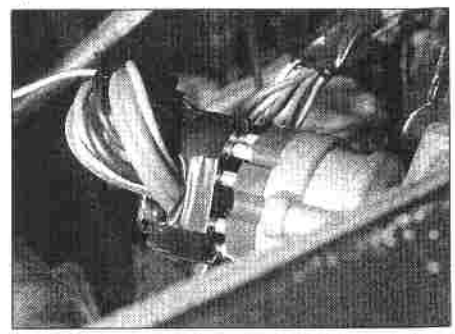
4.4b Disconnecting a column switch multi-plug



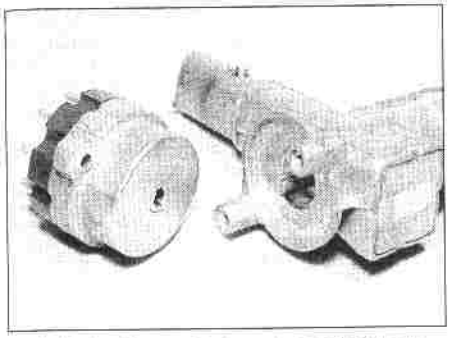
4.7 Removing the column adjuster control knob screw



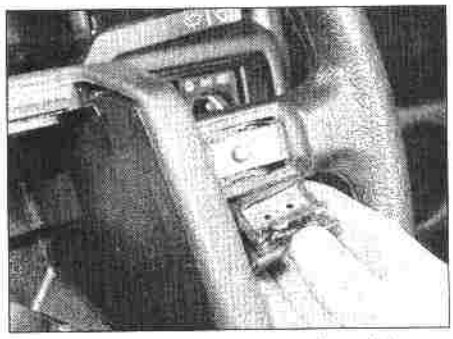
4.9 Removing a steering column switch



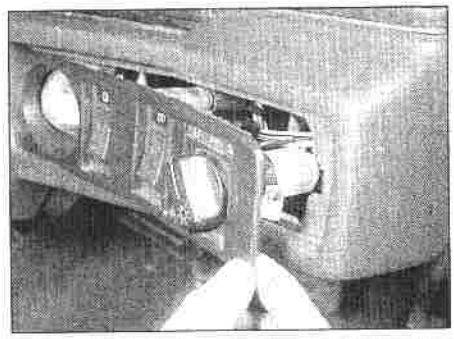
4.13 Disconnecting the ignition switch multi-plug



4.15 Ignition switch and steering lock showing driving hole and spindle



4.16 Removing a horn push switch



4.17 Unclipping a switch panel from the facia

Ignition/starter switch

11 Disconnect the battery negative lead.
12 Remove the trim panel from below the steering column.
13 Disconnect the multi-plug from the switch **(see illustration)**.
14 Remove the two screws which secure the switch to the steering lock. Withdraw the switch.
15 Refit by reversing the removal operations. Note that the hole in the centre of the switch is shaped so that it will only engage with the driving spindle in one position **(see illustration)**.

Horn push switches

16 These are removed by prising them out of the steering wheel. They are difficult to remove without damage **(see illustration)**.

Facia panel switches

17 Unclip the switch panel (and its surround, if applicable) and withdraw it from the facia **(see illustration)**.
18 Disconnect the switch multi-plugs, making identifying marks or notes if necessary **(see illustration)**.
19 Remove the switch concerned by depressing its retaining lugs **(see illustration)**.
20 Refit by reversing the removal operations.

Rear console switches

21 See Chapter 11, Section 34.

Window/mirror control switches

22 Remove the door armrest and separate the switch panel from it. See Chapter 11, Section 11.
23 Disconnect the multi-plug from the switch in question **(see illustration)**.
24 Carefully prise free the retaining lugs and remove the switch from the underside of the switch plate.
25 Refit by reversing the removal operations.

Door/tailgate switches

26 Open the door or tailgate. Remove the securing screw and withdraw the switch **(see illustration)**.
27 Secure the wires with a clothes peg before disconnecting them so that they are not lost in the door pillar.
28 Refit by reversing the removal operations.

Brake stop-light switch

29 Remove the steering column/pedal trim.
30 Disconnect the wiring from the switch. Undo the locknut and unscrew the switch.
31 When refitting, screw the switch in so that it operates after 8 to 14 mm movement of the brake pedal. Reconnect the wires and tighten the locknut.
32 Check for correct operation, then refit the disturbed trim.

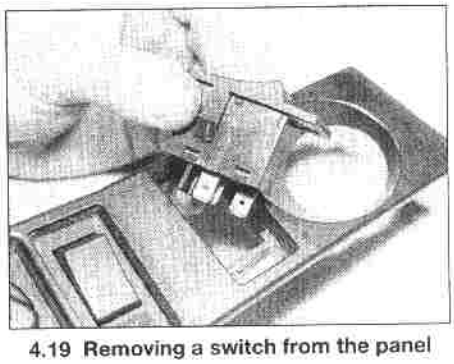
Handbrake warning switch

33 Remove the rear console (Chapter 11, Section 34).
34 Remove the switch securing screw **(see illustration)**. Lift out the switch, disconnect the lead from it and remove it.
35 Refit by reversing the removal operations. Check for correct operation of the switch before refitting the rear console.

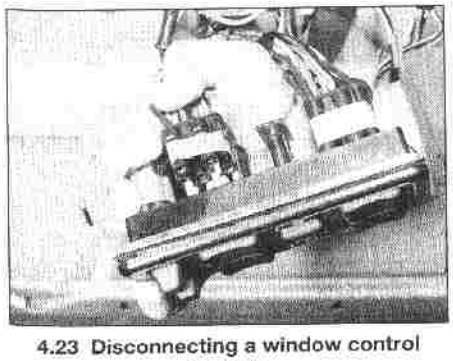
Other switches

36 Some switches will be found in the Chapter dealing with their system or equipment - for example, temperature-operated switches in Chapter 3, and transmission-operated switches in Chapter 7.

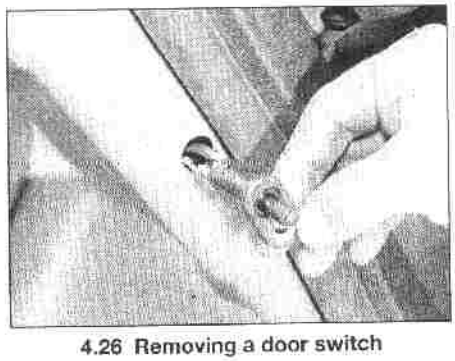
4.18 Disconnecting a switch multi-plug



4.19 Removing a switch from the panel

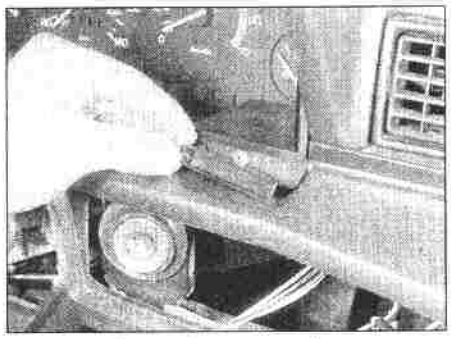


4.23 Disconnecting a window control switch

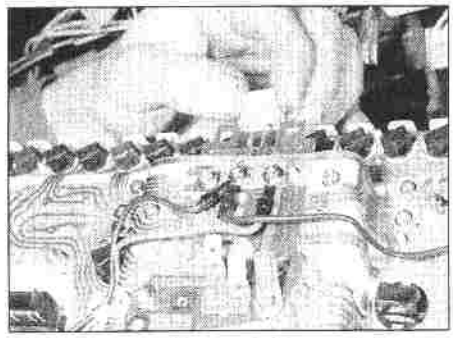


4.26 Removing a door switch

4.34 Handbrake warning switch - securing screw arrowed



5.2 Exposing an instrument cluster screw



5.4 Disconnecting an instrument cluster multi-plug

5 Instrument cluster - removal and refitting

Removal

All models except 760 - 1988 onwards

1 Disconnect the battery negative lead.
2 Remove the two screws at the bottom corners of the instrument cluster. These may be concealed by plastic covers, which will have to be pulled off first **(see illustration)**.
3 Pull the cluster towards the steering wheel. (If difficulty is experienced, remove the steering column/pedal lower trim to gain access to the rear of the panel.)
4 Disconnect the multi-plugs and (when applicable) the boost gauge pipe from the rear of the cluster **(see illustration)**.
5 Lift out the cluster. Do not drop or jar it.

760 models, 1988 onwards

6 Disconnect the battery negative lead.
7 Prise out the bright trim strip to the right of the cluster.
8 Remove the screw which secures the left-hand bright trim strip. This screw is accessible from inside the glovebox **(see illustration)**. Prise out the trim strip.
9 Unclip the switch panels, disconnect the multi-plugs and remove the panels. (The main lighting switch can be left in position.)
10 Remove the air direction grilles by turning them upwards as far as possible, then unclipping them from their pivots using firm hand pressure.
11 Remove the seven screws which secure the cluster surround. These are located as follows: one in each air grille housing, two (under covers) below the air grille housings, and two (under covers) on the underside of the instrument hood **(see illustrations)**. Remove the surround.
12 Remove the four screws, one in each corner, which secure the instrument cluster itself. Carefully draw the cluster out of its recess and disconnect the multi-plugs from it **(see illustration)**. Remove the cluster.

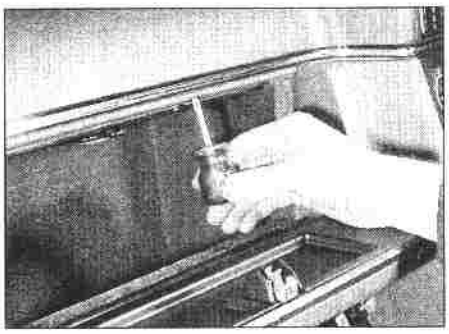
Refitting

13 Refit by reversing the removal operations.

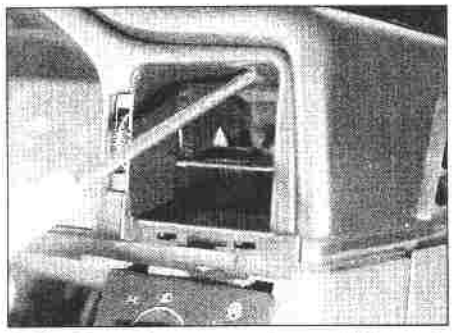
6 Instrument cluster - dismantling and reassembly

Dismantling

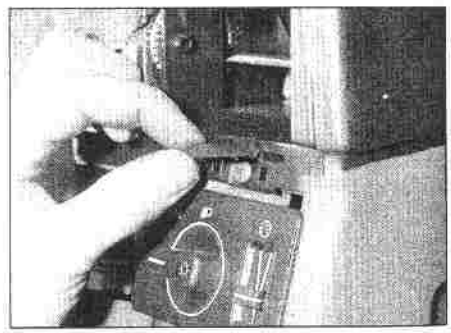
1 Remove the screws which secure the instrument cluster to the transparent panel and surround. Carefully remove the cluster.
2 Individual instruments can now be removed after undoing their securing nuts or screws **(see illustration)**. Note that the screws are not identical: those which secure conductors are plated.
3 Bulb holders are removed by twisting them 90° and pulling. Some bulbs can be separated from their holders for renewal; others must be renewed complete with holder **(see illustrations)**.
4 The printed circuit can be renewed after removing all the instruments, bulbs and connectors. Be careful when handling the printed circuit, it is fragile.



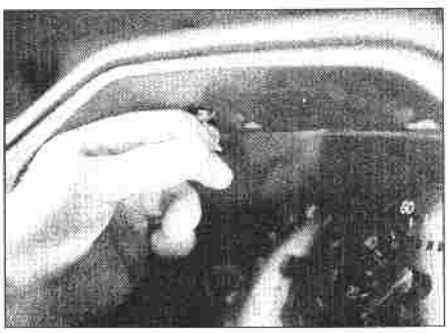
5.8 Removing the trim strip screw



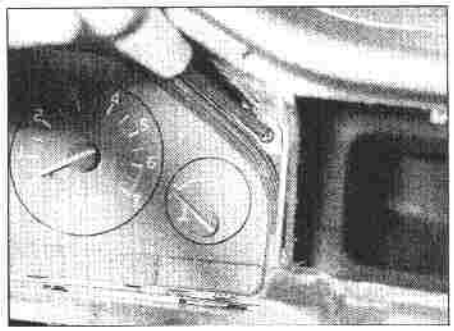
5.11a Removing a screw from within an air grille housing



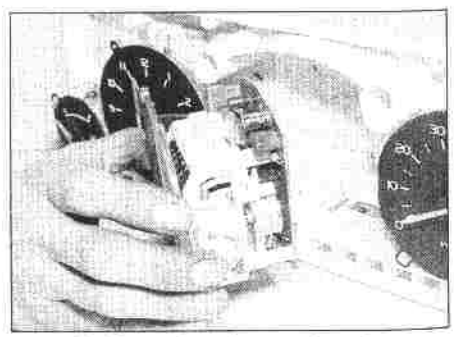
5.11b Removing a screw cover below an air grille housing



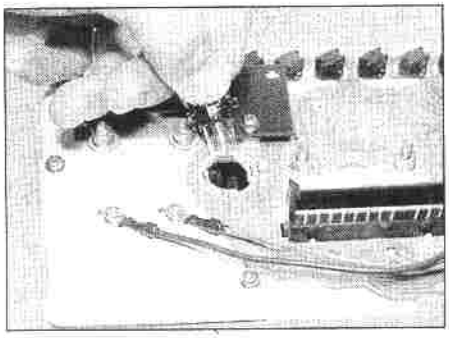
5.11c Removing an instrument hood screw cover



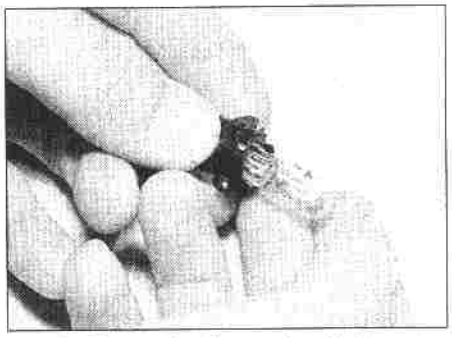
5.12 Removing an instrument cluster screw



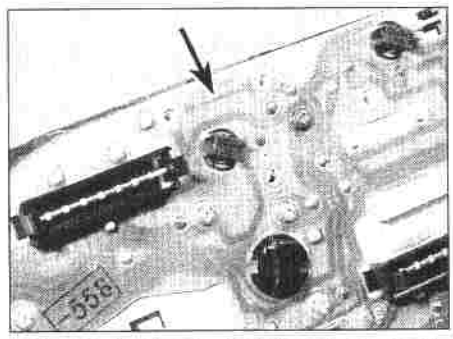
6.2 Removing the speedometer



6.3a Removing a bulb and holder from the printed circuit



6.3b Separating the capless bulb and holder



6.5 Fusible link (arrowed) in the printed circuit

5 Some makes of instrument cluster incorporate a fusible link in the printed circuit **(see illustration)**. If this link blows, a repair strip or portion of circuit card should be obtained and secured in the same position. The fault which caused the original link to blow must also be rectified.

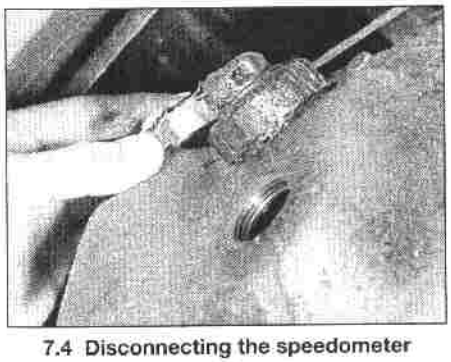
Reassembly

6 Reassembly is the reversal of the dismantling sequence.

7 Speedometer sender unit - removal and refitting

Removal

1 Raise the rear of the vehicle on ramps.



7.4 Disconnecting the speedometer sender

2 Although not essential, it will improve access if the rear axle oil filler plug and the Panhard rod are removed. See Chapter 10.

3 If there is a sealing wire on the sender connector, cut the wire and remove it.

4 Unplug the sender connector **(see illustration)**.

5 Unscrew the ring nut (or Allen screw) which secures the sender, using a self-locking wrench. This nut may be very tight: be careful not to crush it or it will be impossible to remove. As a last resort, the axle oil may be drained, the differential cover plate removed complete with the sender unit, and the assembly dealt with on the bench.

6 Remove the sender unit and shim(s).

Refitting

7 Refit by reversing the removal operations. If a new sender unit is being fitted, or if other related components have been disturbed, check the clearance between the sender unit and the toothed wheel as follows.

8 Working through the oil filler hole, introduce feeler blades between the sender unit and the toothed wheel and determine the clearance. On models without ABS, the desired value is 0.85 mm ± 0.35 mm. On models with ABS, the desired value is 0.60 mm with a tolerance range of 0.35 to 0.75 mm. Adjust by adding or removing shims between the sender unit and the differential cover.

9 Refit the oil filler plug and reconnect the sender unit connector. Check the sender for correct operation before fitting a new seal.

8 Bulbs (exterior lights) - renewal

General

1 With all light bulbs, remember that if they have just been in use, they may be very hot. Switch off the power before renewing a bulb.

2 With quartz halogen bulbs (headlights and similar applications), do not touch the bulb glass with the fingers. Even small quantities of grease from the fingers will cause blackening and premature failure. If a bulb is accidentally touched, clean it with methylated spirit and a clean rag.

3 Unless otherwise stated, fit the new bulb by reversing the removal operations.

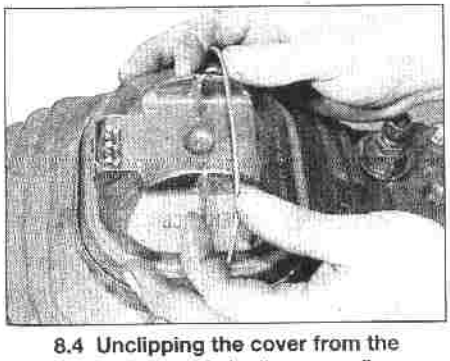
Bulb renewal

Headlight

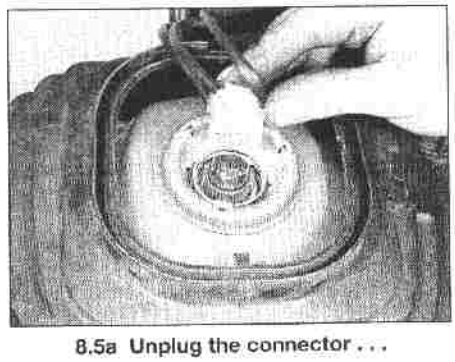
4 Open the bonnet. Unclip the plastic cover from the rear of the headlight unit **(see illustration)**. There is no need to disconnect the multi-plug.

5 Unplug the connector from the bulb. Release the retainer by pushing it and twisting it anti-clockwise. Remove the retainer, spring and bulb **(see illustrations)**.

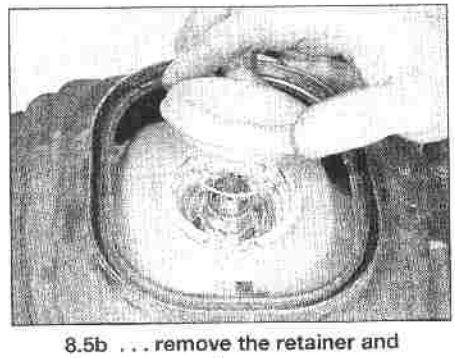
6 When fitting the new bulb, do not touch the glass (paragraph 2). Make sure that the lugs on the bulb flange engage with the slots in the holder.



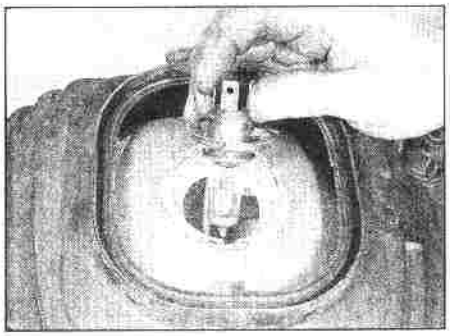
8.4 Unclipping the cover from the headlight unit (unit removed)



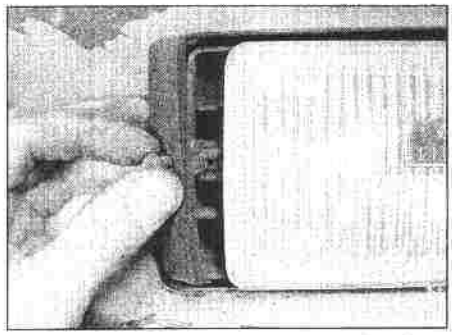
8.5a Unplug the connector . . .



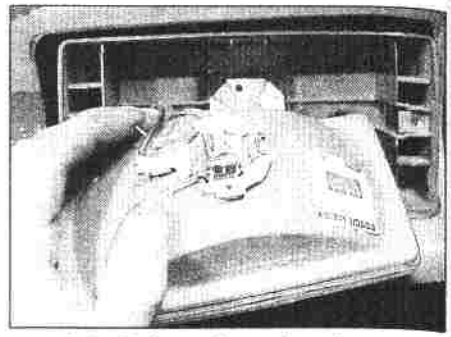
8.5b . . . remove the retainer and spring . . .



8.5c . . . and the bulb. Do not touch the bulb glass



8.8 Auxiliary light lens screw and strip



8.9a Release the spring clip . . .

7 Observe the "OBEN/TOP" marking when refitting the plastic cover.

Auxiliary front light

8 Remove the lens/reflector unit, which is secured by two screws and retaining strips **(see illustration)**.

9 Unplug the bulb wiring connector, release the spring clip and withdraw the bulb **(see illustrations)**.

10 Fit the new bulb, being careful not to touch it with the fingers (paragraph 2). Reconnect the wiring.

11 Refit the lens/reflector unit, observing the "TOP" marking.

Front direction indicator/day running/parking lights

12 Open the bonnet. Turn the appropriate bulb holder anti-clockwise (without disconnecting it) and withdraw it **(see illustration)**.

13 Remove the bulb from the holder **(see illustration)**.

14 When fitting the combined day running/parking light bulb, note that the pins are offset so it will only fit one way round.

Direction indicator side repeater

15 Slide the lens forwards and free it from the rear. Withdraw the bulb holder from the lens without disconnecting the wiring.

16 When refitting, make sure that the rubber seal is seated in the hole.

Rear light cluster (Saloon models)

17 Open the boot. Undo the knurled screw on the light unit cover and pivot the cover downwards.

18 Remove the appropriate bulb holder from the unit by twisting the holder anti-clockwise and pulling it **(see illustration)**.

19 Remove the bayonet fitting bulb from the holder **(see illustration)**.

Rear light cluster (Estate models)

20 Open the tailgate. Unclip the light unit cover **(see illustration)**, then proceed as for Saloon models.

High level stop light

21 Remove the brake light cover. On Estates it simply pulls off; on Saloons the catch at the base of the cover must be depressed with a screwdriver **(see illustration)**.

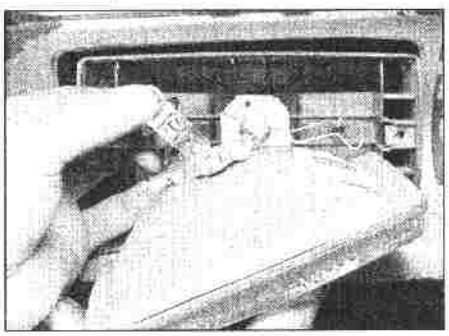
22 Squeeze the catches on each side of the reflector/bulbholder and withdraw it **(see illustration)**.

23 Remove the old bulb and fit a new one.

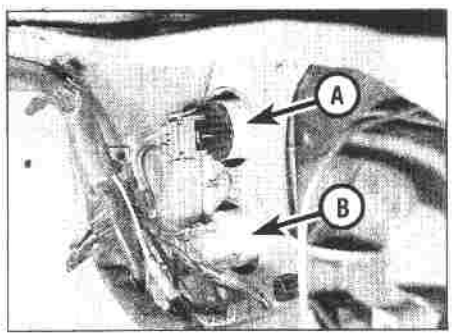
24 Fit the reflector and press it home until the catches engage. Check for correct operation, then refit the cover.

Number plate light

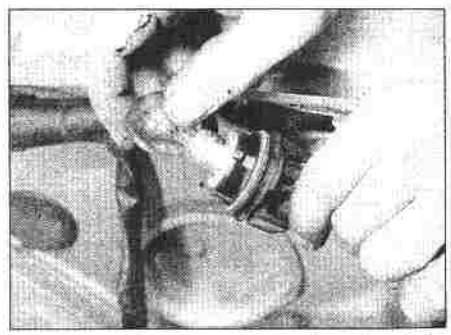
25 Unclip the light unit by sliding it rearwards.



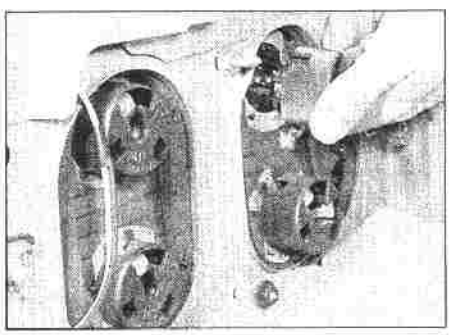
8.9b . . . and withdraw the bulb



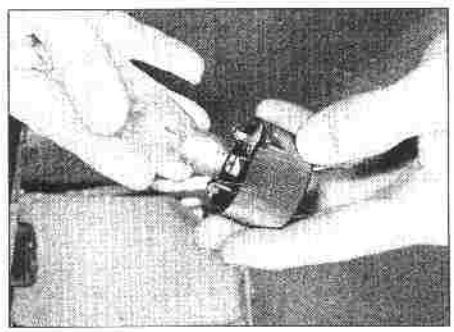
8.12 Front light bulb holders - day running light (A) and direction indicator (B)



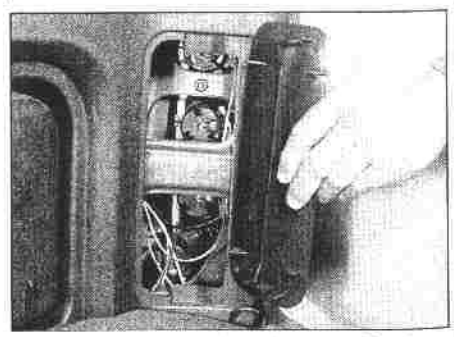
8.13 Removing a day running/parking light bulb



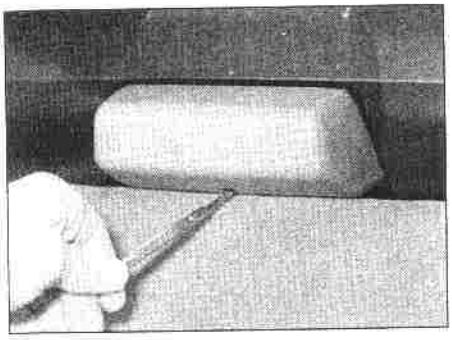
8.18 Remove the bulb and holder from the rear light cluster . . .



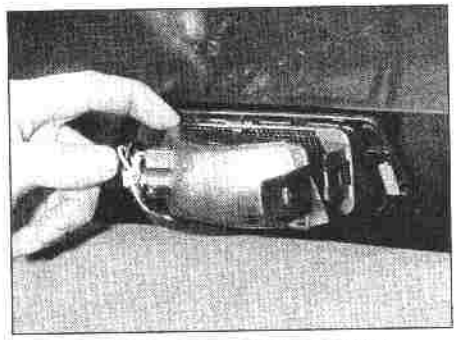
8.19 . . . then separate the two



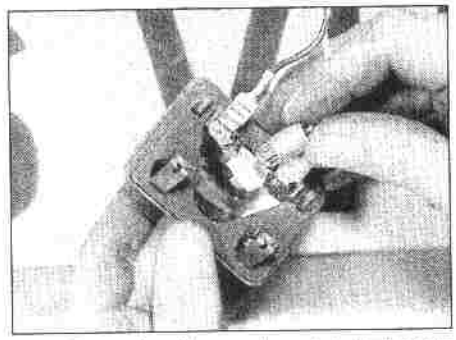
8.20 Rear light unit and cover - Estate



8.21 Releasing the brake light cover - Saloon



8.22 Removing the brake light reflector/bulbholder



8.26 Removing the number plate light bulb

26 Release the bulb by sliding the live contact off its tail. The bulb can then be removed upwards **(see illustration)**.

9 Bulbs (interior lights) - renewal

General

1 See Section 8, paragraphs 1 and 3.

2 Some switch illumination/pilot bulbs are integral with their switches and cannot be renewed separately.

Bulb renewal

Courtesy/load area lights

3 Pull or prise the light unit from its mountings.

4 Renew the bulb(s), which may be bayonet or end clip fitting **(see illustration)**.

Glovebox lights

5 Unclip the combined bulb holder/switch unit from the top of the glovebox for access to the bulb **(see illustration)**.

6 When vanity mirror bulbs are fitted, these are accessible after prising out the light diffuser strip **(see illustration)**.

Door edge marker lights

7 Prise off the lens for access to the bulb. The bulb is of the capless type, so it is a push fit **(see illustration)**.

Automatic transmission selector light

8 Remove the selector quadrant as if for access to the starter inhibitor switch (Chapter 7B, Section 6). The bulb and holder can then be pulled out **(see illustration)**.

Seat belt buckle light

9 Unclip the bulb holder from the buckle for access to the bulb.

Switch illumination bulbs

10 When these are separable from the switch, they simply pull out **(see illustration)**.

Instrument panel bulbs

11 See Sections 5 and 6. (The reader with small hands and deft fingers may manage to renew bulbs *in situ* after removing the steering column/pedal trim.)

Under-bonnet light

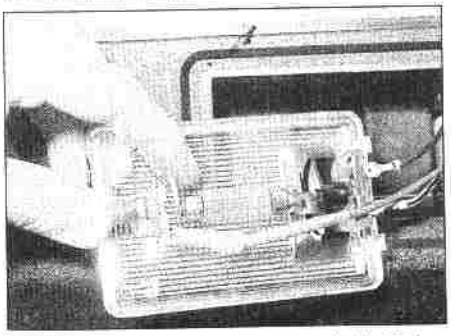
12 Prise off the lens with a screwdriver. The bulb is of the end clip fitting type **(see illustration)**.

Cigarette lighter/ashtray light

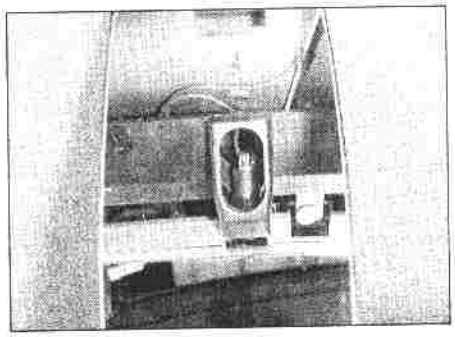
13 See Section 19.

Vanity mirror light (760 models)

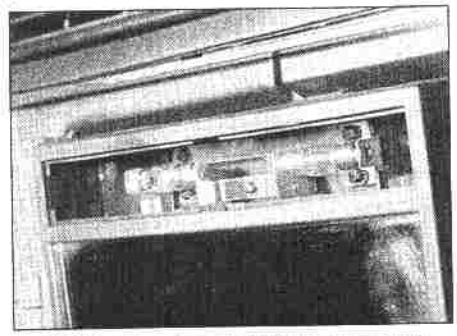
14 Move the light switch to the left ("off" position).



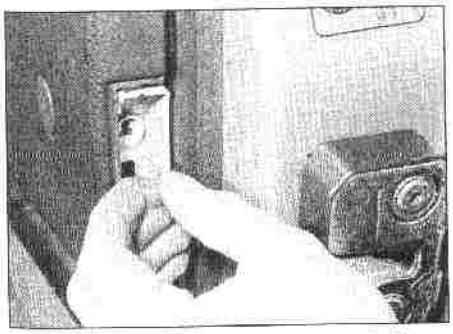
9.4 A load area light with an end clip fitting bulb



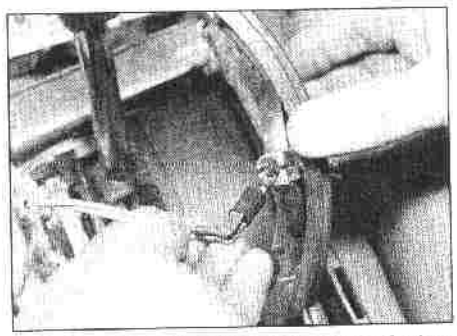
9.5 Glovebox light and switch (seen in a mirror)



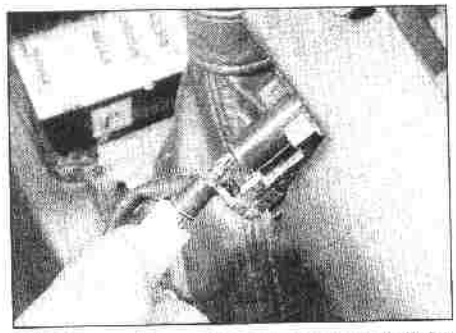
9.6 Vanity mirror light bulbs exposed



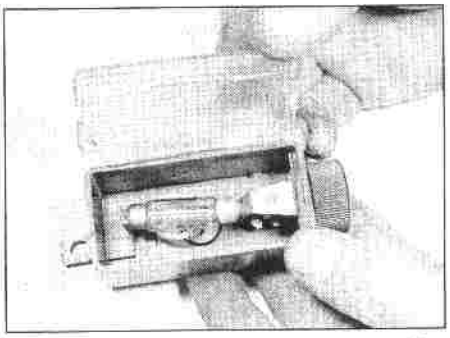
9.7 Fitting a door edge marker bulb



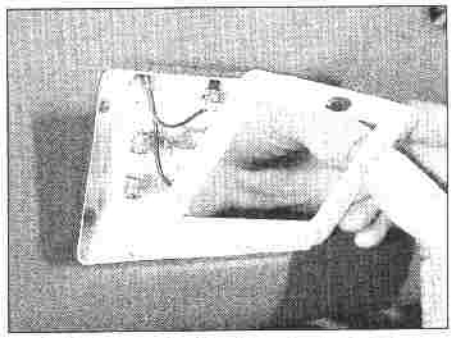
9.8 Extracting the automatic transmission selector light



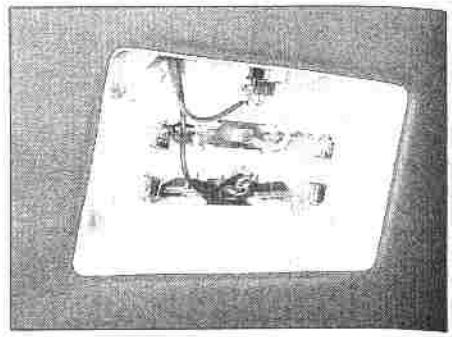
9.10 Removing a rear console switch light



9.12 Under-bonnet light unit (removed)



9.16 Removing the illuminated vanity mirror



9.17 Vanity mirror light bulbs exposed

15 Lever the mirror surround away from the sun visor, starting on the right-hand side and working anti-clockwise. It will be necessary to hold the surround away from the sun visor to stop it slipping back into place. When levering at the top of the surround, do so at least 10 mm below the top edge.

16 When the two clips at the top have been released, pivot the mirror and surround downwards and lift it out **(see illustration)**.

17 Renew the light bulbs as required **(see illustration)**.

18 Engage the mirror surround bottom lugs. Press firmly on the top edge of the surround (not on the mirror itself) to engage the clips.

10 Exterior light units - removal and refitting

Note: *Ensure that all lights are switched off before disconnecting any wiring connectors.*

Headlight unit

All models except 760, - 1988 onwards

1 Remove the front grille and the headlight wiper arm.

2 Disconnect the multi-plugs from the headlight and from the day running light/direction indicator light unit **(see illustration)**. Remove the latter unit, which is secured by one nut.

3 Remove the four nuts which secure the headlight unit. Disconnect the washer tube from the wiper arm, if not already done, and remove the headlight unit.

4 The lens and seal may now be renewed after removing the trim strip and the retaining clips **(see illustrations)**.

5 Refit by reversing the removal operations. Remember to feed the washer tube through the trim strip.

6 Have the beam alignment checked on completion **(see illustration)**.

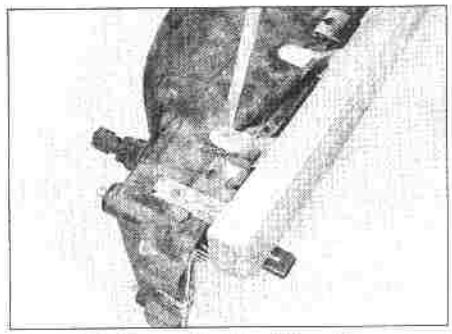
760 models - 1988 onwards

7 Remove the front grille. On the left-hand side also remove the air cleaner.

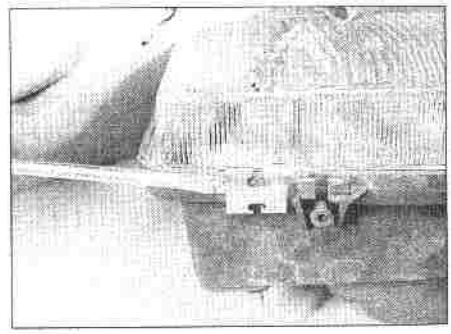
8 Remove the bulbholders, with bulbs, from the direction indicator/parking light unit. Push and twist the holders to release them **(see illustration)**.

9 Unclip the direction indicator/parking light unit and remove it **(see illustration)**.

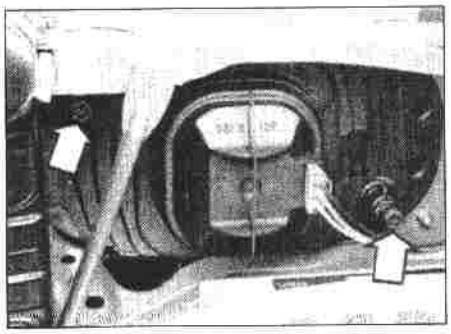
10.2 Disconnecting a headlight multi-plug



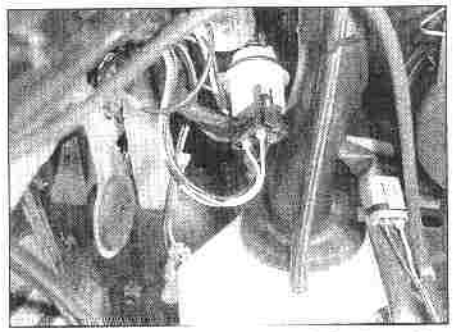
10.4a Removing the trim strip . . .



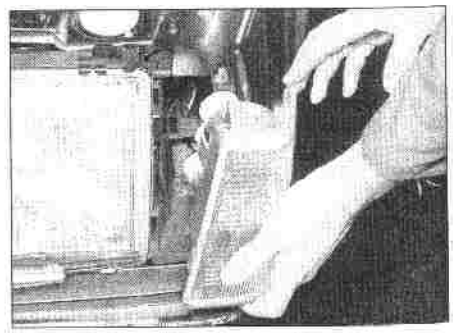
10.4b . . . and a retaining clip



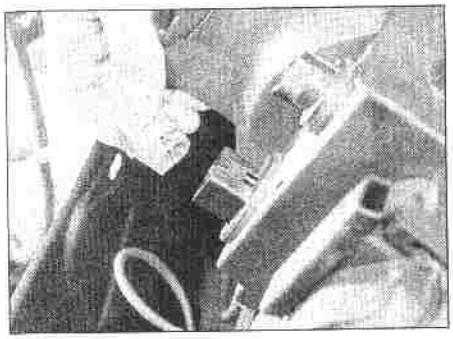
10.6 Headlight beam alignment screws (arrowed)



10.8 Removing a bulb and holder from the direction indicator/parking light unit

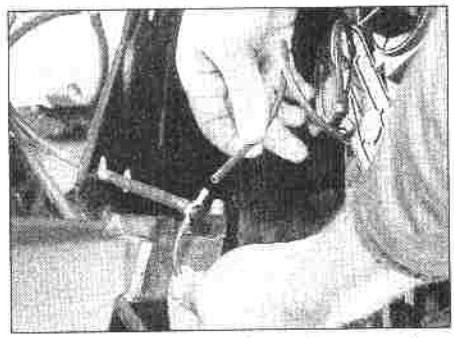


10.9 Removing the direction indicator/parking light unit



10.10 Headlight/auxiliary front light connector

10.11a Headlight wiper motor connector



10.11b Headlight washer tube connector

10 Unplug the headlight and auxiliary front light connector **(see illustration)**.

11 Unplug the headlight wiper motor connector and disconnect the headlight washer tube connector **(see illustrations)**.

12 Remove the four screws, two on each side, which secure the headlight unit. Note that the screws on the grille side also secure a baffle plate; on the left-hand side they also secure the air cleaner air inlet **(see illustrations)**.

13 Remove the headlight unit complete with wiper motor, arm and blade.

14 To dismantle the unit, remove the two screws which secure the headlight wiper motor. Unclip the front trim strip and remove the wiper motor complete with arm, blade and trim strip **(see illustrations)**.

15 Remove the four wiper blade stops, which are secured by one screw each **(see illustration)**.

16 Remove the eight clips which secure the lens to the reflector.

17 Remove the lens and extract the seal.

18 Remove the bulb covers from the rear of the unit. Disconnect and remove the bulbs, being careful not to touch the glass with the fingers.

19 Renew components as necessary and reassemble by reversing the dismantling procedure. Pay particular attention to the condition and fit of the lens-to-reflector seal.

20 Refit the unit to the car by reversing the removal operations. Note that the securing screws allow the headlight unit to be moved to align it relative to the body, then bumper and the other headlight; do not tighten the screws until satisfied with the position of the unit. If the headlight is fitted too high, the bonnet will strike it.

21 Have the headlight beam alignment checked on completion. The adjustment screws are on top of the unit **(see illustration)**.

Auxiliary front light

22 Follow the wiring back from the light unit and unplug the connector.

23 Remove the nut which secures the light unit to the bracket, or unbolt the bracket complete with the light unit, as wished **(see illustration)**.

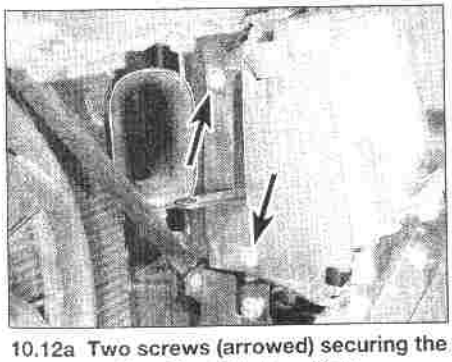
24 Refit by reversing the removal operations.

Direction indicator/day running light unit

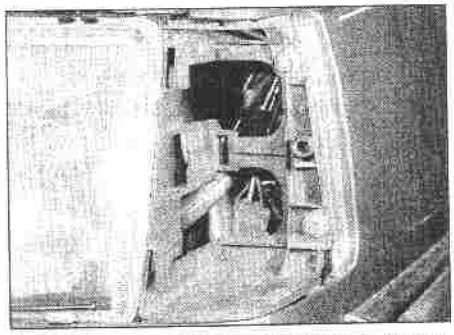
25 Open the bonnet. Disconnect the two multi-plugs from the bulb holders on the rear of the unit.

26 Remove the single securing nut from the rear of the light unit. Free it from the lugs on the side of the headlight and withdraw it **(see illustration)**.

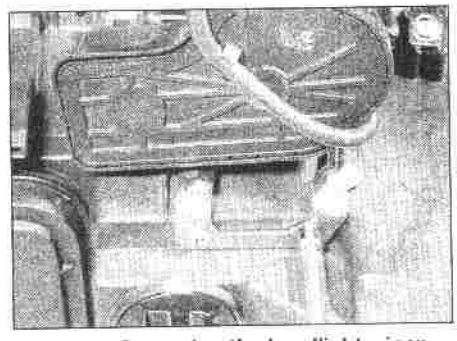
27 Refit by reversing the removal operations.



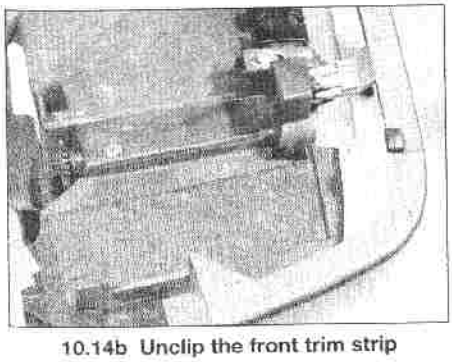
10.12a Two screws (arrowed) securing the grille side of the headlight



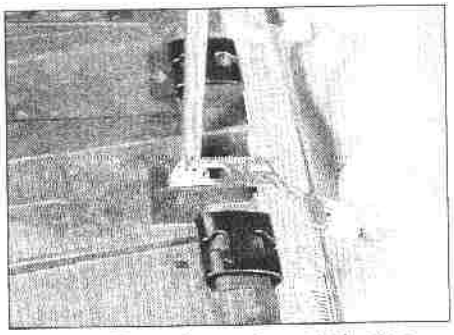
10.12b Two screws securing the indicator side of the headlight



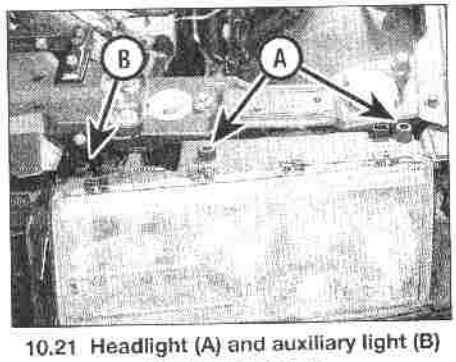
10.14a Removing the headlight wiper motor screws



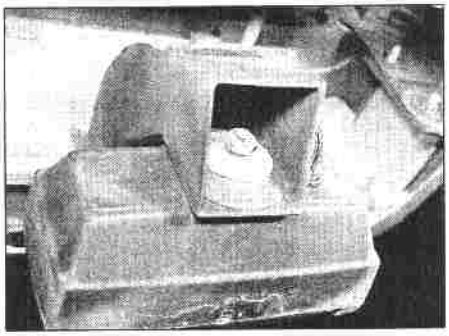
10.14b Unclip the front trim strip



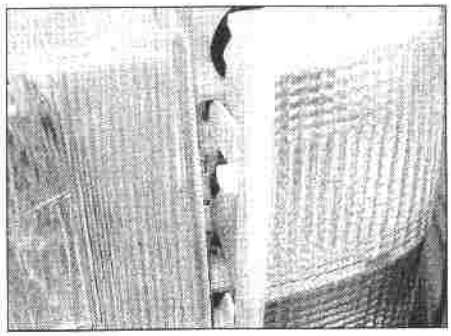
10.15 Removing a wiper blade stop



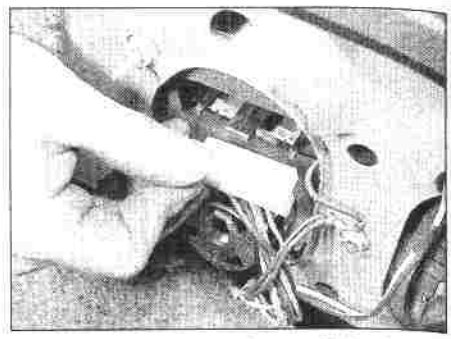
10.21 Headlight (A) and auxiliary light (B) alignment screws



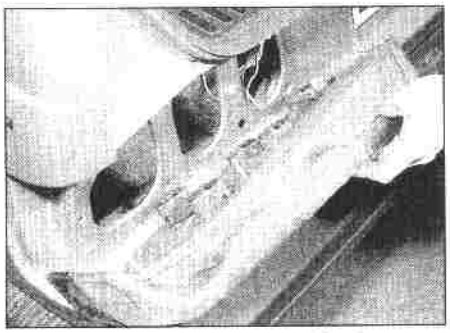
10.23 Auxiliary light showing securing nut



10.26 Disengaging the front light unit from the headlight



10.29 Disconnecting the rear light cluster multi-plug



10.31 Removing the rear light cluster

Rear light cluster (Saloon models)

28 Proceed as for light bulb renewal, but remove the hinged cover completely. It is secured by two nuts.

29 Disconnect the cluster multi-plug **(see illustration)**.

30 Remove the five flanged nuts and the single screw which secure the unit. Note that the screw also secures earth tags.

31 Remove the cluster from the vehicle **(see illustration)**.

32 Refit by reversing the removal operations.

Rear light cluster (Estate models)

33 Proceed as described for Saloon models, making allowances for the detail differences which will be found.

11 Headlight beam alignment - checking and adjusting

Beam alignment should be carried out by a Volvo dealer or other specialist having the necessary optical alignment equipment.

In an emergency, adjustment may be carried out on a trial and error basis, using the two adjustment screws on the rear, or on the top, of each headlight unit.

12 Bulb failure warning system - general information

1 The bulb failure warning sensor is a special kind of relay. It is mounted on the central electrical unit.

2 The sensor contains a number of reed switches surrounded by coils of wire. Current to each bulb covered by the system travels through one coil. The coils are arranged in pairs, one pair carrying the current for one pair of bulbs.

3 When both bulbs of a pair are lit, the magnetic fields produced by the two coils cancel each other out. If one bulb fails, the coil remaining in circuit will produce an uncancelled magnetic field. The magnetic field operates the reed switch, which illuminates the warning light.

4 From the above it will be realised that no warning will be given if a pair of bulbs fails simultaneously. False alarms may result if bulbs of different wattage, or even of different make, are fitted.

5 Wiring for trailer lighting must be connected upstream of the bulb failure warning sensor, otherwise it may be damaged by excessive current flow. Consult a Volvo dealer or an auto-electrician.

13 Horn - removal and refitting

Removal

1 Raise the front of the vehicle on ramps.

2 Working under the front bumper, disconnect the wires from the horn **(see illustration)**.

3 Unbolt the horn from its bracket and remove it.

Refitting

4 Refit by reversing the removal operations.

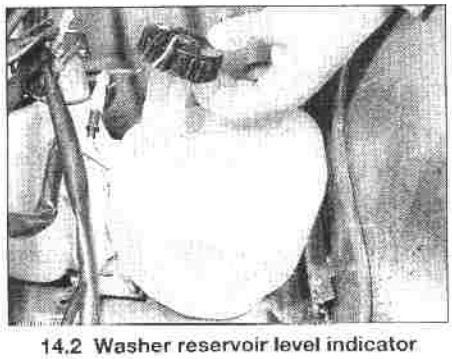
14 Windscreen/headlight/tailgate washers - general information

1 The washer systems share a common reservoir, located under the bonnet. For access to the pump(s) and level indicator it will be necessary to remove the air cleaner unit.

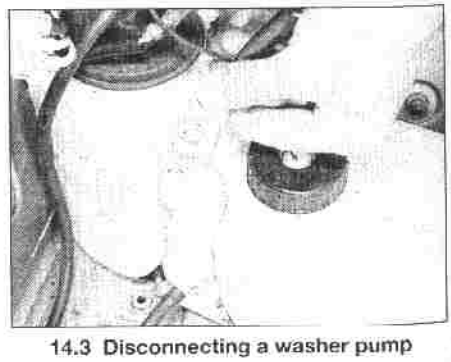
2 The level indicator is a float-operated switch which can be removed after unscrewing its retaining ring **(see illustration)**.

3 To remove a washer pump, unplug its electrical connector, disconnect the hose from it and pull the pump out of its locating spigot **(see illustration)**. Be prepared for fluid spillage.

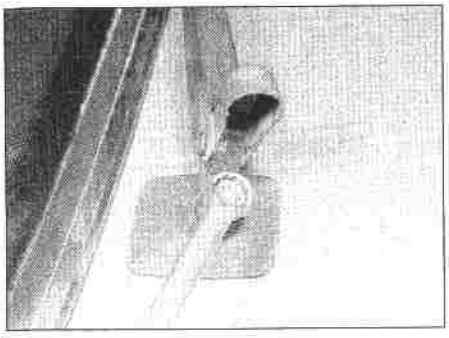
13.2 Horn wiring connectors (arrowed)



14.2 Washer reservoir level indicator



14.3 Disconnecting a washer pump



15.2 Removing a wiper arm nut

4 If a pump malfunctions it must be renewed.
5 Only use clean water, and an approved screen wash additive if wished, in the washer reservoir. Use an additive with antifreeze properties (not engine antifreeze) in freezing conditions.

15 Wiper arms - removal and refitting

Removal

1 Remove the wiper blades as described in "*Weekly checks*".
2 Remove the nut at the base of the wiper arm and pull the arm off the splines **(see illustration)**.

Refitting

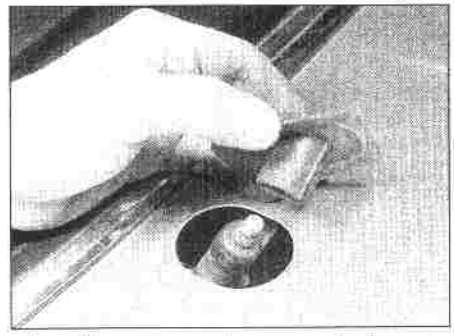
3 Refit by reversing the removal operations. In the case of the headlight wiper blades, note that the longer end goes towards the grille.
4 Bias the headlight wiper arms by refitting them with the blades just below the stops (motors parked). Secure the arms, then lift the blades over the stops.

16 Windscreen wiper motor and linkage - removal and refitting

Removal

All models except 760 - 1988 onwards

1 Disconnect the battery negative lead.
2 Remove the windscreen wiper arms and spindle seals **(see illustration)**.
3 Raise the bonnet to its fully open position.
4 Remove the scuttle panel, which is secured by three bolts and some clips **(see illustration)**. Close the bonnet.
5 Unclip the heater air inlet cover and disconnect the wiper motor multi-plug **(see illustration)**.
6 Remove the two bolts and lift out the wiper motor, linkage and cover **(see illustration)**.
7 The motor may be removed from the linkage by undoing the spindle nut and the three securing screws **(see illustration)**. Do not attempt to dismantle the motor except out of curiosity; spares are unlikely to be available.

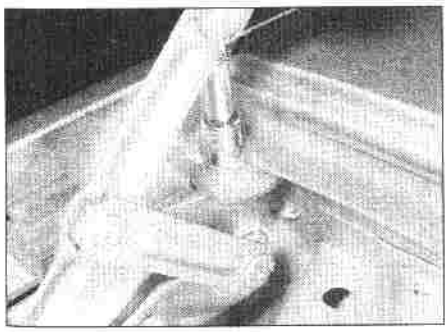


16.2 Removing a wiper arm spindle seal

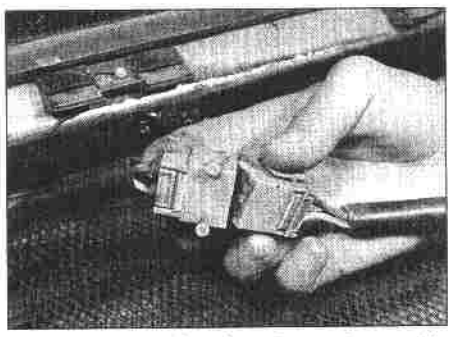
8 Other components of the linkage, including the cable, may be renewed as necessary. There is a tensioning nut at one end of the cable **(see illustration)**.

760 models - 1988 onwards

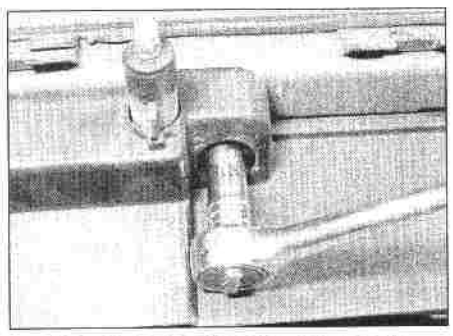
9 Disconnect the battery negative lead.
10 Remove the nuts which secure the wiper arms. Mark the positions of the arms on the screen if necessary, then pull them off their spindles.
11 Remove the six screws from the front of the water shield. Note that the two end screws are longer **(see illustration)**.
12 Release the drain hoses from each end of the water shield.
13 Remove the water shield. Note how the clips on its rear edge engage with the bottom of the windscreen.



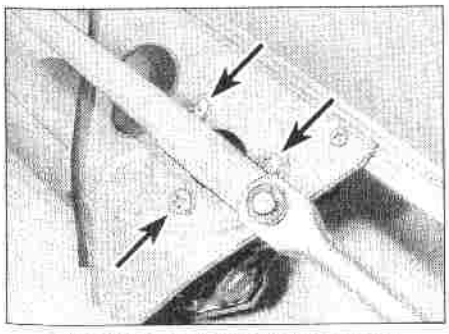
16.4 Removing one of the scuttle panel bolts



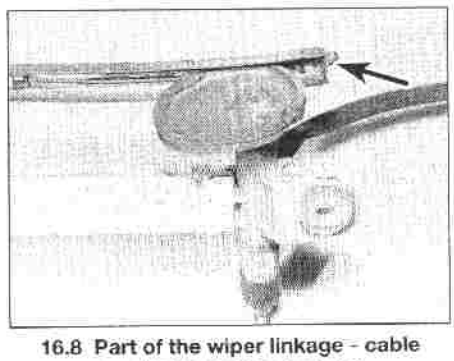
16.5 Disconnecting the wiper motor multi-plug



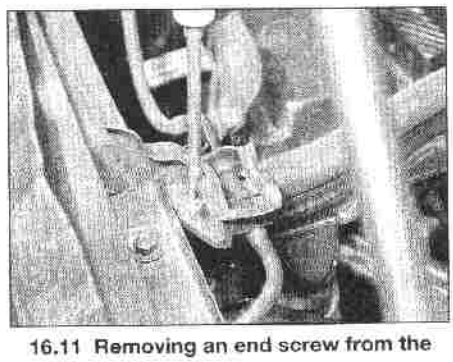
16.6 Unbolting the wiper assembly



16.7 Wiper motor securing screws (arrowed)



16.8 Part of the wiper linkage - cable tensioning nut is arrowed



16.11 Removing an end screw from the wiper water shield

14 Disconnect the wiper motor multi-plug **(see illustration)**.
15 Remove the four bolts which secure the motor and linkage to the bulkhead **(see illustrations)**. Also remove the screw which secures the motor wiring earth tag. Lift out the motor and linkage. Note the position of any spacers.

Refitting

16 On all models, refit by reversing the removal operations. Before refitting the wiper arms, switch the wipers on and off to bring the motor into the parked position.

17 Headlight wiper motor - removal and refitting

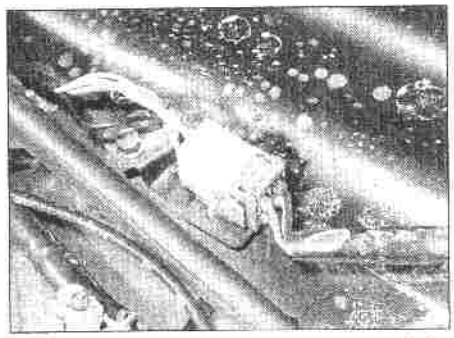
Note: *On 760 models from 1988 onward, the wiper motor is removed complete with the headlight unit then separated after removal. Refer to Section 10.*

Removal

1 Remove the headlight unit on the side concerned (Section 10).
2 Follow the wiper motor wiring back to the multi-plug and disconnect it.
3 Remove the two nuts which secure the motor **(see illustration)**. Withdraw the motor.

Refitting

4 Refit by reversing the removal operations. If there is any doubt that the motor is in the "parked" position, operate the wipers and washers before refitting the wiper arm.



16.14 Wiper motor multi-plug. Bolt to left secures earth tag

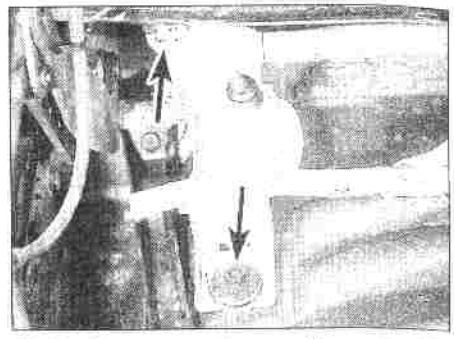
18 Tailgate wiper motor - removal and refitting

Removal

1 Remove the tailgate interior trim (Chapter 11).
2 Prise the link balljoint off the wiper motor crank arm **(see illustration)**.
3 Remove the three bolts which secure the motor. Withdraw the motor (it may be necessary to rotate the crank arm) and disconnect the wiring from it **(see illustration)**.

Refitting

4 Refit by reversing the removal operations. Check the operation of the motor before refitting the trim.



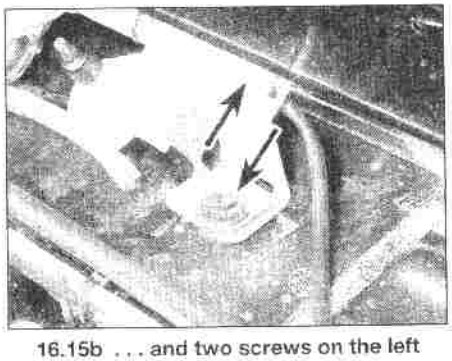
16.15a Two screws (arrowed) securing the right-hand end of the linkage . . .

19 Cigarette lighter - removal and refitting

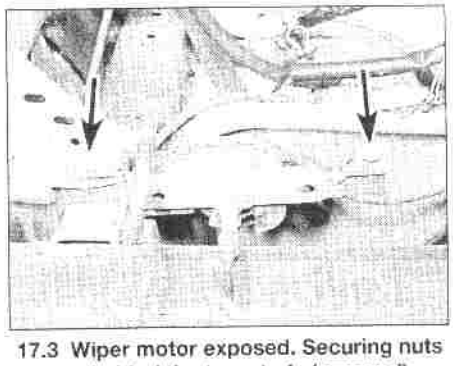
Removal

Front lighter

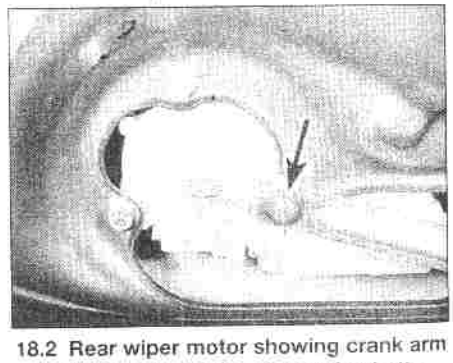
1 Make sure that the ignition is switched off.
2 Remove the lighter element and unclip the trim from around the aperture.
3 Remove the screws now exposed **(see illustration)**.
4 Remove the lighter and tray, disconnecting the wiring feed and bulb holder from the rear **(see illustration)**. Also disconnect any audio equipment which may be occupying the tray.
5 The lighter may now be removed from the tray if wished.



16.15b . . . and two screws on the left

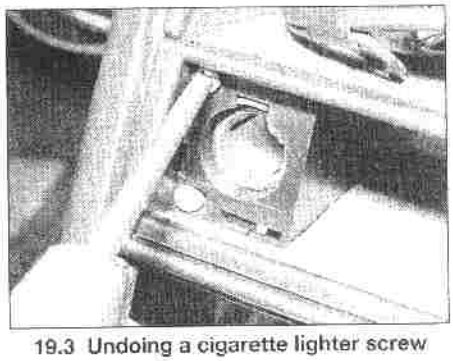


17.3 Wiper motor exposed. Securing nuts are behind the two studs (arrowed)

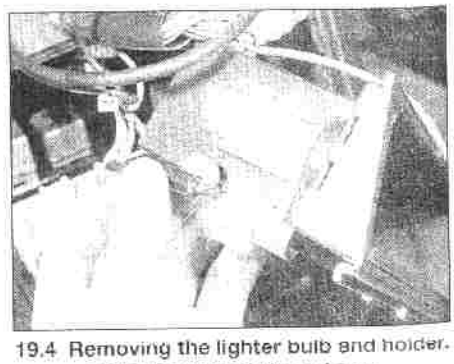


18.2 Rear wiper motor showing crank arm balljoint (arrowed) and securing bolts

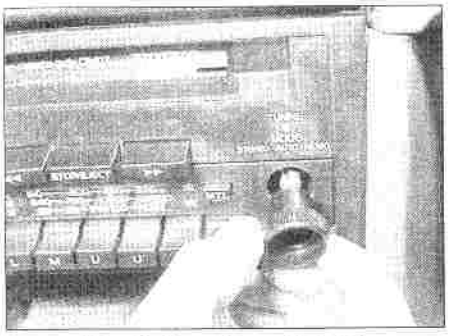
18.3 Removing the rear wiper motor



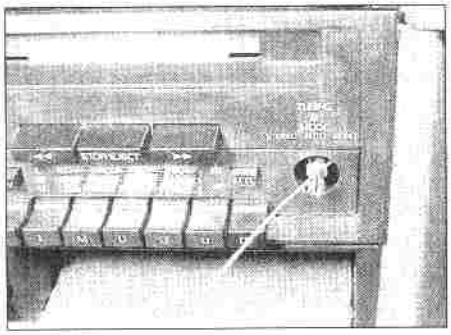
19.3 Undoing a cigarette lighter screw



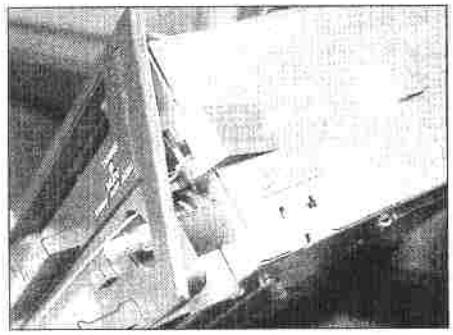
19.4 Removing the lighter bulb and holder. This also serves the ashtray



21.3 Pulling off a radio knob



21.4a Insert a wire hook . . .



21.4b . . . to retract the side clip (unit removed to show clip)

Rear lighter

6 This is covered in removal of the rear console (Chapter 11).

Refitting

7 Refit by reversing the removal operations.

20 Heated rear window - general information

1 All models are equipped with a heated rear window. Heating is achieved by passing current through a resistive grid bonded to the inside of the rear window.

2 Do not allow hard or sharp items of luggage to rub against the heating grid. Use a soft cloth or chamois to clean the inside of the window, working along the lines of the grid.

> **HAYNES HiNT** ***Small breaks in the heated rear window grid can be repaired using special conductive paint, obtainable from motor accessory shops. Use the paint as directed by the manufacturer.***

3 The heated rear window draws a high current, so it should not be left switched on longer than necessary. On some models a so-called "delay relay" is incorporated into the circuit in order to switch the window off after a few minutes.

4 When heated door mirrors are fitted, their heaters are controlled by the heated rear window switch.

21 Radio/cassette player (original equipment) - removal and refitting

Removal

Fixed type unit

1 The radio/cassette player seen in the accompanying illustration is removed as follows.

2 Disconnect the battery negative lead.

3 Pull the control knobs off the front of the instrument **(see illustration)**.

4 Using a hook made of a piece of bent wire, retract the side securing clips, working through the control knob apertures. As the clips are retracted, draw the unit out of its mounting **(see illustrations)**.

5 Withdraw the unit fully and disconnect the wiring.

Detachable type unit

6 On some models a quickly detachable radio is fitted. The unit is removed, as an anti-theft measure or for any other reason, as follows.

7 Make sure that the radio is switched off.

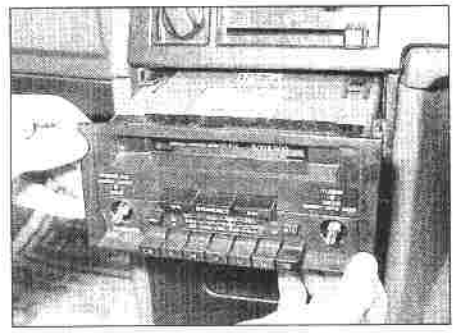
8 Push and release the two securing clips to raise them.

9 Pull the radio from its location by means of the two clips. Disconnect the wiring from the rear of the radio and remove it **(see illustrations)**.

Refitting

10 Reconnect the wiring, then push the unit home until the clips snap into place.

11 On the fixed type unit, refit the control knobs and reconnect the battery.



21.4c Removing the radio/cassette unit

22 Radio aerial (original equipment) - removal and refitting

Note: *Two types of original equipment aerial are shown in the accompanying illustrations. Others may be encountered.*

Removal

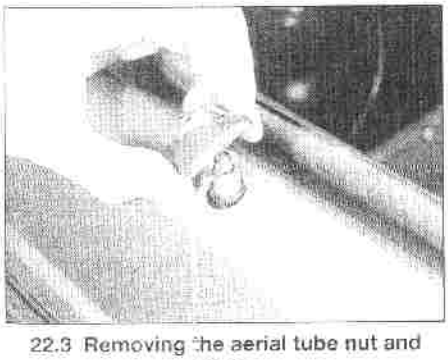
Saloon models (automatic aerial, in boot)

1 Disconnect the battery negative lead.

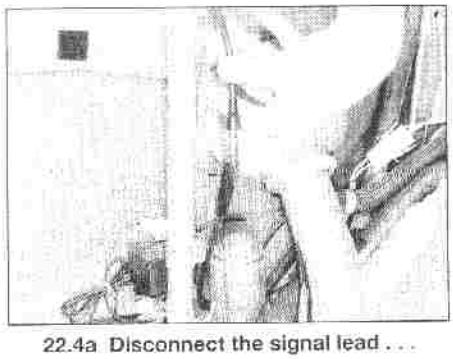
2 Open the boot and remove the left-hand side trim.

3 Remove the nut and cover which secure the aerial tube to the rear wing **(see illustration)**.

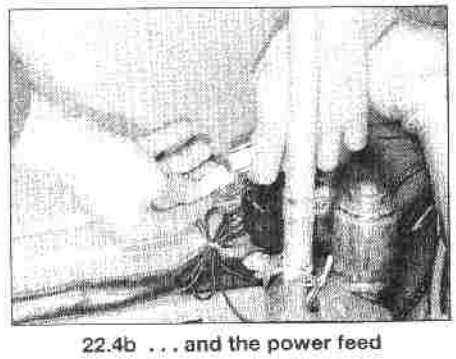
4 Disconnect the aerial signal and power leads **(see illustrations)**.



22.3 Removing the aerial tube nut and cover



22.4a Disconnect the signal lead . . .



22.4b . . . and the power feed

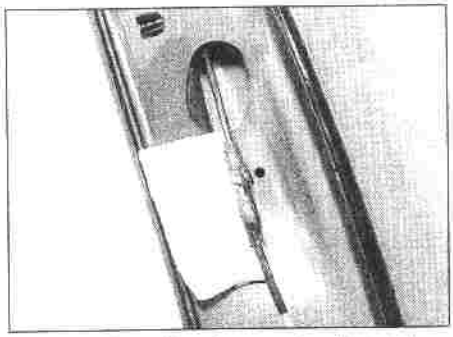
5 Remove the tube and drive securing nuts and bolts. Withdraw the aerial into the boot.

Estate models (fixed aerial, on rear pillar)

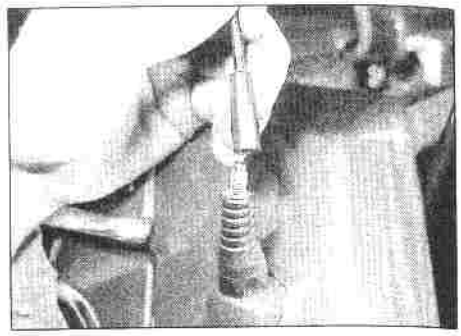
6 Open the tailgate. Unclip the trim panel which covers the aerial mounting and wiring.
7 Disconnect the aerial signal lead **(see illustration)**.
8 Outside the vehicle, unscrew the aerial rod from the stub **(see illustration)**. Recover the spacer.
9 Unscrew the tube securing nut. Recover the lower spacer and seal and withdraw the aerial into the vehicle **(see illustrations)**.

Refitting

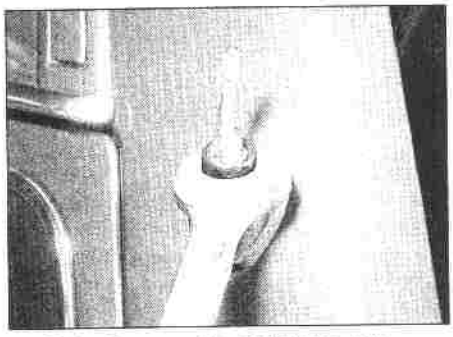
10 On all types, refit by reversing the removal operations, but check for correct operation before refitting disturbed trim.



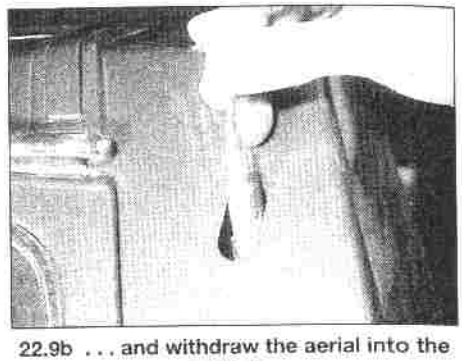
22.7 Signal lead connector (Estate) wrapped in sticky tape



22.8 Unscrewing the aerial rod from the stub



22.9a Remove the aerial tube nut . . .



22.9b . . . and withdraw the aerial into the vehicle

Key to wiring diagrams WD1 to WD4

No	Item	Grid ref*
1	Battery	B2
2	Ignition switch	D3
3	Instrument panel connector (3-pole)	N3
4	Ignition coil	B4
5	Distributor	B3
6	Spark plugs	C3
7	Instrument panel connector (7-pole)	N3
8	Instrument panel connector (8-pole)	M3
9	Starter motor	B3
10	Alternator and voltage regulator	B3
11	Fusebox	B1, E1, H1
12	Instrument panel connector (12-pole)	M3
13	Headlight main beam	A2, A4, A5
14	Headlight dipped beam	A2, A5
15	No 15 terminal (in central electrical unit)	K4
16	Parking light	A2, A5, J2, J5
17	Day running light	A2, A5
18	Direction indicators	A1, A2, A5, B5, J2, J5
19	Reversing light	J2, J5
20	Rear foglight	J2, J5
21	Tail light	J2, J5
22	Stop-light	J5
23	Front foglight/spotlight	N5, O5, Q1
24	Number plate light	J3, J4
25	Interior light unit	H3
26	Map reading lights	H3
27	Courtesy light	H3
28	Rear reading lights	H3, H4
29	Positive terminal	C2
30	No 30 terminal (in central electrical unit)	K4
31	Earth connection (in central electrical unit)	K2
32	Glovebox light	D2, E2, M4
33	Front ashtray light	E2
34	Rear ashtray light	H4
35	Switch illumination	H4
36	Switch illumination	H4
37	Gear selector light (auto)	H4
38	Instrument illumination	F3, F4
39	Engine bay light	B2
40	Boot light	H4
41	Door edge marker light	L3, L4
42	Heater control illumination	F3, F1
43	Vanity mirror light	M5
45	Driver's belt lock tight	H3, L3
46	Passenger's belt lock light	H3
47	Windscreen wiper switch	F2
48	Light switch	F3
49	Direction indicator/hazard warning/dip switches	F3
50	Horn switch	B4
51	Heated rear window switch	J3
52	Rear foglight switch	H5
53	Passenger seat heater switch	H3
54	Overdrive switch (auto)	M3
55	Heater blower switch	N1
56	Window switch (driver's door)	O3
57	Window switch (front passenger's door)	P4
58	Window switch (RH rear)	P4
59	Window switch (LH rear)	O4
60	Door mirror switch (driver's door)	N4
61	Door mirror switch (passenger's door)	O4
62	Central locking link rod switch	O4
63	Central locking key switch	O4
64	Sunroof switch	M2
65	Front foglight/spotlight switch	N5, P5, Q1
66	Stop-light switch	F3
67	Choke control switch (not UK)	D2
68	Handbrake switch	D2
69	Brake failure warning switch	E2
70	Reversing light switch	H5
71	Starter inhibitor switch (auto)	B2
72	Driver's door switch	H5, L4
73	Passenger's door switch	H2, J5, L3
74	Rear door switches	J2, M3

Key to wiring diagrams WD1 to WD4 (continued)

No	Item	Grid ref*
75	Passenger's seat contact	H3
71	Overdrive switch (manual)	H2
78	CIS microswitch	K1, N3
79	Lambdasond microswitch (not UK)	L2
80	Thermal time switch	C5
81	Air conditioner pressure sensor	N2, O1
82	ACC control panel sensor	O1
83	ACC coolant thermal switch	O2
85	Speedometer	E3, N3
86	Tachometer	D3
87	Clock	D3, D4
88	Coolant temperature gauge	E3
89	Fuel gauge	F3
90	Voltmeter	E4
91	Oil pressure gauge	E3
92	Ambient temperature gauge	D3
93	Instrument voltage regulator	E3
94	Panel light rheostat	E3
95	Panel illumination	E3
96	Oil level warning light	D3
97	Oil pressure warning light	D3
98	Choke warning light (not UK)	D3
99	Handbrake warning light	D3
100	Brake failure warning light	E3
101	Washer fluid level warning light	E3
102	Spare	E3
103	Bulb failure warning light	E3
104	Preheater pilot light (Diesel)	E3
105	Ignition (no charge) warning light	D4
106	Overdrive pilot light (auto)	D4
107	Exhaust temperature light (Japan)	D4
108	Direction indicator pilot light (LH)	D4
109	Main beam pilot light	E4
110	Direction indicator pilot light (RH)	E4
111	Lambdasond light (not UK)	E4
112	Overdrive pilot light (manual)	E4
113	Seat belt reminder (front)	E4, L3

No	Item	Grid ref*
114	Seat belt reminder (rear)	H3, L3
115	Bulb failure sensor	G3
116	Seat belt buzzer	F3, L2
117	Wiper delay relay	F3
119	Fuel pump relay	D4
120	Fuel injection impulse relay	D5
121	Flasher unit	F3
122	Exhaust temperature sensor (Japan)	N5
123	Overdrive relay	H3
124	Window winder/cooling fan relay	P3
125	Central locking relay – opening	N3
126	Central locking relay – closing	O3
127	Auxiliary light relay	O5, P5, Q2
129	Foglight relay (Sweden)	O5, Q1
130	Glow plug relay (Diesel)	L4
131	Heater blower relay	N1, P1
132	Air conditioning delay relay	N1, O1
133	Oil level relay	D3
136	Overdrive relay (auto)	M4
137	Main beam relay	F4
138	Driver's seat heater	H4
139	Driver's backrest heater	H4
140	Passenger's seat heater	H2
141	Passenger's backrest heater	H2
142	Seat heater thermostats	H2, H4
143	Loudspeaker – LH front	M1
144	Loudspeaker – RH front	M1
145	Loudspeaker – LH rear	M1
146	Loudspeaker – RH rear	M1
147	Aerial (static)	L1
148	Aerial (power-operated)	M1
149	Radio	L1
150	Window motor – driver's door	P3
151	Window motor – passenger's door	P4
152	Window motor – RH rear	P4
153	Window motor – LH rear	O4
154	Driver's door mirror	N4

Key to wiring diagrams WD1 to WD4 (continued)

No	Item	Grid ref*
155	Passenger's door mirror	P4
156	Cooling fan motor	K1
157	Headlight wiper motor	A3, A4
158	Sunroof motor	M3
159	Locking motor – passenger's door	N4
160	Locking motor – RH rear	N4
161	Locking motor – LH rear	N4
162	Locking motor – boot	N4
163	Windscreen wiper motor	F3
164	Windscreen washer motor	F3
165	Heater blower motor	N1, P1
166	Capacitor (interference suppression)	B3
167	Interference suppressors – spark plugs	C3
168	Ignition ballast resistor	B3
169	Heater blower resistor	N1, P1
170	Catalyst element (Japan)	M5
171	Lambdasond thermostat (not UK)	L2
173	Interior light delay	H3
174	Oil level control unit	C3
175	Ignition system control unit	C4
176	CIS control unit	O2
177	Lambdasond control unit (not UK)	L2
178	Washer fluid level sensor	E2
179	Oil level sensor	C4
180	Speedometer sender	E5
187	Coolant temperature sensor	E5
182	Fuel gauge sender	E5
183	TDC sensor	P4
184	CIS temperature sensor	N3
187	Lambda sensor (not UK)	L2
188	Start injector	C5
189	Control pressure regulator	B5
190	Auxiliary air valve	C5
191	Frequency valve	L2
192	Pressure differential switch	M2

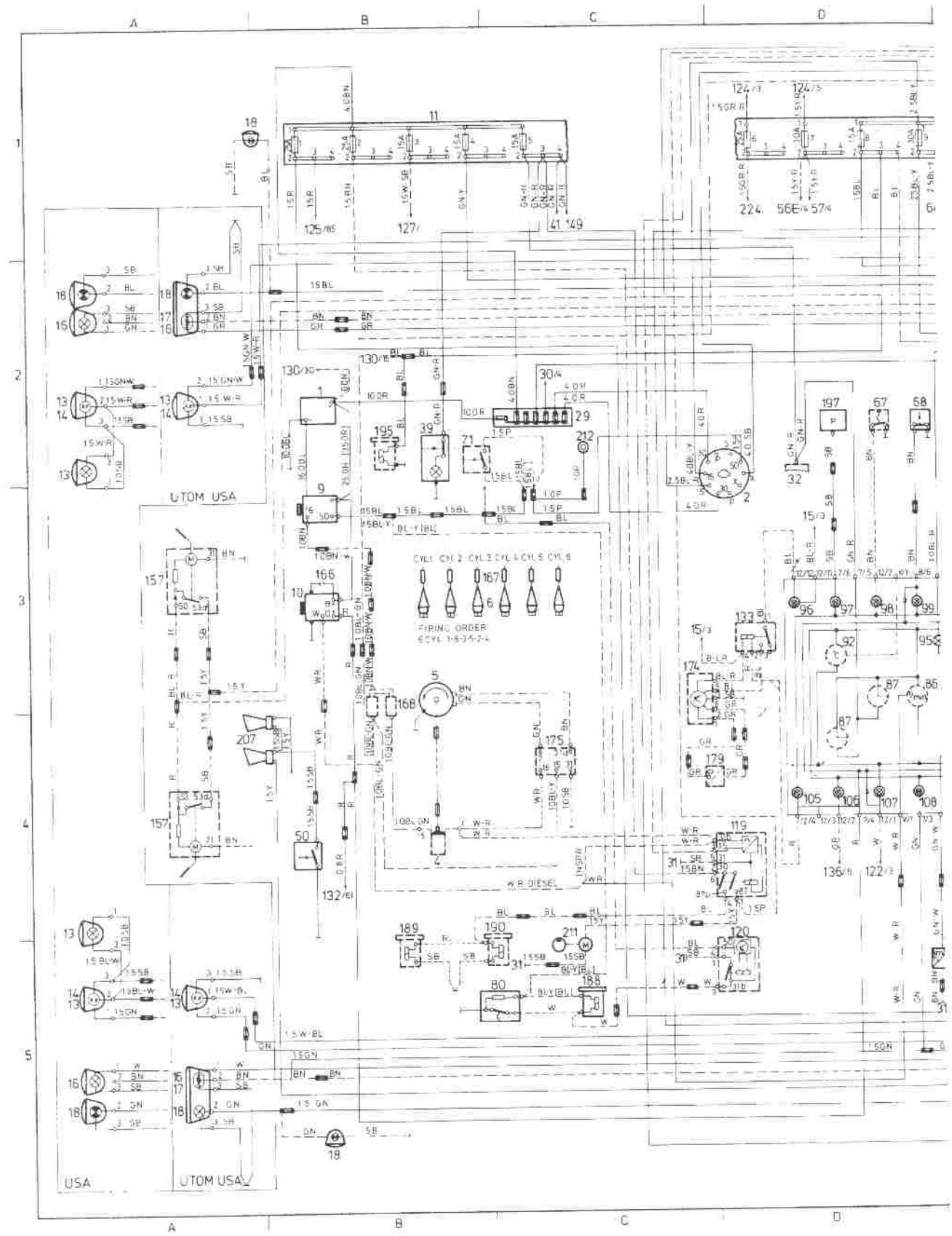
No	Item	Grid ref*
193	Hot start injector	B2
194	Idle up solenoid	K4
195	Fuel cut-off solenoid	B2
196	CIS idle valve	O3
197	Oil pressure sensor	D2
199	Temperature sensor (Diesel)	L5
200	Air conditioning compressor solenoid	K5
201	Overdrive solenoid	H2, N4
202	Heater control	N2
203	ACC temperature control	O2
204	ACC ambient temperature sensor	O2
205	ACC cabin temperature sensor	O2
206	ACC programmer	P2
207	Horn	A4
208	Glow plugs (Diesel)	L4
210	Tank pump	H2
211	Main fuel pump	C5
212	Starter cranking contact	C2
219	Lambdasond test point (not UK)	L2
220	CIS test point	N3
221	Heated rear window	J3
222	Cruise control speedometer connection	E3
223	Cigarette lighter	E2
224	Fan thermoswitch	K1
225	Cruise control switch	K1
226	Cruise control control unit	K2
227	Vacuum pump	K2
228	Clutch switch	K2
229	Brake switch	K2
231	Rear foglight relay	O5, Q1
233	Turbo pressure sensor (Diesel)	D2
236	Pressure sensor relay (Diesel)	K1
237	Pressure sensor (Diesel)	K1
250	Auxiliary tank fuel gauge sender	E4
251	Connector	D4

'UTOM' means 'except'

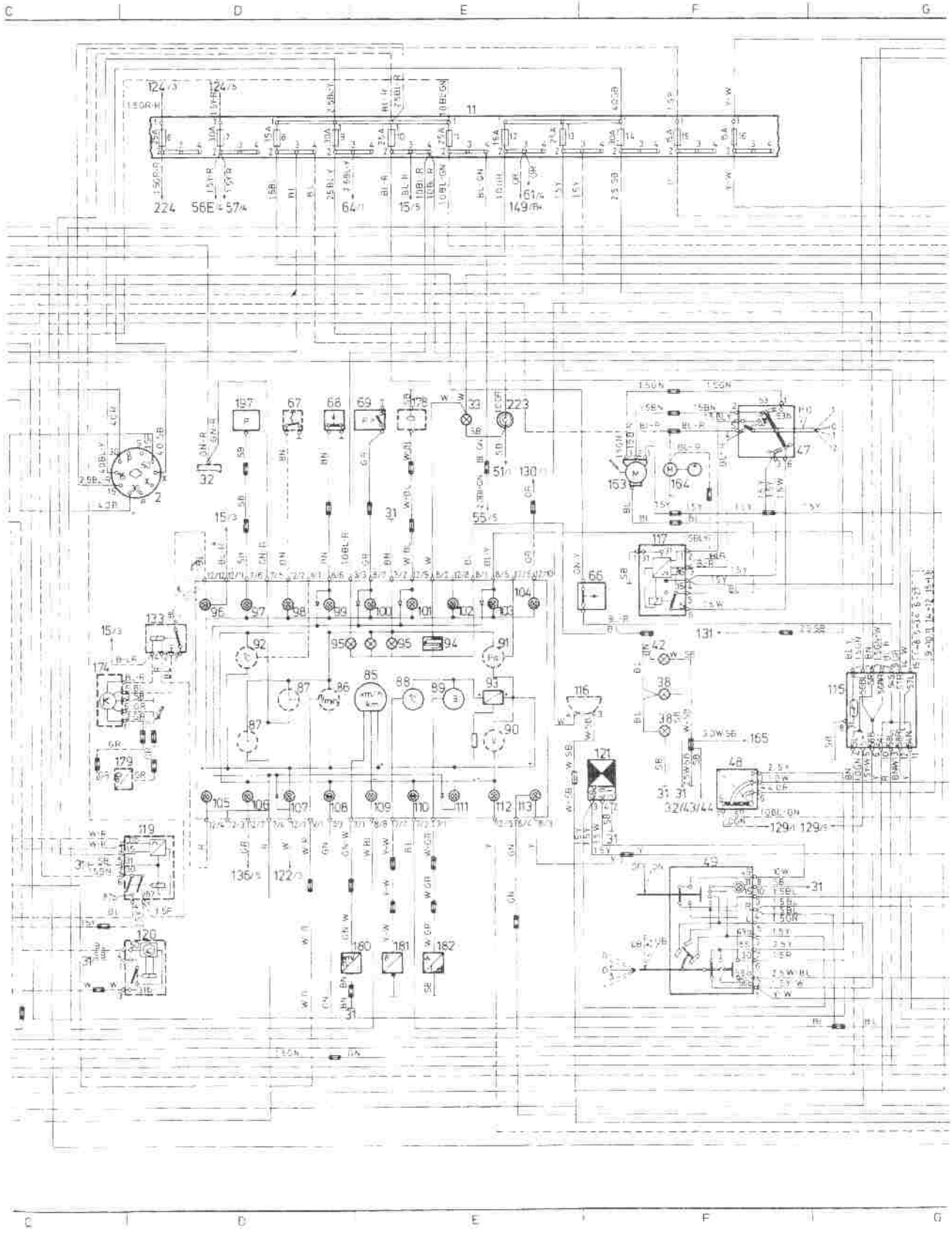
*The grid references given here are correct for the 1982 wiring diagram.

Colour code

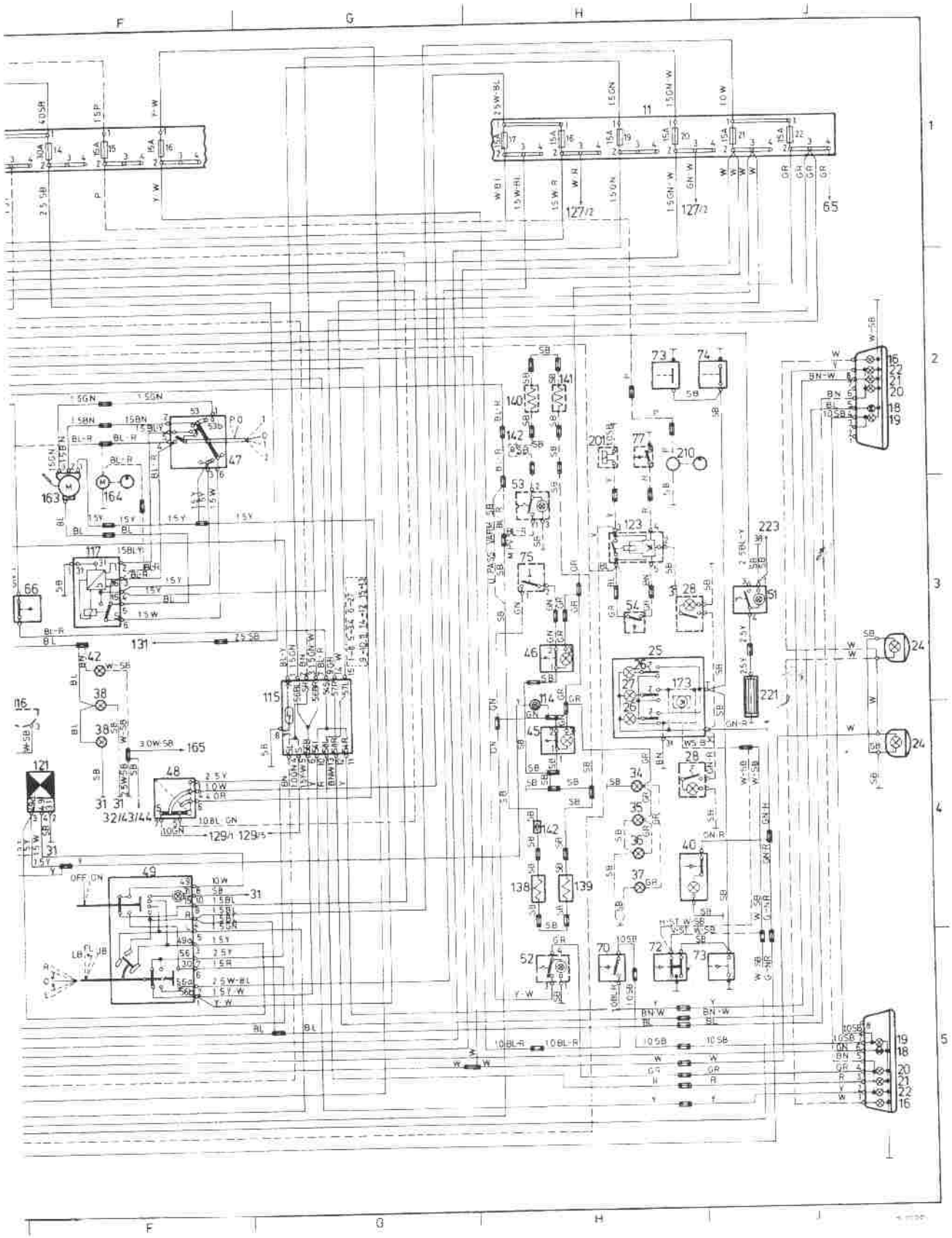
BL Blue	GR Grey	R Red	W White
BN Brown	OR Orange	SB Black	Y Yellow
GN Green	P Pink	VO Violet	



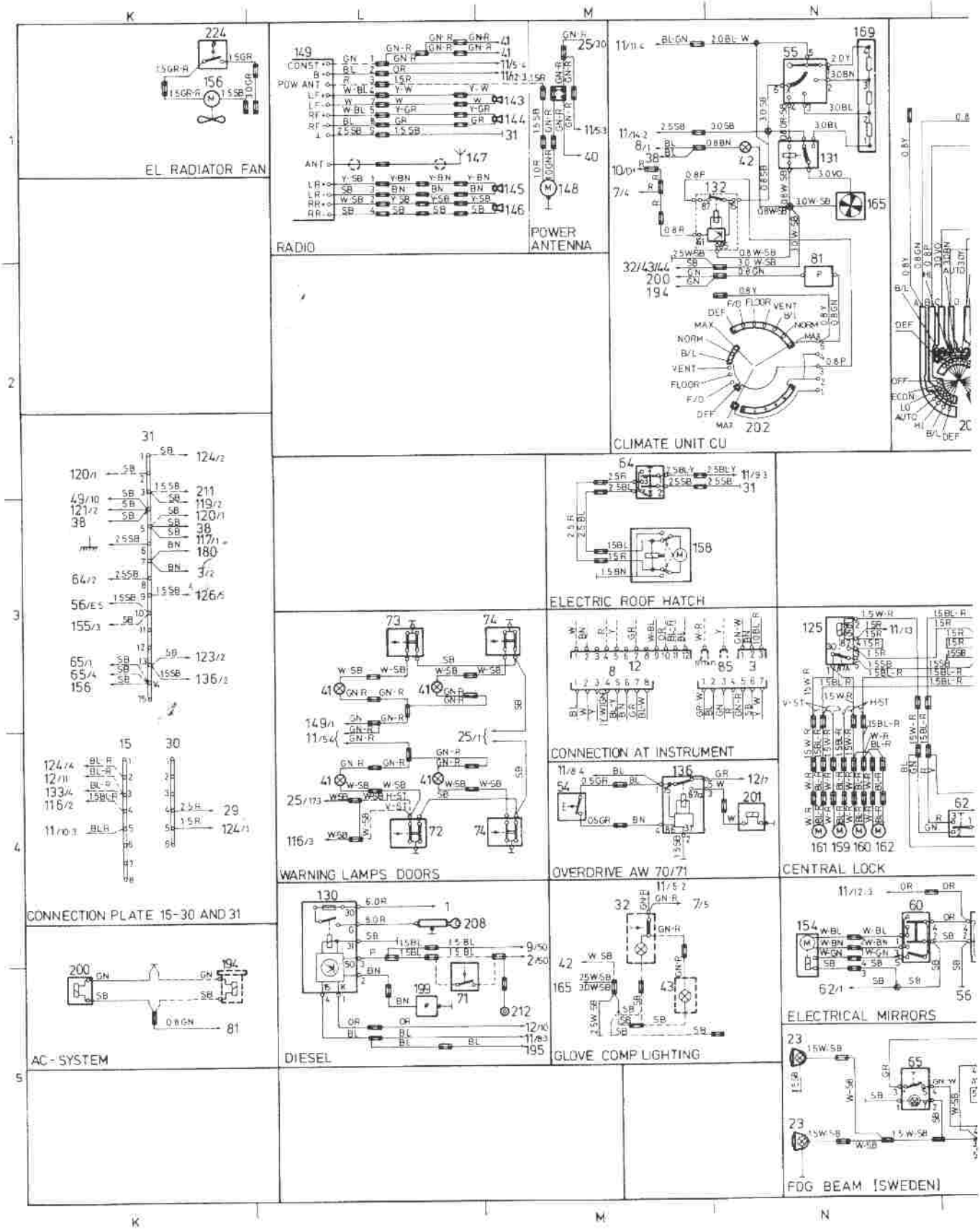
WD1 : Main wiring diagram for 1982 models



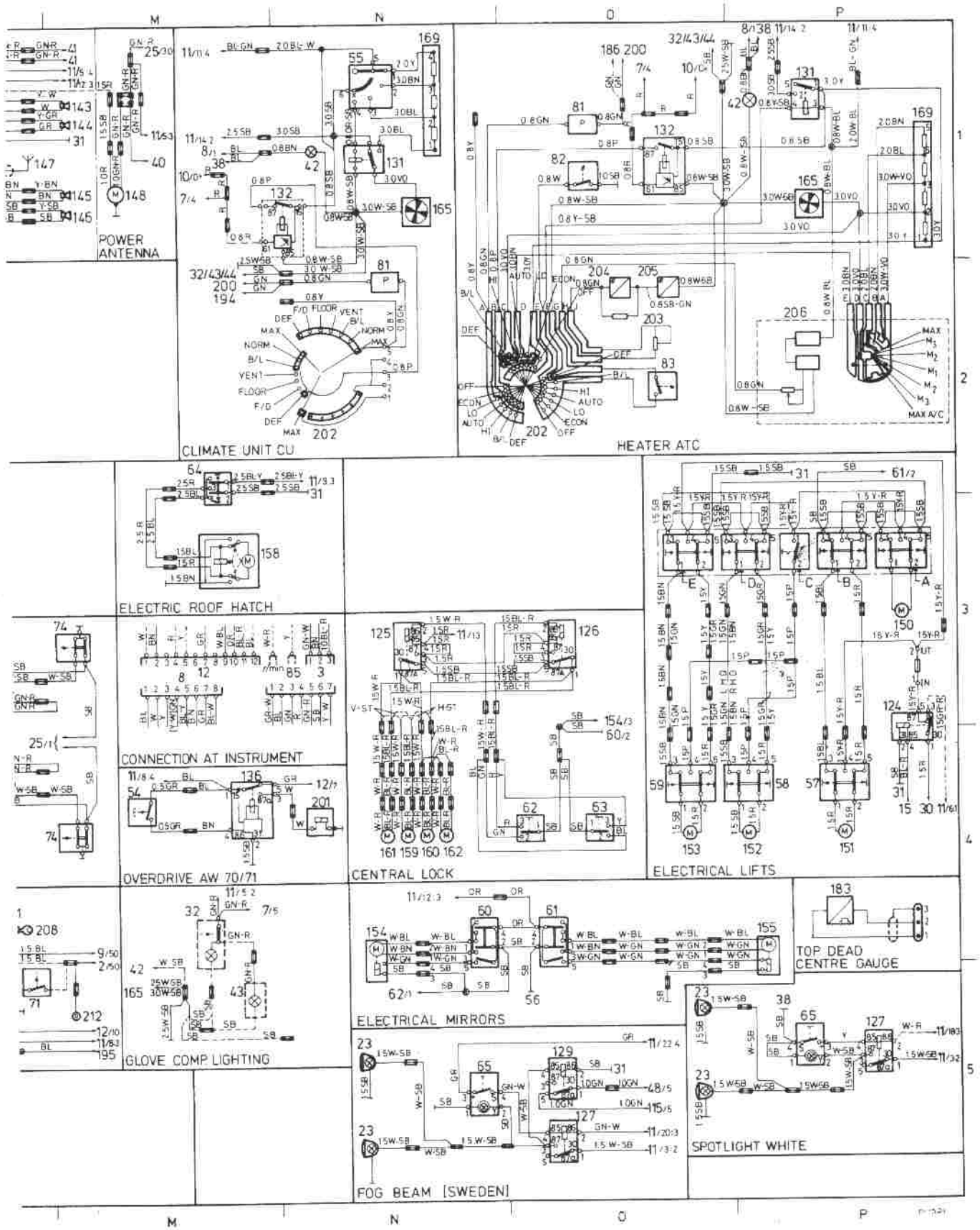
WD1 (continued) : Main wiring diagram for 1982 models



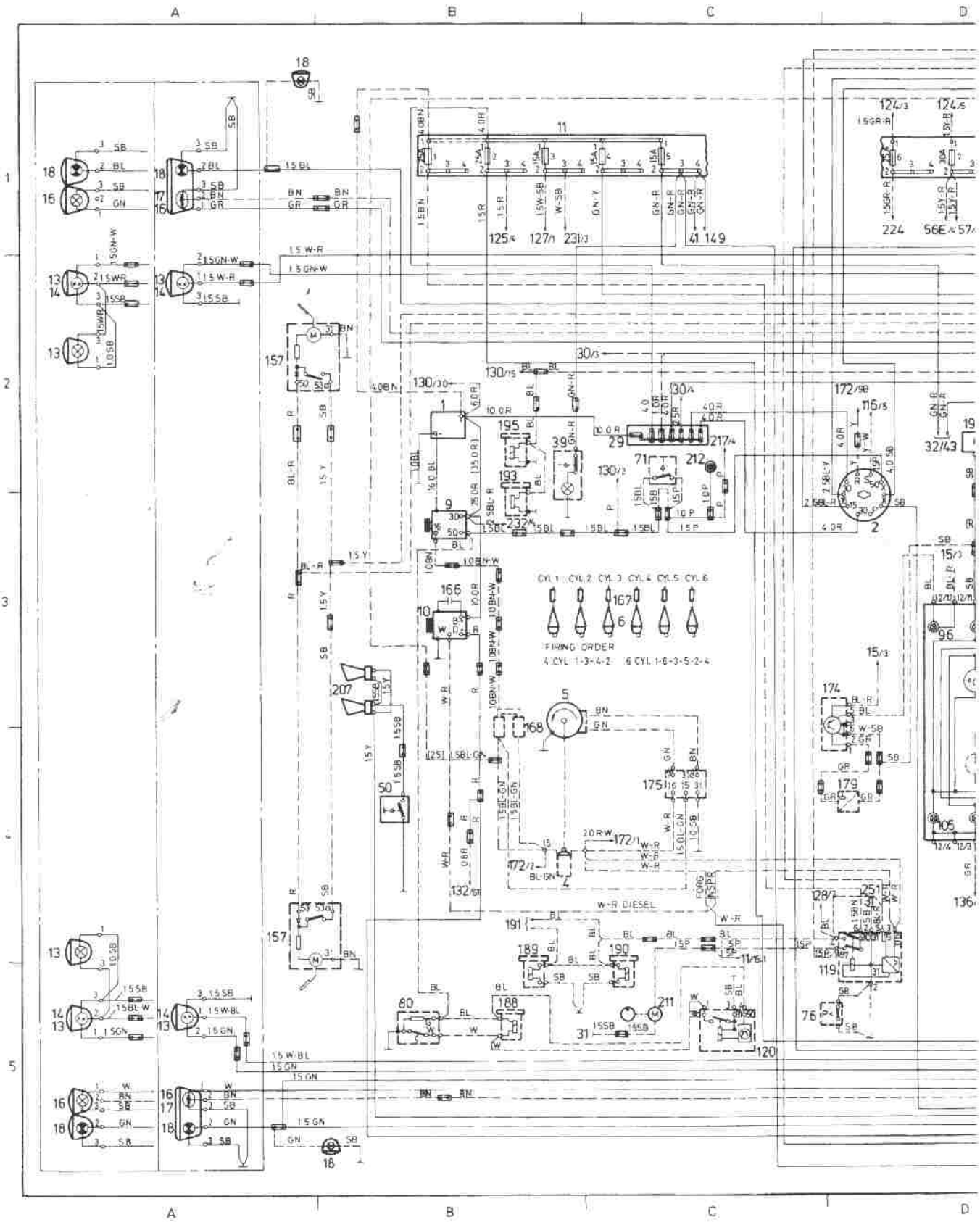
WD1 (continued) : Main wiring diagram for 1982 models



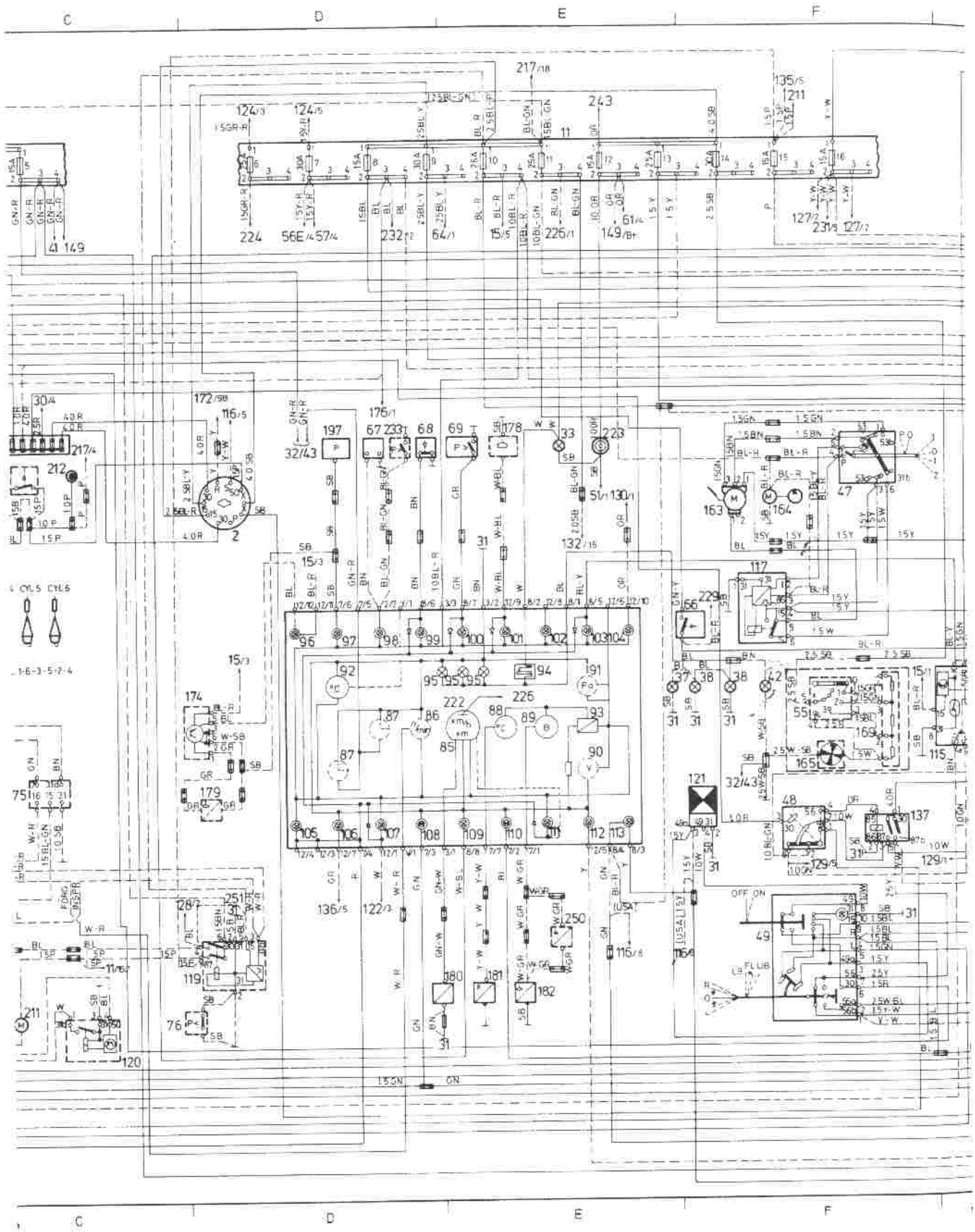
WD2 : Supplementary wiring diagram for 1982 models



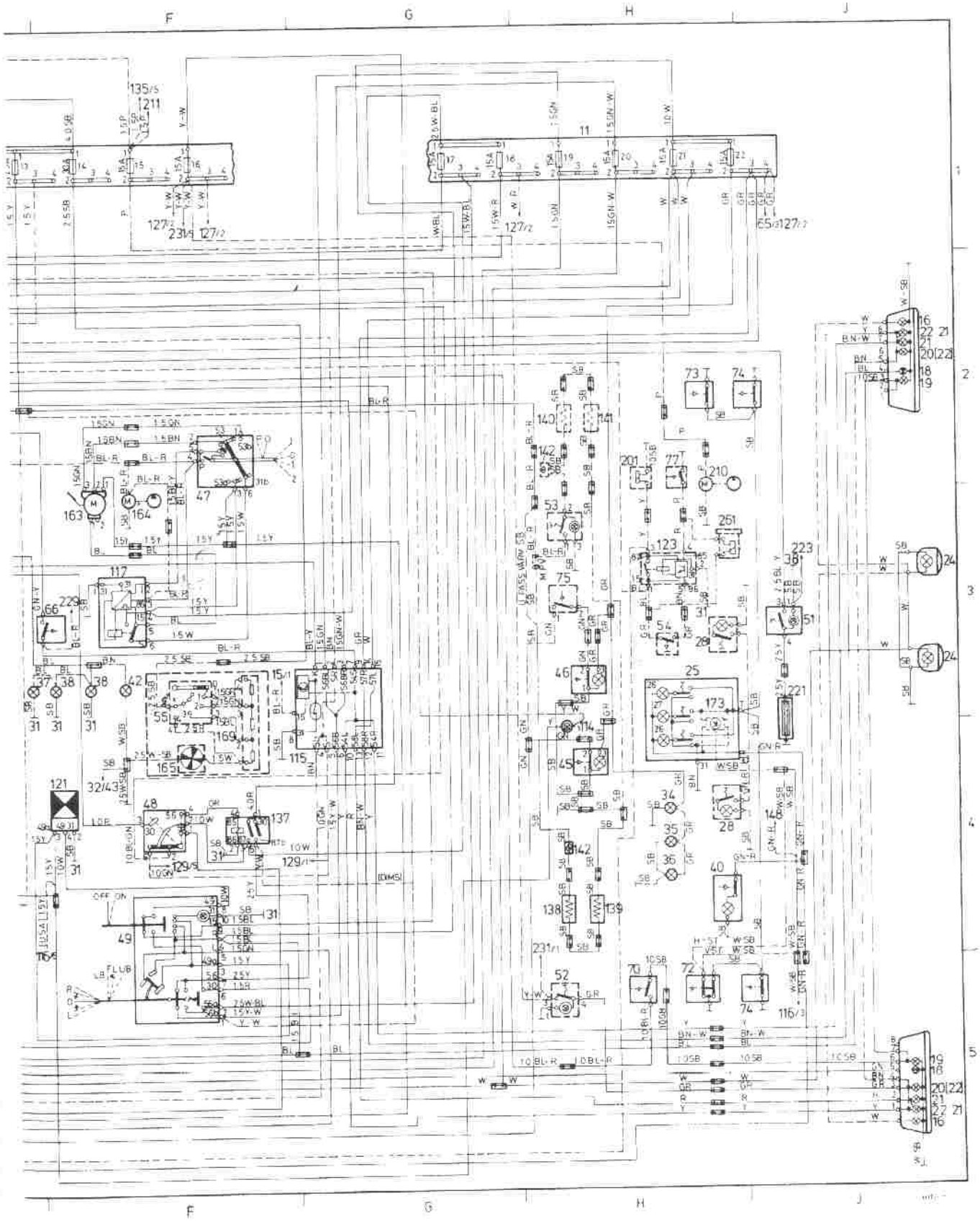
WD2 (continued) : Supplementary wiring diagram for 1982 models



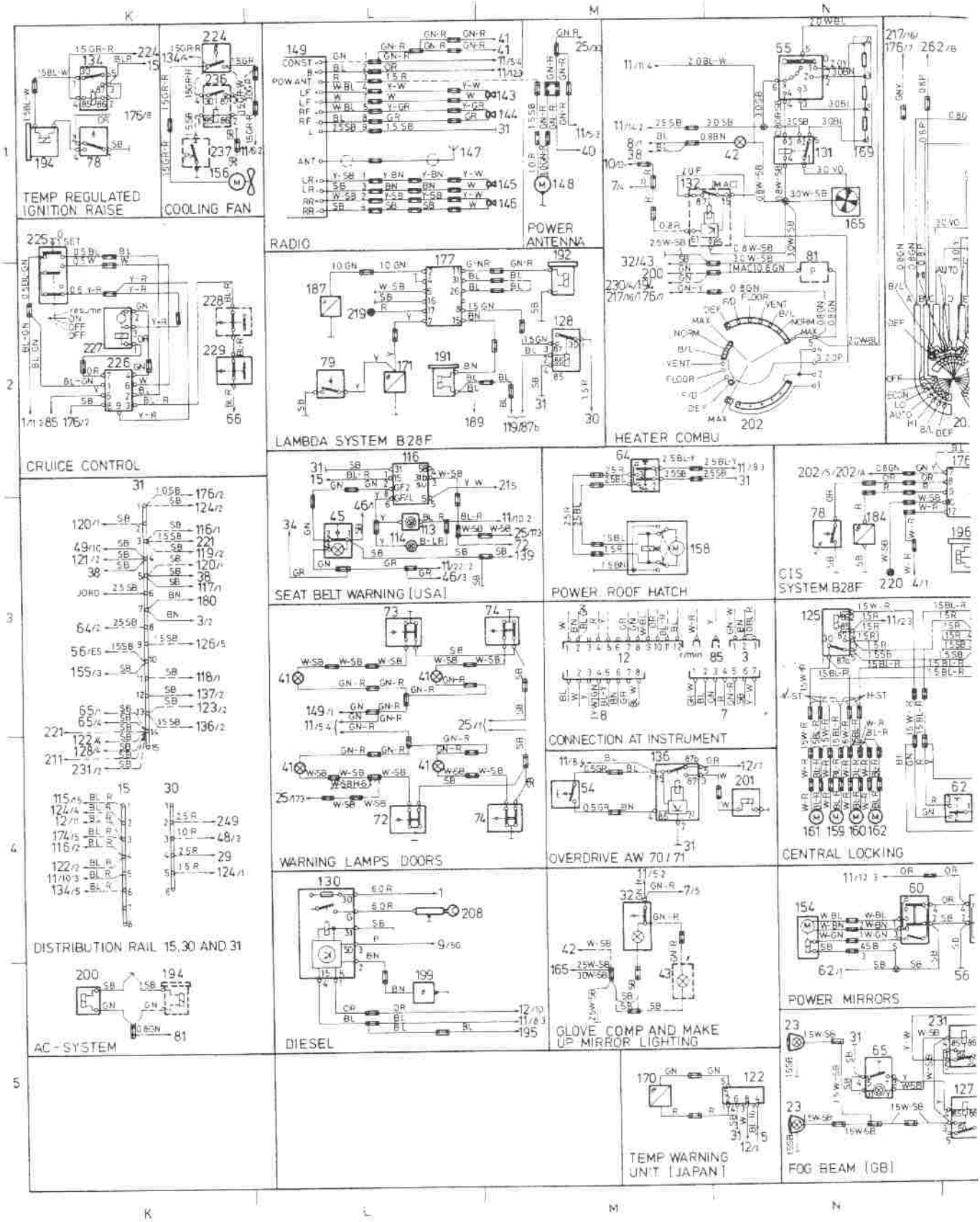
WD3 : Main wiring diagram for 1983 models



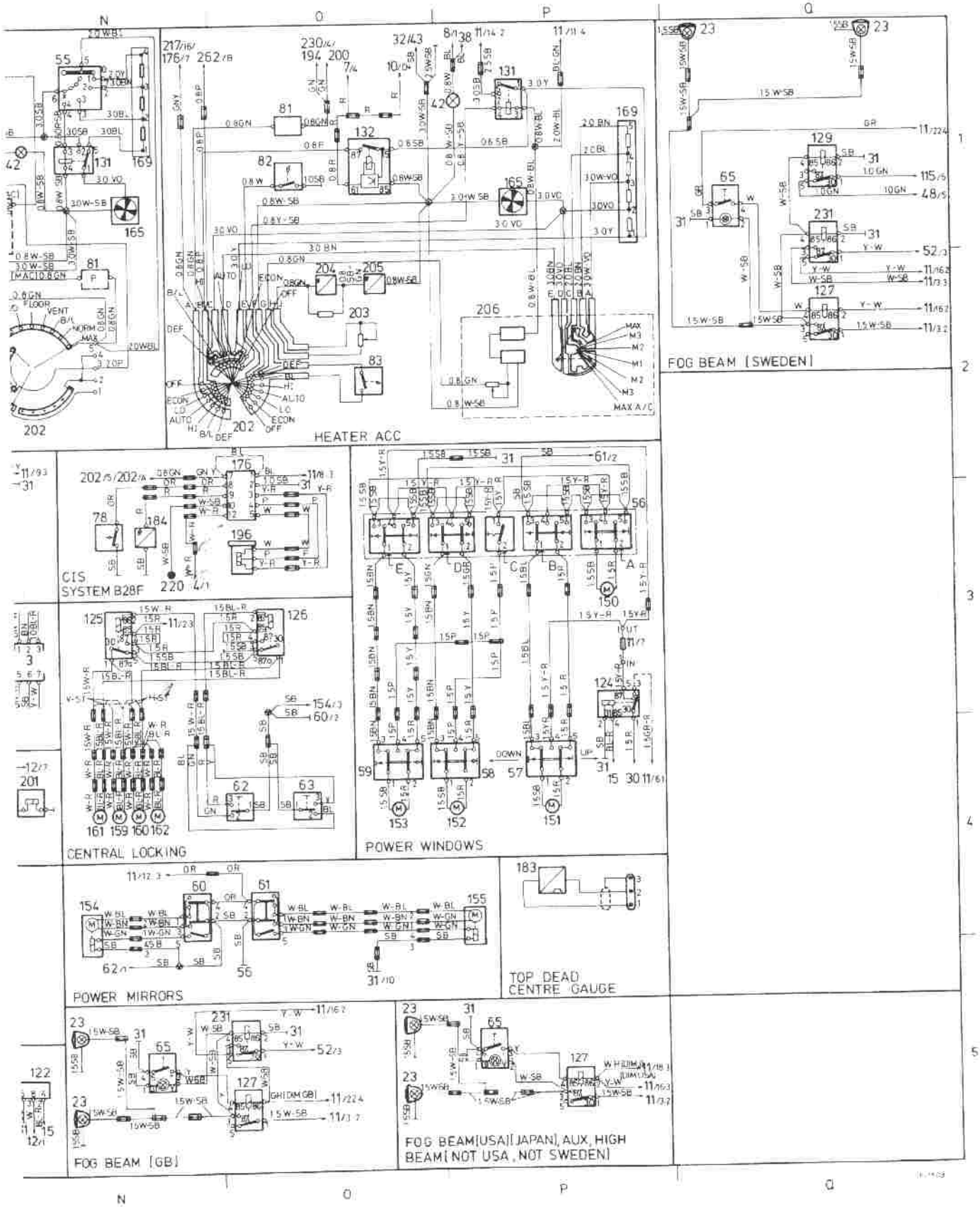
WD3 (continued) : Main wiring diagram for 1983 models



WD3 (continued) : Main wiring diagram for 1983 models



WD4 : Supplementary wiring diagram for 1983 models



WD4 (continued) : Supplementary wiring diagram for 1983 models

Key to wiring diagrams WD5 and WD6

No	Item	Grid ref
1	Battery	C2
2	Ignition/starter switch	E3
3	Instrument panel connector (3-pole)	W4
4	Ignition coil	C5, N3
5	Distributor	C4, M5, N3, 55
6	Spark plugs	C4
7	Instrument panel connector (7-pole)	W4
8	Instrument panel connector (8-pole)	W4
9	Starter motor	C3
10	Alternator and voltage regulator	B3
11	Fusebox	C1, E1, H1
12	Instrument panel connector (12-pole)	W4
13	Headlight main beam	A2, A5, A6
14	Headlight dipped beam	A2, A6
15	No 15 terminal (in central electrical unit)	T4
16	Parking light	A1, A6, L1, M6
17	Day running light	A1, A6
18	Direction indicators	A1, B1, L1, M1, M6
19	Reversing light	L1, M1, M6
20	Rear foglight	L1, M1, M6
21	Tail light	L1, M1, M6
22	Stop-light	L1, M1, M6
23	Front foglight/spotlight	X6, Y6
24	Number plate light	M3, M4
25	Interior light unit	K4
26	Map reading light	K4
27	Courtesy light	K4
28	Rear reading lights	K4
29	Positive terminal	D3
30	No 30 terminal (in central electrical unit)	T4
31	Earth connection (in central electrical unit)	T3
32	Glovebox light	K3
33	Front ashtray light	G3
34	Rear ashtray light	K5
35	Switch illumination	F3
36	Switch illumination	K5
37	Gear selector light (auto)	K5
38	Instrument illumination	F3
39	Engine bay light	C2
40	Boot light	K5
41	Door edge marker light	U4, V4
42	Heater control illumination	G3, W1, Y1
43	Vanity mirror light	K3
44	Fuel injectors	N2, T2, T3, T4
45	Driver's belt lock light	K4, U3
46	Passenger's belt lock light	K4
47	Windscreen wiper switch	H3
48	Main light switch	G4

No	Item	Grid ref
49	Direction indicator/hazard warning/dip switches	G5
50	Horn switch	B4
51	Heated rear window switch	L3
52	Rear foglight switch	X6, Z6
53	Passenger seat heater switch	J3
54	Overdrive switch	V4, W6
55	Heater blower switch	G4, W1
56	Window switch (driver's door)	Y3
57	Window switch (passenger's door)	Z4
58	Window switch (LH rear)	Z4
59	Window switch (RH rear)	Y4
60	Door mirror switch (driver's door)	X4
61	Door mirror switch (passenger's door)	X4
62	Central locking link rod switch	Y4
64	Sunroof switch	W3
65	Front foglight/spotlight switch	Y6, Z6
66	Stop-light switch	G3
67	Choke control switch (not UK)	E3
68	Handbrake switch	F3
69	Brake failure warning switch	F3
70	Reversing light switch	K5
71	Starter inhibitor switch (auto)	D3
72	Driver's door switch	K5, V5
73	Passenger's door switch	K2, V4
74	Rear door switch	K5, V4, V5
75	Passenger's seat contact	K3
76	Turbo overpressure switch	D6, R1
77	Overdrive switch (manual)	W5
78	CIS microswitch	T1, X3
79	Lambdasond microswitch (not UK)	U2
80	Thermal time switch	B6
81	Air conditioner pressure sensor	X2, V1
82	ACC control panel sensor	Y1
83	ACC coolant thermal switch	Y2
84	Coolant temperature sensor	R2, T3
85	Speedometer	F4, W4
86	Tachometer	F4
87	Clock	F4
88	Coolant temperature gauge	F4
89	Fuel gauge	E4
90	Voltmeter	E4
93	Instrument voltage regulator	G4
94	Panel light rheostat	F4
95	Panel illumination	F4
96	Oil level warning light	E4
97	Oil pressure warning light	E4
98	Choke/turbo boost pressure warning light	E4

Key to wiring diagrams WD5 and WD6 (continued)

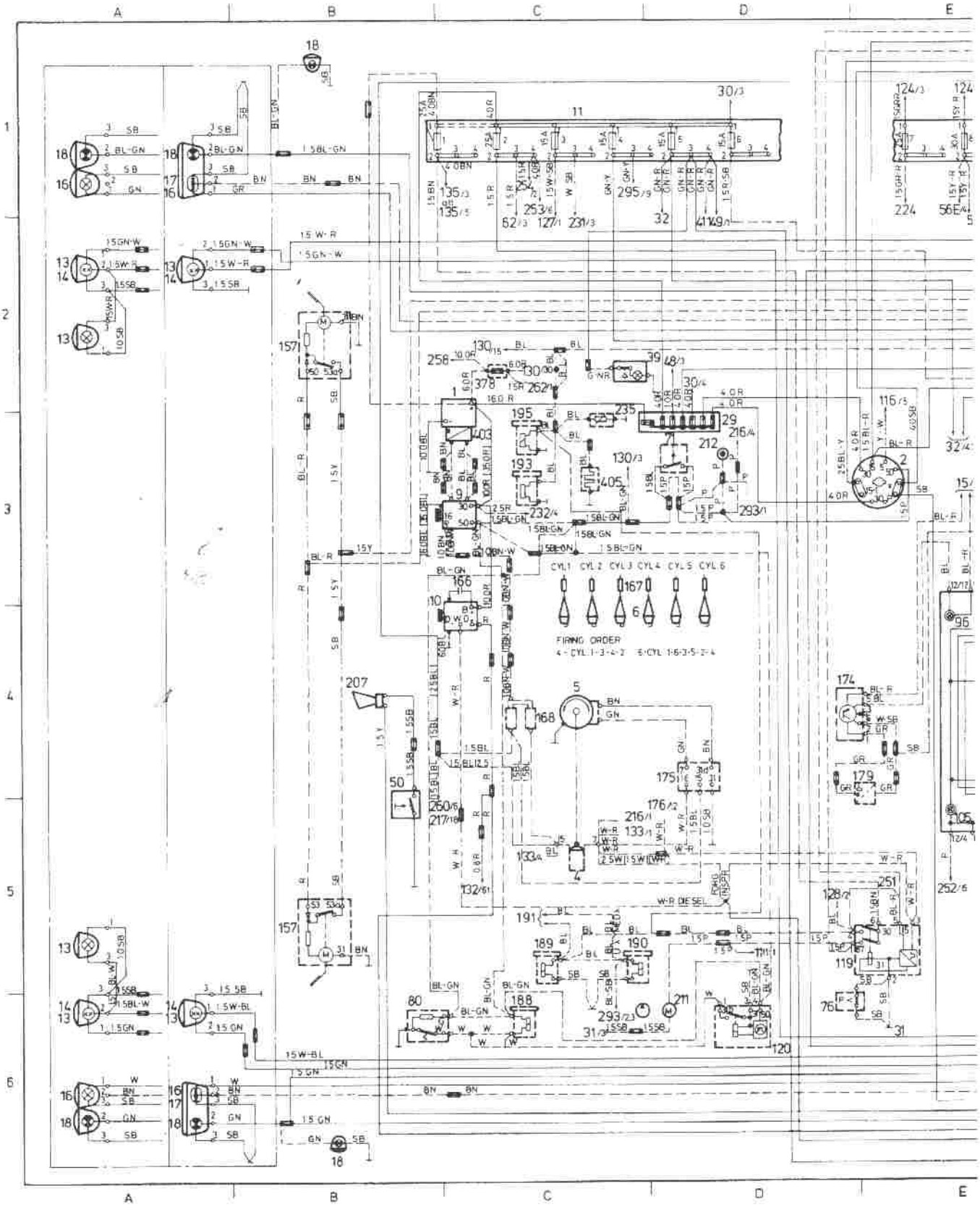
No	Item	Grid ref
99	Handbrake warning light	F4
100	Brake failure warning light	F4
101	Washer fluid level warning light	E3
102	Gearshift indicator	F4
103	Bulb failure warning light	F4
104	Preheater pilot light (Diesel)	G4
105	Ignition (no charge) warning light	E5
106	Overdrive pilot light (auto)	E5
107	Exhaust temperature light (Japan)	E5
108	Direction indicator pilot light (LH)	F5
109	Main beam pilot light	F5
110	Direction indicator pilot light (RH)	F5
111	Lambdasond light (not UK)	F5
112	Overdrive pilot light (manual)	F5
113	Seat belt reminder (front)	G5, V3
114	Seat belt reminder (rear)	V3, J4
115	Bulb failure sensor	H4
116	Seat belt reminder (not UK)	V3
117	Windscreen wiper delay relay	G3
118	Tailgate wiper delay relay	P4
119	Fuel pump relay	E5
120	Fuel injection impulse relay	D6
121	Flasher unit	G4
122	Exhaust temperature sensor (Japan)	Z5
123	Overdrive relay (manual)	W5
124	Window winder/cooling fan relay	Z4
127	Auxiliary light relay	Y6, Z6
128	Lambdasond relay (not UK)	V2
130	Glow plug relay (Diesel)	V5
131	Heater blower relay	X1, Z2
132	Air conditioning delay relay	W1, Y1
133	Ignition control unit (T2 28)	N3, R6
134	Ignition advance relay (not UK)	T1
135	Motronic/LH Jetronic relay	R2, R5
136	Overdrive relay (auto)	W4
137	Main beam relay	H5
138	Driver's seat heater	J5
139	Driver's backrest heater	K5
140	Passenger's seat heater	J3
141	Passenger's backrest heater	K3
142	Seat heater thermostats	J3, K5
143	Loudspeaker – LH front	V1
144	Loudspeaker – RH front	V1
145	Loudspeaker – LH rear	V1
146	Loudspeaker – RH rear	V1
147	Aerial (Static)	V1
148	Aerial (power-operated)	V1
149	Radio	U1

No	Item	Grid ref
150	Window motor – driver's door	Z4
151	Window motor – passenger's door	Z5
152	Window motor – RH rear	Y5
153	Window motor – LH rear	Y5
154	Driver's door mirror	L3, X4
155	Passenger's door mirror	L3, Z5
156	Cooling fan motor	U1
157	Headlight wiper motor	B2, B5
158	Sunroof motor	W3
159	Locking motor – passenger's door	Y5
160	Locking motor – LH rear	W4
161	Locking motor – RH rear	W5
162	Locking motor – boot or tailgate	W4
163	Windscreen wiper motor	G3
164	Windscreen washer motor	G3
165	Heater blower motor	G4, X1, Z1
166	Capacitor (interference suppression)	C3
167	Interference suppressors – spark plugs	C3
168	Ignition ballast resistor	C4
169	Heater blower resistor	X1, Z1
170	Catalyst element (not UK)	Z5
171	Lambdasond thermostat (not UK)	V2
173	Interior light delay	K4
174	Oil level control unit	D4
175	Ignition system control unit (Bosch)	D4
176	CIS control unit	X3
177	Lambdasond control unit (not UK)	R5, V2
178	Washer fluid level sensor	F3
179	Oil level sensor	E4
180	Speedometer sensor	F5
181	Coolant temperature sensor	F5
182	Fuel gauge sender	F5
184	CIS temperature sensor	X3
185	Charge air temperature sensor	52
186	Airflow meter	T1
187	Lambda sensor (not UK)	R4, U2
188	Start injector	C6
189	Control pressure regulator	C5
190	Auxiliary air valve	C5
191	Frequency valve	V2
192	Pressure differential switch	V2
193	Hot start injector	C3
194	Idle up solenoid	T5, T1
195	Fuel cut-off solenoid	C3
196	CIS idle valve	R4, X3
197	Oil pressure sensor	E3
198	Throttle switch (LH Jetronic)	54
199	Temperature sensor (Diesel)	V5

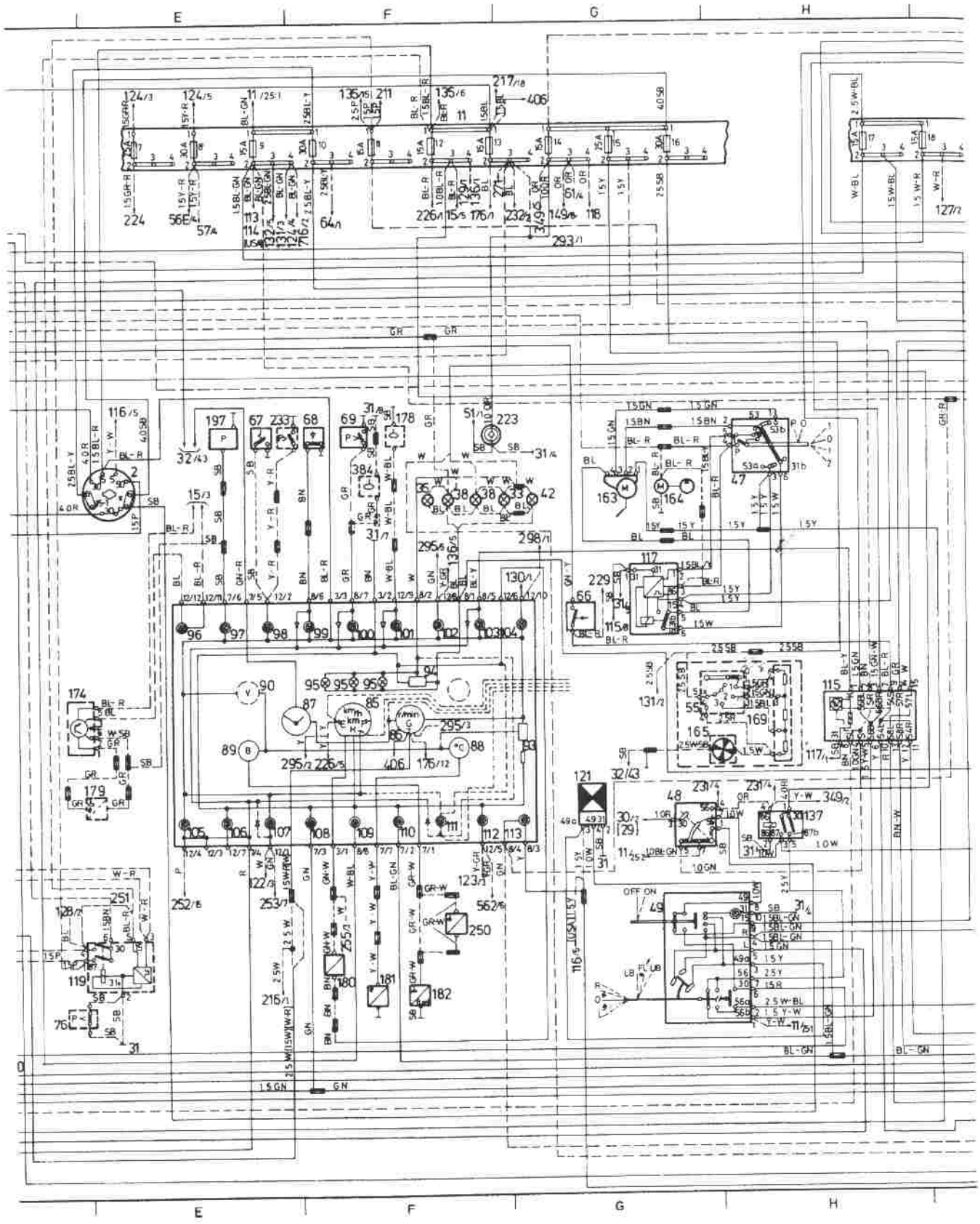
Key to wiring diagrams WD5 and WD6 (continued)

No	Item	Grid ref
200	Air conditioning compressor solenoid	T6
201	Overdrive solenoid	V5, W4
202	Heater control	W3, X3
203	ACC temperature control	Y2
204	ACC ambient temperature sensor	P5, Y2
205	ACC cabin temperature sensor	Y2
206	ACC programmer	Z2
207	Horn	B4
208	Glow plugs (Diesel)	V5
210	Tank pump	K2
211	Main fuel pump	D6
212	Starter cranking contact	D3
213	Throttle switch (Motronic)	S1
214	Crankshaft position sensor	R1
215	Engine speed sensor	R1
216	Motronic control unit	S1
217	LH-Jetronic control unit	S3
218	Knock sensor	56
219	Lambdasond test point (not UK)	U2
220	CIS test point	S4, X3
221	Heated rear window	L2
223	Cigarette lighter	F3
224	Fan thermoswitch	U1
225	Cruise control switch	T1
226	Cruise control control unit	T2
227	Vacuum pump	T2
228	Clutch switch	U2
229	Brake switch	G3, U2
231	Rear foglight relay	X6
232	Hot spot relay	T5
233	Turbo pressure sensor (Diesel)	E3
234	Hot spot thermostat	U5
235	Hot spot PTC resistor	U5
236	Pressure sensor relay (Diesel)	U1
237	Pressure sensor (Diesel)	U1
238	Rear washer pump	P4
239	Rear wiper connector	P3
240	Rear wash/wipe switch	P3
241	Rear wiper motor	P3
242	Power seat emergency stop	Q4
243	Power seat 'on' switch	Q4
244	Power seat control unit	Q3
245	Power seat motor – fore/aft	R4
246	Power seat motor – up/down (front)	R3
247	Power seat motor – up/down (rear)	R3
248	Power seat motor – backrest inclination	R4
250	Auxiliary tank fuel gauge sender	F5
251	Connector	E5
252	ABS control unit	R1
253	ABS modulator	Q3
254	ABS surge protector	Q2
255	ABS converter	Q1
256	ABS sensor – LH front	P2, Q1
257	ABS sensor – RH front	P2, Q1
258	ABS fusebox	Q2
259	Charge pressure sensor	R4
260	Ignition system control unit (EZ-K)	S6
261	EGR solenoid (not UK)	W5
262	ACC vacuum valve	X1
263	Overdrive oil pressure switch	S3
264	Charge pressure switch	S3
265	Torque limiter relay	P2, S3
266	Heated rear window timer	L3
267	EZ-K test point	S6
268	Gear position sensor	R3
270	ABS speedometer sensor	Q1
271	Fuel shut-off valve	V6
272	Throttle pedal switch	S6
273	EZ-K temperature sensor	S6
274	EGR relay (not UK)	Q6
275	EGR idling switch (not UK)	Q5
277	EGR 3-way valve (not UK)	R5
278	Aneroid switch (not UK)	P6
279	Altitude compensation solenoid valve (not UK)	P6
280	Driver's seat heater relay	J3
284	Air mass meter	S4
286	ETC sensor – LH rear	N1
287	ETC sensor – RH rear	N1
288	ETC pressure sensor	P1
289	ETC power stage	N1, T3
290	ETC control unit	P1
292	Idle advance solenoid valve	T6, W6
293	Idle advance relay	P5, T6, U6, V6, W6
295	Gearshift indicator relay	Q5
298	ETC relay	N1
349	Instrument connector (6-pole)	P5
375	Seat heater switch	J5
376	Ballast resistor (Jetronic)	N1, S2
378	Positive terminal (engine bay)	C2
379	Trip computer electronic unit	P5
384	Brake fluid level sensor	Q1, F3
395	ETC switch	P1
403	Battery temperature sensor	C3
404	Vacuum switch	R6
405	Choke heater	C3
406	Renix ignition unit (not UK)	P5
407	Renix impulse sender (not UK)	P5
408	Gearshift indicator switch	Q5

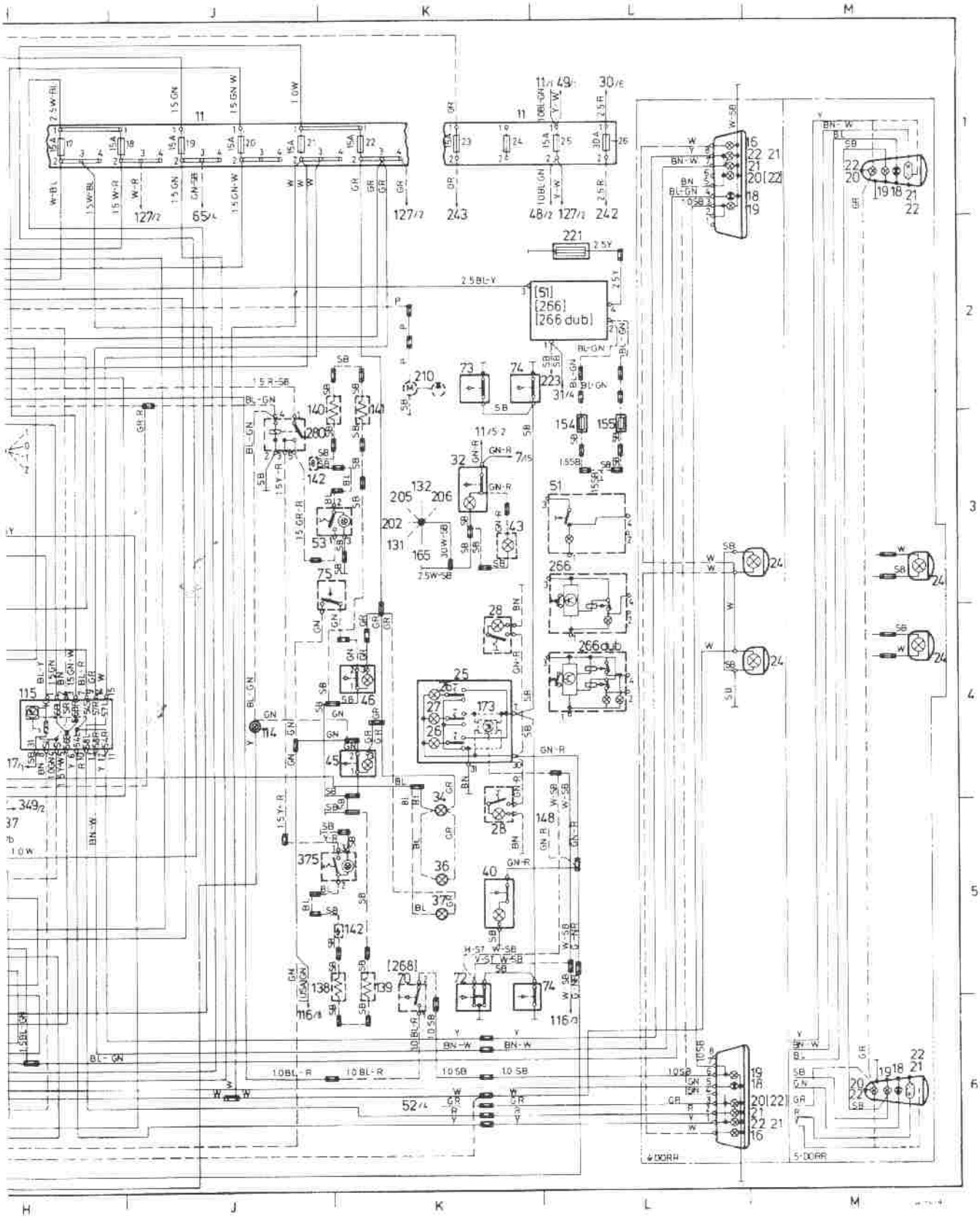
BL	Blue	GR	Grey	R	Red	W	White
BN	Brown	OR	Orange	SB	Black	Y	Yellow
GN	Green	P	Pink	VO	Violet		



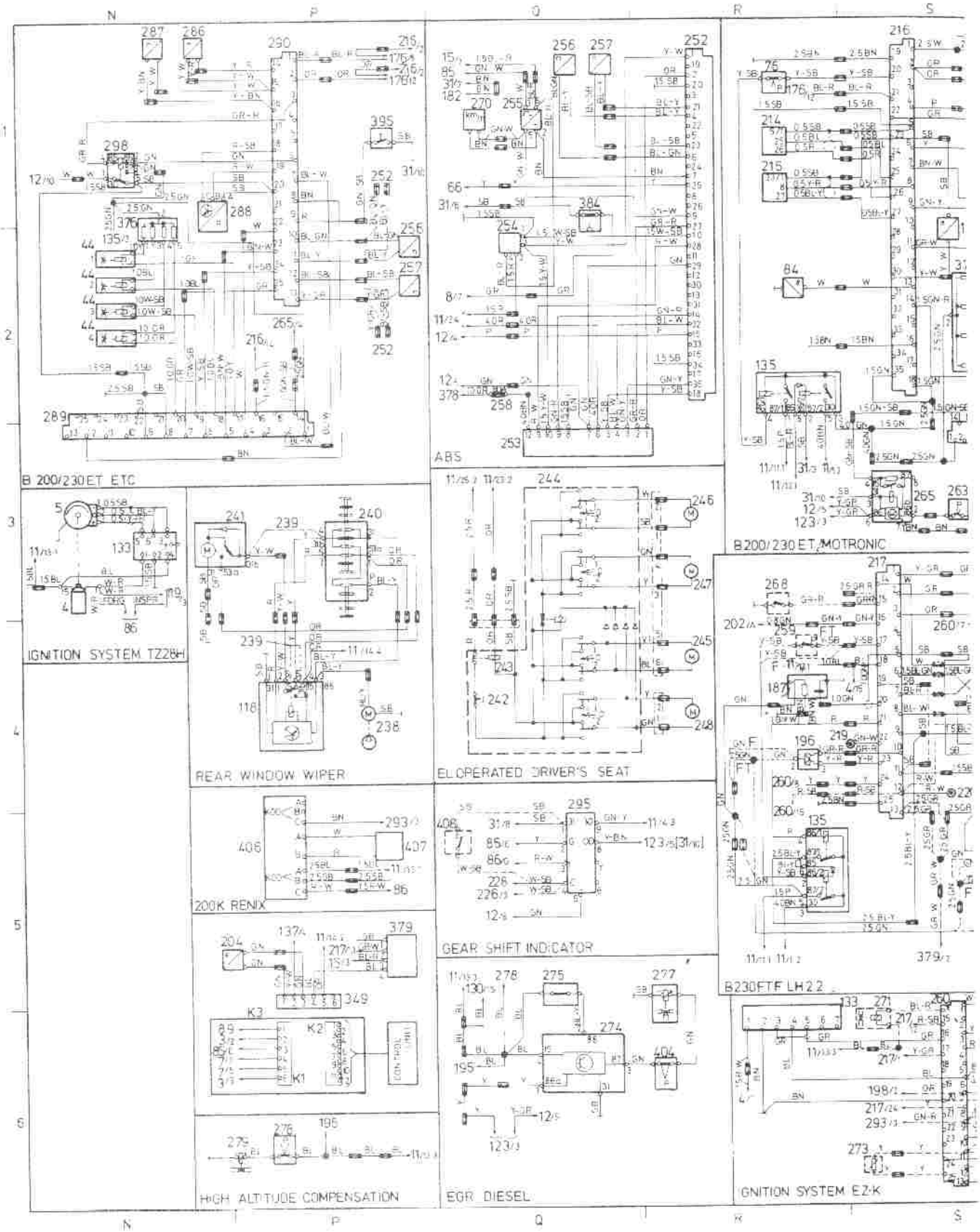
WD5 : Main wiring diagram for 1984 to 1988 models



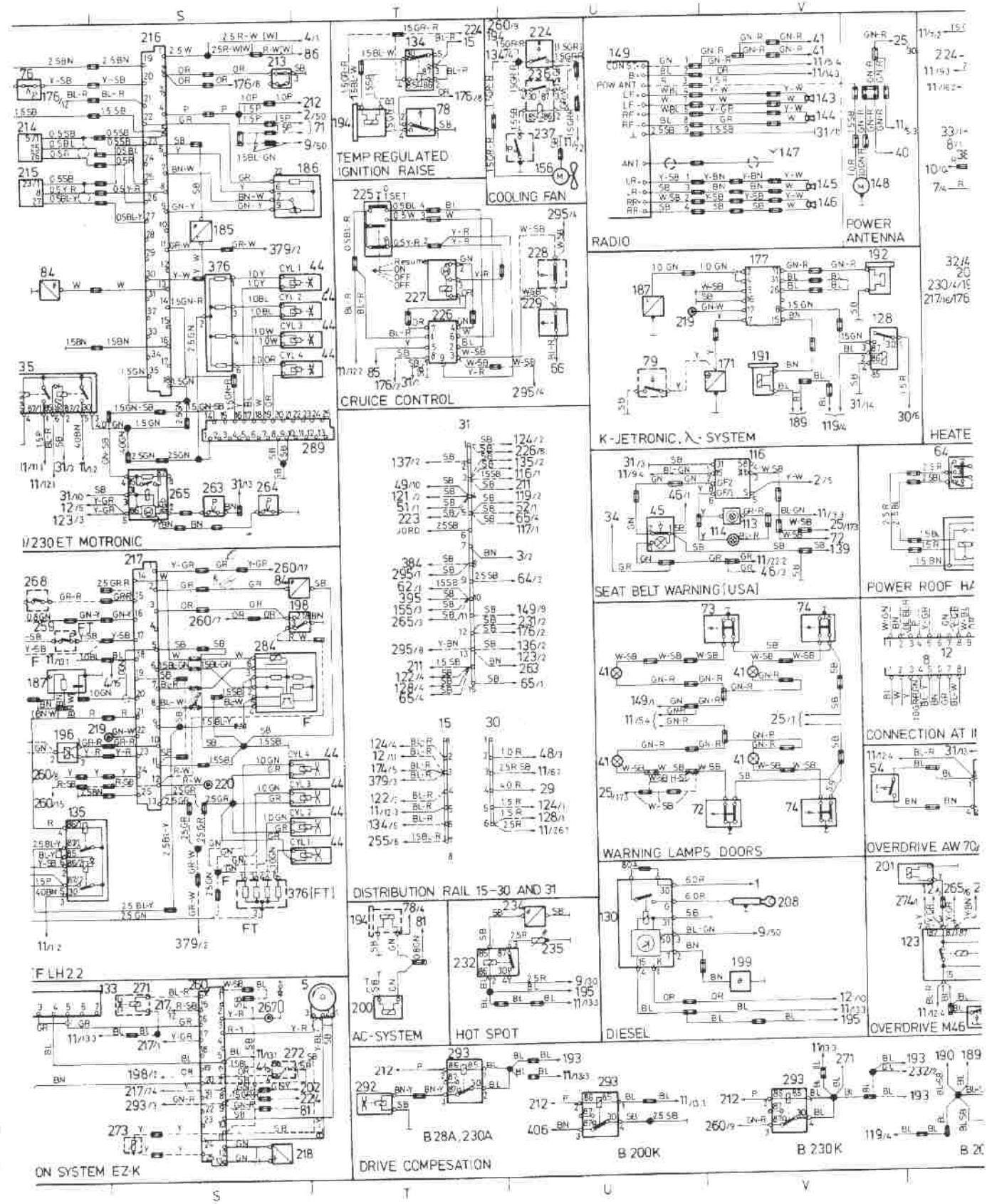
WD5 (continued) : Main wiring diagram for 1984 to 1988 models



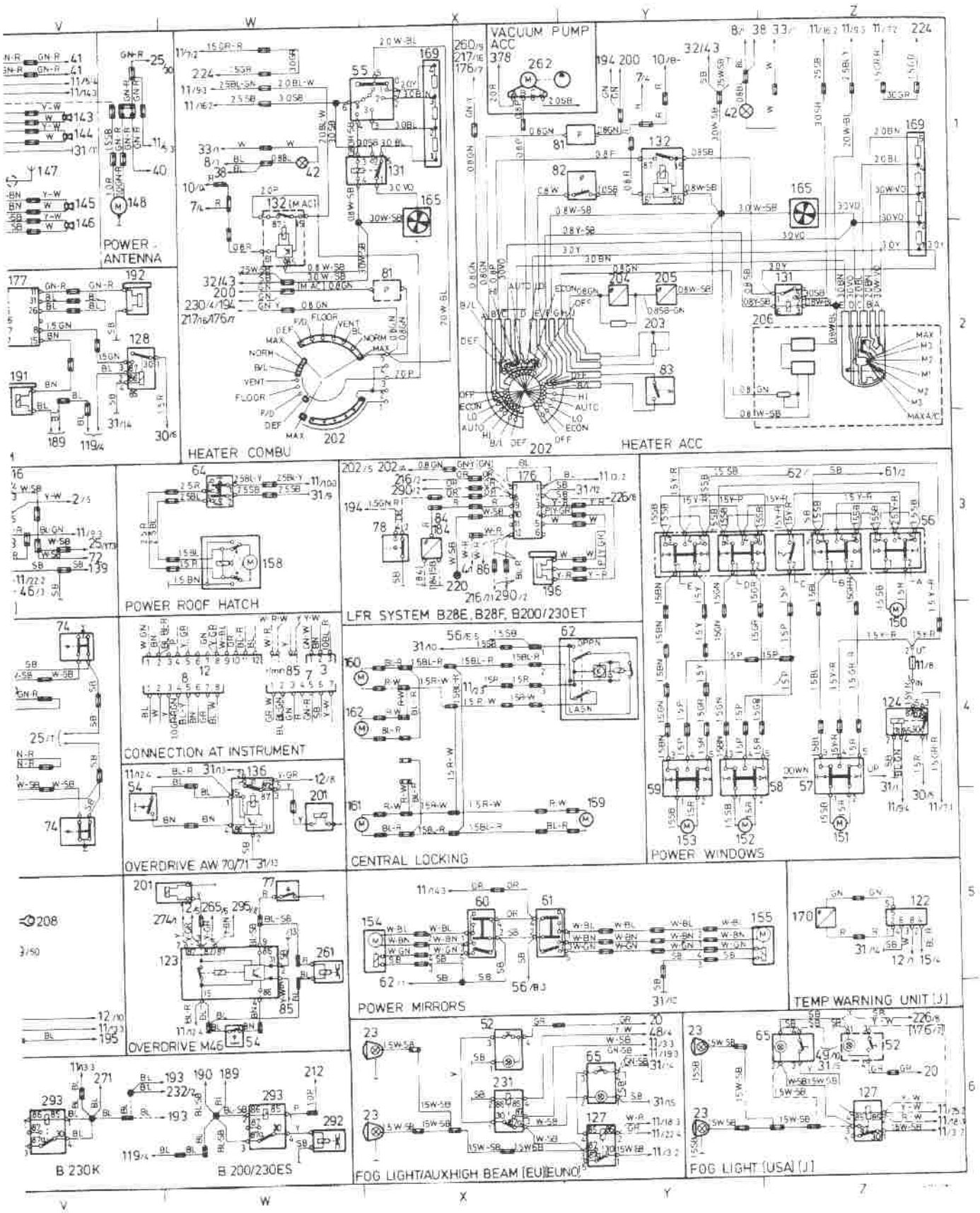
WD5 (continued) : Main wiring diagram for 1984 to 1988 models



WD6 : Supplementary wiring diagram for 1984 to 1988 models



WD6 (continued) : Supplementary wiring diagram for 1984 to 1988 models



WD6 (continued) : Supplementary wiring diagram for 1984 to 1988 models

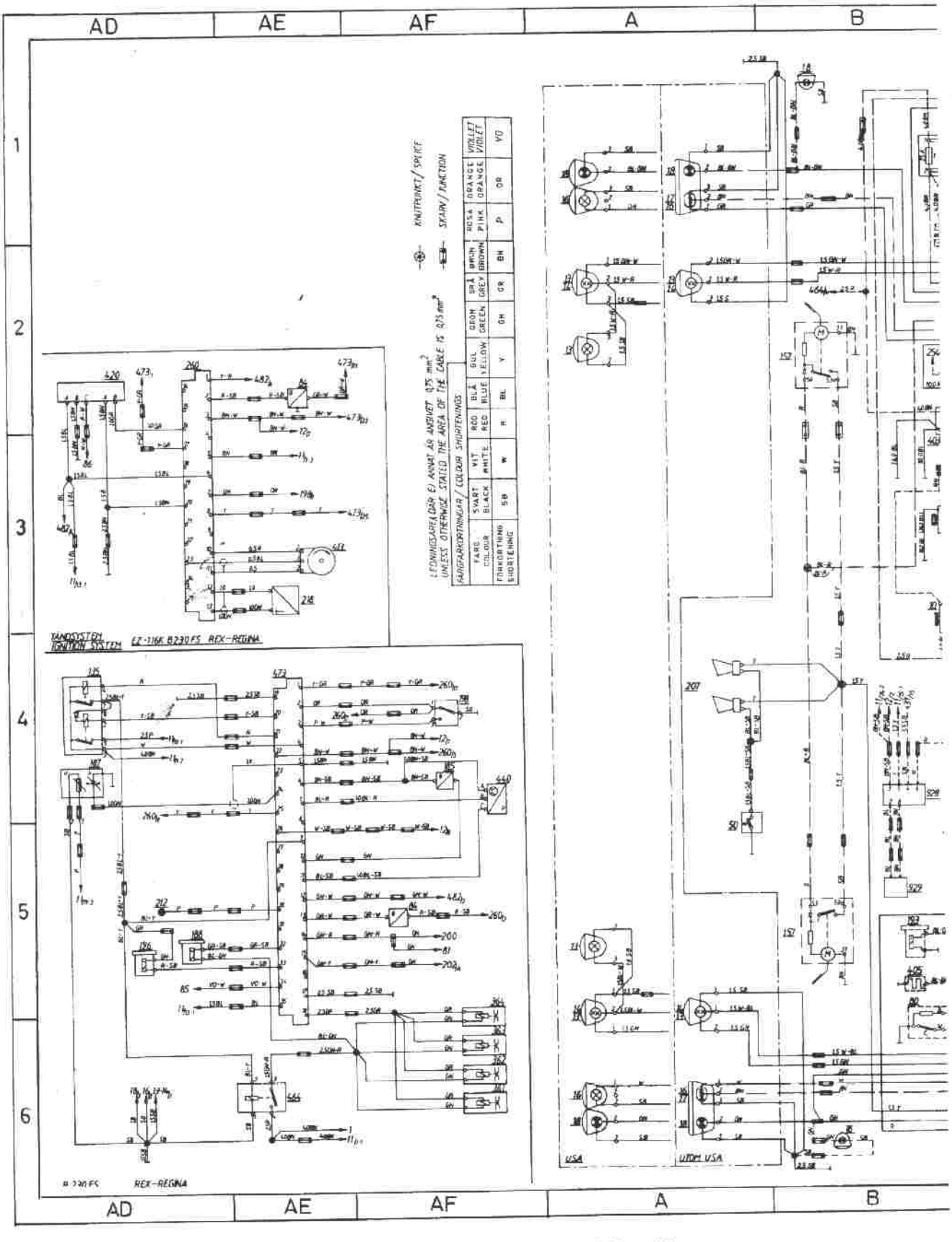
Key to wiring diagrams WD7 and WD8

No	Description	Coordinate
1	Battery	B2
2	Ignition switch	E3
3	Instrument connection (4-pole)	Z4
4	Ignition coil	C5
5	Distributor	C4, R4
6	Spark plug	C3
7	Instrument connection (7-pole)	Z4
8	Instrument connection (8-pole)	Z4
9	Starter motor	B3
10	Alternator (incl. regulator)	B3
11	Fusebox	B-K1
12	Instrument connection (12-pole)	Z4
13	High beam	A2, A5
14	Low beam	A2, A5
15	Relay unit, 15 circuit	W4
16	Parking light (USA incl. rear)	A1, A6, L1, L6
17	Hazard lights	A1, A6
18	Turn signal bulb	A1, A6, B1, B6, L1, L6
19	Back-up light bulb	L1, L6
20	Rear fog light bulb	L1, L6
22	Brake light bulb	L1, L4, L6
23	Fog light bulb	A2, A5
24	Numberplate lighting	L3, L4
25	Courtesy light bulb	N5
26	Reading light, front	N5
27	Inside lights	N5
29	Positive terminal	D2
30	Relay unit (30 circuit)	W4
31	Relay unit (31 circuit)	W3
32	Glove compartment light	M4
33	Ashtray light, front	G3
34	Ashtray light, rear	J4
35	Sunroof switch light	F3
36	Seat heater switch light, passenger	J4
37	Gear selector light, auto. trans	J4
38	Instrument and panel lighting	F3, G3
39	Engine compartment light	C2, N3
40	Trunk light	M5
41	Door-open warning light	M5, N5
42	Heater controls light	G3, Z1, AB1
43	Sunvisor light	N4
45	Seat belt lock, driver	J5, X4
46	Seat belt lock, passenger	J4, X4
47	Windscreen wiper and washer switch	H3
48	Headlight switch	H4
49	Turn signal/hazard light switch	H5
49	High beam/low beam	
50	Horn	A5
51	Heated rear window switch	K2, K3
52	Rear fog light switch	T5, AB6, AC6
53	Seat heater switch, passenger	J3, Q3
54	Overdrive switch	Z4, Z5
55	Heater fan switch	J3, Z1
56	Power window switch, driver	A3
57	Power window switch, passenger	AC4
58	Power window switch, driver side, rear	AB4
59	Power window switch, passenger side, rear	AB4
60	Power door mirror switch, driver	AA5
61	Power door mirror switch, passenger	AA5
62	Central lock linkage	Z4
64	Sunroof switch	Z3
65	Fog light switch	T6, AA6, AC6
66	Brake light contact	G3, T5, W2
67	Choke contact	F3
68	Parking brake contact	F3
70	Back-up light contact	J6
71	Start inhibitor switch, auto.trans	D3
72	Driver door switch	M4
73	Passenger door switch	N4
74	Door switch, rear	M6, N6
75	Passenger seat contact	J4
76	Pressure sensor, turbocharger	U4
77	Overdrive contact (M46)	Z5
80	Thermal time-switch	B6

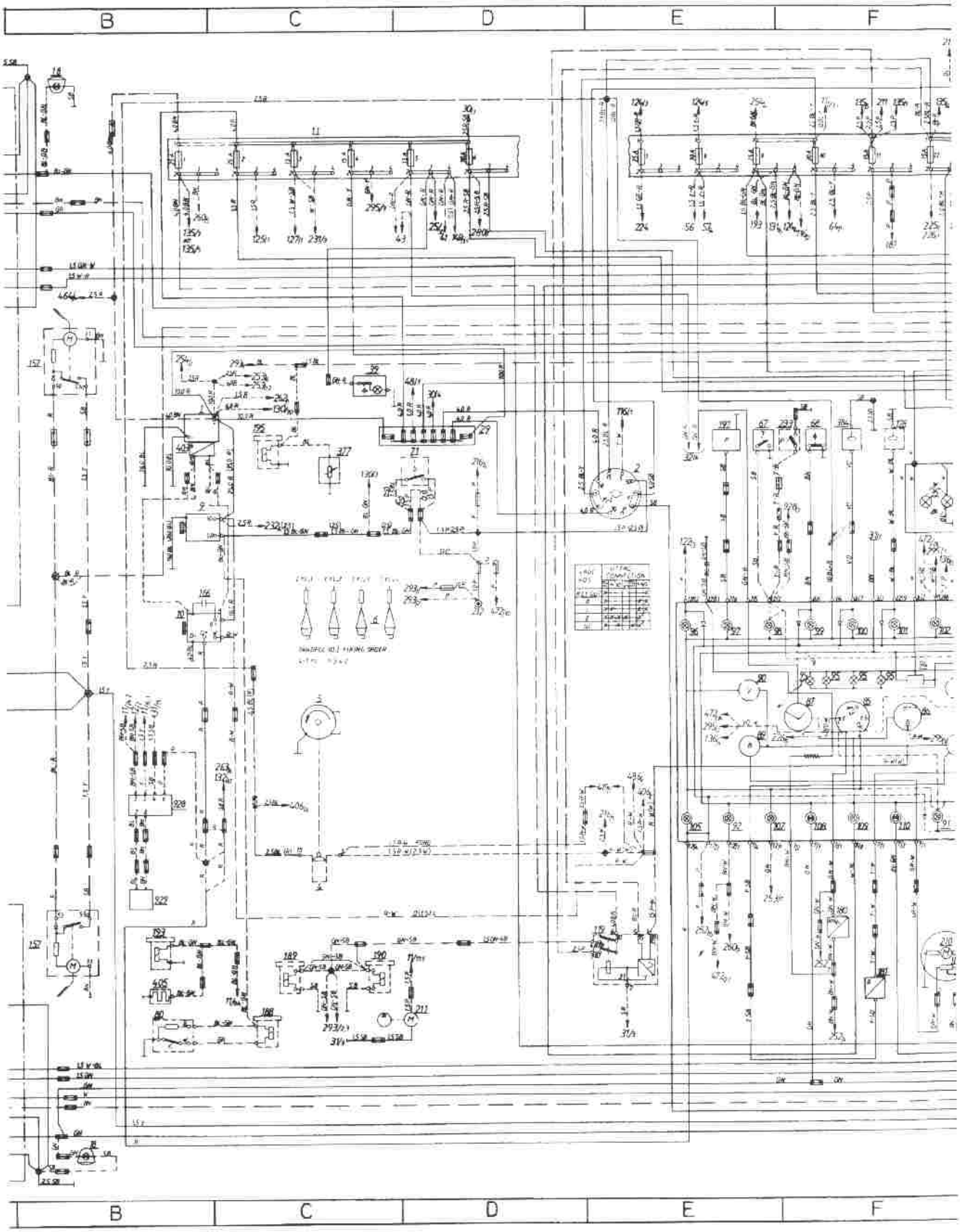
No	Description	Coordinate
81	AC pressure sensor	AC1, A2
82	Temperature sensor, heater fan	AB2
84	Coolant temperature sensor	P5, Q1, U2, V3, AA3, N2, AE2, AF5
85	Speedometer	F4
86	Tachometer	F4
87	Clock	F4
88	Engine temperature gauge	F4
89	Fuel gauge	E4
90	Volt meter	E4
91	Service reminder light	F5
92	Indicator lamp, diagnosis	E5
94	Panel lighting intensity (rheostat F)	F4
95	Instrument lighting	F4
96	Indicator light, exhaust gas temperature (Japan)	E4
97	Indicator lamp, oil pressure	E4
98	Indicator lamp, choke	E4
98	(alt) Indicator lamp, boost pressure (turbocharger)	
99	Indicator lamp, parking brake	F4
100	Indicator lamp, brake failure	F4
101	Indicator lamp, washer level	F4
102	Indicator lamp, AW70/71 auto.trans. overdrive	F4
103	Indicator lamp, bulb failure	G3
104	Indicator lamp, glow plugs (diesel)	G3
104	Indicator lamp, (Diesel)	
105	Indicator lamp, battery charge	E5
107	Indicator lamp, ABS	E5
108	Indicator lamp, left turn signal	F5
109	Indicator lamp, high beam	F5
110	Indicator lamp, right turn signal	F5
112	Indicator lamp, M46 overdrive	F5
113	Indicator lamp, front seat belts	F5, X3
114	Indicator lamp, rear seat belts	J5, X3
115	Bulb failure warning sensor	I4
116	Fasten seat belt light (USA)	X3
117	Windscreen wipers, intermittent relay	G3
118	Rear windscreen wiper, intermittent relay	R4
119	Relay, fuel pump	E5
121	Flasher unit, hazard lights	G4
122	Relay, exhaust gas temperature (Japan)	O5
123	Relay, M46 overdrive	Z5
124	Relay, power windows	AC4
125	Relay, central lock	AA4
127	Relay, auxiliary lights	I6, AB6, AC6
130	Relay, glow plugs (diesel)	R5
131	Relay, fan	AA1, AC2
132	Relay, AC	Z1
135	Relay, Motronic, LH-2.2, LH-2.4	M1, U2, U5, AC4
136	Relay, overdrive AW70/71	Z4
137	Relay, headlights	H4
138	Seat heater pad, driver	K5, R3
138	Seat heater pad, passenger	J2
139	Seat heater backrest, driver	K5, P3
139	Seat heater backrest, passenger	K2, Q3
142	Thermostat, driver seat	J5, P3
142	Thermostat, passenger seat	J2, Q3
143	Loudspeaker, passenger door	Y1, Y2
144	Loudspeaker, driver door	Y1, Y2
145	Loudspeaker, rear left	Y1, Y2
146	Loudspeaker, rear right	Y1, Y2
147	Aerial	Y1, Y3
148	Power aerial	Y1, Y2
149	Radio	X1, X2
150	Motor, driver power window	AC3
151	Motor, passenger power window	AC5
152	Motor, power window, rear, driver side	AB5
153	Motor, power window, rear, passenger side	AB5
154	Power mirror, driver side	K2, Z5
155	Power mirror, passenger side	K2, A5
156	Motor, electric cooling fan	W1
157	Motor, headlight wiper	B2, B5
158	Motor, sunroof opening	Z3
159	Motor, central lock, passenger door	AB4
160	Motor, central lock, rear door, driver side	Z5

Key to wiring diagrams WD7 and WD8 (continued)

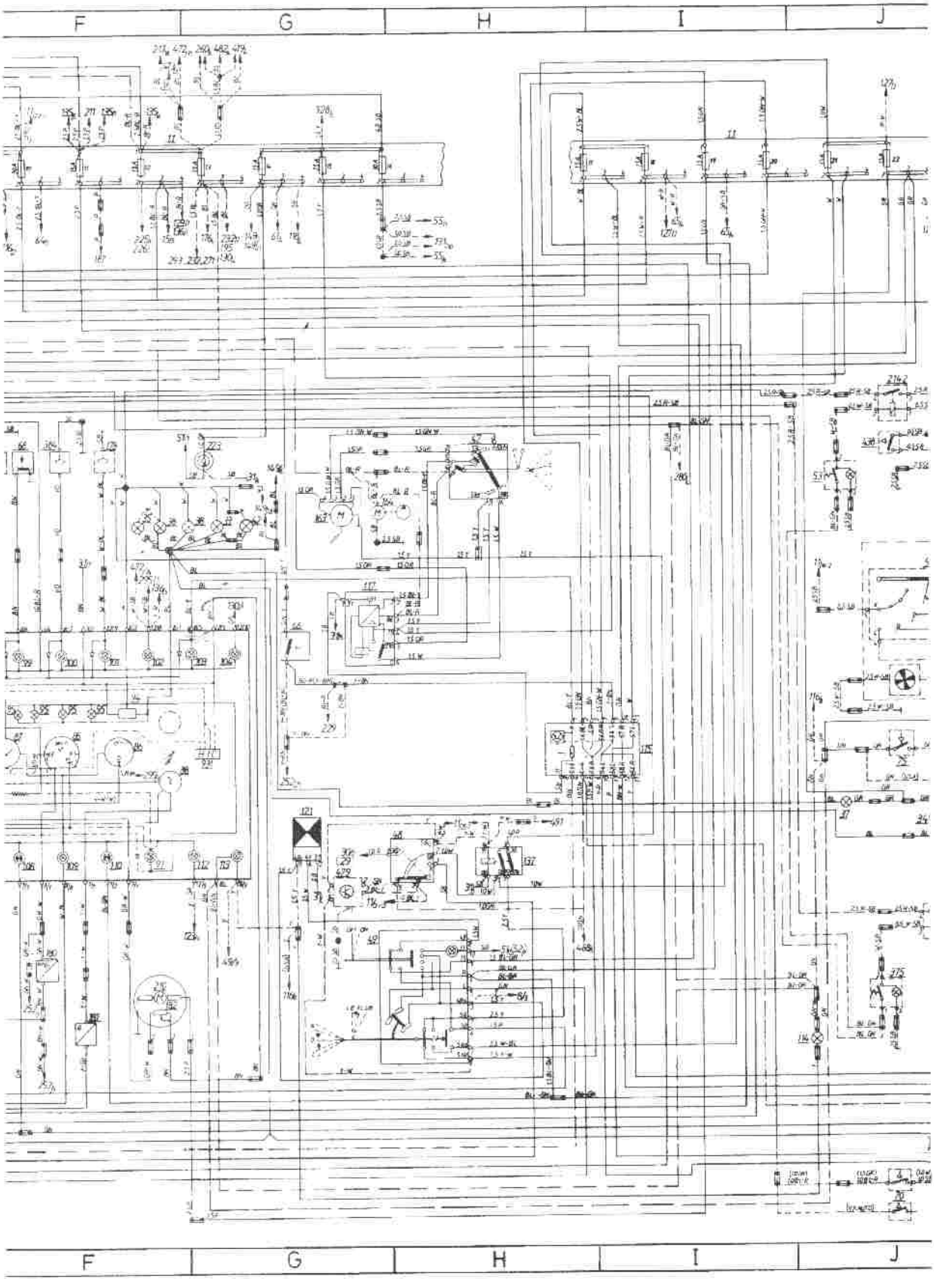
No	Description	Coordinate
161	Motor, central lock, rear door, passenger side	AB5
162	Motor, central lock, trunk	AA5
163	Motor, windscreen wiper	G3
164	Motor, windscreen washer	G3
165	Motor, heater fan	AA2, AB1
166	Capacitor	C3
169	Resistor, heater	AA1, AB1
170	Catalytic converter, thermo element	AC5
173	Delay relay, courtesy light	N4
176	Control unit, CIS	AA3
178	Washer level sensor	F3
180	Speedometer sensor	F5, T2
181	Engine temperature sensor	F5
182	Fuel level sensor	F5
185	Charge air temperature sensor	AF4
186	Air flow meter	V1
187	Lambdasond, heated or unheated	AD4
188	Starter valve	AD5, M2
189	Control pressure valve	C5
190	Auxiliary air valve	C5
193	Hot start valve	B5
194	Solenoid valve, AC compensation/ignition advance	X4
195	Solenoid valve, carburettor	S5
195	(alt) Fuel valve (diesel)	
196	Idle valve	AD5
197	Oil pressure sensor	E3
198	Throttle switch, LH-Jetronic	AF4
199	Temperature sensor (diesel)	S5
200	Actuator solenoid	X4
201	Actuator solenoid, overdrive	Y5, Z4
202	Climate control	Z3, AA2
203	Temperature control	Ä2, AB2
204	Outside temperature sensor	Ä2, AB2
205	Inside temperature sensor	Ä2, AB2
206	Program controller	Ö2, AC2
207	Horn	A4
208	Glow plug (diesel)	S5
210	Tank pump	F5
211	Fuel pump	D5
212	Service socket	D3, S5, W6, X6, AD5
213	Throttle switch, Motronic	P1
214	Crankshaft position indicator	U1
215	Engine RPM sensor	U1
216	Control unit, Motronic	U1
217	Control unit, LH-2.2	U3
218	Knock sensor	Q2, Q6, AE3
219	Test point, Lambdasond	U4
220	Test point, idle	V4, AA3
221	Heated rear window	K2
223	Cigarette lighter	G2
224	Thermostat, electric cooling fan	W1
225	Cruise control switch	W1
226	Control unit, cruise control	W2
227	Vacuum pump, cruise control	W2
228	Bridge connector, clutch	T5, W2
229	Bridge connector, brake	T5, W2
231	Relay, fog lights, rear	T5, AA6
232	Relay, hot spot	X5
233	Turbocharger pressure sensor (turbo diesel)	R6, E3
234	Thermostat, hot spot	Y5
235	PIC resistor, hot spot	X5
238	Motor, window washer, rear	S4
239	Cut-over, window washer, rear	R4
240	Contact, wiper/washer, rear window	S3
241	Motor, wiper, rear window	R3
251	Kickdown unit	Z5
252	Control unit, ABS	T1
253	Hydraulic unit, ABS	T3
254	Transient surge protector, ABS	S2
256	Sensor ABS, front left	T1
257	Sensor ABS, front right	T1
258	Hydraulic pump, ABS	T3
260	Control unit, EX-K ignition system	P1, Q4, AD2
262	Vacuum pump, ACC	AA1
263	Relay, vacuum pump, ACC	AA1
266	Delay relay, heated rear window	K2, K4
267	Test outlet, EZ-K	Q5
271	Fuel turn-off valve	P4
272	Microswitch, engine	Q5
274	Time-relay, EGR	T3
275	Microswitch, idle	T3
276	Transformer, EGR	Q1
277	Three-way valve, EGR	T3
278	Aneroid switch	T4
279	Solenoid, altitude compensation	T4
280	Relay, heater, driver seat	P2
284	Air mass meter	N1, V4
289	Power stage	P3
292	Solenoid, idle increase	Z6
293	Relay, idle increase	W6, X6, Z6
295	Relay, gear shift indicator	S5
346	Roof light, trunk	M6
347	Door contact, rear	N6
361	Injector 1	N3, V2, V6, AF6
362	Injector 2	N3, V2, V6, AF6
363	Injector 3	N3, V2, V6, AF6
364	Injector 4	N3, V2, V6, AF6
375	Seat heater switch, driver	L5, P3
376	Ballast resistor	U6, V2
377	PTC resistor	C3
378	Positive pole, engine compartment, ABS	T2
384	Brake fluid level sensor	F3, T1
403	Temperature sensor, battery	B2
404	Microswitch, vacuum control valve	T3
405	Half-automatic heated choke	B5
406	Control unit, Renix	Q3
407	Impulse generator, Renix	R3
413	Impulse generator, EZ-K	Q2, AE2
419	Power stage, EZ-K	P1, P4
420	Power stage, REX-1	AO2
424	Solenoid valve, charge pressure limiter	R6
438	Seat heater contact	J3
440	Pressure sensor, REX-1	AF4
464	Relay, injectors	N3, U6, V3, AE6
472	Control unit, LH-2.4	M1, M2
473	Control unit, REX-Regina	AE4
479	Control unit, DIM-DIP	G5
482	Diagnostic outlet	N2, Q2, P2, AD3
488	Relay, hazard lights	T5
490	Power aerial switch	Y2
886	Transfer box 1234705	N1, V4
901	Amplifier, radio	X2
928	SRS	B4
929	Ignition module, SRS	B5
931	Safety circuit, SRS	G4



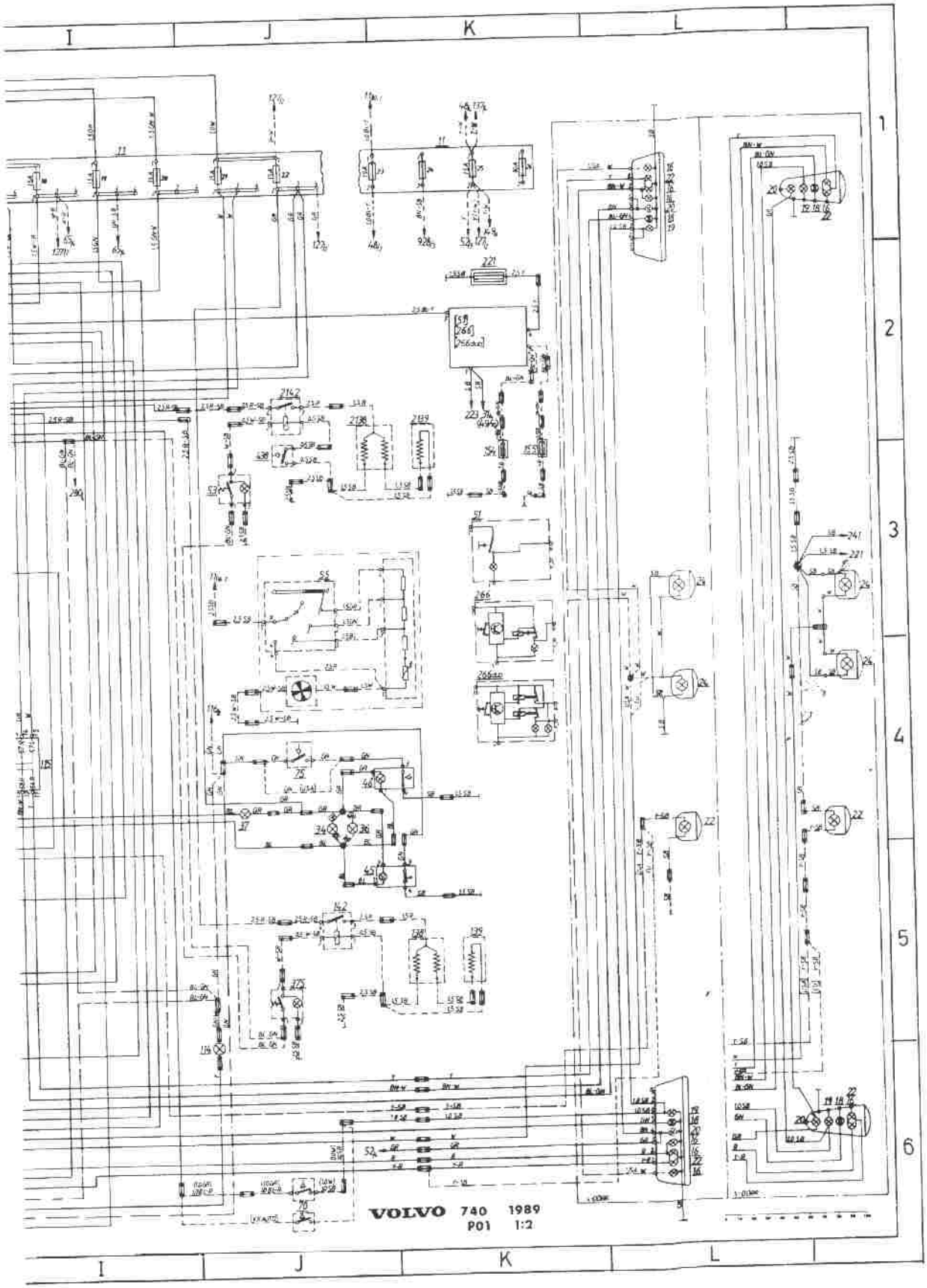
WD7 : Main wiring diagram for 1989 740 models



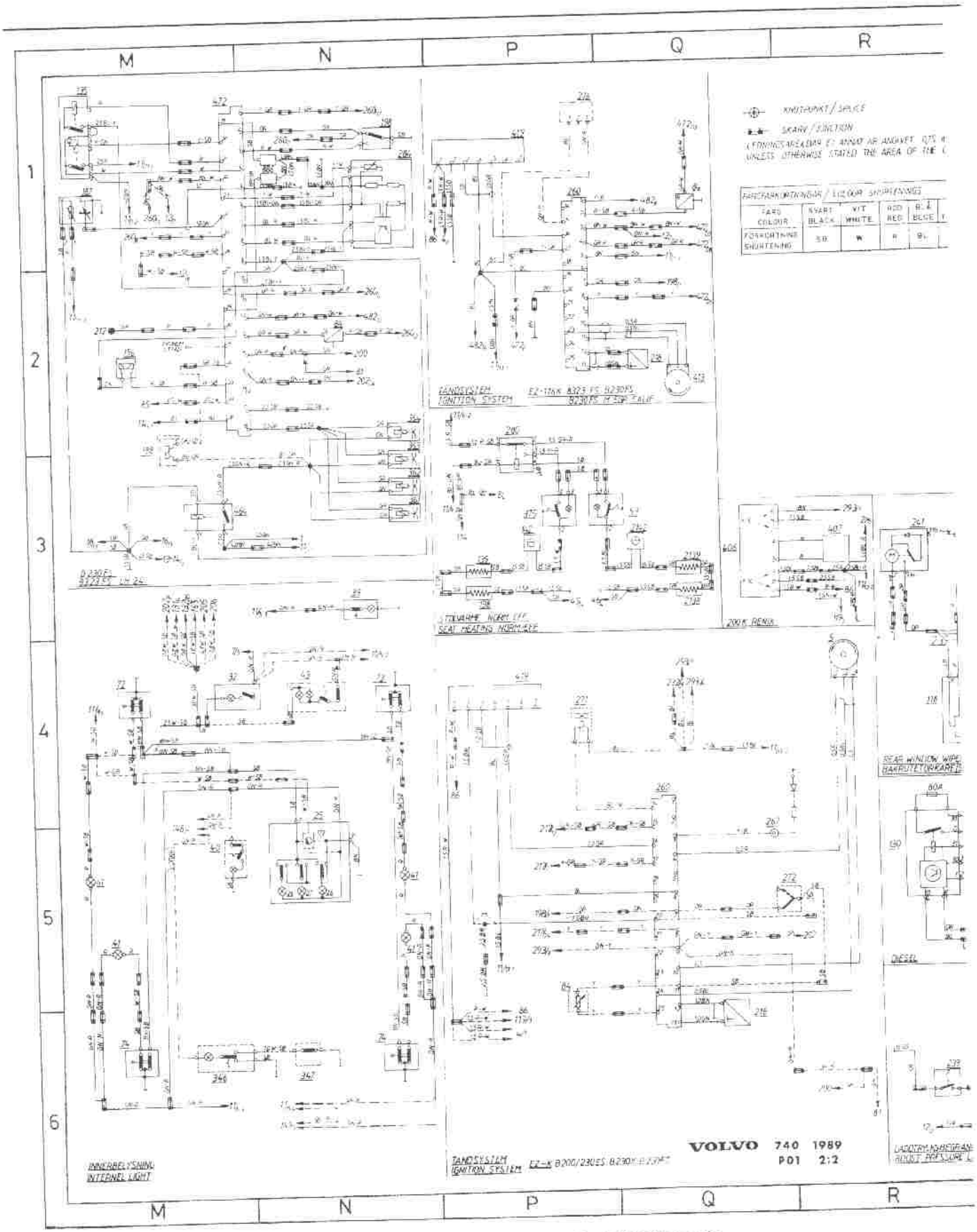
WD7 (continued) : Main wiring diagram for 1989 740 models



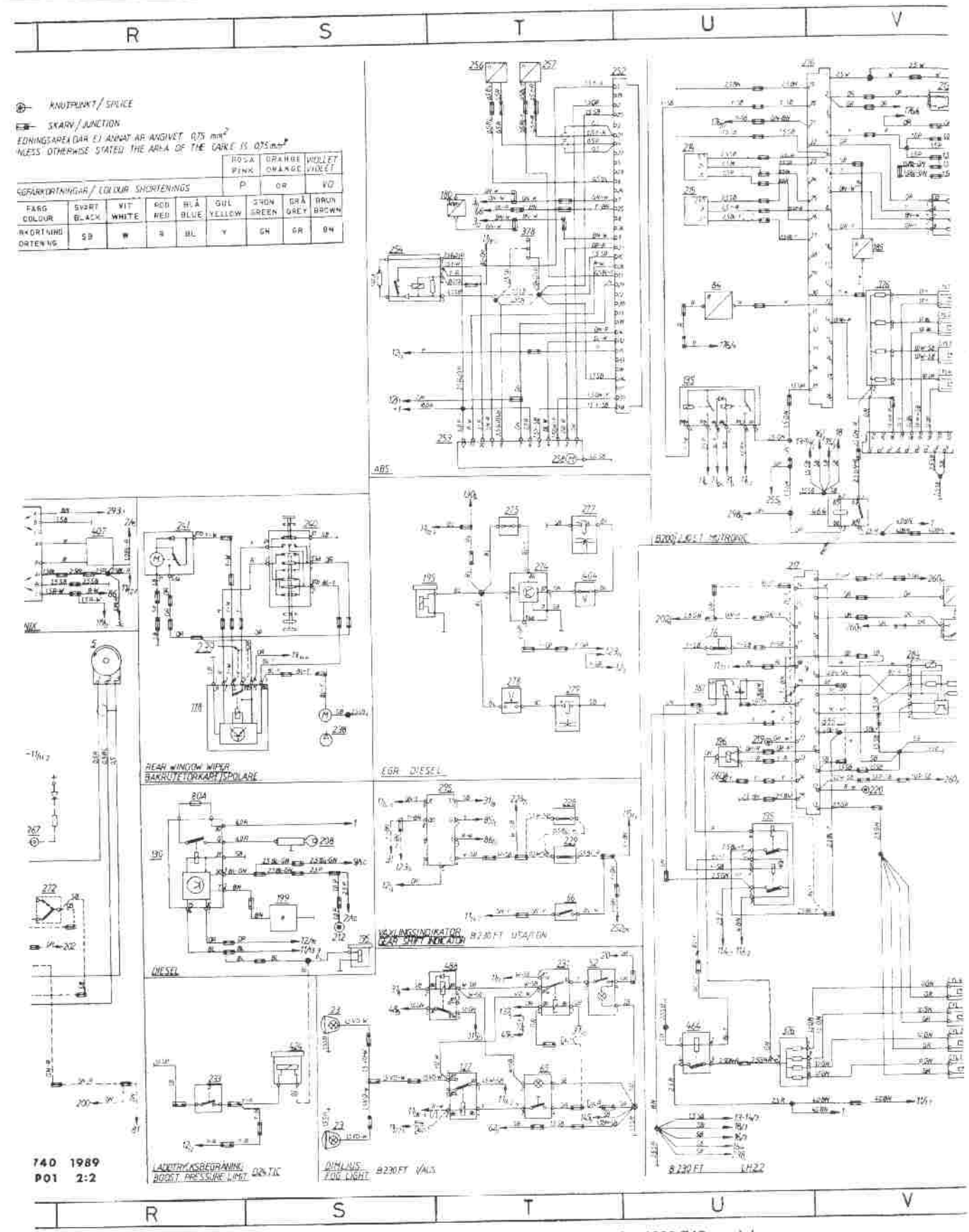
WD7 (continued) : Main wiring diagram for 1989 740 models



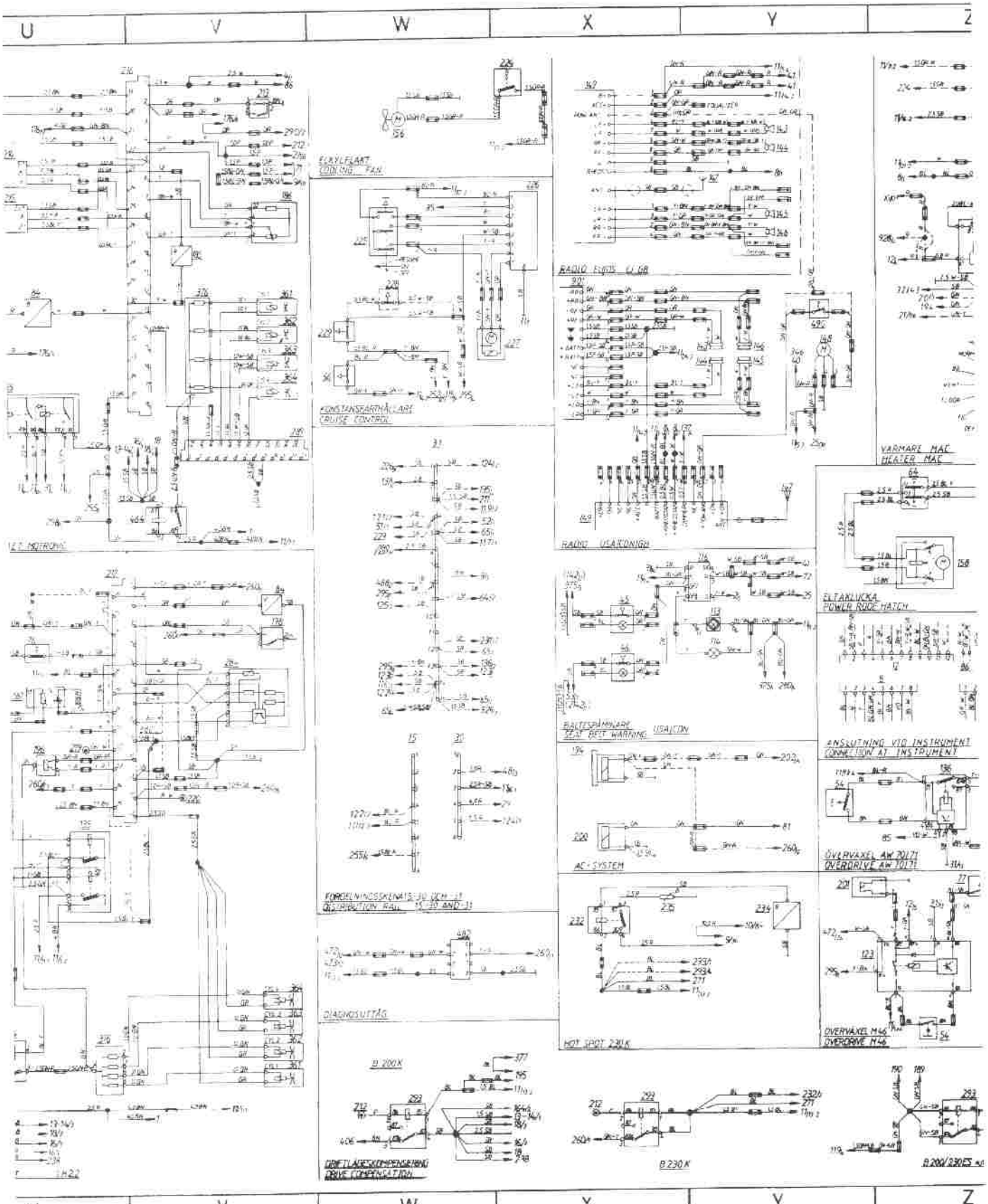
WD7 (continued) : Main wiring diagram for 1989 740 models



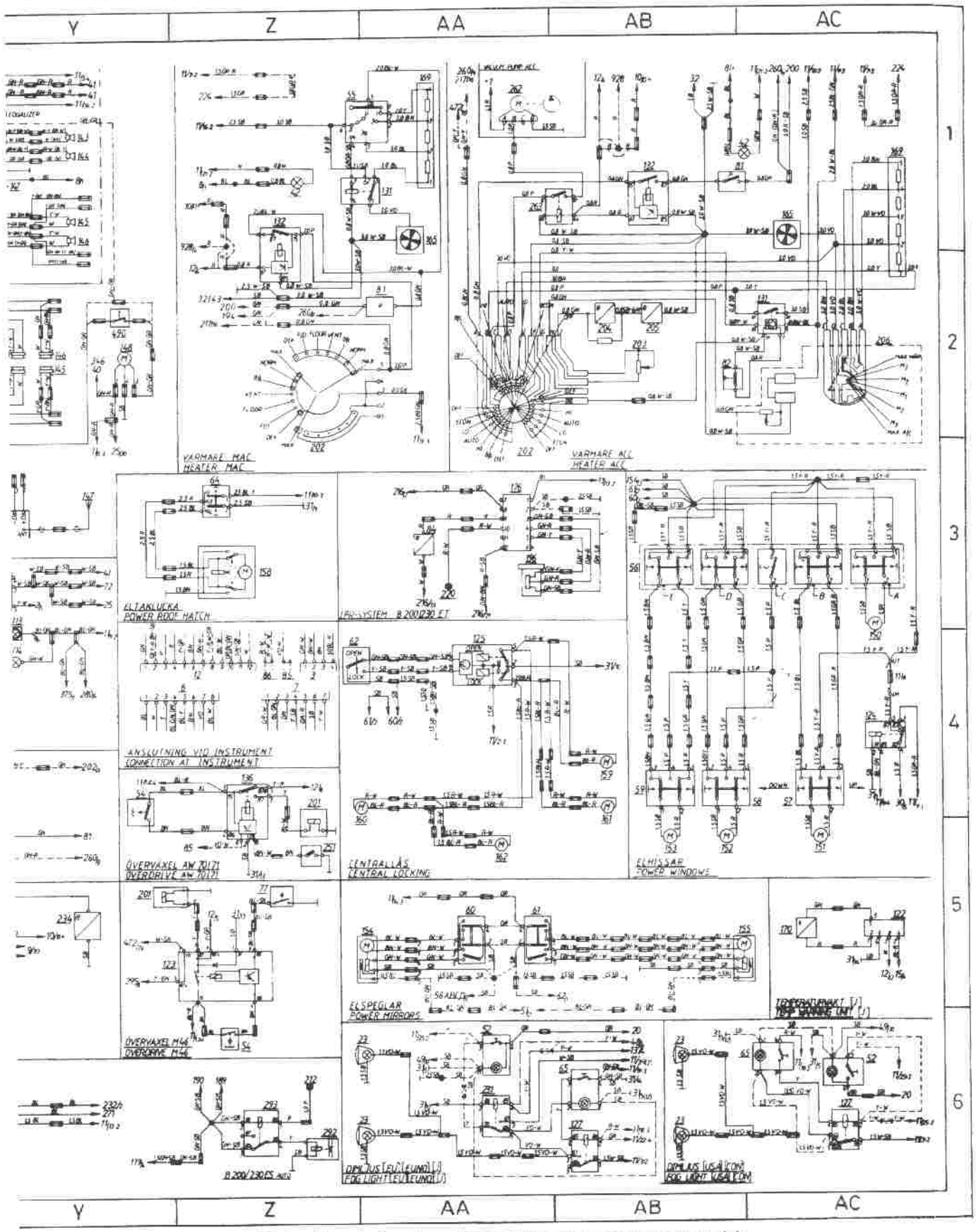
WD8 : Supplementary wiring diagram for 1989 740 models



WD8 (continued) : Supplementary wiring diagram for 1989 740 models



WD8 (continued) : Supplementary wiring diagram for 1989 740 models



WD8 (continued) : Supplementary wiring diagram for 1989 740 models

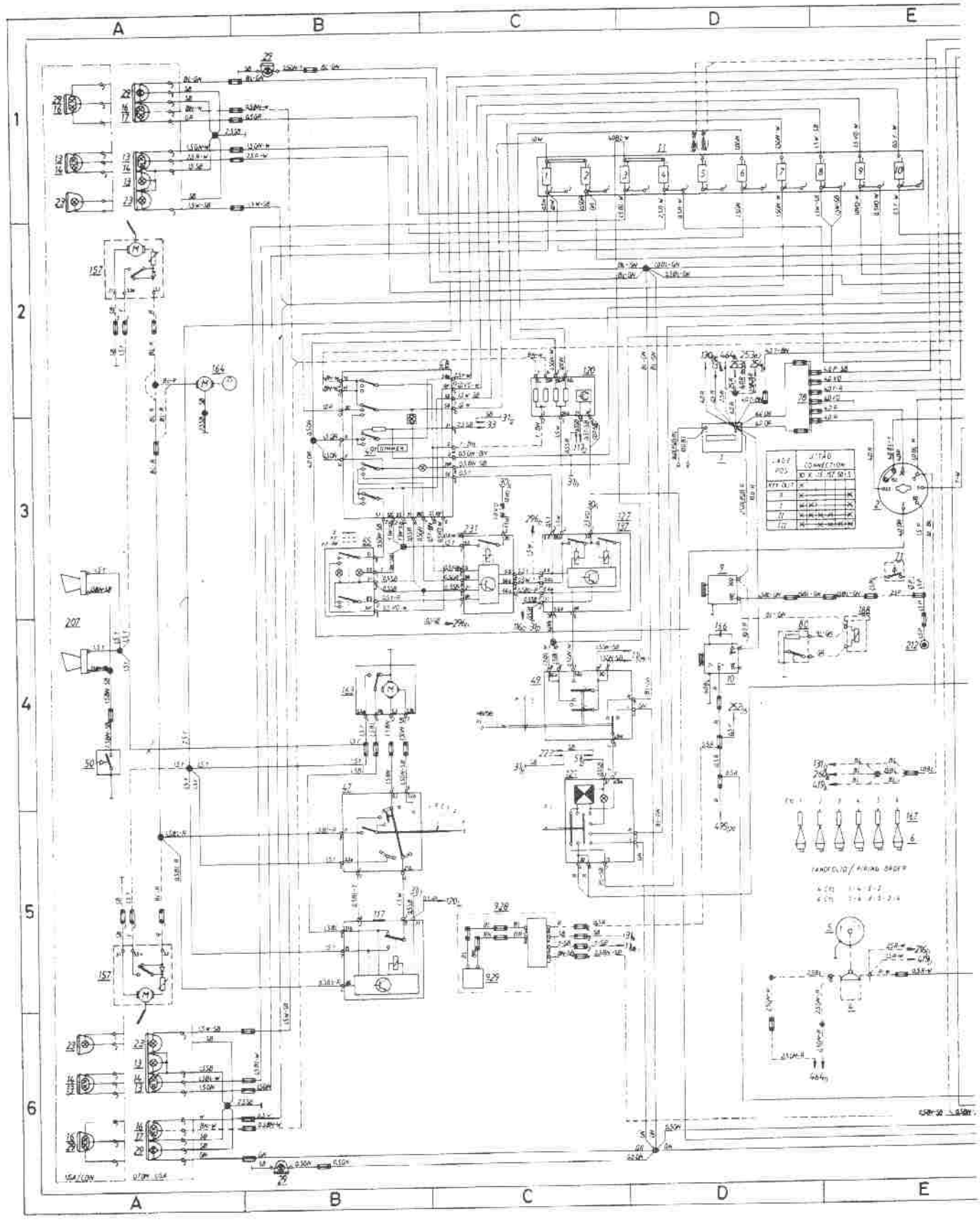
Key to wiring diagrams WD9 and WD10

No	Description	Coordinate
1	Battery 12V	D3
2	Ignition switch	E3
3	Instrument connection (4-pole)	T5
4	Ignition coil 12V	D6, N5, P5
5	Distributor	D5, R5
6	Spark plug	E5
8	Instrument connection (8-pole)	T5
9	Starter motor 800W	Q3
10	Alternator (incl. regulator)	Q4
11	Fusebox	B-K1
12	Instrument connection (12-pole)	T5
13	High beam 60W	A1, A6
14	Low beam 55W max	A1, A6
15	Relay unit, 15 circuit	
16	Parking light 4CP/5W (USA: rear also)	A1, A6, L1, L6
17	Hazard light 32CP/21W	A1, A6
18	Instrument connection (18-pole)	T6
21	Tail light 4CP/5W	L2, L6
22	Brake light 32CP/21W	L1, L5, L6
23	Fog light 55W	A1, A6, L1, L6
24	Numberplate lighting 4CP/5W	L4
25	Courtesy light	W5
26	Reading light, front 5W	W5
27	Reading light, front 5W	W5
27	Courtesy light 10W	W5
28	Reading light, rear 5W	V5, W5
29	Turn signal bulb 32 CP/21W	A1, A6, B1, B6, L2, L6
30	Relay unit (30 circuit)	T4
31	Relay unit (21 circuit)	T4
32	Glove compartment light 2W	W4
33	Ashtray light, front 1.2W	I3
34	Ashtray light, rear 1.2W	I3
35	Sunroof switchlight 1.2W	I3
36	Seat heater switch light, passenger 1.2W	
37	Gear selector light, auto. trans. 1.2W	I3
38	Instrument and panel lighting 1.2W	H3
39	Engine compartment light 15W	W3
40	Trunk light	V5
41	Door-open warning light	V4, V5, W4, W5
42	Heater controls light	H3
43	Sun visor light	W4
44	Glove compartment light switch	W4
45	Seat belt lock light, driver 1.2W	J4
46	Seat belt lock light, passenger 1.2W	J3
47	Windscreen wiper switch	B4
48	Headlight switch	B2
49	Turn signal/hazard lights/headlight switch	C4
50	Horn switch	A4
51	Heated rear window switch	K2
52	Seat heater switch, driver	J4
53	Seat heater switch, passenger	J3
54	Overdrive switch M46	P6
56	Power window switch, driver, front	X3
57	Power window switch, passenger front	Y5
58	Power window switch, driver, rear	Y5
59	Power window switch, passenger, rear	X5
60	Power door mirror switch, driver	X5
61	Power door mirror switch, passenger	X5
62	Central lock linkage switch	W6
64	Sunroof switch	T6
65	Fog light switch, front/rear	B3
66	Brake light contact	J5, R6, S5
68	Parking brake switch	G5
70	Back-up light contact	J6
71	Start inhibitor switch, auto.trans	E3
72	Driver door switch	V3
73	Passenger door switch	X3
74	Door contact, rear	V4, X4
75	Passenger seat contact	I4
76	Pressure sensor, turbocharger	N3
77	Overdrive contact (M46)	P6, R6
78	Positive terminal	E2
79	Fuse box light	W4
80	Thermal time-switch	O4
81	AC pressure sensor	U3

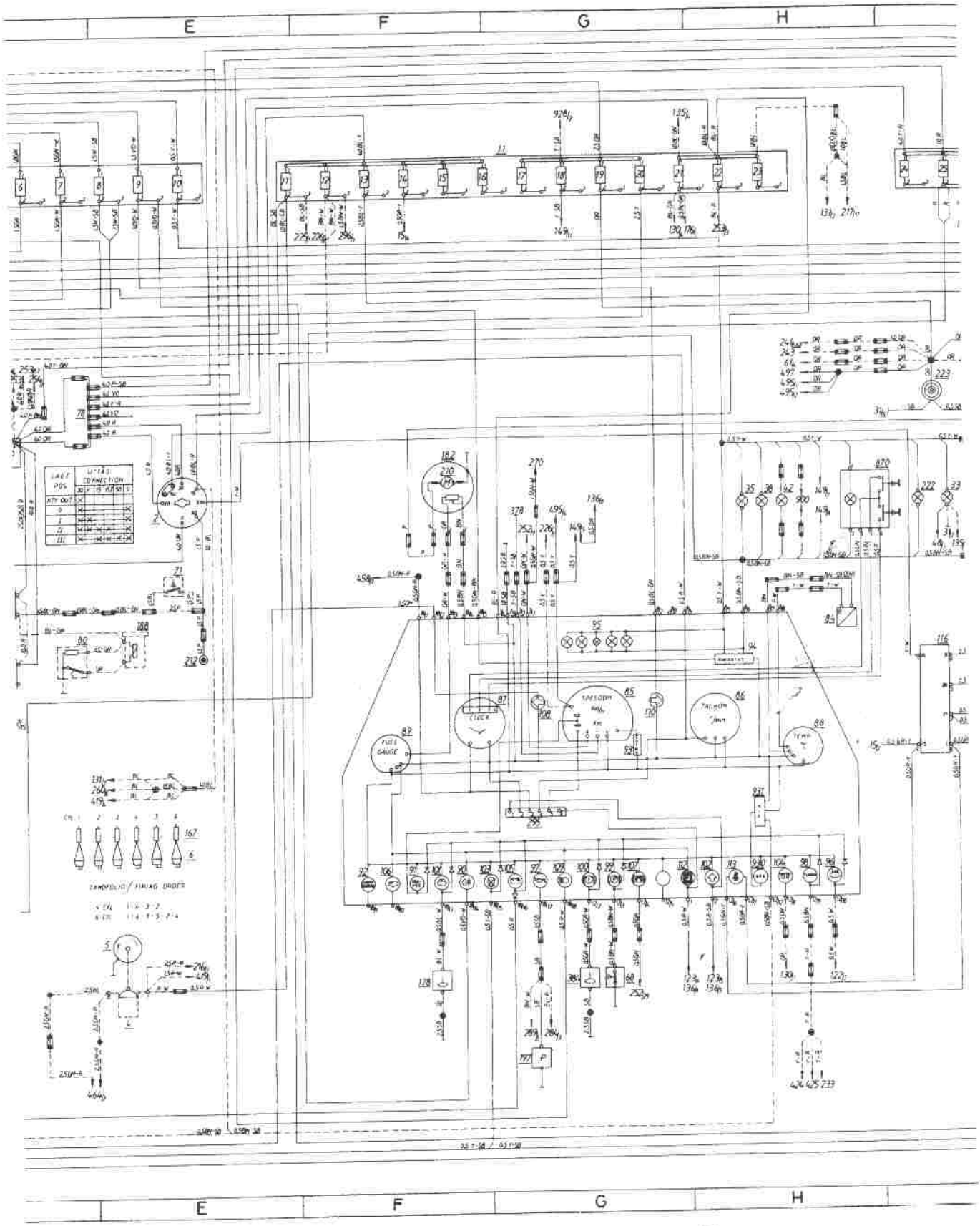
No	Description	Coordinate
84	Coolant temperature sensor	Q2, P3, P5, R3, S3, V1
85	Speedometer	G4, Z4
86	Tachometer	H4
87	Clock	F4
88	Engine temperature gauge	H4
89	Fuel gauge	F4
90	Indicator light, rear foglight	F5
91	Indicator lamp, service	F5
92	Indicator lamp, diagnosis	F5
93	Speed warning chime	G4
94	Panel lighting intensity (rheostat)	H4
95	Instrument lighting	G4
96	Indicator lamp, temperature warning	H5
97	Indicator lamp, oil pressure	G5
98	Indicator lamp, boost pressure (turbocharger)	H5
99	Indicator lamp, parking brake	G5
100	Indicator lamp, brake failure	G5
101	Indicator lamp, washer level	F5
102	Indicator lamp, W/70/71 auto.trans. overdrive	H5
103	Indicator lamp, bulb failure	F5
104	Indicator lamp, glow plugs (diesel)	H5
105	Indicator lamp, battery charge	F5
106	Indicator lamp, trailer	F5
107	Indicator lamp, ABS	G5
108	Indicator lamp, left turn signal	G4
109	Indicator lamp, high beam	G5
110	Indicator lamp, right turn signal	G4
112	Indicator lamp, M46 overdrive	G5
113	Indicator lamp, front seat belts	H5
114	Indicator lamp, rear seat belts	I4
115	Bulb failure warning sensor (14-pole)	K5
116	Fasten seat belt light (USA)	I4
117	Windscreen wipers, intermittent relay	B5
118	Rear windscreen wiper, intermittent relay	U6
120	Bulb failure warning sensor (9-pole)	C2
121	Flasher unit and switch, hazard lights	C4
122	Relay, temperature warning (Japan)	R5
123	Relay, M46 overdrive	N6
124	Relay, power windows and electric cooling fan	Y5
125	Relay, central lock	X6
127	Relay, auxiliary lights	C3
130	Relay, glow plugs (diesel)	S5
131	Relay, fan	V2
135	Relay, Motronic, LH-2.2	N3, Q2, Q3
136	Relay, overdrive AW70/71	Q6
137	Relay, headlights	C3
138	Seat heater pad, driver 30/130W	K4
	Seat heater pad, passenger 30/130W	K3
139	Seat heater backrest, driver	K4
	Seat heater backrest, passenger	K3
140	Loudspeaker, instrument panel, left	U2
141	Loudspeaker, instrument panel, right	U2
142	Thermostat, driver seat	J4
	Thermostat, passenger seat	J3
143	Loudspeaker (4 Ω), passenger door	U1
144	Loudspeaker (4 Ω), driver door	U2
145	Loudspeaker (4 Ω), rear left	U2
146	Loudspeaker (4 Ω), right rear	U1
147	Aerial	T2
148	Power aerial 3A	U3
149	Radio	T2
150	Motor (5A), driver power window	Y4
151	Motor (5A), passenger power window	Y5
152	Motor (5A), driver power window, rear	X5
153	Motor (5A), passenger power window, rear	X5
154	Power mirror, driver side	W5
155	Power mirror, passenger side	Y5
156	Motor (13A), electric cooling fan	W2
157	Motor (1A), headlight wiper	A2, A5
158	Motor, sunroof opening	T6
159	Motor, central lock, passenger door	Y6
160	Motor, central lock, rear door, driver side	W6
161	Motor, central lock, rear door, passenger side	Y6
162	Motor, central lock, trunk	Y6
163	Motor (3.5A), windscreen wiper	B4

Key to wiring diagrams WD9 and WD10 (continued)

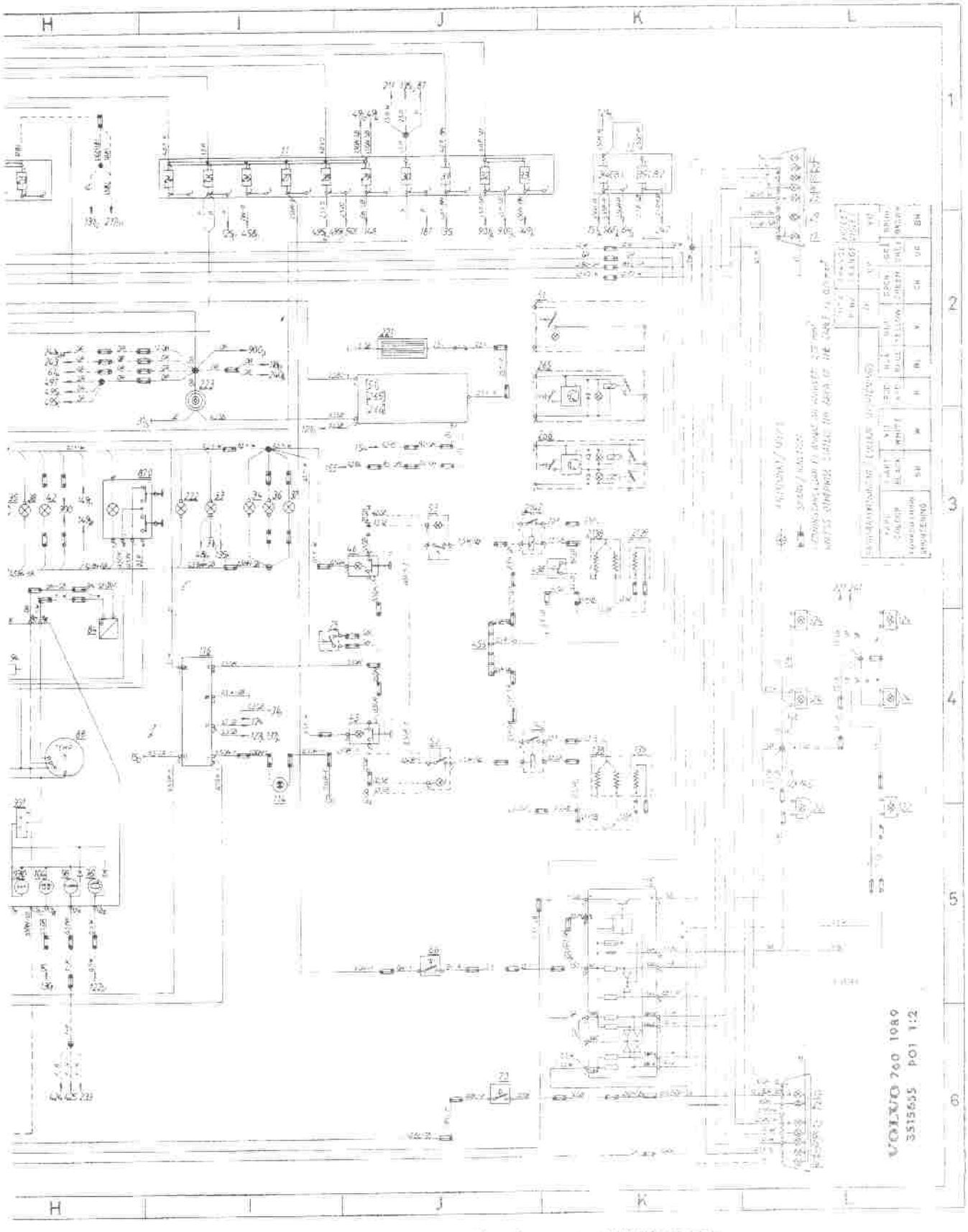
No	Description	Coordinate
164	Motor (2.6A), windscreen washer	A2
166	Capacitor	D4
167	Suppressor resistor	E4
170	Thermo-element, catalytic converter	R5
176	Control unit, CIS	S3
178	Washer level sensor	F5
182	Fuel level sensor	R3
185	Charge air temperature sensor	Q2
186	Air flow meter	R1
187	Lambdasond	N3, Q4
188	Cold start injector	E4
195	Solenoid valve, carburettor	S5
195	(alt) fuel valve (diesel)	S5
196	Idle valve	N4, Q4, S3
197	Oil pressure sensor	G6
198	Throttle switch	P3, P5, R3, R5
199	Temperature sensor (diesel)	S5
200	AC compressor (3.9A)	U3
201	Actuator solenoid, overdrive	P6, R6
207	Horn (5A + 5A)	A3
208	Glow plug (diesel)	S5
210	Tank pump	F3
211	Fuel pump (6.5A)	N4, Q2, Q4
212	Service socket	E4
213	Throttle switch, Motronic	R1
214	Crankshaft position sensor	Q1
215	Engine RPM sensor	Q1
216	Control unit, Motronic	Q1
217	Control unit, LH-2.2	N3, R3
218	Knock sensor	N4, Q4
219	Test point, Lambdasond	N4, Q4
220	Test point, idle system	P4, R4, S3
221	Heated rear window 150W	L2
222	Cigarette lighter (7A)	I3
223	Cigarette lighter light	I2
224	Thermostat, electric cooling fan	W3
225	Cruise control switch	S4
226	Control unit, cruise control	T4
227	Vacuum pump, cruise control	S5
228	Bridge connector, clutch pedal	R6, S5
229	Bridge connector, brake pedal	S5
231	Relay, rear fog lights	C3
233	Turbocharger pressure sensor (turbo diesel)	S6
238	Motor, window washer, rear (2.6A)	U6
240	Switch, wiper/washer, rear	U5
241	Motor, wiper, rear	U5
242	Power seat emergency stop	V6
243	Relay, power seat	V6
244	Control unit, adjustable power seat	V5
245	Power seat motor, fore-aft	W6
246	Power seat motor, up-down, front	W5
247	Power seat motor, up-down, rear	W5
248	Power seat motor, backrest tilt	W6
251	Kickdown inhibitor	R6
252	Control unit, ABS	T1
253	Hydraulic unit, ABS	S3
254	Transient surge protector, ABS	S2
256	Sensor ABS, front left	S1
257	Sensor ABS, front right	S1
260	Control unit, EX-K ignition system	N5, Q4
265	Delay relay, heated rear window	K2
266	Delay relay, heated rear window and door mirrors	K3
267	Test point, EZ-K	Q5
270	Speedometer sensor	S1
284	Air mass meter	R4
289	Power stage, DME	R2
295	Relay, gear shift indicator	G5, R5
296	Control unit, DIM-DIP	T3
346	Roof light, trunk	W5
347	Door contact, rear	W5
361	Injector 1	P4, R2, R4
362	Injector 2	P4, R2, R4
363	Injector 3	P4, R2, R4
364	Injector 4	P4, R2, R4
365	Injector 5	R4
366	Injector 6	R4
376	Series resistance	P4, R2
378	Ground, ABS	S1
384	Brake fluid level sensor	G5, S1
413	Impulse generator, EZ-K	P5
416	HT lead sensor	N5
417	Service socket, EZ-K	P5
419	Power stage, EZ-K	N4, Q4
424	Solenoid valve, charge pressure limiter	S6
425	Temperature sensor, charge pressure limiter	S6
438	Seat heater contact	L3
456	Relay unit (30 circuit)	J4
457	Relay unit, fuse box	W4
458	Relay unit (30 circuit), fuse box	W4
464	Relay, injectors	N3, Q4, R2
490	Power aerial switch	U2
491	Dimmer	B3
495	Heater controls, ECC 130	Y1
496	Heater controls, ECC sensor	W1
497	Solenoid valve, ECC	W1
498	Servo motor, ECC heater	Y3
499	Power unit, ECC	X2
501	Fan motor, ECC	X2
502	Ambient air temperature, ECC	V1
503	Sun heat sensor, ECC	W1
504	Inside air temperature sensor, ECC	V1
870	Clock switch	H3
886	Transfer box 1234705	P4, R4
900	Accessories	H3
901	Amplifier, radio	T1
928	SRS	C5
929	Ignition module, SRS	C5
930	Indicator lamp, SRS	H5
931	Safety circuit, SRS	H5



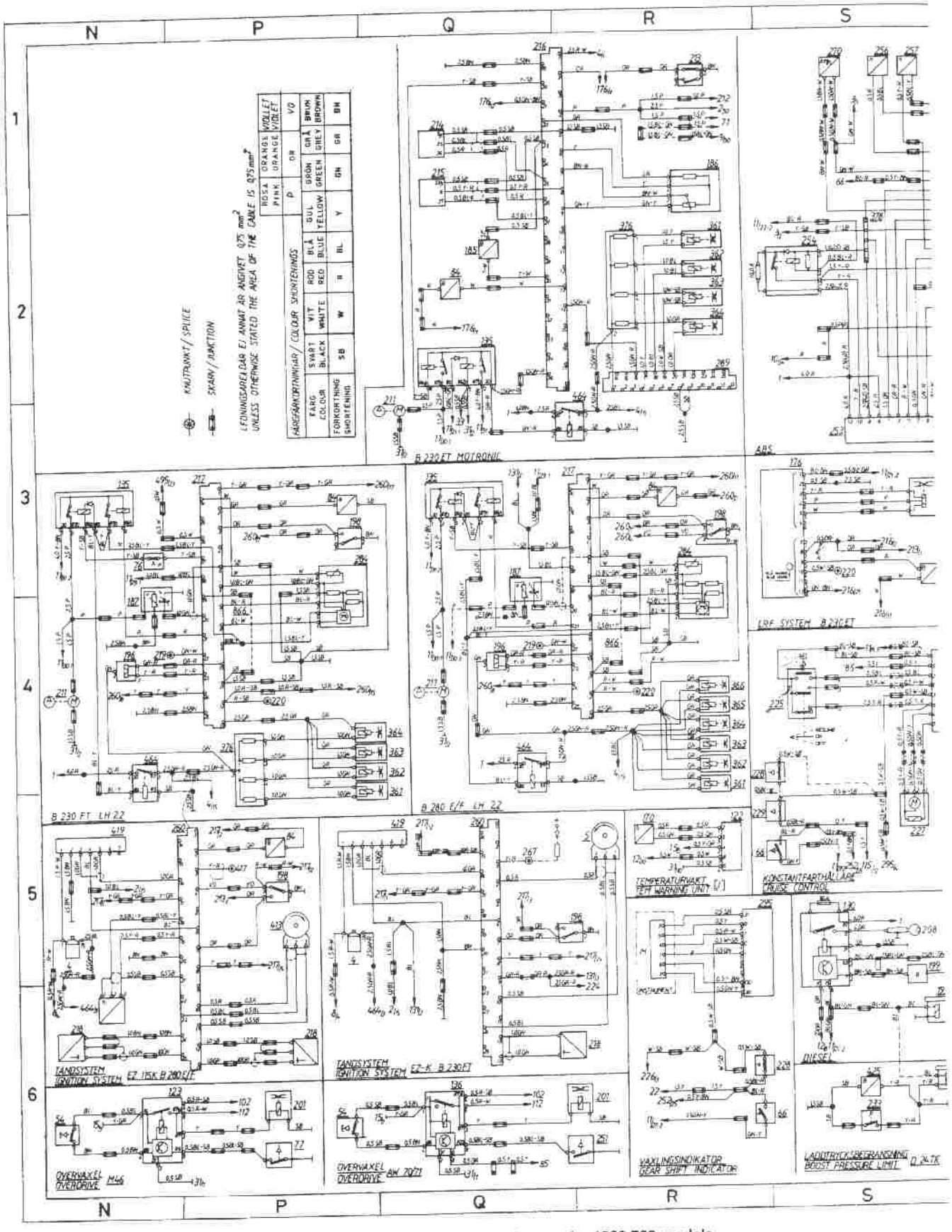
WD9 : Main wiring diagram for 1989 760 models



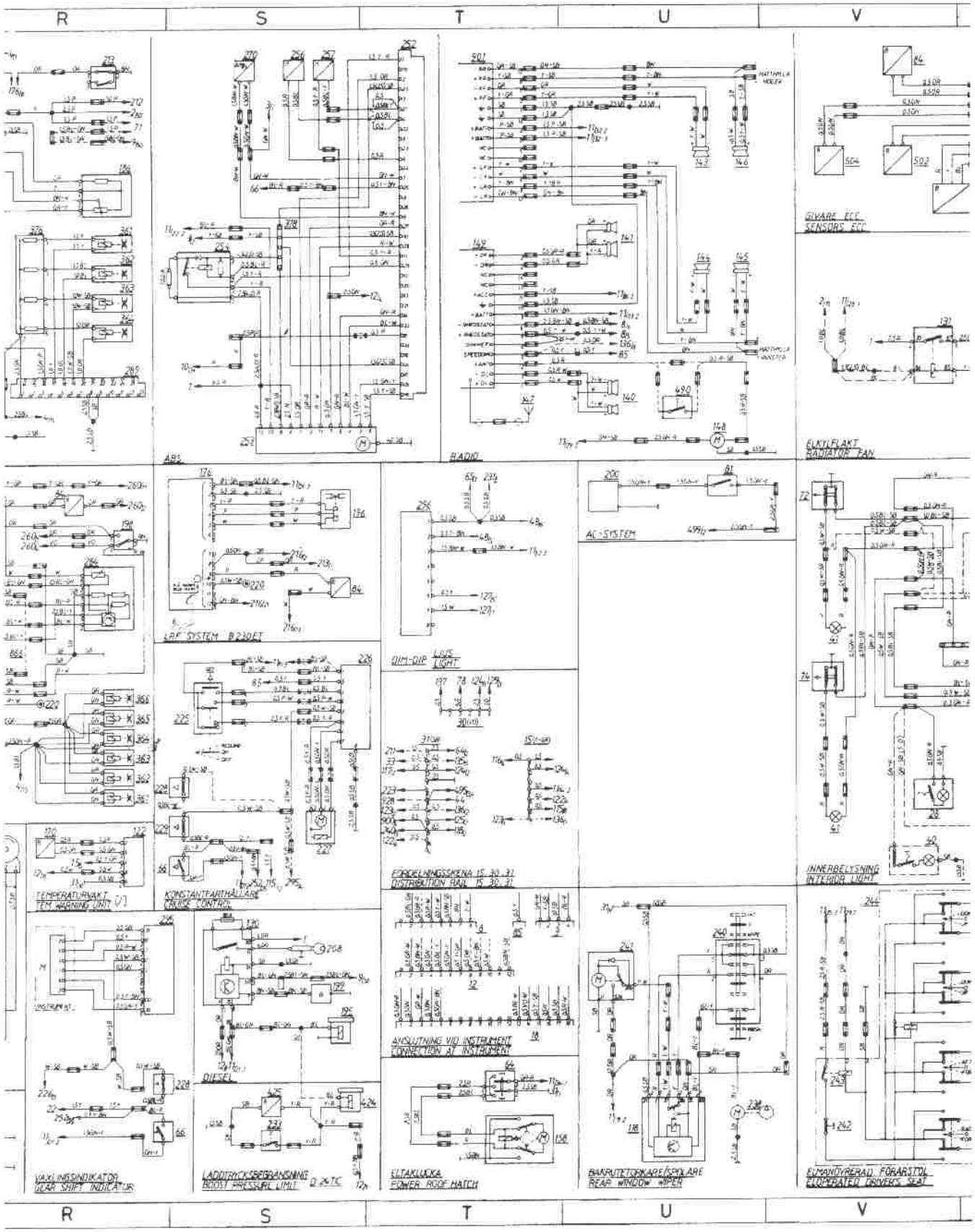
WD9 (continued) : Main wiring diagram for 1989 760 models



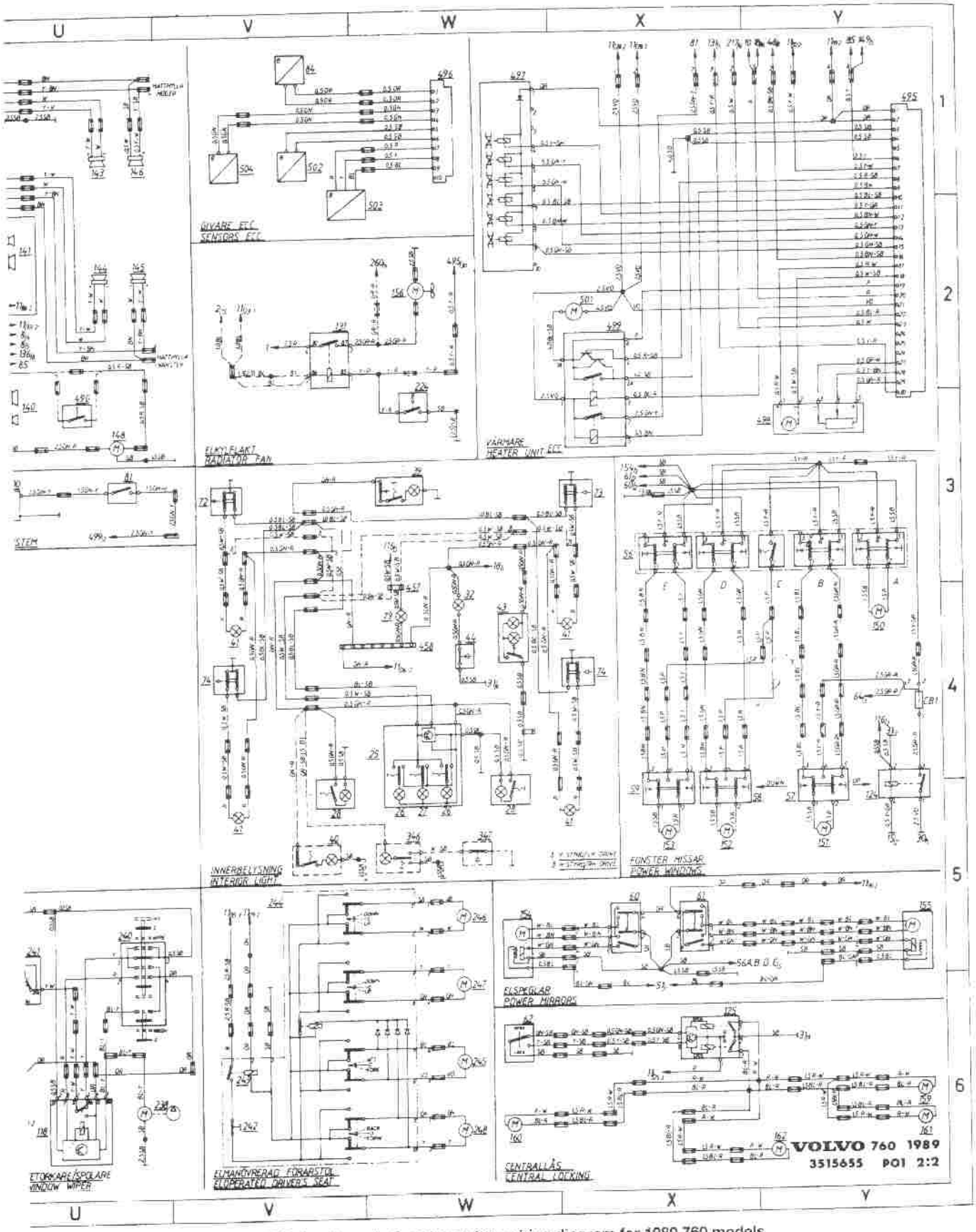
WD9 (continued) : Main wiring diagram for 1989 760 models



WD10 : Supplementary wiring diagram for 1989 760 models



WD10 (continued) : Supplementary wiring diagram for 1989 760 models



WD10 (continued) : Supplementary wiring diagram for 1989 760 models

Dimensions and Weights

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

Dimensions

Overall length	4785 mm
Overall width	1760 mm
Overall height	1430 mm
Wheelbase	2770 mm

Weights

Kerb weight (depending on equipment):	
740 models	1270 to 1460 kg
760 models	1330 to 1500 kg
Gross vehicle weight	(see type designation plate in engine compartment)

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

Our advice regarding spare part sources is as follows.

Officially-appointed garages

This is the best source of parts which are peculiar to your car, and are not otherwise generally available (eg badges, interior trim, certain body panels, etc). It is also the only place at which you should buy parts if the vehicle is still under warranty.

Accessory shops

These are very good places to buy materials and components needed for the maintenance of your car (oil, air and fuel filters, spark plugs, light bulbs, drivebelts, oils and greases, brake pads, touch-up paint, etc). Parts like this sold by a reputable shop are of the same standard as those used by the car manufacturer.

Motor factors

Good factors will stock all the more important components which wear out comparatively quickly and can sometimes supply individual components needed for the overhaul of a larger assembly. They may also handle work such as cylinder block reboring, crankshaft regrinding and balancing, etc.

Tyre and exhaust specialists

These outlets may be independent or part of a local or national chain. They frequently offer competitive prices compared with a main dealer or local garage, but it pays to get several quotes before making a decision. Also ask what 'extras' may be added to the quote - for instance, fitting a new valve and balancing the wheel are both often charged on top of the price of a new tyre.

Other sources

Beware of parts or materials obtained from market stalls, car boot sales or similar outlets. Such items are not invariably sub-standard, but there is little chance of compensation if they do prove unsatisfactory. In the case of safety-critical components such as brake pads there is the risk not only of financial loss but also of an accident causing injury or death.

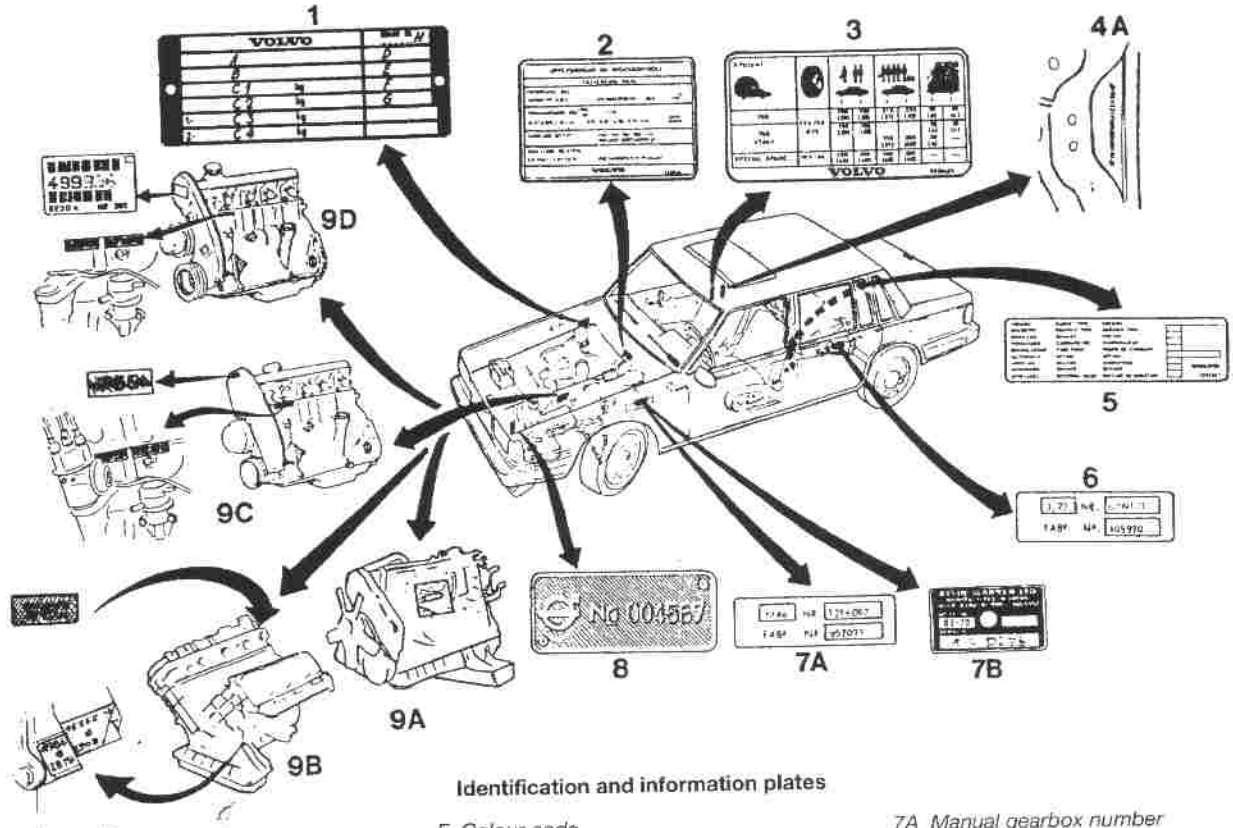
Vehicle Identification

When ordering spare parts, always give as much information as possible. Quote the car model, year of manufacture and if necessary the chassis number.

The locations of the various identification plates are shown in the accompanying diagram **(see illustration)**. The information to be found on the service plate is normally sufficient for routine maintenance and repair requirements **(see illustration)**. It is interpreted as follows:

Part	Manufacturer	Code
Brakes	Girling front and rear	1
	Girling front and ATE rear	2
	DBA front, ATE rear	3
Carburettor	SU	2
	Pierburg	3
	Solex	5
Fuel pump	Bosch	3
	AC-Delco	4
	Sofabex	5
Clutch	Fichtel & Sachs	2
	Verto/Valeo	3
Alternator	Bosch	1
Steering box	Cam Gear	2
	Zahnrad Fabrik (ZF)	3

Some models do not have a service plate, and the information required for maintenance and repair is on the tyre designation plate **(see illustration)**.



Identification and information plates

1 *Type designation:*
- *A Type approval*
- *B Vehicle identification number*
- *C1 Gross vehicle weight*
- *C2 Gross train weight*
- *C3 Front axle weight*
- *C4 Rear axle weight*
- *D Special applications*
- *E Market code*
- *F Colour code*
- *G Trim level*
- *H Country of origin*

2 *Emission control decal (not UK)*

3 *Tyre pressure information*

4 *Type designation, model year and chassis number*

5 *Service plate*

6 *Final drive ratio, type and serial number*

7A Manual gearbox number

7B Automatic transmission number

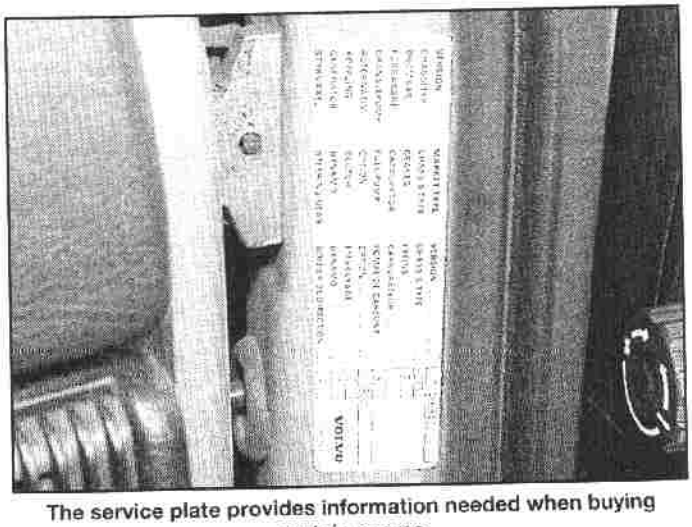
8 Body number

9A Engine number (Diesel)

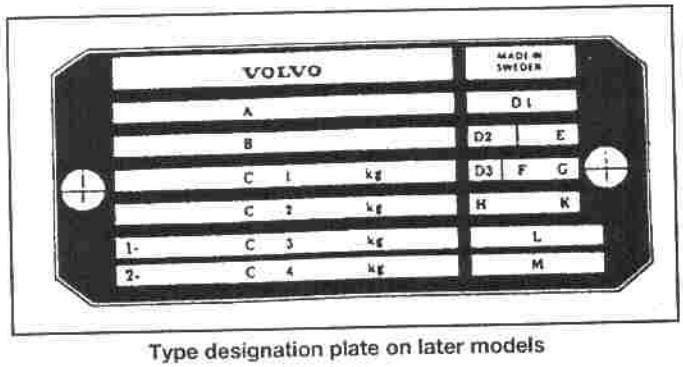
9B Engine number (B 28)

9C Engine number (B 23)

9D Engine number (B230)



The service plate provides information needed when buying certain spares



Type designation plate on later models

A to C4 As before

D1 Main type, number of doors, engine, equipment

D2 Body type, gearbox, left-or right-hand drive

D3 Market code

E Chassis type

F Emission control

G Steering gear:

Cam gear	2
Zahnrad Fabrik (ZF)	3

H Brakes:

Girling front, ATE rear	2
DBA front, ATE rear	3
Girling front and rear	4
DBA front, Girling rear	5

K Interior fittings code

L Colour code

M Special applications

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 tool. Alternatively, a number of self-tapping screws may be screwed into the seal, and these used as a purchase for pliers or similar 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 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 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.

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.

The jack supplied with the vehicle tool kit should only be used for changing the roadwheels - see *"Wheel changing"*. When carrying out any other kind of work, raise the vehicle using a hydraulic (or "trolley") jack, and always supplement the jack with axle stands positioned under the vehicle jacking points **(see illustration)**.

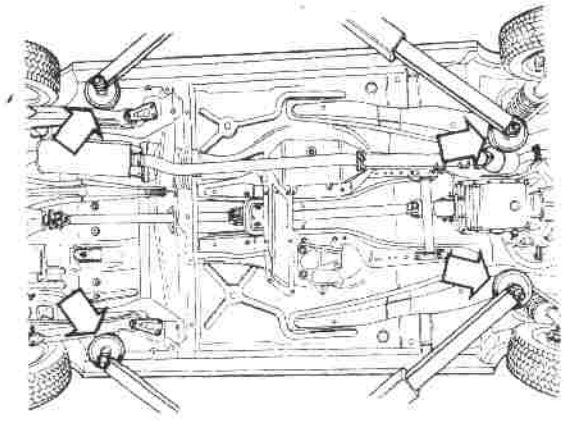
When using a hydraulic jack or axle stands, always position the jack head or axle stand head under one of the relevant jacking points.

To raise the front of the vehicle, remove the engine undertray and position the jack head below the centre of the front axle crossmember. Do not jack the vehicle under the sump or any of the steering or suspension components.

To raise the rear of the vehicle, position the jack head under the rear axle final drive casing, but use a block of wood between the jack head and the casing.

The jack supplied with the vehicle locates in the jacking points on the underside of the sills. Ensure that the jack head is correctly engaged before attempting to raise the vehicle.

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



Support points (arrowed) for a four-point lift, or when using four axle stands

Radio/cassette Anti-theft System - Precaution

The radio/cassette unit fitted as standard equipment by Volvo may be equipped with a built-in security code, to deter thieves. If the power source to the unit is cut, the anti-theft system will activate. Even if the power source is immediately reconnected, the radio/cassette unit will not function until the correct security code has been entered. Therefore, if you do not know the correct security code for the radio/cassette unit **do not** disconnect either of the battery terminals, or remove the radio/cassette unit from the vehicle.

To enter the correct security code, follow the instructions provided with the radio/cassette player handbook.

If an incorrect code is entered, the unit will become locked, and cannot be operated.

If this happens, or if the security code is lost or forgotten, seek the advice of your Volvo dealer.

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.

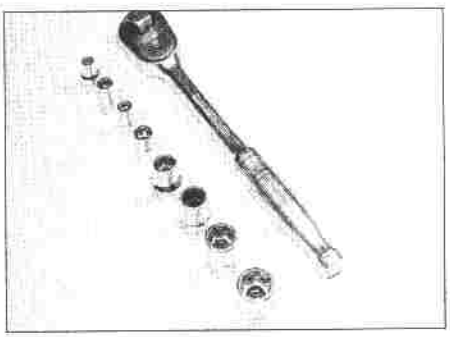
- ☐ *Combination spanners:*
  Metric - 8 to 19 mm inclusive
- ☐ *Adjustable spanner - 35 mm jaw (approx.)*
- ☐ *Spark plug spanner (with rubber insert) - petrol models*
- ☐ *Spark plug gap adjustment tool - petrol models*
- ☐ *Set of feeler gauges*
- ☐ *Brake bleed nipple spanner*
- ☐ *Screwdrivers:*
  Flat blade - 100 mm long x 6 mm dia
  Cross blade - 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

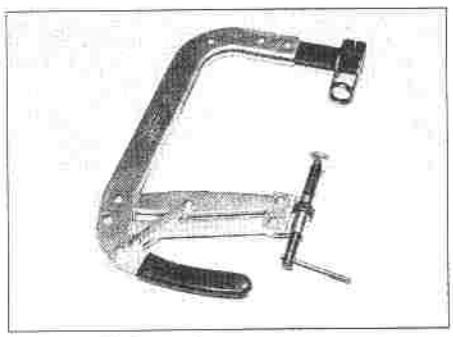
These tools are virtually essential for anyone undertaking any major repairs to a motor vehicle, and are additional to those given in the *Maintenance and minor repair* list. Included in this list is a comprehensive set of sockets. Although these are expensive, they will be found invaluable as they are 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.

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

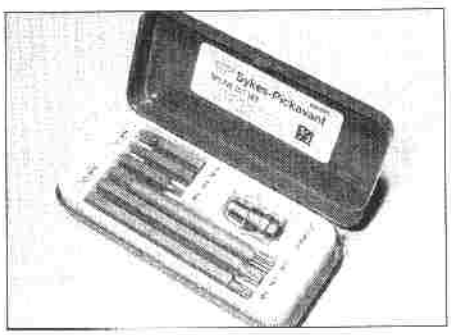
- ☐ *Sockets (or box spanners) to cover range in previous list (including Torx sockets)*
- ☐ *Reversible ratchet drive (for use with sockets)*
- ☐ *Extension piece, 250 mm (for use with sockets)*
- ☐ *Universal joint (for use with sockets)*
- ☐ *Torque wrench (for use with sockets)*
- ☐ *Self-locking 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)*
- ☐ *Selection of files*
- ☐ *Wire brush*
- ☐ *Axle stands*
- ☐ *Jack (strong trolley or hydraulic type)*
- ☐ *Light with extension lead*



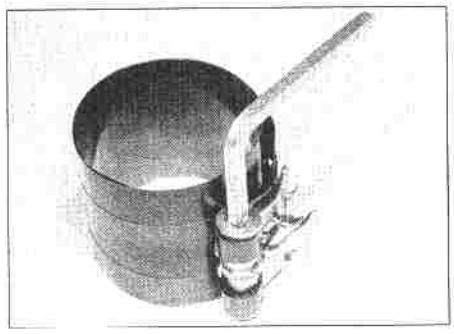
Sockets and reversible ratchet drive



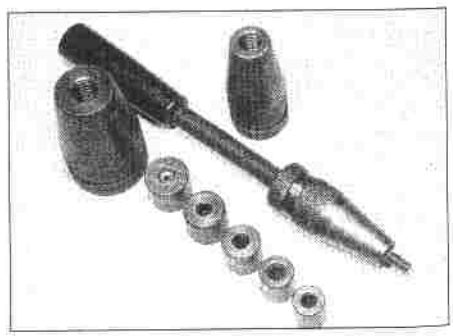
Valve spring compressor



Spline bit set



Piston ring compressor



Clutch plate alignment set

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 dealer.

- ☐ *Valve spring compressor*
- ☐ *Valve grinding tool*
- ☐ *Piston ring compressor*
- ☐ *Piston ring removal/installation tool*
- ☐ *Cylinder bore hone*
- ☐ *Balljoint separator*
- ☐ *Coil spring compressors (where applicable)*
- ☐ *Two/three-legged hub and bearing puller*
- ☐ *Impact screwdriver*
- ☐ *Micrometer and/or vernier calipers*
- ☐ *Dial gauge*
- ☐ *Stroboscopic timing light*
- ☐ *Dwell angle meter/tachometer*
- ☐ *Universal electrical multi-meter*
- ☐ *Cylinder compression gauge*
- ☐ *Hand-operated vacuum pump and gauge*
- ☐ *Clutch plate alignment set*
- ☐ *Brake shoe steady spring cup removal tool*
- ☐ *Bush and bearing removal/installation set*
- ☐ *Stud extractors*
- ☐ *Tap and die set*
- ☐ *Lifting tackle*
- ☐ *Trolley jack*

Buying tools

Reputable motor accessory shops and superstores 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. Beware of 'bargains' offered on market stalls or at car boot sales. 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 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, a suitable working area becomes essential.

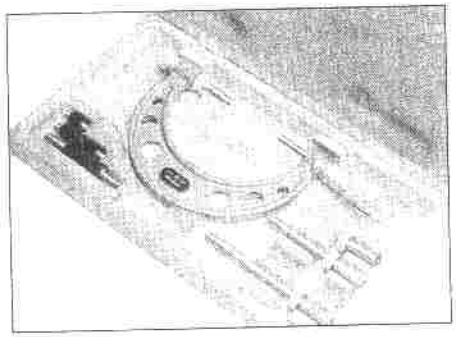
It is appreciated that many an owner-mechanic is forced by circumstances to remove an engine or similar item without the benefit of a garage or workshop. Having done this, any repairs should always be done under the cover of a roof.

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

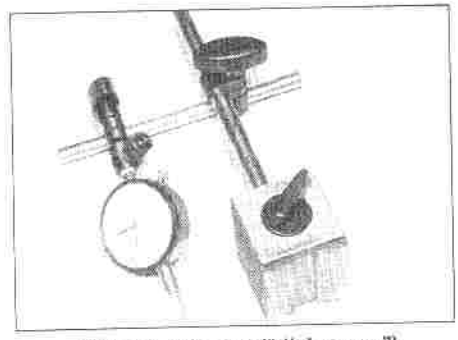
Any workbench needs a vice; one with a jaw opening of 100 mm is suitable for most jobs. As mentioned previously, some clean dry storage space is also required for tools, as well as for any lubricants, cleaning fluids, touch-up paints etc, which become necessary.

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.

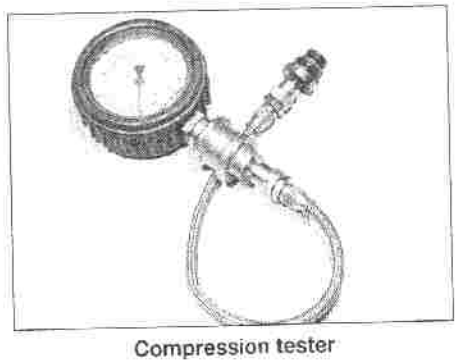


Micrometer set

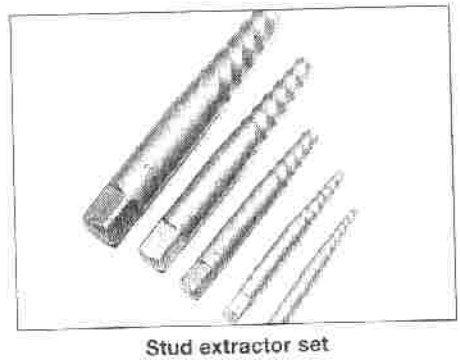


Dial test indicator ("dial gauge")

Stroboscopic timing light



Compression tester



Stud extractor set

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**

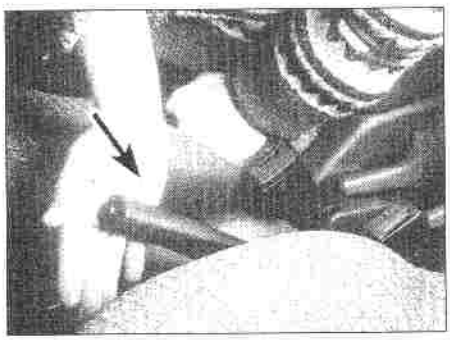
4 Checks carried out on **YOUR VEHICLE'S EXHAUST EMISSION SYSTEM**

1 Checks carried out FROM THE DRIVER'S SEAT

Handbrake

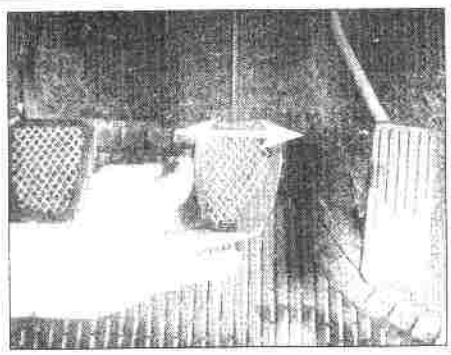
☐ Test the operation of the handbrake. Excessive travel (too many clicks) indicates incorrect brake or cable adjustment.

☐ 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.

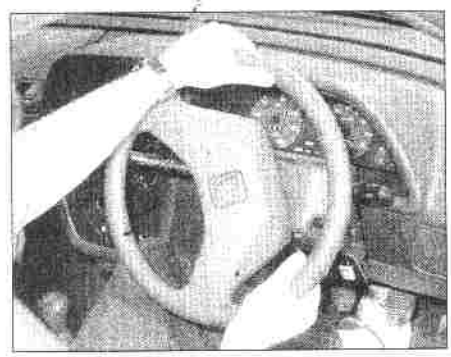
☐ Check the servo unit (when applicable) by operating the brake pedal several times, then keeping the pedal depressed and starting the engine. As the engine starts, the pedal will move down slightly. If not, the vacuum hose or the servo itself may be faulty.

Steering wheel and column

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

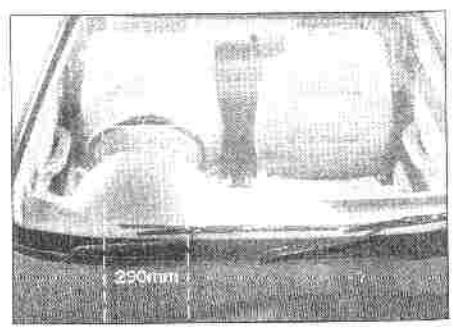
☐ Move the steering wheel from side to side and then up and down. Check that the steering wheel is not loose on the column, indicating wear or a loose retaining nut. Continue moving the steering wheel as before, but also turn it slightly from left to right.

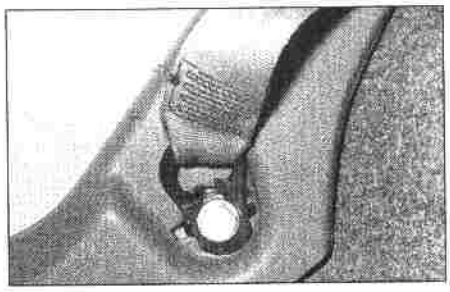
☐ Check that the steering wheel is not loose on the column, and that there is no abnormal movement of the steering wheel, indicating wear in the column support bearings or couplings.



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

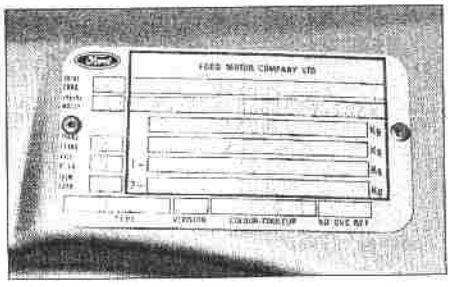
☐ Both front doors must be able to be opened and closed from outside and inside, and must latch securely when closed.

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).

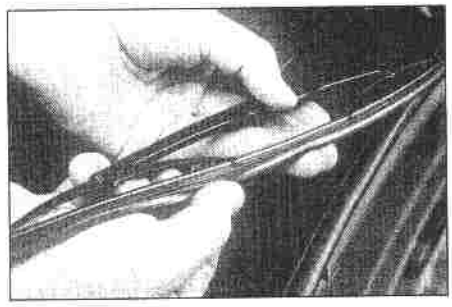
☐ The VIN plate and/or homologation plate must be legible.



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.

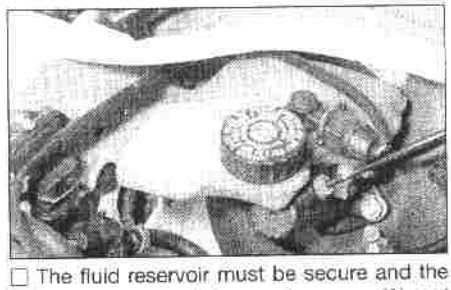
☐ Check the operation and alignment of the headlights. The headlight reflectors must not be tarnished and the lenses must be undamaged.

☐ 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.

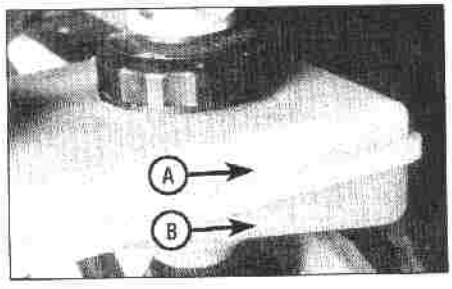
☐ Check the operation of the rear foglight(s), including the warning light on the instrument panel or in the switch.

Footbrake

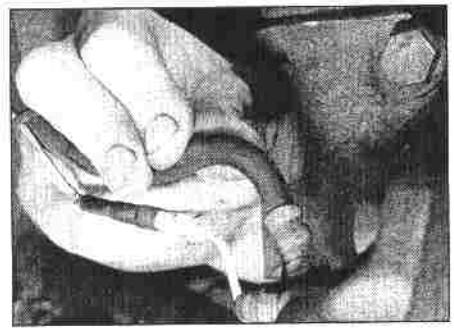
☐ Examine the master cylinder, brake pipes and servo unit for leaks, loose mountings, corrosion or other damage.



☐ 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.

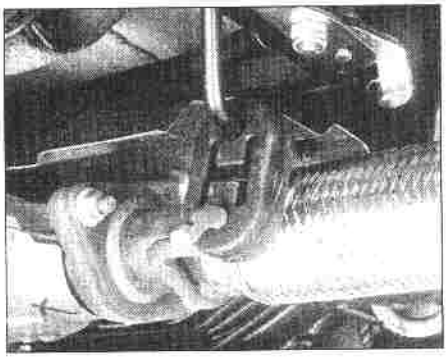
☐ Check that the vehicle is standing level, and at approximately the correct ride height.

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.



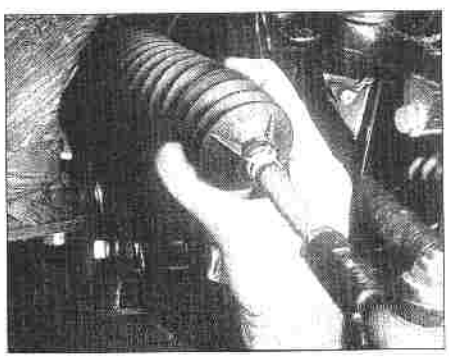
3 Checks carried out WITH THE VEHICLE RAISED AND THE WHEELS FREE TO TURN

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.

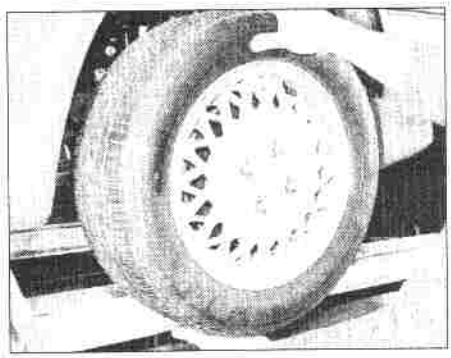
☐ Examine the steering rack rubber gaiters for damage or insecurity of the retaining clips. If power steering is fitted, check for signs of damage or leakage of the fluid hoses, pipes or connections. Also check for excessive stiffness or binding of the steering, a missing split pin or locking device,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



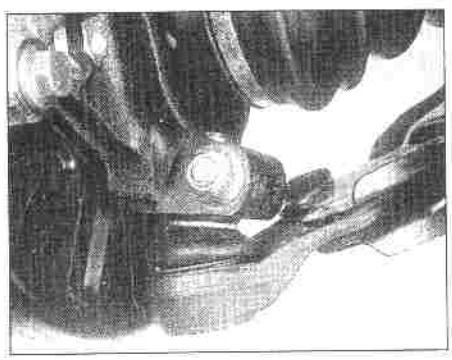
Front and rear suspension and wheel bearings

☐ 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.

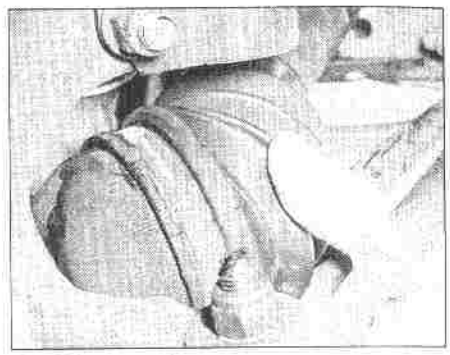
☐ If leaf springs are fitted, check that all leaves are intact, that the axle is securely attached to each spring, and that there is no deterioration of the spring eye mountings, bushes, and shackles.

☐ 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.

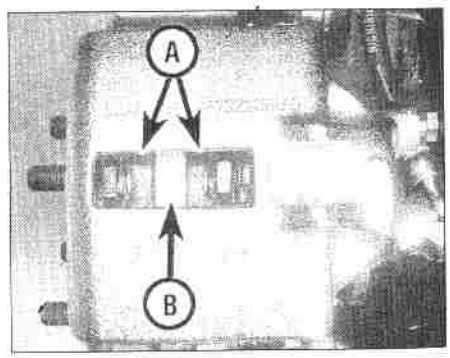
Driveshafts (fwd vehicles only)

☐ 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

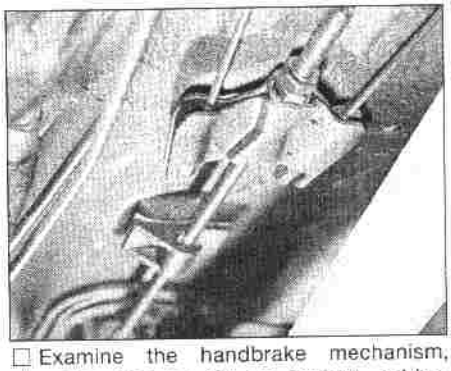
☐ If possible without dismantling, check brake pad wear and disc condition. Ensure that the friction lining material has not worn excessively, (A) and that the discs are not fractured, pitted, scored or badly worn (B).



☐ 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.



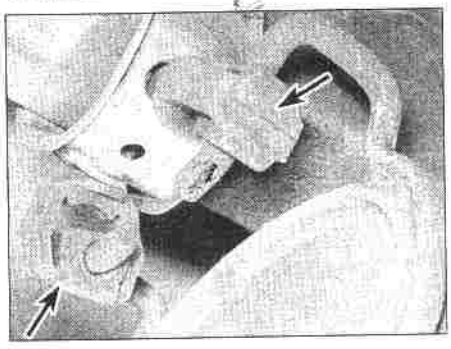
☐ Examine the handbrake mechanism, checking for frayed or broken cables, excessive corrosion, or wear or insecurity of the linkage. Check that the mechanism works on each relevant wheel, and releases fully, without binding.

☐ 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

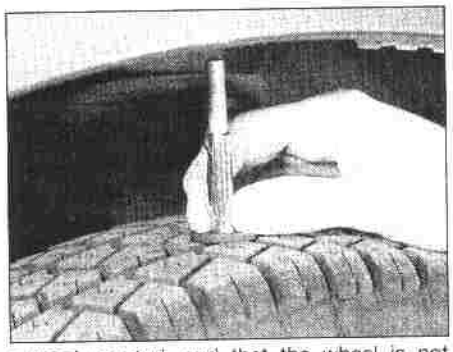
☐ Inspect the fuel tank (including the filler cap), fuel pipes, hoses and unions. All components must be secure and free from leaks.

☐ 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.

Engine

- Engine backfires
- Engine difficult to start when cold
- Engine difficult to start when hot
- Engine fails to rotate when attempting to start
- Engine hesitates on acceleration
- Engine idles erratically
- Engine lacks power
- Engine misfires at idle speed
- Engine misfires throughout the driving speed range
- Engine noises
- Engine rotates but will not start
- Engine runs-on after switching off
- Engine stalls
- Engine starts but stops immediately
- Oil pressure warning light illuminated with engine running
- Starter motor noisy or excessively-rough in engagement

Cooling system

- Corrosion
- External coolant leakage
- Internal coolant leakage
- Overcooling
- Overheating

Fuel and exhaust systems

- Excessive fuel consumption
- Excessive noise or fumes from exhaust system
- Fuel leakage and/or fuel odour

Clutch

- Clutch fails to disengage (unable to select gears)
- Clutch slips (engine speed increases with no increase in vehicle speed)
- Judder as clutch is engaged
- Noise when depressing or releasing clutch pedal
- Pedal travels to floor - no pressure or very little resistance

Manual transmission

- Jumps out of gear
- Lubricant leaks
- Noisy in neutral with engine running
- Noisy in one particular gear
- Vibration

Automatic transmission

- Engine will not start in any gear, or starts in gears other than Park or Neutral
- Fluid leakage
- General gear selection problems
- Transmission fluid brown, or has burned smell
- Transmission slips, shifts roughly, is noisy, or has no drive in forward or reverse gears
- Transmission will not downshift (kickdown) with accelerator fully depressed

Propeller shaft

- Vibration when accelerating or decelerating
- Noise (grinding or high pitched squeak) when moving slowly
- Noise (knocking or clicking) when accelerating or decelerating

Braking system

- Brake pedal feels spongy when depressed
- Brakes binding
- Excessive brake pedal effort required to stop vehicle
- Excessive brake pedal travel
- Judder felt through brake pedal or steering wheel when braking
- Noise (grinding or high-pitched squeal) when brakes applied
- Rear wheels locking under normal braking
- Vehicle pulls to one side under braking

Rear axle

- Roughness or rumble from rear of vehicle (perhaps less with handbrake slightly applied)
- Noise (high pitched whine) increasing with roadspeed
- Noise (knocking or clicking) when accelerating or decelerating
- Lubricant leaks

Suspension and steering systems

- Excessive pitching and/or rolling around corners, or during braking
- Excessive play in steering
- Excessively-stiff steering
- Lack of power assistance
- Tyre wear excessive
- Vehicle pulls to one side
- Wandering or general instability
- Wheel wobble and vibration

Electrical system

- Battery will not hold a charge for more than a few days
- Central locking system inoperative, or unsatisfactory in operation
- Electric windows inoperative, or unsatisfactory in operation
- Horn inoperative, or unsatisfactory in operation
- Ignition warning light fails to come on
- Ignition warning light remains illuminated with engine running
- Instrument readings inaccurate or erratic
- Lights inoperative
- Windscreen/tailgate washers inoperative, or unsatisfactory in operation
- Windscreen/tailgate wipers inoperative, or unsatisfactory in operation

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.

Self-Diagnostic Unit

On B234F engines, fitted with the LH2.4 Jetronic fuel injection system and EZ116K ignition system, there is a built-in self-diagnostic unit which can display fault codes and perform functional tests and control tests. This is an advanced feature, capable of diagnosing a wide variety of faults and you are encouraged to use it. See Chapters 4B and 5B.

Engine

Engine fails to rotate when attempting to start

- Battery terminal connections loose or corroded ("*Weekly checks*").
- Battery discharged or faulty (Chapter 5A).
- Broken, loose or disconnected wiring in the starting circuit (Chapter 5A).
- Defective starter solenoid or switch (Chapter 5A).
- Defective starter motor (Chapter 5A).
- Starter pinion or flywheel ring gear teeth loose or broken (Chapter 2A, 2B, 2C and 5A).
- Engine earth strap broken or disconnected (Chapter 5A).
- Automatic transmission not in Park/Neutral position, or selector lever position sensor faulty (Chapter 7B).

Engine rotates but will not start

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

Engine difficult to start when cold

- Battery discharged (Chapter 5A).
- Battery terminal connections loose or corroded ("*Weekly checks*").
- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Other ignition system fault (Chapters 1 and 5B).
- Engine management system fault (Chapters 1 and 4B).
- Incorrect valve clearance adjustment (Chapter 1).
- Low cylinder compressions (Chapter 2A or 2B).

Engine difficult to start when hot

- Air filter element dirty or clogged (Chapter 1).
- Engine management system fault (Chapters 1 and 4B).
- Incorrect valve clearance adjustment (Chapter 1).
- Low cylinder compressions (Chapter 2A or 2B).

Starter motor noisy or excessively-rough in engagement

- Starter pinion or flywheel ring gear teeth loose or broken (Chapters 2A, 2B, 2C or 5A).
- Starter motor mounting bolts loose or missing (Chapter 5A).
- Starter motor internal components worn or damaged (Chapter 5A).

Engine starts but stops immediately

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

Engine idles erratically

- Engine management system fault (Chapters 1 and 4B).
- Air filter element clogged (Chapter 1).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1 and 4A or 4B).
- Worn, faulty or incorrectly-gapped spark plugs (Chapter 1).
- Incorrect valve clearance adjustment (Chapter 1).
- Uneven or low cylinder compressions (Chapter 2A or 2B).
- Camshaft lobes worn (Chapter 2A or 2B).
- Camshaft drivebelt incorrectly-tensioned (Chapter 2A).
- Timing chain or tensioners worn (Chapter 2B).

Engine misfires at idle speed

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

Engine misfires throughout the driving speed range

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

Engine hesitates on acceleration

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

Engine stalls

- Engine management system fault (Chapters 1 and 4B).
- Vacuum leak at the inlet manifold or associated hoses (Chapters 1 and 4A or 4B).
- Fuel filter choked (Chapter 1).
- Fuel pump faulty (Chapter 4A or 4B).
- Fuel tank vent blocked or fuel pipes restricted (Chapter 4A or 4B)

Engine (continued)

Engine lacks power

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

Engine backfires

- ☐ Ignition timing incorrect (Chapter 5B).
- ☐ Engine management system fault (Chapters 1 and 4B).
- ☐ Camshaft drivebelt incorrectly fitted or incorrectly tensioned (Chapter 2A).
- ☐ Timing chains incorrectly fitted (Chapter 2B).
- ☐ Vacuum leak at the inlet manifold or associated hoses (Chapters 1, and 4A or 4B).
- ☐ Emission control system fault (Chapter 4C).

Oil pressure warning light illuminated with engine running

- ☐ Low oil level or incorrect oil grade ("*Weekly checks*").
- ☐ Faulty oil pressure warning light switch (Chapter 5A).
- ☐ Worn engine bearings and/or oil pump (Chapter 2C).
- ☐ High engine operating temperature (Chapter 3).
- ☐ Oil pressure relief valve defective (Chapter 2A, 2B or 2C).
- ☐ Oil pick-up strainer clogged (Chapter 2A, 2B or 2C).

Engine runs-on after switching off

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

Engine noises

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

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

Whistling or wheezing noises

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

Tapping or rattling noises

- ☐ Incorrect valve clearance adjustment (Chapter 1).
- ☐ Worn valve gear or camshaft (Chapter 2A, 2B or 2C).
- ☐ Worn camshaft drivebelt or tensioner (Chapter 2A).
- ☐ Worn timing chain(s) and tensioners (Chapter 2B).
- ☐ Ancillary component fault (water pump, alternator, etc) (Chapters 3 and 5A).

Knocking or thumping noises

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

Cooling system

Overheating

- ☐ Insufficient coolant in system ("*Weekly checks*").
- ☐ 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 and 4B).
- ☐ Pressure cap faulty (Chapter 3).
- ☐ Accessory drivebelt(s) worn or slipping (Chapter 1).
- ☐ Ignition timing incorrect (Chapter 5B).
- ☐ 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 2C).

Internal coolant leakage

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

Corrosion

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

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 and 4B).
- ☐ Ignition timing incorrect (Chapter 5B).
- ☐ Tyres under-inflated ("*Weekly checks*").

Fuel leakage and/or fuel odour

- ☐ Damaged or corroded fuel tank, pipes or connections (Chapter 1).

Excessive noise or fumes from exhaust system

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

Clutch

Pedal travels to floor - no pressure or very little resistance

- ☐ Air in clutch hydraulic system (Chapter 6).
- ☐ Faulty clutch slave cylinder (Chapter 6).
- ☐ Faulty clutch master cylinder (Chapter 6).
- ☐ Broken clutch cable (Chapter 6).
- ☐ Incorrect adjustment (Chapter 6).
- ☐ Broken diaphragm spring in clutch pressure plate (Chapter 6).

Clutch fails to disengage (unable to select gears)

- ☐ Air in clutch hydraulic system (Chapter 6).
- ☐ Faulty clutch slave cylinder (Chapter 6).
- ☐ Faulty clutch master cylinder (Chapter 6).
- ☐ Broken clutch cable (Chapter 6).
- ☐ Incorrect adjustment (Chapter 6).
- ☐ Clutch disc sticking on transmission mainshaft splines (Chapter 6).
- ☐ Clutch disc sticking to flywheel or pressure plate (Chapter 6).
- ☐ Faulty pressure plate assembly (Chapter 6).
- ☐ Clutch release mechanism worn or incorrectly assembled (Chapter 6).

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

- ☐ Clutch disc linings excessively worn (Chapter 6).
- ☐ Clutch disc linings contaminated with oil or grease (Chapter 6).
- ☐ Faulty pressure plate or weak diaphragm spring (Chapter 6).

Judder as clutch is engaged

- ☐ Clutch disc linings contaminated with oil or grease (Chapter 6).
- ☐ Clutch disc linings excessively worn (Chapter 6).
- ☐ Faulty or distorted pressure plate or diaphragm spring (Chapter 6).
- ☐ Worn or loose engine/transmission mountings (Chapter 2A or 2B).
- ☐ Clutch disc hub or transmission mainshaft splines worn (Chapter 6).

Noise when depressing or releasing clutch pedal

- ☐ Worn clutch release bearing (Chapter 6).
- ☐ Worn or dry clutch pedal bushes (Chapter 6).
- ☐ Faulty pressure plate assembly (Chapter 6).
- ☐ Pressure plate diaphragm spring broken (Chapter 6).
- ☐ Broken clutch disc cushioning springs (Chapter 6).

Manual transmission

Noisy in neutral with engine running

- ☐ Mainshaft bearings worn (noise apparent with clutch pedal released, but not when depressed) (Chapter 7A).*
- ☐ Clutch release bearing worn (noise apparent with clutch pedal depressed, possibly less when released) (Chapter 6).

Noisy in one particular gear

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

Difficulty engaging gears

- ☐ Clutch fault (Chapter 6).
- ☐ Worn or damaged gear linkage (Chapter 7A).
- ☐ Worn synchroniser assemblies (Chapter 7A).*

Jumps out of gear

- ☐ Worn or damaged gear linkage (Chapter 7A).
- ☐ Worn synchroniser assemblies (Chapter 7A).*
- ☐ Worn selector forks (Chapter 7A).*

Vibration

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

Lubricant leaks

- ☐ Leaking differential side gear oil seal (Chapter 7A).
- ☐ Leaking gearchange shaft or speedometer pinion oil seals (Chapter 7A).
- ☐ Leaking housing joint (Chapter 7A).*
- ☐ Leaking mainshaft oil seal (Chapter 7A).*

** 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.*

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 service department or automatic transmission specialist.*

Fluid leakage

- ☐ Automatic transmission fluid is usually dark 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) Transmission oil sump (Chapters 1 and 7B).
b) Dipstick tube (Chapters 1 and 7B).
c) Transmission-to-fluid cooler pipes/unions (Chapter 1 and 7B).
d) Transmission oil seals (Chapter 7B).

Transmission fluid brown, or has burned smell

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

General gear selection problems

- ☐ Chapter 7B, 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 7B for the selector cable adjustment procedure.

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

- ☐ Low transmission fluid level (Chapter 1).
- ☐ Incorrect kickdown cable adjustment (Chapter 7B).
- ☐ Incorrect selector cable adjustment (Chapter 7B).

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

- ☐ Incorrect selector cable adjustment (Chapter 7B).
- ☐ Incorrect starter inhibitor switch adjustment (Chapter 7B).

Transmission slips, 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.

Propeller shaft

Vibration when accelerating or decelerating

- ☐ Propeller shaft out of balance or incorrectly fitted (Chapter 8).
- ☐ Propeller shaft flange bolts loose (Chapter 8).
- ☐ Excessive wear in universal joints (Chapter 8).

Noise (grinding or high pitched squeak) when moving slowly

- ☐ Excessive wear in universal joints (Chapter 8).
- ☐ Excessive wear in centre bearing (Chapter 8).

Noise (knocking or clicking) when accelerating or decelerating

- ☐ Propeller shaft flange bolts loose (Chapter 8).
- ☐ Excessive wear in universal joints (Chapter 8).

Rear axle

Roughness or rumble from rear of vehicle (perhaps less with handbrake slightly applied)

- ☐ Rear hub bearings worn (Chapter 8).

Noise (high-pitched whine) increasing with roadspeed

- ☐ Differential crownwheel and pinion gear teeth worn (Chapter 8).
- ☐ Incorrect crownwheel and pinion mesh (Chapter 8).
- ☐ Differential bearings worn (Chapter 8).

Noise (knocking or clicking) when accelerating or decelerating

- ☐ Worn halfshaft splines (Chapter 8).
- ☐ Differential pinion flange bolts loose (Chapter 8).
- ☐ Incorrect crownwheel and pinion mesh (Chapter 8).
- ☐ Roadwheel nuts loose (Chapters 1 and 10).

Lubricant leaks

- ☐ Leaking oil seal (Chapter 8).
- ☐ Leaking differential housing or cover joint (Chapter 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 Volvo dealer for diagnosis.*

Vehicle pulls to one side under braking

- ☐ Worn, defective, damaged or contaminated front or rear brake pads on one side (Chapter 9).
- ☐ Seized or partially-seized front or rear brake caliper piston (Chapter 9).
- ☐ A mixture of brake pad lining materials fitted between sides (Chapter 9).

- ☐ Brake caliper 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 friction lining material worn down to metal backing (Chapter 9).
- ☐ Excessive corrosion of brake disc (may be apparent after the vehicle has been standing for some time) (Chapter 9).

Excessive brake pedal travel

- ☐ 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 piston(s) (Chapter 9).
- ☐ Brake pads incorrectly fitted (Chapter 9).
- ☐ Incorrect grade of brake pads fitted (Chapter 9).
- ☐ Brake pad linings contaminated (Chapter 9).

Judder felt through brake pedal or steering wheel when braking

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

Brakes binding

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

Rear wheels locking under normal braking

- ☐ Rear brake pad linings contaminated (Chapter 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.*

Vehicle pulls to one side

- ☐ Defective tyre (*"Weekly checks"*).
- ☐ Excessive wear in suspension or steering components (Chapter 10).
- ☐ Incorrect front or rear 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) (*"Weekly checks"*).
- ☐ Rear roadwheels out of balance (vibration felt throughout the vehicle) (*"Weekly checks"*).
- ☐ Roadwheels damaged or distorted (Chapter 1 and *"Weekly checks"*).
- ☐ Faulty or damaged tyre (*"Weekly checks"*).
- ☐ 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 wheel alignment (Chapter 10).
- ☐ Worn steering or suspension joints, bushes or components (Chapter 10).
- ☐ Roadwheels out of balance (*"Weekly checks"*).
- ☐ Faulty or damaged tyre (*"Weekly checks"*).
- ☐ Roadwheel nuts loose (Chapter 1).
- ☐ Defective shock absorbers (Chapters 1 and 10).

Excessively-stiff steering

- ☐ Broken or incorrectly adjusted power steering pump (accessory) drivebelt (Chapter 1).
- ☐ Power steering pump faulty (Chapter 10).
- ☐ Seized track rod end balljoint or suspension balljoint (Chapter 10).
- ☐ 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) (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 power steering pump (accessory) drivebelt (Chapter 1).
- ☐ Incorrect power steering fluid level (*"Weekly checks"*).
- ☐ 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 (*"Weekly checks"*).
- ☐ 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 (*"Weekly checks"*).

Tyres worn on inside and outside edges

- ☐ Tyres under-inflated (*"Weekly checks"*).

Tyres worn unevenly

- ☐ Tyres out of balance (*"Weekly checks"*).
- ☐ Excessive wheel or tyre run-out (*"Weekly checks"*).
- ☐ Worn shock absorbers (Chapters 1 and 10).
- ☐ Faulty tyre (*"Weekly checks"*).

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 for more than a few days

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

Ignition/no-charge warning light remains illuminated with engine running

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

Ignition/no-charge warning light fails to come on

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

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 instrument voltage stabiliser (Chapter 12).

Fuel or temperature gauges give no reading

- Faulty instrument voltage stabiliser (Chapter 12).
- Faulty gauge sender unit (Chapters 3, 4A or 4B).
- Wiring open-circuit (Chapter 12).
- Faulty gauge (Chapter 12).

Fuel or temperature gauges give continuous maximum reading

- Faulty instrument voltage stabiliser (Chapter 12).
- Faulty gauge sender unit (Chapters 3, 4A or 4B).
- Wiring short-circuit (Chapter 12).
- Faulty gauge (Chapter 12).

Horn inoperative, or unsatisfactory in operation

Horn fails to operate

- Blown fuse (Chapter 12).
- Steering wheel cable connections loose, broken or disconnected (Chapter 10).
- Faulty horn (Chapter 12).

Horn emits intermittent or unsatisfactory sound

- Steering wheel cable connections loose, broken or disconnected (Chapter 10).
- Horn mountings loose (Chapter 12).
- Faulty horn (Chapter 12).

Horn operates all the time

- Horn push either earthed or stuck down (Chapter 12).
- Steering wheel cable connections earthed (Chapter 10).

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 12).
- Excessive wear of wiper linkage (Chapter 12).
- Wiper motor or linkage mountings loose or insecure (Chapter 12).

Wiper blades fail to clean the glass effectively

- Wiper blade rubbers worn or perished (*"Weekly checks"*).
- Wiper arm tension springs broken, or arm pivots seized (Chapter 12).
- Insufficient windscreen washer additive to adequately remove road film (*"Weekly checks"*).

Windscreen/tailgate washers inoperative, or unsatisfactory in operation

One or more washer jets inoperative

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

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).

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).

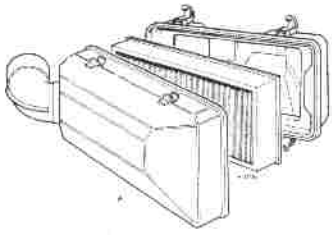
A

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.

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.

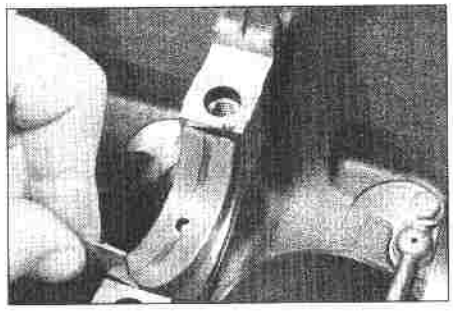
Axle A shaft on which a wheel revolves, or which revolves with a wheel. Also, a solid beam that connects the two wheels at one end of the vehicle. An axle which also transmits power to the wheels is known as a live axle.

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.

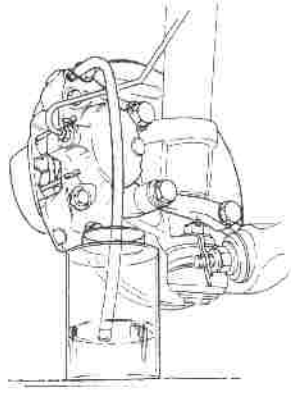


Bearing

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.

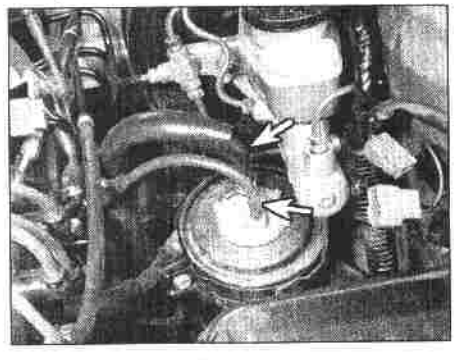
Bulkhead The insulated partition between the engine and the passenger compartment.

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.



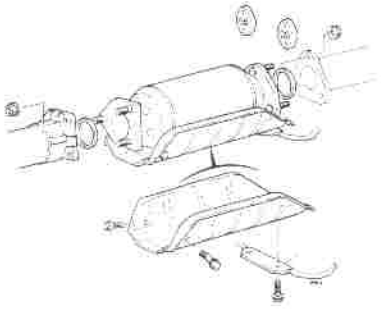
Canister

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.

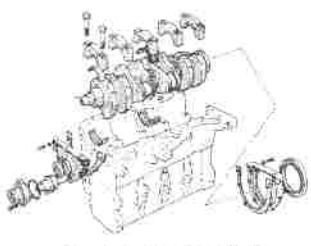
Compression ratio The relationship between cylinder volume when the piston is at top dead centre and cylinder volume when the piston is at bottom dead centre.

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

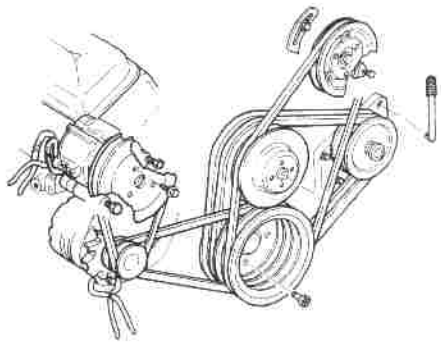
D

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.

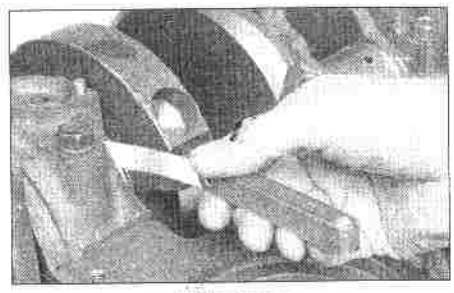
Engine management system (EMS) A computer controlled system which manages the fuel injection and the ignition systems in an integrated fashion.

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.

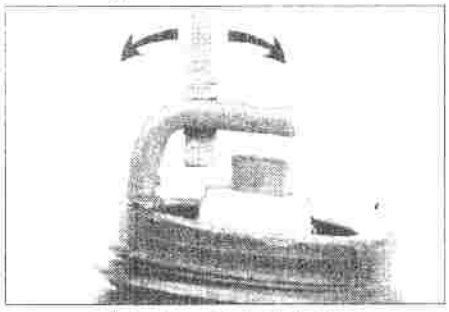
Free play The amount of travel before any action takes place. The "looseness" in a linkage, or an assembly of parts, between the initial application of force and actual movement. For example, the distance the brake pedal moves before the pistons in the master cylinder are actuated.

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.

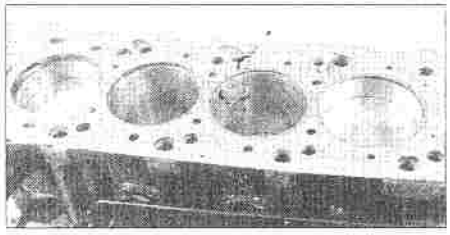
G

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).

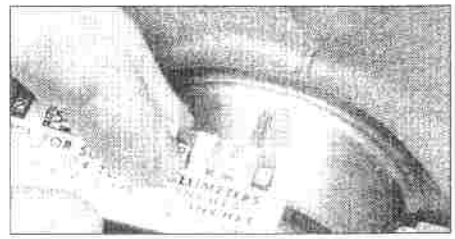
Overhead valve (ohv) engine An engine with the valves located in the cylinder head, but with the camshaft located in the engine block.

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.

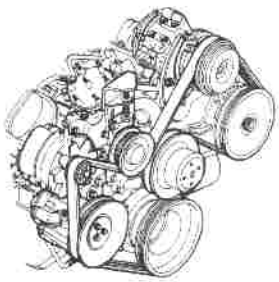
Runout The amount of wobble (in-and-out movement) of a gear or wheel as it's rotated. The amount a shaft rotates "out-of-true." The out-of-round condition of a rotating part.

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*.

Note: *References throughout this index are in the form - "Chapter number" • "page number"*

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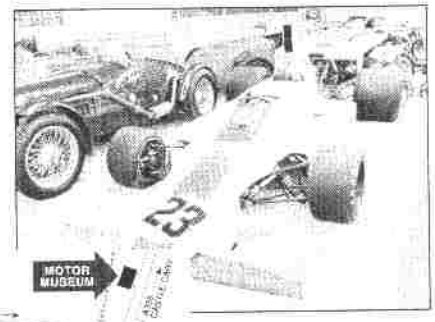
John Haynes O.B.E., Founder and Chairman of the museum at the wheel of a Haynes Light 12.



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.

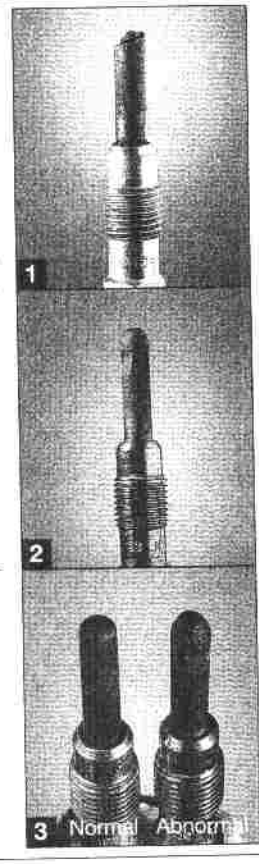
Open 9.30am - 5.30pm (10.00am - 4.00pm Winter) 7 days a week, *except Christmas Day, Boxing Day and New Years Day*
Special rates available for schools, coach parties and outings. Charitable Trust No. 292048

Are Your Plugs Trying To Tell You Something?

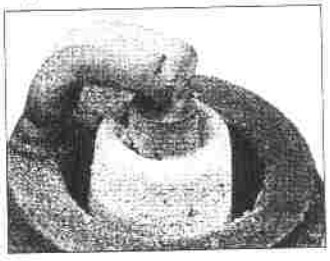
CHAMPION

Glow Plugs for Diesel engines.

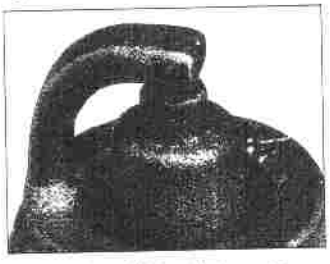
Possible causes	Corrective Action
1 Melted or broken sheath • Injectors (incorrect injection pressure, overadvanced injection, dripping nozzles). • Oil in the combustion chamber (overheating due to too high an oil level) • Worn valve guides, broken piston rings	• Recalibration of injection system • Correct engine oil level • Replacement of pistol rings/reboring of valve guides
2 Corroded Sheath • Electronic Control Relay Failure • Incorrect system voltage • Incorrect plug type fitted • Thermal exchange regulation chamber compressed due to excessive torque on tightening of plug. A narrowed thermal exchange regulating chamber causes the sheath to overheat.	• Check and/or replace Electronic Control Relay • Check electrical system • Check the plug type is correct for the vehicle • The plug has to be mounted with care using a torque wrench, paying particular attention to the recommended torque levels
3 Open circuit with apparently undamaged sheath • Defective electrical system causing excessive voltage from battery • Electronic Control Relay failure	• Check electrical system • Check and/or replace Electronic Control Relay



Spark Plugs for petrol engines.



Normal – Grey-brown deposits, lightly coated core nose. Plugs ideally suited to engine, and engine in good condition.

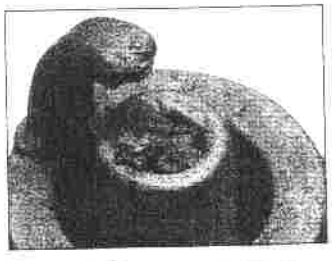


Oil Fouling – Wet, oily deposits. **Fault:** worn bores/piston rings or valve guides; sometimes occurs (temporarily) during running-in period.

Heavy Deposits – A build up of crusty deposits, light-grey sandy colour in appearance. **Fault:** often caused by worn valve guides, excessive use of upper cylinder lubricant, or idling for long periods.

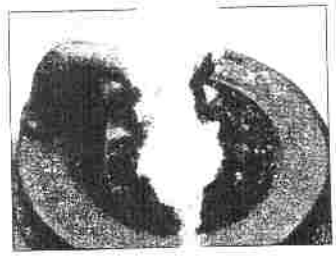
Overheating – Electrodes have glazed appearance, core nose very white - few deposits. **Fault:** plug overheating. **Check:** plug value, ignition timing, fuel octane rating (too w) and fuel mixture (too w

Lead Glazing – Plug insulator firing tip appears yellow or green/yellow and shiny in appearance. **Fault:** often caused by incorrect carburation, excessive idling followed by sharp acceleration. Also check ignition timing.



Electrode Damage – Electrodes burned away; core nose has burned glazed appearance. **Fault:** pre-ignition. **Check:** for correct heat range and as for 'overheating'.

Carbon Fouling – Dry, black, sooty deposits. **Fault:** over-rich fuel mixture. **Check:** carburettor mixture settings, float level, choke operation, air filter.



Split Core Nose – (May appear initially as a crack). **Fault:** detonation or wrong gap-setting technique. **Check:** ignition timing, cooling system, fuel mixture (too weak).

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- **Service your car** – complete step-by-step guide
- **Fault finding** – pinpoint specific problems easily
- **Roadside Emergencies** – how to deal with them
- **Pass the MOT** – step-by-step test checks
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