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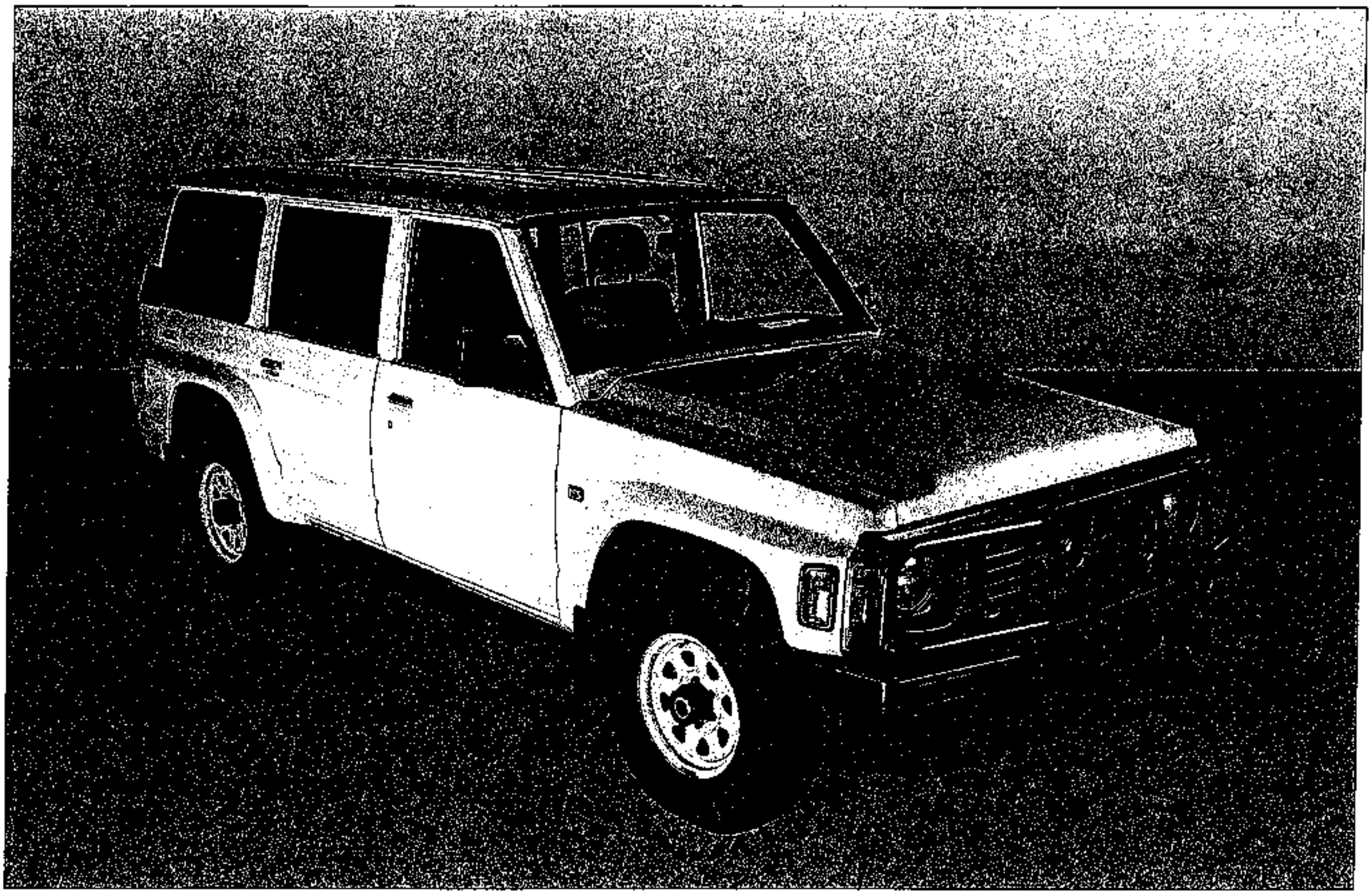


Nissan Patrol

About this manual

Its purpose

The purpose of this manual is to help you get the best value from your vehicle. It can do so in several ways. It can help you decide what work must be done, even if you choose to have it done by a dealer service department or a repair shop; it provides information and procedures for routine maintenance and servicing; and it offers diagnostic and repair procedures to follow when trouble occurs.

We hope you use the manual to tackle the work yourself. For many simpler jobs, doing it yourself may be quicker than arranging an appointment to get the vehicle into a shop and making the trips to leave it and pick it up. More importantly, a lot of money can be saved by avoiding the expense the shop must pass on to you to cover its labor and overhead costs. An added benefit is the sense of satisfaction and accomplishment that you feel after doing the job yourself.

Using the manual

The manual is divided into Chapters. Each Chapter is divided into numbered Sections, which are headed in bold type between horizontal lines. Each Section consists of consecutively numbered paragraphs.

At the beginning of each numbered Section you will be referred to any illustrations which apply to the procedures in that Section. The reference numbers used in illustration captions pinpoint the pertinent Section and the Step within that Section. That is, illustration 3.2 means the illustration refers to Section 3 and Step (or paragraph) 2 within that Section.

Procedures, once described in the text, are not normally repeated. When it's necessary to refer to another Chapter, the reference will be given as Chapter and Section number. Cross references given without use of the word "Chapter" apply to Sections and/or paragraphs in the same Chapter. For example, "see Section 8" means in the same Chapter.

References to the left or right side of the vehicle assume you are sitting in the driver's seat, facing forward.

Even though we have prepared this manual with extreme care, neither the publisher nor the author can accept responsibility for any errors in, or omissions from, the information given.

NOTE

A **Note** provides information necessary to properly complete a procedure or information which will make the procedure easier to understand.

CAUTION

A **Caution** provides a special procedure or special steps which must be taken while completing the procedure where the Caution is found. Not heeding a Caution can result in damage to the assembly being worked on.

WARNING

A **Warning** provides a special procedure or special steps which must be taken while completing the procedure where the Warning is found. Not heeding a Warning can result in personal injury.

Introduction to the Nissan Patrol/Ford Maverick

Nissan Patrols/Ford Mavericks are available in two-door hardtop, four-door station wagon, utility and cab-and-chassis models.

They are available with both petrol and diesel engines. The 4.2 litre diesel engine is covered by this manual as are the 3.0 litre and 4.2 litre petrol engines.

The 3.0 litre in-line six-cylinder engine is equipped with a carburettor and electronic ignition. The 4.2 litre in-line six cylinder petrol engine originally came with a carburettor and breaker-point ignition. It was later upgraded to computer-controlled fuel injection and electronic ignition.

The engine drives the front and rear solid axles through either a manual or automatic transmission, a transfer case and driveshafts. All models are equipped with four wheel drive.

Two suspension systems are used. Coil springs and shock absorbers with control arms are used on hardtop and wagons. Most utility and cab chassis models are equipped with leaf springs and shock absorbers.

The steering gearbox is mounted to the right of the engine and is connected to the steering knuckles by a rod or series of rods.

The brakes are disc at the front and disc or drum at the rear. The parking brake is mounted to the rear of the transfer case.

Vehicle Identification Numbers

Modifications are a continuing and unpublicised process in vehicle manufacturing. Since spare parts manuals and lists are compiled on a numerical basis, the individual vehicle numbers are essential to correctly identify the component required.

Vehicle Identification Number (VIN)

This very important identification number is stamped on a plate attached to the right inner fender near the windscreen washer reservoir **(see illustration)**. The VIN also appears on the Vehicle Certificate of Title and Registration. It contains information such as where and when the vehicle was manufactured, the model year and the body style.

Engine serial number

On 4.2 litre engines, the serial number is stamped on the engine block at the left front. On 3.0 litre engines, it is stamped at the lower left side of the engine block below the exhaust manifold.

Compliance plate

This tag is riveted to the firewall on the upper right side above the master cylinder **(see illustration)**. The plate contains the name of the manufacturer, the month and year of production, the Gross Vehicle Weight Rating (GVWR) and the certification statement **(see illustration)**.

Build date plate

This plate, located at the extreme left front of the engine compartment identifies the date of manufacture for the vehicle **(see illustration)**.

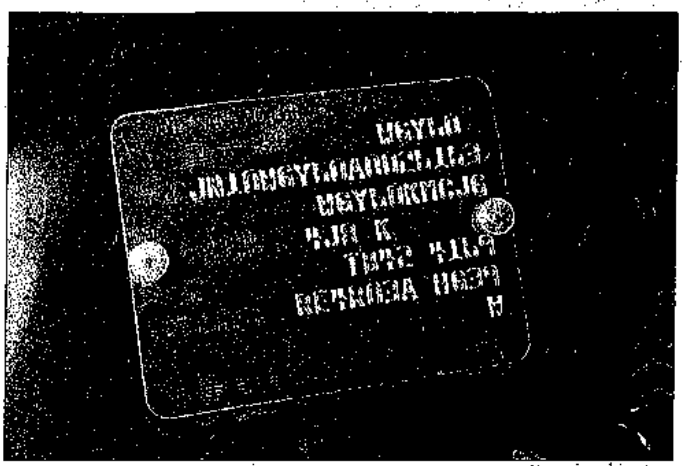
Vehicle Emission Control Information (VECI) label

The VECI label is affixed to the valve cover on most models. It contains information on the emission control systems fitted on the vehicle as well as the tune-up specifications **(see illustration)**.

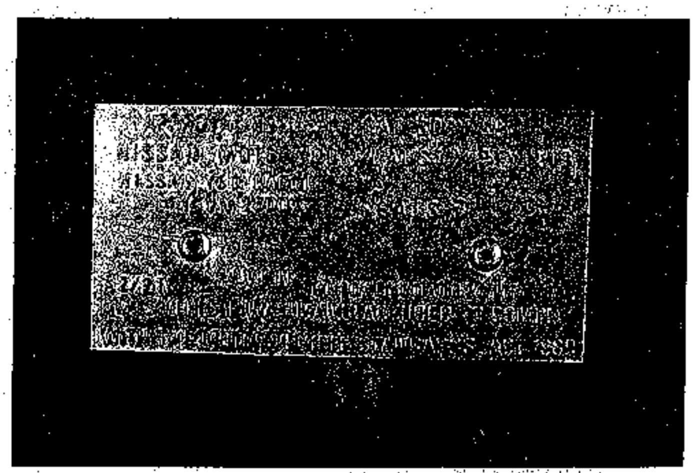
Transmission and transfer case serial numbers

The manual transmission has a tag affixed to the top cover towards the front. The automatic transmission serial tag is secured to the right side of the transmission towards the rear.

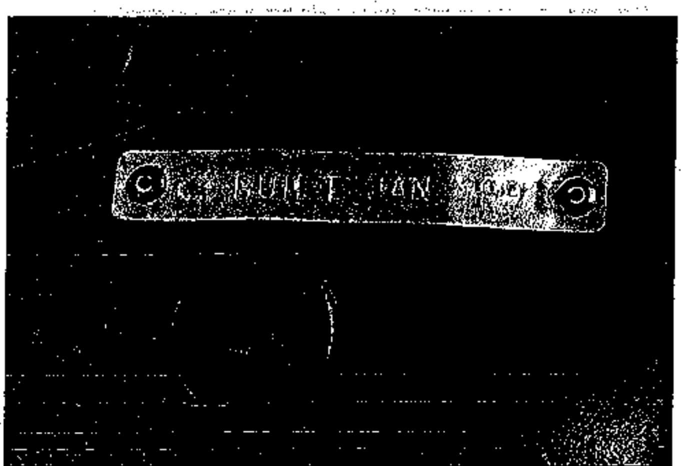
The transfer case identification number is found on the left rear of the unit.



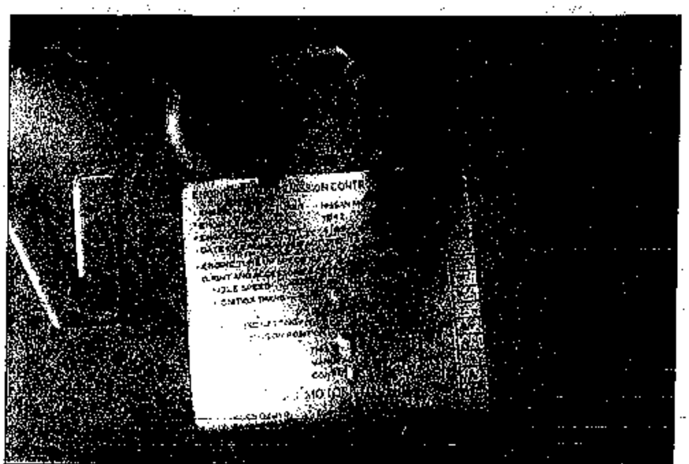
The vehicle identification plate has important information concerning the vehicle. It is behind the windscreen washer reservoir attached with special rivets to the inner fender



The compliance plate is fixed to the firewall



The build date plate is located on the left side of the radiator support



The VECI label gives the proper tune-up specifications for the engine. Its information supersedes all other specifications

Buying parts

Spares are available from many sources, which generally fall into one of two categories - authorised dealer parts departments and independent retail auto parts stores. Our advice concerning these parts is as follows:

Retail auto parts stores: Good auto parts stores will stock frequently needed components which wear out relatively fast, such as clutch components, exhaust systems, brake parts, tune-up parts, etc. These stores often supply new or reconditioned parts on an exchange basis, which can save a considerable amount of money. Discount auto parts stores are often very good places to buy materials and parts needed for general vehicle maintenance such as oil, grease, filters, spark plugs, belts, touch-up paint, bulbs, etc. They also usually sell tools and general accessories, have convenient hours, charge lower prices and can often be found not far from home.

Authorised dealer parts department: This is the best source for parts which are unique to the vehicle and not generally available elsewhere (such as major engine parts, transmission parts, trim pieces, etc.).

Warranty information: If the vehicle is still covered under warranty, be sure that any spares purchased - regardless of the source - do not invalidate the warranty!

To be sure of obtaining the correct parts, have engine and chassis numbers available and, if possible, take the old parts along for positive identification.

Maintenance techniques, tools and working facilities

Maintenance techniques

There are a number of techniques involved in maintenance and repair that will be referred to throughout this manual. Application of these techniques will enable the home mechanic to be more efficient, better organised and capable of performing the various tasks properly, which will ensure that the repair job is thorough and complete.

Fasteners

Fasteners are nuts, bolts, studs and screws used to hold two or more parts together. There are a few things to keep in mind when working with fasteners. Almost all of them use a locking device of some type, either a lockwasher, locknut, locking tab or thread adhesive. All threaded fasteners should be clean and straight, with undamaged threads and undamaged corners on the hex head where the wrench fits. Develop the habit of renewing all damaged nuts and bolts. Special locknuts with nylon or fibre inserts can only be used once. If they are removed, they lose their locking ability and must be renewed.

Rusted nuts and bolts should be treated with a penetrating fluid to ease removal and prevent breakage. Some mechanics use turpentine in a spout-type oil can, which works quite well. After applying the rust penetrant, let it work for a few minutes before trying to loosen the nut or bolt. Badly rusted fasteners may have to be chiselled or sawed off or removed with a special nut breaker, available at tool stores.

If a bolt or stud breaks off in an assembly, it can be drilled and removed with a special tool commonly available for this purpose. Most automotive machine shops can perform this task, as well as other repair procedures, such as the repair of threaded holes that have been stripped out.

Flat washers and lockwashers, when removed from an assembly, should always be fitted exactly as removed. Renew any damaged washers. Never use a lockwasher on any soft metal surface (such as aluminium), thin sheet metal or plastic.

Fastener sizes

For a number of reasons, automobile manufacturers are making wider and wider use of metric fasteners. Therefore, it is important to be able to tell the difference between standard (sometimes called U.S. or SAE) and metric hardware, since they cannot be interchanged.

All bolts, whether standard or metric, are sized according to diameter, thread pitch and length. For example, a standard M12 - 1.75 x 25 metric bolt is 12 mm in diameter, has a thread pitch of 1.75 mm (the distance between threads) and is 25 mm long. The two bolts are nearly identical, and easily confused, but they are not interchangeable.

In addition to the differences in diameter, thread pitch and length, metric and standard bolts can also be distinguished by examining the bolt heads. To begin with, the distance across the flats on a standard bolt head is measured in inches, while the same dimension on a metric bolt is sized in millimetres (the same is true for nuts). As a result, a standard spanner should not be used on a metric bolt and a metric spanner should not be used on a standard bolt. Also, most standard bolts have slashes radiating out from the centre of the head to denote the grade or strength of the bolt, which is an indication of the amount of torque that can be applied to it. The greater the number of slashes, the greater the strength of the bolt. Grades 0 through 5 are commonly used on automobiles. Metric bolts have a property class (grade) number, rather than a slash, moulded into their heads to indicate bolt strength. In this case, the higher the number, the stronger the bolt. Property class numbers 8.8, 9.8 and 10.9 are commonly used on automobiles.

Strength markings can also be used to distinguish standard hex nuts from metric hex nuts. Many standard nuts have dots stamped into one side, while metric nuts are marked with a number. The greater the number of dots, or the higher the number, the greater the strength of the nut.

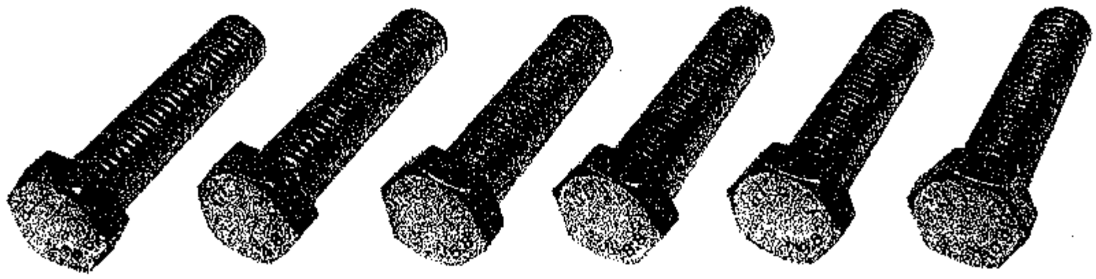
Metric studs are also marked on their ends according to property class (grade). Larger studs are numbered (the same as metric bolts), while smaller studs carry a geometric code to denote grade.

It should be noted that many fasteners, especially Grades 0 through 2, have no distinguishing marks on them. When such is the case, the only way to determine whether it is standard or metric is to measure the thread pitch or compare it to a known fastener of the same size.

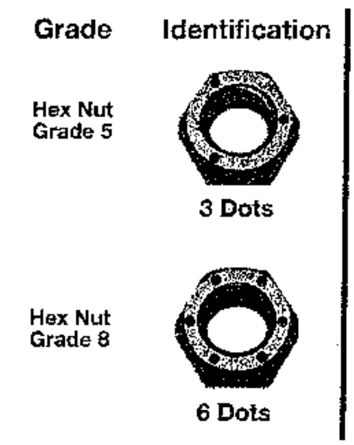
Standard fasteners are often referred to as SAE, as opposed to metric. However, it should be noted that SAE technically refers to a non-metric fine thread fastener only. Coarse thread non-metric fasteners are referred to as USS sizes.

Since fasteners of the same size (both

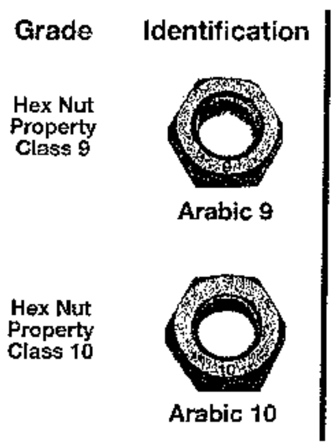
Grade 1 or 2 Grade 5 Grade 8



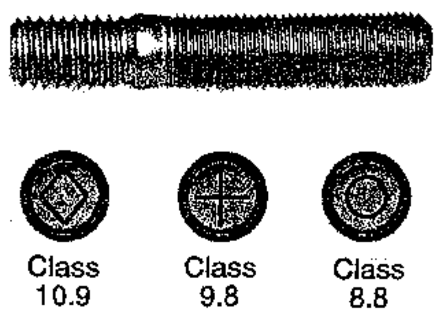
Bolt strength marking (standard/SAE/USS; bottom - metric)



Standard hex nut strength markings



Metric hex nut strength markings



Metric stud strength markings

00-1 HAYNES

standard and metric) may have different strength ratings, be sure to refit any bolts, studs or nuts removed from your vehicle in their original locations. Also, when renewing a fastener, make sure that the new one has a strength rating equal to or greater than the original.

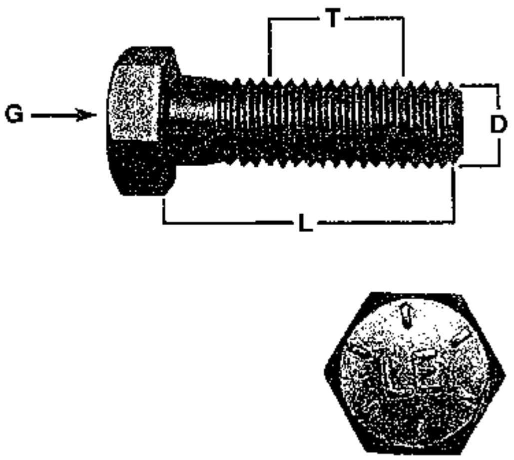
Tightening sequences and procedures

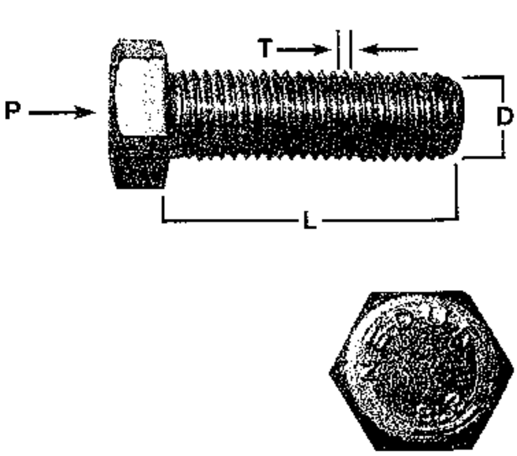
Most threaded fasteners should be tightened to a specific torque value (torque is the twisting force applied to a threaded component such as a nut or bolt). Overtightening the fastener can weaken it and cause it to break, while undertightening can cause it to eventually come loose. Bolts, screws and studs, depending on the material they are made of and their thread diameters, have specific torque values, many of which are noted in the Specifications at the beginning of each Chapter. Be sure to follow the torque recommendations closely. For fasteners not assigned a specific torque, a general torque value chart is presented here as a guide. These torque values are for dry (unlubricated) fasteners threaded into steel or cast iron (not aluminium). As was previously mentioned, the size and grade of a fastener determine the amount of torque that can safely be applied to it. The figures listed here are approximate for Grade 2 and Grade 3 fasteners. Higher grades can tolerate higher torque values.

Fasteners laid out in a pattern, such as cylinder head bolts, sump bolts, differential cover bolts, etc., must be loosened or tightened in sequence to avoid warping the component. This sequence will normally be shown in the appropriate Chapter. If a specific pattern is not given, the following procedures can be used to prevent warping.

Initially, the bolts or nuts should be assembled finger-tight only. Next, they should be tightened one full turn each, in a

Metric thread sizes	Nm	Ft-lbs
M-6	9 to 12	6 to 9
M-8	19 to 28	14 to 21
M-10	38 to 54	28 to 40
M-12	68 to 96	50 to 71
M-14	109 to 154	80 to 140
Pipe thread sizes		
1/8	7 to 10	5 to 8
1/4	17 to 24	12 to 18
3/8	30 to 44	22 to 33
1/2	34 to 47	25 to 35
U.S. thread sizes		
1/4 - 20	9 to 12	6 to 9
5/16 - 18	17 to 24	12 to 18
5/16 - 24	19 to 27	14 to 20
3/8 - 16	30 to 43	22 to 32
3/8 - 24	37 to 51	27 to 38
7/16 - 14	55 to 74	40 to 55
7/16 - 20	55 to 81	40 to 60
1/2 - 13	75 to 108	55 to 80





00-2 HAYNES

Standard (SAE and USS) bolt dimensions/grade marks

G Grade marks (bolt strength)
L Length (in inches)
T Thread pitch (number of threads per inch)
D Nominal diameter (in inches)

Metric bolt dimensions/grade marks

P Property class (bolt strength)
L Length (in millimetres)
T Thread pitch (distance between threads in millimetres)
D Diameter

criss-cross or diagonal pattern. After each one has been tightened one full turn, return to the first one and tighten them all one-half turn, following the same pattern. Finally, tighten each of them one-quarter turn at a time until each fastener has been tightened to the proper torque. To loosen and remove the fasteners, the procedure would be reversed.

Component disassembly

Component disassembly should be done with care and purpose to help ensure that the parts go back together properly. Always keep track of the sequence in which parts are removed. Make note of special characteristics or marks on parts that can be fitted more than one way, such as a grooved thrust washer on a shaft. It is a good idea to lay the disassembled parts out on a clean surface in the order that they were removed. It may also be helpful to make sketches or take instant photos of components before removal.

When removing fasteners from a component, keep track of their locations. Sometimes threading a bolt back in a part, or putting the washers and nut back on a stud, can prevent mix-ups later. If nuts and bolts cannot be returned to their original locations, they should be kept in a compartmented box or a series of small boxes. A cupcake or muffin tin is ideal for this purpose, since each cavity can hold the bolts and nuts from a particular area (i.e. sump bolts, valve cover bolts, engine mount bolts, etc.). A pan of this type is especially helpful when working on assemblies with very small parts, such as the carburettor, alternator, valve train or interior dash and trim pieces. The cavities can be marked with paint or tape to identify the contents.

Whenever wiring looms, harnesses or connectors are separated, it is a good idea to identify the two halves with numbered pieces of masking tape so they can be easily reconnected.

Gasket sealing surfaces

Throughout any vehicle, gaskets are used to seal the mating surfaces between two parts and keep lubricants, fluids, vacuum or pressure contained in an assembly.

Many times these gaskets are coated with a liquid or paste-type gasket sealing compound before assembly. Age, heat and pressure can sometimes cause the two parts to stick together so tightly that they are very difficult to separate. Often, the assembly can be loosened by striking it with a soft-face hammer near the mating surfaces. A regular hammer can be used if a block of wood is placed between the hammer and the part. Do not hammer on cast parts or parts that could be easily damaged. With any particularly stubborn part, always recheck to make sure that every fastener has been removed.

Avoid using a screwdriver or bar to prise apart an assembly, as they can easily mar the gasket sealing surfaces of the parts, which must remain smooth. If levering is absolutely necessary, use an old broom handle, but keep in mind that extra clean up will be necessary if the wood splinters.

After the parts are separated, the old gasket must be carefully scraped off and the gasket surfaces cleaned. Stubborn gasket material can be soaked with rust penetrant or treated with a special chemical to soften it so it can be easily scraped off. A scraper can be fashioned from a piece of copper tubing by flattening and sharpening one end. Copper is recommended because it is usually softer than the surfaces to be scraped, which reduces the chance of gouging the part. Some gaskets can be removed with a wire brush, but regardless of the method used, the mating surfaces must be left clean and smooth. If for some reason the gasket surface is gouged, then a gasket sealer thick enough to fill scratches will have to be used during reassembly of the components. For most applications, a non-drying (or semi-drying) gasket sealer should be used.

Hose removal tips

Warning: *If the vehicle is equipped with air conditioning, do not disconnect any of the A/C hoses without first having the system depressurised by a dealer service department or a service station.*

Hose removal precautions closely parallel gasket removal precautions. Avoid scratching or gouging the surface that the hose mates against or the connection may leak. This is especially true for radiator hoses. Because of various chemical reactions, the rubber in hoses can bond itself to the metal spigot that the hose fits over. To remove a hose, first loosen the hose clamps that secure it to the spigot. Then, with slip-joint pliers, grab the hose at the clamp and rotate it around the spigot. Work it back and forth until it is completely free, then pull it off. Silicone or other lubricants will ease removal if they can be applied between the hose and the outside of the spigot. Apply the same lubricant to the inside of the hose and the outside of the spigot to simplify fitting.

As a last resort (and if the hose is to be renewed with a new one anyway), the rubber can be slit with a knife and the hose peeled from the spigot. If this must be done, be careful that the metal connection is not damaged.

If a hose clamp is broken or damaged, do not reuse it. Wire-type clamps usually weaken with age, so it is a good idea to renew them with screw-type clamps whenever a hose is removed.

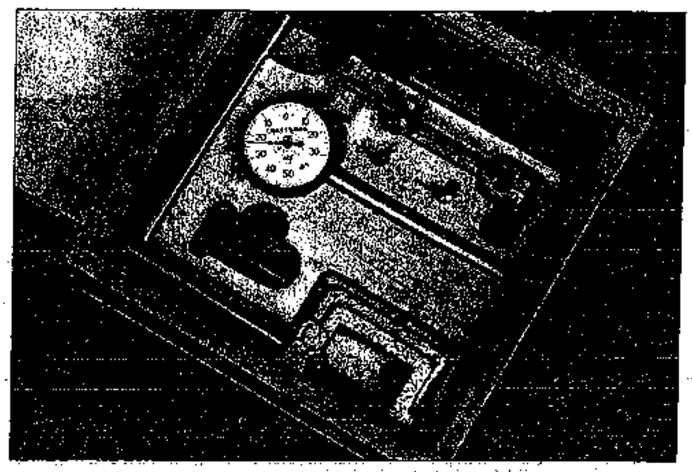
Tools

A selection of good tools is a basic requirement for anyone who plans to maintain and repair his or her own vehicle. For the owner who has few tools, the initial investment might seem high, but when compared to the spiralling costs of professional auto maintenance and repair, it is a wise one.

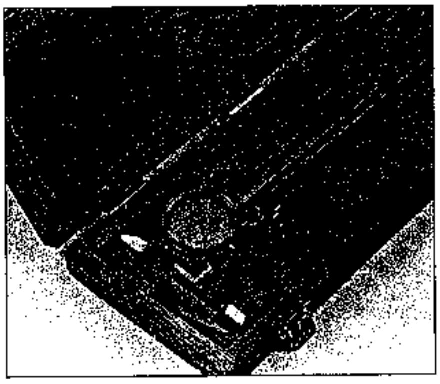
To help the owner decide which tools are needed to perform the tasks detailed in this manual, the following tool lists are offered: *Maintenance and minor repair*, *Repair/overhaul* and *Special*.

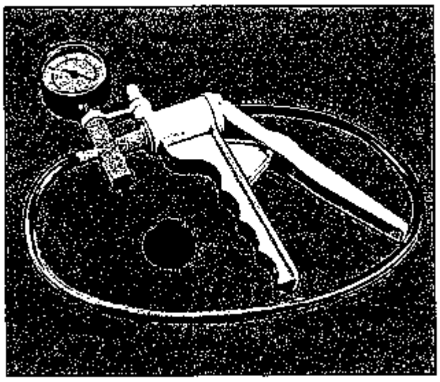
The newcomer to practical mechanics should start off with the *maintenance and minor repair* tool kit, which is adequate for the simpler jobs performed on a vehicle. Then, as confidence and experience grow, the owner can tackle more difficult tasks, buying additional tools as they are needed.

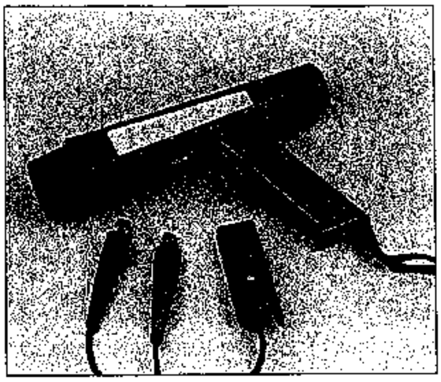
Micrometer set

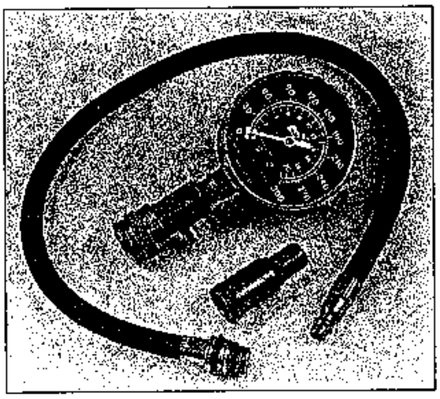


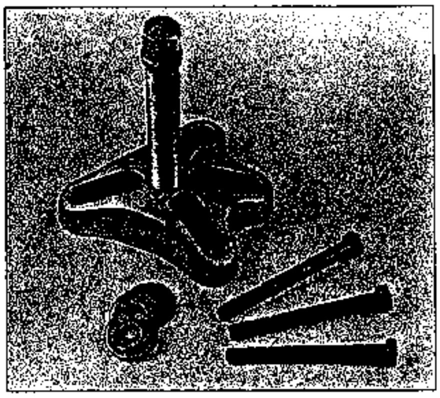
Dial indicator set

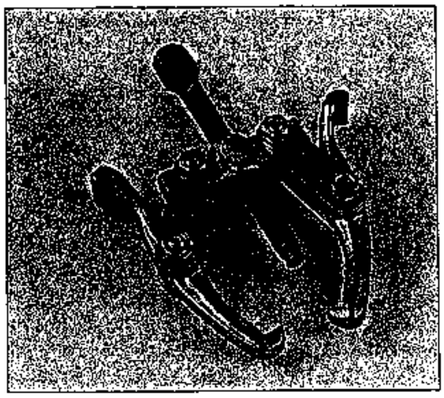

Dial caliper

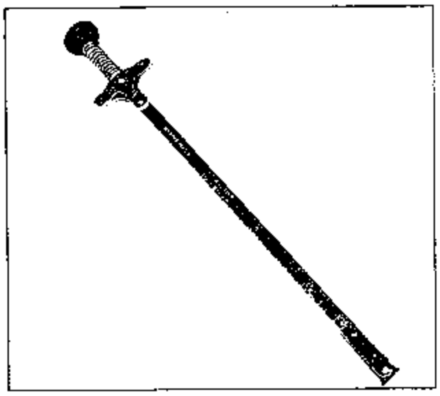

Hand-operated vacuum pump

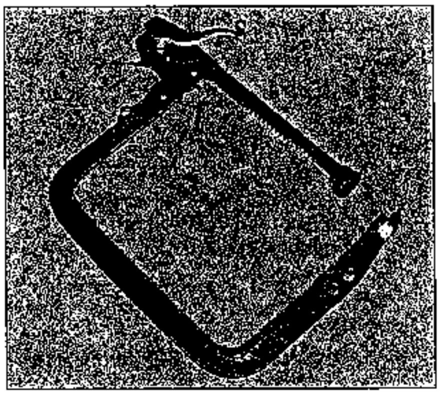

Timing light

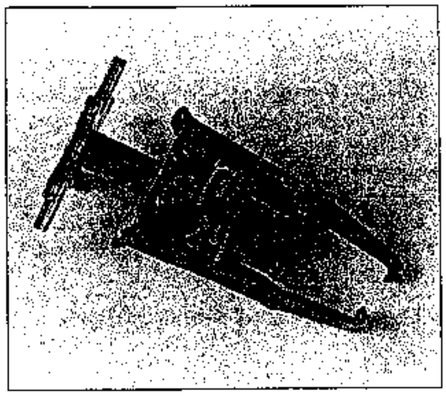

Compression gauge with spark plug hole adaptor

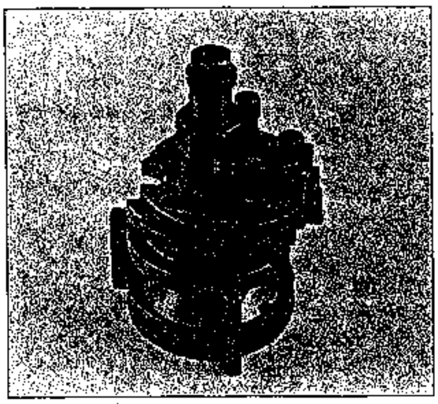

Damper/steering wheel puller

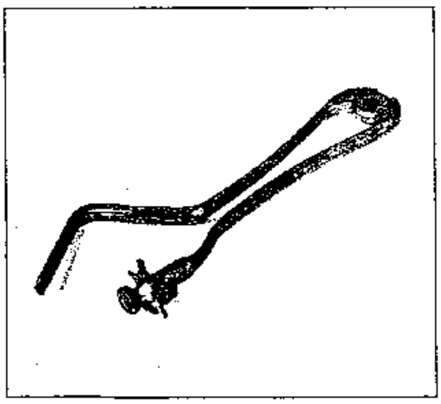

General purpose puller

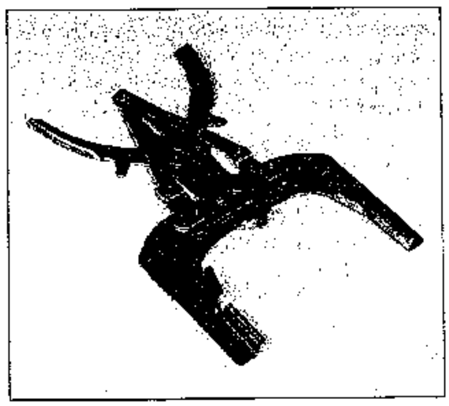

Hydraulic lifter removal tool

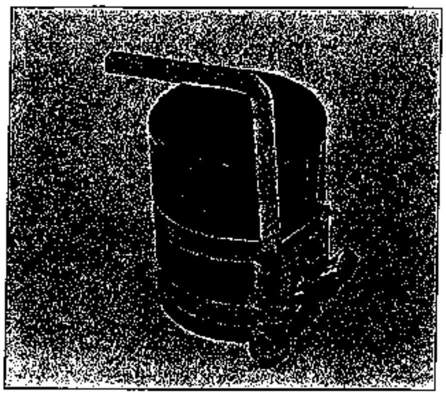

Valve spring compressor

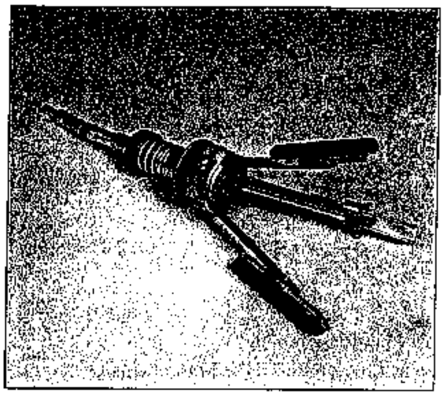

Valve spring compressor

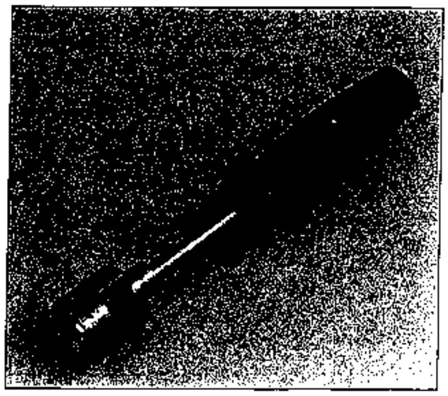

Ridge reamer

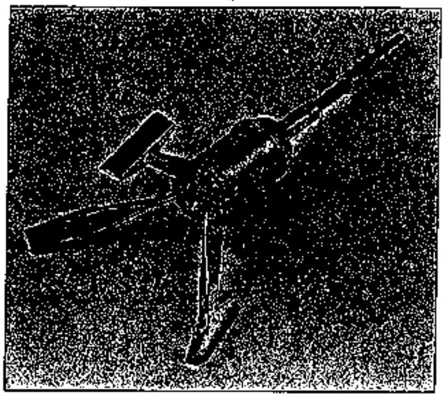

Piston ring groove cleaning tool

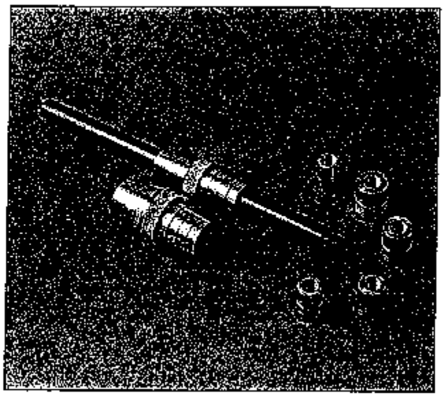

Ring removal/fitting tool

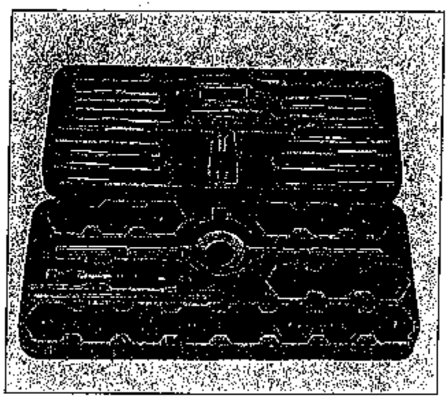

Ring compressor


Cylinder hone


Brake hold-down spring tool


Brake cylinder hone


Clutch plate alignment tool


Tap and die set

Eventually the basic kit will be expanded into the *repair and overhaul* tool set. Over a period of time, the experienced do-it-yourselfer will assemble a tool set complete 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 frequency of use.

Maintenance and minor repair tool kit

The tools in this list should be considered the minimum required for performance of routine maintenance, servicing and minor repair work. We recommend the purchase of combination spanners (box-end and open-end combined in one spanner). While more expensive than open end spanners, they offer the advantages of both types of spanners.

Combination spanner set (6 mm to 19 mm)
Adjustable spanner
Spark plug socket with rubber insert
Spark plug gap adjusting tool
Feeler gauge set
Brake bleeder spanner
Standard screwdriver
Phillips screwdriver
Combination pliers
Hacksaw and assortment of blades
Tyre pressure gauge
Grease gun
Oil can
Fine emery cloth
Wire brush
Battery post and cable cleaning tool
Oil filter wrench
Funnel (medium size)
Safety goggles
Jackstands (2)
Drain pan

Note: *If basic tune-ups are going to be part of routine maintenance, it will be necessary to purchase a good quality stroboscopic timing light and combination tachometer/dwell meter. Although they are included in the list of special tools, it is mentioned here because they are absolutely necessary for tuning most vehicles properly.*

Repair and overhaul tool set

These tools are essential for anyone who plans to perform major repairs and are in addition to those in the maintenance and minor repair tool kit. Included is a comprehensive set of sockets which, though expensive, are invaluable because of their versatility, especially when various extensions and drives are available. We recommend the 1/2-inch drive over the 3/8-inch drive. Although the larger drive is bulky and more expensive, it has the capacity of accepting a very wide range of large sockets. Ideally, however, the mechanic should have a 3/8-inch drive set and a 1/2-inch drive set.

Socket set(s)
Reversible ratchet
Extension
Universal joint
Torque wrench (same size drive as sockets)
Ball peen hammer
Soft-face hammer (plastic/rubber)
Standard screwdriver
Standard screwdriver (stubby)
Phillips screwdriver
Phillips screwdriver (stubby - No. 2)
Pliers - vice grip
Pliers - lineman's
Pliers - needle nose
Pliers - snap-ring (internal and external)
Cold chisel
Scribe
Scraper (made from flattened copper tubing)
Centrepunch
Pin punches
Steel rule/straightedge
Allen wrench set (4 mm to 10 mm)
A selection of files
Wire brush (large)
Jackstands (second set)
Jack (scissors or hydraulic type)

Note: *Another tool which is often useful is an electric drill with a chuck capacity of 10 mm and a set of good quality drill bits.*

Special tools

The tools in this list include those which are not used regularly, are expensive to buy, or which need to be used in accordance with their manufacturer's instructions. Unless these tools will be used frequently, it is not very economical to purchase many of them. A consideration would be to split the cost and use between yourself and a friend or friends. In addition, most of these tools can be obtained from a tool rental shop on a temporary basis.

This list primarily contains only those tools and instruments widely available to the public, and not those special tools produced by the vehicle manufacturer for distribution to dealer service departments. Occasionally, references to the manufacturer's special tools are included in the text of this manual. Generally, an alternative method of doing the job without the special tool is offered. However, sometimes there is no alternative to their use. Where this is the case, and the tool cannot be purchased or borrowed, the work should be turned over to the dealer service department or an automotive repair shop.

Valve spring compressor
Piston ring groove cleaning tool
Piston ring compressor
Piston ring fitting tool
Cylinder compression gauge
Cylinder ridge reamer
Cylinder surfacing hone
Cylinder bore gauge
Micrometers and/or dial calipers
Hydraulic lifter removal tool
Balljoint separator
Universal-type puller
Impact screwdriver
Dial indicator set
Stroboscopic timing light (inductive pick-up)
Hand operated vacuum/pressure pump
Tachometer/dwell meter
Universal electrical multimeter
Cable hoist
Brake spring removal and fitting tools
Floor jack

Buying tools

For the do-it-yourselfer who is just starting to get involved in vehicle maintenance and repair, there are a number of options available when purchasing tools. If maintenance and minor repair is the extent of the work to be done, the purchase of individual tools is satisfactory. If, on the other hand, extensive work is planned, it would be a good idea to purchase a modest tool set from one of the large retail chain stores. A set can usually be bought at a substantial savings over the individual tool prices, and they often come with a tool box. As additional tools are needed, add-on sets, individual tools and a larger tool box can be purchased to expand the tool selection. Building a tool set gradually allows the cost of the tools to be spread over a longer period of time and gives the mechanic the freedom to choose only those tools that will actually be used.

Tool stores will often be the only source of some of the special tools that are needed, but regardless of where tools are bought, try to avoid cheap ones, especially when buying screwdrivers and sockets, because they won't last very long. The expense involved in renewing cheap tools will eventually be greater than the initial cost of quality tools.

Care and maintenance of tools

Good tools are expensive, so it makes sense to treat them with respect. Keep them clean and in useable condition and store them properly when not in use. Always wipe off any dirt, grease or metal chips before putting them away. Never leave tools lying around in the work area. Upon completion of a job, always check closely under the bonnet for tools that may have been left there so they won't get lost during a test drive.

Some tools, such as screwdrivers, pliers, spanners and sockets, can be hung on a panel mounted on the garage or workshop wall, while others should be kept in a tool box or tray. Measuring instruments, gauges, metres, etc. must be carefully stored where they cannot be damaged by weather or impact from other tools.

When tools are used with care and stored properly, they will last a very long time. Even with the best of care, though, tools will wear out if used frequently. When a tool is damaged or worn out, renew it. Subsequent jobs will be safer and more enjoyable if you do.

How to repair damaged threads

Sometimes, the internal threads of a nut or bolt hole can become stripped, usually from overtightening. Stripping threads is an all-too-common occurrence, especially when working with aluminium parts, because aluminium is so soft that it easily strips out.

Usually, external or internal threads are only partially stripped. After they've been cleaned up with a tap or die, they'll still work. Sometimes, however, threads are badly damaged. When this happens, you've got three choices:

1) *Drill and tap the hole to the next suitable oversize and fit a larger diameter bolt, screw or stud.*
2) *Drill and tap the hole to accept a threaded plug, then drill and tap the plug to the original screw size. You can also buy a plug already threaded to the original size. Then you simply drill a hole to the specified size, then run the threaded plug into the hole with a bolt and jam nut. Once the plug is fully seated, remove the jam nut and bolt.*
3) *The third method uses a patented thread repair kit like Heli-Coil or Slimsert. These easy-to-use kits are designed to repair damaged threads in straight-through holes and blind holes. Both are available as kits which can handle a variety of sizes and thread patterns. Drill the hole, then tap it with the special included tap. Fit the Heli-Coil and the hole is back to its original diameter and thread pitch.*

Regardless of which method you use, be sure to proceed calmly and carefully. A little impatience or carelessness during one of these relatively simple procedures can ruin your whole day's work and cost you a bundle if you wreck an expensive part.

Working facilities

Not to be overlooked when discussing tools is the workshop. If anything more than routine maintenance is to be carried out, some sort of suitable work area is essential.

It is understood, and appreciated, that many home mechanics do not have a good workshop or garage available, and end up removing an engine or doing major repairs outside. It is recommended, however, that the overhaul or repair be completed under the cover of a roof.

A clean, flat workbench or table of comfortable working height is an absolute necessity. The workbench should be equipped with a vice that has a jaw opening of at least 10 centimetres.

As mentioned previously, some clean, dry storage space is also required for tools, as well as the lubricants, fluids, cleaning solvents, etc. which soon become necessary.

Sometimes waste oil and fluids, drained from the engine or cooling system during normal maintenance or repairs, present a disposal problem. To avoid pouring them on the ground or into a sewage system, pour the used fluids into large containers, seal them with caps and take them to an authorised disposal site or recycling centre. Plastic jugs, such as old antifreeze containers, are ideal for this purpose.

Always keep a supply of old newspapers and clean rags available. Old towels are excellent for mopping up spills. Many mechanics use rolls of paper towels for most work because they are readily available and disposable. To help keep the area under the vehicle clean, a large cardboard box can be cut open and flattened to protect the garage or shop floor.

Whenever working over a painted surface, such as when leaning over a fender to service something under the bonnet, always cover it with an old blanket or bedspread to protect the finish. Vinyl covered pads, made especially for this purpose, are available at auto parts stores.

Jacking and towing

Jacking

The jack supplied with the vehicle should only be used for raising the vehicle for changing a tyre or placing jackstands under the frame. **Warning:** *Never crawl under the vehicle or start the engine when the jack is being used as the only means of support.*

All vehicles are supplied with a screw-type jack. When jacking the vehicle, it must be directly under the front or rear axle housing **(see illustration)**. Follow the instructions provided with the jack.

The vehicle should be on level ground with the wheels blocked and the transmission in Park (automatic) or Reverse (manual). Loosen the lug nuts one-half turn and leave them in place until the wheel is raised off the ground.

Place the jack under the side of the vehicle in the indicated position. Use the supplied wrench to turn the jackscrew clockwise until the wheel is raised off the ground. Remove the lug nuts, pull off the wheel and renew it with the spare.

With the bevelled side in, renew the lug nuts and tighten them until snug. Lower the vehicle by turning the jackscrew counterclockwise. Remove the jack and tighten the nuts in a diagonal pattern to the torque listed in the Chapter 1 Specifications. If a torque wrench is not available, have the torque checked by a service station as soon as possible. Renew the hubcap by placing it in position and using the heel of your hand or a rubber mallet to seat it.

Towing

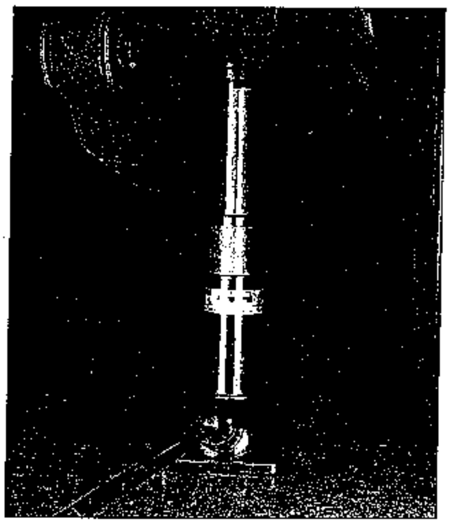
Manual transmission-equipped vehicles can be towed with all four wheels on the ground. Automatic transmission-equipped models should only be towed with all four wheels on the ground if speeds do not exceed 55 kph and the distance is not over 50 kilometres, otherwise transmission damage can result.

Towing equipment specifically designed for this purpose should be used and should be attached to the main structural members of the vehicle, not the bumper or brackets.

Safety is a major consideration when towing and all applicable state and local laws must be obeyed. A safety chain system must be used for all towing.

While towing, the parking brake should be released and the transmission should be in Neutral. Front hubs should always be set to the unlocked position.

The steering must be unlocked (ignition switch in the Off position). Remember that power steering and power brakes will not work with the engine off.



Front and rear jacking point - place the jack under the outer end of the axle housing

Booster battery (jump) starting

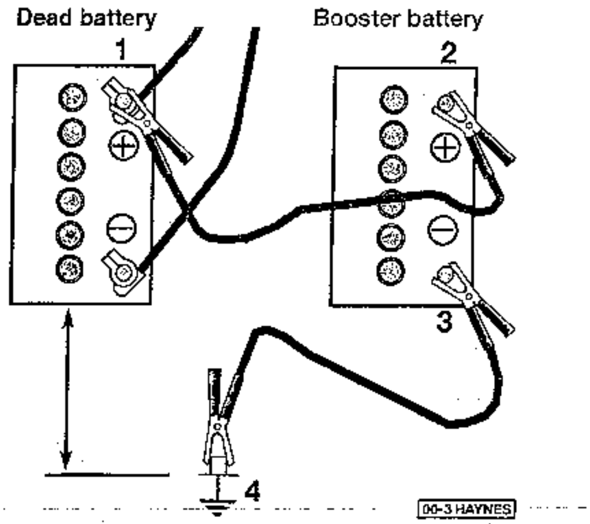
Observe these precautions when using a booster battery to start a vehicle:

a) *Before connecting the booster battery, make sure the ignition switch is in the Off position.*
b) *Turn off the lights, heater and other electrical loads.*
c) *Your eyes should be shielded. Safety goggles are a good idea.*
d) *Make sure the booster battery is the same voltage as the dead one in the vehicle.*
e) *The two vehicles MUST NOT TOUCH each other!*
f) *Make sure the transmission is in Neutral (manual) or Park (automatic).*
g) *If the booster battery is not a maintenance-free type, remove the vent caps and lay a cloth over the vent holes.*

Connect the red jumper cable to the positive (+) terminals of each battery.

Connect one end of the black jumper cable to the negative (-) terminal of the booster battery. The other end of this cable should be connected to a good earthing point on the vehicle to be started, such as a bolt or bracket on the engine block **(see illustration)**. Make sure the cable will not come into contact with the fan, drivebelts or other moving parts of the engine.

Start the engine using the booster battery, then, with the engine running at idle speed, disconnect the jumper cables in the reverse order of connection.



Make the booster battery cable connections in the numerical order shown (note that the negative cable of the booster battery is NOT attached to the negative terminal of the dead battery)

Automotive chemicals and lubricants

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

Cleaners

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

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

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

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

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

Lubricants

Motor oil is the lubricant formulated for use in engines. It normally contains a wide variety of additives to prevent corrosion and reduce foaming and wear. Motor oil comes in various weights (viscosity ratings) from 5 to 80. The recommended weight of the oil depends on the season, temperature and the demands on the engine. Light oil is used in cold climates and under light load conditions. Heavy oil is used in hot climates and where high loads are encountered. Multi-viscosity oils are designed to have characteristics of both light and heavy oils and are available in a number of weights from 5W-20 to 20W-50.

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

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

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

White grease is a heavy grease for metal-to-metal applications where water is a problem. White grease stays soft under both low and high temperatures (usually from -56 to +106-degrees C), and will not wash off or dilute in the presence of water.

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

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

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

Moly penetrants loosen and lubricate seized, rusted and corroded fasteners and prevent future rusting or freezing.

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

Sealants

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

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

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

Chemicals

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

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

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

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

Miscellaneous

Brake fluid is specially formulated hydraulic fluid that can withstand the heat and pressure encountered in brake systems. Care must be taken so this fluid does not come in contact with painted surfaces or plastics. An opened container should always be resealed to prevent contamination by water or dirt.

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

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

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

Conversion factors

Length (distance)				
Inches (in)	X 25.4	= Millimetres (mm)	X 0.0394	= Inches (in)
Feet (ft)	X 0.305	= Metres (m)	X 3.281	= Feet (ft)
Miles	X 1.609	= Kilometres (km)	X 0.621	= Miles
Volume (capacity)				
Cubic inches (cu in; in^3)	X 16.387	= Cubic centimetres (cc; cm^3)	X 0.061	= Cubic inches (cu in; in^3)
Imperial pints (Imp pt)	X 0.568	= Litres (l)	X 1.76	= Imperial pints (Imp pt)
Imperial quarts (Imp qt)	X 1.137	= Litres (l)	X 0.88	= Imperial quarts (Imp qt)
Imperial quarts (Imp qt)	X 1.201	= US quarts (US qt)	X 0.833	= Imperial quarts (Imp qt)
US quarts (US qt)	X 0.946	= Litres (l)	X 1.057	= US quarts (US qt)
Imperial gallons (Imp gal)	X 4.546	= Litres (l)	X 0.22	= Imperial gallons (Imp gal)
Imperial gallons (Imp gal)	X 1.201	= US gallons (US gal)	X 0.833	= Imperial gallons (Imp gal)
US gallons (US gal)	X 3.785	= Litres (l)	X 0.264	= US gallons (US gal)
Mass (weight)				
Ounces (oz)	X 28.35	= Grams (g)	X 0.035	= Ounces (oz)
Pounds (lb)	X 0.454	= Kilograms (kg)	X 2.205	= Pounds (lb)
Force				
Ounces-force (ozf; oz)	X 0.278	= Newtons (N)	X 3.6	= Ounces-force (ozf; oz)
Pounds-force (lbf; lb)	X 4.448	= Newtons (N)	X 0.225	= Pounds-force (lbf; lb)
Newtons (N)	X 0.1	= Kilograms-force (kgf; kg)	X 9.81	= Newtons (N)
Pressure				
Pounds-force per square inch (psi; lbf/in^2; lb/in^2)	X 0.070	= Kilograms-force per square centimetre (kgf/cm^2; kg/cm^2)	X 14.223	= Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Pounds-force per square inch (psi; lbf/in^2; lb/in^2)	X 0.068	= Atmospheres (atm)	X 14.696	= Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Pounds-force per square inch (psi; lbf/in^2; lb/in^2)	X 0.069	= Bars	X 14.5	= Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Pounds-force per square inch (psi; lbf/in^2; lb/in^2)	X 6.895	= Kilopascals (kPa)	X 0.145	= Pounds-force per square inch (psi; lbf/in^2; lb/in^2)
Kilopascals (kPa)	X 0.01	= Kilograms-force per square centimetre (kgf/cm^2; kg/cm^2)	X 98.1	= Kilopascals (kPa)
Torque (moment of force)				
Pounds-force inches (lbf in; lb in)	X 1.152	= Kilograms-force centimetre (kgf cm; kg cm)	X 0.868	= Pounds-force inches (lbf in; lb in)
Pounds-force inches (lbf in; lb in)	X 0.113	= Newton metres (Nm)	X 8.85	= Pounds-force inches (lbf in; lb in)
Pounds-force inches (lbf in; lb in)	X 0.083	= Pounds-force feet (lbf ft; lb ft)	X 12	= Pounds-force inches (lbf in; lb in)
Pounds-force feet (lbf ft; lb ft)	X 0.138	= Kilograms-force metres (kgf m; kg m)	X 7.233	= Pounds-force feet (lbf ft; lb ft)
Pounds-force feet (lbf ft; lb ft)	X 1.356	= Newton metres (Nm)	X 0.738	= Pounds-force feet (lbf ft; lb ft)
Newton metres (Nm)	X 0.102	= Kilograms-force metres (kgf m; kg m)	X 9.804	= Newton metres (Nm)
Vacuum				
Inches mercury (in. Hg)	X 3.377	= Kilopascals (kPa)	X 0.2961	= Inches mercury
Inches mercury (in. Hg)	X 25.4	= Millimetres mercury (mm Hg)	X 0.0394	= Inches mercury
Power				
Horsepower (hp)	X 745.7	= Watts (W)	X 0.0013	= Horsepower (hp)
Velocity (speed)				
Miles per hour (miles/hr; mph)	X 1.609	= Kilometres per hour (km/hr; kph)	X 0.621	= Miles per hour (miles/hr; mph)
Fuel consumption*				
Miles per gallon, Imperial (mpg)	X 0.354	= Kilometres per litre (km/l)	X 2.825	= Miles per gallon, Imperial (mpg)
Miles per gallon, US (mpg)	X 0.425	= Kilometres per litre (km/l)	X 2.352	= Miles per gallon, US (mpg)

Temperature

Degrees Fahrenheit = (°C x 1.8) + 32

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

**It is common practice to convert from miles per gallon (mpg) to litres/100 kilometres (l/100km), where mpg (Imperial) x l/100 km = 282 and mpg (US) x l/100 km = 235*

Safety first!

Regardless of how enthusiastic you may be about getting on with the job at hand, take the time to ensure that your safety is not jeopardised. A moment's lack of attention can result in an accident, as can failure to observe certain simple safety precautions. The possibility of an accident will always exist, and the following points should not be considered a comprehensive list of all dangers. Rather, they are intended to make you aware of the risks and to encourage a safety conscious approach to all work you carry out on your vehicle.

Essential DOs and DON'Ts

DON'T rely on a jack when working under the vehicle. Always use approved jackstands to support the weight of the vehicle and place them under the recommended lift or support points.
DON'T attempt to loosen extremely tight fasteners (i.e. wheel lug nuts) while the vehicle is on a jack - it may fall.
DON'T start the engine without first making sure that the transmission is in Neutral (or Park where applicable) and the parking brake is set.
DON'T remove the radiator cap from a hot cooling system - let it cool or cover it with a cloth and release the pressure gradually.
DON'T attempt to drain the engine oil until you are sure it has cooled to the point that it will not burn you.
DON'T touch any part of the engine or exhaust system until it has cooled sufficiently to avoid burns.
DON'T siphon toxic liquids such as petrol, antifreeze and brake fluid by mouth, or allow them to remain on your skin.
DON'T inhale brake lining dust - it is potentially hazardous (see *Asbestos* below).
DON'T allow spilled oil or grease to remain on the floor - wipe it up before someone slips on it.
DON'T use loose fitting spanners or other tools which may slip and cause injury.
DON'T push on spanners when loosening or tightening nuts or bolts. Always try to pull the spanner toward you. If the situation calls for pushing the spanner away, push with an open hand to avoid scraped knuckles if the spanner should slip.
DON'T attempt to lift a heavy component alone - get someone to help you.
DON'T rush or take unsafe shortcuts to finish a job.
DON'T allow children or animals in or around the vehicle while you are working on it.
DO wear eye protection when using power tools such as a drill, sander, bench grinder, etc. and when working under a vehicle.
DO keep loose clothing and long hair well out of the way of moving parts.
DO make sure that any hoist used has a safe working load rating adequate for the job.
DO get someone to check on you periodically when working alone on a vehicle.
DO carry out work in a logical sequence and make sure that everything is correctly assembled and tightened.
DO keep chemicals and fluids tightly capped and out of the reach of children and pets.
DO remember that your vehicle's safety affects that of yourself and others. If in doubt on any point, get professional advice.

Asbestos

Certain friction, insulating, sealing, and other products - such as brake linings, brake bands, clutch linings, torque converters, gaskets, etc. - may contain asbestos. Extreme care must be taken to avoid inhalation of dust from such products, since it is hazardous to health. If in doubt, assume that they do contain asbestos.

Fire

Remember at all times that petrol is highly flammable. Never smoke or have any kind of open flame around when working on a vehicle. But the risk does not end there. A spark caused by an electrical short circuit, by two metal surfaces contacting each other, or even by static electricity built up in your body under certain conditions, can ignite petrol vapours, which in a confined space are highly explosive. Do not, under any circumstances, use petrol for cleaning parts. Use an approved safety solvent.

Always disconnect the battery negative (-) cable at the battery before working on any part of the fuel system or electrical system. Never risk spilling fuel on a hot engine or exhaust component. It is strongly recommended that a fire extinguisher suitable for use on fuel and electrical fires be kept handy in the garage or workshop at all times. Never try to extinguish a fuel or electrical fire with water.

Fumes

Certain fumes are highly toxic and can quickly cause unconsciousness and even death if inhaled to any extent. Petrol vapour falls into this category, as do the vapours from some cleaning solvents. Any draining or pouring of such volatile fluids should be done in a well ventilated area.

When using cleaning fluids and solvents, read the instructions on the container carefully. Never use materials from unmarked containers.

Never run the engine in an enclosed space, such as a garage. Exhaust fumes contain carbon monoxide, which is extremely poisonous. If you need to run the engine, always do so in the open air, or at least have the rear of the vehicle outside the work area.

If you are fortunate enough to have the use of an inspection pit, never drain or pour petrol and never run the engine while the vehicle is over the pit. The fumes, being heavier than air, will concentrate in the pit with possibly lethal results.

The battery

Never create a spark or allow a bare light bulb near a battery. They normally give off a certain amount of hydrogen gas, which is highly explosive.

Always disconnect the battery negative (-) cable at the battery before working on the fuel or electrical systems.

If possible, loosen the filler caps or cover when charging the battery from an external source (this does not apply to sealed or maintenance-free batteries). Do not charge at an excessive rate or the battery may burst.

Take care when adding water to a non maintenance-free battery and when carrying a battery. The electrolyte, even when diluted, is very corrosive and should not be allowed to contact clothing or skin.

Always wear eye protection when cleaning the battery to prevent the caustic deposits from entering your eyes.

Household current

When using an electric power tool, inspection light, etc., which operates on household current, always make sure that the tool is correctly connected to its plug and that, where necessary, it is properly earthed. Do not use such items in damp conditions and, again, do not create a spark or apply excessive heat in the vicinity of fuel or fuel vapour.

Secondary ignition system voltage

A severe electric shock can result from touching certain parts of the ignition system (such as the spark plug wires) when the engine is running or being cranked, particularly if components are damp or the insulation is defective. In the case of an electronic ignition system, the secondary system voltage is much higher and could prove fatal.

Troubleshooting

Contents

Engine and performance

1 Engine will not rotate when attempting to start

1 Battery terminal connections loose or corroded. Check the cable terminals at the battery; tighten cable clamp and/or clean off corrosion as necessary (see Chapter 1).
2 Battery discharged or faulty. If the cable ends are clean and tight on the battery posts, turn the key to the On position and switch on the headlights or windscreen wipers. If they won't run, the battery is discharged.
3 Automatic transmission not engaged in park (P) or Neutral (N); faulty inhibitor switch (Chapter 7B).
4 Broken, loose or disconnected wires in the starting circuit. Inspect all wires and connectors at the battery, starter solenoid and ignition switch (on steering column).
5 Starter motor pinion jammed in flywheel ring gear. If manual transmission, place transmission in gear and rock the vehicle to manually turn the engine. Remove starter (Chapter 5) and inspect pinion and flywheel (Chapter 2) at earliest convenience.
6 Starter solenoid faulty (Chapter 5).
7 Starter motor faulty (Chapter 5).
8 Ignition switch faulty (Chapter 12).
9 Engine seized. Try to turn the crankshaft with a large socket and breaker bar on the pulley bolt.

2 Engine rotates but will not start

1 Fuel tank empty.
2 Battery discharged (engine rotates slowly). Check the operation of electrical components as described in previous Section.
3 Battery terminal connections loose or corroded. See previous Section.
4 Fuel not reaching carburettor or fuel injector. Check for clogged fuel filter or lines and defective fuel pump. Also make sure the tank vent lines aren't clogged (Chapter 4A or 4B).
5 Choke not operating properly (Chapter 1).
6 Faulty distributor components (petrol engines). Check the cap and rotor (Chapter 1).
7 Low cylinder compression. Check as described in Chapter 2.
8 Valve clearances not properly adjusted - Chapter 1.
9 Water in fuel. Drain tank and fill with new fuel.
10 Defective ignition coil (petrol engines) (Chapter 5).
11 Dirty or clogged carburettor jets or fuel injector (Chapter 4B). Carburettor out of adjustment (petrol engines). Check the float level (Chapter 4A).
12 Wet or damaged ignition components (petrol engines) (Chapters 1 and 5).
13 Worn, faulty or incorrectly gapped spark plugs (petrol engines) (Chapter 1).
14 Broken, loose or disconnected wires in the starting circuit (see previous Section).
15 Loose distributor (changing ignition timing) (petrol engines). Turn the distributor body as necessary to start the engine, then adjust the ignition timing as soon as possible (Chapter 1).
16 Broken, loose or disconnected wires at the ignition coil or faulty coil (petrol engines) (Chapter 5).
17 Timing chain or belt failure or wear affecting valve timing (Chapter 2).
18 Faulty diesel fuel cut-off solenoid or circuit (Chapter 4C).
19 Water in diesel fuel (Chapter 4C).
20 Defective diesel fuel injection pump (Chapter 4C).
21 Incorrect diesel fuel injection pump timing (Chapter 4C).

3 Starter motor operates without turning engine

1 Starter pinion sticking. Remove the starter (Chapter 5) and inspect.
2 Starter pinion or flywheel/driveplate teeth worn or broken. Remove the inspection cover and inspect.

4 Engine hard to start when cold

1 Battery discharged or low. Check as described in Chapter 1.
2 Fuel not reaching the carburettor or fuel injectors. Check the fuel filter, lines and fuel pump (Chapters 1 and 4).
3 Choke inoperative (Chapters 1 and 4).
4 Defective spark plugs (petrol engines) (Chapter 1).
5 Glow plugs(diesel) not operational (Chapter 4C).

5 Engine hard to start when hot

1 Air filter dirty (Chapter 1).
2 Fuel not reaching carburettor or fuel injectors (see Chapter 4). Check for a vapour lock situation, brought about by clogged fuel tank vent lines.
3 Bad engine earth connection.
4 Choke sticking (Chapter 1).
5 Defective pick-up coil in distributor (petrol engines) (Chapter 5).
6 Float level too high (petrol engines) (Chapter 4A).
7 Faulty engine temperature sensor (Chapter 6).
8 Contaminated diesel fuel (Chapter 4C).
9 Defective diesel injection pump (diesel engine).
10 Incorrect diesel fuel injection pump timing (diesel engine).

6 Starter motor noisy or engages roughly

1 Pinion or flywheel/driveplate teeth worn or broken. Remove the inspection cover on the left side of the engine and inspect.
2 Starter motor mounting bolts loose or missing.

7 Engine starts but stops immediately

1 Loose or damaged wire harness connections at distributor, coil or alternator.
2 Inlet manifold vacuum leaks(petrol engines). Make sure all mounting bolts/nuts are tight and all vacuum hoses connected to the manifold are attached properly and in good condition (Chapters 2A, 4A, 4B).
3 Insufficient fuel flow to carburettor or fuel injectors (Chapter 4).
4 Idle speed incorrect (Chapter 1).
5 Contaminated diesel fuel (Chapter 4C).
6 Defective diesel injection pump (diesel engine).
7 Incorrect diesel fuel injection pump timing (diesel engine).

8 Engine 'lopes' while idling or idles erratically

1 Vacuum leaks (petrol engines). Check mounting bolts at the inlet manifold for tightness. Make sure that all vacuum hoses are connected and in good condition. Use a stethoscope or a length of fuel hose held against your ear to listen for vacuum leaks while the engine is running. A hissing sound will be heard. A soapy water solution will also detect leaks. Check the inlet manifold gasket surfaces.
2 Leaking EGR valve or plugged PCV valve (petrol engines) (see Chapters 1 and 6).
3 Air filter clogged (Chapter 1).
4 Fuel pump not delivering sufficient fuel (Chapter 4).
5 Leaking head gasket. Perform a cylinder compression check (Chapter 2).
6 Timing belt or chain worn (Chapter 2).
7 Camshaft lobes worn (Chapter 2).
8 Valve clearance out of adjustment - Chapter 1.
9 Valves burned or otherwise leaking (Chapter 2).
10 Ignition timing out of adjustment (petrol engines) (Chapter 1).
11 Ignition system not operating properly (petrol engines) (Chapters 1 and 5).
12 Thermostatic air cleaner not operating properly (petrol engines) (Chapter 1).
13 Choke not operating properly (petrol engines) (Chapters 1 and 4).
14 Dirty or clogged injector(s). Carburettor dirty, clogged or out of adjustment. Check the float level (Chapter 4).

15 Idle speed out of adjustment (Chapter 1).
16 Diesel injection pump timing incorrect (Chapter 4C).
17 Air or water in diesel fuel (Chapter 4C).
18 Defective diesel fuel injection pump (Chapter 4C).

9 Engine misses at idle speed

1 Spark plugs faulty or not gapped properly (petrol engines) (Chapter 1).
2 Faulty spark plug wires (petrol engines) (Chapter 1).
3 Wet or damaged distributor components (petrol engines) (Chapter 1).
4 Short circuits in ignition, coil or spark plug wires (petrol engines).
5 Sticking or faulty emissions systems (see Chapter 6).
6 Clogged fuel filter and/or foreign matter in fuel. Remove the fuel filter (Chapter 1) and inspect.
7 Vacuum leaks at inlet manifold or hose connections (petrol engines). Check as described in Section 8.
8 Incorrect idle speed (Chapter 1) or idle mixture (Chapter 4).
9 Incorrect ignition timing (petrol engines) (Chapter 1).
10 Low or uneven cylinder compression. Check as described in Chapter 2.
11 Choke not operating properly (petrol engines) (Chapter 1).
12 Clogged or dirty fuel injectors (Chapter 4).
13 Diesel injection pump timing incorrect (Chapter 4C).
14 Air or water in diesel fuel (Chapter 4C).
15 Defective diesel fuel injection pump (Chapter 4C).

10 Excessively high idle speed

1 Sticking throttle linkage (Chapter 4A).
2 Choke opened excessively at idle (petrol engines) (Chapter 4A).
3 Idle speed incorrectly adjusted (Chapter 1).
4 Valve clearances incorrectly adjusted - Chapter 1.
5 Hand throttle misadjusted (Chapter 4A).

11 Battery will not hold a charge

1 Alternator drivebelt defective or not adjusted properly (Chapter 1).
2 Battery cables loose or corroded (Chapter 1).
3 Alternator not charging properly (Chapter 5).
4 Loose, broken or faulty wires in the charging circuit (Chapter 5).
5 Short circuit causing a continuous drain on the battery.
6 Battery defective internally.

12 Alternator light stays on

1 Fault in alternator or charging circuit (Chapter 5).
2 Alternator drivebelt defective or not properly adjusted (Chapter 1).

13 Alternator light fails to come on when key is turned on

1 Faulty bulb (Chapter 12).
2 Defective alternator (Chapter 5).
3 Fault in the printed circuit, dash wiring or bulb holder (Chapter 12).

14 Engine misses throughout driving speed range

1 Fuel filter clogged and/or impurities in the fuel system. Check fuel filter (Chapter 1) or clean system (Chapter 4).
2 Faulty or incorrectly gapped spark plugs (petrol engines) (Chapter 1).
3 Incorrect ignition timing (petrol engines) (Chapter 1).
4 Cracked distributor cap, disconnected distributor wires or damaged distributor components (petrol engines) (Chapter 1).
5 Defective spark plug wires (petrol engines) (Chapter 1).
6 Emissions system components faulty (Chapter 6).
7 Low or uneven cylinder compression pressures. Check as described in Chapter 2.
8 Weak or faulty ignition coil (petrol engines) (Chapter 5).
9 Weak or faulty ignition system (petrol engines) (Chapter 5).
10 Vacuum leaks at inlet manifold or vacuum hoses (petrol engines) (see Section 8).
11 Dirty or clogged carburettor or fuel injector (Chapter 4).
12 Leaky EGR valve (Chapter 6).
13 Carburettor out of adjustment (Chapter 4A).
14 Diesel injection pump timing incorrect (Chapter 4C).
15 Air or water in diesel fuel (Chapter 4C).
16 Defective diesel fuel injection pump (Chapter 4C).
17 Clogged fuel filter (Chapter 1).

15 Hesitation or stumble during acceleration

1 Ignition timing incorrect (petrol engines) (Chapter 1).
2 Ignition system not operating properly (petrol engines) (Chapter 5).
3 Dirty or clogged carburettor or fuel injector (Chapter 4A, 4B).
4 Low fuel pressure. Check for proper operation of the fuel pump and for restrictions in the fuel filter and lines (Chapter 4A).
5 Carburettor out of adjustment (Chapter 4A).
6 Carburettor accelerator pump worn (Chapter 4A).
7 Diesel injection pump timing incorrect (Chapter 4C).
8 Air or water in diesel fuel (Chapter 4C).
9 Defective diesel fuel injection pump (Chapter 4C).

16 Engine stalls

1 Idle speed incorrect (Chapter 1).
2 Fuel filter clogged and/or water and impurities in the fuel system (Chapter 1).
3 Choke not operating properly (Chapter 1).
4 Damaged or wet distributor cap and wires (petrol engines).
5 Emissions system components faulty (Chapter 6).
6 Faulty or incorrectly gapped spark plugs (petrol engines) (Chapter 1). Also check the spark plug wires and the ignition points (petrol engines) (Chapter 1).
7 Vacuum leak at the carburettor, inlet manifold or vacuum hoses. Check as described in Section 8.
8 Valve clearances incorrect - Chapter 1.
9 Diesel injection pump timing incorrect (Chapter 4C).
10 Air or water in diesel fuel (Chapter 4C).
11 Defective diesel fuel injection pump (Chapter 4C).

17 Engine lacks power

1 Incorrect ignition timing (petrol engines) (Chapter 1).
2 Excessive play in distributor shaft. At the same time check for faulty distributor cap, wires and the ignition points, etc. (petrol engines) (Chapter 1).
3 Faulty or incorrectly gapped spark plugs (petrol engines) (Chapter 1).
4 Air filter dirty (Chapter 1).
5 Faulty ignition coil (petrol engines) (Chapter 5).
6 Brakes binding (Chapters 1 and 10).
7 Automatic transmission fluid level incorrect, causing slippage (Chapter 1).
8 Clutch slipping (Chapter 8).
9 Fuel filter clogged and/or impurities in the fuel system (Chapters 1 and 4).
10 EGR system not functioning properly (Chapter 6).
11 Use of sub-standard fuel. Fill tank with proper octane fuel.
12 Low or uneven cylinder compression pressures. Check as described in Chapter 2D.
13 Air leak at carburettor or inlet manifold (petrol engines) (check as described in Section 8).
14 Dirty or clogged carburettor jets or malfunctioning choke (petrol engines) (Chapters 1 and 4).
15 Diesel fuel injection pump timing incorrect (Chapter 4C).

18 Engine backfires

1 EGR system not functioning properly (Chapter 6).
2 Ignition timing incorrect (petrol engines) (Chapter 1).
3 Thermostatic air cleaner system not operating properly (petrol engines) (Chapter 6).
4 Vacuum leak (petrol engines) (refer to Section 8).
5 Valve clearances incorrect - Chapter 1 .
6 Damaged valve springs or sticking valves (Chapter 2).
7 Intake air leak (see Section 8).
8 Carburettor float level out of adjustment (Chapter 4A).
9 Diesel fuel injection pump timing incorrect (Chapter 4C).

19 Engine surges while holding accelerator steady

1 Intake air leak (see Section 8).
2 Fuel pump not working properly (Chapter 4A, 4B).
3 Air or water in the diesel fuel supply (Chapter 4C).
4 Internal diesel injection pump problem (Chapter 4C).

20 Pinging or knocking engine sounds when engine is under load

1 Incorrect grade of fuel. Fill tank with fuel of the proper octane rating.
2 Ignition timing incorrect (petrol engines) (Chapter 1).
3 Carbon build-up in combustion chambers. Remove cylinder head(s) and clean combustion chambers (Chapter 2).
4 Incorrect spark plugs (petrol engines) (Chapter 1).
5 Contaminated diesel fuel (Chapter 4C).
6 Diesel fuel injection pump timing incorrect (Chapter 4C).

21 Engine diesels (continues to run) after being turned off

1 Idle speed too high (Chapter 1).
2 Ignition timing incorrect (petrol engines) (Chapter 1).
3 Incorrect spark plug heat range (petrol engines) (Chapter 1).
4 Intake air leak (see Section 8).
5 Carbon build-up in combustion chambers.
6 Valves sticking (Chapter 2).
7 Valve clearances incorrect (Chapter 1).
8 EGR system not operating properly (Chapter 4).
9 Fuel shut-off system not operating properly (Chapter 6).
10 Check for causes of overheating (Section 27).

22 Low oil pressure

1 Improper grade of oil.
2 Oil pump worn or damaged (Chapter 2).
3 Engine overheating (refer to Section 27).
4 Clogged oil filter (Chapter 1).
5 Clogged oil strainer (Chapter 2).
6 Oil pressure gauge not working properly (Chapter 2D).
7 Worn engine bearings.

23 Excessive oil consumption

1 Loose oil drain plug.
2 Loose bolts or damaged sump gasket (Chapter 2).
3 Loose bolts or damaged front cover gasket (Chapter 2).
4 Front or rear crankshaft oil seal leaking (Chapter 2).
5 Loose bolts or damaged rocker arm cover gasket (Chapter 2).
6 Loose oil filter (Chapter 1).
7 Loose or damaged oil pressure switch (Chapter 2).
8 Pistons and cylinders excessively worn (Chapter 2).
9 Piston rings not fitted correctly on pistons (Chapter 2).
10 Worn or damaged piston rings (Chapter 2).
11 Intake and/or exhaust valve oil seals worn or damaged (Chapter 2).
12 Worn valve stems.
13 Worn or damaged valves/guides (Chapter 2).

24 Excessive fuel consumption

1 Dirty or clogged air filter element (Chapter 1).
2 Incorrect ignition timing or dwell (Chapter 1).
3 Incorrect idle speed (Chapter 1).
4 Low tyre pressure or incorrect tyre size (Chapter 11).
5 Fuel leakage. Check all connections, lines and components in the fuel system (Chapter 4A).
6 Choke not operating properly (Chapter 1).
7 Dirty or clogged carburettor jets or fuel injectors (Chapter 4A or 4B).

25 Fuel odour

1 Fuel leakage. Check all connections, lines and components in the fuel system (Chapter 4A).
2 Fuel tank overfilled. Fill only to automatic shut-off.
3 Charcoal canister filter in Evaporative Emissions Control system clogged (Chapter 1).
4 Vapour leaks from Evaporative Emissions Control system lines (Chapter 6).
5 Leaking fuel injector (Chapter 4B).

26 Miscellaneous engine noises

1 A strong dull noise that becomes more rapid as the engine accelerates indicates worn or damaged crankshaft bearings or an unevenly worn crankshaft. To pinpoint the trouble spot (petrol models only), remove the spark plug wire from one plug at a time and crank the engine over. If the noise stops, the cylinder with the removed plug wire indicates the problem area. Renew the bearing and/or service or renew the crankshaft (Chapter 2).
2 A similar (yet slightly higher pitched) noise to the crankshaft knocking described in the previous paragraph, that becomes more rapid as the engine accelerates, indicates worn or damaged connecting rod bearings (Chapter 2). The procedure for locating the problem cylinder is the same as described in Paragraph 1.
3 An overlapping metallic noise that increases in intensity as the engine speed increases, yet diminishes as the engine warms up indicates abnormal piston and cylinder wear (Chapter 2). To locate the problem cylinder, use the procedure described in Paragraph 1.
4 A rapid clicking noise that becomes faster as the engine accelerates indicates a worn piston pin or piston pin hole. This sound will happen each time the piston hits the highest and lowest points in the stroke (Chapter 2). The procedure for locating the problem piston is described in Paragraph 1.
5 A metallic clicking noise coming from the water pump indicates worn or damaged water pump bearings or pump. Renew the water pump (Chapter 3).
6 A rapid tapping sound or clicking sound that becomes faster as the engine speed increases indicates valve tapping or improperly adjusted valve clearances. This can be identified by holding one end of a section of hose to your ear and placing the other end at different spots along the rocker arm cover. The point where the sound is loudest indicates the problem valve. Adjust the valve clearance (Chapter 1 or 2B). If the problem persists, you likely have a collapsed valve lifter or other damaged valve train component. Changing the engine oil and adding a high viscosity oil treatment will sometimes cure a stuck lifter problem. If the problem still persists, the lifters, pushrods and rocker arms must be removed for inspection (see Chapter 2).
7 A steady metallic rattling or rapping sound coming from the area of the timing chain cover indicates a worn, damaged or out-of-adjustment timing chain. Service or renew the chain and related components (Chapter 2).

Cooling system

27 Overheating

1 Insufficient coolant in system (Chapter 1).
2 Drivebelt defective or not adjusted properly (Chapter 1).
3 Radiator core blocked or radiator grille dirty or restricted (Chapter 3).
4 Thermostat faulty (Chapter 3).
5 Fan not functioning properly (Chapter 3).
6 Radiator cap not maintaining proper pressure. Have cap pressure tested by a repair shop.
7 Ignition timing incorrect (Chapter 1).
8 Defective water pump (Chapter 3).
9 Improper grade of engine oil.
10 Inaccurate temperature gauge (Chapter 12).

28 Overcooling

1 Thermostat faulty (Chapter 3).
2 Inaccurate temperature gauge (Chapter 12).

29 External coolant leakage

1 Deteriorated or damaged hoses. Loose clamps at hose connections (Chapter 1).
2 Water pump seals defective. If this is the case, water will drip from the weep hole in the water pump body (Chapter 3).
3 Leakage from radiator core or header tank. This will require the radiator to be professionally repaired (see Chapter 3 for removal procedures).
4 Engine drain plugs or water jacket freeze plugs leaking (see Chapters 1 and 2).
5 Leak from coolant temperature switch (Chapter 3).
6 Leak from damaged gaskets or small cracks (Chapter 2).
7 Damaged head gasket. This can sometimes be verified by checking the condition of the engine oil as noted in Section 30.

30 Internal coolant leakage

Note: *Internal coolant leaks can usually be detected by examining the oil. Check the dipstick and inside the rocker arm cover for water deposits and an oil consistency like that of a milkshake.*
1 Leaking cylinder head gasket. Have the system pressure tested or remove the cylinder head (Chapter 2) and inspect.
2 Cracked cylinder bore or cylinder head. Dismantle engine and inspect (Chapter 2).
3 Loose cylinder head bolts (tighten as described in Chapter 2).

31 Abnormal coolant loss

1 Overfilling system (Chapter 1).
2 Coolant boiling away due to overheating (see causes in Section 27).
3 Internal or external leakage (see Sections 29 and 30).
4 Faulty radiator cap. Have the cap pressure tested.
5 Cooling system being pressurised by engine compression. This could be due to a cracked head or block or leaking head gasket(s).

32 Poor coolant circulation

1 Inoperative water pump. A quick test is to pinch the top radiator hose closed with your hand while the engine is idling, then release it. You should feel a surge of coolant if the pump is working properly (Chapter 3).
2 Restriction in cooling system. Drain, flush and refill the system (Chapter 1). If necessary, remove the radiator (Chapter 3) and have it reverse flushed or professionally cleaned.
3 Loose water pump drivebelt (Chapter 1).
4 Thermostat sticking (Chapter 3).
5 Insufficient coolant (Chapter 1).

33 Corrosion

1 Excessive impurities in the water. Soft, clean water is recommended. Distilled or rainwater is satisfactory.
2 Insufficient antifreeze solution (refer to Chapter 1 for the proper ratio of water to antifreeze).
3 Infrequent flushing and draining of system. Regular flushing of the cooling system should be carried out at the specified intervals as described in (Chapter 1).

Clutch

Note: *All clutch related service information is located in Chapter 8, unless otherwise noted.*

34 Fails to release (pedal pressed to the floor - shift lever does not move freely in and out of Reverse)

1 Freeplay incorrectly adjusted (see Chapter 8).
2 Clutch plate warped, distorted or otherwise damaged.
3 Diaphragm spring fatigued. Remove clutch cover/pressure plate assembly and inspect.
4 Broken, binding or damaged release cable (cable-operated clutch).
5 Leakage of fluid from clutch hydraulic system. Inspect master cylinder, operating cylinder and connecting lines.
6 Air in clutch hydraulic system. Bleed the system.
7 Insufficient pedal stroke. Check and adjust as necessary.
8 Piston seal in operating cylinder deformed or damaged.
9 Lack of grease on pilot bearing.

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

1 Worn or oil-soaked clutch plate.
2 Diaphragm spring weak or damaged. Remove clutch cover/pressure plate assembly and inspect.
3 Flywheel warped (Chapter 2).
4 Debris in master cylinder preventing the piston from returning to its normal position.
5 Clutch hydraulic line damaged.
6 Binding in the release mechanism.

36 Grabbing (chattering) as clutch is engaged

1 Oil on clutch plate. Remove and inspect. Repair any leaks.
2 Worn or loose engine or transmission mounts. They may move slightly when clutch is released. Inspect mounts and bolts.
3 Worn splines on transmission input shaft. Remove clutch components and inspect.
4 Warped pressure plate or flywheel. Remove clutch components and inspect.
5 Diaphragm spring fatigued. Remove clutch cover/pressure plate assembly and inspect.
6 Clutch linings hardened or warped.
7 Clutch lining rivets loose.

37 Squeal or rumble with clutch engaged (pedal released)

1 Improper pedal adjustment. Adjust pedal freeplay (Chapter 8).
2 Release bearing binding on transmission shaft. Remove clutch components and check bearing. Remove any burrs or nicks, clean and relubricate before refitting.
3 Pilot bush worn or damaged.
4 Clutch rivets loose.
5 Clutch plate cracked.
6 Fatigued clutch plate torsion springs. Renew clutch plate.
7 Worn transmission bearing.

38 Squeal or rumble with clutch disengaged (pedal depressed)

1 Worn or damaged release bearing.
2 Worn or broken pressure plate diaphragm fingers.

39 Clutch pedal stays on floor when disengaged

Binding linkage or release bearing. Inspect linkage or remove clutch components as necessary.

Manual transmission

Note: *All manual transmission service information is located in Chapter 7, unless otherwise noted.*

40 Noisy in Neutral with engine running

1 Input shaft bearing worn.
2 Damaged main drive gear bearing.
3 Insufficient transmission oil (Chapter 1).
4 Transmission oil in poor condition. Drain and fill with proper grade oil. Check old oil for water and debris (Chapter 1).
5 Noise can be caused by variations in engine torque. Change the idle speed and see if noise disappears.

41 Noisy in all gears

1 Any of the above causes, and/or:
2 Worn or damaged output gear bearings or shaft.

42 Noisy in one particular gear

1 Worn, damaged or chipped gear teeth.
2 Worn or damaged synchroniser.

43 Slips out of gear

1 Worn gear.
2 Transmission loose on clutch housing.
3 Stiff shift lever seal.
4 Shift linkage binding.
5 Broken or loose input gear bearing retainer.
6 Dirt between clutch lever and engine housing.
7 Worn linkage.
8 Damaged or worn check balls, fork rod ball grooves or check springs.
9 Worn mainshaft or countershaft bearings.
10 Loose engine mounts (Chapter 2).
11 Excessive gear end play.
12 Worn synchronisers.

44 Oil leaks

1 Excessive amount of lubricant in transmission (see Chapter 1 for correct checking procedures). Drain lubricant as required.
2 Rear oil seal or speedometer oil seal damaged.
3 To pinpoint a leak, first remove all built-up dirt and grime from the transmission. Degreasing agents and/or steam cleaning will achieve this. With the underside clean, drive the vehicle at low speeds so the air flow will not blow the leak far from its source. Raise the vehicle and determine where the leak is located.

45 Difficulty engaging gears

1 Clutch not releasing completely.
2 Loose or damaged shift linkage. Make a thorough inspection, renewing parts as necessary.
3 Insufficient transmission oil (Chapter 1).
4 Transmission oil in poor condition. Drain and fill with proper grade oil. Check oil for water and debris (Chapter 1).

46 Noise occurs while shifting gears

1 Check for proper operation of the clutch (Chapter 8).
2 Faulty synchroniser assemblies.

Automatic transmission

Note: *Due to the complexity of the automatic transmission, it's difficult for the home mechanic to properly diagnose and service. For problems other than the following, the vehicle should be taken to a reputable mechanic.*

47 Fluid leakage

1 Automatic transmission fluid is a deep red colour, and fluid leaks should not be confused with engine oil which can easily be blown by air flow to the transmission.
2 To pinpoint a leak, first remove all built-up dirt and grime from the transmission. Degreasing agents and/or steam cleaning will achieve this. With the underside clean, drive the vehicle at low speeds so the air flow will not blow the leak far from its source. Raise the vehicle and determine where the leak is located. Common areas of leakage are:

a) ***Fluid pan:*** *tighten mounting bolts and/or renew pan gasket as necessary (Chapter 1).*
b) ***Rear extension:*** *tighten bolts and/or renew oil seal as necessary.*
c) ***Filler pipe:*** *renew the rubber oil seal where pipe enters transmission case.*
d) ***Transmission oil lines:*** *tighten fittings where lines enter transmission case and/or renew lines.*
e) ***Vent pipe:*** *transmission overfilled and/or water in fluid (see checking procedures, Chapter 1).*

48 General shift mechanism problems

Chapter 7 deals with checking and adjusting the shift linkage on automatic transmissions. Common problems which may be caused by out of adjustment linkage are:

a) *Engine starting in gears other than P (park) or N (Neutral).*
b) *Indicator pointing to a gear other than the one actually engaged.*
c) *Vehicle moves with transmission in P (Park) position.*

49 Transmission will not downshift with the accelerator pedal pressed to the floor

Throttle sensor faulty.

50 Engine will start in gears other than Park or Neutral

Chapter 7 deals with adjusting the inhibitor switch fitted on automatic transmissions.

51 Transmission slips, shifts rough, is noisy or has no drive in forward or Reverse gears

1 There are many probable causes for the above problems, but the home mechanic should concern himself only with one possibility: fluid level.
2 Before taking the vehicle to a shop, check the fluid level and condition as described in Chapter 1. Add fluid, if necessary, or change the fluid and filter if needed. If problems persist, have a professional diagnose the transmission.

Driveshaft

Note: *Refer to Chapter 8, unless otherwise specified, for service information.*

52 Leaks at front of driveshaft

Defective transfer case rear seal. See Chapter 7 for renewal procedure. As this is done, check the splined yoke for burrs or roughness that could damage the new seal. Remove burrs with a fine file or whetstone.

53 Knock or clunk when transmission is under initial load (just after transmission is put into gear)

1 Loose or disconnected rear suspension components. Check all mounting bolts and bushes (Chapters 7 and 10).

2 Loose driveshaft bolts. Inspect all bolts and nuts and tighten them securely.
3 Worn or damaged universal joint bearings. Inspect the universal joints (Chapter 8).
4 Worn sleeve yoke and mainshaft spline.

54 Metallic grating sound consistent with vehicle speed

Pronounced wear in the universal joint bearings. Renew U-joints or driveshafts, as necessary.

55 Vibration

Note: *Before blaming the driveshaft, make sure the tyres are perfectly balanced and perform the following test.*
1 Fit a tachometer inside the vehicle to monitor engine speed as the vehicle is driven. Drive the vehicle and note the engine speed at which the vibration (roughness) is most pronounced. Now shift the transmission to a different gear and bring the engine speed to the same point.
2 If the vibration occurs at the same engine speed (rpm) regardless of which gear the transmission is in, the driveshaft is NOT at fault since the driveshaft speed varies.
3 If the vibration decreases or is eliminated when the transmission is in a different gear at the same engine speed, refer to the following probable causes.
4 Bent or dented driveshaft. Inspect and renew as necessary.
5 Undercoating or built-up dirt, etc. on the driveshaft. Clean the shaft thoroughly.
6 Worn universal joint bearings. Renew the U-joints or driveshaft as necessary.
7 Driveshaft and/or companion flange out of balance. Check for missing weights on the shaft. Remove driveshaft and refit 180-degrees from original position, then recheck. Have the driveshaft balanced if problem persists.
8 Loose driveshaft mounting bolts/nuts.
9 Defective centre bearing, if so equipped.
10 Worn transmission rear bush (Chapter 7).

56 Scraping noise

Make sure the dust cover on the sleeve yoke isn't rubbing on the transmission extension housing.

57 Whining or whistling noise

Debris rubbing on drivebelt.

Rear axle and differential

Note: *For differential servicing information, refer to Chapter 8, unless otherwise specified.*

58 Noise - same when in drive as when vehicle is coasting

1 Road noise. No corrective action available.
2 Tyre noise. Inspect tyres and check tyre pressures (Chapter 1).
3 Front wheel bearings loose, worn or damaged (Chapter 1).
4 Insufficient differential oil (Chapter 1).
5 Defective differential.

59 Knocking sound when starting or shifting gears

Defective or incorrectly adjusted differential.

60 Noise when turning

Defective differential.

61 Vibration

See probable causes under Driveshaft. Proceed under the guidelines listed for the driveshaft. If the problem persists, check the rear wheel bearings by raising the rear of the vehicle and spinning the wheels by hand. Listen for evidence of rough (noisy) bearings. Remove and inspect (Chapter 8).

62 Oil leaks

1 Pinion oil seal damaged (Chapter 8).
2 Axleshaft oil seals damaged (Chapter 8).
3 Differential cover leaking. Tighten mounting bolts or renew the gasket as required.
4 Loose filler or drain plug on differential (Chapter 1).
5 Clogged or damaged breather on differential.

Transfer case

Note: *Unless otherwise specified, refer to Chapter 7C for service and repair information.*

63 Gear jumping out of mesh

1 Incorrect control lever freeplay.
2 Internal wear or incorrect adjustments.

64 Difficult shifting

1 Lack of oil.
2 Internal wear, damage or incorrect adjustment.
3 Damaged linkage.

65 Noise

1 Lack of oil in transfer case.
2 Noise in 4H and 4L, but not in 2H indicates cause is in the front differential or front axle.
3 Noise in 2H, 4H and 4L indicates cause is in rear differential or rear axle.
4 Noise in 2H and 4H but not in 4L, or in 4L only, indicates internal wear or damage in transfer case.

Brakes

Note: *Before assuming a brake problem exists, make sure the tyres are in good condition and inflated properly, the front end alignment is correct and the vehicle is not loaded with weight in an unequal manner. All service procedures for the brakes are included in Chapter 9, unless otherwise noted.*

66 Vehicle pulls to one side during braking

1 Defective, damaged or oil contaminated brake pad on one side. Inspect as described in Chapter 1. Refer to Chapter 10 if renewal is required.
2 Excessive wear of brake pad material or disc on one side. Inspect and repair as necessary.
3 Loose or disconnected front suspension components. Inspect and tighten all bolts securely (Chapters 1 and 11).
4 Defective caliper assembly. Remove caliper and inspect for stuck piston or damage.
5 Brake pad-to-disc adjustment needed. Inspect automatic adjusting mechanism for proper operation.
6 Scored or out of round disc.
7 Loose caliper mounting bolts.
8 Incorrect wheel bearing adjustment.

67 Noise (high-pitched squeal)

1 Front brake pads worn out. This noise comes from the wear sensor rubbing against the disc. Renew pads with new ones immediately!
2 Glazed or contaminated pads.
3 Dirty or scored disc.
4 Bent support plate.

68 Excessive brake pedal travel

1 Partial brake system failure. Inspect entire system (Chapter 1) and correct as required.
2 Insufficient fluid in master cylinder. Check (Chapter 1) and add fluid - bleed system if necessary.
3 Air in system. Bleed system.

4 Excessive lateral disc runout.
5 Brakes out of adjustment. Check the operation of the automatic adjusters.
6 Defective proportioning valve. Renew valve and bleed system.

69 Brake pedal feels spongy when depressed

1 Air in brake lines. Bleed the brake system.
2 Deteriorated rubber brake hoses. Inspect all system hoses and lines. Renew parts as necessary.
3 Master cylinder mounting nuts loose. Inspect master cylinder bolts (nuts) and tighten them securely.
4 Master cylinder faulty.
5 Incorrect shoe or pad clearance.
6 Defective check valve. Renew valve and bleed system.
7 Clogged reservoir cap vent hole.
8 Deformed rubber brake lines.
9 Soft or swollen caliper seals.
10 Poor quality brake fluid. Bleed entire system and fill with new approved fluid.

70 Excessive effort required to stop vehicle

1 Power brake booster not operating properly.
2 Excessively worn linings or pads. Check and renew if necessary.
3 One or more caliper pistons seized or sticking. Inspect and rebuild as required.
4 Brake pads or linings contaminated with oil or grease. Inspect and renew as required.
5 New pads or linings fitted and not yet seated. It'll take a while for the new material to seat against the disc or drum.
6 Worn or damaged master cylinder or caliper assemblies. Check particularly for seized pistons.
7 Also see causes listed under Section 69.

71 Pedal travels to the floor with little resistance

Little or no fluid in the master cylinder reservoir caused by leaking caliper piston(s) or loose, damaged or disconnected brake lines. Inspect entire system and repair as necessary.

72 Brake pedal pulsates during brake application

1 Wheel bearings damaged, worn or out of adjustment (Chapter 1).
2 Caliper not sliding properly due to improper fitting or obstructions. Remove and inspect.
3 Disc not within specifications. Remove the disc and check for excessive lateral runout and parallelism. Have the discs resurfaced or renew them. Also make sure that all discs are the same thickness.
4 Out of round rear brake drums. Remove the drums and have them turned or renew.

73 Brakes drag (indicated by sluggish engine performance or wheels being very hot after driving)

1 Output rod adjustment incorrect at the brake pedal.
2 Obstructed master cylinder compensator. Disassemble master cylinder and clean.
3 Master cylinder piston seized in bore. Overhaul master cylinder.
4 Caliper assembly in need of overhaul.
5 Brake pads or shoes worn out.
6 Piston cups in master cylinder or caliper assembly deformed. Overhaul master cylinder.
7 Disc not within specifications (Section 72).
8 Parking brake assembly will not release.
9 Clogged brake lines.
10 Wheel bearings out of adjustment (Chapter 1).
11 Brake pedal height improperly adjusted.
12 Wheel cylinder needs overhaul.
13 Improper shoe to drum clearance. Adjust as necessary.

74 Rear brakes lock up under light brake application

1 Tyre pressures too high.
2 Tyres excessively worn (Chapter 1).
3 Load sensing valve problem.

75 Rear brakes lock up under heavy brake application

1 Tyre pressures too high.
2 Tyres excessively worn (Chapter 1).
3 Front brake pads contaminated with oil, mud or water. Clean or renew the pads.
4 Front brake pads excessively worn.
5 Defective master cylinder or caliper assembly.
6 Load sensing valve problem.

Suspension and steering

Note: *All service procedures for the suspension and steering systems are included in Chapter 10, unless otherwise noted.*

76 Vehicle pulls to one side

1 Tyre pressures uneven (Chapter 1).
2 Defective tyre (Chapter 1).
3 Excessive wear in suspension or steering components (Chapter 1).
4 Wheel alignment incorrect.
5 Front brakes dragging. Inspect as described in Section 73.
6 Wheel bearings improperly adjusted (Chapter 1 or 8).
7 Wheel lug nuts loose.

77 Shimmy, shake or vibration

1 Tyre or wheel out of balance or out of round. Have them balanced on the vehicle.
2 Loose, worn or out of adjustment wheel bearings (Chapter 1 or 8).
3 Shock absorbers and/or suspension components worn or damaged. Check for worn bushes in the upper and lower links.
4 Wheel lug nuts loose.
5 Incorrect tyre pressures.
6 Excessively worn or damaged tyre.
7 Loosely mounted steering gear housing.
8 Steering gear improperly adjusted.
9 Loose, worn or damaged steering components.

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

1 Defective shock absorbers. Renew as a set.
2 Broken or weak leaf springs and/or suspension components.
3 Worn or damaged stabiliser bar or bushes.
4 Rear stabiliser bar released.

79 Wandering or general instability

1 Improper tyre pressures.
2 Worn or damaged upper and lower link or tension rod bushes.
3 Incorrect front end alignment.
4 Worn or damaged steering linkage or suspension components.
5 Improperly adjusted steering gear.
6 Out of balance wheels.
7 Loose wheel lug nuts.
8 Worn rear shock absorbers.
9 Fatigued or damaged rear leaf springs.

80 Excessively stiff steering

1 Lack of lubricant in power steering fluid reservoir, where appropriate (Chapter 1).
2 Incorrect tyre pressures (Chapter 1).
3 Lack of lubrication at hubs (Chapter 1).
4 Steering gear out of adjustment or lacking lubrication.
5 Improperly adjusted wheel bearings.
6 Worn or damaged steering gear.
7 Low tyre pressures.
8 Worn or damaged hubs.
9 Worn or damaged steering linkage.
10 See also Section 79.

81 Excessive play in steering

1 Worn steering linkage.
2 Excessive wear in suspension bushes (Chapter 1).
3 Steering gear improperly adjusted.
4 Incorrect wheel alignment.
5 Steering gear mounting bolts loose.

82 Lack of power assistance

1 Steering pump drivebelt faulty or not adjusted properly (Chapter 1).
2 Fluid level low (Chapter 1).
3 Hoses or pipes restricting the flow. Inspect and renew parts as necessary.
4 Air in power steering system. Bleed system.
5 Defective power steering pump.
6 Defective steering gear.

83 Steering wheel fails to return to straight-ahead position

1 Incorrect front end alignment.
2 Tyre pressures low.
3 Worn or damaged balljoint.
4 Worn or damaged steering linkage.
5 Insufficient oil in steering gear.
6 Lack of fluid in power steering pump.

84 Steering effort not the same in both directions (power system)

1 Leaks in steering gear.
2 Clogged fluid passage in steering gear.

85 Noisy power steering pump

1 Insufficient oil in pump.
2 Clogged hoses or oil filter in pump.
3 Loose pulley.
4 Improperly adjusted drivebelt (Chapter 1).
5 Defective pump.

86 Miscellaneous noises

1 Improper tyre pressures.
2 Insufficiently lubricated hub or steering linkage.
3 Loose or worn steering gear, steering linkage or suspension components.
4 Defective shock absorber.
5 Defective wheel bearing.
6 Worn or damaged suspension bushes.
7 Damaged leaf spring.
8 Loose wheel lug nuts.
9 Worn or damaged axleshaft spline.
10 Worn or damaged shock absorber mounting bush.
11 Incorrect rear axle end play.
12 See also causes of noises at the rear axle and driveshaft.

87 Excessive tyre wear (not specific to one area).
1 Incorrect tyre pressures.
2 Tyres out of balance. Have them balanced on the vehicle.
3 Wheels damaged. Inspect and renew as necessary.
4 Suspension or steering components worn (Chapter 1).

88 Excessive tyre wear on outside edge

1 Incorrect tyre pressure.
2 Excessive speed in turns.
3 Front end alignment incorrect (excessive toe-in).

89 Excessive tyre wear on inside edge

1 Incorrect tyre pressure.
2 Front end alignment incorrect (toe-out).
3 Loose or damaged steering components (Chapter 1).

90 Tyre tread worn in one place

1 Tyres out of balance. Have them balanced on the vehicle.
2 Damaged or buckled wheel. Inspect and renew if necessary.
3 Defective tyre.

Chapter 1
Tune-up and routine maintenance

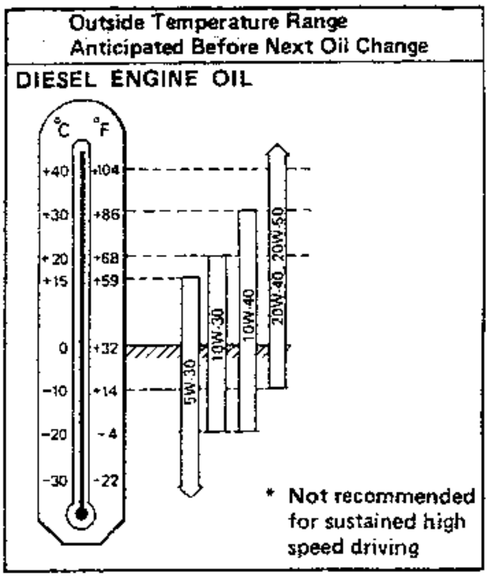
Contents

Specifications

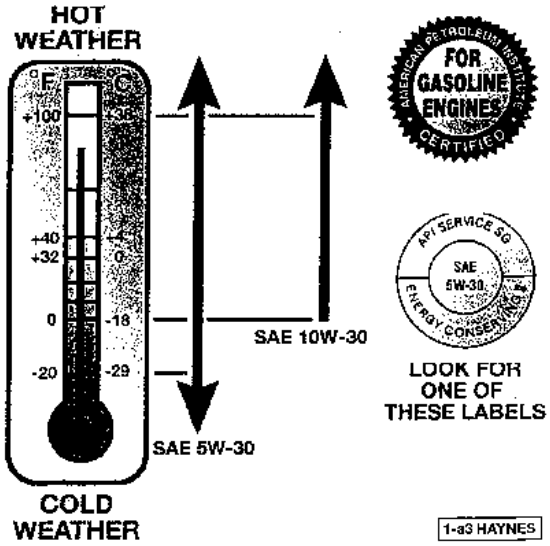
Recommended lubricants and fluids

Note: *Listed here are manufacturer recommendations at the time this manual was written. Manufacturers occasionally upgrade their fluid and lubricant specifications, so check with your local auto parts store for current recommendations.*

Engine oil	
Petrol engines	
Type	API grade SG or SH energy conserving oil
Viscosity	See accompanying chart



Diesel engine oil viscosity chart - use only oils intended for diesel engines (API grade CC or CD)



Engine oil viscosity chart (petrol engines - for best fuel economy and cold starting, select the lowest SAE viscosity grade for the expected temperature range

Recommended lubricants and fluids (continued)

Engine oil (continued)	
Diesel engine	
Type	API grade CC or CD energy conserving oil
Viscosity	See accompanying chart
Coolant	Ethylene glycol based anti-freeze
Brake fluid	DOT 3
Clutch fluid	DOT 3 brake fluid
Power steering fluid	DEXRON II ATF
Automatic transmission fluid	Nissan Matic D
Manual transmission lubricant	API GL-4 or GL-5 SAE 80W or 90W gear oil
Transfer lubricant, models built prior to Oct. 1991	API GL-4 or GL-5 SAE 80W-90 gear oil
Transfer lubricant, models built after Oct. 1991	DEXRON II ATF
Differential lubricant, standard	API GL-5 SAE 80W-90 hypoid gear oil
Differential lubricant, limited slip	Limited slip differential hypoid gear oil
Chassis grease	NLGI no. 2 lithium base chassis grease
Auto free-running hub grease	Nissan part no. KRC19-00025 or equivalent
Front axle joint grease	NLGI no. 2 moly disulphide

Capacities*

Engine oil (with filter change)	
4.2 litre petrol engine	8.3 litres
4.2 litre diesel engine	9.2 litres
3.0 litre engine	6.4 litres
Cooling system (includes reservoir tank)	
With heater	
4.2 litre engine	
Automatic transmission	13.6 litres
Manual transmission	13.9 litres
3.0 litre engine	11.9 litres
Without heater	
4.2 litre engine	
Automatic transmission	13.0 litres
Manual transmission	13.3 litres
3.0 litre engine	11.2 litres
Automatic transmission (drain and refill)	8.4 litres
Manual transmission (drain and refill)	
FS5R50A transmission	3.9 litres
FS5R30A transmission	5.1 litres
Transfer (drain and refill)	2.0 litres

Differential	
Front axle	
All except pick-up	5.4 litres
Pick-up	4.3 litres
Rear axle	
H33B series axle	
Without locking feature	2.1 litres
With locking feature	3.0 litres
H260 series axle	4.7 litres

**All capacities approximate. Add as necessary to bring to appropriate level.*

Ignition system

Spark plug type and gap

4.2 litre petrol engines	
With carburettor	NGK BP5ES @ 0.8 to 0.9 mm
With EFI	NGK BPR5ES @ 0.8 to 0.9 mm
3.0 litre engines	NGK BKR6E @ 0.8 to 0.19 mm
Spark plug wire resistance, maximum	30,000 ohms

Distributor ignition points

Point gap	0.45 to 0.55 mm
Dwell angle	34 to 40 degrees

Ignition timing and idle speed*

4.2 litre petrolengine	9 to 11 degrees BTDC @ 600 to 700 RPM
3.0 litre engine	1 to 5 degrees BTDC @ 800 to 900 RPM

Note: *Use the information printed on the Vehicle Emissions Control Information label, if different than the Specifications listed here.*
**With the distributor vacuum line disconnected and plugged.*

Idle mixture

Carburetted models	1.0% to 2.0% CO

Firing order and distributor rotation

All petrol models	1-5-3-6-2-4, counterclockwise

Valve clearances (engine hot)

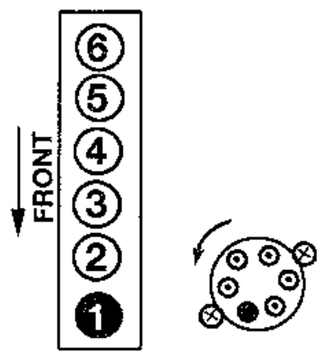
4.2 litre petrol engine	0.38 mm
4.2 litre diesel engine	0.35 mm
3.0 litre engine	Not adjustable
3.0 litre engines	Not adjustable

Clutch pedal

Height	202 to 212 mm
Free play	1 to 3 mm
Stop lamp switch clearance	0.3 to 1.0 mm

Brakes

Disc brake pad lining thickness (minimum)	2 mm
Drum brake shoe lining thickness (minimum)	1 mm
Brake pedal	
Height	
Automatic transmission models	202 to 212 mm
Manual transmission models	192 to 202 mm
Free play	1 to 3 mm
Parking brake adjustment notches	
Warning light energising	2 notches
At normal of handle force	7 to 9 notches



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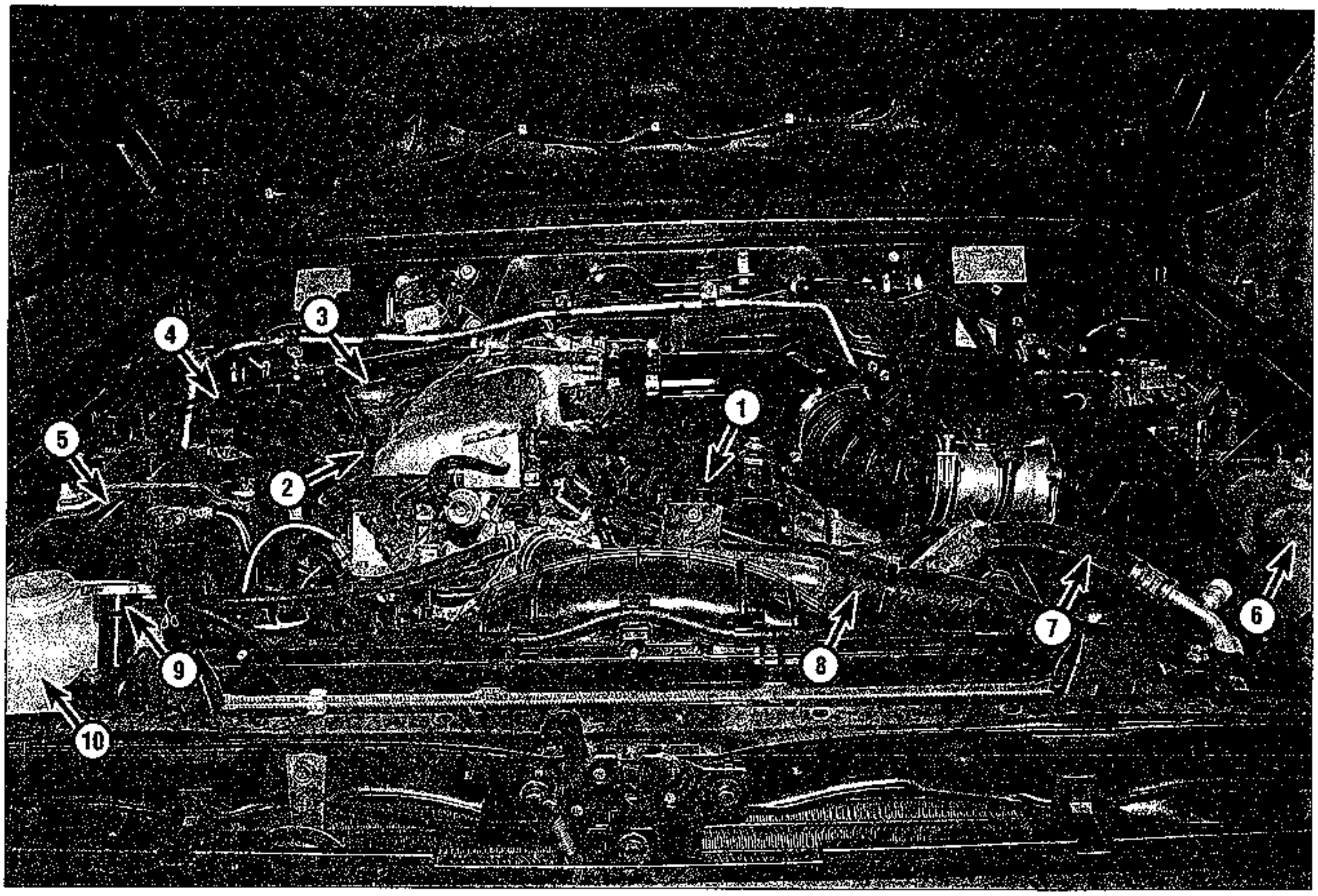
Cylinder location and distributor rotation -

The blackened terminal shown on the distributor cap indicates the Number One spark plug wire position

Suspension and steering

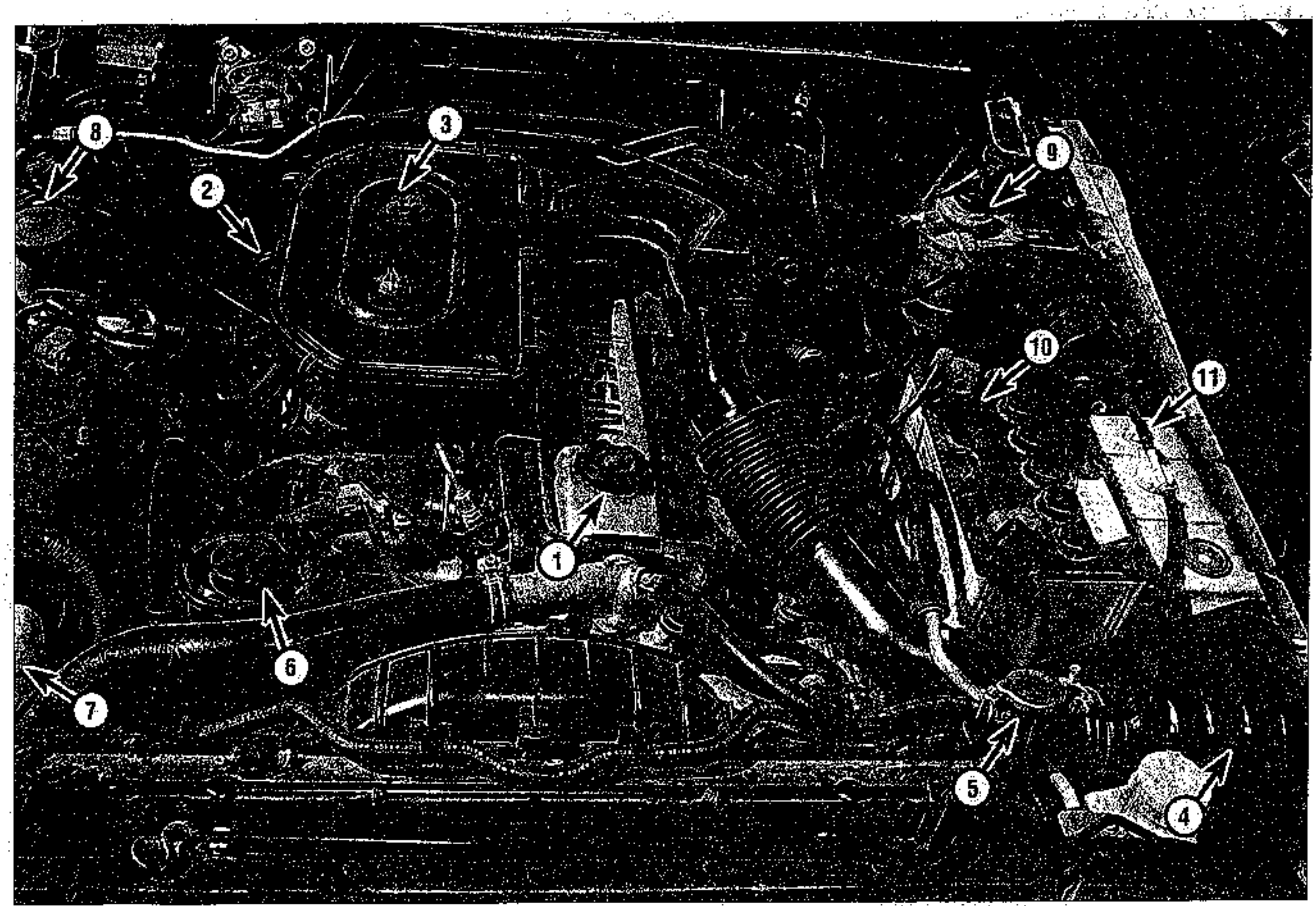
Steering wheel freeplay limit	35 mm
Balljoint allowable movement	0.0 mm

Torque specifications	Nm (unless otherwise specified)
Air cleaner wing nuts	3 turns after contact with air cleaner
Alternator securing bolt	59 to 75
Alternator adjusting lock bolt	21 to 26
Alternator adjusting bar bolt	43 to 55
Automatic transmission pan bolts	6 to 8
Body mount bolts, wagon and hardtop, except rear 2	31 to 39
Body mount bolts, wagon and hardtop, rear 2	55 to 71
Body mount bolts, pickup, small bolts	43 to 55
Body mount bolts, pickup, large bolts	Tighten until bolt protrudes 3 mm
Brake rotor to hub bolts	50 to 68
Carburettor nuts	16 to 19
Clutch master cylinder pushrod lock nut	8 to 11
Clutch pedal stop lock nut	16 to 22
Differential fill/drain plug	
Front	39 to 59
Rear	59 to 98
Distributor bolt	13 to 16
Engine block drain plug	34 to 44
Engine oil drain plug	29 to 39
Front wheel hub lower flange bolts	30 to 40
Manual transmission fill/drain plug	25 to 34
Rocker cover screw, 4.2 litre engine	1 to 3
Spark plugs	20 to 29
Transfer fill/drain plug	25 to 34
Valve rocker adjusting nuts	16 to 22
Wheel bearing outer lock nut, manual hubs	167 to 196
Wheel lug nuts	118 to 147



Engine compartment locations - 4.2 litre petrol engine

1 *Oil filler cap*
2 *Oil dipstick*
3 *Clutch master cylinder reservoir*
4 *Master cylinder reservoir*
5 *Battery*
6 *Windscreen wiper washer reservoir*
7 *Air cleaner housing*
8 *Upper radiator hose*
9 *Radiator cap*
10 *Coolant recovery bottle*



Engine compartment locations - 4.2 litre diesel engine

1. *Oil filler cap*
2. *Engine oil dipstick*
3. *Air cleaner*
4. *Pre cleaner*
5. *Radiator cap*
6. *Power steering reservoir*
7. *Windscreen washer reservoir*
8. *Brake master cylinder reservoir*
9. *Fuel filter and lift pump*
10. *Battery*
11. *Coolant reservoir*

Nissan Patrol/ Ford Maverick Maintenance Schedule

Every 500 kilometres or weekly, whichever comes first

Check the engine oil level (Section 4)
Check the engine coolant level (Section 4)
Check the windscreen washer fluid level (Section 4)
Check the brake and clutch fluid level (Section 4)
Check the tyres and tyre pressures (Section 5)

Every 5,000 kilometres or 3 months, whichever comes first

All items listed above, plus . . .
Check the automatic transmission fluid level (Section 6)
Check the power steering fluid level (Section 7)
Change the engine oil and filter (diesel engines) (Section 8)

Every 10,000 kilometres or 6 months, whichever comes first

Change the engine oil and filter (petrol engines) (Section 8)*
Inspect and renew, if necessary, all underbonnet hoses (Section 9)
Check, adjust and renew, if necessary, the drive belts (Section 10)
Rotate the tyres (Section 11)
Check the clutch and brake pedals for proper height and freeplay (Section 12)
Check the seat belts (Section 13)
Check and service the battery (Section 14)
Lubricate the chassis components (Section 15)*
Check and renew, if necessary, the windscreen wiper blades (Section 16)
Check the idle speed and mixture adjustment (Section 17)
Inspect the exhaust system (Section 18)
Inspect the suspension and steering components (Section 19)
Service the fuel filter (diesel engine) (Section 20)

Every 20,000 kilometres or 12 months, whichever comes first

All items listed above, plus . . .
Renew the air filter and PCV filter (Section 21)
Check the Positive Crankcase Ventilation (PCV) system (Section 22)
Inspect the fuel system (Section 23)
Check the cooling system (Section 24)
Check the ignition timing (Section 25)
Renew the ignition points (non-electronic ignition models only) (Section 26)
Inspect the automatic pre-heat air cleaner (carburetted engines only) (Section 27)
Tighten the body mounts (Section 28)*
Check the brakes (Section 29)*
Check the manual transmission, transfer and differential lubricants (Section 30)
Renew the spark plugs (Section 31)
Check the carburettor choke (Section 32) 1
Check the EGR valve (Section 33)
Adjust the valve clearances (4.2 litre engines only) (Section 34)

Every 40,000 kilometres or 24 months, whichever comes first

All items listed above, plus . . .
Inspect the spark plug wires, distributor cap and rotor (Section 35)
Change the automatic transmission fluid (Section 36)**
Change the manual, differential and transfer transmission lubricants (Section 37)
Service the cooling system (drain, flush and refill) (Section 38)
Inspect, repack and adjust the front wheel bearings and hubs (Section 39)*
Inspect the evaporative emissions control system (Section 40)
Renew the fuel filter (Section 41)*
Check the cyclone pre-air filter (Section 42)*
Check the oxygen sensor (fuel injected engines only) (Section 43)

Every 100,000 kilometres

Renew the timing belt (3.0 litre engines only) (see Chapter 2B)

**This item is affected by "severe" operating conditions, as described below. If the vehicle is operated under severe conditions, perform all maintenance indicated with an asterisk (*) at 5,000 kilometre/three-month intervals. Severe conditions exist if you mainly operate the vehicle . . .*
in dusty areas
towing a trailer
idling for extended periods and/or driving at low speeds when outside temperatures remain below freezing and most trips are less than six kilometres long
driving in water often
driving in sand or mud often
driving on salted roads

***If operated under one or more of the following conditions, change the automatic transmission fluid every 25,000 kilometres:*
in heavy city traffic where the outside temperature regularly reaches 32-degrees C or higher
in hilly or mountainous terrain
frequent trailer pulling

2 Introduction

This Chapter is designed to help the home mechanic maintain the Nissan Patrol/Ford Maverick for peak performance, economy, safety and long life.

On the following pages is a master maintenance schedule, followed by Sections dealing specifically with each item on 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 location of various components.

Servicing your Patrol or Maverick in accordance with the maintenance schedule and the following Sections will provide it with a planned maintenance program that 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.

As you service your vehicle, you will discover that many of the procedures can, and should, be grouped together because of the nature of the particular procedure you're performing or because of the close proximity of two otherwise unrelated components to one another.

For example, if the vehicle is raised for any reason, you should inspect the exhaust, suspension, steering and fuel systems while you're under the vehicle. When you're rotating the tyres, it makes good sense to check the brakes and wheel bearings since the wheels are already removed.

Finally, let's suppose you have to borrow or rent a torque wrench. Even if you only need to tighten the spark plugs, you might as well check the torque of as many critical fasteners as time allows.

The first step of this maintenance program is to prepare yourself before the actual work begins. Read through all Sections pertinent to the procedures you're planning to do, then make a list of and gather together all the parts and tools you will need to do the job. If it looks as if you might run into problems during a particular segment of some procedure, seek advice from your local parts man or dealer service department.

3 Tune-up general information

The term tune-up is used in this manual to represent a combination of individual operations rather than one specific procedure.

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.

More likely than not, however, there will be times when the engine is running poorly due to 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, an engine tune-up will be needed outside of the regular routine maintenance intervals.

The first step in any tune-up or diagnostic procedure to help correct a poor running engine is a cylinder compression check. A compression check (see Chapter 2, Part C) will help determine the condition of internal engine components and should be used as a guide for tune-up and repair procedures. If, for instance, the compression check indicates serious internal engine wear, a conventional tune-up won't improve the performance of the engine and would be a waste of time and money. Because of its importance, the compression check should be done by someone with the right equipment and the knowledge to use it properly.

The following procedures are those most often needed to bring a generally poor running engine back into a proper state of tune.

Minor tune-up

- Check all engine related fluids (Section 4)
- Clean, inspect and test the battery (Section 14)
- Check the cooling system (Section 24)
- Check all underbonnet hoses (Section 9)
- Check the PCV valve (petrol engines) (Section 22)
- Check the air filter and the PCV filter (Section 21)
- Renew the spark plugs (petrol engines) (Section 31)
- Renew the ignition points (early 4.2 litre petrol models only) (Section 26)
- Inspect the spark plug wires, distributor cap and rotor (petrol engines) (Section 35)
- Check and adjust the valve clearances (4.2 litre models only) (Section 34)
- Check and adjust the idle speed and mixture (Section 17)
- Check and adjust the ignition timing (petrol engines) (Section 25)
- Check and adjust the drivebelts (Section 10)

Major tune-up

All items listed under Minor tune-up, plus . . .

- Check the EGR system (Section 32)
- Renew the PCV valve (Section 21)
- Renew the air filter and the PCV filter (Section 20)
- Check the fuel system (Section 22)
- Renew the fuel filter (Section 40)
- Renew the distributor cap, rotor and spark plug wires (Section 34)
- Check the ignition system (Chapter 5)
- Check the charging system (Chapter 5)

4 Fluid level checks (every 500 kilometres or weekly)

Note: *The following are fluid level checks to be done on a 500-kilometre or weekly basis. Additional fluid level checks can be found in specific maintenance procedures which follow. Regardless of intervals, be alert to fluid leaks under the vehicle which would indicate a fault to be corrected immediately.*

4.2 The engine oil dipstick is located on the right side of the engine compartment

1 Fluids are an essential part of the lubrication, cooling, brake and windscreen washer systems. Because the fluids gradually become depleted and/or contaminated during normal operation of the vehicle, they must be periodically replenished. See *Recommended lubricants and fluids* at the beginning of this Chapter before adding fluid to any of the following components. **Note:** *The vehicle must be level when fluid levels are checked.*

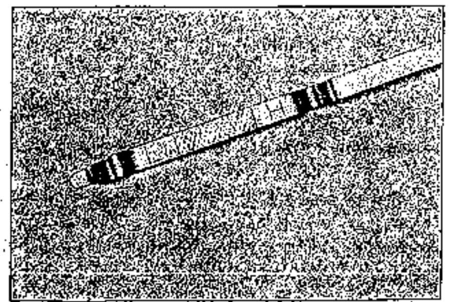
Engine oil

Refer to illustrations 4.2, 4.4 and 4.6

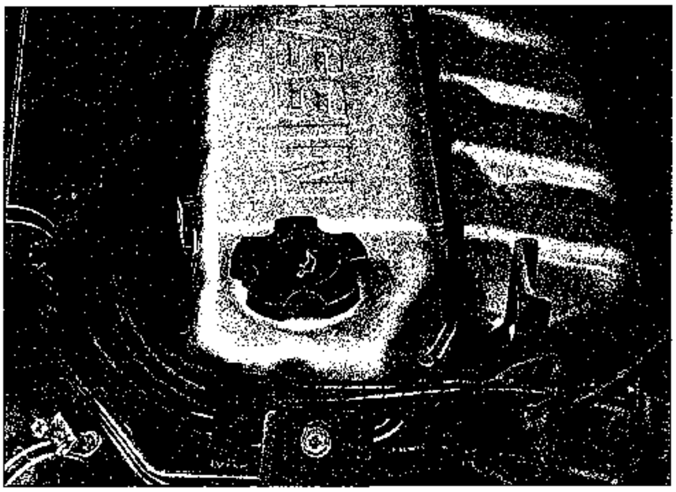
2 The engine oil level is checked with a dipstick that extends through a tube and into the sump at the bottom of the engine **(see illustration)**.

3 The oil level should be checked before the vehicle has been driven, or a few minutes after the engine has been shut off. 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.

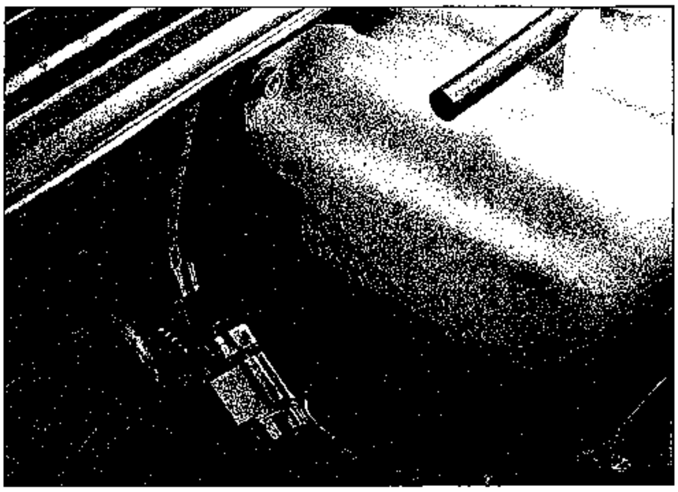
4 Pull the dipstick out of the tube and wipe all the oil from the end with a clean rag or paper towel. Insert the clean dipstick all the way back into the tube, then pull it out again. Note the oil at the end of the dipstick. Add oil as necessary to keep the level between the L and H marks on the dipstick **(see illustration)**.



4.4 The oil level must be kept in the cross-hatched area at all times



4.6 Add oil through the filler cap located in the valve cover



4.9 Keep the coolant reservoir clean so that it will be easy to read the MIN and MAX markings

5 Do not overfill the engine by adding too much oil since this may result in oil-fouled spark plugs, frothy oil or oil seal failures.

6 Oil is added to the engine after removing the cap from the valve cover **(see illustration)**. A funnel may help to reduce spills.

7 Checking the oil level is an important preventive maintenance step. A consistently low oil level indicates oil leakage through damaged seals, defective gaskets or past worn rings or valve guides. If the oil looks milky or has water droplets in it, the cylinder head gasket may be blown or the head or block may be cracked. The engine should be checked immediately. The condition of the oil should also be checked. Whenever you check the oil level, slide your thumb and index finger up the dipstick before wiping off the oil. If you see small dirt or metal particles clinging to the dipstick, the oil should be changed (see Section 8).

Engine coolant

Refer to illustration 4.9

Warning: *Do not allow antifreeze to come in contact with your skin or painted surfaces of the vehicle. Flush contaminated areas immediately with plenty of water. Don't store new coolant or leave old coolant lying around where it's accessible to children or pets – they're attracted by its sweet smell. Ingestion of even a small amount of coolant can be fatal! Wipe up garage floor and drip pan spills immediately. Keep antifreeze containers covered and repair cooling system leaks as soon as they're noticed.*

8 All vehicles covered by this manual are equipped with a pressurised coolant recovery system. A coolant reservoir is connected by a hose to the base of the coolant filler cap. As the coolant warms during engine operation, coolant escapes through a pressurised filler cap, then through a connecting hose into the reservoir. As the engine cools, the coolant is automatically drawn back into the cooling system to maintain the correct level.

9 The coolant level should be checked regularly. It must be between the MIN and MAX lines on the tank **(see illustration)**. The level will vary with the temperature of the engine. When the engine is cold, the coolant level should be at or slightly above the LOW mark on the tank. Once the engine has warmed up, the level should be at or near the FULL mark. If it isn't, allow the fluid in the tank to cool, then remove the cap from the reservoir and add coolant to bring the level up to the FULL line. Use only ethylene/glycol type coolant and water in the mixture ratio recommended by your owner's manual. Do not use supplemental inhibitor additives. If only a small amount of coolant is required to bring the system up to the proper level, water can be used. However, repeated additions of water will dilute the recommended antifreeze and water solution. In order to maintain the proper ratio of antifreeze and water, it is advisable to top up the coolant level with the correct mixture. Refer to your owner's manual for the recommended ratio.

10 If the coolant level drops within a short time after replenishment, there may be a leak in the system. Inspect the radiator, hoses, engine coolant filler cap, drain plugs and water pump. If no leak is evident, have the radiator cap pressure tested by your dealer. **Warning:** *Never remove the radiator cap when the engine is running or has just been shut down, because the cooling system is hot. Escaping steam and scalding liquid could cause serious injury.*

11 If it is necessary to open the radiator cap, wait until the system has cooled completely, then wrap a thick cloth around the cap and turn it to the first stop. If any steam escapes, wait until the system has cooled further, then remove the cap.

12 When checking the coolant level, always note its condition. It should be relatively clear. If it is brown or rust coloured, the system should be drained, flushed and refilled. Even if the coolant appears to be normal, the corrosion inhibitors wear out with use, so it must be renewed at the specified intervals.

13 Do not allow antifreeze to come in contact with your skin or painted surfaces of the vehicle. Flush contacted areas immediately with plenty of water.

Windscreen washer fluid

Refer to illustration 4.14

14 Fluid for the windscreen washer system may be stored in two places depending on model year of the vehicle. The primary reservoir for the front windscreen/headlight washer system is located on the right (driver) side of the engine compartment near the radiator **(see illustration)**. In milder climates, plain water can be used to top up the reservoir, but the reservoir should be kept no more than two-thirds full to allow for expansion should the water freeze. In colder climates, the use of a specially designed windscreen washer fluid, available at your dealer and any auto parts store, will help lower the freezing point of the fluid. Mix the solution with water in accordance with the manufacturer's directions on the container. Do not use regular antifreeze. It will damage the vehicle's paint.

Battery electrolyte

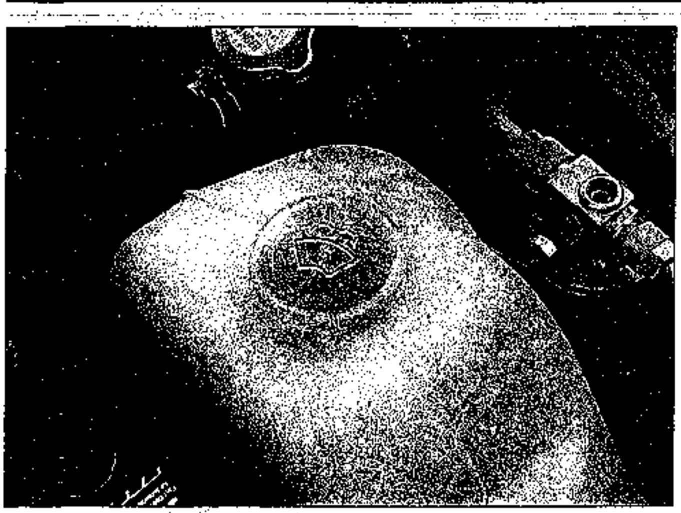
Refer to illustration 4.15

15 On models not equipped with a sealed battery, check the electrolyte level **(see illustration)** of all six battery cells. It must be between the upper and lower levels. If the level is low, remove the filler/vent cap and add distilled water. Refit and securely re-tighten the cap. **Caution:** *Overfilling the cells may cause electrolyte to spill over during periods of heavy charging, causing corrosion or damage.*

Brake and clutch fluid

Refer to illustration 4.17

16 The brake master cylinder is mounted on the front of the power booster unit in the engine compartment. The hydraulic clutch master cylinder used on manual transmission vehicles is located next to the brake master cylinder.



4.14 The reservoir for the windscreen washer is near the battery. Never add coolant to this reservoir

4.15 Each cell of the battery should be checked for low electrolyte level (maintenance-type battery only)

17 To check the fluid level of the brake and clutch master cylinders, simply look at the MAX and MIN marks on the reservoir **(see illustration)**. The level should be about 6 mm below the maximum fill line.

18 If the level is low, wipe the top of the reservoir cover with a clean rag to prevent contamination of the brake system before lifting the cover.

19 Add only the specified brake fluid to the brake and clutch reservoirs (refer to *Recommended lubricants and fluids* at the front of this Chapter or to your owner's manual). Mixing different types of brake fluid can damage the system. **Warning:** *Use caution when filling either reservoir - brake fluid can harm your eyes and damage painted surfaces. Do not use brake fluid that has been opened for more than one year or has been left open. Brake fluid absorbs moisture from the air. Excess moisture can cause a dangerous loss of braking.*

20 While the reservoir cap is removed, inspect the master cylinder reservoir for contamination. If deposits, dirt particles or water droplets are present, the system should be drained and refilled.

21 After filling the reservoir to the proper level, make sure the lid is properly seated to prevent fluid leakage and/or system pressure loss.

22 The fluid in the brake master cylinder will drop slightly as the brake pads at each wheel wear down during normal operation. If either master cylinder requires repeated replenishing to keep it at the proper level, this is an indication of leakage in the brake or clutch system, which should be corrected immediately. If the brake system shows an indication of leakage check all brake lines and connections, along with the calipers, wheel cylinders and booster (see Section 28 for more information). If the hydraulic clutch system shows an indication of leakage check all clutch lines and connections, along with the clutch slave cylinder (see Chapter 8 for more information).

23 If, upon checking the brake or clutch master cylinder fluid level, you discover one or both reservoirs empty or nearly empty, the systems should be bled (see Chapters 8 and 9).

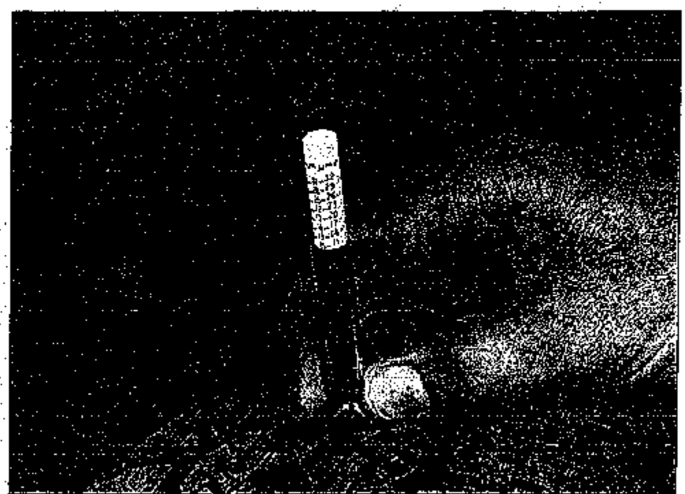
5 Tyre and tyre pressure checks (every 500 kilometres or weekly)

Refer to illustrations 5.2, 5.3, 5.4a, 5.4b and 5.8

1 Periodic inspection of the tyres may spare you the inconvenience of being stranded with a flat tyre. It can also provide you with vital information regarding possible problems in the steering and suspension systems before major damage occurs.

2 The original tyres on this vehicle are equipped with 12 mm wear bands that will appear when tread depth reaches 1.6 mm, but they don't appear until the tyres are worn out. Tread wear can be monitored with a simple, inexpensive device known as a tread depth indicator **(see illustration)**.

4.17 The brake master cylinder also uses a translucent fluid reservoir to make checking the level easy



5.2 Use a tyre tread depth indicator to monitor tyre wear - they are available at auto parts stores and service stations and cost very little

UNDERINFLATION

CUPPING

Cupping may be caused by:

- Underinflation and/or mechanical irregularities such as out-of-balance condition of wheel and/or tyre, and bent or damaged wheel.
- Loose or worn steering tie-rod or steering idler arm.
- Loose, damaged or worn front suspension parts.

OVERINFLATION

INCORRECT TOE-IN OR EXTREME CAMBER

FEATHERING DUE TO MISALIGNMENT

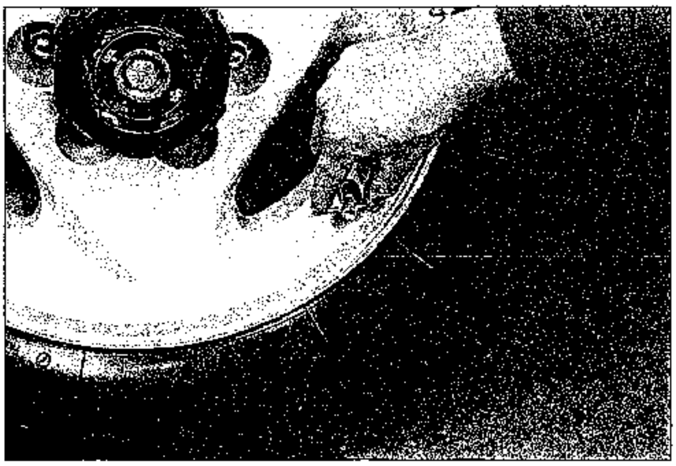
5.3 This chart will help you determine the condition of the tyres, the probable cause(s) of abnormal wear and the corrective action necessary

3 Note any abnormal tread wear **(see illustration)**. Tread pattern irregularities such as cupping, flat spots and more wear on one side than the other are indications of front end alignment and/or balance problems. If any of these conditions are noted, take the vehicle to a tyre shop or service station to correct the problem.

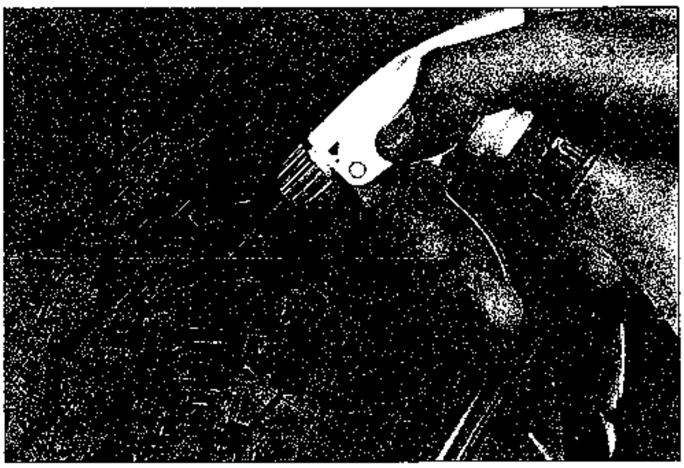
4 Look closely for cuts, punctures and embedded nails or tacks. Sometimes a tyre will hold air pressure for a short time or leak down very slowly after a nail has embedded itself in the tread. If a slow leak persists, check the valve stem core to make sure it's tight **(see illustration)**. Examine the tread for an object that may have embedded itself in the tyre or for a "plug" that may have begun to leak (radial tyre punctures are repaired with a rubber plug that's fitted in the hole). If a puncture is suspected, it can be easily verified by spraying a solution of soapy water onto the puncture area **(see illustration)**. The soapy solution will bubble if there's a leak. Unless the puncture is unusually large, a tyre shop or service station can usually repair the tyre.

5 Carefully inspect the inner sidewall of each tyre for evidence of brake fluid leakage. If you see any, inspect the brakes immediately.

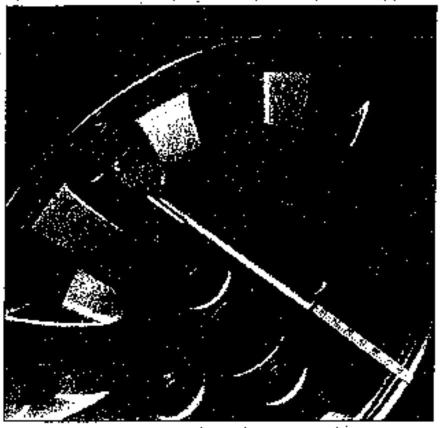
6 Correct air pressure increases the lifespan of the tyres, improves fuel economy and enhances overall ride quality. Tyre pressure cannot be accurately estimated by looking at



5.4a If a tyre loses air on a steady basis, check the valve core first to make sure it is tight (special inexpensive wrenches are available at auto parts stores)



5.4b If the valve core is tight, raise the corner of the vehicle with the low tyre and spray a soapy water solution onto the tread as the tyre is turned slowly - leaks will cause small bubbles to appear



5.8 To extend the life of the tyres, check the air pressure at least once a week with an accurate gauge (don't forget the spare!)

a tyre, especially if it's a radial. A tyre pressure gauge is essential. Keep an accurate gauge in the vehicle. The pressure gauges attached to the nozzles of air hoses at gas stations are often inaccurate.

7 Always check tyre pressure when the tyres are cold. Cold, in this case, means the vehicle has not been driven over a kilometre in the three hours preceding a tyre pressure check. A pressure rise of two to four kilograms is not uncommon once the tyres are warm.

8 Unscrew the valve cap protruding from the wheel or hubcap and push the gauge firmly onto the valve stem **(see illustration)**. Note the reading on the gauge and compare the figure to the recommended tyre pressure shown on the placard on the driver's side door pillar. Be sure to refit the valve cap to keep dirt and moisture out of the valve stem mechanism. Check all four tyres and, if necessary, add enough air to bring them up to the recommended pressure.

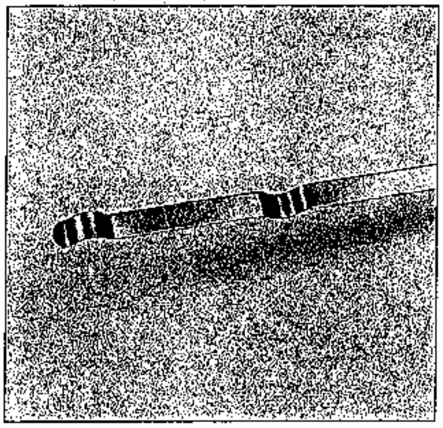
9 Don't forget to keep the spare tyre inflated to the specified pressure (consult your owner's manual).

6 Automatic transmission fluid level check (every 5,000 kilometres or 3 months)

Refer to illustration 6.6

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 15 kilometres (25 kilometres in a frigid climate), and the fluid temperature is above 60 degrees C, the transmission is hot. **Caution:** *If the vehicle has just been driven for a long time at high speed or in city traffic in hot weather, or if it has been pulling a trailer, an accurate fluid level reading cannot be obtained. Allow the fluid to cool down for about 30 minutes.*



6.6 The transmission fluid level can be checked when it is cold by reading the side of the dipstick marked for that condition

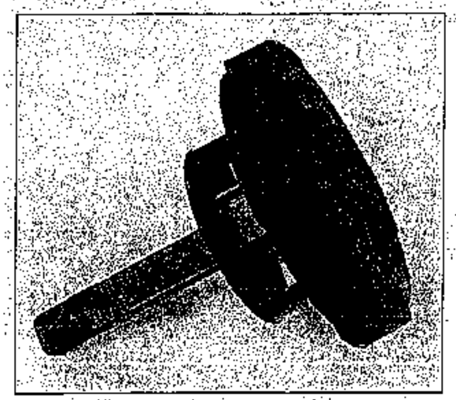
3 If the vehicle has not been driven, park the vehicle on a level area, set the parking brake, then start the engine and bring it to operating temperature. While the engine is idling, depress the brake pedal and move the selector lever through all the gear ranges, beginning and ending in Park.

4 With the engine still idling, remove the dipstick from its tube. It is located near the firewall on the driver side of the engine compartment. Check the level of the fluid on the dipstick and note its condition.

5 Wipe the fluid from the dipstick with a clean rag and reinsert it back into the filler tube until the cap seats.

6 Pull the dipstick out again and note the fluid level. If the transmission is cold, the level should be in the COLD range on the dipstick. If it is hot, the fluid level should be higher **(see illustration)**. If the level is at the low side of either range, add the specified automatic transmission fluid through the dipstick tube with a funnel.

7 Add just enough of the recommended fluid to fill the transmission to the proper level. It takes about one half litre to raise the level from the low mark to the high mark



7.6 The dipstick is marked for the proper fluid levels hot and cold

7.5 The power steering dipstick is located directly in the cap of the pump. Twist it to remove it

when the fluid is hot, so add the fluid a little at a time and keep checking the level until it is correct.

8 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 emits a burned smell, the fluid should be changed (see Section 35). If you are in doubt about the condition of the fluid, purchase some new fluid and compare the two for colour and smell.

7 Power steering fluid level check (every 5,000 kilometres or 3 months)

Refer to illustrations 7.5 and 7.6

1 Unlike manual steering, the power steering system relies on fluid which may, over a period of time, require replenishing.

2 The fluid reservoir for the power steering pump is located on the pump body at the front of the engine.

3 For the check, the front wheels should be pointed straight ahead and the engine should be off.

4 Use a clean rag to wipe off the reservoir cap and the area around the cap. This will help prevent any foreign matter from entering the reservoir during the check.

5 Twist off the cap and determine the temperature of the fluid at the end of the dipstick with your finger **(see illustration)**.

6 Wipe off the fluid with a clean rag, reinsert the dipstick, then withdraw it and read the fluid level. The fluid should be at the proper level, depending on whether it was checked hot or cold **(see illustration)**. Never allow the fluid level to drop below the lower mark on the dipstick.

7 If additional fluid is required, pour the specified type directly into the reservoir, using a funnel to prevent spills.

8 If the reservoir requires frequent fluid additions, all power steering hoses, hose connections and the power steering pump should be carefully checked for leaks.

8 Engine oil and filter change (every 10,000 kilometres or 6 months, petrol engines- every 5,000 kilometres or 3 months, diesel engines)

Refer to illustrations 8.2, 8.7, 8.13 and 8.15

1 Frequent oil changes are the best preventive maintenance the home mechanic can give the engine, because aging 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 **(see illustration)**. You should also have plenty of rags or newspapers handy for mopping up any spills.

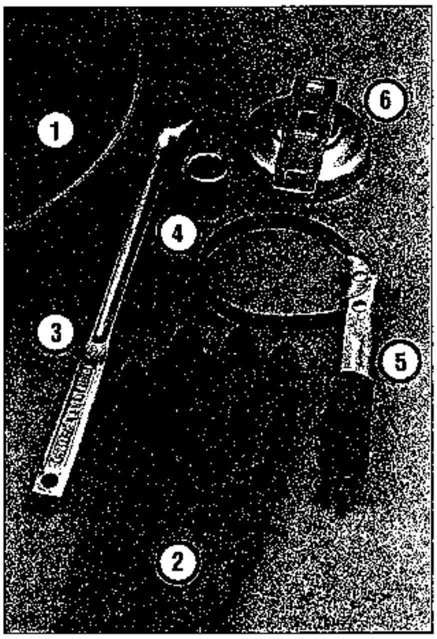
3 Access to the underside of the vehicle is greatly improved if the vehicle can be lifted on a hoist, driven onto ramps or supported by jackstands.

4 If this is your first oil change, get under the vehicle and familiarise yourself with the location of the oil drain plug. The engine and exhaust components will be warm during the actual work, so try to anticipate any potential problems before the engine and accessories are hot.

5 Park the vehicle on a level spot. Start the engine and allow it to reach its normal operating temperature (the needle on the temperature gauge should be at least above the bottom mark). Warm oil and contaminates will flow out more easily. Turn off the engine when it's warmed up. Remove the filler cap in the valve cover.

6 Raise the vehicle and support it on jackstands. **Warning:** *To avoid personal injury, never get beneath the vehicle when it is supported by only by a jack. The jack provided with your vehicle is designed solely for raising the vehicle to remove and renew the wheels. Always use jackstands to support the vehicle when it becomes necessary to place your body underneath the vehicle.*

7 Being careful not to touch the hot exhaust components, place the drain pan under the drain plug in the bottom of the pan and remove the plug **(see illustration)**. You may want to wear gloves while unscrewing the plug the final few turns if the engine is really hot.



8.2 These tools are required when changing the engine oil and filter

1 ***Drain pan*** *- It should be fairly shallow in depth, but wide to prevent spills*
2 ***Rubber gloves*** *- When removing the drain plug and filter, you will get oil on your hands (the gloves will prevent burns)*
3 ***Breaker bar*** *- Sometimes the oil drain plug is tight, and a long breaker bar is needed to loosen it*
4 ***Socket*** *- To be used with the breaker bar or a ratchet (must be the correct size to fit the drain plug - six-point preferred)*
5 ***Filter wrench*** *- This is a metal band-type wrench, which requires clearance around the filter to be effective*
6 ***Filter wrench*** *- This type fits on the bottom of the filter and can be turned with a ratchet or breaker bar (different-size wrenches are available for different types of filters)*

8 Allow the old oil to drain into the pan. It may be necessary to move the pan farther under the engine as the oil flow slows to a trickle. Inspect the old oil for the presence of metal shavings.

9 After all the oil has drained, wipe off the drain plug with a clean rag. Even minute metal particles clinging to the plug would immediately contaminate the new oil.

10 Inspect the drain plug gasket and renew it if it appears worn. Clean the area around the drain plug opening, refit the plug and tighten it to the recommended torque, but do not strip the threads.

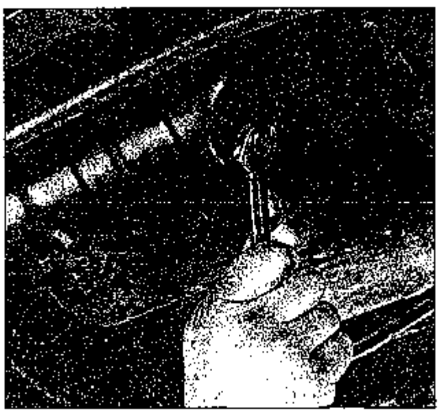
11 Move the drain pan into position under the oil filter.

12 Remove all tools, rags, etc. from under the vehicle, being careful not to spill the oil in the drain pan, then lower the vehicle.

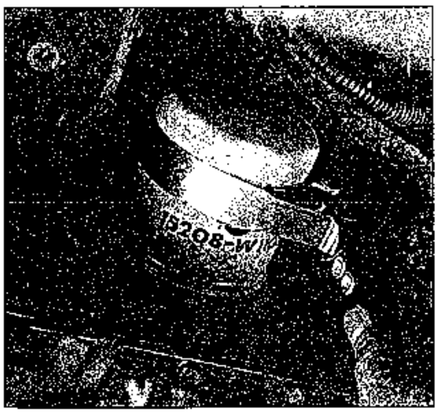
13 Loosen the oil filter (s) **(see illustration)** by turning it counterclockwise with the filter wrench. Any standard filter wrench should work. Once the filter is loose, use your hands to unscrew it from the block. Just as the filter is detached from the block, immediately tilt the open end up to prevent the oil inside the filter from spilling out. **Warning:** *The engine exhaust manifold may still be hot, so be careful.*

14 With a clean rag, wipe off the mounting surface on the block. If a residue of old oil is allowed to remain, it will smoke when the block is heated up. It will also prevent the new filter from seating properly. Also make sure that the none of the old gasket remains stuck to the mounting surface.

15 Compare the old filter with the new one to make sure they are the same type. Smear some engine oil on the rubber gasket of the new filter and screw it into place **(see illustration)**. Because over-tightening the filter will damage the gasket, do not use a filter wrench to tighten the filter. Tighten it by hand



8.7 The engine oil drain plug is usually very tight - it is usually better to use a box end spanner when removing it to avoid damaging the head



8.13 A special oil filter spanner will be required to remove the oil filter- don't use the spanner to fit the new one!

8.15 Lubricate the oil filter gasket with clean engine oil before refitting the filter on the engine

until the gasket contacts the seating surface. Then seat the filter by giving it an additional 3/4-turn.

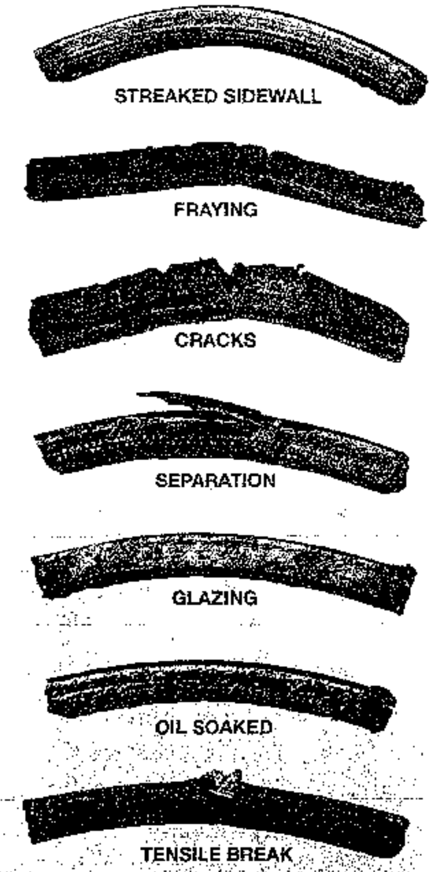
16 Add new oil to the engine through the oil filler cap in the valve cover. Use a spout or funnel to prevent oil from spilling onto the top of the engine. Pour five litres of fresh oil into the engine. Wait a few minutes to allow the oil to drain into the pan, then check the level on the oil dipstick (see Section 4 if necessary). If the oil level is at or near the H mark, refit the filler cap hand tight, start the engine and allow the new oil to circulate.

17 Allow the engine to run for about a minute. While the engine is running, look under the vehicle and check for leaks at the sump drain plug and around the oil filter. If either is leaking, stop the engine and tighten the plug or filter slightly.

18 Wait a few minutes to allow the oil to drain down into the pan, then recheck the level on the dipstick and, if necessary, add enough oil to bring the level to the H mark.

19 During the first few trips after an oil change, make it a point to check frequently for leaks and proper oil level.

20 The old oil drained from the engine cannot be reused in its present state and should be discarded. Oil reclamation centres, auto repair shops and gas stations will normally accept the oil, which can be recycled. After the oil has cooled, it can be drained into a suitable container (capped plastic jugs, topped bottles, milk cartons, etc.) for transport to one of these disposal sites.



10.3 Here are some of the more common problems associated with drivebelts (check the belts very carefully to prevent an untimely breakdown)

9 Underbonnet hose check and renewal (every 10,000 kilometres or 6 months)

General

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

2 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. Refer to Section 24 for more information on checking cooling system hoses.

3 Some, but not all, hoses are secured to the 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.

Vacuum hoses

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

5 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 refitting.

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

7 A small piece of vacuum hose (6 mm inside diameter) 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 drivebelt, cooling fan, etc.*

Fuel hose

Warning: *There are certain precautions which must be taken when inspecting or servicing fuel system components. Work in a well ventilated area and do not allow open flames (cigarettes, appliance pilot lights, etc.) or bare light bulbs near the work area. Mop up any spills immediately and do not store fuel soaked rags where they could ignite.*

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

9 Only high quality fuel line should be used for fuel line renewal. Never, under any circumstances, use unreinforced vacuum line, clear plastic tubing or water hose for fuel lines.

10 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. Renew all spring-type clamps with screw clamps whenever a hose is renewed.

Metal lines

11 Sections of metal line are often used in the fuel system. Check carefully to be sure the line has not been bent or crimped and that cracks have not started in the line.

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

13 Check the metal brake lines where they enter the master cylinder and brake proportioning unit (if used) for cracks in the lines or loose fittings. Any sign of brake fluid leakage calls for an immediate thorough inspection of the brake system.

10 Drivebelt check, adjustment and renewal (every 10,000 kilometres or 6 months)

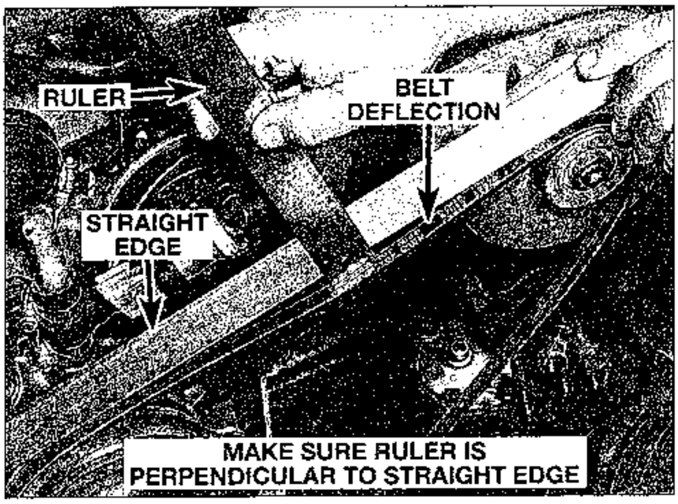
Check

Refer to illustrations 10.3 and 10.4

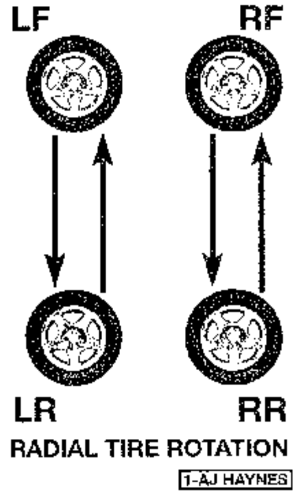
1 The drivebelts, or V-belts as they are sometimes called, are located at the front of the engine and play an important role in the overall operation of the vehicle and its components. Due to their function and material make-up, the belts are prone to failure after a period of time and should be inspected and adjusted periodically to prevent major engine damage.

2 The number of belts used on a particular vehicle depends on the accessories fitted. Drivebelts are used to turn the fan, alternator, power steering pump, water pump and air conditioning compressor. Depending on the pulley arrangement, more than one of these components may be driven by a single belt.

3 With the engine off, open the bonnet and locate the various belts at the front of the engine. Using your fingers (and a flashlight, if necessary), move along the belts checking for cracks and separation of the belt plies. Also check for fraying and glazing, which gives the belt a shiny appearance **(see illustration)**. Both sides of each belt should be



10.4 Measuring drivebelt deflection with a straightedge and ruler



11.2 Tyre rotation diagram for radial tyres

inspected, which means you will have to twist the belt to check the underside.

4 The tension of each belt is checked by pushing on the belt at a distance halfway between the pulleys. Push firmly with your thumb and see how much the belt moves (deflects) **(see illustration)**. As a rule of thumb, if the distance from pulley centre-to-pulley centre is between 175 and 300 mm, the belt should deflect 6 mm. If the belt travels between pulleys spaced 300 to 400 mm apart, the belt should deflect 12 mm for a V-belt or 6 mm for a serpentine belt.

Adjustment

5 If it is necessary to adjust the belt tension, either to make the belt tighter or looser, it is done by moving the adjustable belt-driven accessory on the bracket.

6 For each belt on the engine there will be one component with an adjusting bolt and a pivot bolt. These bolts must be loosened to enable you to move the component.

7 After the two bolts have been loosened, move the component away from the engine to tighten the belt or toward the engine to loosen the belt. Hold the accessory in position and check the belt tension. If it is correct, tighten the two bolts until just snug, then recheck the tension. If the tension is all right, tighten the bolts.

8 On earlier models it will be necessary to use some sort of lever to move the accessory while the belt is adjusted. If this must be done to gain the proper leverage, be very careful not to damage the component being moved or the part being pried against. Power steering pumps are particularly vulnerable.

Renewal

9 To renew a belt, follow the above procedures for drivebelt adjustment but slip the belt off the pulleys and remove it. Since belts tend to wear out more or less at the same time, it's a good idea to renew all of them at the same time. Number each belt and the corresponding pulley grooves so the new belts can be fitted properly.

10 Take the old belts with you when purchasing new ones in order to make a direct comparison for length, width and design.

11 Adjust the belts as described earlier in this Section.

11 Tyre rotation (every 10,000 kilometres or 6 months)

Refer to illustration 11.2

1 The tyres should be rotated at the specified intervals and whenever uneven wear is noticed. Since the vehicle will be raised and the tyres removed anyway, check the brakes (see Section 28) at this time.

2 Radial tyres must be rotated in a specific pattern **(see illustration)**.

3 Refer to the information in *Jacking and towing* at the front of this manual for the proper procedures to follow when raising the vehicle and changing a tyre. If the brakes are to be checked, do not apply the parking brake as stated. Make sure the tyres are blocked to prevent the vehicle from rolling.

4 Preferably, the entire vehicle should be raised at the same time. This can be done on a hoist or by jacking up each corner and then lowering the vehicle onto jackstands placed under the frame rails. Always use four jackstands and make sure the vehicle is firmly supported.

5 After rotation, check and adjust the tyre pressures as necessary and be sure to check the lug nut tightness.

6 For further information on the wheels and tyres, refer to Chapter 10.

12 Clutch/brake pedal height and freeplay adjustment (every 10,000 kilometres or 6 months)

1 The height of the clutch and brake pedals is the distance the pedal sits from the floor. If the pedal height is not within the specified range, it must be adjusted. To make measurements, pull back the carpet and place the end of your scale directly on the melt sheet which is adhered to the steel floor pan. Measure to the top of the pedal pad.

Brake pedal height

2 Before measuring the brake pedal height, make sure the pedal is in the fully returned position, then start the engine and depress the accelerator several times to activate the brake power booster. Measure the pedal height and adjust if necessary. To adjust the pedal height, loosen the locknut and back the brake switch out for the necessary clearance, then loosen the locknut on the brake pushrod. Turn the pushrod to adjust the pedal height in the middle of the specified range, then retighten the locknut. **Warning:** *The pushrod must not extend out so that its end is outside of the opening in the clevis.*

3 Adjust the pedal switch by turning it clockwise until the clearance is as listed in this Chapter's Specifications. Ensure that the brake lights are not on when the brake pedal is released.

Brake pedal freeplay

4 Check the free play and adjust the brake lamp switch as before if it is not correct.

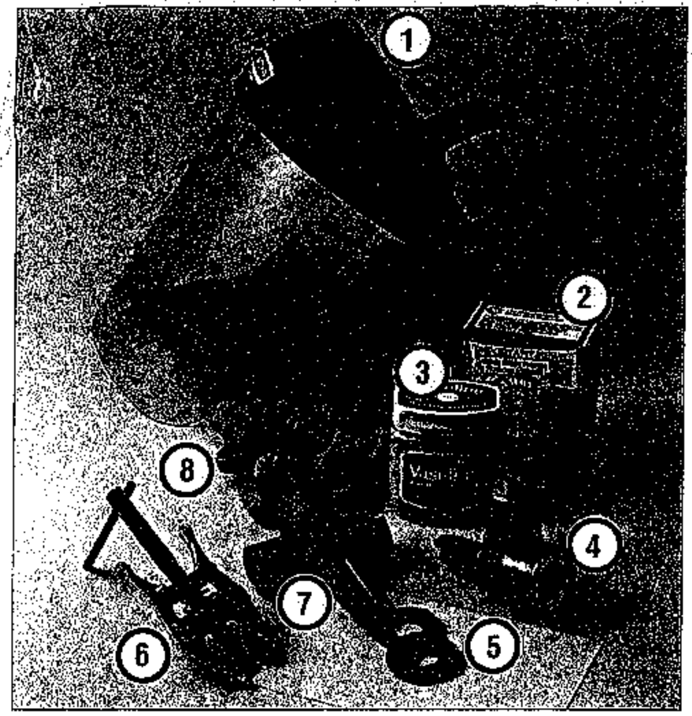
Clutch pedal height

5 Adjust the clutch pedal height with the pedal stop. Loosen the locknut, adjust the stop until the correct pedal height is reached, then tighten the locknut.

Clutch pedal free play

6 The freeplay is the pedal slack, or the distance the pedal can be depressed before it begins to have any effect on the clutch system. If the pedal freeplay is not within the specified range, it must be adjusted.

7 To adjust the clutch pedal freeplay loosen the locknut on the clutch pushrod. Then back off the pushrod to adjust the pedal freeplay to the specified range and retighten the locknut.



14.1 Tools and materials required for battery maintenance

1 ***Face shield/safety goggles*** - *When removing corrosion with a brush, the acidic particles can easily fly up into your eyes*
2 ***Baking soda*** - *A solution of baking soda and water can be used to neutralise corrosion*
3 ***Petroleum jelly*** - *A layer of this on the battery posts will help prevent corrosion*
4 ***Battery post/cable cleaner*** - *This wire brush cleaning tool will remove all traces of corrosion from the battery posts and cable clamps*
5 ***Treated felt washers*** - *Placing one of these on each post, directly under the cable clamps, will help prevent corrosion*
6 ***Puller*** - *Sometimes the cable clamps are very difficult to pull off the posts, even after the nut/bolt has been completely loosened. This tool pulls the clamp straight up and off the post without damage*
7 ***Battery post/cable cleaner*** - *Here is another cleaning tool which is a slightly different version of Number 4 above, but it does the same thing*
8 ***Rubber gloves*** - *Another safety item to consider when servicing the battery; remember that's acid inside the battery!*

13 Seat belt check (every 20,000 kilometres or 12 months)

1 Check the seat belts, buckles, latch plates and guide loops for any obvious damage or signs of wear.
2 Make sure the seat belt reminder light comes on when the key is turned on.
3 The seat belts are designed to lock up during a fast stop or impact, yet allow free movement during normal driving. The retractors should hold the belt against your chest while driving and rewind the belt when the buckle is unlatched.
4 If any of the above checks reveal problems with the seat belt system, renew parts as necessary.

14 Battery check, maintenance and charging (every 10,000 kilometres or 6 months)

Refer to illustrations 14.1, 14.6a, 14.6b, 14.7a and 14.7b

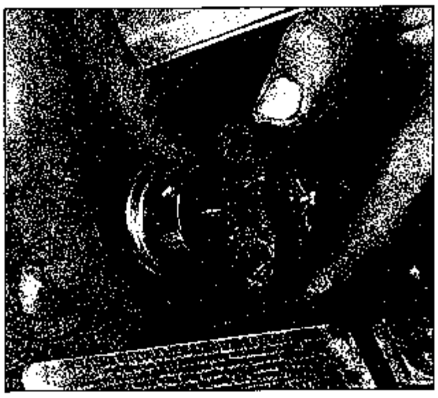
Warning: *Certain precautions must be followed when checking and servicing the battery. Hydrogen gas, which is highly flammable, is always present in the battery cells, so keep lighted tobacco and all other open flames and sparks away from the battery. The electrolyte inside the battery is actually dilute sulfuric acid, which will cause injury if splashed on your skin or in your eyes. It will also ruin clothes and painted surfaces. When removing the battery cables, always detach the negative cable first and hook it up last!*

Maintenance

1 A routine preventive maintenance program for the battery in your vehicle is the only way to ensure quick and reliable starts. But before performing any battery maintenance, make sure that you have the proper equipment necessary to work safely around the battery **(see illustration)**.
2 There are also several precautions that should be taken whenever battery maintenance is performed. Before servicing the battery, always turn the engine and all accessories off and disconnect the cable from the negative terminal of the battery.
3 The battery produces hydrogen gas, which is both flammable and explosive. Never create a spark, smoke or light a match around the battery. Always charge the battery in a ventilated area.
4 Electrolyte contains poisonous and corrosive sulfuric acid. Do not allow it to get in your eyes, on your skin on your clothes. Never ingest it. Wear protective safety glasses when working near the battery. Keep children away from the battery.
5 Note the external condition of the battery. If the positive terminal and cable clamp on your vehicle's battery is equipped with a rubber protector, make sure that it's not torn or damaged. It should completely cover the terminal. Look for any corroded or loose connections, cracks in the case or cover or loose hold-down clamps. Also check the entire length of each cable for cracks and frayed conductors.
6 If corrosion, which looks like white, fluffy deposits **(see illustration)** is evident, particularly around the terminals, the battery should be removed for cleaning. Loosen the cable clamp bolts with a wrench, being careful to remove the earth cable first, and slide them off the terminals **(see illustration)**. Then disconnect the hold-down clamp bolt and nut, remove the clamp and lift the battery from the engine compartment.

14.6a Battery terminal corrosion usually appears as light, fluffy powder

14.6b Removing the cable from a battery post with a wrench - sometimes special battery pliers are required for this procedure if corrosion has caused deterioration of the nut hex (always remove the negative cable first and hook it up last!)



14.7a When cleaning the cable clamps, all corrosion must be removed (the inside of the clamp is tapered to match the taper on the post, so don't remove too much material)

7 Clean the cable clamps thoroughly with a battery brush or a terminal cleaner and a solution of warm water and baking soda **(see illustration)**. Wash the terminals and the top of the battery case with the same solution but make sure that the solution doesn't get into the battery. When cleaning the cables, terminals and battery top, wear safety goggles and rubber gloves to prevent any solution from coming in contact with your eyes or hands. Wear old clothes too - even diluted, sulfuric acid splashed onto clothes will burn holes in them. If the terminals have been extensively corroded, clean them up with a terminal cleaner **(see illustration)**. Thoroughly wash all cleaned areas with plain water.

8 Make sure that the battery tray is in good condition and the hold-down clamp bolts are tight. If the battery is removed from the tray, make sure no parts remain in the bottom of the tray when the battery is refitted. When refitting the hold-down clamp bolts, do not overtighten them.

9 Any metal parts of the vehicle damaged by corrosion should be covered with a zinc-based primer, then painted.

10 Information on removing and refitting the battery can be found in Chapter 5. Information on jump starting can be found at the front of this manual. For more detailed battery checking procedures, refer to the *Haynes Automotive Electrical Manual*.

Charging

Warning: *When batteries are being charged, hydrogen gas, which is very explosive and flammable, is produced. Do not smoke or allow open flames near a battery. Wear eye protection when near the battery during charging. Also, make sure the charger is unplugged before connecting or disconnecting the battery from the charger.*

Note: *The manufacturer recommends the battery be removed from the vehicle for charging because the gas that escapes during this procedure can damage the paint. Fast charging with the battery cables connected can result in damage to the electrical system.*

14.7b Regardless of the type of tool used on the battery posts, a clean, shiny surface should be the result

11 Slow-rate charging is the best way to restore a battery that's discharged to the point where it will not start the engine. It's also a good way to maintain the battery charge in a vehicle that's only driven a few kilometres between starts. Maintaining the battery charge is particularly important in the winter when the battery must work harder to start the engine and electrical accessories that drain the battery are in greater use.

12 It's best to use a one or two-amp battery charger (sometimes called a "trickle" charger). They are the safest and put the least strain on the battery. They are also the least expensive. For a faster charge, you can use a higher amperage charger, but don't use one rated more than 1/10th the amp/hour rating of the battery. Rapid boost charges that claim to restore the power of the battery in one to two hours are hardest on the battery and can damage batteries not in good condition. This type of charging should only be used in emergency situations.

13 The average time necessary to charge a battery should be listed in the instructions that come with the charger. As a general rule, a trickle charger will charge a battery in 12 to 16 hours.

14 Remove all the cell caps (if equipped) and cover the holes with a clean cloth to prevent spattering electrolyte. Disconnect the negative battery cable and hook the battery charger cable clamps up to the battery posts (positive to positive, negative to negative), then plug in the charger. Make sure it is set at 12-volts if it has a selector switch.

15 If you're using a charger with a rate higher than two amps, check the battery regularly during charging to make sure it doesn't overheat. If you're using a trickle charger, you can safely let the battery charge overnight after you've checked it regularly for the first couple of hours.

16 If the battery has removable cell caps, measure the specific gravity with a hydrometer every hour during the last few hours of the charging cycle. Hydrometers are available inexpensively from auto parts stores - follow the instructions that come with the hydrometer. Consider the battery charged when there's no change in the specific gravity reading for two hours and the electrolyte in the cells is gassing (bubbling) freely. The specific gravity reading from each cell should be very close to the others. If not, the battery probably has a bad cell(s).

17 Some batteries with sealed tops have built-in hydrometers on the top that indicate the state of charge by the colour displayed in the hydrometer window. Normally, a bright-coloured hydrometer indicates a full charge and a dark hydrometer indicates the battery still needs charging.

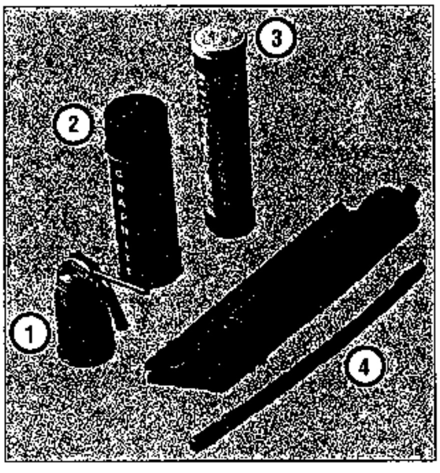
18 If the battery has a sealed top and no built-in hydrometer, you can hook up a voltmeter across the battery terminals to check the charge. A fully charged battery should read 12.6 volts or higher after the surface charge has been removed.

19 Further information on the battery and jump starting can be found in Chapter 5 and at the front of this manual.

15 Chassis lubrication (every 10,000 kilometres or 6 months)

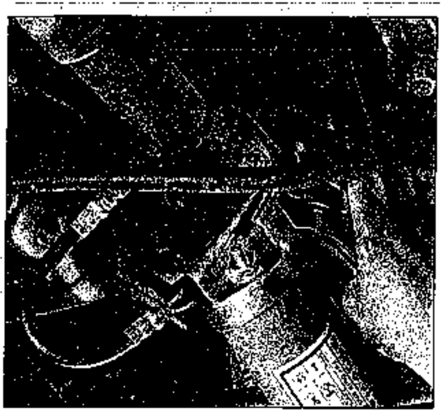
Refer to illustrations 15.1 and 15.8

1 Refer to *Recommended lubricants and fluids* at the front of this Chapter to obtain the necessary grease, etc. You will also need a grease gun **(see illustration)**. Occasionally plugs will be fitted rather than grease fittings.



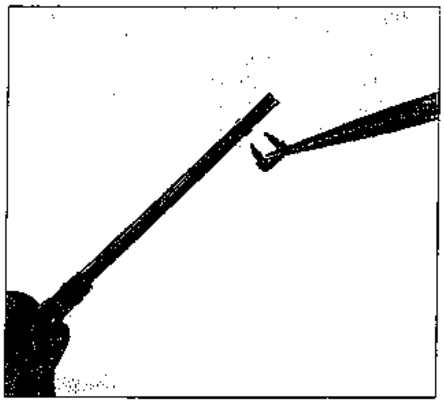
15.1 Materials required for chassis and body lubrication

1 ***Engine oil*** - *Light engine oil in a can like this can be used for door and bonnet hinges*
2 ***Graphite spray*** - *Used to lubricate lock cylinders*
3 ***Grease*** - *Grease, in a variety of types and weights, is available for use in a grease gun. Check the Specifications for your requirements*
4 ***Grease gun*** - *A common grease gun, shown here with a detachable hose and nozzle, is needed for chassis lubrication. After use, clean it thoroughly*



15.8 Don't forget to lubricate the slip collars on the driveshafts

16.5 In order to renew the wiper blades, first separate the blade assembly from the wiper arm



16.6 Pliers are usually needed to remove the clip from the end of the blade

If so, grease fittings will have to be purchased and fitted.

2 Look under the vehicle for grease fittings or plugs on the steering, suspension, and driveline components. They are normally found on the tie-rod ends and universal joints. If there are plugs, remove them and fit grease fittings, which will thread into the component. An automotive parts store will be able to supply the correct fittings. Straight, as well as angled, fittings are available.

3 For easier access under the vehicle, raise it with a jack and place jackstands under the frame. Make sure it is safely supported by the stands. If the wheels are to be removed at this interval for tyre rotation or brake inspection, loosen the lug nuts slightly while the vehicle is still on the ground.

4 Before beginning, force a little grease out of the nozzle to remove any dirt from the end of the gun. Wipe the nozzle clean with a rag.

5 With the grease gun and plenty of clean rags, crawl under the vehicle and begin lubricating the components.

6 Wipe the top of both steering knuckles free of dirt, then detach the pipe plug from each steering knuckle. Insert the nozzle, then squeeze the trigger on the grease gun to force grease into the component. For all other suspension and steering components, continue pumping grease into the fitting until it oozes out of the joint between the two components. If it escapes around the grease gun nozzle, the fitting is clogged or the nozzle is not completely seated on the fitting. Resecure the gun nozzle to the fitting and try again. If necessary, renew the fitting.

7 Wipe the excess grease from the components and the grease fitting. Repeat the procedure for the remaining fittings.

8 Lubricate the driveshaft slip yoke by pumping grease into the fitting until it can be seen coming out of the slip yoke seal **(see illustration)**.

9 Lubricate conventional universal joints until grease can be seen coming out of the contact points.

10 While you are under the vehicle, clean and lubricate the parking brake cable along with the cable guides and levers. This can be done by smearing some chassis grease onto the cable and its related parts with your fingers.

11 Lubricate the contact points on the steering knuckle stop and adjustment bolt.

12 Open the bonnet and smear a little chassis grease on the bonnet latch mechanism. Have an assistant pull the bonnet release lever from inside the vehicle as you lubricate the cable at the latch.

13 Lubricate all the hinges (door, bonnet, etc.) with engine oil to keep them in proper working order.

14 The key lock cylinders can be lubricated with spray-on graphite or silicone lubricant, which is available at auto parts stores.

15 Lubricate the door weatherstripping with silicone spray. This will reduce chafing and retard wear.

16 If the vehicle has been used in water, remove one of the bolts from the bottom of each front hub. Check with a probe for any water which may have become trapped. Refer to Section 37 for further information.

17 On manual transmission vehicles that have been used in water, remove the plug from the bottom of the bellhousing to check for moisture and drain any that has accumulated.

16 Wiper blade inspection and renewal (every 10,000 kilometres or 6 months)

Refer to illustrations 16.5, 16.6 and 16.7

1 The windscreen wiper and blade assembly should be inspected periodically for damage, loose components and cracked or worn blade elements.

2 Road film can build up on the wiper blades and affect their efficiency, so they should be washed regularly with a mild detergent solution.

3 The action of the wiping mechanism can loosen bolts, nuts and fasteners, so they should be checked and tightened, as necessary, at the same time the wiper blades are checked.

4 If the wiper blade elements are cracked, worn or warped, or no longer clean adequately, they should be renewed.

5 Lift the arm assembly away from the glass for clearance. It will lock in position. Press on the clip, then slide the wiper blade arm assembly off **(see illustration)**.

6 Use needle-nose pliers to remove the clip at the end of the arm **(see illustration)**.

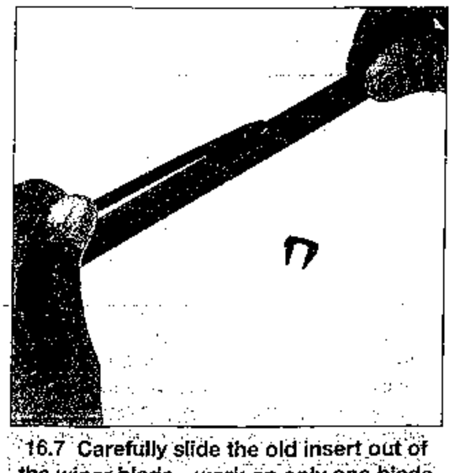
7 Pull out the old rubber and discard it **(see illustration)**.

8 Refitting is the reverse of removal. Make sure that the new insert is securely locked into the arm. Test the wipers briefly to ensure that they are solidly mounted.

17 Idle speed and mixture adjustment (every 10,000 kilometres or 6 months)

Refer to illustration 17.4

Note: *The idle speed can be adjusted on fuel injected models using these procedures, however, the idle mixture is controlled by the computer and various sensors. Refer to Chapter 4B for more information on fuel injected vehicles.*



16.7 Carefully slide the old insert out of the wiper blade - work on only one blade at a time to avoid confusion

Petrol engines

1 Engine idle speed is the speed at which the engine operates when fully warmed and when no accelerator pedal force is applied. The idle speed is critical to the performance of the engine as well as many engine sub-systems.

2 Make sure the parking brake is firmly set and the wheels blocked to prevent the vehicle from rolling. This is especially true if the specifications require the transmission to be in Drive. An assistant inside the vehicle pressing on the brake pedal is the safest method.

3 A hand-held tachometer must be used when adjusting idle speed to get an accurate reading. The exact hook-up for these meters varies with the manufacturer, so follow the particular directions included with the instrument.

4 For most applications, the idle speed is set by turning an adjustment screw which is located next to the throttle lever **(see illustration)**. This screw changes the amount the throttle plate is held open by the throttle linkage.

5 For all applications, the engine must be completely warmed-up to operating temperature, which will automatically render the choke and fast idle inoperative.

6 Once you have located the idle screw, experiment with different length screwdrivers until the adjustment can be easily made without coming into contact with hot or moving engine components.

7 If the air cleaner is removed, the vacuum hose to the snorkel should be plugged.

8 Since the manufacturer recommended many different adjustment procedures over the time period covered by this manual, it would be impractical to cover all types in this Section. Most models have a tune-up decal or Vehicle Emission Control Information (VECI) label located in the engine compartment with instructions for setting idle speed. If no VECI label is found refer to the Specifications Section at the beginning of this Chapter and to the adjustment procedures specified in Chapter 4A.

9 The idle mixture is adjusted at the same time as the idle speed. This manual assumes that you do not have access to an exhaust emissions analyser. If you do, adjust the idle mixture screw to yield the percentage of CO as listed in this Chapter's Specifications.

10 Adjust the idle mixture screw (carburettor only) until the smoothest possible idle is found **(see illustration 17.4)**. Turn the screw clockwise one additional turn. Reset the idle speed if necessary.

Diesel engine

11 The engine idle speed should be checked on diesel engines every 20,000 kilometres.

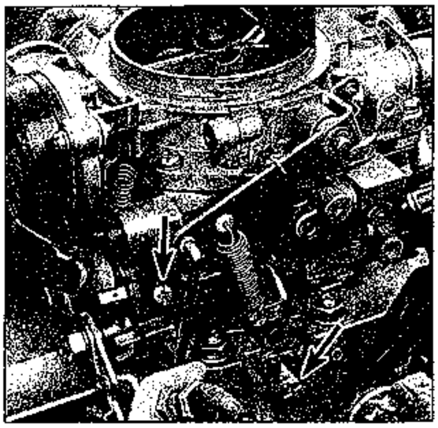
12 Before checking the idle speed, make certain that the injection timing is correct and that the injector nozzles are clean. All other systems must be in proper order, including the valve clearances and the air filter.

13 Warm the engine to operating temperature. Turn off all accessories including the lights, air conditioner and heater. The vehicle must be in Neutral or Park with the parking brake set.

14 Remove the clamps which secure the number one injector tube. Attach the lead of a special diesel tachometer to the number one injector tube.

15 Run the engine at approximately 2,000 rpm for two minutes, then allow it to idle for one minute. Observe the idle speed. Compare the reading with that on the VECI label in the engine compartment. If this information is not available, set the idle speed to 700 to 750 rpm.

16 Locate the adjustment screw on the top of the injection pump. Loosen the lock-nut and adjust the screw while observing the tachometer. Tighten the lock-nut.



17.4 The upper screw near the throttle linkage adjusts the idle speed - the one at the base of the carburettor is for the mixture setting

18 Exhaust system check (every 10,000 kilometres or 6 months)

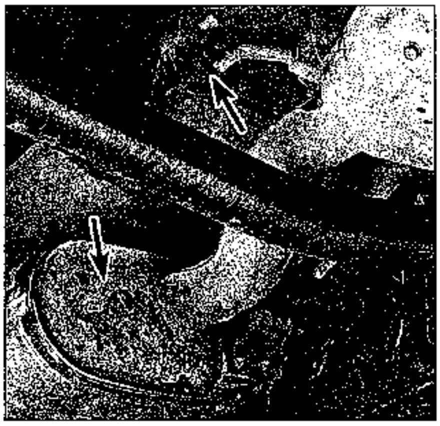
Refer to illustration 18.2

1 With the engine cold (at least three hours after the vehicle has been driven), check the complete exhaust system from the manifold to the end of the tailpipe. Be careful around the catalytic converter (if equipped), which may be hot even after three hours. The inspection should be done with the vehicle on a hoist to permit unrestricted access. If a hoist isn't available, raise the vehicle and support it securely on jackstands.

2 Check the exhaust pipes and connections for signs of leakage and/or corrosion indicating a potential failure. Make sure that all brackets and hangers are in good condition and tight **(see illustration)**. Leaks usually show up as black sooty stains on surrounding areas.

3 Inspect the underside of the body for holes, corrosion, open seams, etc. which may allow exhaust gasses to enter the passenger compartment. Seal all body openings with silicone sealant or body putty.

4 Rattles and other noises can often be traced to the exhaust system, especially the hangers, mounts and heat shields. Try to move the pipes, mufflers and catalytic converter. If the components can come in contact with the body or suspension parts, secure the exhaust system with new brackets and hangers.



18.2 Corrosion will be apparent at the ends of the muffler. Check all of the rubber mounts for cracking at the same time

19 Suspension and steering check (every 10,000 kilometres or 6 months)

Refer to illustrations 19.6a and 19.6b

Note: *For detailed illustrations of the steering and suspension components, refer to Chapter 10.*

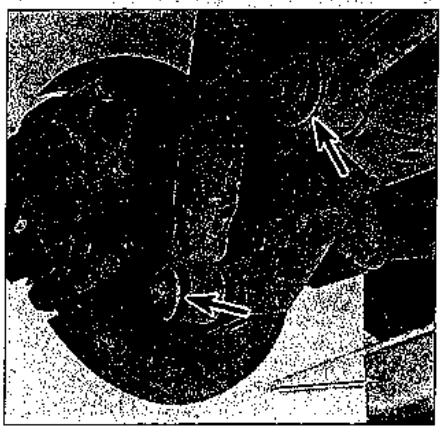
With the wheels on the ground

1 With the vehicle stopped and the front wheels pointed straight ahead, rock the steering wheel gently back and forth. If freeplay is excessive, a front wheel bearing, main shaft yoke, intermediate shaft yoke, steering knuckle bearing or tie rod end is worn or the steering gear is out of adjustment or broken. Refer to Chapter 10 for the appropriate repair procedure.

2 Other symptoms, such as excessive vehicle body movement over rough roads, swaying (leaning) around corners and binding as the steering wheel is turned, may indicate faulty steering and/or suspension components.

3 Check the shock absorbers by pushing down and releasing the vehicle several times at each corner. If the vehicle does not come back to a level position within one or two bounces, the shocks/struts are worn and must be renewed. When bouncing the vehicle up and down, listen for squeaks and noises from the suspension components.

1



19.6a The suspension system uses many rubber bushes which must be inspected. If they are severely cracked, broken or missing altogether, they must be renewed immediately

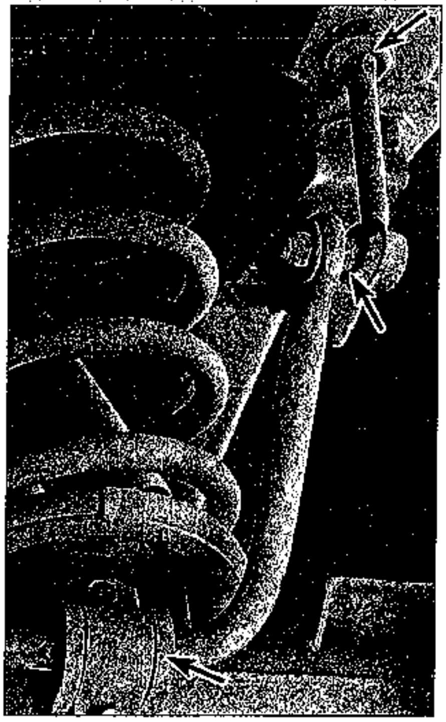
Under the vehicle

4 Raise the vehicle with a floor jack and support it securely on jackstands. See *jacking and towing* at the front of this book for proper jacking points.

5 Check the tyres for irregular wear patterns and proper inflation. See Section 5 for information regarding tyre wear.

6 Inspect the universal joint between the steering shaft and the steering gear housing. Check the steering gear housing for grease leakage. Check the steering linkage for looseness or damage. Check the tie-rod ends for excessive play. Look for loose bolts, broken or disconnected parts and deteriorated rubber bushes on all suspension and steering components **(see illustrations)**. While an assistant turns the steering wheel from side to side, check the steering components for free movement, chafing and binding. If the steering components do not seem to be reacting with the movement of the steering wheel, try to determine where the slack is located.

7 Check the wheel bearings. Do this by spinning the front wheels. Listen for any abnormal noises and watch to make sure the wheel spins true (doesn't wobble). Grab the top and bottom of the tyre and pull in-and-out on it. Notice any movement which would indicate a loose wheel bearing assembly. If the bearings are suspect, they should be checked and repacked.



19.6b Rubber bushes will degenerate quickly if they are allowed to become oil-soaked - repair all oil leaks as soon as possible

8 Check the steering knuckle, moving the knuckle up and down with a prise bar to ensure that knuckle bearings have no play. If the bearings are suspect, they should be checked and repacked. Refer to Chapter 10 for more information.

9 Inspect the driveshafts for worn U-joints and for excessive play in the slip yoke and spline area (see Chapter 8).

21.4a The air filter lid is secured with a combination of wing-nuts and clips on carburetted models - make sure that you tighten the wing-nuts three full turns after they first contact the lid when reassembling it

10 Check the transfer case and differentials for evidence of fluid leakage.

20 Fuel filter service (diesel engine) (every 10,000 kilometres or 12 months)

Caution: *Drain the fuel filter at once if the fuel filter warning light or buzzer alerts you.*

1 Turn the engine OFF. Place a small container in the engine compartment under the fuel filter.

2 Open the drain valve on the bottom of the filter no more than five turns and allow any water to escape.

3 When clear fuel runs out, tighten the valve.

4 Bleed the fuel system before attempting to start the engine (refer to Chapter 4C).

21 Air filter and PCV filter check and renewal (every 20,000 kilometres or 12 months)

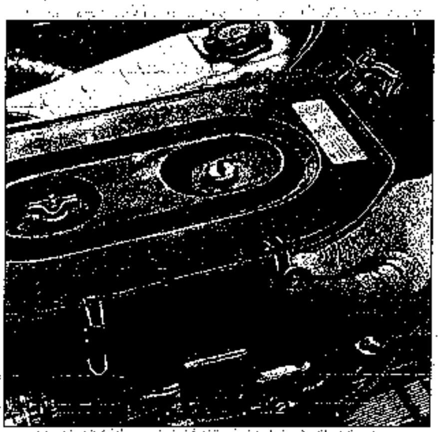
Refer to illustrations 21.4a, 21.4b, 21.4c, 21.5a and 21.5b

Note: *Refer to Section 42 for the service procedure for the cyclone pre-air filter.*

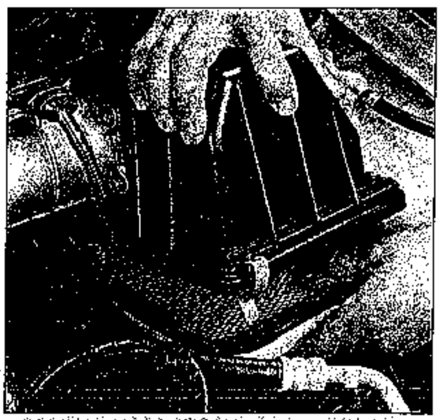
1 At the specified intervals, the air filter should be renewed. A thorough preventive maintenance schedule would also require the filters to be inspected between filter changes.

2 On carburetted models, the air filter housing is mounted on top of the carburettor in the engine compartment. On diesel engines, two air filters are used. The prefilter can be cleaned with compressed air (from the inside out) when it has become dirty. The main filter is serviced as with the petrol engine filters.

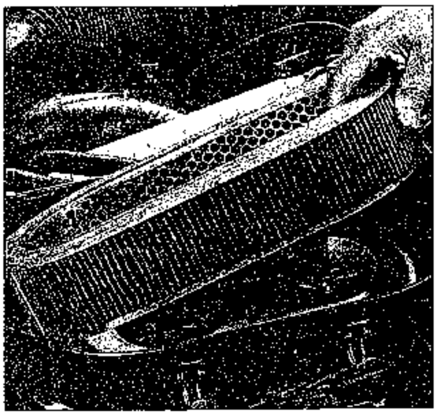
3 On fuel-injected models, the air filter housing is located at the front of the engine compartment.



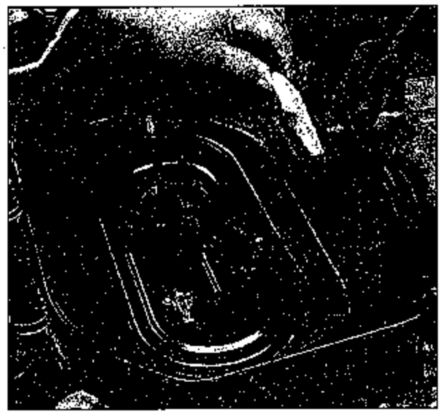
21.4b The air filter lid can be quickly removed without the use of tools - there is no excuse for not checking the filter regularly



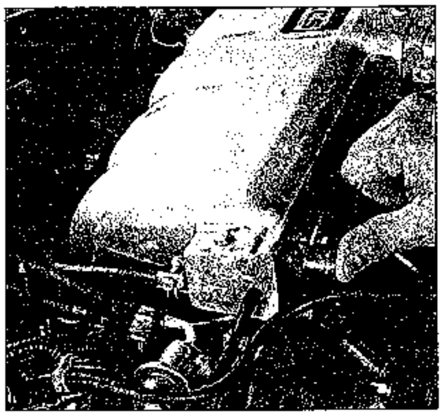
21.4c Be careful when servicing the air filter on fuel injected models - the air flow meter is attached to the air filter lid and it is delicate



21.5a Lift the air filter out and then clean the housing thoroughly



21.5b The PCV filter should be renewed every time the air filter is renewed



22.3 Place a thumb over the PCV valve with the engine idling - a strong vacuum should be felt

4 On carburetted models, remove the wing nut(s) and the cover retaining clips **(see illustrations)**. Then detach all hoses that would interfere with the removal of the air cleaner cover from the air cleaner housing. On fuel injected models, unclip the cover and pull it aside **(see illustration)**. While the top cover is off, be careful not to drop anything down into the carburettor or air cleaner assembly.
5 Lift the air filter element out of the housing **(see illustration)** and wipe out the inside of the air cleaner housing with a clean rag. The PCV filter is secured to the side of the air filter housing. Renew it at the same time as the air filter **(see illustration)**.
6 Inspect the outer surface of the filter element. If it is dirty, renew it. If it is only moderately dusty, it can be reused by blowing it clean from the back to the front surface with compressed air. Because it is a pleated paper type filter, it cannot be washed or oiled. If it cannot be cleaned satisfactorily with compressed air, discard and renew it. **Caution:** *Never drive the vehicle with the air cleaner removed. Excessive engine wear could result and backfiring could even cause a fire under the bonnet.*
7 Place the new filter in the air cleaner housing, making sure it seats properly.
8 Refitting of the cover is the reverse of removal. See the Specifications in this Chapter for the correct tightening procedure for the air filter lid wing nuts.
9 Some later model vehicles use an air cleaner service indicator lamp to alert the driver that the air filter and/or the cyclone pre-air filter are extremely dirty. Both filters should be serviced immediately when the lamp is lit.
10 The indicator is usually located at the rear of the carburettor. Make certain that the red part of the indicator is not visible when the engine is idling. **Note:** *The indicator switch can be tested by removing it and applying a vacuum of 10.0 to 11.5 kPa to it using a hand vacuum pump. Use an ohmmeter to check that the switch has continuity at that vacuum level and that continuity disappears when vacuum is released.*

22 Positive Crankcase Ventilation (PCV) valve check and renewal (petrol engines) (every 20,000 kilometres or 12 months)

Refer to illustration 22.3

1 The PCV valve is located in the inlet manifold.
2 With the engine idling at normal operating temperature, pull the PCV hose from the PCV valve.
3 Place your finger over the valve **(see illustration)**. If there's no vacuum, renew the valve. Renew any plugged or deteriorated hoses at the same time.
4 Turn off the engine, remove and shake the PCV valve, listening for a rattle. If the valve doesn't rattle, renew it.
5 To renew the valve, remove it from the inlet manifold.
6 When purchasing a PCV valve, make sure it's for your particular vehicle and engine size. Compare the old valve with the new one to make sure they're the same.
7 Fit the new valve into the inlet manifold.
8 Inspect all rubber hoses and grommets for damage and hardening. Renew them, if necessary.
9 Press the PCV hose securely into position.

23 Fuel system check (every 20,000 kilometres or 12 months)

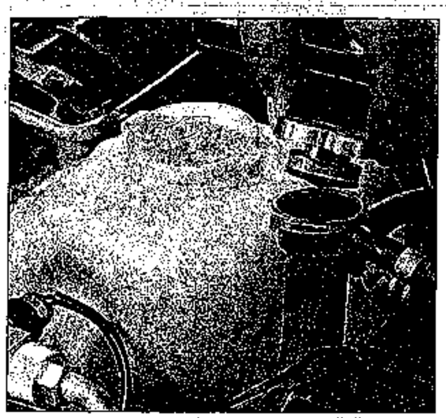
Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or clothes dryer) with a pilot light is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. The fuel system is under constant pressure, so, if any fuel lines are to be disconnected, the fuel pressure in the system must be relieved first (see Chapter 4, Part A for more information). When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

1 The fuel system is most easily checked with the vehicle raised on a hoist so the components underneath the vehicle are readily visible and accessible.
2 If the smell of fuel is noticed while driving or after the vehicle has been in the sun, the system should be thoroughly inspected immediately.
3 Remove the fuel tank cap and check for damage, corrosion and an unbroken sealing imprint on the gasket. Renew the cap if necessary.
4 With the vehicle raised and safely supported, inspect the fuel tank and filler neck for punctures, cracks and other damage. The connection between the filler neck and the tank is particularly critical. Sometimes a rubber filler neck will leak because of loose clamps or deteriorated rubber. These are problems a home mechanic can usually rectify. **Warning:** *Do not, under any circumstances, try to repair a fuel tank (except rubber components). A welding torch or any open flame can easily cause fuel vapours inside the tank to explode.*
5 Carefully check all rubber hoses and metal lines leading away from the fuel tank. Check for loose connections, deteriorated hoses, crimped lines and other damage. Follow the lines to the front of the vehicle, carefully inspecting them all the way to the carburettor or fuel injectors. Repair or renew damaged sections as necessary.
6 If a fuel odour is still evident after the inspection, refer to Chapter 6 and check the EVAP system.

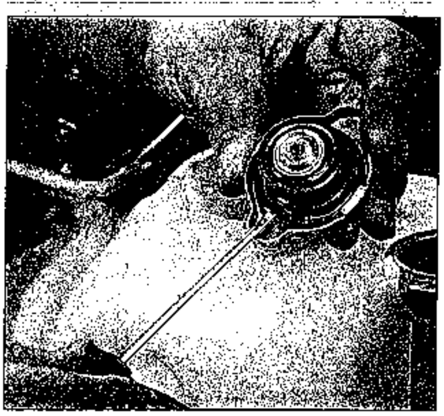
24 Cooling system check (every 20,000 kilometres or 12 months)

Refer to illustrations 24.3a, 24.3b and 24.4

1 Many major engine failures can be attributed to a faulty cooling system. If the vehicle is equipped with an automatic trans-



24.3a The engine must have cooled completely any time you attempt to remove the radiator cap - it is best to remove before the vehicle has been driven for the day



24.3b The cap is a critical element of the cooling system - make certain that the rubber seals in it are not deformed or cracked

mission, the cooling system also cools the transmission fluid and thus plays an important role in prolonging transmission life.

2 The cooling system should be checked with the engine cold. Do this before the vehicle is driven for the day or after it has been shut off for at least three hours.

3 Remove the radiator cap by turning it to the left until it reaches a stop **(see illustration)**. If you hear a hissing sound (indicating there is still pressure in the system), wait until this stops. Now press down on the cap with the palm of your hand and continue turning to the left until the cap can be removed. Thoroughly clean the cap, inside and out, with clean water **(see illustration)**. Also clean the filler neck on the radiator. All traces of corrosion should be removed. The coolant inside the radiator should be relatively transparent. If it is rust coloured, the system should be drained and refilled (see Section 37). If the coolant level is not up to the top, add additional antifreeze/coolant mixture (see Section 4).

4 Carefully check the large upper and lower radiator hoses along with the smaller diameter heater hoses which run from the engine to the firewall. Inspect each hose along its entire length, renewing any hose which is cracked, swollen or shows signs of deterioration. Cracks may become more apparent if the hose is squeezed **(see illustration)**. Regardless of condition, it's a good idea to renew hoses every two years.

5 Make sure all hose connections are tight. A leak in the cooling system will usually show up as white or rust coloured deposits on the areas adjoining the leak. If wire-type clamps are used at the ends of the hoses, it may be a good idea to renew them with more secure screw-type clamps.

6 Use compressed air or a soft brush to remove bugs, leaves, etc. from the front of the radiator or air conditioning condenser. Be careful not to damage the delicate cooling fins or cut yourself on them.

7 Every other inspection, or at the first indication of cooling system problems, have the cap and system pressure tested. If you don't have a pressure tester, most petrol stations and repair shops will do this for a minimal charge.

25 Ignition timing check and adjustment (petrol engines) (every 40,000 kilometres or 24 months)

Refer to illustrations 25.2, 25.3, 25.6 and 25.11

Note: *It is imperative that the procedures included on the tune-up or Vehicle Emissions Control Information (VECI) label be followed when adjusting the ignition timing. The label will include all information concerning preliminary steps to be performed before adjusting the timing, as well as the timing specifications. If no VECI label is found, refer to the specifications chart at the beginning of this Chapter.*

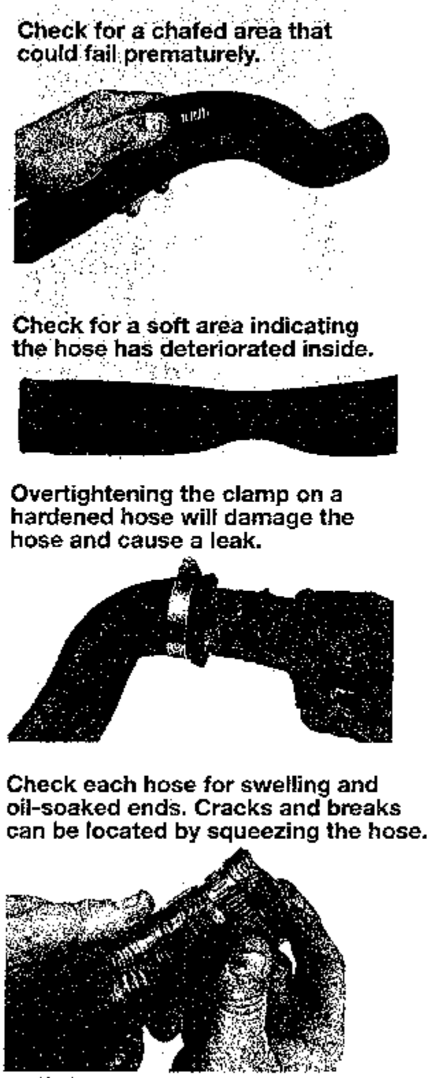
1 At the specified intervals, the ignition timing should be checked and adjusted.

2 Various procedures (depending on the model of the vehicle) must be performed to disable the distributor or computer advance mechanism before attempting to check the timing. Locate the Tune-up or VECI label under the bonnet and read through and perform all preliminary instructions concerning ignition timing **(see illustration)**. If no VECI label is found, refer to the Specifications Section at the beginning of this Chapter. Generally, the distributor vacuum hose will be disconnected on carburetted models and the AAC wiring will be disconnected on fuel injected models.

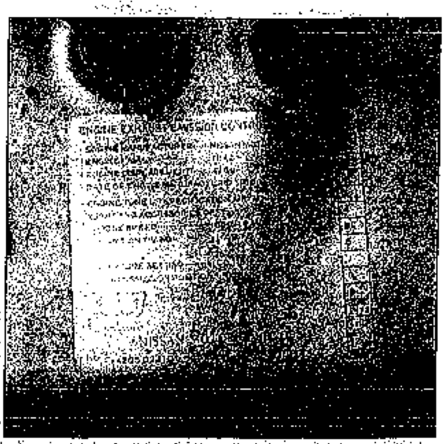
3 Before attempting to check the timing some special tools will be needed for this procedure **(see illustration)**.

4 Check that the idle speed is as specified (see Section 17).

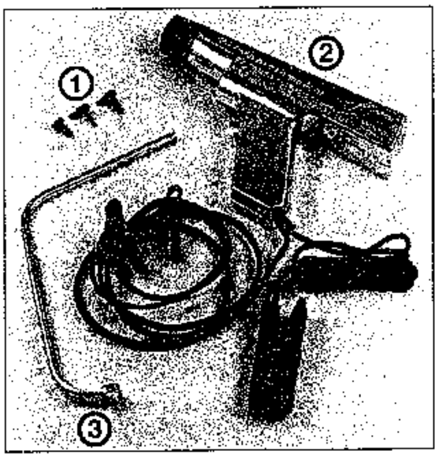
5 Connect a timing light in accordance with the manufacturer's instructions. Generally, the light will be connected to power and earth sources and to the number one spark



24.4 Hoses, like drivebelts, have a habit of failing at the worst possible time - to prevent the inconvenience of a blown radiator or heater hose, inspect hem carefully as shown here



25.2 There should be a sticker in the engine compartment which will give you important information regarding all of the tune-up operations

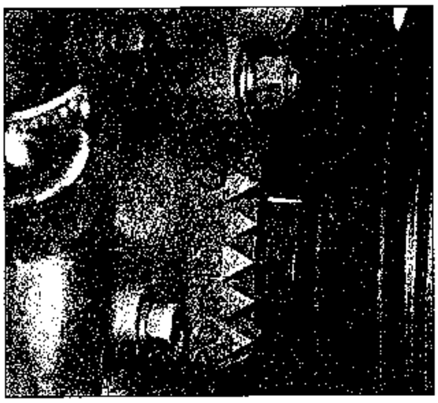


25.3 Tools needed to check and adjust the ignition timing

1 ***Vacuum plugs** - Vacuum hoses will, in most cases, have to be disconnected and plugged. Moulded plugs in various shapes and sizes are available for this*
2 ***Inductive pick-up timing light** - Flashes a bright, concentrated beam of light when the number one spark plug fires. Connect the leads according to the instructions supplied with the light*
3 ***Distributor wrench** - On some models, the hold-down bolt for the distributor is difficult to reach and turn with conventional wrenches or sockets. A special wrench like this must be used*

plug wire (refer to the cylinder location diagram in this Chapter's Specifications).

6 Locate the timing marks on the engine **(see illustration)**. Clean them off with solvent if necessary so you can see the numbers or marks and small grooves.



25.6 These are the timing marks on the 4.2 litre engine - number one piston will be at top dead centre when the white mark is aligned with the zero

7 Use chalk or paint to mark the groove in the crankshaft pulley.

8 Mark the timing tab in accordance with the number of degrees called for on the VECI label or the tune-up label in the engine compartment.

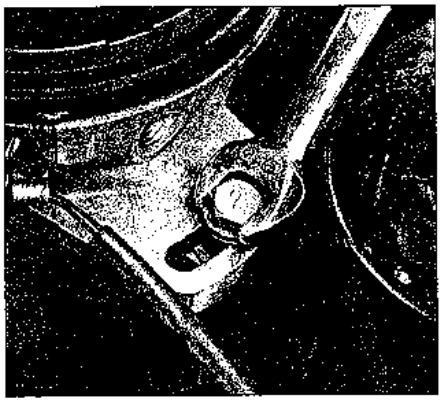
9 Make sure the timing light is clear of all moving engine components, then start the engine and warm it up to normal operating temperature.

10 Aim the flashing timing light at the timing mark by the crankshaft pulley, again being careful not to come in contact with moving parts. The marks should appear to be stationary. If the marks are in alignment, the timing is correct.

11 If the notch on the crankshaft pulley is not aligned with the correct mark on the timing tab, loosen the distributor hold-down bolt and rotate the distributor until the notch is aligned with the correct timing mark **(see illustration)**.

12 Retighten the hold-down bolt and recheck the timing.

13 Turn off the engine and disconnect the timing light. Reconnect the vacuum advance hose or the AAC wiring, if removed, and any other components which were disconnected.



25.11 Loosen the distributor locking bolt only enough to allow you to adjust the timing

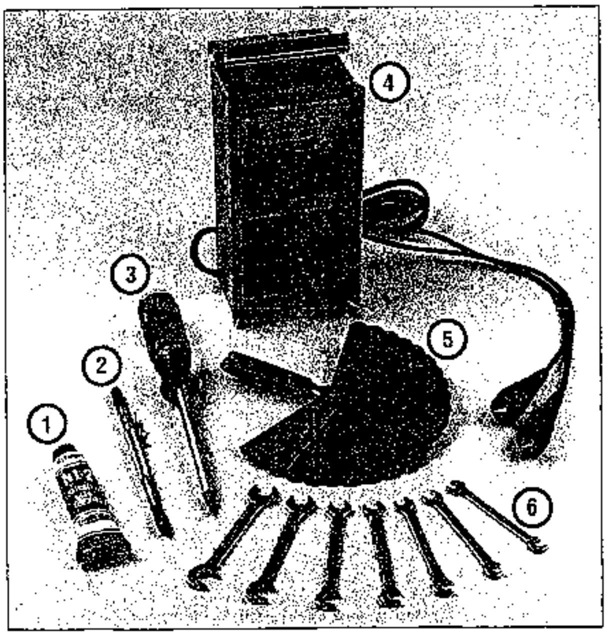
26 Ignition points check, renewal and adjustment (every 20,000 kilometres or 12 months)

Refer to illustration 26.1

Check and renewal

1 The ignition points must be renewed at regular intervals on early petrol vehicles not equipped with electronic ignition. All later vehicles are equipped with electronic ignitions which do not require regular service. Occasionally the rubbing block will wear enough to require adjustment of the points or the contacts themselves will become burned or eroded. It's also possible to clean and dress them with a fine file, but renewal is recommended since they are relatively accessible and inexpensive. Several special tools are required for this procedure **(see illustration)**.

1



26.1 Tools and materials needed for contact point renewal and dwell angle adjustment

1 ***Distributor cam lube** - Sometimes this special lubricant comes with the new points; however, it's a good idea to buy a tube and have it on hand*
2 ***Screw starter** - This tool has special claws which hold the screw securely as it's started, which helps prevent accidental dropping of the screw*
3 ***Magnetic screwdriver** - Serves the same purpose as 2 above. If you don't have one of these special screwdrivers, you risk dropping the point mounting screws down into the distributor body*
4 ***Dwell meter** - A dwell meter is the only accurate way to determine the point setting (gap). Connect the meter according to the instructions supplied with it.*
5 ***Blade-type feeler gauges** - These are required to set the initial point gap (space between the points when they are open)*
6 ***Ignition wrenches** - These special wrenches are made to work within the tight confines of the distributor. Specifically, they are needed to loosen the nut/bolt which secures the leads to the points*

2 After removing the distributor cap and rotor (see Section 34), the ignition points are plainly visible. They can be examined by gently levering them open to reveal the condition of the contact surfaces. If they're rough, pitted, covered with oil or burned, they should be renewed, along with the condenser. **Caution:** *This procedure requires the removal of small screws which can easily fall down into the distributor. To retrieve them, the distributor would have to be removed and disassembled. Use a magnetic or spring-loaded screwdriver and be extra careful.*

3 If not already done, remove the distributor cap.

4 Position the cap (with the spark plug wires still attached) out of the way. Use a length of wire to hold it out of the way, if necessary.

5 Remove the rotor, by grasping the rotor with one hand and pulling straight up on the rotor to remove it.

6 Note how the wires in the distributor are routed, then disconnect the primary wire leads from the points. The wires may be attached with a small nut (which should be loosened, but not removed), a small screw or by a spring-loaded terminal.

7 Loosen the screws which secure the ignition points to the breaker plate, but don't completely remove the screws (most ignition point sets have slots at these locations). Slide the points out of the distributor.

8 The condenser can now be removed from the breaker plate. Loosen the mounting strap screw and slide the condenser out or completely remove the condenser and strap. If you remove both the condenser and strap, be careful not to drop the mounting screw down into the distributor body.

9 Before fitting the new points and condenser, clean the breaker plate and the cam on the distributor shaft to remove all dirt, dust and oil.

10 Apply a small amount of distributor cam lube (usually supplied with the new points, but also available separately) to the lobes.

11 Position the new condenser and tighten the mounting strap screw securely.

12 Slide the new point set into place and make sure the protrusions on the breaker plate fit into the holes in the point base (to properly position the point set), then tighten the screws.

13 Attach the primary and condenser wires to the new points. Make sure the wires are routed so they don't interfere with breaker plate or advance weight movement.

Adjustment

Refer to illustration 36.16

14 Although the final dwell angle will be adjusted later, make the initial gap adjustment now, which will allow the engine to be started.

15 Make sure that the point rubbing block is resting on one of the high points of the cam. If it isn't, rotate the crankshaft with a breaker bar and socket attached to the large bolt that holds the vibration damper in place.

16 With the rubbing block on a cam high point (points open), insert a 0.50 mm gauge between the contact surfaces. Insert a screwdriver into the slot between the breaker plate and the point base to adjust the gap. The gap is correct when a slight amount of drag is felt as the feeler gauge is withdrawn.

17 Inspect and fit the rotor and distributor cap as described in Section 35.

18 Whenever new ignition points are fitted or the original points are cleaned, the dwell angle must be checked and adjusted. Precise adjustment of the dwell angle requires an instrument called a dwell meter. Combination tach/dwell meters are commonly available at reasonable cost from auto parts stores.

19 If a dwell meter is not available, the initial adjustment described above will be sufficient until a competent automotive repair facility can adjust the dwell angle for you.

20 Hook the dwell meter up following the manufacturer's instructions.

21 Start the engine and allow it to run at idle until normal operating temperature is reached (the engine must be warm to obtain an accurate reading). Record the dwell reading on the meter. If the reading is not within specifications it will need to be adjusted.

22 Dwell angle specifications can be found in this Chapter's Specifications and on the VECI label or tune-up decal in the engine compartment. If there's a discrepancy between the two, assume the VECI label or tune-up decal is correct.

23 If the dwell angle is incorrect, readjust the point gap as described above in Step 16. Repeat this process until the meter reading is as specified. **Note:** *Opening the point gap will decrease the dwell reading while closing the point gap will increase the dwell reading.*

27 Pre-heat air cleaner check (carburetted models) (every 20,000 kilometres or 12 months)

1 Carburetted engines are equipped with a thermostatically controlled air cleaner which draws air to the carburettor from different locations, depending upon engine temperature.

2 This is a visual check. If access is limited, a small mirror may have to be used.

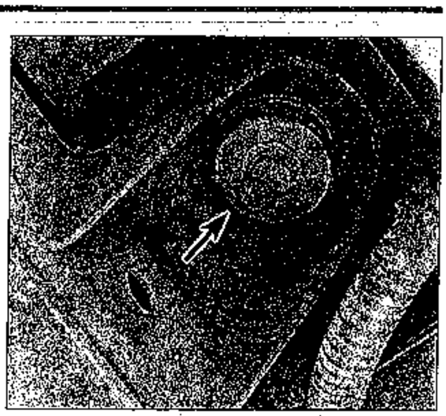
3 Open the bonnet and locate the damper door inside the air cleaner assembly. It is inside the long snorkel of the air cleaner housing.

4 If there is a flexible air duct attached to the end of the snorkel, leading to an area behind the grille, disconnect it at the snorkel. This will enable you to look through the end of the snorkel and see the damper inside. A mirror may be needed if you can't look safely into the end of the snorkel.

5 The check should be done when the engine is cold. Start the engine and look through the snorkel at the damper, which should move to a closed position. With the damper closed, air cannot enter through the end of the snorkel, but instead enters the air cleaner through the flexible duct attached to the exhaust manifold and the heat stove passage.

6 As the engine warms up to operating temperature, the damper should open to allow air through the snorkel end. Depending on outside temperature, this may take 10 to 15 minutes. To speed up this check you can reconnect the snorkel air duct, drive the vehicle, then check to see if the damper is completely open.

7 If the thermostatic air cleaner isn't operating properly , see Chapter 6 for more information.



28.1 The bolts which secure the body to the frame may become loose during extended severe use - they must be checked for tightness as a regular maintenance procedure

28 Body mounts check and tightening (every 20,000 kilometres or 12 months)

Refer to illustration 28.1

1 There are ten body mounting nuts and bolts on wagon and hardtop models **(see illustration)**. Utility models use twenty mounting fasteners. These should be checked for tightness periodically if the vehicle has been put to severe use.

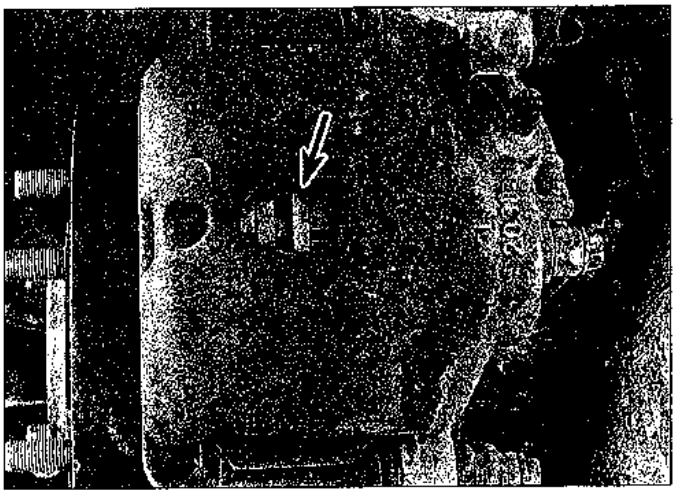
2 Remove any dirt or mud from around the heads of the nuts and bolts.

3 Use a torque wrench to tighten all the bolts. Renew any missing components.

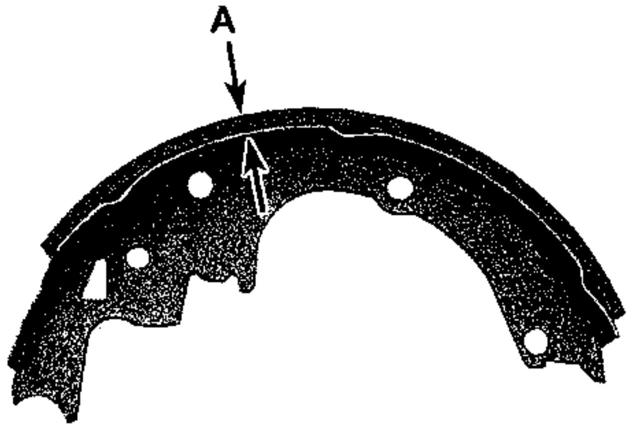
4 Refer to the torques listed in this Chapter's Specifications.

29 Brake check (every 20,000 kilometres or 12 months)

Warning: *The dust created by the brake system may contain asbestos, which is harmful to your health. Never blow it out with compressed air and don't inhale any of it. An approved filtering mask should be worn when working on the brakes. Do not, under any circumstances, use petroleum-based solvents*



29.5 It is not necessary to completely disassemble the front brakes in order to check the pad thickness - simply remove a wheel and look through this window



29.12 If the lining is bonded to the brake shoe, measure the lining thickness from the outer surface to the metal shoe, as shown here; if the lining is riveted to the shoe, measure from the lining outer surface to the rivet head

to clean brake parts. Use brake system cleaner only! Try to use non-asbestos renewal parts whenever possible.

Note: *For detailed photographs of the brake system, refer to Chapter 9.*

1 In addition to the specified intervals, the brakes should be inspected every time the wheels are removed or whenever a defect is suspected. Any of the following symptoms could indicate a potential brake system defect: The vehicle pulls to one side when the brake pedal is depressed; the brakes make squealing or dragging noises when applied; brake pedal travel is excessive; the pedal pulsates; brake fluid leaks, usually onto the inside of the tyre or wheel.

2 Loosen the wheel lug nuts.

3 Raise the vehicle and place it securely on jackstands.

4 Remove the wheels (see *Jacking and towing* at the front of this book, or your owner's manual, if necessary).

Disc brakes

Refer to illustration 29.5

5 There are two pads (an outer and an inner) in each caliper. The pads are visible through inspection holes in each caliper **(see illustration)**.

6 Check the pad thickness by looking at each end of the caliper and through the inspection hole in the caliper body. If the lining material is less than the thickness listed in this Chapter's Specifications, renew the pads. **Note:** *Keep in mind that the lining material is riveted or bonded to a metal backing plate and the metal portion is not included in this measurement.* If the lining is of the riveted type, it will be impossible to measure the amount of pad remaining above the heads of the rivets using this method. the calipers will have to be at least partially removed to check this.

7 If it is difficult to determine the exact thickness of the remaining pad material by the above method, or if you are at all concerned about the condition of the pads, remove the caliper(s) for further inspection (refer to Chapter 9).

8 Once the calipers are removed, measure the pad thickness with a dial or vernier caliper.

9 Measure the disc thickness with a micrometer to make sure that it still has service life remaining. If any disc is thinner than the specified minimum thickness, renew it (refer to Chapter 9). Even if the disc has service life remaining, check its condition. Look for scoring, gouging and burned spots. If these conditions exist, remove the disc and have it resurfaced (see Chapter 9).

10 Before refitting the wheels, check all brake lines and hoses for damage, wear, deformation, cracks, corrosion, leakage, bends and twists, particularly in the vicinity of the rubber hoses at the calipers. Check the clamps for tightness and the connections for leakage. Make sure that all hoses and lines are clear of sharp edges, moving parts and the exhaust system. If any of the above conditions are noted, repair, reroute or renew the lines and/or fittings as necessary (see Chapter 9).

Drum brakes

Refer to illustration 29.12

11 Refer to Chapter 9 and remove the rear brake drums.

12 Note the thickness of the lining material on the rear brake shoes **(see illustration)** and look for signs of contamination by brake fluid and grease. If the lining material is within 1.0 mm of the recessed rivets or metal shoes, renew the brake shoes. The shoes should also be renewed if they are cracked, glazed (shiny lining surfaces) or contaminated with brake fluid or grease. See Chapter 9 for the renewal procedure.

13 Check the shoe return and hold-down springs and the adjusting mechanism to make sure they're refitted correctly and in good condition. Deteriorated or distorted springs, if not renewed, could allow the linings to drag and wear prematurely.

14 Check the wheel cylinders for leakage by carefully peeling back the rubber boots. If brake fluid is noted behind the boots, the wheel cylinders must be renewed (see Chapter 9).

15 Check the drums for cracks, score marks, deep scratches and hard spots, which will appear as small discoloured areas. If imperfections cannot be removed with emery cloth, the drums must be resurfaced by an automotive machine shop (see Chapter 9 for more detailed information).

16 Refer to Chapter 9 and refit the brake drums.

17 Refit the wheels and snug the wheel lug nuts finger tight.

18 Remove the jackstands and lower the vehicle.

19 Tighten the wheel lug nuts to the torque listed in this Chapter's Specifications.

Brake booster check

20 Sit in the driver's seat and perform the following sequence of tests.

21 With the engine stopped, depress the brake pedal several times - the travel distance should not change.

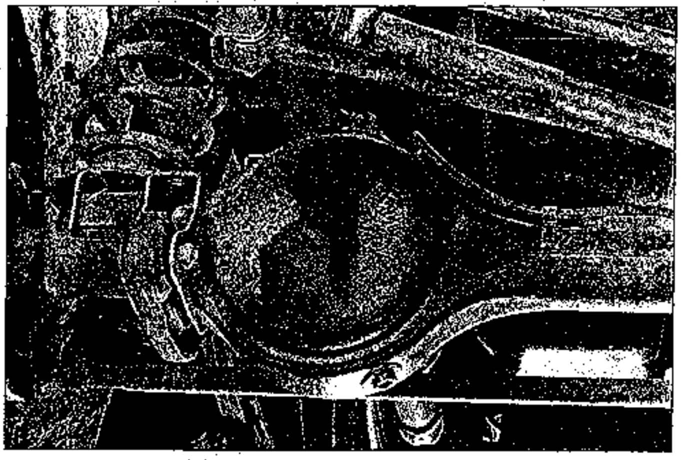
22 With the brake fully depressed, start the engine - the pedal should move down a little when the engine starts.

23 Depress the brake, stop the engine and hold the pedal in for about 30 seconds - the pedal should neither sink nor rise.

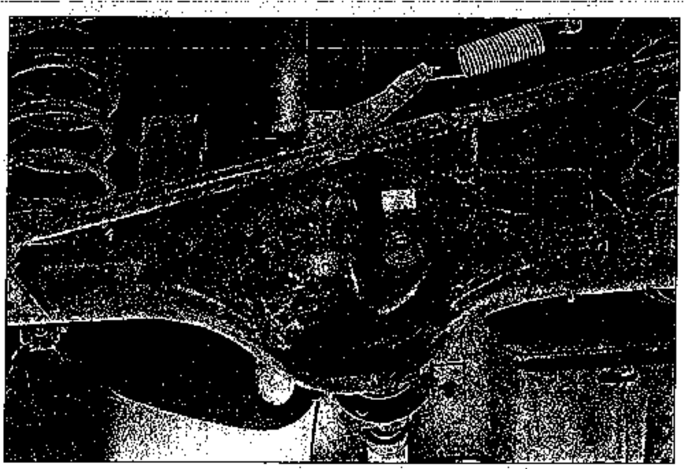
24 Restart the engine, run it for about a minute and turn it off. Then firmly depress the brake several times - the pedal travel should decrease with each application.

25 If your brakes do not operate as described above when the preceding tests are performed, the brake booster is either in need of repair or has failed. Refer to Chapter 9 for the removal procedure.

1



30.2a The filler plug for the front differential should be removed to check the fluid level . .



30.2b . . . every time the rear differential is checked

Parking brake

26 Slowly pull up on the parking brake and count the number of clicks you hear until the handle is up as far as it will go. The adjustment should be within the specified number of clicks listed in this Chapter's Specifications. If you hear more or fewer clicks, adjust the parking brake (refer to Chapter 9).

27 An alternative method of checking the parking brake is to park the vehicle on a steep hill with the parking brake set and the transmission in Neutral (be sure to stay in the vehicle during this check!). If the parking brake cannot prevent the vehicle from rolling, it is in need of adjustment (see Chapter 9).

28 However, on vehicles with rear disc brakes the parking brake assembly itself should be visually inspected every 12 months (or whenever a fault is suspected).

29 With the vehicle raised and supported on jackstands, remove the rear wheels.

30 Remove the rear discs as outlined in Chapter 9. Support the caliper assemblies with a coat hanger or heavy wire and do not disconnect the brake line from the caliper.

31 With the disc removed, the parking brake components are visible and can be inspected for wear and damage. The linings should last the life of the vehicle. However, they can wear down if the parking brake system has been improperly adjusted. There is no minimum thickness specification for the parking brake shoes, but as a rule of thumb, if the shoe material is less 0.8 mm thick, you should renew them. Also check the springs and adjuster mechanism and inspect the disc for deep scratches and other damage. For more information on the brake system see Chapter 9.

30 Manual transmission, transfer and differential lubricant level check (every 20,000 kilometres or 12 months)

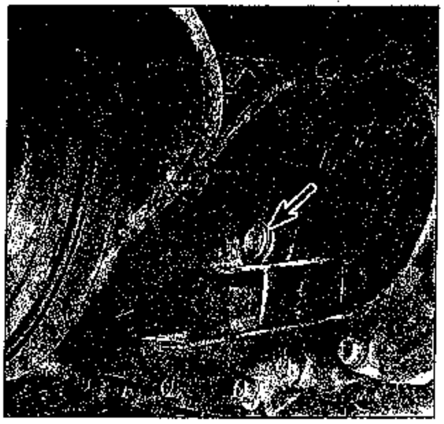
Refer to illustrations 30.2a, 30.2b and 30.2c

1 All three of these components have a filler plug which must be removed to check the lubricant level. If the vehicle is raised to gain access to the plugs, be sure to support it safely on jackstands - DO NOT crawl under a vehicle which is supported only by a jack! Be sure the vehicle is level or the check may be inaccurate.

2 Using a wrench, unscrew each fill plug **(see illustrations)** and use a finger to reach inside the housing to determine the lubricant level. The level should be at or near the bottom of the plug hole.

3 If it isn't, add the recommended lubricant through the plug hole with a pump or squeeze bottle.

4 Refit and tighten the plug and check for leaks after the first few kilometres of driving.

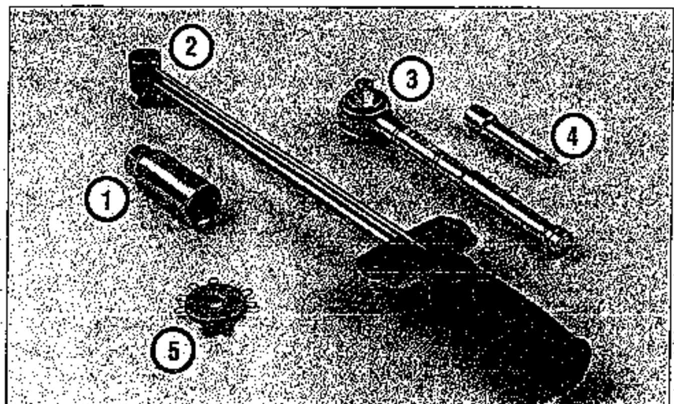


30.2c Don't forget to check the transfer lubricant using the same method as for the differentials

31 Spark plug renewal (petrol engines) (every 20,000 kilometres or 12 months)

Refer to illustrations 31.1, 31.4 and 31.5

1 Spark plug renewal requires a spark plug socket which fits onto a ratchet spanner. This socket is lined with a rubber grommet 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 gauge to check and adjust



31.1 Tools required for changing spark plugs

1 **Spark plug socket** - *This will have special padding inside to protect the spark plug's porcelain insulator*
2 **Torque wrench** - *Although not mandatory, using this tool is the best way to ensure the plugs are tightened properly*
3 **Ratchet** - *Standard hand tool to fit the spark plug socket*
4 **Extension** - *Depending on model and accessories, you may need special extensions and universal joints to reach one or more of the plugs*
5 **Spark plug gap gauge** - *This gauge for checking the gap comes in a variety of styles. Make sure the gap for your engine is included*

the spark plug gap and a torque wrench to tighten the new plugs to the specified torque **(see illustration)**.

2 If you are renewing the plugs, purchase the new plugs, adjust them to the proper gap and then renew each plug one at a time. **Note:** *When buying new spark plugs, it's essential that you obtain the correct plugs for your specific vehicle. This information can be found in the Specifications Section at the beginning of this Chapter, on the Vehicle Emissions Control Information (VECI) label located on the underside of the bonnet or in the owner's manual. If these sources specify different plugs, purchase the spark plug type specified on the VECI label because that information is provided specifically for your engine.*

3 Inspect each of the new plugs for defects. If there are any signs of cracks in the porcelain insulator of a plug, don't use it.

4 Check the electrode gaps of the new plugs. Check the gap by inserting the wire gauge of the proper thickness between the electrodes at the tip of the plug **(see illustration)**. The gap between the electrodes should be identical to that listed in this Chapter's Specifications or on the VECI label. If the gap is incorrect, use the notched adjuster on the feeler gauge body to bend the curved side electrode slightly **(see illustration)**.

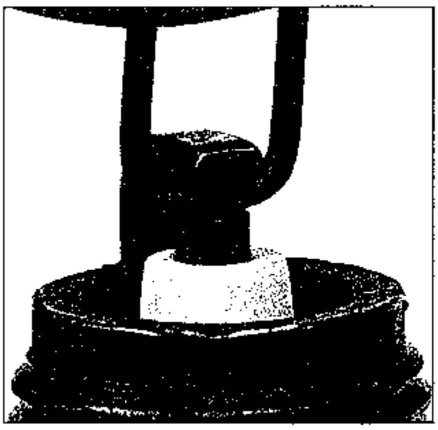
5 If the side electrode is not exactly over the centre electrode, use the notched adjuster to align them. **Caution:** *If the gap of a new plug must be adjusted, bend only the base of the side electrode - do not touch the tip.*

Removal

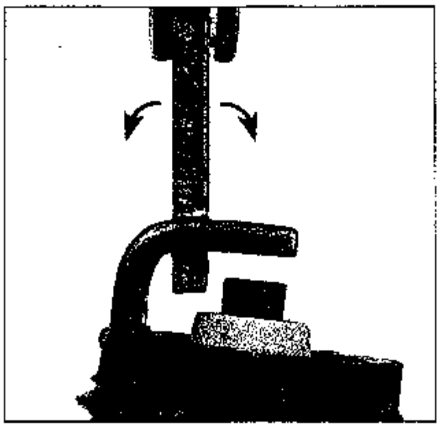
Refer to illustrations 31.6 and 31.8

6 To prevent the possibility of mixing up spark plug wires, work on one spark plug at a time. Remove the wire and boot from one spark plug. Grasp the boot - not the cable - as shown, give it a half twisting motion and pull straight up **(see illustration)**.

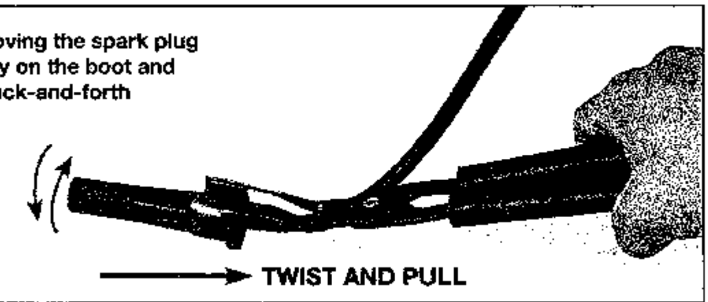
7 If compressed air is available, blow any dirt or foreign material away from the spark plug area before proceeding (a common bicycle pump will also work).



31.4 Spark plug manufacturers recommend using a wire-type gauge when checking the gap - if the wire does not slide between the electrodes with a slight drag, adjustment is required



31.5 To change the gap, bend the side electrode only, as indicated by the arrows, and be very careful not to crack or chip the porcelain insulator surrounding the centre electrode



31.6 When removing the spark plug wires, pull only on the boot and twist it back-and-forth

8 Remove the spark plug **(see illustration)**.

9 Whether you are renewing the plugs at this time or intend to reuse the old plugs, compare each old spark plug with the chart shown on the inside back cover of this manual to determine the overall running condition of the engine.

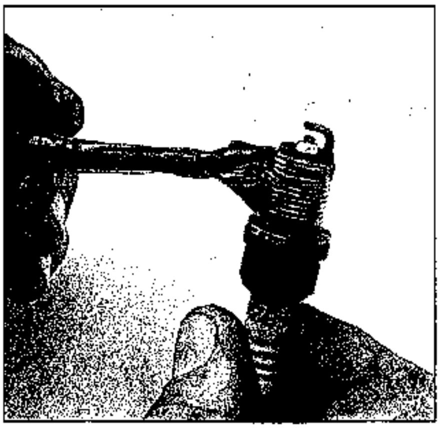
Refitting

Refer to illustrations 31.10a and 31.10b

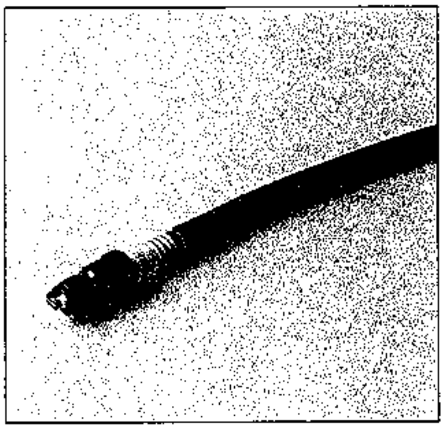
10 Prior to fitting, apply a coat of anti-seize compound to the plug threads **(see illustration)**. It's often difficult to insert spark plugs into their holes without cross-threading them. To avoid this possibility, fit a short piece of rubber hose over the end of the spark plug **(see illustration)**. The flexible hose acts as a universal joint to help align the plug with the plug hole. Should the plug begin to cross-thread, the hose will slip on the spark plug, preventing thread damage. Tighten the plug to the torque listed in this Chapter's Specifications.

11 Attach the plug wire to the new spark plug, again using a twisting motion on the boot until it is firmly seated on the end of the spark plug.

31.8 Renew one spark plug at a time to avoid confusion with the spark plug wires



31.10a Anti-seize will help prevent future problems with removing them



31.10b A length of rubber hose will save time and prevent damaged threads when refitting the spark plugs

12 Follow the above procedure for the remaining spark plugs, renewing them one at a time to prevent mixing up the spark plug wires.

32 Carburettor choke check (every 20,000 kilometres or 12 months)

Refer to illustration 32.3

1 The choke operates when the engine is cold, and thus this check can only be performed before the vehicle has been started for the day.

2 Open the bonnet and remove the top plate of the air cleaner assembly. If any vacuum hoses must be disconnected, make sure you tag the hoses for refitting in their original positions. Place the top plate and fasteners aside, out of the way of moving engine components.

3 Look at the centre of the air cleaner housing. You will notice a flat plate (arrow) at the carburettor opening **(see illustration)**.

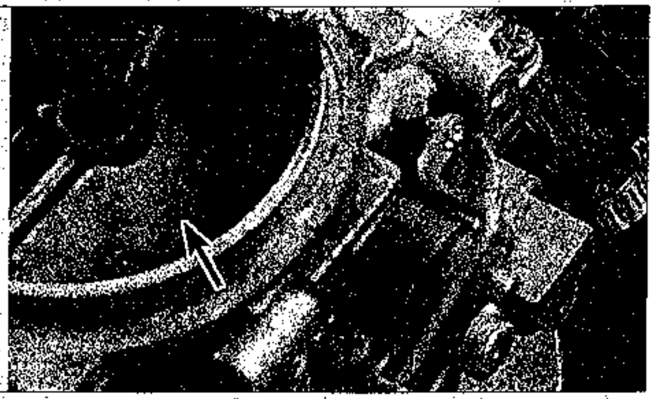
4 Press the accelerator pedal to the floor. The plate should close completely. Start the engine and then watch the plate at the carburettor. **Warning:** *Do not position your face directly over the carburettor, as the engine could backfire, causing serious burns.* When the engine starts, the choke plate should open slightly.

5 Allow the engine to continue running at an idle speed. As the engine warms up to operating temperature, the plate should slowly open, allowing more cold air to enter through the top of the carburettor. It will be necessary to tap the throttle periodically to allow the choke to move.

6 After a few minutes, the choke plate should be fully open to the vertical position. Press quickly on the accelerator to make sure the fast idle cam disengages.

7 You will notice that the engine speed corresponds with the plate opening. With the plate fully closed, the engine should run at a fast idle speed. As the plate opens and the throttle is moved to disengage the fast idle cam, the engine speed will decrease.

8 If there is any problem with the operation of the choke, refer to Chapter 4.



32.3 The choke blade (arrow) is located at the top of the carburettor

33 Exhaust Gas Recirculation (EGR) system check (petrol engines) (every 20,000 kilometres or 12 months)

Note: *The EGR system is not fitted on all models.*

1 The EGR valve is usually located on the inlet manifold. Most of the time when a problem develops in this emissions system, it's due to a stuck or corroded EGR valve.

2 With the engine cold, to prevent burns, push on the EGR valve diaphragm. Using moderate force, you should be able to push the diaphragm up into the housing.

3 If the diaphragm doesn't move or is hard to move, renew the EGR valve. If in doubt about the condition of the valve, compare the free movement of your EGR valve with a new valve.

4 Refer to Chapter 6 for more information on the EGR system.

34 Valve clearance adjustment (4.2 litre petrol and diesel engines) (every 20,000 kilometres or 12 months)

Refer to illustration 34.3

1 Make sure the engine is warmed up to operating temperature before beginning this procedure. The adjustments must be made with the engine not running.

2 Refer to Chapter 2A and remove the valve cover, then use the crankshaft pulley and timing cover marks, to position the number one piston at TDC on the compression stroke (see Chapter 2A). **Note:** *Verify TDC for the number one piston by observing that both of the foremost two valves are closed and their rocker arms are loose.*

3 On petrol engines, measure the clearances of valves numbered 1, 2, 3, 6, 7 and 10. On diesel engines set valves numbered 1, 2, 4, 5, 8 and 9 as counted from the front of the engine **(see illustration)** Insert a feeler gauge of the specified thickness (see this Chapter's Specifications) between the valve stem tip and the rocker arm. The feeler gauge should slip between the valve stem tip and rocker arm with a slight amount of drag.

4 If the clearance is incorrect (too loose or too tight), loosen the locknut and turn the adjusting screw slowly until you can feel a slight drag on the feeler gauge as you withdraw it from between the valve stem tip and the rocker arm.

5 Once the clearance is adjusted, hold the adjusting screw with a screwdriver (to keep it from turning) and tighten the locknut to the torque listed in this Chapter's Specifications. Recheck the clearance to make sure it hasn't changed after tightening the locknut.

6 Rotate the crankshaft one complete revolution (360-degrees) and realign the marks so that the number one cylinder is at TDC on the exhaust stroke. The valves on number one cylinder will now both be slightly open and their rocker arms will not have any free play. Check the clearance of the remaining valves 4, 5, 8, 9, 11 and 12 on petrol engines **(see illustration 34.3)**. On diesel engines, set valves numbered 3, 6, 7, 10, 11 and 12.

7 If necessary, repeat the adjustment procedure described in Steps 3, 4 and 5 until all the valves are adjusted to specifications.

8 Refit the valve covers.

34 Spark plug wire, distributor cap and rotor check and renewal (petrol engines) (every 40,000 kilometres or 24 months)

Refer to illustrations 35.11 and 35.12

1 The spark plug wires should be checked whenever new spark plugs are fitted.

2 Begin this procedure by making a visual check of the spark plug wires while the engine is running. In a darkened garage (make sure there is adequate ventilation) start the engine and observe each plug wire. Be careful not to come into contact with any moving engine parts. If there is a break in the wire, you will see arcing or a small spark at the damaged area. If arcing is noticed, make a note to obtain new wires, then allow the engine to cool and check the distributor cap and rotor.

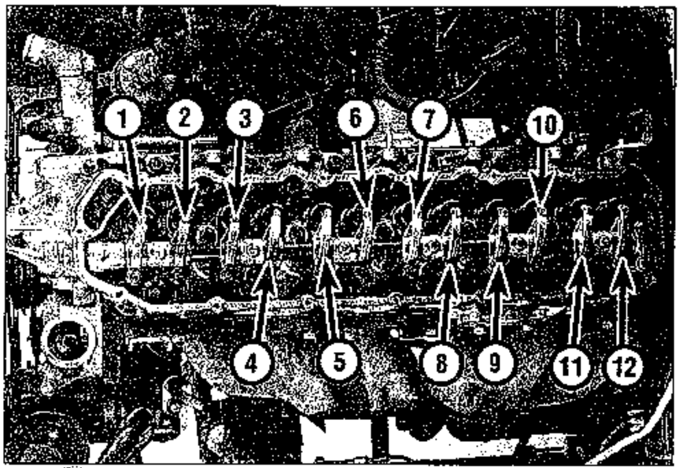
3 The spark plug wires should be inspected one at a time to prevent mixing up the order, which is essential for proper engine operation **(see illustration)**. Each original plug wire should be numbered to help identify its location. If the number is illegible, a piece of tape can be marked with the correct number and wrapped around the plug wire.

4 Disconnect the plug wire from the spark plug. A removal tool can be used for this purpose or you can grasp the rubber boot, twist the boot half a turn and pull the boot free. Do not pull on the wire itself.

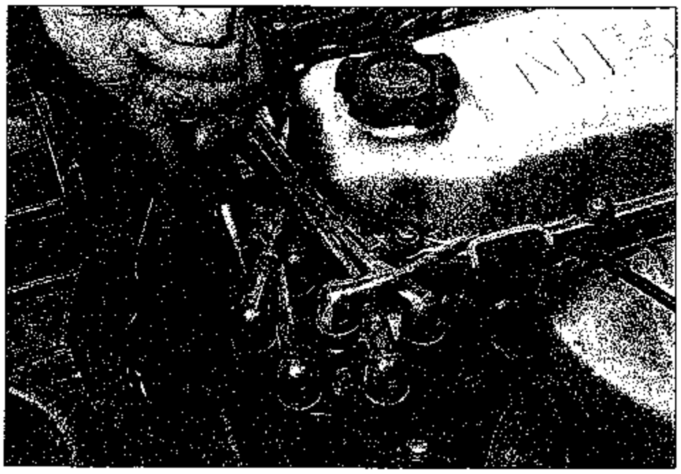
5 Check inside the boot for corrosion, which will look like a white crusty powder.

6 Push the wire and boot back onto the end of the spark plug. It should fit tightly onto the end of the plug. If it doesn't, remove the wire and use pliers to carefully crimp the metal connector inside the wire boot until the fit is snug.

7 Using a clean rag, wipe the entire length of the wire to remove built-up dirt and grease. Once the wire is clean, check for burns, cracks and other damage. Do not bend the wire sharply.



34.3 With the number one piston at TDC on the compression stroke, adjust valves 1, 2, 3, 6, 7 and 10. With the piston at TDC on the exhaust stroke the first two valves will be tight - adjust valves 4, 5, 8, 9, 11 and 12



35.11 Remove the distributor cap to renew the rotor and to check the condition of the cap - it will usually last longer than the rotor, but it is good practice to renew them both at the same time

8 Remove the rubber boot (if equipped) and disconnect the wire from the distributor. Again, pull only on the rubber boot. Check for corrosion and a tight fit. Renew the wire in the distributor.

9 Inspect the remaining spark plug wires, making sure that each one is securely fastened at the distributor and spark plug when the check is complete.

10 If new spark plug wires are required, purchase a set for your specific engine model. Remove and renew the wires one at a time to avoid mix-ups in the firing order.

11 Detach the distributor cap by loosening the cap retaining screws **(see illustration)**. Look inside it with a bright light for very small cracks, carbon tracks and worn, burned or loose.

12 Pull the rotor off the distributor shaft and examine it for the same kinds of tiny cracks and carbon tracks **(see illustration)**. Renew the cap and rotor if any damage or defects are noted. It is a good idea to renew the rotor whenever the spark plugs are renewed.

13 It is common practice to fit a new cap whenever new spark plug wires are fitted, but if you wish to continue using the old cap, make sure that you inspect it carefully.

14 When fitting a new cap, remove the wires from the old cap one at a time and attach them to the new cap in the exact same locations. **Note:** *If an accidental mix-up occurs, refer to the firing order Specifications at the beginning of this Chapter.*

36 Automatic transmission fluid and filter change (every 40,000 kilometres or 24 months)

Refer to illustrations 36.6, 36.8, 36.9, 36.11a, 36.11b, 36.11c and 36.11d

1 At the specified intervals, the transmission fluid should be drained and renewed. Since the fluid will remain hot long after driving, perform this procedure only after the engine has cooled down completely.

2 Before beginning work, purchase the specified transmission fluid (see *Recommended lubricants and fluids* at the front of this Chapter) and a new filter.

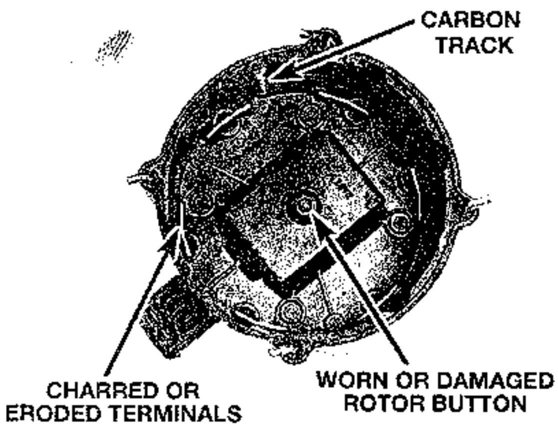
3 Other tools necessary for this job include a floor jack, jackstands to support the vehicle in a raised position, a drain pan capable of holding at least ten litres, newspapers and clean rags.

4 Raise the vehicle and support it securely on jackstands.

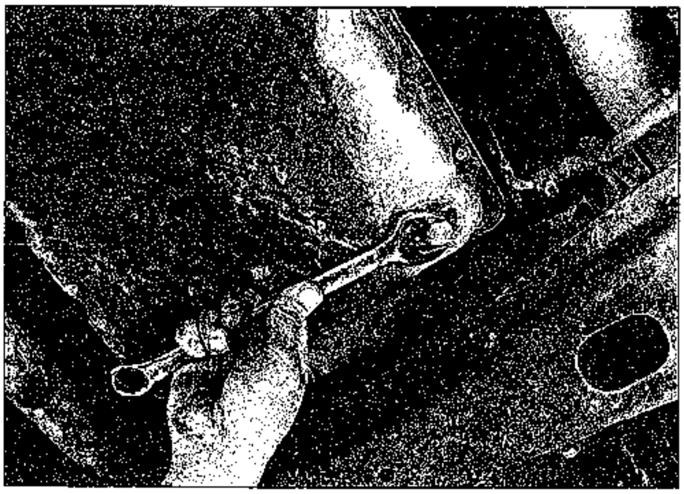
5 Detach the transmission pan rock shield (if equipped).

6 Place the pan beneath the transmission. Remove the drain plug and allow all the fluid to drain completely **(see illustration)**.

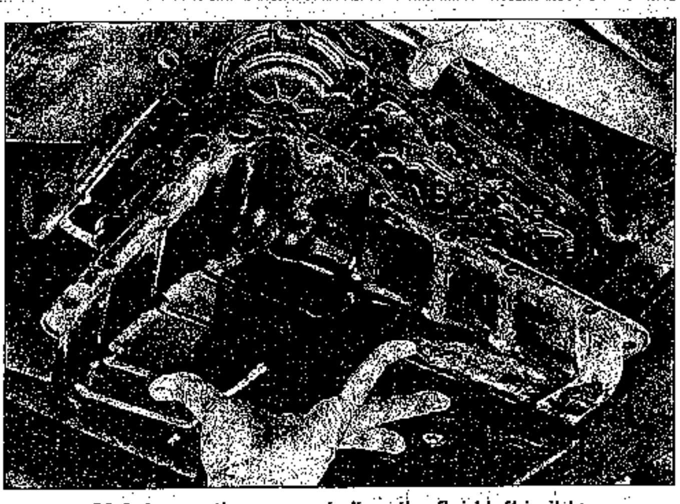
7 Remove the transmission pan bolts. If required, carefully tap on the pan to break the layer of gasket between the pan and the transmission case. **Note:** *Levering between the pan and the transmission case with a screwdriver or similar tool may result in damage to the sealing surface on the transmission case.*



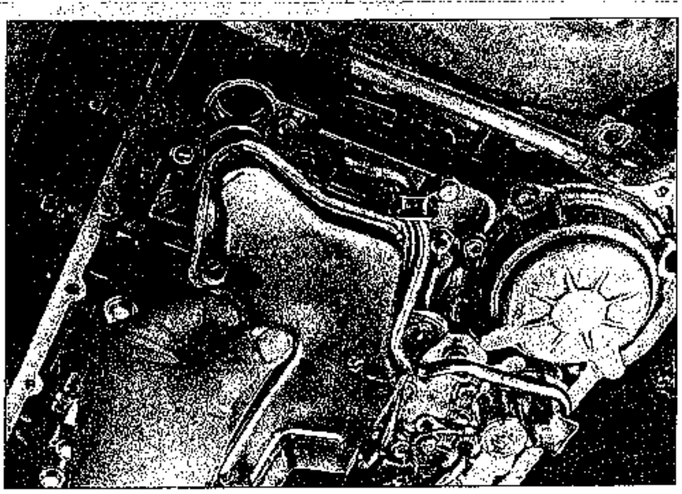
35.12 Shown here are some of the common defects to look for when inspecting the distributor cap (if in doubt about its condition, fit a new one)



36.6 Draining the transmission fluid on the Patrol/Maverick is made simple with this drain plug. Be careful - the fluid may be hot!



36.8 Lower the pan and allow the fluid left in it to drain into a container



36.9 The filter should be removed and renewed whenever the pan is removed

8 Lower the pan from the vehicle and drain the remaining transmission fluid from the pan **(see illustration)**.

9 Remove the filter retaining screws from the valve body and remove the filter **(see illustration)**.

10 Thoroughly inspect the bottom of the pan, the filter and the fluid. Although normally bright red, transmission fluid may turn dark red or brown during normal use. If you find the fluid very dark coloured, or if it smells burned, it usually indicates the transmission has been overheated. If you find small pieces of metal or clutch material in the pan or filter, it indicates wear or damage have occurred to the internal parts or clutches. If you have any concerns about the condition of your transmission based on what you find in the fluid, pan and filter, it's a good idea to take your vehicle to your dealer or a transmission shop for further evaluation.

11 Clean the pan with solvent and dry it with compressed air if available. Clean the magnet thoroughly **(see illustration)**. Use a gasket scraper to remove any traces of old gasket material remaining on the transmission case or valve body **(see illustration)**. **Note:** *Be very careful not to gouge the delicate aluminium gasket surface on the valve body.* Fit a new filter and gasket **(see illustration)**. Lubricate the O-ring for the filter with ATF to ease refitting **(see illustrations)**.

12 Make sure the gasket surface on the transmission pan is clean, then fit a new layer of gasket sealer to the pan. Place the pan against the transmission case. Working around the pan, tighten each bolt a little at a time to the torque listed in this Chapter's Specifications. Do not overtighten these bolts.

13 Lower the vehicle and add the specified type of automatic transmission fluid through the filler tube (see Section 6).

14 With the transmission in Park and the parking brake set, start the engine.

15 Move the gear selector through each range and back to Park. Check the fluid level and add fluid, if necessary, until the level is within the correct range on the dipstick.

16 Check under the vehicle for leaks during the first few trips. Check the fluid level again when the transmission is hot (see Section 6).

37 Manual transmission, transfer and differential lubricant change (every 40,000 kilometres or 24 months)

Refer to illustrations 37.3a and 37.3b

1 Raise the vehicle and support it securely on jackstands.

2 Move a drain pan, rags, newspapers and tools under the component being serviced first.

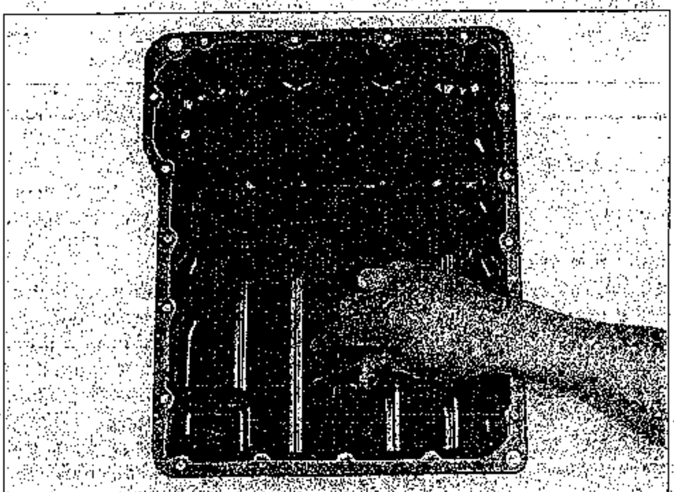
3 Remove the drain plug at the bottom of the case and allow the lubricant to drain into the pan **(see illustrations)**.

4 After the lubricant has drained completely, refit the plug and tighten it securely.

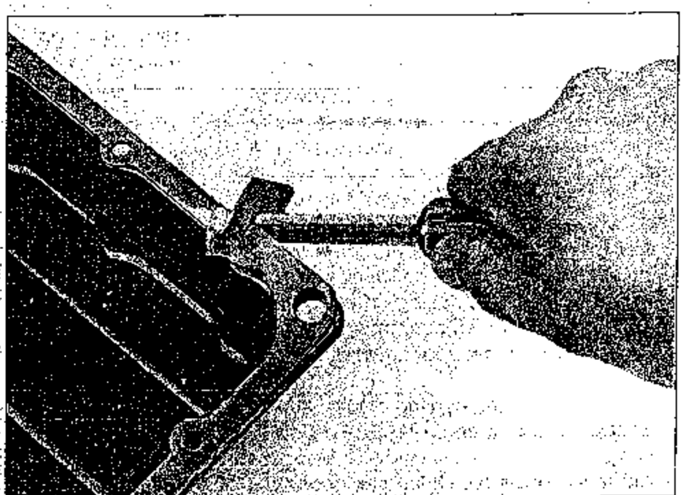
5 Remove the fill plug from the side of the case. Using a hand pump, syringe or funnel, fill the unit with the specified lubricant until it is level with the lower edge of the filler hole. Refit the fill plug and tighten it securely.

6 Lower the vehicle.

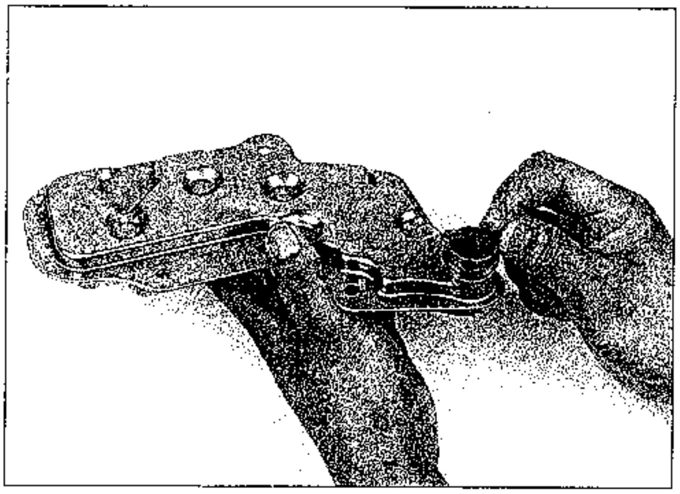
7 Drive the vehicle for a short distance, then check the drain and fill plugs for leakage.



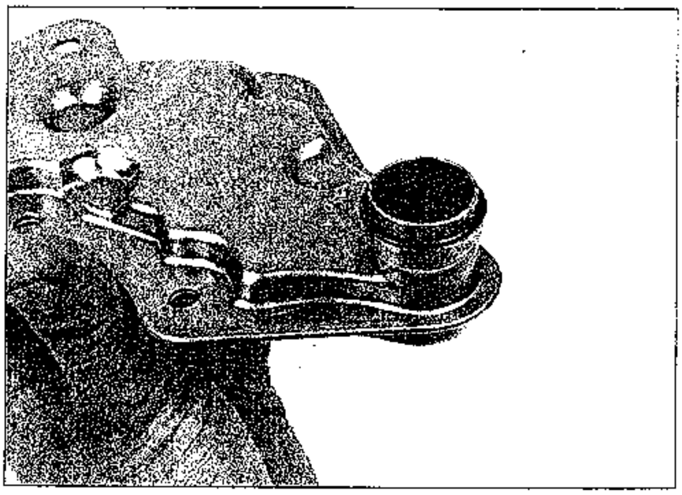
36.11a The interior of the pan must be cleaned meticulously. Remove the magnet and clean it separately of all iron residue



36.11b Scrape the gasket from the pan carefully to avoid deforming the flange

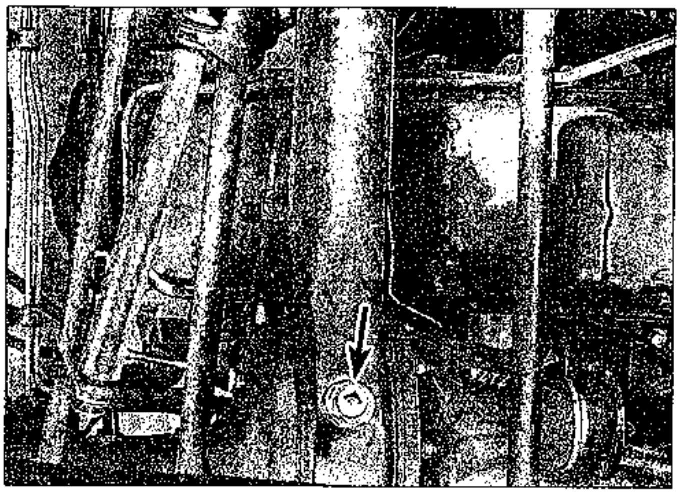


36.11c Do not forget to fit a new O-ring on the new filter.

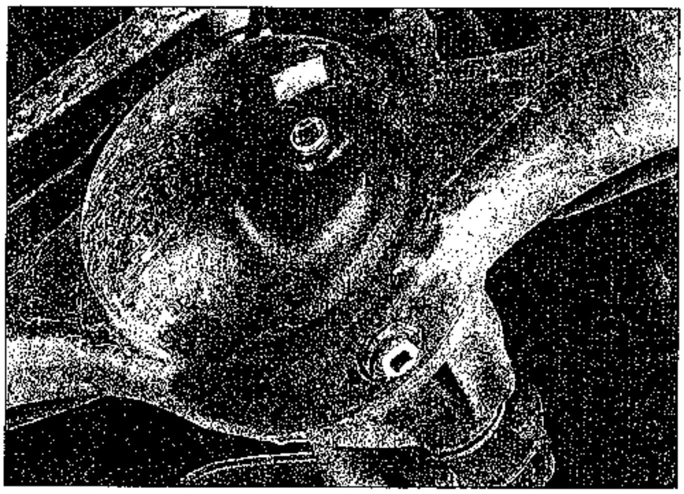


36.11d The O-ring must be fully seated in place before the unit is refitted

1



37.3a The front differential has a convenient drain plug . . .



37.3b . . . as does the rear differential

38 Cooling system servicing (draining, flushing and refilling) (every 50,000 kilometres or 24 months)

Warning: *Do not allow antifreeze to come in contact with your skin or painted surfaces of the vehicle. Rinse off spills immediately with plenty of water. Antifreeze is highly toxic if ingested. Never leave antifreeze lying around in an open container or in puddles on the floor; children and pets are attracted by it's sweet smell and may drink it. Check with local authorities about disposing of used antifreeze. Many communities have collection centres which will see that antifreeze is disposed of safely.*

1 Periodically, the cooling system should be drained, flushed and refilled to replenish the antifreeze mixture and prevent formation of rust and corrosion, which can impair the performance of the cooling system and cause engine damage. When the cooling system is serviced, all hoses and the radiator cap should be checked and renewed if necessary.

2 Apply the parking brake and block the wheels. **Warning:** *If the vehicle has just been driven, wait several hours to allow the engine to cool down before beginning this procedure.*

3 Move a large container under the radiator drain to catch the coolant. The radiator drain plug is located on the lower tank of the radiator. Open the drain fitting (a pair of pliers may be required to turn it).

4 On 3.0 litre engines and fuel injected engines, loosen the air bleed plug at the thermostat housing. Remove the radiator cap and allow the radiator to drain, then, move the container under the driver's side of the engine block. Remove the engine block drain plug (located under the exhaust manifold) and allow the coolant in the block to drain **(see illustration 39.3)**. **Note:** *Frequently, the coolant will not drain from the block after the plug is removed. This is due to a rust layer that has built up behind the plug. Insert a Phillips screwdriver into the hole to break the rust barrier.*

5 While the coolant is draining, check the condition of the radiator hoses, heater hoses and clamps (refer to Section 9 if necessary).

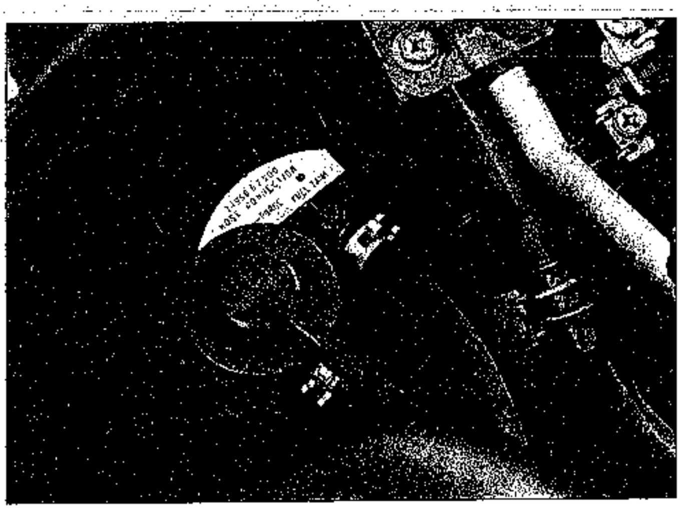
6 Renew any damaged clamps or hoses.

7 Once the system is completely drained, flush the radiator with fresh water from a garden hose until it runs clear at the drain. The flushing action of the water will remove sediments from the radiator but will not remove rust and scale from the engine and cooling tube surfaces.

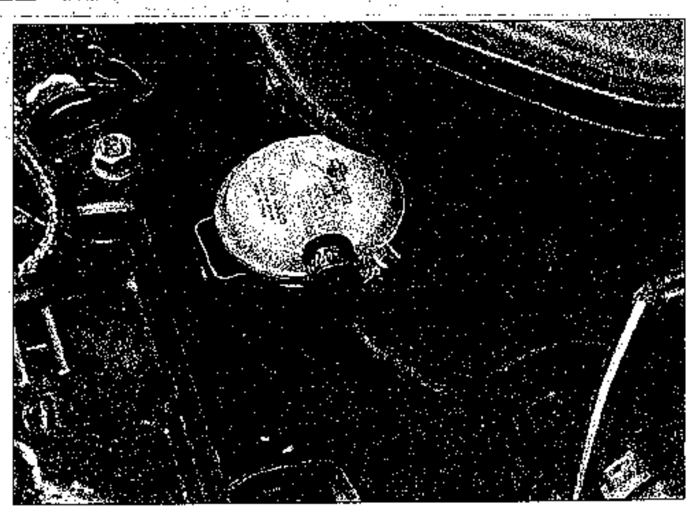
8 These deposits can be removed with a chemical cleaner. Follow the procedure outlined in the manufacturer's instructions. If the radiator is severely corroded, damaged or leaking, it should be removed (see Chapter 3) and taken to a radiator repair shop.

9 Remove the overflow hose from the coolant reservoir and flush the reservoir with clean water, then reconnect the hose.

10 Close and tighten the radiator drain fit-



40.2 The evaporation canister is located in the engine compartment - check it for cracks if you detect a petrol odour



41.2 The fuel filter can cause many performance problems - it should be renewed as a regular part of the service schedule. One bad tank of petrol can clog the filter completely

ting. Refit and tighten the block drain plug.

11 Place the heater temperature control in the maximum heat position.

12 Slowly add new coolant (a 50/50 mixture of water and antifreeze) to the radiator until it's full. Add coolant to the reservoir up to the lower mark. Tighten the air bleed plug, if equipped.

13 Leave the radiator cap off and run the engine in a well-ventilated area until the thermostat opens (coolant will begin flowing through the radiator and the upper radiator hose will become hot).

14 Turn the engine off and let it cool. Add more coolant mixture to bring the level back up to the lip on the radiator filler neck.

15 Squeeze the upper radiator hose to expel air, then add more coolant mixture if necessary. Renew the radiator cap.

16 Start the engine, allow it to reach normal operating temperature and check for leaks.

39 Front hub and wheel bearing check, repack and adjustment (every 50,000 kilometres or 24 months)

1 The service for the front hubs and wheel bearings is very involved and complex. The entire procedure is detailed in Chapter 8.

2 A simple check of the hubs can be done at more frequent intervals. Remove a bolt from the bottom of each swivel hub assembly. There should not be any signs of water dripping out.

3 Insert a wire into the hole. Move it around and then remove it and examine it to check for debris or mud.

4 If there is apparent water accumulation or obvious wear, refer to Chapter 8 for the complete service procedure.

5 Refit the bolt and tighten it to the torque specification listed in this Chapter.

40 Evaporative emissions control system check (petrol engines) (every 40,000 kilometres or 24 months)

Refer to illustration 40.2

1 The function of the evaporative emissions control system is to draw fuel vapours from the fuel tank and fuel system, store them in a charcoal canister and route them to the inlet manifold during normal engine operation.

2 The most common symptom of a fault in the evaporative emissions system is a strong fuel door in the engine compartment. If a fuel door is detected, inspect the charcoal canister, located in the front of the engine compartment **(see illustration)**. Check the canister and all hoses for damage and deterioration.

3 The evaporative emissions control system is explained in more detail in Chapter 6.

41 Fuel filter renewal (every 40,000 kilometres or 24 months)

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or clothes dryer) with a pilot light is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B Type fire extinguisher on hand.*

1 This job should be done with the engine cold (after sitting at least three hours). Place a metal container, rags or newspapers under the filter to catch spilled fuel.

Carburetted models

Refer to illustration 41.2

2 The fuel filter is located in the engine compartment **(see illustration)**. Locate it and place a container or some rags beneath it.

3 Obtain a golf tee, a tapered punch or another tapered object to insert into the fuel inlet hose to prevent leakage.

4 To renew the filter, release the clamps and slide them down the hoses, past the fittings on the filter.

5 Carefully twist and pull on the hoses to separate them from the filter. Insert the plug into the inlet hose. If the hoses are in bad shape, now would be a good time to renew them. Slide off the old clamps and fit new ones.

6 Pull the filter out of the clip and fit the new one, then hook up the hoses and reposition the clamps. Note that the arrow on the filter must point in the direction of fuel flow (toward the carburettor). Start the engine and check carefully for leaks at the filter hose connections.

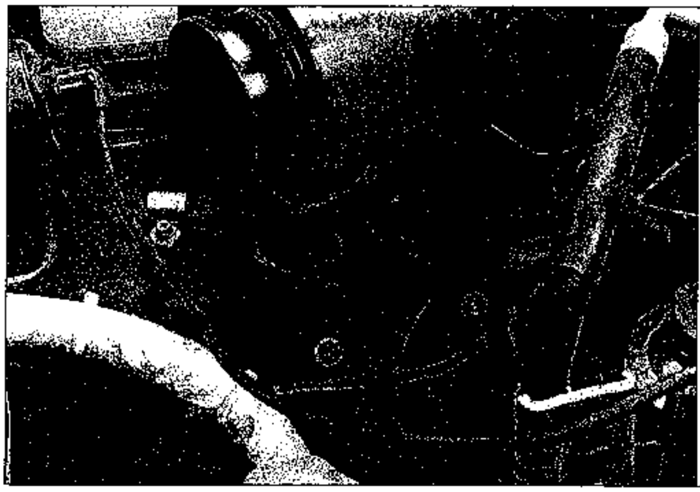
Fuel injected models

Warning: *Refer to Chapter 4 and depressurize the fuel system before removing the filter!*

7 Locate the fuel filter under the bonnet near the battery. Place a container or some rags beneath it.

8 To renew the filter, release the clamps and slide them down the hoses, past the fittings on the filter.

9 Carefully twist and pull on the hoses to separate them from the filter. If the hoses are in bad shape, now would be a good time to renew them. Slide off the old clamps and fit new ones.



42.1 Check the cyclone pre-air filter frequently when driving in sandy or dusty conditions

10 Pull the filter out of the clip and fit the new one, then hook up the hoses and reposition the clamps. Note that the arrow on the filter must point in the direction of fuel flow (towards the engine).
11 Renew the fuse previously removed during the fuel pressure relief procedure. Start the engine and check carefully for leaks at the filter hose connections.

Diesel models

12 Drain the fuel filter completely into a container (refer to Section 20).
13 Disconnect the wiring at the base of the fuel filter. Unscrew the water sensor from the base of the filter.
14 Using an adjustable filter removal tool, remove the filter.
15 Apply a small amount of fuel or oil to the gasket on the new filter. Refitting is the reverse of removal. Tighten the new filter 2/3 of a turn after the gasket first makes contact with the adapter.
16 Bleed the fuel system (refer to Chapter 4C).

42 Cyclone pre-air filter check (every 40,000 kilometres or 24 months)

Refer to illustration 42.1

1 The cyclone-type pre-air filter is located in the air inlet duct upstream of the main air filter **(see illustration)**. If the vehicle has been operated in extremely dusty or wet conditions, check it frequently.
2 Remove the main air ducts.
3 Pull the rubber water cover from the small lower tube and dump out any collected water or debris. Clean the unit thoroughly with a damp rag. 1
4 Renew the two large ducts and the lower duct seal.

43 Oxygen sensor check (fuel injected models only) (every 40,000 kilometres or 24 months)

Refer to Chapter 6 for this procedure.

44 Timing belt renewal (3.0 litre models) (every 100,000 kilometres)

Refer to Chapter 2B for this procedure.

Notes

Chapter 10
Suspension and steering systems

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1 General information

Front suspension

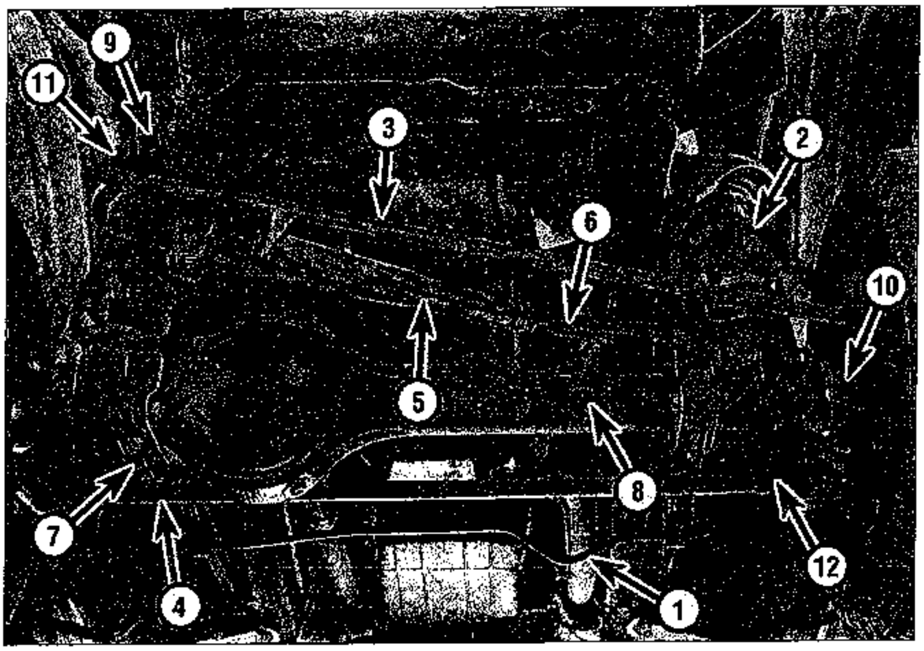
Refer to illustration 1.1

All of the vehicles covered by this manual utilise a solid front axle. The front axle consists of a one piece steel housing and axle tube assembly (for more information on the internal components of the front axle, see Chapter 8). Most utility and cab chassis models use a pair of shock absorbers and a pair leaf springs to control vertical and lateral movement of the front axle. All other models use two control arms, a pair of shock absorbers and coil springs to control vertical and fore/aft movement of the front axle while lateral movement is prevented by a Panhard bar. A stabiliser bar controls body roll on some models. Each steering knuckle is positioned by a pair of tapered roller bearings to upper and lower ends of a yoke welded to the end of the axle **(see illustration)**.

Rear suspension

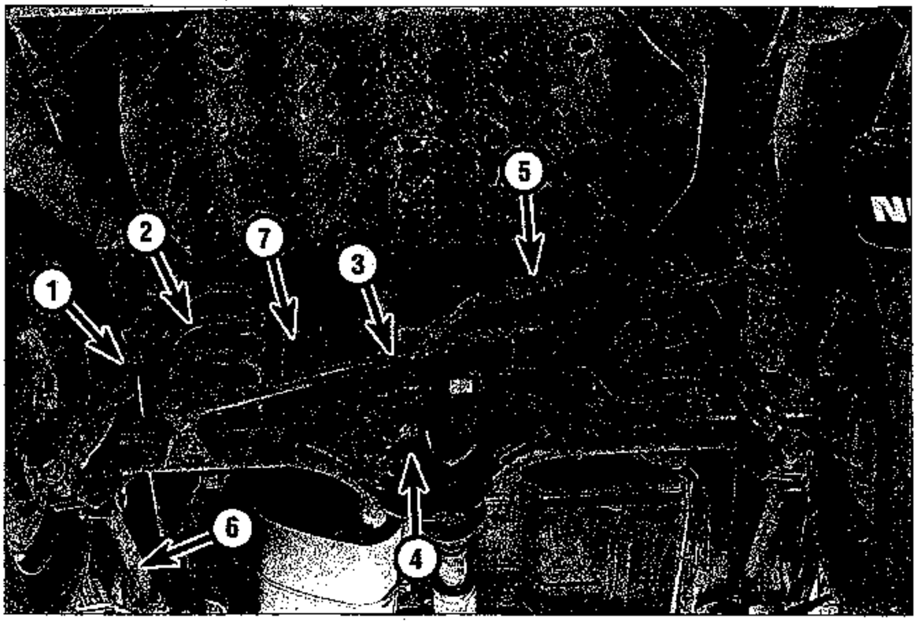
Refer to illustration 1.2

The rear axle also consists of a one piece steel housing and axle tube assembly (for more information on the internal components of the rear axle, see Chapter 8). Most utility and cab chassis models use a pair of



1.1 Front suspension and steering components - coil spring model

1 *Stabiliser bar*
2 *Coil spring*
3 *Relay rod*
4 *Tie rod*
5 *Steering damper*
6 *Panhard bar*
7 *Suspension arm*
8 *Differential and axle housing*
9 *Steering gear*
10 *Swivel hub (knuckle flange)*
11 *Pitman arm*
12 *Tie-rod end*



1.2 Rear suspension components - coil spring model

1 *Shock absorber*
2 *Coil spring*
3 *Panhard bar*
4 *Differential and axle housing*
5 *Stabiliser bar release spring*
6 *Lower suspension arm*
7 *Upper suspension arm*

shock absorbers and a pair leaf springs to control vertical and lateral movement of the rear axle. All other models use four control arms, a pair of shock absorbers and coil springs to control vertical and fore/aft movement of the rear axle while lateral movement is prevented by a Panhard bar. A stabiliser bar controls body roll on all models **(see illustration)**. The rear stabiliser bar can be disconnected by the driver on some models.

Steering

The power steering system uses a recirculating-ball type steering gearbox which transmits turning force through the steering linkage (Pitman arm and relay rod assembly) to the left steering knuckle arm. The tie-rod connects the front wheel to each other. A steering damper refitted in the linkage reduces unwanted kick-back and shimmy of the steering wheel. A flexible coupling connects the steering column to the steering gearbox. The steering column is designed to collapse in the event of an accident.

Frequently, when working on the suspension or steering system components, you may come across fasteners which seem impossible to loosen. These fasteners on the underside of the vehicle are continually subjected to water, road grime, mud, etc., and can become rusted or "seized," making them extremely difficult to remove. In order to unscrew these stubborn fasteners without damaging them (or other components), be sure to use lots of penetrating oil and allow it to soak in for a while. Using a wire brush to clean exposed threads will also ease removal of the nut or bolt and prevent damage to the threads. Sometimes a sharp blow with a hammer and punch is effective in breaking the bond between a nut and bolt threads, but care must be taken to prevent the punch from slipping off the fastener and ruining the threads. Heating the stuck fastener and surrounding area with a torch sometimes helps too, but isn't recommended because of the obvious dangers associated with fire. Long breaker bars and extension, or "cheater," pipes will increase leverage, but never use an extension pipe on a ratchet - the ratcheting mechanism could be damaged. Sometimes, turning the nut or bolt in the tightening (clockwise) direction first will help to break it loose. Fasteners which require drastic measures to unscrew should always be renewed.

Since most of the procedures that are dealt with in this Chapter involve jacking up the vehicle and working underneath it, a good pair of jackstands will be needed. A hydraulic floor jack is the preferred type of jack to lift the vehicle, and it can also be used to support certain components during various operation. **Warning:** *Never, under any circumstances, rely on a jack to support the vehicle while working on it.*

Whenever any of the suspension or steering fasteners are loosened or removed they must be inspected and, if necessary, renewed with ones of the same part number or of original equipment quality and design. Torque specifications must be followed for proper reassembly and component retention. Never attempt to heat or straighten any suspension or steering components. Instead, renew any bent or damaged parts.

2 Stabiliser bar and bushes (front and rear) - removal and refitting

Note 1: *Some models are not equipped with a front and/or rear stabiliser bar.* **Note 2:** *Some models are equipped with a rear stabiliser bar disconnection/release device. Refer to Section 8 for information about servicing this component.*

Removal

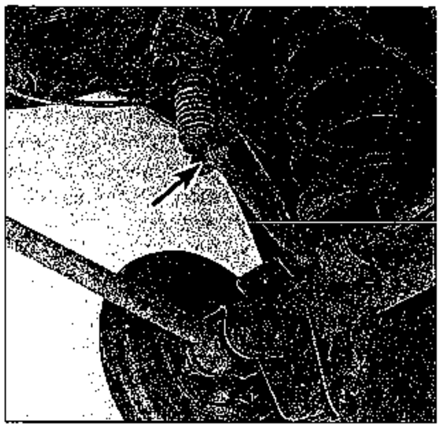
Refer to illustrations 2.2a, 2.2b and 2.3

1 Apply the parking brake. Raise the vehicle and support it securely on jackstands. It will be easier to remove the stabiliser bar if the jackstands are placed under the axle housing in order to let the vehicle rest at normal ride height.

2 Disconnect the stabiliser bar from the end links **(see illustrations)**. Note the order in which the upper and lower retainers and grommets are refitted on the links. If it is necessary to remove the links, simply unbolt them from the axle brackets. **Note:** *Some models use a swivel joint at the end of the stabiliser bar. These units are serviced in a similar manner, but the joint itself must be inspected for deterioration like a tie-rod end would be.*

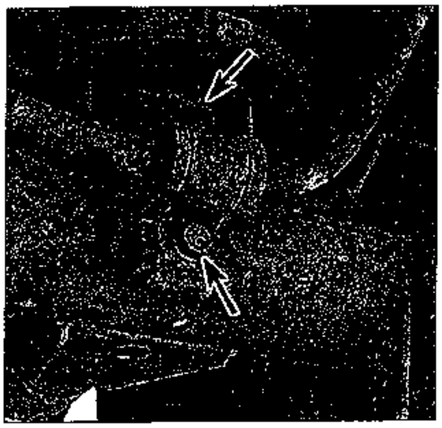
3 Remove the retaining bolts from the sta-

2.2a Front stabiliser bar end link mounting details (coil spring model). Not all front suspensions use a stabiliser bar



2.2b Disconnect the ends of the bar from the link or the release device (arrow)

10



2.3 To disconnect the stabiliser bar from the axle housing, remove the bush clamp bolts (arrows); inspect the rubber bushes and renew them if they're hard, cracked or otherwise deformed

biliser bar bush clamps and detach the bar from the vehicle **(see illustration)**.

4 Pull the bushes off the stabiliser bar and inspect them for cracks, hardness and other signs of deterioration. If the bushes are damaged, renew them. Inspect the bushes in the lower ends of the links, renewing them if necessary.

Refitting

5 Position the stabiliser bar bushes on the bar.

6 Push the brackets over the bushes and raise the bar up to the frame. Refit the bracket bolts but don't tighten them completely at this time.

7 Refit the stabiliser bar end links (or joints) in the reverse order of removal. Tighten the nuts to the torque listed in this Chapter's Specifications.

8 Tighten the bracket bolts to the torque listed in this Chapter's Specifications.

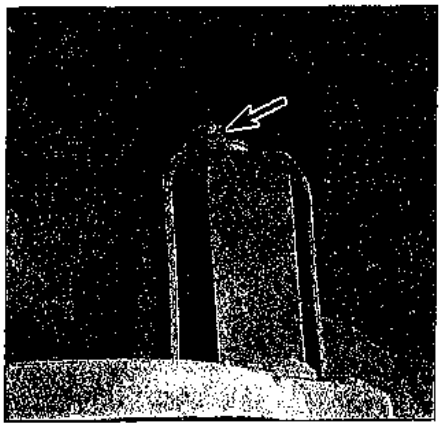
3 Shock absorbers (front and rear) - removal and refitting

Removal

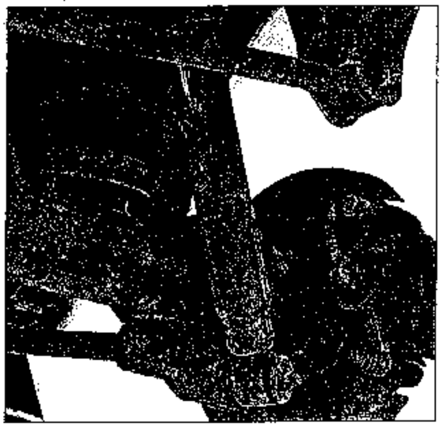
Refer to illustrations 3.2a, 3.2b, 3.2c and 3.2d

1 Loosen the wheel lug nuts, raise the vehicle and support it securely on jackstands. It will be necessary to place the jackstands under the axle housing in order to let the vehicle rest at normal ride height. Apply the parking brake. Remove the wheel.

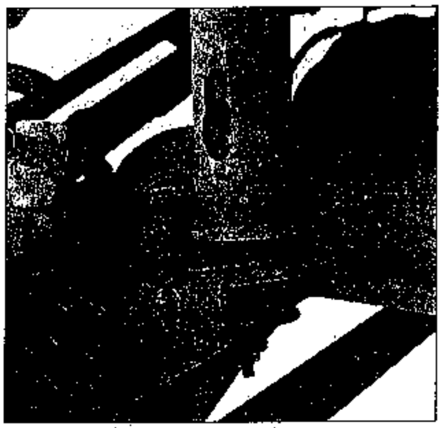
2 Remove the upper shock absorber nuts or bolts **(see illustrations)**. On stud mounted shock absorbers, use an open end spanner to keep the stem from turning. If the nut won't loosen because of rust, apply some penetrating oil on the stud threads and allow it to soak in for awhile. It may be necessary to keep the stud from turning with a pair of locking pliers, since the flats provided for a spanner are quite small.



3.2a Upper shock coil spring models (arrow)



3.2c All models use a conventional stud and nut for the lower rear shock absorber mount



3.2b Lower front shock mount for coil spring-equipped vehicles

3.2d The upper rear shock absorber is mounted directly to the frame rail with a nut and bolt

3 Remove the lower shock mount nuts or bolts and pull the shock absorber out from the wheel well.

Refitting

4 Follow the mounting instructions according to the manufacturer. If you're renewing the old shocks with gas filled shock absorbers, do not cut the retaining strap on the new shock until the top of the shock has been firmly mounted.

5 Move the shock absorber back-and-forth to ensure the grommets are centred in the mounts. Tighten the nut loosely, then guide the lower end into position.

6 Release the retaining strap (if equipped).

7 Refit the lower mounting bolts or nuts and tighten the fasteners to the torques listed in this Chapter's Specifications.

4 Leaf springs and bushes - removal and refitting

Bush - check and renewal

1 All leaf springs are fitted with a two piece bush that is pressed into each spring eye. The bushes should be inspected for cracks, damage and looseness indicating excessive wear. To check for wear, jack up the frame until the weight is removed from the spring bush. Prise the spring eye up and down with a long bar to check for movement. If there is considerable movement, the bush is worn and should be renewed.

2 The leaf spring bushes have a two piece design and can be removed by inserting a screwdriver into the inner diameter of the bush half and pushing outward. If the bushes won't loosen because of dirt and rust, apply some penetrating oil between the spring eye and bush and allow it to soak in for awhile.

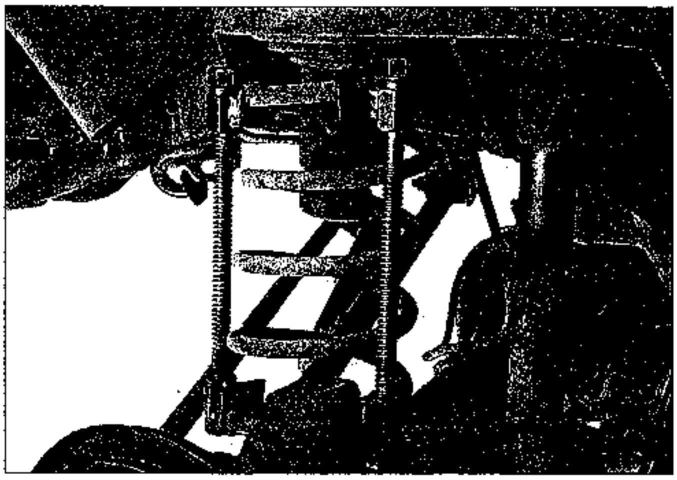
3 Coat the inside of the spring eye with a thin layer of chassis grease and press the new bush into position.

Spring

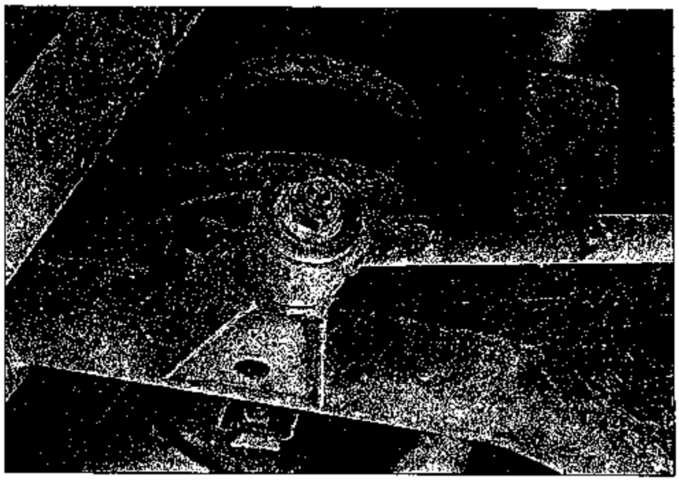
Removal

Note: *This procedure applies to both the front and rear leaf spring assemblies. We recommend that you do one side at a time, to keep the axle under control and so you'll have one side to use as a "guide" to reassembly.*

4 Loosen the front or rear wheel lug-nuts, raise the front or rear of the vehicle and support it securely on jackstands. Position the jackstands under the chassis in order to allow the springs to extend. Remove the wheel.



5.5 Compress the coil spring evenly until it can be removed. The bump stop inside the spring has to be disconnected and dropped inside the spring first



6.3 Remove the retaining nut and bolt securing the lower end of the Panhard bar to the rear axle housing

5 Position a floor jack under the axle and raise the jack just enough to support the weight of the axle.
6 Remove the lower shock mounting fasteners (see Section 3) and move the shock absorber aside.
7 Unscrew the U-bolt nuts, then remove the spring tie plate and the U-bolts from the axle.
8 Remove the spring-to-shackle bolt.
9 Remove the spring eye-to-frame bracket bolt and remove the spring from the vehicle.

Refitting

10 Refitting is the reverse of the removal procedure. Be sure to tighten the spring mounting bolts and the spring tie plate U-bolt nuts to the torques listed in this Chapter's Specifications. The U-bolt nuts must be tightened gradually to avoid distorting the hardware. **Note:** *The vehicle must be sitting at normal ride height before tightening the front and rear spring mounting bolts. Normal ride height can be attained by supporting the vehicle with a floor jack under the axle housing.*

5 Coil springs - removal and refitting

Front

Refer to illustration 5.5

Caution: *This procedure requires a special coil spring compressor tool available at most auto part stores. Attempts to perform this procedure without the spring compressor tool may result in personal injury.*

1 Loosen the front wheel lug nuts, raise the front of the vehicle and support it securely on jackstands. The jackstands must be positioned under the chassis, not the axle. Remove the wheels.
2 Remove the cover from above the axle bump stop.
3 Remove the nut from the bump stop stud and allow the stop to fall to the base of the spring.
4 Obtain a coil spring compressor.
5 Refit the spring compressor and compress the coil spring **(see illustration)**.
6 Remove the coil spring from the vehicle.
7 Check the spring for deep nicks and corrosion, which will cause premature failure of the spring. Renew the spring if these or any other questionable conditions are evident.
8 Refit the spring compressor tool and compress the new coil spring. Place the bump stop into the spring. Insert the upper end of the coil spring and align the lower spring end with the stop in the lower spring seat.
9 The remainder of the refitting is the reverse of removal. Tighten all fasteners to the torque listed in this Chapter's Specifications.

Rear

10 Loosen the rear wheel lug nuts, raise the rear of the vehicle and support it securely on jackstands. Place the jackstands under the chassis, not the axle. Remove the wheels.
11 Support the axle assembly with a floor jack under the differential.
12 Unbolt the stabiliser bar and the shock absorbers from the rear axle housing (see Sections 2 and 3).
13 Disconnect the rear axle housing breather hose.
14 Slowly lower the axle assembly until the coil springs are almost fully extended. Grasp the lower end of the spring and remove the spring from the vehicle. **Caution:** *Be careful not to rupture the rear brake hose.*
15 Check the spring for deep nicks and corrosion, which will cause premature failure of the spring. Renew the spring if these or any other questionable conditions are evident.
16 Refitting is the reverse of removal. Make sure the coil spring is properly seated. Tighten all fasteners to the torque listed in this Chapter's Specifications.

6 Panhard bar (coil spring models) - removal and refitting

Refer to illustration 6.3

Note: *This procedure applies to front and rear bars.*

1 Raise the front or rear of the vehicle and support it securely on jackstands.
2 Remove the retaining nut and bolt from the frame rail bracket. **Note:** *Some models have the steering damper connected to the Panhard rod. On these models, disconnect the steering damper from the Panhard rod and tie it out of the way with wire before removing any other bolts.*
3 Remove the retaining nut and bolt from the axle tube bracket **(see illustration)**.
4 Remove the Panhard bar.
5 Refitting is the reverse of removal. Be sure to tighten the fasteners to the torque listed in this Chapter's Specifications. **Note:** *The vehicle must be sitting at normal ride height before tightening the mounting fasteners.*

7 Suspension arms (coil spring models) - removal and refitting

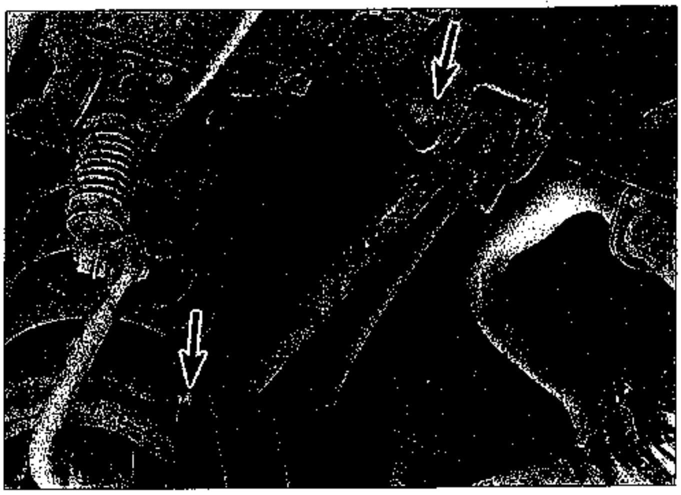
Note: *Remove and refit only one suspension arm at a time to avoid the possibility of the axle housing shifting out of position, which would make reassembly much more difficult. If it is absolutely necessary to remove more than one at a time, support the axle with a floor jack.*

Front

Refer to illustration 7.7

1 Raise the front of the vehicle and support it securely on jackstands. Place the jackstands under the chassis.
2 Remove the wheel.
3 Support the axle assembly with either a floor jack under the differential or, preferably, two jacks, one at each end of the axle (the latter option provides better balance).

7.7 To remove the front suspension arm, detach the nuts and bolts from the axle housing bracket (arrow)



7.13a To remove the upper rear suspension arm, detach the nuts and bolts (arrows) from the axle housing bracket and the frame bracket

4 Disconnect the stabiliser bar from the arm if the vehicle is equipped with one.

5 Disconnect the tie-rod from the knuckle (refer to Section 10).

6 Remove the retaining nut from the frame rail bracket. Remove the washer and bush.

7 Remove the retaining nuts and bolts from the axle housing **(see illustration)**.

8 Remove the front suspension arm. If it is difficult to remove the suspension arm, use the jack to take weight from the suspension arm and drive the bolts out using a brass drift with a hammer.

9 Inspect the bush in the suspension arm for cracking, hardness and general deterioration. If it is in need of renewal, take the arm to a dealer service department or an automotive machine shop to have it renewed. Because of the hydraulic press and adapters required for this job, it is difficult to do at home.

10 Refitting is the reverse of removal. Be sure to tighten the fasteners to the torque listed in this Chapter's Specifications. **Note:** *The vehicle must be sitting at normal ride height before tightening the mounting fasteners.*

Rear

Refer to illustrations 7.13a, 7.13b and 7.13c

11 Raise the rear of the vehicle and support it securely on jackstands.

12 Support the axle assembly with either a floor jack under the differential or, preferably, two jacks, one at each end of the axle (the latter option provides better balance).

13 Remove the nuts and bolts securing the suspension arm to the axle housing bracket and to the frame bracket **(see illustrations)**. Remove the suspension arm from the vehicle.

14 Inspect the bush in the suspension arm for cracking, hardness and general deterioration. If it is in need of renewal, take it to a dealer service department or an automotive machine shop to have it renewed. Because of the hydraulic press and adapters required for this job, it is difficult to do at home.

15 Refitting is the reverse of removal. Be sure to tighten the fasteners to the torque listed in this Chapter's Specifications. **Note:** *The vehicle must be sitting at normal ride height before tightening the mounting fasteners.*

8 Rear stabiliser release - removal, refitting and adjustment

Refer to illustration 8.3

Note: *This device is fitted to some coil spring suspension models for use at slow speeds over very rough terrain.*

1 Raise the vehicle and support it securely with jackstands. Place the jackstands under the rear axle housing.

2 Set the operating handle to ENGAGE.

3 Disconnect the stabiliser bar from the link attached to the release assembly **(see illustration)**.

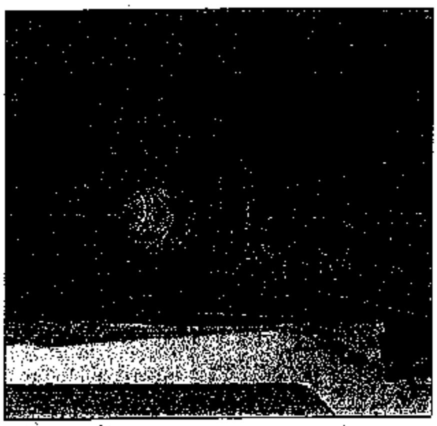
4 Disconnect the operating cables from each other at the cable adjuster.

5 Remove the clamps that secure the rear cable to the chassis and place the cable so it is free of obstructions.

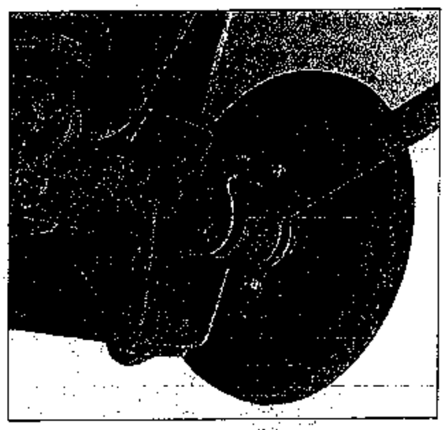
6 Disconnect the wiring from the release unit.

7 Remove the unit from the chassis.

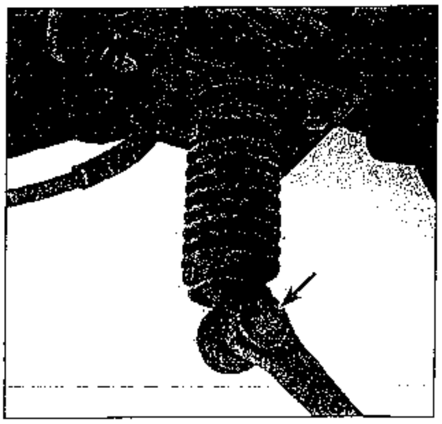
8 Check the cable for signs of damage. Make certain that it locks and unlocks easily. Renew the entire assembly if necessary.



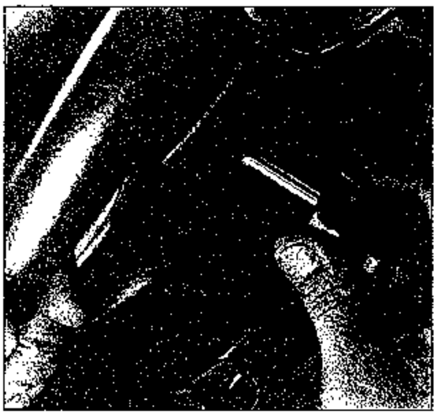
7.13b To remove the lower rear suspension arm, detach the nut and bolt from the frame bracket . . .



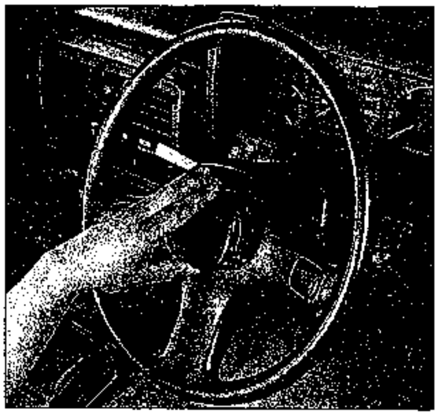
7.13c . . . and the axle housing



8.3 Disconnect the stabiliser bar from the release assembly at this point (arrow)



9.2 Detach the steering wheel cover retaining screws (on most models) located on the backside of the steering wheel



9.3 Lift the centre cover off

9.4 Disconnect the wiring. Make sure that the negative battery cable has been disconnected first

9 Refitting is the reverse of removal.
10 Assemble the cable together at the adjuster. Adjust the cable length so that the dash handle has less than 1 mm of freeplay.

9 Steering wheel - removal and refitting

Removal

Refer to illustrations 9.2, 9.3, 9.4, 9.5 and 9.6

1 Park the vehicle with the wheels pointing straight ahead. Disconnect the cable from the negative terminal of the battery.
2 Remove the screws securing the steering wheel centre cover from the back of the steering wheel, if equipped **(see illustration)**.
3 On some models, the cover has no screws. In this case, simply use a small screwdriver to prise it free. Lift the cover off **(see illustration)**.
4 Disconnect the wiring **(see illustration)**.
5 Remove the steering wheel retaining nut, then mark the relationship of the steering shaft to the hub (if marks don't already exist or don't line up) to simplify refitting and ensure steering wheel alignment **(see illustration)**.
6 Use a puller to detach the steering wheel from the shaft **(see illustration)**. Don't hammer on the shaft to dislodge the steering wheel.

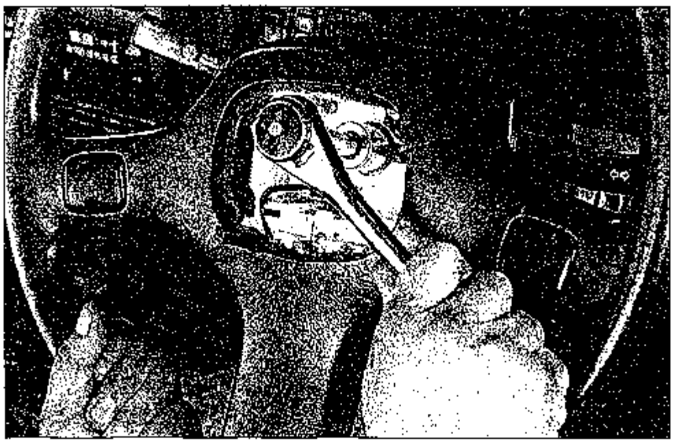
Refitting

7 To refit the wheel, align the mark on the steering wheel hub with the mark on the shaft and slip the wheel onto the shaft. Refit the nut and tighten it to the torque listed in this Chapter's Specifications.
8 Plug in the electrical connectors and refit the steering wheel pad.
9 Connect the negative battery cable.

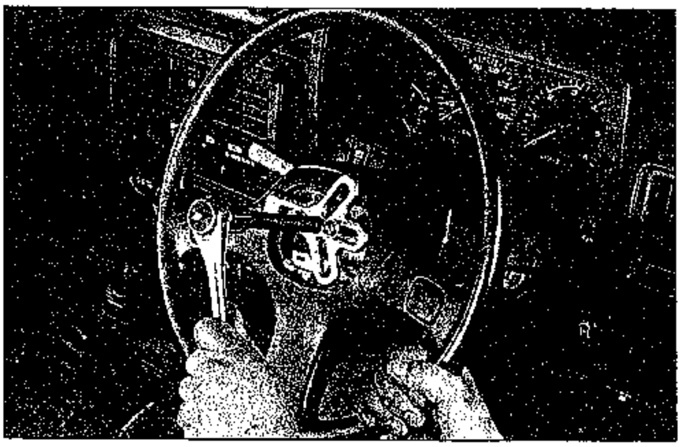
10 Steering linkage - inspection, removal and refitting

Inspection

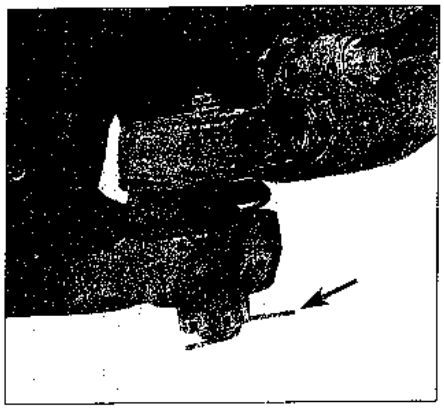
1 The steering linkage connects the steering gear to the front wheels and keeps the wheels in proper relation to each other. The Pitman arm, fastened to the steering gear shaft, moves the relay rod back and forth. The back-and-forth motion of the relay rod is transmitted directly to the steering knuckle on hardtop and wagon models. On utility and cab chassis models, there is also a relay arm unit which acts as a support for a shorter relay rod. It transmits the action to the drag link, which operates the steering knuckle.
2 A tie-rod assembly connects the steering knuckles of each wheel together. The tie-rod is made up of a tube, clamps and two tie-rod ends. A steering damper reduces shimmy and unwanted forces to the steering gear.
3 Set the wheels in the straight ahead position and lock the steering wheel.
4 Raise one side of the vehicle until the tyre is slightly off the pavement.
5 Mount a dial indicator with the needle resting on the outside edge of the wheel. Grasp the front and rear of the tyre and using light force, wiggle the wheel back-and-forth and note the dial indicator reading. The gauge reading should be less than 5 mm. If the play in the steering system is more than specified, inspect each steering linkage pivot point and ball stud for looseness and renew parts if necessary.
6 Raise the vehicle and support it on jackstands. Check for torn ball stud boots, seized joints and bent or damaged linkage components.



9.5 Remove the nut and then mark the shaft and the steering wheel so they can be reassembled in exactly the same position



9.6 It is necessary to use a puller for this operation. Do not attempt to hammer the steering wheel off



10.8 Use a pair of needle nose pliers to remove the split pin from the tie rod end castle nut (arrow)

Removal and refitting

Tie-rod ends

Refer to illustration 10.8

7 Loosen the wheel lug nuts, raise the vehicle and support it securely on jackstands. Apply the parking brake. Remove the wheels.

8 Remove the split pin and loosen, but do not remove, the castle nut from the ball stud **(see illustration)**.

9 Using a small puller, separate the ball stud from the steering knuckle. Remove the castle nut and pull the tie-rod end from the steering knuckle. **Caution:** *The use of a fork-separator-type balljoint separator will most likely cause damage to the balljoint boot.*

10 If a tie-rod end must be renewed, count the number of threads showing and jot down this number to maintain correct toe-in during reassembly. Loosen the adjuster tube clamp and unscrew the tie-rod end.

11 Lubricate the threaded portion of the tie-rod end with chassis grease. Screw the new tie-rod end into the adjuster tube and adjust the distance from the tube to the ball stud by threading the tie-rod into the adjuster tube until the same number of threads are showing as before (the number of threads showing on both side of the adjuster tube should be within three threads of each other). Don't tighten the adjuster tube clamps yet.

12 To refit the tie-rod end, insert the tie-rod end ball stud into the steering knuckle. Make sure the ball stud is fully seated. Refit the nut and tighten it to the torque listed in this Chapter's Specifications. If a ball stud spins when attempting to tighten the nut, force it into the tapered hole with a large pair of pliers.

13 Refit new split pins. If necessary, tighten the nut slightly more to align a slot in the nut with the hole in the ball stud. **Note:** *DO NOT loosen the castle nut to align the split pin hole.*

14 Tighten the adjuster tube clamp nuts.

15 Refit the wheels and lug nuts, lower the vehicle and tighten the lug nuts to the torque listed in the Chapter 1 Specifications. Drive the vehicle to an alignment shop to have the front end toe-in alignment checked and, if necessary, adjusted.

10.18a It is best to use a two-jaw puller to release all linkage ends. If such a tool is not available, use a "picklefork" type separator, but realise that the rubber boot on the end of the fitting will be damaged. If neither tool is available, try striking the side of the joint sharply with a hammer, just below the nut (not on the swiveling part)

Relay rod

Refer to illustrations 10.18a and 10.18b

16 Raise the front of the vehicle and support it securely on jackstands. Apply the parking brake. Remove the left wheel.

17 Remove the steering damper (refer to Steps 31 through 35).

18 Separate the relay rod ends from the Pitman arm and the steering knuckle using the same technique described in Steps 7 and 8 **(see illustrations)**.

19 If the ends are in need of renewal, the entire rod must be renewed.

20 Refitting is the reverse of the removal procedure. If the ball studs spin when attempting to tighten the nuts, force them into the tapered holes with a large pair of pliers. Be sure to tighten all fasteners to the torque listed in this Chapter's Specifications.

Relay arm and drag link (utility and cab chassis models)

21 The drag link is removed using the same method as used for the relay rod, except that there is no need to remove the steering damper. Refer to Steps 15 through 19.

22 To remove the relay arm, first raise the vehicle and support it securely with jackstands.

23 Disconnect both ball studs from the relay arm (refer to Steps 7 and 8).

24 Disconnect the steering damper, if it connects to the relay arm on your model.

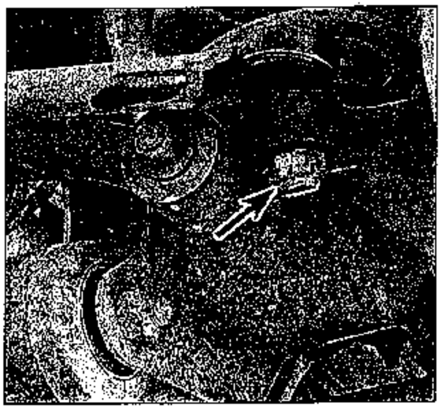
25 Unbolt the relay arm assembly and remove it from the vehicle.

26 Refitting is the reverse of removal. **Note:** *The relay arm is rebuildable, however it is not a practical job for the home workshop. Obtain a new or factory rebuilt unit if your relay arm has excessive freeplay, cracks or is binding.*

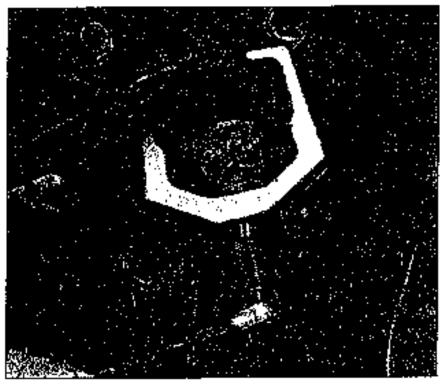
Pitman arm

Refer to illustration 10.29

27 Disconnect the relay rod from the Pitman arm (see above).



10.18b The opposite end of the relay rod attaches to the steering knuckle at this point (arrow)



10.29 Use a Pitman arm puller to detach the Pitman arm - notice the nut has been loosened but not removed; this will prevent the components from separating violently

28 Loosen - but don't remove - the Pitman arm retaining nut. Mark the relationship of the Pitman arm to the steering shaft with a small dab of paint.

29 Refit a Pitman arm removal tool and pull off the Pitman arm **(see illustration)**.

30 Remove the Pitman arm retaining nut and remove the Pitman arm.

31 Refitting is the reverse of removal. Make sure the marks you made before removal are aligned when refitting the Pitman arm.

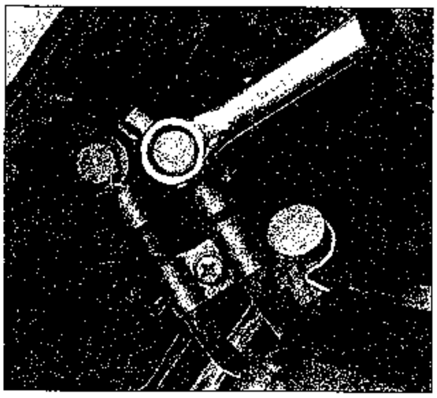
Steering damper

32 Raise the vehicle and support it securely with jackstands.

33 Remove the nuts and washers securing the steering damper at each end. On some models, it will be necessary to hold the shaft of the damper near the end with pliers while loosening the nut. **Note:** *There are several mounting points used for various years and models. The damper may be connected to the relay rod, Panhard rod or the chassis.*

34 Remove the steering damper from the vehicle. Keep the washers and bushes in order and facing the proper directions for reassembly.

35 Operate the damper by hand. It should



11.2 Loosen these fittings and disconnect the power steering fluid lines from the steering gearbox

have a smooth resistance throughout its stroke. If there is any obvious damage or if the resistance is not firm and even, renew it.
36 Refitting is the reverse of removal.

11 Steering gear - removal and refitting

Caution: *Make sure the steering shaft is not turned while the steering gear is removed. One way to prevent the shaft from turning is to place the ignition key in the LOCK position.*

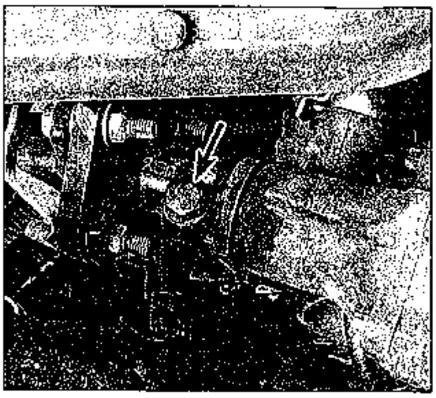
Removal

Refer to illustrations 11.2, 11.3 and 11.5

1 Raise the front of the vehicle and support it securely on jackstands. Apply the parking brake. Point the wheels straight ahead.
2 Place a drain pan under the steering gear. Disconnect the power steering line fittings and cap the ends to prevent excessive fluid loss and contamination **(see illustration)**.
3 Mark the relationship of the steering gear shaft to the flexible coupling with paint. Remove the shaft lower pinch bolt **(see illustration)**. **Note:** *Slightly spread the pinch coupling to ease removal of the shaft.*
4 Mark the position of the Pitman arm to the shaft with paint. Remove the Pitman arm nut and washer, then remove the Pitman arm (see Section 10). It is not necessary to disconnect the relay rod from the Pitman arm.
5 Support the steering gear and remove the mounting bolts **(see illustration)**. Lower the unit slightly, separate the intermediate steering shaft and flexible coupling from the steering gear input shaft and remove the steering gear from the vehicle.

Refitting

6 Raise the steering gear into position and connect the flexible coupling, aligning the marks.
7 Refit the mounting bolts and washers and tighten them to the torque listed in this Chapter's Specifications.
8 Slide the Pitman arm onto the shaft. Make sure the marks previously made are



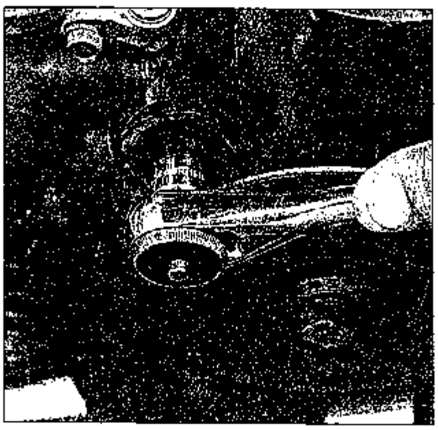
11.3 Mark the relationship of the flex joint to the steering gear input shaft and loosen the pinch bolt (arrow)

aligned. Refit the washer and nut and tighten the nut to the torque listed in this Chapter's Specifications.
9 Refit the intermediate shaft lower pinch bolt and tighten it to the torque listed in this Chapter's Specifications.
10 Connect the power steering hoses/lines to the steering gear using new copper washers. Fill the power steering pump reservoir with the recommended fluid (see Chapter 1).
11 Lower the vehicle and bleed the steering system (see Section 13).

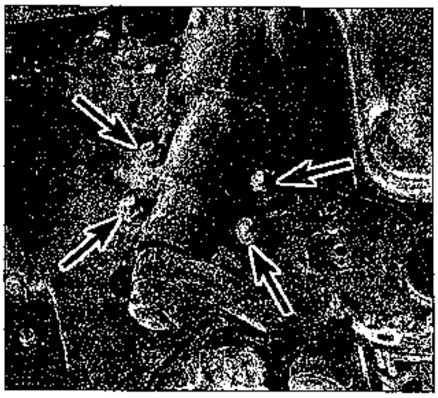
12 Power steering pump - removal and refitting

Refer to illustrations 12.3, 12.4a and 12.4b

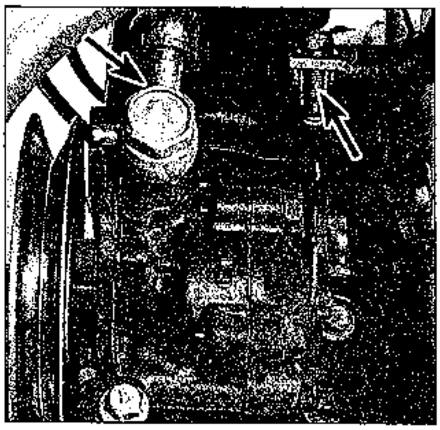
1 Disconnect the negative battery cable.
2 Loosen the pump adjuster and slip the belt over the pulley (see Chapter 1).
3 Using a suction gun, withdraw as much power steering fluid from the reservoir as possible. Position a drain pan under the pump and disconnect the high pressure line and fluid return hose **(see illustration)**. Cap the ends of the lines to prevent excessive fluid leakage and the entry of contaminants.
4 Remove the adjusting and mounting bolts **(see illustrations)**. Remove the pump from the vehicle.



12.4a Remove the mounting bolts . . .

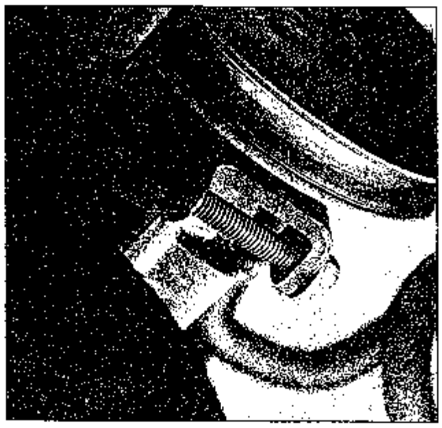


11.5 The steering gear is mounted to the frame rail with four bolts (arrows)



12.3 Remove the power steering pump pressure line and return hose connections (arrows) after placing a drain pan under the assembly

5 Refitting of the power steering pump is the reverse of the removal procedure. Renew the copper washers at the high pressure hose connection. Check the condition of the return hose clamp and renew it if necessary.
6 Adjust the belt tension (refer to Chapter 1).
7 Add the proper amount of the correct fluid and bleed the power steering system following the procedure in Section 13.



12.4b . . . and the adjuster bolts from the power steering pump

13 Power steering system - bleeding

1 Following any operation in which the power steering fluid lines have been disconnected, the power steering system must be bled to remove all air and obtain proper steering performance.
2 With the front wheels in the straight ahead position, check the power steering fluid level and, if low, add fluid until it reaches the Cold (C) mark on the dipstick.
3 Start the engine and allow it to run at fast idle. Recheck the fluid level and add more if necessary to reach the Cold (C) mark on the dipstick.
4 Bleed the system by turning the wheels from side-to-side. Do not hold the steering wheel against the stops for more than a few seconds at a time. This will work the air out of the system. Keep the reservoir full of fluid as this is done.
5 When the air is worked out of the system, return the wheels to the straight ahead position and leave the vehicle running for several more minutes before shutting it off.
6 Road test the vehicle to be sure the steering system is functioning normally and noise-free.
7 Recheck the fluid level to be sure it is up to the Hot (H) mark on the dipstick while the engine is at normal operating temperature. Add fluid if necessary (see Chapter 1).

14 Wheels and tyres - general information

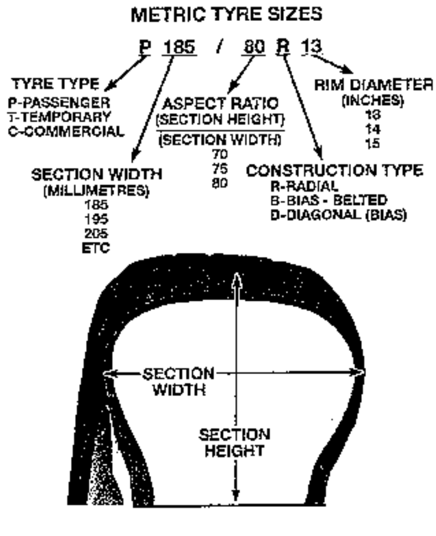
Refer to illustration 14.1

Most vehicles covered by this manual are equipped with metric-sized fiberglass or steel-belted radial tyres **(see illustration)**. Use of other size or type of tyres may affect the ride and handling of the vehicle. Don't mix different types of tyres, such as radials and bias belted, on the same vehicle as handling may be seriously affected. It is recommended that tyres be renewed in pairs on the same axle, but if only one tyre is being renewed, be sure it's the same size, structure and tread design as the other.

Because tyre pressure has a substantial effect on handling and wear, the pressure on all tyres should be checked at least once a month or before any extended trips (see Chapter 1).

Wheels must be renewed if they are bent, dented, leak air, have elongated bolt holes, are heavily rusted, out of vertical symmetry or if the lug nuts won't stay tight. Wheel repairs that use welding or peening are not recommended.

Tyre and wheel balance is important to the overall handling, braking and performance of the vehicle. Unbalanced wheels can adversely affect handling and ride characteristics as well as tyre life. Whenever a tyre is refitted on a wheel, the tyre and wheel should be balanced by a shop with the proper equipment.



14.1 Metric tyre size code

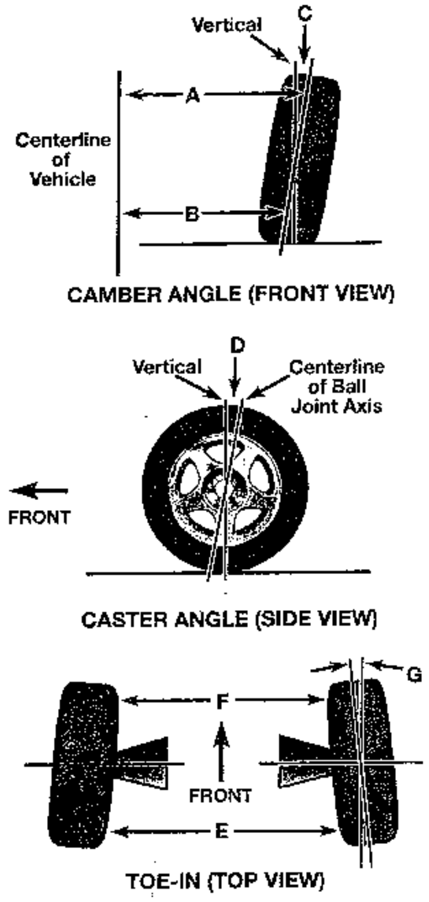
15 Front end alignment - general information

Refer to illustration 15.3

A front end alignment refers to the adjustments made to the front wheels so they are in proper angular relationship to the suspension and the ground. Front wheels that are out of proper alignment not only affect steering control, but also increase tyre wear. The only front end adjustments normally done on these vehicles are caster and toe-in.

Getting the proper front wheel alignment is a very exacting process, one in which complicated and expensive machines are necessary to perform the job properly. Because of this, you should have a technician with the proper equipment perform these tasks. We will, however, use this space to give you a basic idea of what is involved with front end alignment so you can better understand the process and deal intelligently with the shop that does the work.

Toe-in is the turning in of the front wheels **(see illustration)**. The purpose of a toe specification is to ensure near-parallel rolling of the front wheels without wandering. In a vehicle with zero toe-in, the distance between the front edges of the wheels will be the same as the distance between the rear edges of the wheels. The actual amount of toe-in is normally zero to two millimetres (with radial tyres). Toe-in adjustment is controlled by the tie-rod end positions on the tie-rod. Incorrect toe-in will cause the tyres to wear improperly by making them scrub against the road surface.



15.3 Front end alignment details

***A minus B = C** (degrees camber)*
***D = caster** (measured in degrees)*
***E minus F = toe-in** (measured in inches or millimetres)*
***G = toe-in** (expressed in degrees)*

Caster is the tilting of the top of the front steering axis from the vertical. A tilt toward the rear is positive caster and a tilt toward the front is negative caster. If this angle isn't correct on leaf spring suspensions, it can be adjusted by adding caster adjusting shims between the axle and the leaf springs. Normal settings vary between two and three degrees positive.

Camber (the tilting of the front wheels from vertical when viewed from the front of the vehicle) is factory present at zero degrees and is not adjusted. If the camber angle isn't correct, the components causing the problem must be renewed. **Caution:** *Never attempt to adjust the camber angle by heating or bending the axle or any other suspension component!*

Chapter 11 Body

Contents

1 General information

The vehicles covered by this manual are built with a body-on-frame construction. The frame is a ladder-type, consisting of two box steel side rails joined by crossmembers. These crossmembers are welded to the side rails, with the exception of the transmission crossmember which is bolted into place for easy removal. The vehicle bodies are secured to the chassis by rubber insulated mounts and can be completely removed from the chassis.

Certain components are particularly vulnerable to accident damage and can be unbolted and repaired or renewed. Among these parts are the body mouldings, fenders, doors, bumpers, the bonnet and tailgate and all glass. Only general body maintenance practices and body panel repair procedures within the scope of the do-it-yourselfer are included in this Chapter.

2 Body - maintenance

1 The condition of your vehicle's body is very important, because the resale value depends a great deal on it. It's much more difficult to repair a neglected or damaged body than it is to repair mechanical components. The hidden areas of the body, such as the wheel wells, the frame and the engine compartment, are equally important, although they don't require as frequent attention as the rest of the body.

2 Once a year, or every 25,000 kilometres, it's a good idea to have the underside of the body steam cleaned. All traces of dirt and oil will be removed and the area can then be inspected carefully for rust, damaged brake lines, frayed electrical wires, damaged cables and other problems. The front suspension components should be greased after completion of this job.

3 At the same time, clean the engine and the engine compartment with a steam cleaner or water-soluble degreaser.

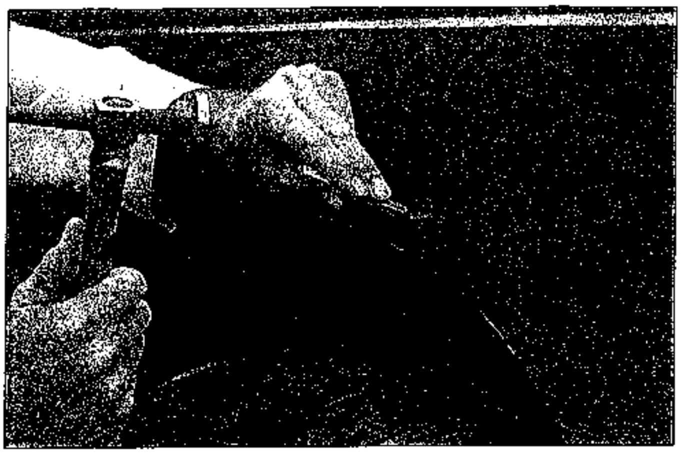
4 The wheel wells should be given close attention, since undercoating can peel away and stones and dirt thrown up by the tyres can cause the paint to chip and flake, allowing rust to set in. If rust is found, clean down to the bare metal and apply an anti-rust paint.

5 The body should be washed about once a week. Wet the vehicle thoroughly to soften the dirt, then wash it down with a soft sponge and plenty of clean soapy water. If the surplus dirt is not washed off very carefully, it can wear down the paint.

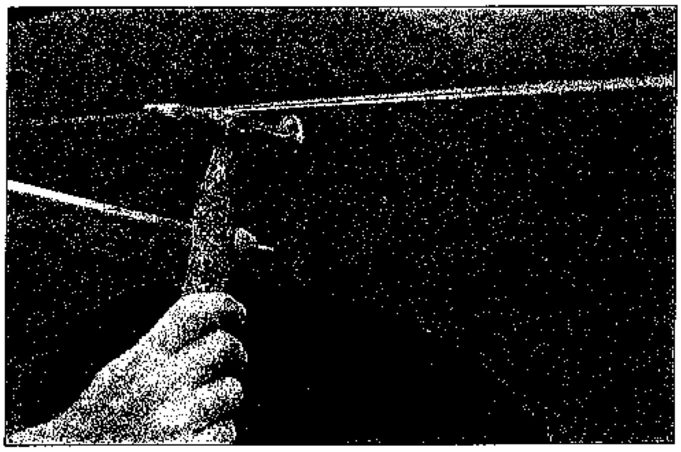
6 Spots of tar or asphalt thrown up from the road should be removed with a cloth soaked in solvent.

7 Once every six months, wax the body and chrome trim. If a chrome cleaner is used to remove rust from any of the vehicle's plated parts, remember that the cleaner also removes part of the chrome, so use it sparingly.

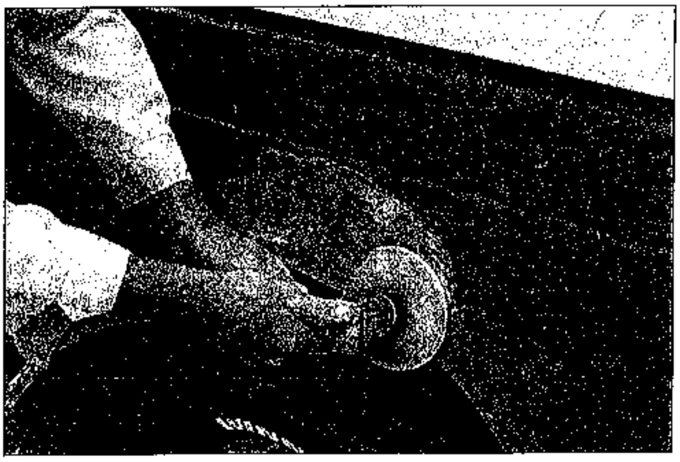
These photos illustrate a method of repairing simple dents. They are intended to supplement *Body repair - minor damage* in this Chapter and should not be used as the sole instructions for body repair on these vehicles.



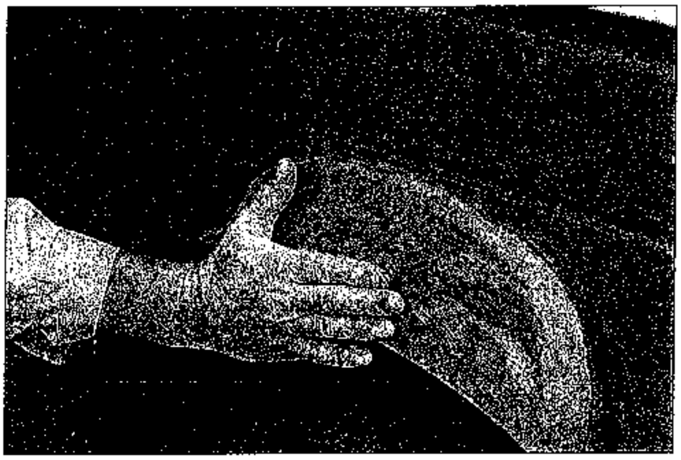
1 If you can't access the backside of the body panel to hammer out the dent, pull it out with a slide-hammer-type dent puller. In the deepest portion of the dent or along the crease line, drill or punch hole(s) at least one inch apart . . .



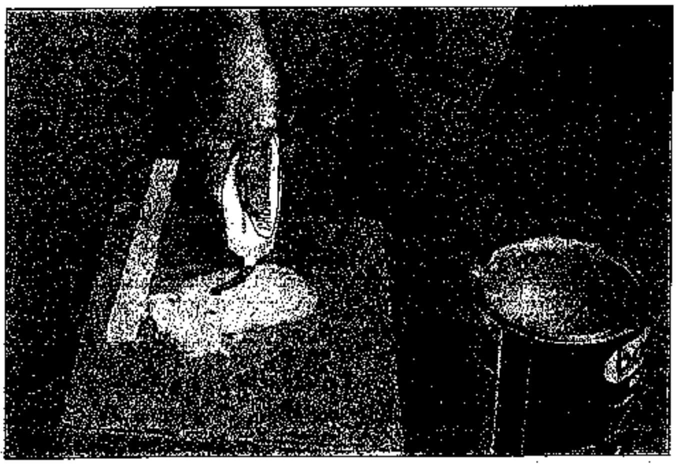
2 . . . then screw the slide-hammer into the hole and operate it. Tap with a hammer near the edge of the dent to help 'pop' the metal back to its original shape. When you're finished, the dent area should be close to its original contour and about 1/8-inch below the surface of the surrounding metal



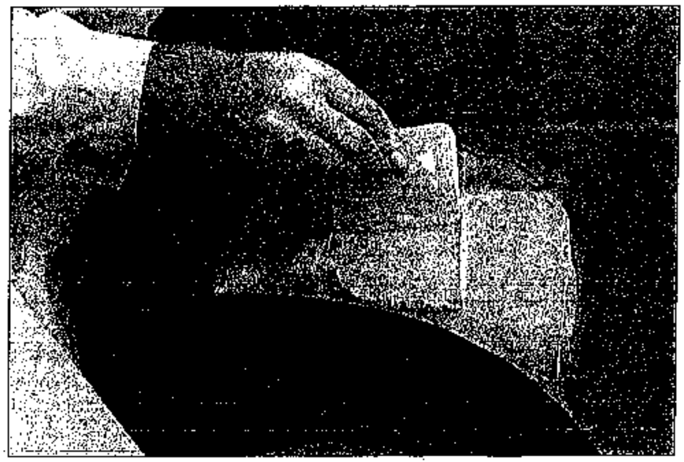
3 Using coarse-grit sandpaper, remove the paint down to the bare metal. Hand sanding works fine, but the disc sander shown here makes the job faster. Use finer (about 320-grit) sandpaper to feather-edge the paint at least one inch around the dent area



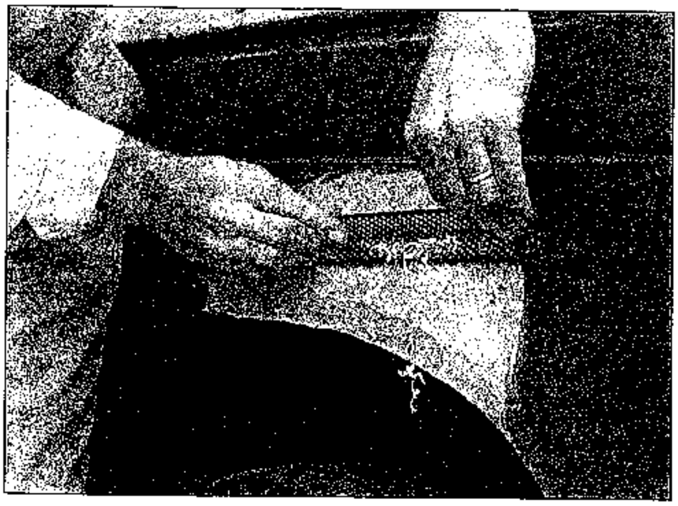
4 When the paint is removed, touch will probably be more helpful than sight for telling if the metal is straight. Hammer down the high spots or raise the low spots as necessary. Clean the repair area with wax/silicone remover



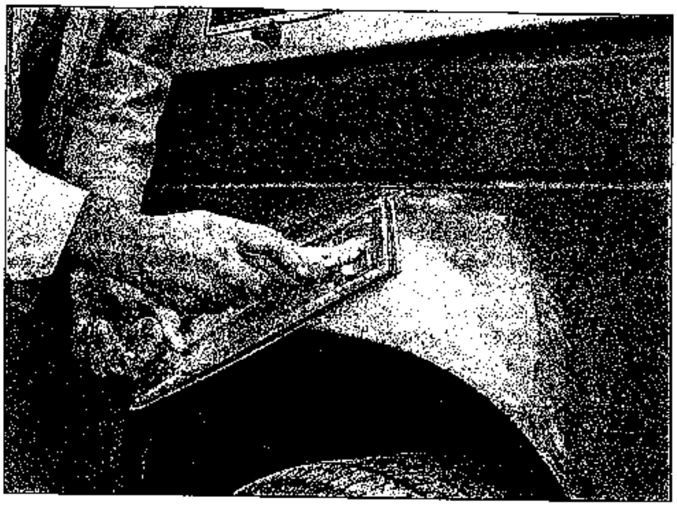
5 Following label instructions, mix up a batch of plastic filler and hardener. The ratio of filler to hardener is critical, and, if you mix it incorrectly, it will either not cure properly or cure too quickly (you won't have time to file and sand it into shape)



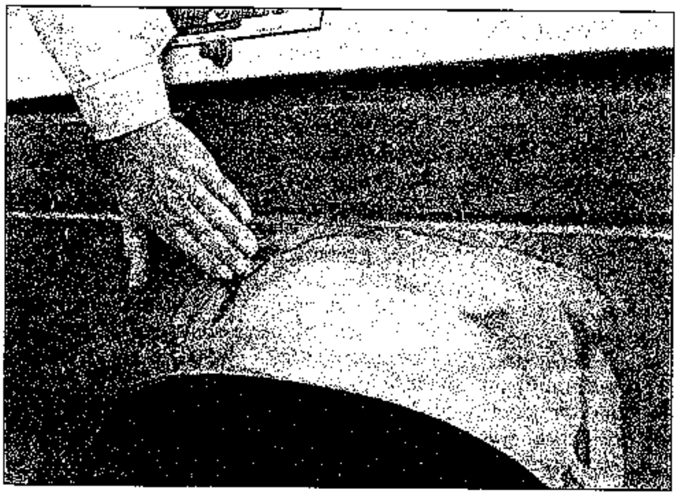
6 Working quickly so the filler doesn't harden, use a plastic applicator to press the body filler firmly into the metal, assuring it bonds completely. Work the filler until it matches the original contour and is slightly above the surrounding metal



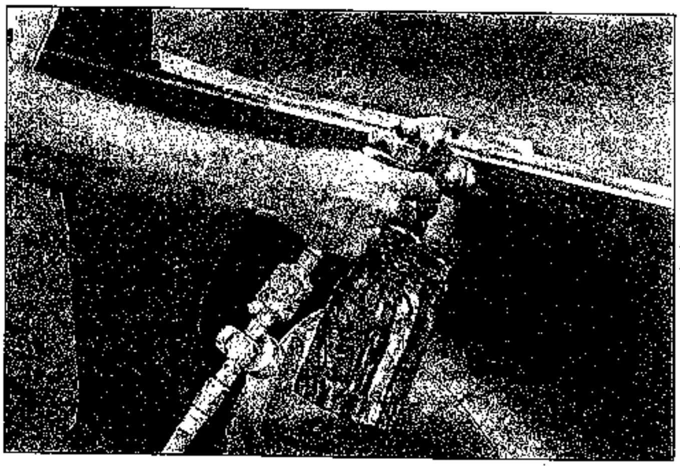
7 Let the filler harden until you can just dent it with your fingernail. Use a body file or Surform tool (shown here) to rough-shape the filler



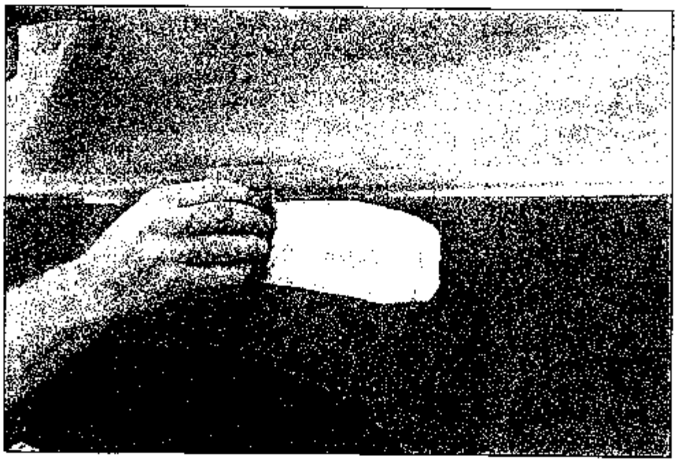
8 Use coarse-grit sandpaper and a sanding board or block to work the filler down until it's smooth and even. Work down to finer grits of sandpaper - always using a board or block - ending up with 360 or 400 grit



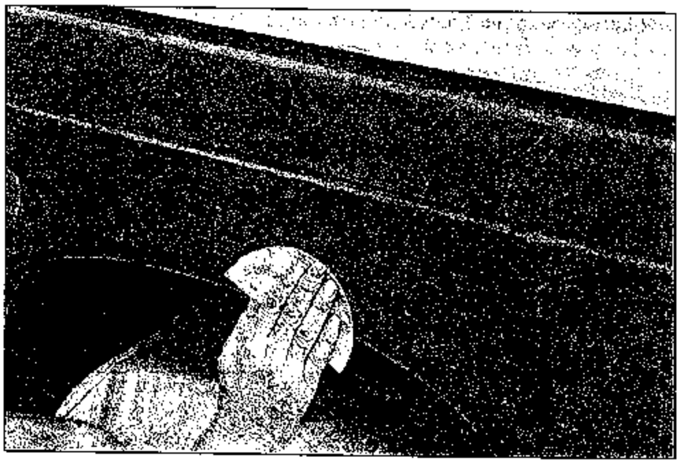
9 You shouldn't be able to feel any ridge at the transition from the filler to the bare metal or from the bare metal to the old paint. As soon as the repair is flat and uniform, remove the dust and mask off the adjacent panels or trim pieces



10 Apply several layers of primer to the area. Don't spray the primer on too heavy, so it sags or runs, and make sure each coat is dry before you spray on the next one. A professional-type spray gun is being used here, but aerosol spray primer is available inexpensively from auto parts stores



11 The primer will help reveal imperfections or scratches. Fill these with glazing compound. Follow the label instructions and sand it with 360 or 400-grit sandpaper until it's smooth. Repeat the glazing, sanding and respraying until the primer reveals a perfectly smooth surface



12 Finish sand the primer with very fine sandpaper (400 or 600-grit) to remove the primer overspray. Clean the area with water and allow it to dry. Use a tack rag to remove any dust, then apply the finish coat. Don't attempt to rub out or wax the repair area until the paint has dried completely (at least two weeks)

3 Vinyl trim - maintenance

Don't clean vinyl trim with detergents, caustic soap or petroleum-based cleaners. Plain soap and water works just fine, with a soft brush to clean dirt that may be ingrained. Wash the vinyl as frequently as the rest of the vehicle. After cleaning, application of a high-quality rubber and vinyl protectant will help prevent oxidation and cracks. The protectant can also be applied to weatherstripping, vacuum lines and rubber hoses, which often fail as a result of chemical degradation, and to the tyres.

4 Upholstery and carpets - maintenance

1 Every three months remove the floor mats and clean the interior of the vehicle (more frequently if necessary). Use a stiff whisk broom to brush the carpeting and loosen dirt and dust, then vacuum the upholstery and carpets thoroughly, especially along seams and crevices.
2 Dirt and stains can be removed from carpeting with basic household or automotive carpet shampoos available in spray cans. Follow the directions and vacuum again, then use a stiff brush to bring back the "nap" of the carpet.
3 Most interiors have cloth or vinyl upholstery, either of which can be cleaned and maintained with a number of material-specific cleaners or shampoos available in auto supply stores. Follow the directions on the product for usage, and always spot-test any upholstery cleaner on an inconspicuous area (bottom edge of a back seat cushion) to ensure that it doesn't cause a colour shift in the material.
4 After cleaning, vinyl upholstery should be treated with a protectant. **Note:** *Make sure the protectant container indicates the product can be used on seats - some products may make a seat too slippery.* **Caution:** *Do not use protectant on vinyl-covered steering wheels.*
5 Leather upholstery requires special care. It should be cleaned regularly with saddle soap or leather cleaner. Never use alcohol, petrol, nail polish remover or thinner to clean leather upholstery.
6 After cleaning, regularly treat leather upholstery with a leather conditioner, rubbed in with a soft cotton cloth. Never use car wax on leather upholstery.
7 In areas where the interior of the vehicle is subject to bright sunlight, cover leather seating areas of the seats with a sheet if the vehicle is to be left out for any length of time.

5 Body repair - minor damage

Repair of scratches

1 If the scratch is superficial and does not penetrate to the metal of the body, repair is very simple. Lightly rub the scratched area with a fine rubbing compound to remove loose paint and built-up wax. Rinse the area with clean water.
2 Apply touch-up paint to the scratch, using a small brush. Continue to apply thin layers of paint until the surface of the paint in the scratch is level with the surrounding paint. Allow the new paint at least two weeks to harden, then blend it into the surrounding paint by rubbing with a very fine rubbing compound. Finally, apply a coat of wax to the scratch area.
3 If the scratch has penetrated the paint and exposed the metal of the body, causing the metal to rust, a different repair technique is required. Remove all loose rust from the bottom of the scratch with a pocket knife, then apply rust inhibiting paint to prevent the formation of rust in the future. Using a rubber or nylon applicator, coat the scratched area with glaze-type filler. If required, the filler can be mixed with thinner to provide a very thin paste, which is ideal for filling narrow scratches. Before the glaze filler in the scratch hardens, wrap a piece of smooth cotton cloth around the tip of a finger. Dip the cloth in thinner and then quickly wipe it along the surface of the scratch. This will ensure that the surface of the filler is slightly hollow. The scratch can now be painted over as described earlier in this Section.

Repair of dents

See photo sequence

4 When repairing dents, the first job is to pull the dent out until the affected area is as close as possible to its original shape. There is no point in trying to restore the original shape completely as the metal in the damaged area will have stretched on impact and cannot be restored to its original contours. 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 metal. In cases where the dent is very shallow, it is not worth trying to pull it out at all.
5 If the back side of the dent is accessible, it can be hammered out gently from behind using a soft-face hammer. While doing this, hold a block of wood firmly against the opposite side of the metal to absorb the hammer blows and prevent the metal from being stretched.
6 If the dent is in a section of the body which has double layers, or some other factor makes it inaccessible from behind, a different technique is required. Drill several small holes through the metal inside the damaged area, particularly in the deeper sections. Screw long, self tapping screws into the holes just enough for them to get a good grip in the metal. Now the dent can be pulled out by pulling on the protruding heads of the screws with locking pliers.
7 The next stage of repair is the removal of paint from the damaged area and from 25 mm or so of the surrounding metal. This is easily done with a wire brush or sanding disk in a drill motor, although it can be done just as effectively by hand with sandpaper. To complete the preparation for filling, score the surface of the bare metal with a screwdriver or the tang of a file or drill small holes in the affected area. This will provide a good grip for the filler material. To complete the repair, see the Section on *filling and painting*.

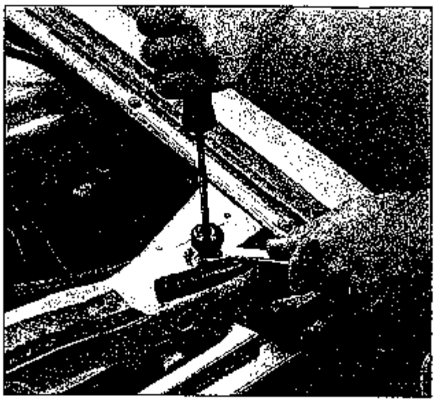
Repair of rust holes or gashes

8 Remove all paint from the affected area and from 25 mm or so of the surrounding metal using a sanding disk or wire brush mounted in a drill motor. If these are not available, a few sheets of sandpaper will do the job just as effectively.
9 With the paint removed, you will be able to determine the severity of the corrosion and decide whether to renew the whole panel, if possible, or repair the affected area. New body panels are not as expensive as most people think and it is often quicker to refit a new panel than to repair large areas of rust.
10 Remove all trim pieces from the affected area except those which will act as a guide to the original shape of the damaged body, such as headlight shells, etc. Using metal snips or a hacksaw blade, remove all loose metal and any other metal that is badly affected by rust. Hammer the edges of the hole on the inside to create a slight depression for the filler material.
11 Wire brush the affected area to remove the powdery rust from the surface of the metal. If the back of the rusted area is accessible, treat it with rust inhibiting paint.
12 Before filling is done, block the hole in some way. This can be done with sheet metal riveted or screwed into place, or by stuffing the hole with wire mesh.
13 Once the hole is blocked off, the affected area can be filled and painted. See the following subsection on *filling and painting*.

Filling and painting

14 Many types of body fillers are available, but generally speaking, body repair kits which contain filler paste and a tube of resin hardener are best for this type of repair work. A wide, flexible plastic or nylon applicator will be necessary for imparting a smooth and contoured finish to the surface of the filler material. Mix up a small amount of filler on a clean piece of wood or cardboard (use the hardener sparingly). Follow the manufacturer's instructions on the package, otherwise the filler will set incorrectly.
15 Using the applicator, apply the filler paste to the prepared area. Draw the applicator across the surface of the filler to achieve the desired contour and to level the filler surface. As soon as a contour that approximates the original one is achieved, stop working the paste. If you continue, the paste will begin to stick to the applicator. Continue to add thin layers of paste at 20-minute intervals until the level of the filler is just above the surrounding metal.
16 Once the filler has hardened, the excess can be removed with a body file. From then on, progressively finer grades of sandpaper should be used, starting with a 180-grit paper and finishing with 600-grit wet-or-dry paper.

9.2 Use white paint or a pencil to mark the exact positions of the bonnet hinges (arrow). During refitting, match the marks up - the bonnet should close and latch perfectly



9.11 If the front of the bonnet is loose or is too high in relation to the fenders, these stops can be adjusted to give firm closure and correct height

Always wrap the sandpaper around a flat rubber or wooden block, otherwise the surface of the filler will not be completely flat. During the sanding of the filler surface, the wet-or-dry paper should be periodically rinsed in water. This will ensure that a very smooth finish is produced in the final stage.

17 At this point, the repair area should be surrounded by a ring of bare metal, which in turn should be encircled by the finely feathered edge of good paint. Rinse the repair area with clean water until all of the dust produced by the sanding operation is gone.

18 Spray the entire area with a light coat of primer. This will reveal any imperfections in the surface of the filler. Repair the imperfections with fresh filler paste or glaze filler and once more smooth the surface with sandpaper. Repeat this spray-and-repair procedure until you are satisfied that the surface of the filler and the feathered edge of the paint are perfect. Rinse the area with clean water and allow it to dry completely.

19 The repair area is now ready for painting. Spray painting must be carried out in a warm, dry, windless and dust free atmosphere. These conditions can be created if you have access to a large indoor work area, but if you are forced to work in the open, you will have to pick the day very carefully. If you are working indoors, dousing the floor in the work area with water will help settle the dust which would otherwise be in the air. If the repair area is confined to one body panel, mask off the surrounding panels. This will help minimise the effects of a slight mismatch in paint colour. Trim pieces such as chrome strips, door handles, etc., will also need to be masked off or removed. Use masking tape and several thickness of newspaper for the masking operations.

20 Before spraying, shake the paint can thoroughly, then spray a test area until the spray painting technique is mastered. Cover the repair area with a thick coat of primer. The thickness should be built up using several thin layers of primer rather than one thick one. Using 600-grit wet-or-dry sandpaper, rub down the surface of the primer until it is very smooth. While doing this, the work area should be thoroughly rinsed with water and the wet-or-dry sandpaper periodically rinsed as well. Allow the primer to dry before spraying additional coats.

21 Spray on the top coat, again building up the thickness by using several thin layers of paint. Begin spraying in the centre of the repair area and then, using a circular motion, work out until the whole repair area and about 50 mm of the surrounding original paint 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 use a very fine rubbing compound to blend the edges of the new paint into the existing paint. Finally, apply a coat of wax.

6 Body repair - major damage

1 Major damage must be repaired by an auto body shop specifically equipped to perform body and frame repairs. These shops have the specialised equipment required to do the job properly.

2 If the damage is extensive, the body must be checked for proper alignment or the vehicle's handling characteristics may be adversely affected and other components may wear at an accelerated rate.

3 Due to the fact that all of the major body components (bonnet, fenders, etc.) are separate and replaceable units, any seriously damaged components should be renewed rather than repaired. Sometimes the components can be found in a wrecking yard that specialises in used vehicle components, often at considerable savings over the cost of new parts.

7 Hinges and locks - maintenance

Once every 5000 kilometres, or every three months, the hinges and latch assemblies on the doors and bonnet should be given a few drops of light oil or lock lubricant. The door latch strikers should also be lubricated with a thin coat of grease to reduce wear and ensure free movement. Lubricate the door and luggage compartment locks with spray-on graphite lubricant.

8 Windscreen and fixed glass - renewal

Renewal of the windscreen and fixed glass requires the use of special fast-setting adhesive/caulk materials and some specialised tools and techniques. These operations should be left to a dealer service department or a shop specialising in glass work.

9 Bonnet - removal, refitting and adjustment

Note: *The bonnet is heavy and somewhat awkward to remove and refit - at least two people should perform this procedure.*

Removal and refitting

Refer to illustration 9.2

1 Use blankets or pads to cover the cowl area of the body and the fenders. This will protect the body and paint as the bonnet is lifted off.

2 Paint marks or scribe a line around the bonnet hinge to ensure proper alignment during refitting **(see illustration)**.

3 Disconnect any washer hoses that will interfere with removal.

4 Have an assistant support the bonnet. Remove the hinge-to-bonnet nuts or bolts.

5 Lift off the bonnet.

6 Refitting is the reverse of removal.

Adjustment

Refer to illustration 9.11

7 Fore-and-aft and side-to-side adjustment of the bonnet is done by moving the hinge plate slot after loosening the bolts or nuts.

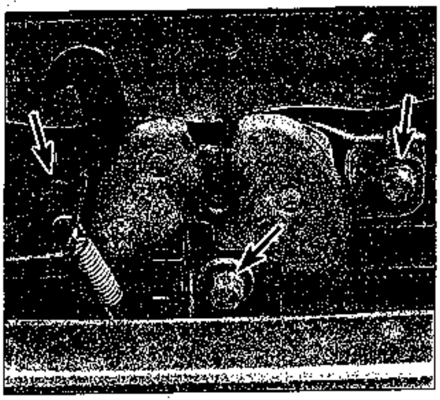
8 Scribe a line around the entire hinge plate so you can judge the amount of movement.

9 Loosen the bolts or nuts and move the bonnet into correct alignment. Move it only a little at a time. Tighten the hinge bolts and carefully lower the bonnet to check the position.

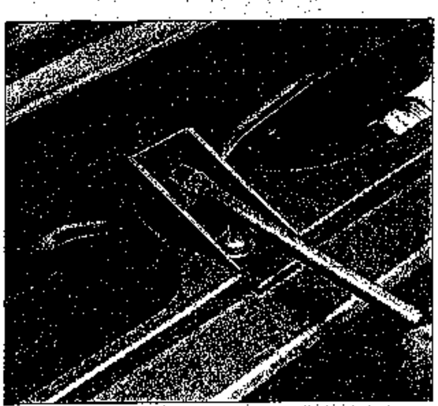
10 If necessary after refitting, the entire bonnet latch assembly can be adjusted up-and-down as well as from side-to-side on the radiator support so the bonnet closes securely and flush with the fenders. To make the adjustment, scribe a line or mark around the bonnet latch mounting bolts to provide a reference point, then loosen them and reposition the latch assembly, as necessary. Following adjustment, retighten the mounting bolts.

11 Adjust the bonnet stop bumpers to achieve the correct bonnet height at the front edges **(see illustration)**.

12 The bonnet latch assembly, as well as the hinges, should be periodically lubricated with white, lithium-base grease to prevent binding and wear.



10.1 After loosening the bolts (arrows), the latch can be repositioned to pull the bonnet down more or less tightly



11.3a These quarter-turn fasteners secure the plastic grille to the radiator core support

11.3b On some models, the turn signal light must be removed for access to some of the clips

10 Bonnet release latch - removal and refitting

Refer to illustration 10.1

1 Scribe a line around the latch to aid alignment when refitting, then detach the latch retaining bolts from the radiator support **(see illustration)** and remove the latch.

2 Disconnect the bonnet release cable by disengaging the cable from the latch assembly.

3 Refitting is the reverse of the removal procedure. **Note:** *Adjust the latch so the bonnet engages securely when closed and the bonnet bumpers are slightly compressed.*

11 Radiator grille - removal and refitting

Refer to illustrations 11.3a and 11.3b

1 Open the bonnet and support it.

2 Remove the screws, disconnect the wiring and remove the front turn signal lamps, if equipped.

3 Release all of the grille clips by turning them a quarter turn and then puling them out **(see illustrations)**.

4 If required for clearance, remove the push bar.

5 Lift the grille out from the top.

6 Refitting is the reverse of removal. Snap all of the clips into place as you refit it.

12 Bumpers - removal and refitting

1 Disconnect any electrical connections that interfere with bumper removal. Remove any trailer hitch and its wiring harness if it will interfere with bumper removal.

2 Support the bumper with a jack or jackstands. Alternatively, have an assistant support the bumper as the bolts are removed. Use masking tape to suspend a towel between the bumper end and the body to make certain there is no contact made between the two.

3 Working from the back of the bumper, remove the retaining bolts securing the bumper bracket to the outside of each frame rail. Remove the bumper from the vehicle.

4 Refitting is the reverse of removal. It is easiest to have two assistants align the bumper while you refit the bolts.

13 Front fender - removal and refitting

1 Loosen the front wheel lug nuts, raise the vehicle and support it securely on jackstands. Remove the wheel.

2 Remove the front bumper (see Section 12).

3 Remove the side marker and turn signal light assembly, if equipped (see Chapter 12).

4 If removing the passenger side fender, disconnect the aerial (see Chapter 12).

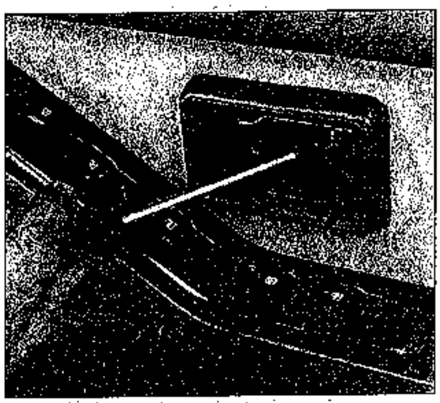
5 Remove the grille.

6 Remove the fender mounting bolts and nuts. Make note of any shims used and their positions.

7 Detach the fender. It's a good idea to have an assistant support the fender while it's being moved away from the vehicle to prevent damage to the surrounding body panels.

8 Refitting is the reverse of removal.

14.2b . . . and lift the bezel off



14.2a Remove the door handle bezel screw . . .

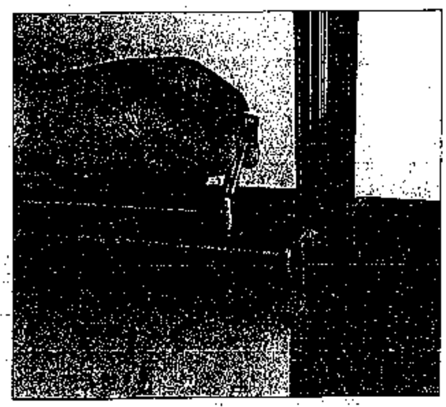
14 Door trim panel - removal and refitting

Refer to illustrations 14.2a, 14.2b, 14.2c, 14.4a, 14.4b, 14.4c, 14.5a, 14.5b, 14.5c, 14.5d, 14.5e, 14.6 and 14.8

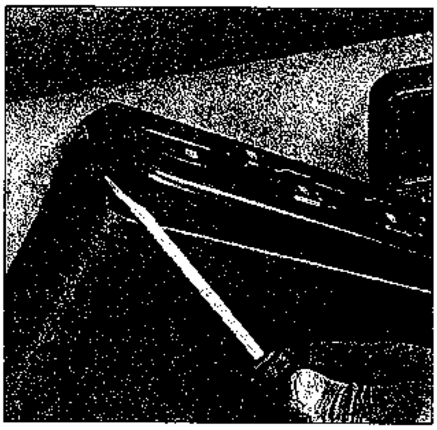
1 Disconnect the negative cable from the battery.

2 Remove the inside door handle trim bezel **(see illustrations)**. Unscrew the door lock knob **(see illustration)**.

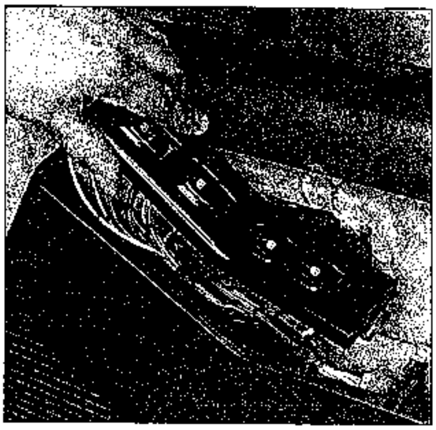
3 On manual window equipped models, remove the window crank, using a hooked tool to remove the retainer clip. A special tool



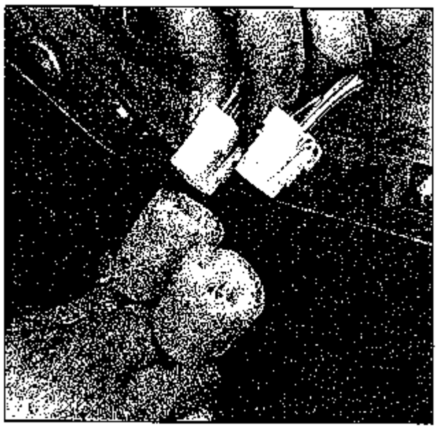
14.2c Unscrew the door lock button.



14.4a On power window equipped vehicles, the front of the control panel can be pried up

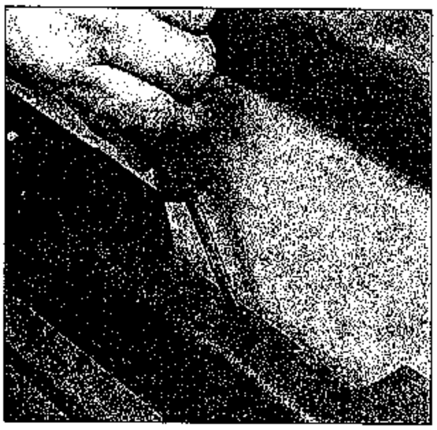


14.4b Grasping it at the front, lift the unit from the armrest

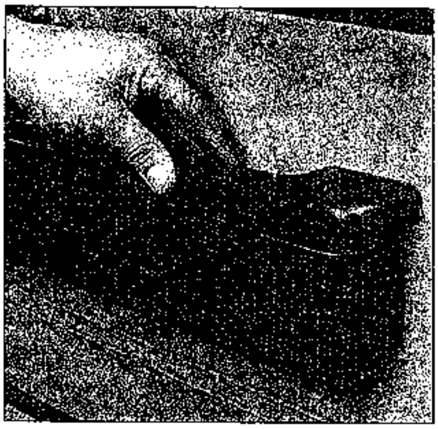


14.4c Disconnect the wiring from the switches

14.5a The armrest screws are concealed beneath these plastic covers. A flat blade screwdriver will remove them



14.5b A Phillips screwdriver is needed to remove the screws beneath the covers



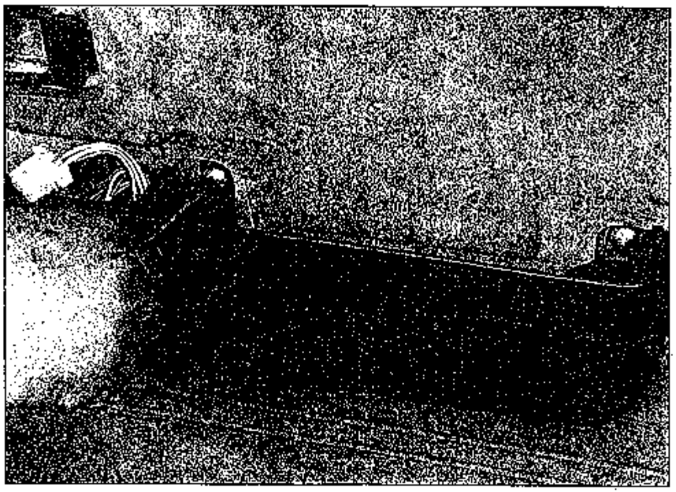
14.5c Lift the cover from the armrest

is available for this purpose, but it's not essential. With the clip removed, pull off the handle.

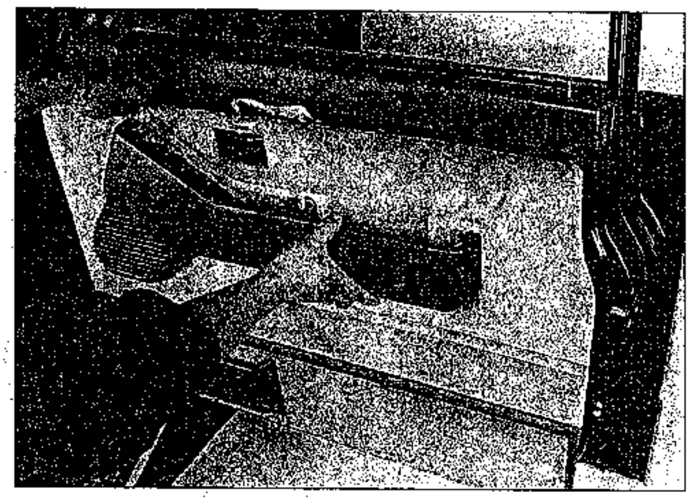
4 On power window equipped models, prise out the armrest switch control plate **(see illustrations)** and disconnect the electrical connections.

5 Remove the cover from the armrest **(see illustrations)**. Detach the armrest pull handle retaining screws and lift off the armrest **(see illustrations)**.

6 Remove the remaining door panel retaining screws at the lower edge of the door panel. Insert a wide putty knife, a thin screwdriver or a special trim panel removal tool between the trim panel and the head of the retaining clip to disengage the door panel retaining clips **(see illustration)**.

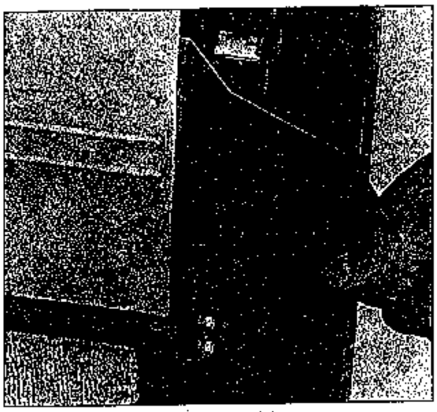


14.5d The large screws which secure the armrest are now accessible

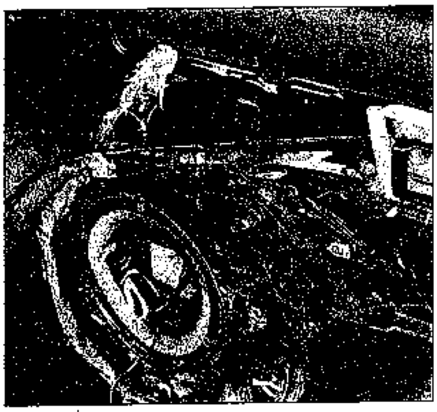


14.5e Lift the armrest from the door panel

11



14.6 A wide tool with no sharp edges should be used to remove the panel from the frame of the door - a putty knife works well



14.8 Be careful as you remove the watershield from the door. It must be renewed to prevent moisture from damaging the door trim panel

15.3 These plastic clips (arrow) need to be released to remove the control rods from the latch

7 Once all of the clips and screws are disengaged, detach the trim panel, disconnect any electrical connectors and remove the trim panel from the vehicle by gently pulling it up and out.
8 For access to the inner door remove the door panel support bracket (if equipped), then peel back the watershield, taking care not to tear it **(see illustration)**. To refit the trim panel, first press the watershield back into place. If necessary, add more sealant to hold it in place.
9 Refitting is the reverse of removal.

15 Door latch, lock cylinder and handles - removal and refitting

Door latch

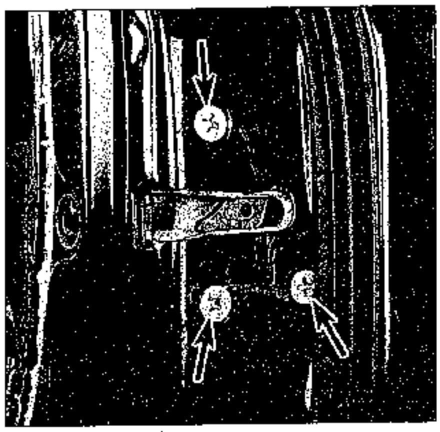
Refer to illustrations 15.3 and 15.4

1 Raise the window then remove the door trim panel and watershield as described in Section 14.
2 Working through the large access hole, disengage the outside door handle to latch rod, outside door lock to latch rod, the inside lock to latch rod, the inside handle to latch rod and the lock solenoid to latch rod (if equipped).
3 All door locking rods are attached by plastic clips **(see illustration)**. The plastic clips can be removed by unsnapping the portion engaging the connecting rod and then by pulling the rod out of its locating hole.
4 Remove the screws securing the latch to the door **(see illustration)**, then remove the latch assembly from the door.
5 Refitting is the reverse of removal.

Outside handle and door lock cylinder

Refer to illustrations 15.7 and 15.8

6 To remove the outside handle and lock cylinder assembly, raise the window then remove the door trim panel and watershield as described in Section 14.
7 Working through the access hole, disengage the plastic clips that secure the outside handle to latch rod and the outside door lock to latch rod **(see illustration)**.
8 Remove the handle retaining bolts and the lock cylinder clip **(see illustration)**.
9 Remove the handle and lock cylinder assembly from the vehicle.
10 Refitting is the reverse of removal.

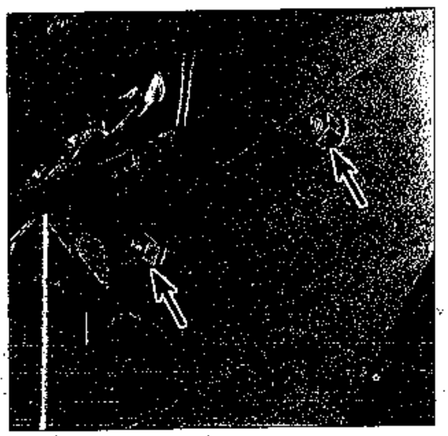


15.4 The latch is retained to the door frame by these flat-head screws (arrows). A large (#3) Phillips screwdriver should be used to avoid damaging the heads

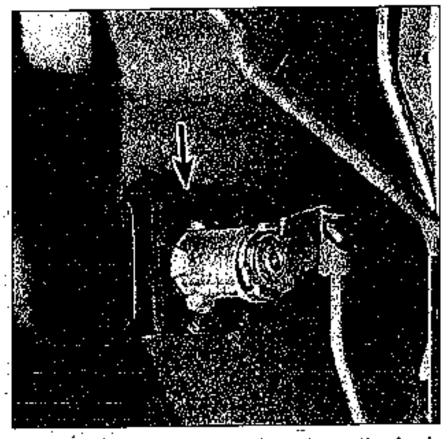
Inside handle

Refer to illustration 15.12

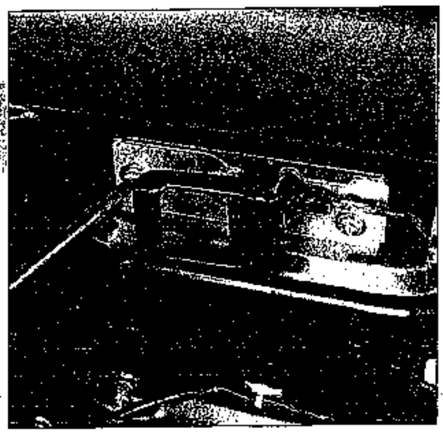
11 Remove the door trim panel as described in Section 14 and peel away the watershield.
12 Unclip the door actuating rod guide,



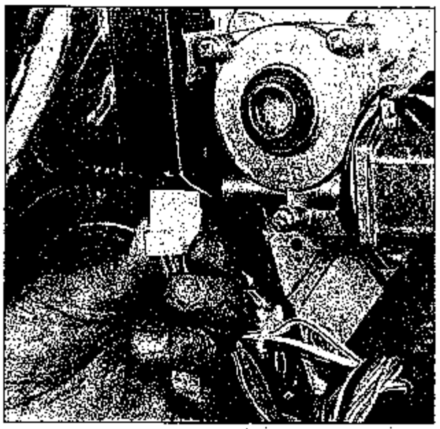
15.7 Remove these nuts (arrows) to allow the outside handle to be lifted off



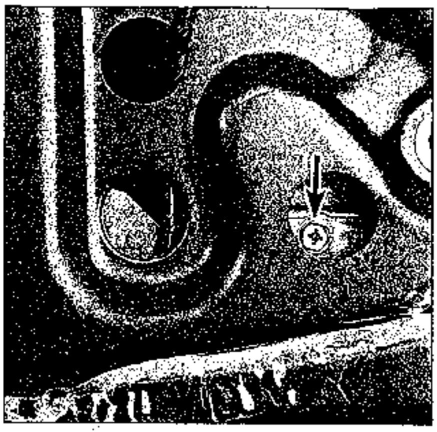
15.8 This flat clip (arrow) secures the lock cylinder; slide it forward with a screwdriver to remove it



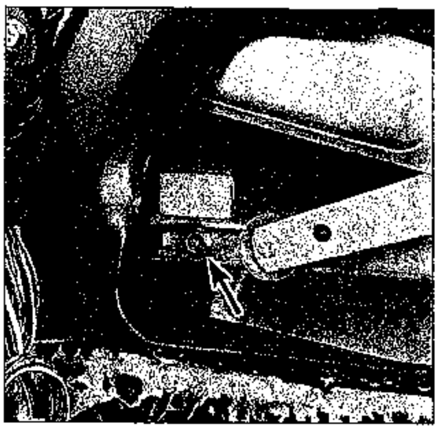
15.12 The inside handle assembly is held with two screws



17.3 The wiring to the window motor must be disconnected on vehicles equipped with this option



17.4a There are holes provided in the door for access to the rear . . .



17.4b . . . and the front window regulator screws

then remove the door handle retaining screws **(see illustration)**.

13 Pull the handle free from the door, then disconnect the actuating rod from the backside of the handle control and remove the handle from the door.

14 Refitting is the reverse of removal.

16 Door window glass - removal and refitting

1 Remove the door trim panel and the plastic watershield (see Section 14).

2 Lower the window glass all the way down into the door.

3 Carefully prise the inner weatherstrip out of the door window opening.

4 Raise the window just enough to access the window retaining bolts through the hole in the door frame.

5 Remove the vent window (if equipped).

6 Place a rag over the glass to help prevent scratching the glass and remove the two glass mounting bolts.

7 Remove the glass by pulling it up and out.

8 Refitting is the reverse of removal.

17 Door window glass regulator - removal and refitting

Refer to illustrations 17.3, 17.4a and 17.4b

1 Remove the door trim panel and the plastic watershield (see Section 14).

2 Remove the window glass assembly (see Section 16).

3 On power operated windows, disconnect the electrical connector from the window regulator motor **(see illustration)**.

4 Remove the equaliser arm bracket and the regulator mounting bolts **(see illustrations)**.

5 Pull the equaliser arm and regulator assemblies through the service hole in the door frame to remove it.

6 Refitting is the reverse of removal.

18 Outside mirrors - removal and refitting

Refer to illustrations 18.1a, 18.1b, and 18.2

1 Remove the screw, then prise off the mirror trim cover **(see illustrations)**.

2 Remove the mirror retaining screws and detach the mirror from the vehicle **(see illustration)**.

3 Disconnect the electrical connector from the mirror (if equipped).

4 Refitting is the reverse of removal.

19 Door - removal, refitting and adjustment

Note: *The door is heavy and somewhat awkward to remove and refit - at least two people should perform this procedure.*

Removal and refitting

Refer to illustrations 19.6 and 19.8

1 Raise the window completely in the door and then disconnect the negative cable from the battery.

2 Open the door all the way and support it on jacks or blocks covered with rags to prevent damaging the paint.

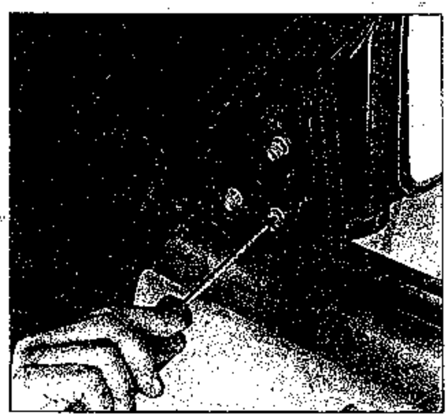
3 Remove the door trim panel and water deflector as described in Section 14.

4 Disconnect all electrical connections, earth connecting wires and harness retaining clips from the door. **Note:** *It is a good idea to label all connections to aid the reassembly process.*

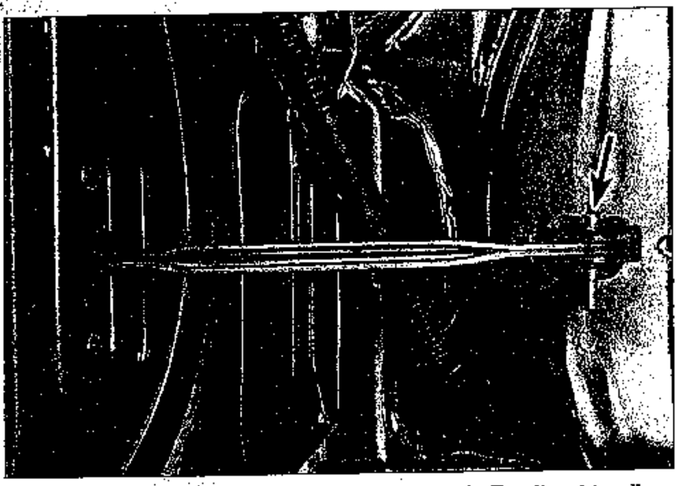
5 From the door side, detach the rubber conduit between the body and the door. Then pull the wiring harness through the conduit hole and it remove from the door.

18.1a One screw secures the inner cover of the mirror

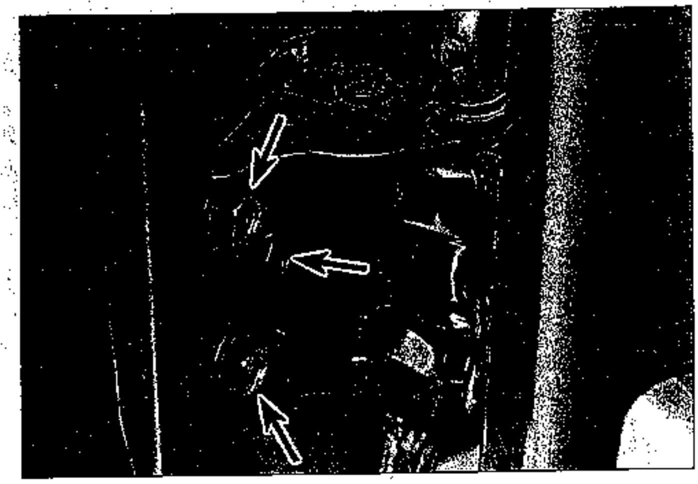
18.1b Lift the cover off - a little levering with a padded screwdriver may be necessary



18.2 Remove the three screws. Support the weight of the mirror as you remove the last two



19.6 This pin (arrow) retains the door stop link. Tap it out to allow the door to swing open and then be removed



19.8 You will need an assistant to support the door as you remove these hinge bolts (arrows). Always disconnect the lower hinge first to ease removal

6 Remove the door stop strut centre pin **(see illustration)**.

7 Mark around the door hinges with a pen or a scribe to facilitate realignment during reassembly.

8 With an assistant holding the door, remove the hinge to door bolts and lift the door off **(see illustration)**.

9 Refitting is the reverse of removal.

Adjustment

10 Having proper door to body alignment is a critical part of a well functioning door assembly. First check the door hinge pins for excessive play. Fully open the door and lift up and down on the door without lifting the body. If a door has 2 mm or more excessive play, the hinges should be renewed.

11 Door-to-body alignment adjustments are made by loosening the hinge-to-body bolts or hinge-to-door bolts and moving the door. Proper body alignment is achieved when the top of the doors are parallel with the roof section, the front door is flush with the fender, the rear door is flush with the rear quarter panel and the bottom of the doors are aligned with the lower rocker panel. If these goals can't be reached by adjusting the hinge-to-body or hinge-to-door bolts, body alignment shims may have to be purchased and inserted behind the hinges to achieve correct alignment.

12 To adjust the door closed position, scribe a line or mark around the striker plate to provide a reference point, then check that the door latch is contacting the centre of the latch striker. If not adjust the up and down position first.

13 Finally adjust the latch striker sideways position, so that the door panel is flush with the centre pillar or rear quarter panel and provides positive engagement with the latch mechanism.

20 Tailgate doors - removal, refitting and adjustment

Note: *The tailgate doors are heavy and somewhat awkward to remove and refit - at least two people should perform this procedure.*

Removal and refitting

Refer to illustrations 20.2a, 20.2b, 20.6a and 20.6b

1 Refer to Section 19 and follow the procedure for the side doors, then proceed to Step 2. All wiring must be disconnected and pulled out of the door.

2 Cover the lower bumper area around the opening with pads or cloths to protect the painted surfaces when the tailgate door is removed **(see illustration)**. Remove the inner door pull handle **(see illustration)**.

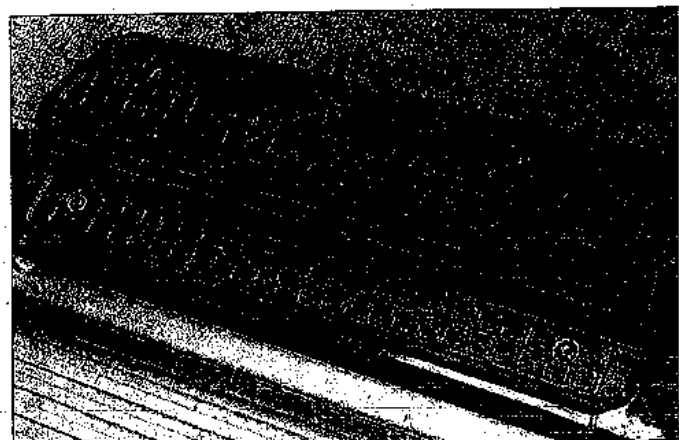
3 Disconnect the speaker wiring and remove the speaker from the door.

4 On the right door, remove the spare wheel and disconnect the washer hose.

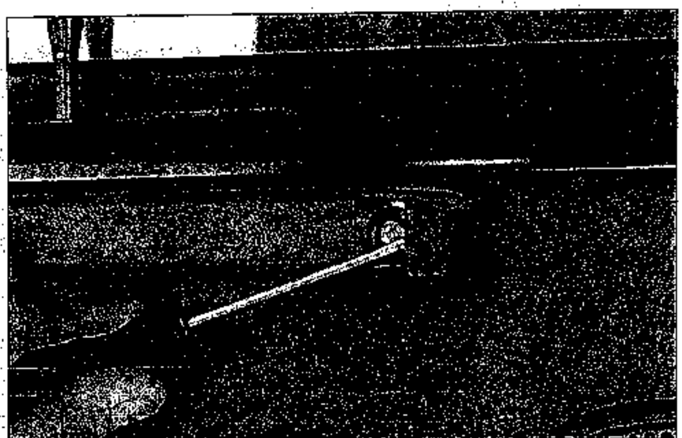
5 Disconnect the lamp wiring and remove the turn signal lamps if they interfere.

6 Detach the hinge to tailgate bolts and remove the tailgate from the vehicle **(see illustrations)**.

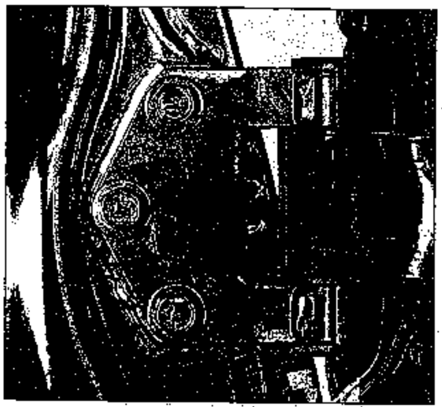
7 Refitting is the reverse of removal.



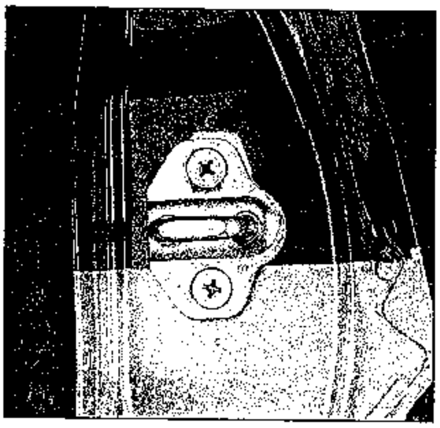
20.2a The rear door entry is protected by a rubber sill, but lay a blanket over it to protect the exposed painted areas



20.2b The rear door pull handle can be removed after levering up the screw covers



20.6a The rear doors can be swung wide open for easy access to the upper . . .

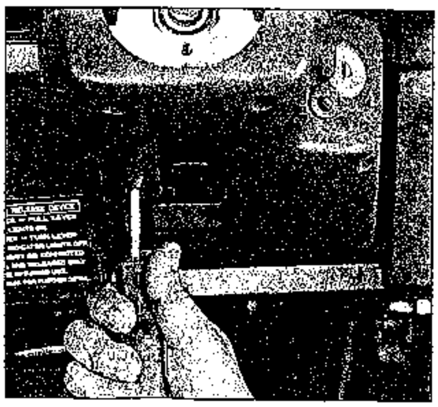


20.9b . . . a door striker . . .

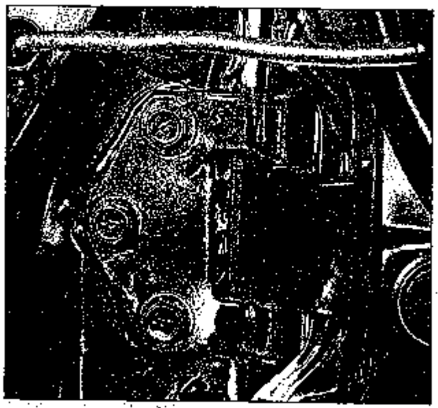
Adjustment

Refer to illustrations 20.9a, 20.9b and 20.9c

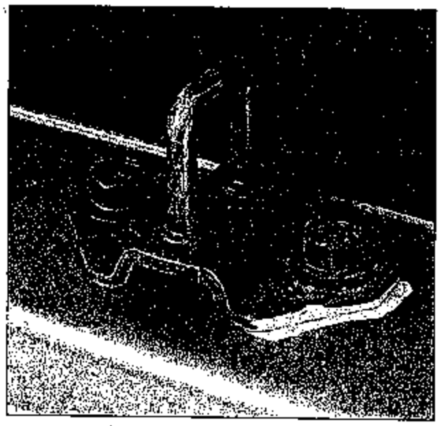
8 Most tailgate door adjustments are made by loosening the hinge-to-tailgate door bolts and moving the tailgate door. Proper alignment is achieved when the top of the tailgate door is aligned with the top of the rear quarter panel. If these goals can't be reached by adjusting the hinge to body or hinge to tailgate door bolts, body alignment shims may have to be purchased and inserted behind the hinges to achieve correct alignment.



22.2 Remove the screws from the lower column cover



20.6b . . . and the lower hinge bolts

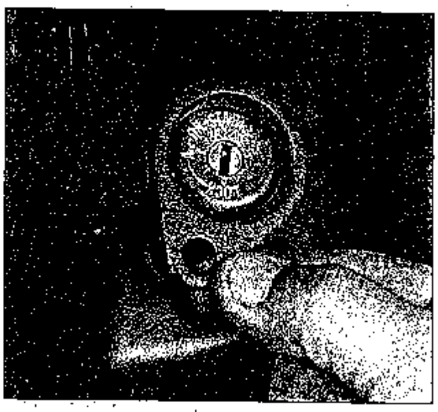


20.9c . . . and a lower striker which can be slightly adjusted for improved rear door sealing

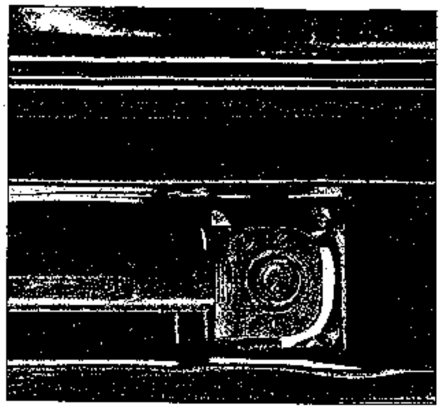
9 Additional alignment can be done by loosening the bolts and repositioning the alignment bar and the strikers **(see illustrations)**.

21 Tailgate (utility models) - removal, refitting and adjustment

Note: *The tailgate is heavy and somewhat awkward to hold - at least two people should perform this procedure.*



22.3 The bezel for the ignition switch is removed from the upper steering column cover



20.9a There is an alignment bar . . .

Removal and refitting

1 Open the tailgate and allow it to hang from the support chains.
2 Use a pencil to mark the exact locations of the hinges.
3 While an assistant supports the tailgate, detach both support chains.
4 Unscrew the hinge to tailgate bolts. and remove the tailgate from the vehicle.
5 Refitting is the reverse of removal.

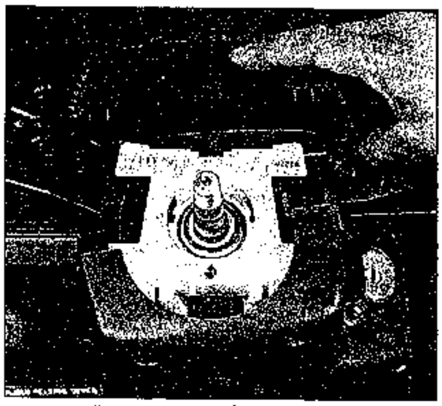
Adjustment

6 Adjustments are made by loosening the hinge-to tailgate bolts and moving the tailgate. Proper alignment is achieved when the edges of the tailgate are parallel with the rear quarter panel and the top of the tailgate.

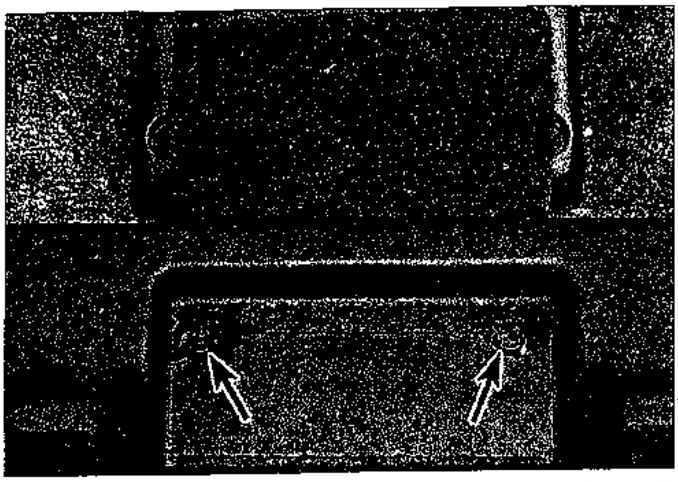
22 Steering column covers - removal and refitting

Refer to illustrations 22.2, 22.3 and 22.4

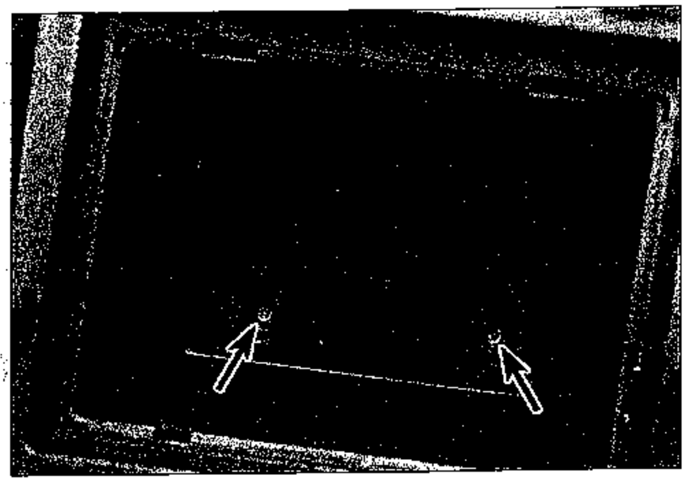
1 Remove the steering wheel (see Chapter 10).
2 Remove the steering column cover screws **(see illustration)**.
3 Remove the ignition switch bezel **(see illustration)**.
4 Separate the cover halves and detach them from the steering column **(see illustration)**.
5 Refitting is the reverse of removal.



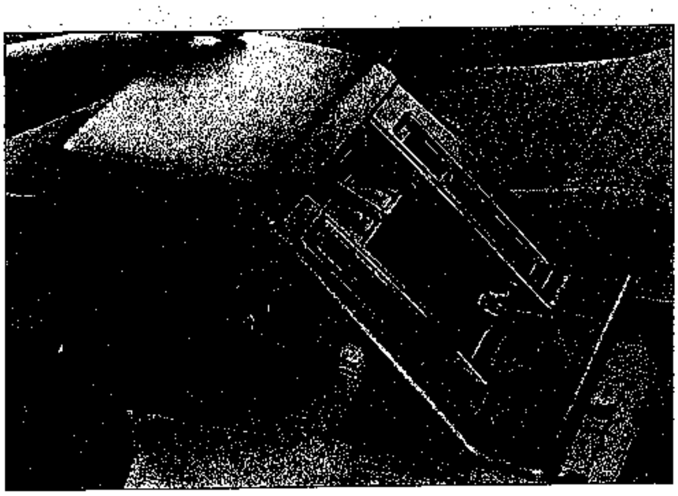
22.4 The two column covers can now be removed



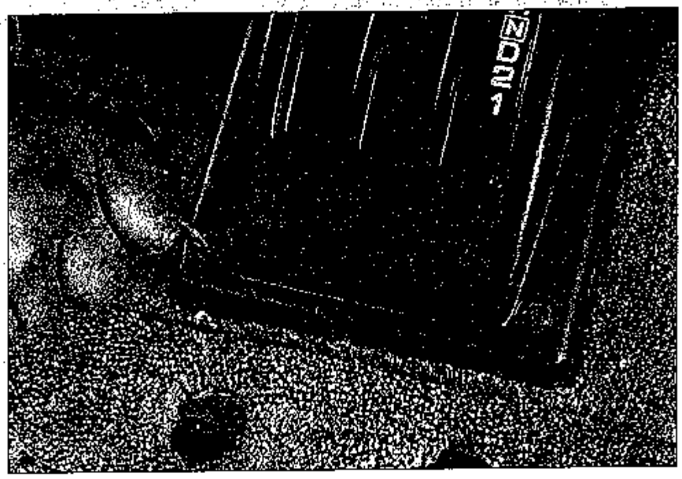
24.1 A small piece of carpet covers two console screws (arrows)



24.2 These screws (arrows) are also covered by carpet in the bottom of the storage compartment



24.4 Lift the console up just enough to disconnect all the wiring beneath it



24.6a The automatic transmission shift lever cover is secured by these screws at the rear

23 Dash trim panels - removal and refitting

Note: *Removal of some trim pieces is covered in Section 25,* Instrument panel removal.

1 All of the dashboard trim panels are held in place by clips and screws. Remove any screws or clips and disengage the trim panels as necessary.

2 Disconnect any wiring harness connectors which would interfere with removal.

3 Refitting is the reverse of removal.

24 Centre console and floor lever trims - removal and refitting

Refer to illustrations 24.1, 24.2 and 24.4

Console

1 Lift the carpet from the front of the console and remove the screws beneath it **(see illustration)**.

2 Lift the carpet from the bottom of the console storage compartment and remove the screws beneath it **(see illustration)**.

3 Raise the console and disconnect the wiring, such as the power window harness, if any.

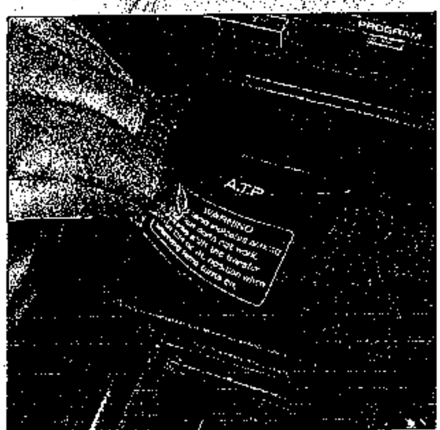
4 Lift the console over the parking brake lever assembly and remove it from the vehicle **(see illustration)**.

5 Refitting is the reverse of removal. Use a dab of RTV silicone sealer or weatherstrip adhesive to fasten the carpet, if necessary.

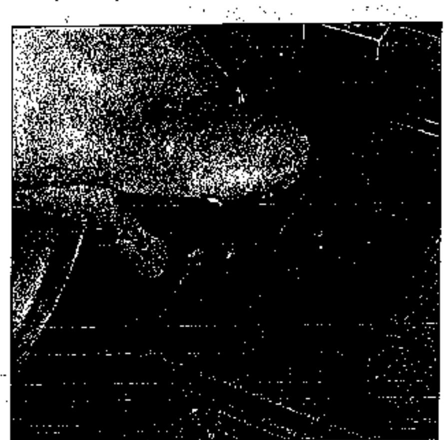
Floor lever trim panels

Refer to illustrations 24.6a, 24.6b, 24.6c, 24.7, 24.8 and 24.9

6 Remove the retaining screws from the trim panel **(see illustrations)**.



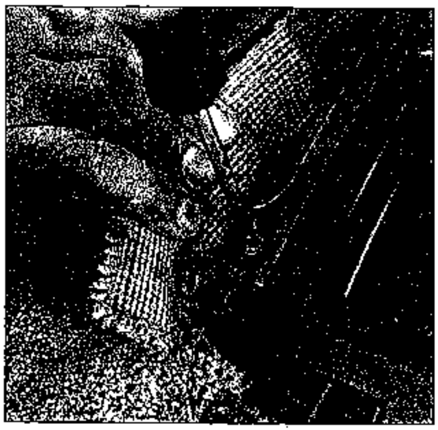
24.6b Peel back this label . . .



24.6c . . . to reveal the screw under it

24.7 There is a small lamp for illumination of the indicator which can be disconnected after the cover is carefully lifted

24.8 The transfer case lever knob is removed for access to the boot



24.9 The boot mounting plate can be removed after pulling back the carpet for access to these screws

7 Lift the cover over the handle and remove the automatic transmission lamp **(see illustration)**. Remove the cover.
8 Remove the transfer case shift lever **(see illustration)**.
9 Pull back the carpet and remove the shift lever boot mounting screws **(see illustration)**.
10 Lift the mounting plate and the boot from the floor.

25 Instrument panel - removal and refitting

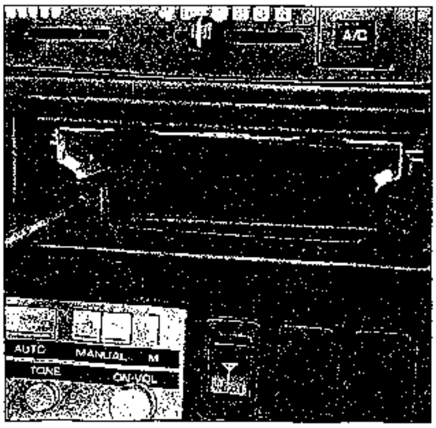
Refer to illustrations 25.5a, 25.5b, 25.8, 25.9a, 25.9b, 25.10, 25.12, 25.13a, 25.13b, 25.14, 25.15a, 25.15b, 25.15c, 25.15d, 25.15e, 25.16 and 25.17

1 Disconnect the negative battery cable.
2 Remove the steering wheel (see Chapter 10).
3 Remove the steering column covers (refer to Section 22).
4 Remove the instrument cluster bezel (refer to Chapter 12).
5 Disconnect the cables for the various cable-controlled mechanisms (such as the fuel door release, bonnet release and the stabiliser release) from beneath the dash **(see illustrations)**.

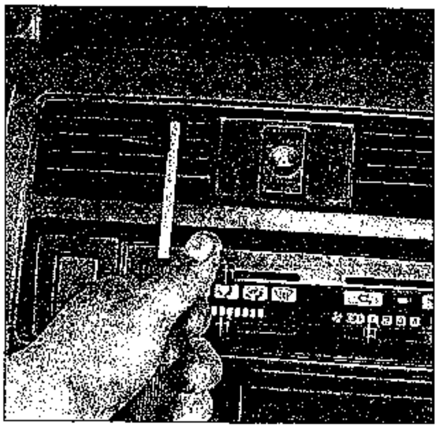
25.5a Remove the fuel door cable bracket . . .

25.5b . . . and the cable assembly for the bonnet release

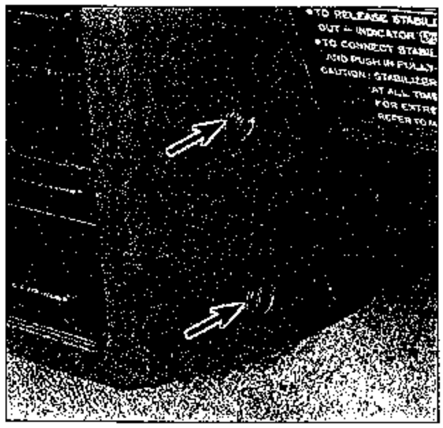
6 Remove the screws, then remove the trim panel below the steering column. **Note:** *There are many fasteners used in the instrument panel assembly. Lay out all of the screws, bolts and clips in order as you remove them to prevent confusion later.*
7 Disconnect the hand throttle assembly, if equipped.
8 Remove the ash tray and the screws beneath it **(see illustration)**.
9 Remove all screws retaining the centre section of the dash **(see illustrations)**.
10 Remove the glove compartment unit all the screws around the glove compartment opening **(see illustration)**.



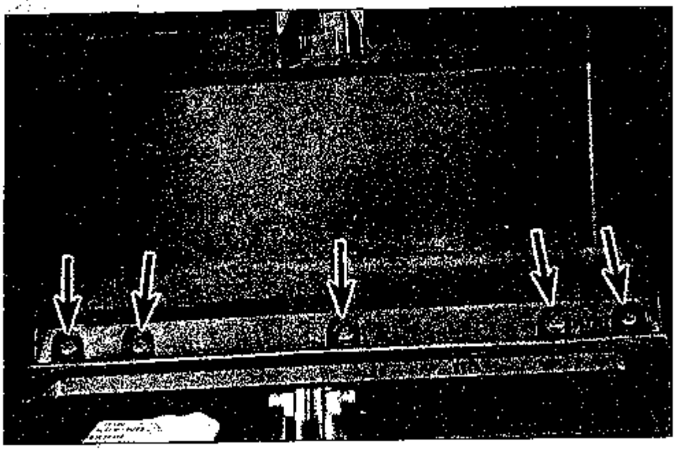
25.8 These screws are visible after the ash tray has been removed



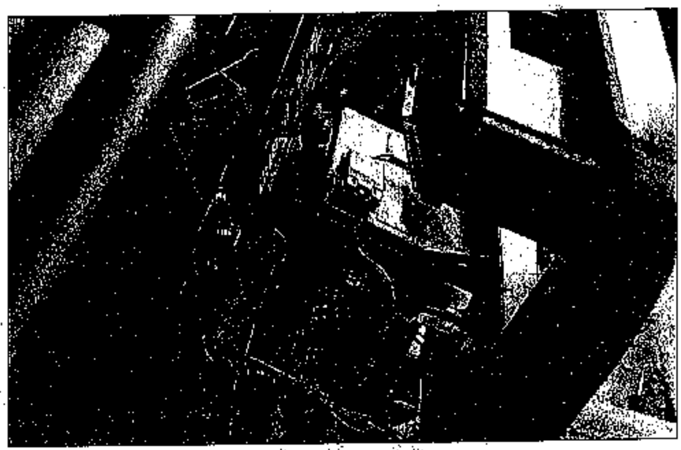
25.9a The cover for the entire centre of the dash is held by screws at several locations



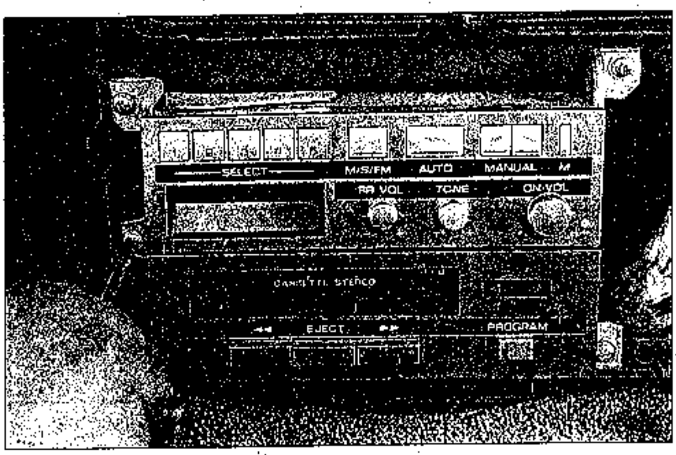
25.9b These screws (arrows) retain the side of the centre dash panel



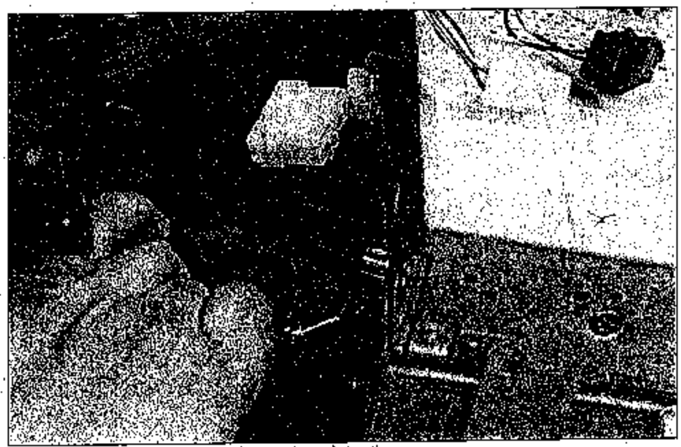
25.10 Open the glove box, remove the screws (arrows) and remove the door. Next remove the remaining screws and pull out the glove compartment itself. There are screws behind it that secure the dash



25.12 After the centre housing has been pulled back, disconnect the wiring for the various controls. Label each to simplify refitting



25.13a Remove the radio mounting screws . . .



25.13b . . . and disconnect the wiring from the radio

11 Pull the transfer case lever and the gear shift lever as far as possible to the rear.

12 Pull the middle dash assembly slightly rearward. Reach behind it and disconnect all remaining wiring harnesses **(see illustration)**. Pull it carefully from the vehicle.

13 Remove the radio screws **(see illustration)**. Pull it slightly rearward and disconnect the wiring from it **(see illustration)**. Withdraw the radio from the vehicle.

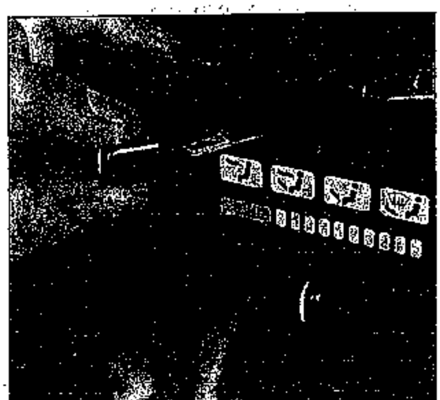
14 Remove the climate control trim panel **(see illustration)**. It will be necessary to release the securing clips as you do this.

15 Remove the covers from the dash screws **(see illustration)**. Remove all of the screws **(see illustrations)**.

16 Check to make certain that all bolts, screws, wiring and cables have been removed from the dash assembly **(see illustration)**.

17 With an assistant to hold one side of the dash, carefully remove it from the vehicle **(see illustration)**.

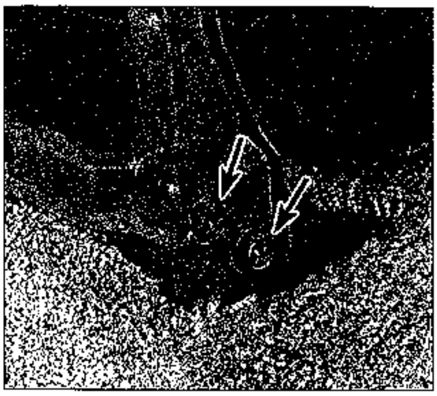
18 Refitting is the reverse of removal. **Note:** *Check the operation of all components as they are refitted. Do not wait until the entire assembly has been completed.*



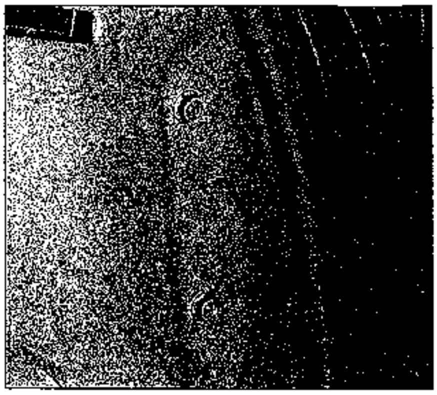
25.14 These knobs must be pulled off of the levers before the face plate can be removed from the heater control assembly

25.15a Several of the dash screws are concealed beneath plastic covers. Pop the covers off with a small screwdriver . . .

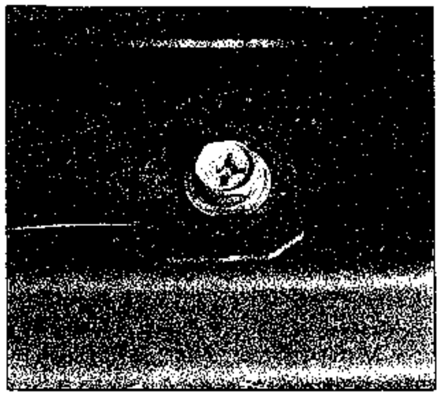
25.15b . . . then remove the screws



25.15c Remove these screws (arrows) to release the bottom of the dash assembly



25.15d Open both doors and remove these screws from the ends of the dash



25.15e Make sure that all fasteners have been removed from the dash. Some (like this one along the top edge) can be overlooked

26 Seats - removal and refitting

Front seat

Refer to illustrations 26.2a and 26.2b

1 Position the seat all the way forward and then all the way to the rear to access the front seat retaining bolts.

2 Remove the retaining bolts **(see illustrations)**.

3 Tilt the seat upward to access the bottom, then disconnect any electrical connectors and lift the seat from the vehicle.

4 Refitting is the reverse of removal.

Rear seat

5 Fold the seat forward, then remove the mounting bolts from the back of the rear seat.

6 Remove the front bolts.

7 Lift up on the lower edge of the seat back and remove it from the vehicle.

8 Refitting is the reverse of removal.

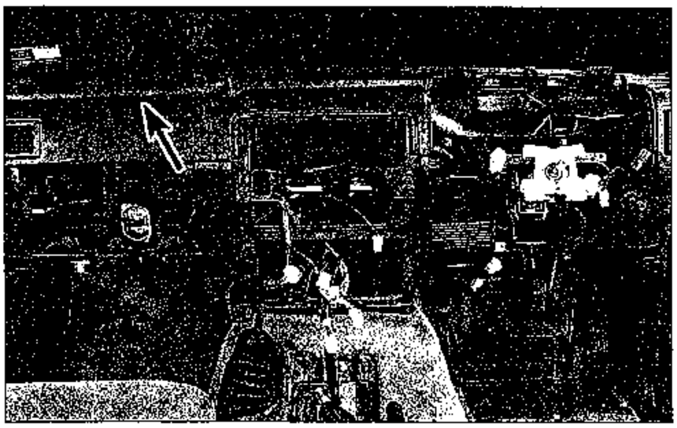
Cargo area seat

Refer to illustration 26.9

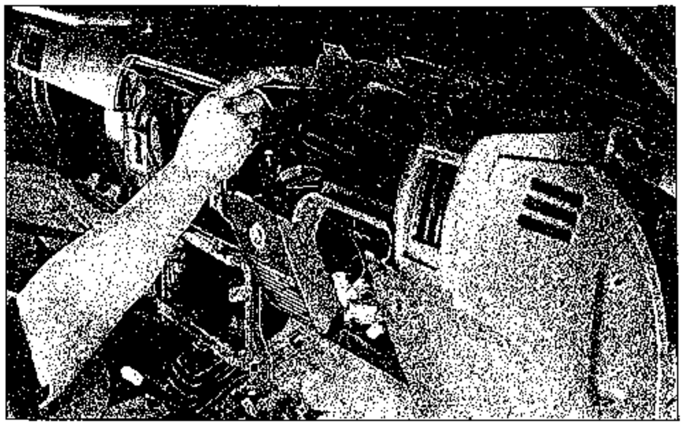
9 Fold the seat up and forward, then unbolt the hinge assembly from the floor **(see illustration)**.

10 Remove the seat.

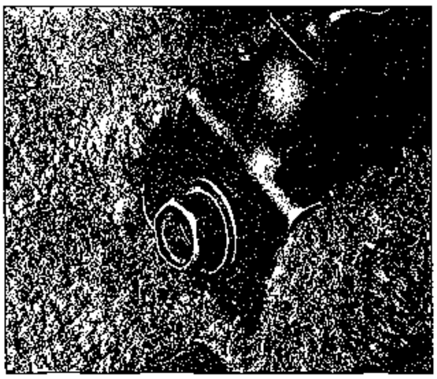
11 Refitting is the reverse of removal.



25.16 Get an assistant to help you pull the dash slowly towards the rear. It can be done without removing the combination switch if you are very careful. The grab bar (arrow) is a good gripping point on the passenger's side

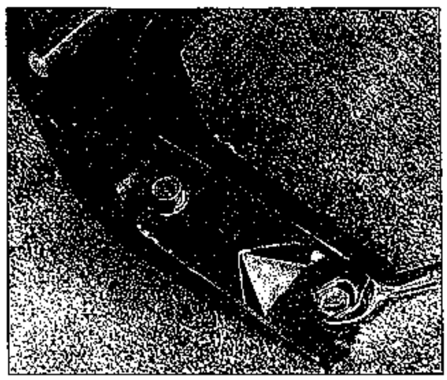


25.17 Make certain that nothing is caught on it as you guide it through the door opening



26.2a The bolts for the front . . .

26.2b . . . and rear of the front seat can be removed after sliding the seat from one extreme to the other



26.9 The cargo area seat is retained by a hinge assembly. Fold the seat forward and the remove the mounting bolts

Notes

Chapter 12
Chassis electrical system

Contents

1 General information

The electrical system is a 12-volt, negative earth type. Power for the lights and all electrical accessories is supplied by a lead/acid-type battery which is charged by the alternator.

This Chapter covers repair and service procedures for the various electrical components not associated with the engine. Information on the battery, alternator, distributor and starter motor can be found in Chapter 5.

It should be noted that when any portion of the electrical system is serviced, the cable should be disconnected from the negative battery terminal to prevent electrical shorts and/or fires.

2 Electrical troubleshooting - general information

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 electrical connectors that link the component to both the battery and the chassis. To help you pinpoint an electrical circuit problem, wiring diagrams are included at the end of this Chapter.

Before tackling any troublesome electrical circuit, first study the appropriate wiring diagrams to get a complete understanding of what makes up that individual circuit. Trouble spots, for instance, can often be narrowed down by noting if other components related to the circuit are operating properly. If several components or circuits fail at one time, chances are the problem is in a fuse or earth connection, because several circuits are often routed through the same fuse and earth connections.

Electrical problems usually stem from simple causes, such as loose or corroded connections, a blown fuse, a melted fusible link or a bad relay. Visually inspect the condition of all fuses, wires and connections in a problem circuit before troubleshooting it.

If testing instruments are going to be utilised, use the diagrams to plan ahead of time where you will make the necessary connections in order to accurately pinpoint the trouble spot.

The basic tools needed for electrical troubleshooting include a circuit tester or voltmeter (a 12-volt bulb with a set of test leads can also be used), a continuity tester, which includes a bulb, battery and set of test leads, and a jumper wire, preferably with a circuit breaker incorporated, which can be used to bypass electrical components. Before attempting to locate a problem with test instruments, use the wiring diagram(s) to decide where to make the connections.

Voltage checks

Voltage checks should be performed if a circuit is not functioning properly. Connect one lead of a circuit tester to either the negative battery terminal or a known good earth. Connect the other lead to a electrical connector in the circuit being tested, preferably nearest to the battery or fuse. If the bulb of the tester lights, voltage is present, which means that the part of the circuit between the electrical connector and the battery is problem free. Continue checking the rest of the circuit in the same fashion. When you reach a point at which no voltage is present, the problem lies between that point and the last test point with voltage. Most of the time the problem can be traced to a loose connection. **Note:** *Keep in mind that some circuits receive voltage only when the ignition key is in the Accessory or Run position.*

Finding a short

One method of finding shorts in a circuit is to remove the fuse and connect a test light or voltmeter in its place. There should be no voltage present in the circuit. Move the wiring harness from side to side while watching the test light. If the bulb goes on, there is a short to earth somewhere in that area, probably where the insulation has rubbed through. The same test can be performed on each component in the circuit, even a switch.

Earth check

Perform an earth test to check whether a component is properly earthed. Disconnect the battery and connect one lead of a self-powered test light, known as a continuity tester, to a known good earth. Connect the other lead to the wire or earth connection being tested. If the bulb goes on, the earth is good. If the bulb does not go on, the earth is not good.

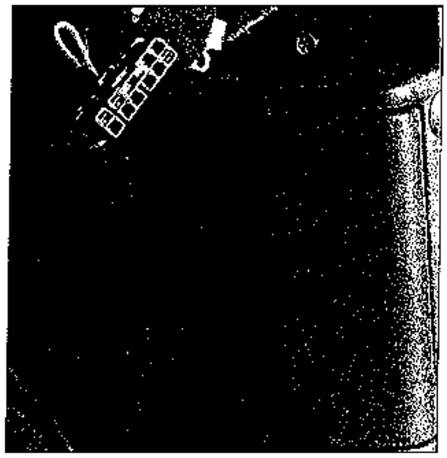
Continuity check

A continuity check is done to determine if there are any breaks in a circuit - if it is passing electricity properly. With the circuit off (no power in the circuit), a self-powered continuity tester can be used to check the circuit. Connect the test leads to both ends of the circuit (or to the "power" end and a good earth), and if the test light comes on the circuit is passing current properly. If the light doesn't come on, there is a break somewhere in the circuit. The same procedure can be used to test a switch, by connecting the continuity tester to the power in and power out sides of the switch. With the switch turned On, the test light should come on.

Finding an open circuit

When diagnosing for possible open circuits, it is often difficult to locate them by sight because oxidation or terminal misalignment are hidden by the electrical connectors. Merely wiggling an electrical connector on a sensor or in the wiring harness may correct the open circuit condition. Remember this when an open circuit is indicated when troubleshooting a circuit. Intermittent problems may also be caused by oxidised or loose connections.

Electrical troubleshooting is simple if you keep in mind that all electrical circuits are basically electricity running from the battery, through the wires, switches, relays, fuses and fusible links to each electrical component (light bulb, motor, etc.) and to earth, from which it is passed back to the battery. Any electrical problem is an interruption in the flow of electricity to and from the battery.


3.1a Remove this cover panel . . .

3 Fuses - general information

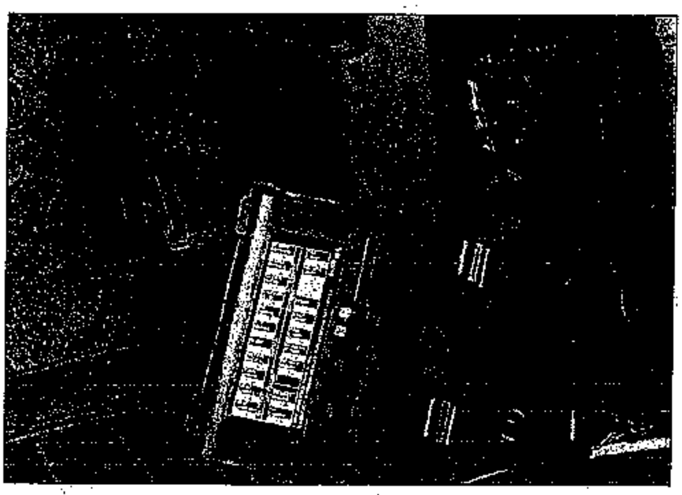
Refer to illustrations 3.1a, 3.1b and 3.3

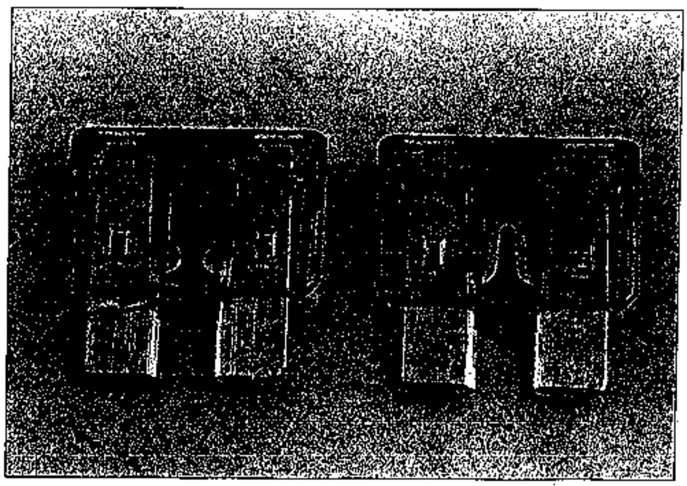
The electrical circuits of the vehicle are protected by a combination of fuses, circuit breakers and fusible links. Fuse blocks are located in the right kick panel and in the engine compartment **(see illustrations)**.

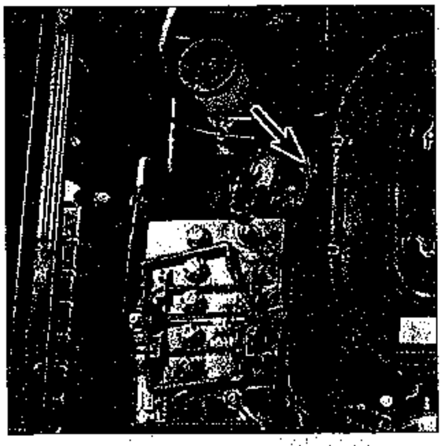
Each of the fuses is designed to protect a specific circuit, and the various circuits are identified on the fuse panel cover.

Miniaturised fuses are employed in the fuse blocks. These compact fuses, with blade terminal design, allow fingertip removal and renewal. If an electrical component fails, always check the fuse first. A blown fuse is easily identified through the clear plastic body. Visually inspect the element for evidence of damage **(see illustration)**.

Be sure to renew blown fuses with the correct amperage rating. Fuses of different ratings are physically interchangeable, but only fuses of the proper rating should be used. Renewing a fuse with one of a higher or lower value than specified is not recommended. Each electrical circuit needs a specific amount


3.1b . . . to access the fuses and relays behind it. There is a spare fuse and a fuse puller on the cover


3.3 When a fuse blows, the element between the terminals burns - the fuse on the left is blown; the fuse on the right is good



4.2 The fusible links are connected to the positive terminal of the battery. Be sure to disconnect the negative terminal before working on them

of protection. The amperage value of each fuse is moulded into the fuse body.

If the replacement fuse immediately fails, don't renew it again until the cause of the problem is isolated and corrected. Fuses do not wear out. There is always another component in the system which caused the fuse to blow. In most cases, this will be a short circuit in the wiring caused by a broken or deteriorated wire.

4 Fusible links - general information

Refer to illustration 4.2

Some circuits are protected by fusible links. The links are used in circuits which are not ordinarily fused, such as the ignition circuit.

There are several fusible links located adjacent to the battery in the engine compartment. They can be easily inspected for melting **(see illustration)**.

Conventional type fusible links cannot be repaired, a new link of the same gauge should be refitted in its place. The procedure is as follows:

a) Disconnect the cable from the negative battery terminal.
b) Disconnect the fusible link from the wiring harness.
c) Cut the damaged fusible link out of the wiring just behind the connector.
d) Strip the insulation back approximately 10 mm.
e) Position the connector on the new fusible link and crimp it into place.
f) Use rosin core solder at each end of the new link to obtain a good solder joint.
g) Use plenty of electrical tape around the soldered joint. No wires should be exposed.
h) Connect the battery earth (negative) cable. Test the circuit for proper operation.

5 Circuit breakers - general information

Circuit breakers can protect components such as, power windows, power door locks and headlights. Not all models utilise circuit breakers.

On some models, the circuit breaker resets itself automatically, so an electrical overload in a circuit breaker protected system will cause the circuit to fail momentarily, then come back on. If the circuit doesn't come back on, check it immediately. Once the condition is corrected, the circuit breaker will resume its normal function. Some circuit breakers must be reset manually.

6 Relays - general information and testing

General information

Refer to illustrations 6.1a and 6.1b

1 Several electrical accessories in the vehicle, such as the fuel injection system, horns, starter, and fog lamps use relays to transmit the electrical signal to the component. Relays use a low-current circuit (the control circuit) to open and close a high-current circuit (the power circuit). If the relay is defective, that component will not operate properly. The various relays are mounted in the engine compartment, at the fuse box and in other locations throughout the vehicle **(see illustrations)**. If a faulty relay is suspected, it can be removed and tested using the procedure below or by a dealer service department or a repair shop. Defective relays must be renewed as a unit.

Testing

2 It's best to refer to the wiring diagram for the circuit to determine the proper hookups for the relay you're testing. However, if you're not able to determine the correct hook-up from the wiring diagrams, you may be able to determine the test hook-ups from the information that follows.

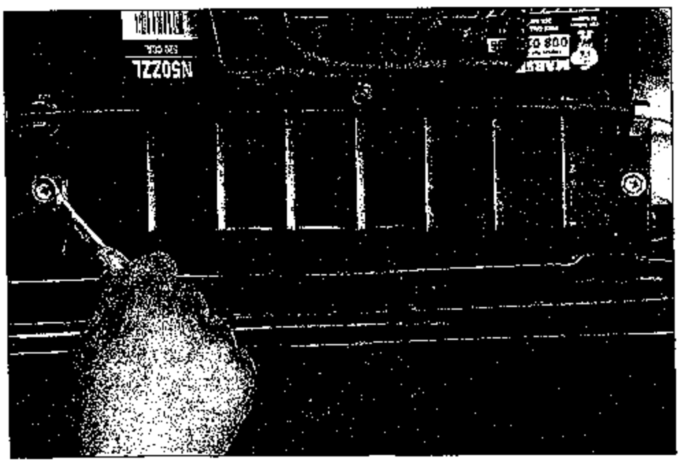
3 On most relays, two of the terminals are the relay's control circuit (they connect to the relay coil which, when energised, closes the large contacts to complete the circuit). The other terminals are the power circuit (they are connected together within the relay when the control-circuit coil is energised).

4 The relays are usually marked as an aid to help you determine which terminals are the control circuit and which are the power circuit.

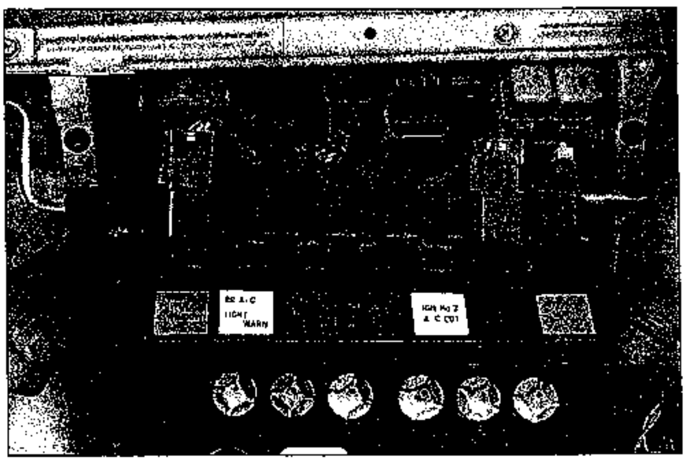
5 Connect a fused jumper wire between one of the two control circuit terminals and the positive battery terminal. Connect another jumper wire between the other control circuit terminal and earth. When the connections are made, the relay should click. On some relays, polarity may be critical, so, if the relay doesn't click, try swapping the jumper wires on the control circuit terminals.

6 With the jumper wires connected, check for continuity between the power circuit terminals as indicated by the markings on the relay.

7 If the relay fails any of the above tests, renew it.

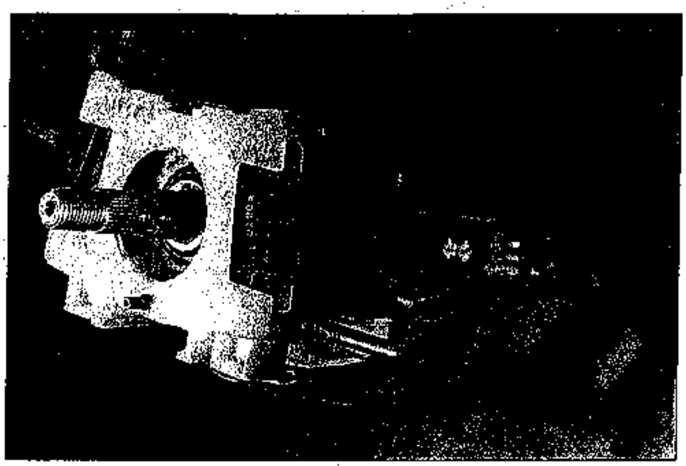


6.1a Two screws secure the cover over the relay box



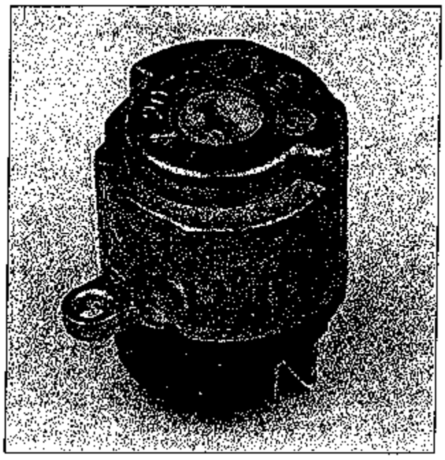
6.1b The relays are clearly labeled. As they operate, they emit a clicking which can be heard and felt

8.4 Disconnect the wiring from the rear of the combination switch before loosening the retaining screw

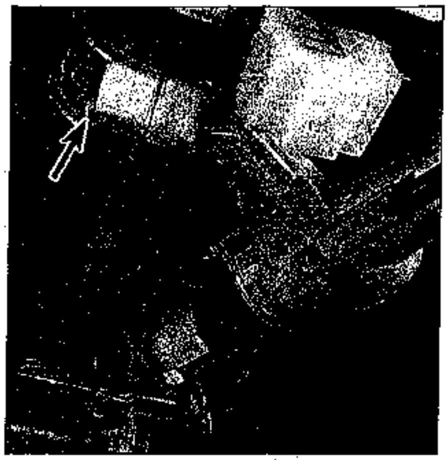


8.7a The individual switches can be removed from the combination switch by removing the mounting screws . . .

8.7b . . . then simply lift the switch off



9.5 The ignition switch is secured by a single screw



9.9 The two shear screws (arrow) must be drilled out in order to remove the entire housing

7 Turn signal and hazard flasher - check and renewal

1 The turn signal/hazard flasher is contained (in most models) in a single small unit located in the wiring harness under the dash to the left of the steering column.

2 When the flasher unit is functioning properly, an audible click can be heard during its operation. If the turn signals fail on one side or the other and the flasher unit does not make its characteristic clicking sound, a faulty turn signal bulb is indicated.

3 If both turn signals fail to blink, the problem may be due to a blown fuse, a faulty flasher unit, a broken switch or a loose or open connection. If a quick check of the fuse box indicates that the turn signal fuse has blown, check the wiring for a short before refitting a new fuse.

4 To renew the flasher, simply pull it out of the socket.

5 Make sure that the new unit is identical to the original. Compare the old one to the new one before refitting it.

6 Refitting is the reverse of removal.

8 Combination switch - removal and refitting

Refer to illustrations 8.4, 8.7a and 8.7b

1 Disconnect the cable from the negative terminal of the battery.

2 Remove the steering wheel (see Chapter 10).

3 Remove the steering column covers (see Chapter 11).

4 Unplug the electrical connectors from the combination switch **(see illustration)**.

5 Remove the retaining screw.

6 Push in on the switch and turn it clockwise. Pull the combination switch from the shaft.

7 Refitting is the reverse of removal. The combination switch must seat correctly with its tab in the hole in the steering column. **Note:** *The wiper/washer switch and the light switch can both be removed from the switch base and renewed independently* **(see illustrations)**.

9 Ignition switch and lock cylinder - removal and refitting

Ignition switch

Refer to illustration 9.5

1 Disconnect the cable from the negative terminal of the battery.

2 Remove the lower steering column cover (see Chapter 11).

3 Remove the switch retaining screw.

4 Disconnect the wiring harness from the switch.

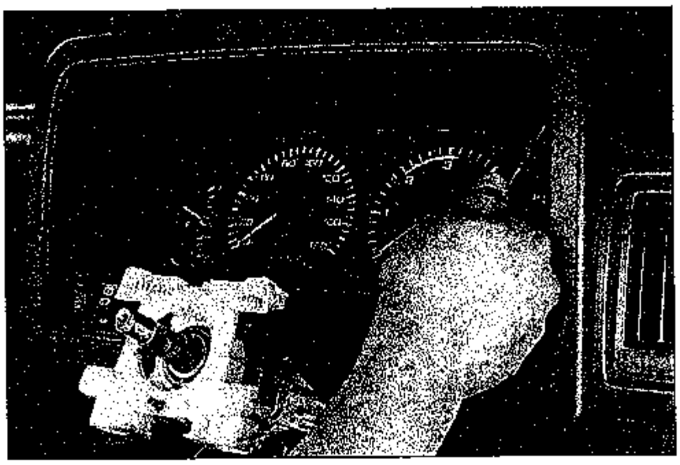
5 Remove the switch **(see illustration)**.

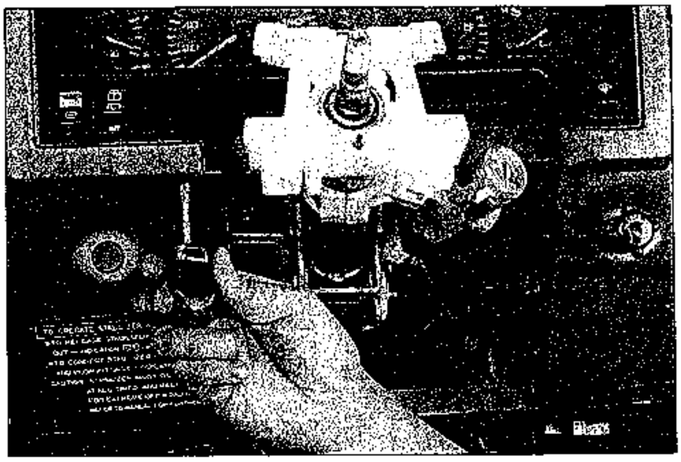
6 Refitting is the reverse of removal.

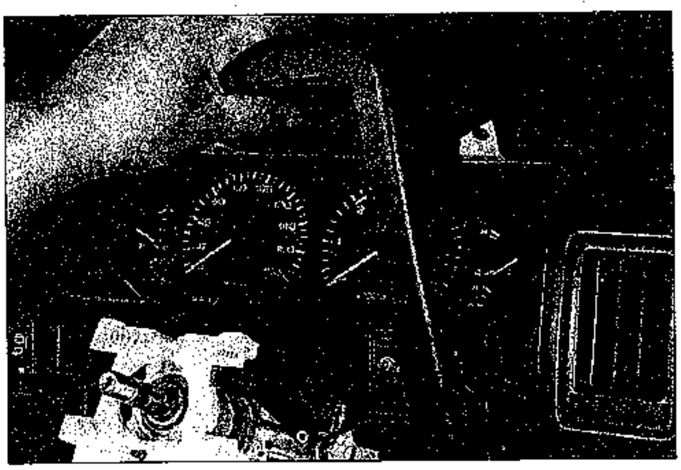
Lock cylinder

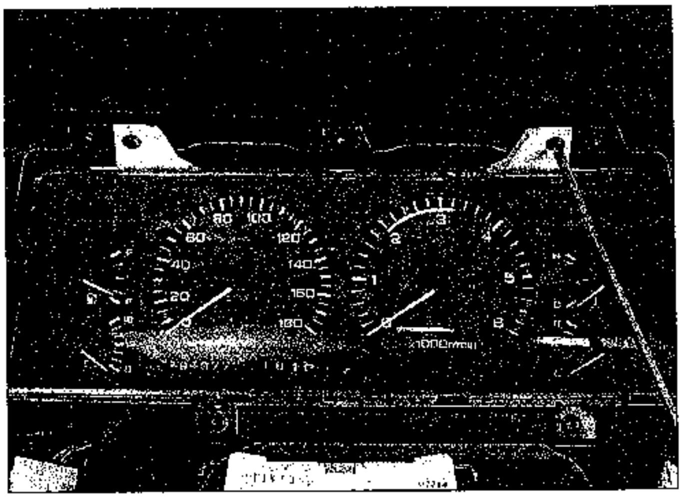
Refer to illustration 9.9

7 Remove the steering column covers (refer to Chapter 11).


11.2a Remove the instrument cluster bezel upper screws


11.2b The bezel lower screws are removed next


11.3 Pull the bezel off. Some components are removed here for clarity - be careful to avoid scratching the upper steering column cover when it is in place


11.4a There are four cluster screws

8 Using a small nail or punch to depress the lock cylinder retaining pin, pull straight out on the lock cylinder assembly to remove it from the vehicle.
9 To refit the lock cylinder, depress the retaining pin and guide the lock cylinder into the steering column housing until the retaining pin extends back into the locating hole in the steering column housing. **Note:** *The lock cylinder housing is secured to the steering shaft with two shear bolts* **(see illustration)**. *These will have to be drilled out if the entire assembly is to be renewed.*
10 The remainder of the refitting is the reverse of removal.

10 Instrument panel gauges - check

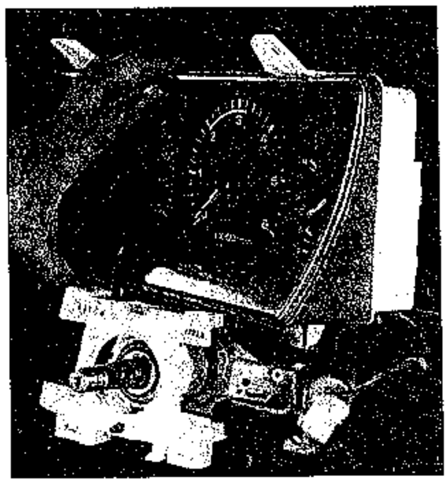
Fuel, oil and temperature gauges

1 All tests below require the ignition switch to be turned to ON position when testing.
2 If the gauge pointer does not move from the empty, low or cold positions, check the fuse. If the fuse is good, locate the particular sending unit for the circuit you're working on (see Chapter 4 for fuel sending unit location, Chapter 2 for the oil sending unit location or Chapter 3 for the temperature sending unit location). Connect the sending unit connector to earth. If the pointer goes to the full, high or hot position renew the sending unit. If the pointer stays in same position, use a jumper wire to earth the sending unit terminal on the back of the gauge, if necessary, refer to the wiring diagrams at the end of this Chapter. If the pointer moves, the problem lies in the wire between the gauge and the sending unit. If the pointer does not move with the sending unit terminal on the back of the gauge earthed, check for voltage at the other terminal of the gauge. If voltage is present, renew the gauge.

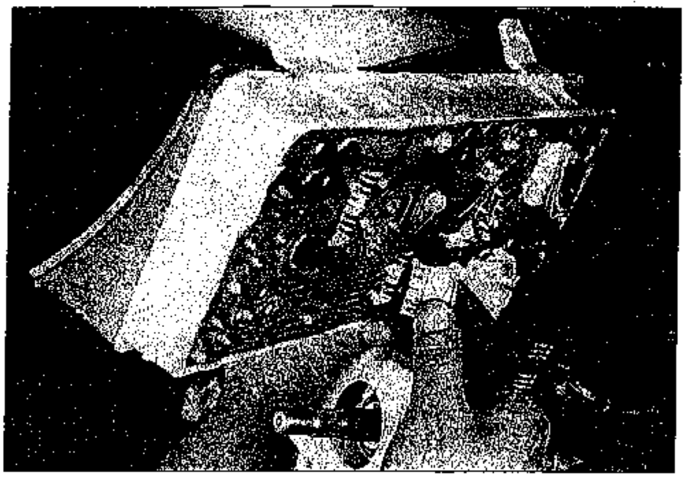
11 Instrument cluster - removal and refitting

Refer to illustrations 11.2a, 11.2b, 11.3, 11.4a, 11.4b and 11.5

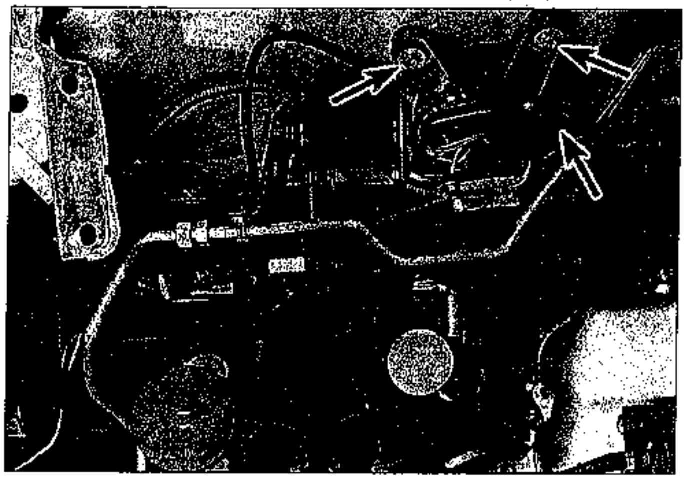
1 Disconnect the negative battery cable.


11.4b Lift the cluster out only slightly . . .

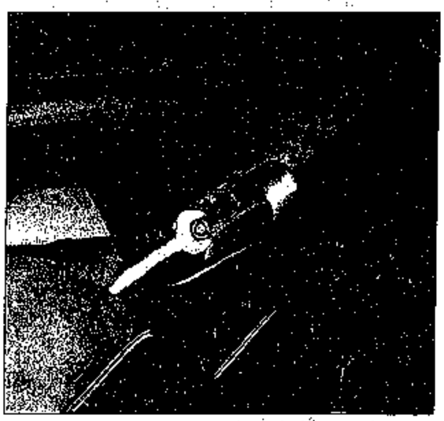
2 Remove the cluster bezel screws **(see illustrations)**.
3 Remove the instrument cluster bezel **(see illustration)**.
4 Remove the cluster mounting screws **(see illustrations)** and pull the instrument



11.5 . . . and then disconnect the wiring



12.10 Remove the mounting bolts (arrows)



12.14a Prise up the cover from the rear wiper arm nut and then remove it

12.14b Unscrew the retaining nut . . .

12.14c . . . remove the nut . . .

cluster towards the steering wheel.

5 Disconnect any electrical connectors that would interfere with removal **(see illustration)**.

6 Cover the steering column with a cloth to protect the trim covers then remove the instrument cluster from the vehicle.

7 Refitting is the reverse of removal.

12 Wiper motor - removal and refitting

Wiper motor circuit check

Note: *Refer to the wiring diagrams for wire colours and locations in the following checks. Keep in mind that power wires are generally larger in diameter and brighter colours, where earth wires are usually smaller in diameter and darker colours. When checking for voltage, probe an earthed 12-volt test light to each terminal at a connector until it lights; this verifies voltage (power) at the terminal.*

1 If the wipers work slowly, make sure the battery is in good condition and has a strong charge (see Chapter 1). If the battery is in good condition, remove the wiper motor (see below) and operate the wiper arms by hand. Check for binding linkage and pivots. Lubricate or repair the linkage or pivots as necessary. Refit the wiper motor. If the wipers still operate slowly, check for loose or corroded connections, especially the earth connection. If all connections look correct, renew the motor.

2 If the wipers fail to operate when activated, check the fuse. If the fuse is good, connect a jumper wire between the wiper motor and earth, then retest. If the motor works now, repair the earth connection. If the motor still doesn't work, turn on the wipers and check for voltage at the motor. If there's no voltage at the motor, remove the motor and check it off the vehicle with fused jumper wires from the battery. If the motor now works, check for binding linkage (see Step 1 above). If the motor still doesn't work, renew it. If there's no voltage at the motor, check for voltage at the switch. If there's no voltage at the switch, check the wiring between the switch and fuse panel for continuity. If the wiring is good, the switch is probably bad.

3 **If the wipers only work on one speed,** check the continuity of the wires between the switch and motor. If the wires are good, renew the switch.

4 **If the interval (delay) function is inoperative,** check the continuity of all the wiring between the switch and motor. If the wiring is good, renew the interval module.

5 **If the wipers stop at the position they're in when the switch is turned off (fail to park),** check for voltage at the wiper motor when the wiper switch is OFF but the ignition is ON. If voltage is present, the limit switch in the motor is malfunctioning. Renew the wiper motor. If no voltage is present, trace and repair the limit switch wiring between the fuse panel and wiper motor.

6 **If the wipers won't shut off unless the ignition is OFF,** disconnect the wiring from the wiper control switch. If the wipers stop, renew the switch. If the wipers keep running, there's a defective limit switch in the motor; renew the motor.

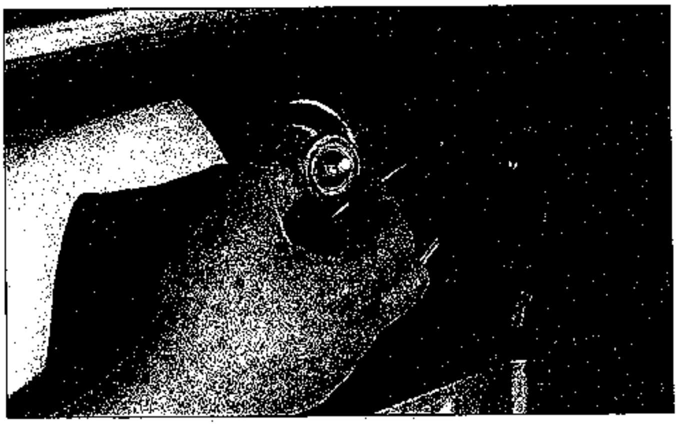
7 **If the wipers won't retract below the bonnet line,** check for mechanical obstructions in the wiper linkage or on the vehicle's body which would prevent the wipers from parking. If there are no obstructions, check the wiring between the switch and motor for continuity. If the wiring is good, renew the wiper motor.

Wiper motor renewal

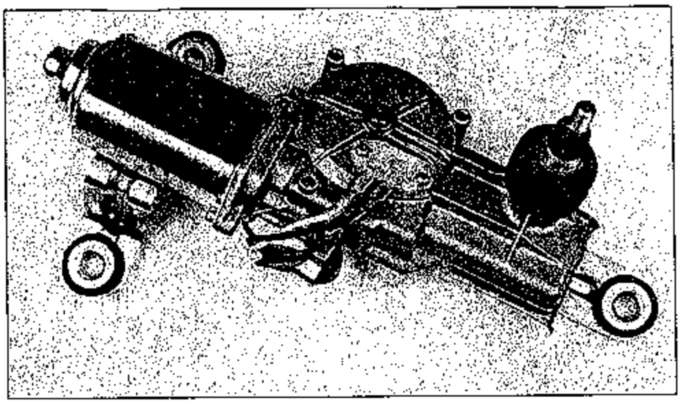
Front

Refer to illustration 12.10

8 Disconnect the negative battery cable.



12.14d . . . and lift off the washer



12.17 The rear wiper motor with the harness disconnected. Do not disconnect the wires shown

9 Disconnect the wiring from the motor.
10 Remove the mounting bolts and pull the motor out slightly **(see illustration)**.
11 Disconnect the wiper transmission from the motor. Remove the motor.
12 Refitting is the reverse of removal.

Rear

Refer to illustrations 12.14a, 12.14b, 12.14c, 12.14d and 12.17

13 Disconnect the negative battery cable.
14 Remove the wiper arm (refer to Chapter 1). It may be necessary to first remove the spare tyre. Remove the nut and bezel from the wiper shaft **(see illustrations)**.
15 Remove the inner door panel (refer to Chapter 11).
16 Disconnect the wiring from the motor.
17 Unbolt the motor and remove it **(see illustration)**.
18 Refitting is the reverse of removal.

13 Radio and speakers - removal and refitting

1 Disconnect the negative battery cable.

Radio

2 Remove the centre dash bezel (refer to Chapter 11).
3 Remove the screws and pull the radio out far enough to access the rear of it.
4 Disconnect the aerial and the wiring harness from the rear of the radio, then remove the radio.
5 Refitting is the reverse of removal.

Speakers

Refer to illustration 13.7

6 Remove the door trim panel (see Chapter 11).
7 Remove the speaker retaining screws. Disconnect the electrical connector and remove the speaker from the vehicle **(see illustration)**.
8 Refitting is the reverse of removal.

14 Aerial - removal and refitting

1 Detach the radio and disconnect the aerial lead from the rear side of the radio (see Section 13). Attach a piece of stiff wire to the end of the aerial lead, then remove any retaining clips under the instrument panel securing the aerial lead.
2 On vehicles equipped with fixed type antennas, use a small spanner and remove the aerial mast retaining nut.
3 Using a pair of snap ring pliers or similar tool, remove the aerial base retaining nut.
4 On vehicles equipped with a power aerial, remove the aerial motor mounting screws from the inner fender well.
5 Pull the aerial up and out to remove it until you can see the wire, then remove the old aerial lead from the wire and renew it with the new aerial lead.
6 Working in the passenger compartment, pull the wire and the aerial lead rearward into the passenger compartment.
7 The remainder of refitting is the reverse of removal.

15 Rear window defogger - check and repair

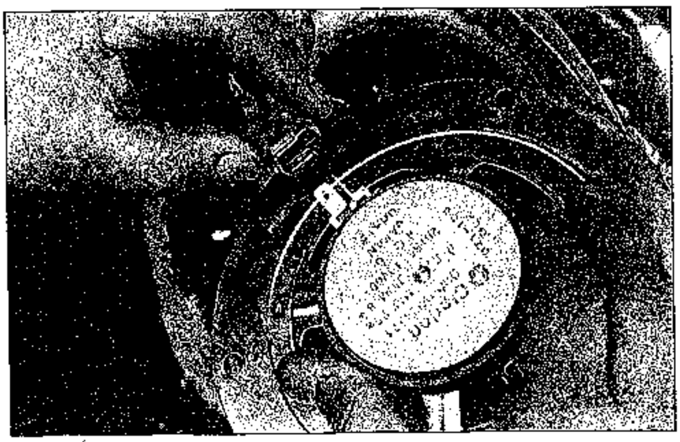
Refer to illustration 15.1

1 The rear window defogger consists of a number of horizontal elements laminated onto the glass surface **(see illustration)**.
2 Small breaks in the element can be repaired without removing the rear window.

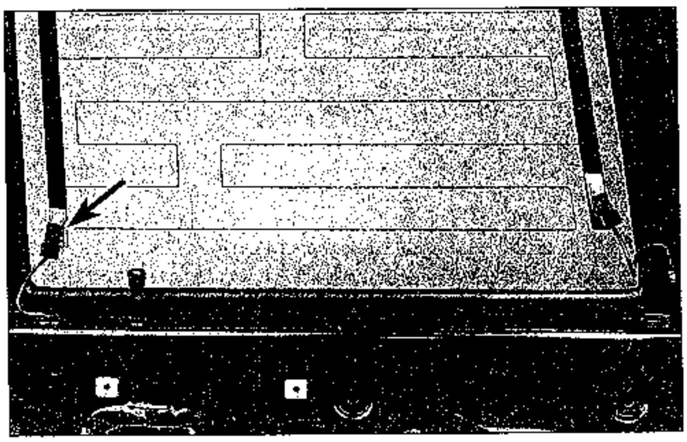
Check

Refer to illustrations 15.4, 15.5 and 15.7

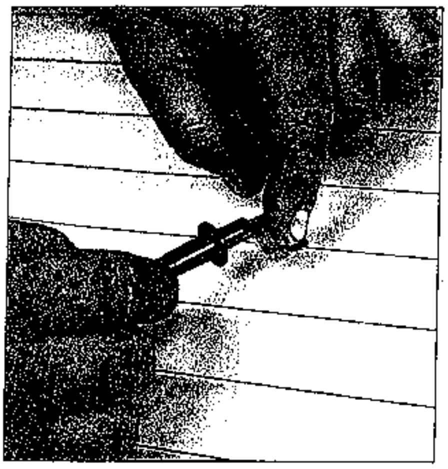
3 Turn the ignition switch and defogger system switches to the ON position.



13.7 Disconnect the speaker wiring after removing it from the door frame



15.1 The defogger circuit consists of a 12 volt input (arrow) and an earth at the other end of the grid



15.4 When measuring the voltage at the rear window defroster grid, wrap a piece of aluminium foil around he negative probe and press the foil against the wire with your finger

15.5 To determine if a heating element has broken, check the voltage at the centre of each element - if the voltage is 6-volts, the element is unbroken - if the voltage is 12-volts, the element is broken between the centre and the positive end - if there is no voltage, the element is broken between the centre and the earth

15.7 To find the break, place the voltmeter positive probe against the defogger positive terminal, place the voltmeter negative probe with the foil strip against the heating element at the positive terminal and slide it toward the negative terminal - the point at which the voltmeter reading changes abruptly is the point at which the element is broken

4 When measuring voltage during the next two tests, wrap a piece of aluminium foil around the tip of the voltmeter negative probe and press the foil against the heating element with your finger **(see illustration)**.

5 Check the voltage at the centre of each heating element **(see illustration)**. If the voltage is 6-volts, the element is okay (there is no break). If the voltage is 12-volts, the element is broken between the centre of the element and the positive end. If the voltage is 0-volts the element is broken between the centre of the element and earth.

6 Connect the negative lead to a good earthing point. The reading should stay the same.

7 To find the break, place the voltmeter positive lead against the defogger positive terminal. Place the voltmeter negative lead with the foil strip against the heating element at the positive terminal end and slide it toward the negative terminal end. The point at which the voltmeter deflects from zero to several volts is the point at which the heating element is broken **(see illustration)**.

Repair

Refer to illustration 15.13

8 Repair the break in the element using a repair kit specifically recommended for this purpose, such as Dupont paste No. 4817 (or equivalent). Included in this kit is plastic conductive epoxy.

9 Prior to repairing a break, turn off the system and allow it to cool off for a few minutes.

10 Lightly buff the element area with fine steel wool, then clean it thoroughly with isopropyl alcohol.

11 Use masking tape to mask off the area being repaired.

12 Thoroughly mix the epoxy, following the instructions provided with the repair kit.

13 Apply the epoxy material to the slit in the masking tape, overlapping the undamaged area about 20 mm on each end **(see illustration)**.

14 Allow the repair to cure for 24 hours before removing the tape and using the system.

16 Headlights - removal and refitting

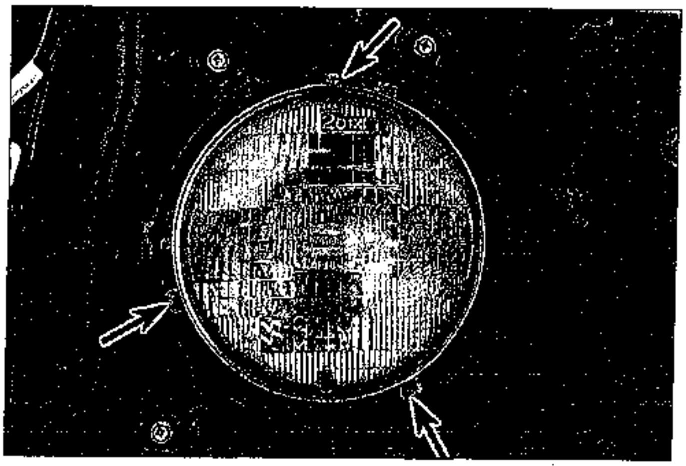
1 Disconnect the negative cable from the battery.

Sealed beam type

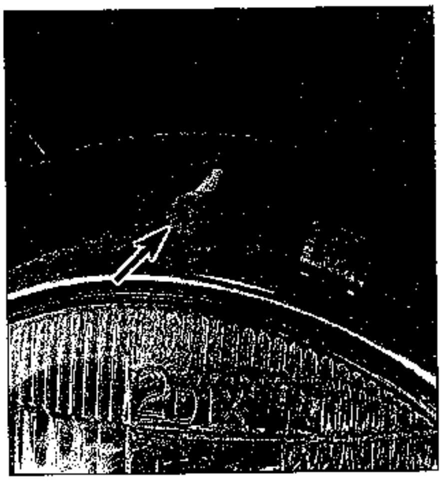
Refer to illustration 16.4

2 Remove the grille/headlight trim bezel on utility and cab chassis models (refer to Chapter 11).

15.13 To use a defogger repair kit, apply masking tape to the inside of the window at the damaged area, then brush on the special conductive coating



16.4 These are the three screws which retain the headlight. The other screws should not be touched

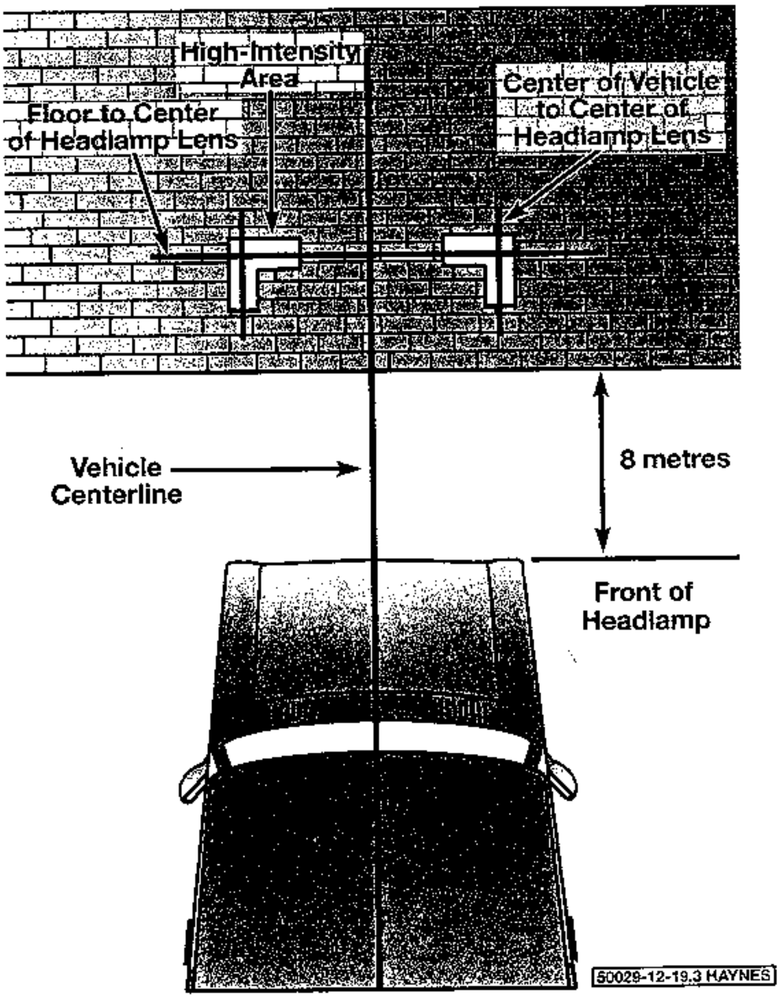


17.1 There are two adjustment screws for each headlight. This (arrow) is an upper one for the vertical adjustment

3 Whenever renewing a headlight, be careful not to turn the spring-loaded adjusting screws of the headlight, as this will alter the aim.
4 Remove the screws which secure the retaining ring and withdraw the ring. Support the light as this is done **(see illustration)**.
5 Pull the headlight out slightly and disconnect the electrical connector from the rear of the light. Remove the light from the vehicle.
6 Position the new unit close enough to connect the electrical connector. Make sure that the numbers moulded into the lens are at the top.
7 Refit the retaining ring with its mounting screws and spring.
8 Check the headlights for proper operation and adjustment. If the adjusting screws were not altered, the new headlight will not need to have its aim adjusted.
9 Refit the radiator grille if necessary.

Halogen bulb-type

Warning: *Halogen gas filled bulbs are under pressure and may shatter if the surface is scratched or the bulb is dropped. Wear eye protection and handle the bulbs carefully, grasping only the base whenever possible. Do not touch the surface of the bulb with your fingers because the oil from your skin could cause it to overheat and fail prematurely. If you do touch the bulb surface, clean it with isopropyl alcohol.*
10 Reach behind the headlight assembly and unplug the electrical connector.
11 Grasp the bulb holder securely and rotate it counterclockwise to remove it from the housing.
12 Remove the rubber cover from the rear of the headlight.
13 Turn the bulb counter-clockwise to remove it from the bulb holder. Without touching the glass with your bare fingers, insert the new bulb assembly into the headlight housing.

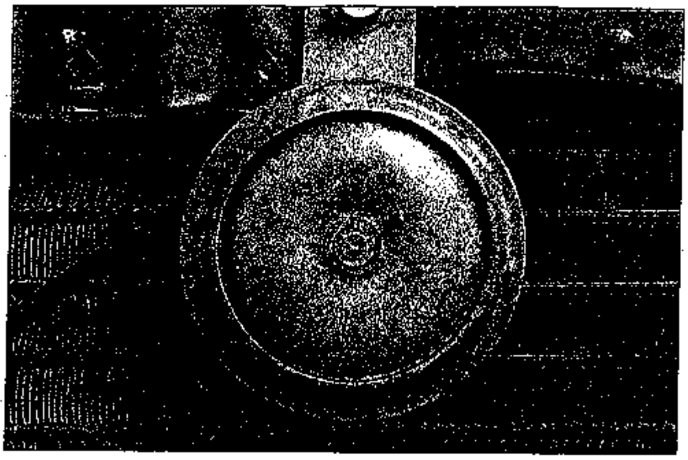


17.3 Headlight adjustment details

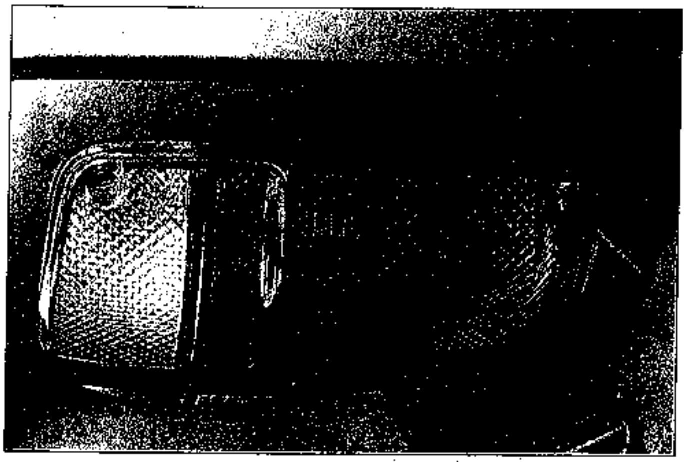
14 Plug in the electrical connector. Test headlight operation, then close the bonnet.

17 Headlights - adjustment

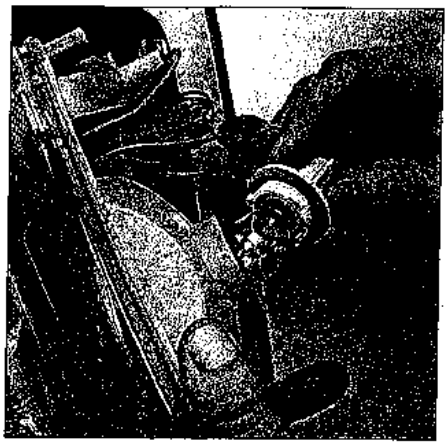
Refer to illustrations 17.1 and 17.3
Note: *The headlights must be aimed correctly. If adjusted incorrectly they could blind the driver of an oncoming vehicle and cause a serious accident or seriously reduce your ability to see the road. The headlights should be checked for proper aim every 12 months and any time a new headlight is refitted or front end body work is performed. It should be emphasised that the following procedure is only an interim step which will provide temporary adjustment until the headlights can be adjusted by a properly equipped shop.*
1 All headlights have two spring loaded adjusting screws, one on the top or bottom controlling up-and-down movement and one on the side controlling left-and-right movement **(see illustration)**.
2 There are several methods of adjusting the headlights. The simplest method requires a blank wall 8 meters in front of the vehicle and a level floor.
3 Position masking tape vertically on the wall in reference to the vehicle centre line and the centre lines of both headlights **(see illustration)**.
4 Position a horizontal tape line in reference to the centre line of all the headlights. **Note:** *It may be easier to position the tape on the wall with the vehicle parked close to the wall.*
5 Adjustment should be made with the vehicle sitting level, the fuel tank half-full and no unusually heavy load in the vehicle.
6 Starting with the low beam adjustment, position the high intensity zone so it is 5 centimetres below the horizontal line and 5 centimetres to the side of the headlight vertical line away from oncoming traffic. Adjustment is made by turning the top or bottom adjusting screw to raise or lower the beam. The adjusting screw on the side should be used in the same manner to move the beam left or right.
7 With the high beams on, the high intensity zone should be vertically centred with the



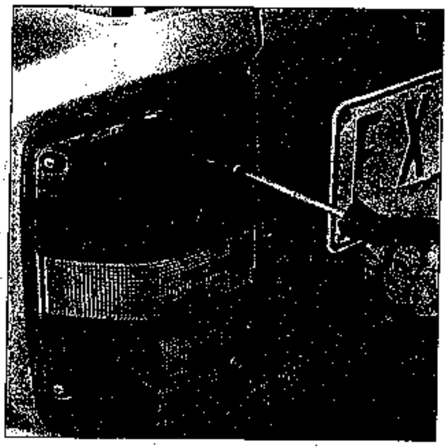
18.9 The horn is secured by a single bolt. It is easiest to remove the horn if the grille is removed completely



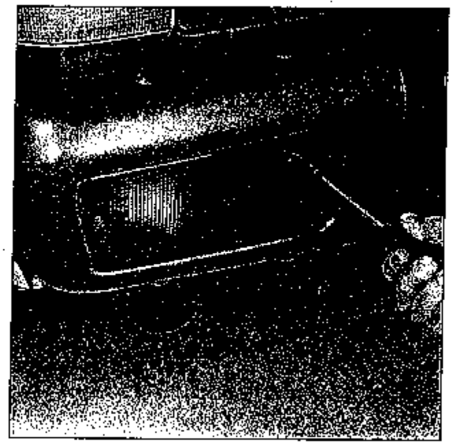
19.1 Most exterior lights are serviced like this turn signal assembly - remove the Phillips head screws and pull it out



19.2 The bulb holder can be removed by turning it counter-clockwise



19.8a Both styles of rear lights are removed with a Phillips screwdriver . . .



19.8b . . . some units are located in the bumper

exact centre just below the horizontal line. **Note:** *It may not be possible to position the headlight aim exactly for both high and low beams. If a compromise must be made, keep in mind that the low beams are the most used and have the greatest effect on driver safety.*

8 Have the headlights adjusted by a dealer service department or service station at the earliest opportunity.

18 Horn - check and renewal

Check

Note: *Check the fuses before beginning electrical diagnosis.*

1 Remove the grille, if necessary and disconnect the electrical connector from the horn.

2 To test the horn, connect battery voltage to the two terminals (or to the terminal and earth) with a pair of jumper wires. If the horn doesn't sound, renew it.

3 If the horn does sound, check for voltage at the terminal when the horn button is depressed. If there's voltage at the terminal, check for a bad earthing point at the horn.

4 If there's no voltage at the horn, check the relay (see Section 6). Note that most horn relays are either the four-terminal or externally earthed three-terminal type.

5 If the relay is good, check for voltage to the relay power and control circuits. If either of the circuits is not receiving voltage, inspect the wiring between the relay and the fuse panel.

6 If both relay circuits are receiving voltage, depress the horn button and check the circuit from the relay to the horn button for continuity to earth. If there's no continuity, check the circuit for an open. If there's no open circuit, renew the horn button.

7 If there's continuity to earth through the horn button, check for an open or short in the circuit from the relay to the horn.

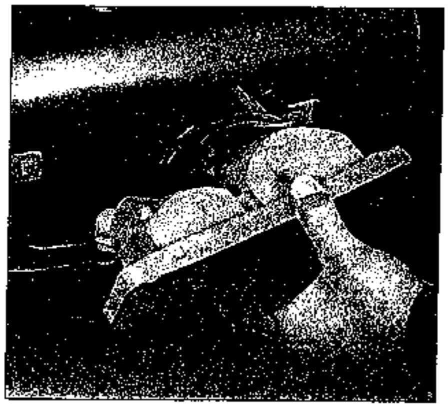
Renewal

Refer to illustration 18.9

8 Remove the radiator grille (see Chapter 11).

9 To renew the horn(s), disconnect the electrical connector and remove the bracket bolt **(see illustration)**.

10 Refitting is the reverse of removal.



19.8c Pull the assembly out . . .

19 Bulb renewal

Front combination or turn signal light

Hardtop and wagon models

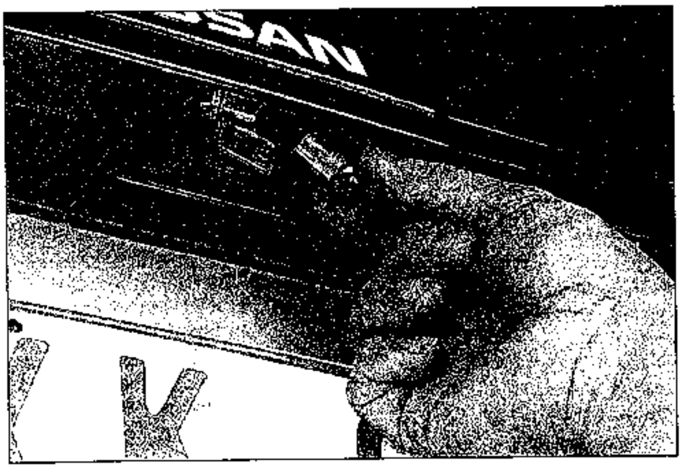
Refer to illustrations 19.1 and 19.2

1 Remove the light assembly **(see illustration)**.

19.9 . . . then remove the bulb holder

19.15a The number plate light should be checked periodically to avoid a citation. If it is defective, remove the screws . . .

19.15b . . . then prise off the lens



19.16 The bulb is then accessible

19.18 A typical side marker light can be pried off with a screwdriver. A card slipped between the blade and the paint is a good idea

2 Turn the bulb holder one quarter turn counter-clockwise and remove it from the rear of the light **(see illustration)**.
3 For parking light bulbs pull the bulb from the socket. For turn signal bulbs, push the bulb inward and turn it counter-clockwise to remove it.
4 Refitting is the reverse of removal.

Early utility and cab chassis models

5 Remove the lens and gasket from the light.
6 Push the bulb inward and turn it counter-clockwise to remove it from the socket.
7 Clean the socket if necessary. Refitting is the reverse of removal.

Rear combination or turn signal light

Hardtop and wagon models

Refer to illustrations 19.8a, 19.8b, 19.8c and 19.9

8 Remove the light from the rear of the vehicle **(see illustrations)**.
9 Turn the bulb holder one quarter turn counter-clockwise and remove it from the rear of the light. **(see illustration)**.
10 Push the bulb inward and turn it counter-clockwise to remove it.
11 Refitting is the reverse of removal.

Utility and cab chassis models

12 Remove the lens and gasket from the light.
13 Push the bulb inward and turn it counter-clockwise to remove it from the socket.
14 Clean the socket if necessary. Refitting is the reverse of removal.

Number plate light

Refer to illustrations 19.15A, 19.15b and 19.16

15 Remove the screws and detach the lens and gasket **(see illustrations)**.
16 Remove the bulb from the socket by pushing inwards and turning it counter-clockwise **(see illustration)**.
17 Refitting is the reverse of removal.

Side marker light

Refer to illustrations 19.18 and 19.19

18 Remove the side marker light from the vehicle **(see illustration)**.
19 Turn the bulb holder one quarter turn counter-clockwise and remove it from the light **(see illustration)**.

19.19 Twist the bulb holder to get at the bulb inside

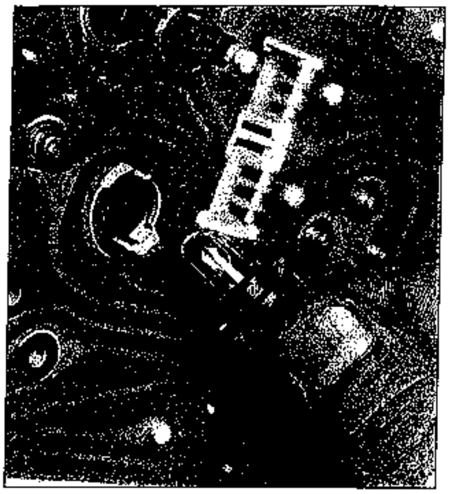
20 Push the bulb inward and turn it counter-clockwise to remove it.
21 Refitting is the reverse of removal.

Instrument cluster lights

Refer to illustration 19.23

22 To gain access to the instrument cluster

12



19.23 Each bulb holder in the rear of the instrument panel can be twisted and then removed

illumination bulbs, the instrument cluster will have to be removed (see Section 11). The bulbs can then be renewed from the rear of the cluster.
23 Rotate the holders counterclockwise to remove them **(see illustration)**. Pull the bulbs out.
24 Refitting is the reverse of removal.

Interior light

Hardtop and wagon models

25 Prise the interior lens off the interior light housing.
26 Pull the bulb directly out of the socket.
27 Refitting is the reverse of removal.

Utility and cab chassis models

28 Rotate the round lens (if used) counterclockwise to remove it.
29 Use a screwdriver to carefully prise off the square lens (if used).
30 Pull the bulb directly out. If it is difficult to remove, prise downward on one end with a small screwdriver. Do not prise on the glass.
31 Refitting is the reverse of removal.

Map light

32 Use a small screwdriver to carefully prise the lens from the lamp.
33 Remove the bulb by pushing it inward while turning it counter-clockwise.
34 Refitting is the reverse of removal.

20 Electric side view mirrors - description and check

1 Most electric rear view mirrors use two motors to move the glass; one for up and down adjustments and one for left-right adjustments.
2 The control switch has a selector portion which sends voltage to the left or right side mirror. With the ignition ON but the engine OFF, roll down the windows and operate the mirror control switch through all functions (left-right and up-down) for both the left and right side mirrors.
3 Listen carefully for the sound of the electric motors running in the mirrors.
4 If the motors can be heard but the mirror glass doesn't move, there's probably a problem with the drive mechanism inside the mirror. Remove and disassemble the mirror to locate the problem.
5 If the mirrors don't operate and no sound comes from the mirrors, check the fuse (see Chapter 1).
6 If the fuse is good, remove the mirror control switch from its mounting without disconnecting the wires attached to it. Turn the ignition ON and check for voltage at the switch. There should be voltage at one terminal. If there's no voltage at the switch, check for an open or short in the circuit between the fuse panel and the switch.
7 If there's voltage at the switch, disconnect it. Check the switch for continuity in all its operating positions. If the switch does not have continuity, renew it.
8 Re-connect the switch. Locate the wire going from the switch to earth. Leaving the switch connected, connect a jumper wire between this wire and earth. If the mirror works normally with this wire in place, repair the faulty earth connection.
9 If the mirror still doesn't work, remove the mirror and check the wires at the mirror for voltage. Check with ignition ON and the mirror selector switch on the appropriate side. Operate the mirror switch in all its positions. There should be voltage at one of the switch-to-mirror wires in each switch position (except the neutral "off" position).
10 If there's not voltage in each switch position, check the circuit between the mirror and control switch for opens and shorts.
11 If there's voltage, remove the mirror and test it off the vehicle with jumper wires. Renew the mirror if it fails this test.

21 Cruise control system - description and check

1 The cruise control system maintains vehicle speed with an electrically operated motor located in the engine compartment, which is connected to the accelerator pedal by a cable. The system consists of the cruise control unit, brake switch, control switches and vehicle speed sensor. Some features of the system require special testers and diagnostic procedures which are beyond the scope of this manual. Listed below are some general procedures that may be used to locate common problems.
2 Locate and check the fuse (Section 3).
3 Have an assistant operate the brake lights while you check their operation (voltage from the brake light switch deactivates the cruise control).
4 If the brake lights don't come on or don't shut off, correct the problem and retest the cruise control.
5 Visually inspect the control cable between cruise control motor and the throttle linkage for free movement, renew if necessary.
6 The cruise control system uses a speed sensing device. The speed sensor is located in the speedometer. To test the speed sensor see Chapter 6.
7 Test drive the vehicle to determine if the cruise control is now working. If it isn't, take it to a dealer service department or an automotive electrical specialist for further diagnosis.

22 Power window system - description and check

1 The power window system operates electric motors, mounted in the doors, which lower and raise the windows. The system consists of the control switches, relays, the motors, regulators, glass mechanisms and associated wiring.
2 The power windows can be lowered and raised from the master control switch by the driver or by remote switches located at the individual windows. Each window has a separate motor which is reversible. The position of the control switch determines the polarity and therefore the direction of operation.
3 The circuit is protected by a fuse and a circuit breaker. Each motor is also equipped with an internal circuit breaker, this prevents one stuck window from disabling the whole system.
4 The power window system will only operate when the ignition switch is ON. In addition, many models have a window lockout switch at the master control switch which, when activated, disables the switches at the rear windows and, sometimes, the switch at the passenger's window also. Always check these items before troubleshooting a window problem.
5 These procedures are general in nature, so if you can't find the problem using them, take the vehicle to a dealer service department or other properly equipped repair facility.
6 If the power windows won't operate, always check the fuse first.
7 If only the rear windows are inoperative, or if the windows only operate from the master control switch, check the rear window lockout switch for continuity in the unlocked position. Renew it if it doesn't have continuity.
8 Check the wiring between the switches and fuse panel for continuity. Repair the wiring, if necessary.
9 If only one window is inoperative from the master control switch, try the other control switch at the window. **Note:** *This doesn't apply to the driver's door window.*
10 If the same window works from one switch, but not the other, check the switch

for continuity. If the continuity is not as specified renew the switch.

11 If the switch tests valid, check for a short or open in the circuit between the affected switch and the window motor.

12 If one window is inoperative from both switches, remove the trim panel from the affected door and check for voltage at the switch and at the motor while the switch is operated.

13 If voltage is reaching the motor, disconnect the glass from the regulator (see Chapter 11). Move the window up and down by hand while checking for binding and damage. Also check for binding and damage to the regulator. If the regulator is not damaged and the window moves up and down smoothly, renew the motor. If there's binding or damage, lubricate, repair or renew parts, as necessary.

14 If voltage isn't reaching the motor, check the wiring in the circuit for continuity between the switches and motors. You'll need to consult the wiring diagram for the vehicle. If the circuit is equipped with a relay, check that the relay is earthed properly and receiving voltage.

15 Test the windows after you are done to confirm proper repairs.

23 Power door lock system - description and check

Refer to illustration 23.2

The power door lock system operates the door lock actuators mounted in each door. The system consists of the switches, actuators, a control unit and associated wiring. Diagnosis can usually be limited to simple checks of the wiring connections and actuators for minor faults which can be easily repaired. In-depth diagnosis should be left to a dealership service department.

Power door lock systems are operated by bi-directional solenoids located in the doors **(see illustration)**. The lock switches have two operating positions: Lock and Unlock. When activated, the switch sends an earth signal to the door lock control unit to lock or unlock the doors. Depending on which way the switch is activated, the control unit reverses polarity to the solenoids, allowing the two sides of the circuit to be used alternately as the feed (positive) and earth side.

23.2 The door lock solenoid is at the base of the door

Some vehicles may have an anti-theft systems incorporated into the power locks. If you are unable to locate the trouble using the following general Steps, consult your a dealer service department.

1 Always check the circuit protection first. Some vehicles use a combination of circuit breakers and fuses.

2 Operate the door lock switches in both directions (Lock and Unlock) with the engine off. Listen for the click of the solenoids operating.

3 Test the switches for continuity. Renew the switch if there's not continuity in both switch positions.

4 Check the wiring between the switches, control unit and solenoids for continuity. Repair the wiring if there's no continuity.

5 Check for a bad earth at the switches or the control unit.

6 If all but one lock solenoids operate, remove the trim panel from the affected door (see Chapter 11) and check for voltage at the solenoid while the lock switch is operated One of the wires should have voltage in the Lock position; the other should have voltage in the Unlock position.

7 If the inoperative solenoid is receiving voltage, renew the solenoid.

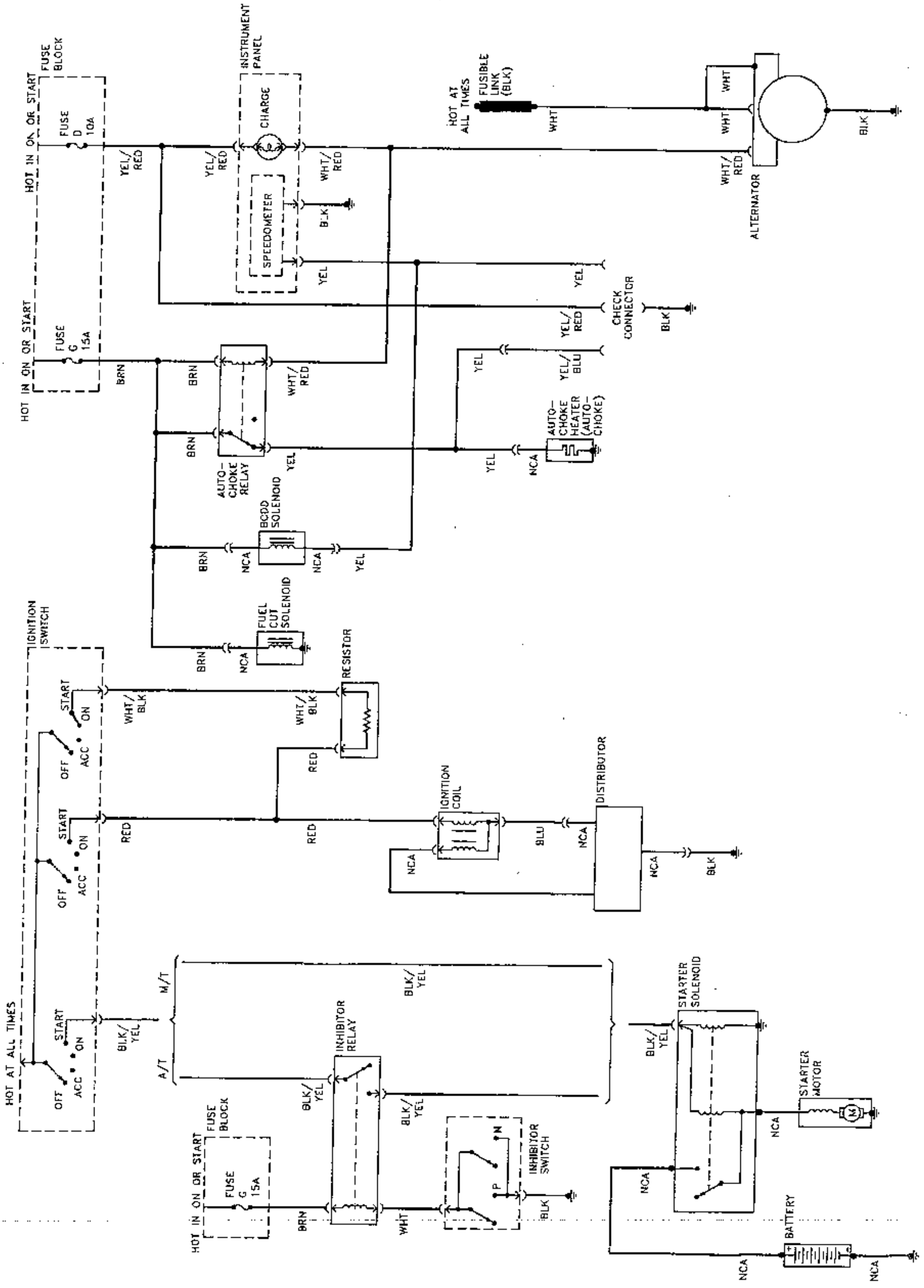
8 If the inoperative solenoid isn't receiving voltage, check the relay or for an open or short in the wire between the lock solenoid and the control unit. **Note:** *It's common for wires to break in the portion of the harness between the body and door (opening and closing the door fatigues and eventually breaks the wires).*

24 Wiring diagrams - general information

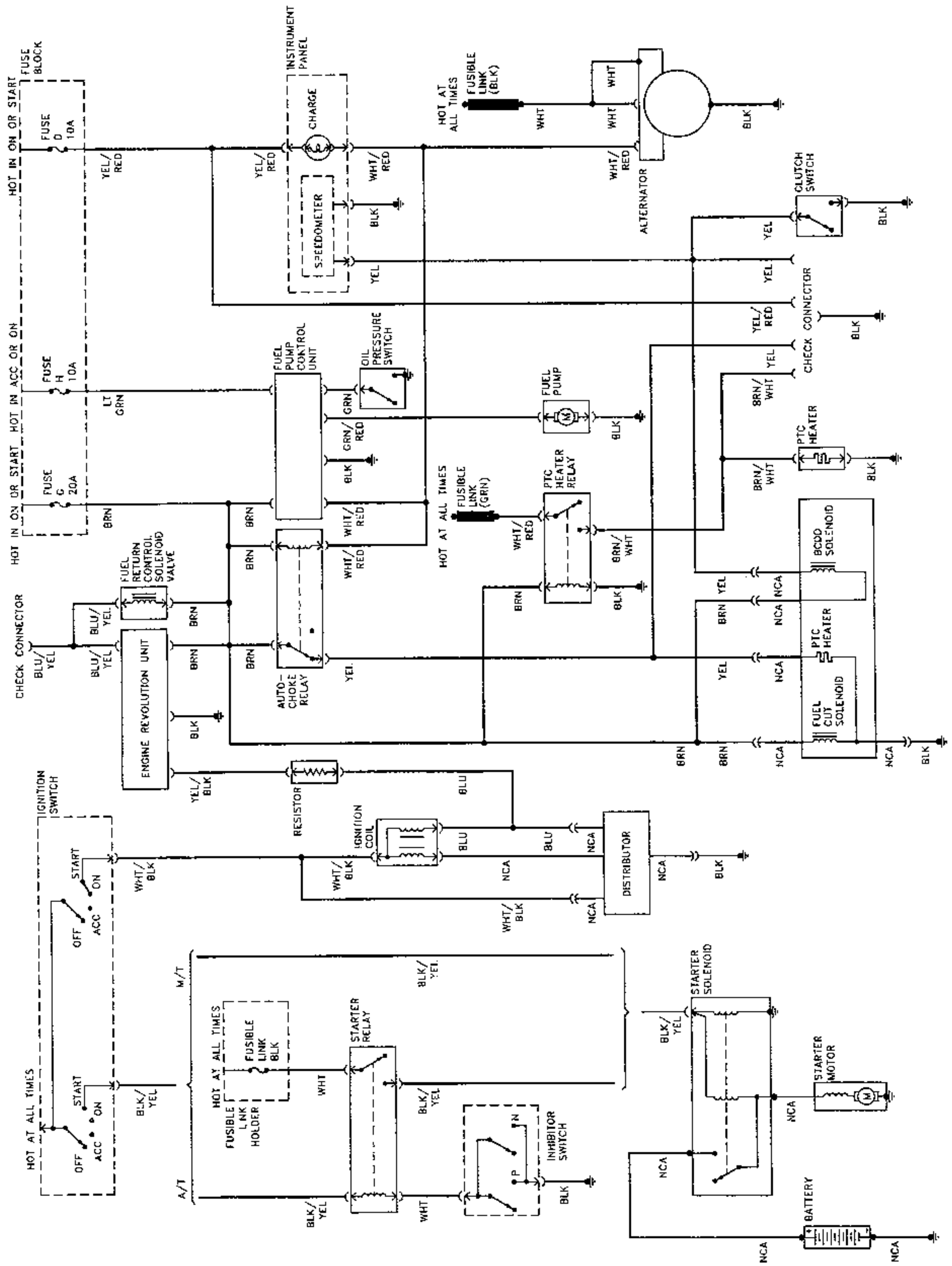
Since it isn't possible to include all wiring diagrams for every year covered by this manual, the following diagrams are those that are typical and most commonly needed.

Prior to troubleshooting any circuits, check the fuse and circuit breakers (if equipped) to make sure they're in good condition. Make sure the battery is properly charged and check the cable connections (see Chapter 1).

When checking a circuit, make sure that all connectors are clean, with no broken or loose terminals. When unplugging a connector, do not pull on the wires. Pull only on the connector housings themselves.

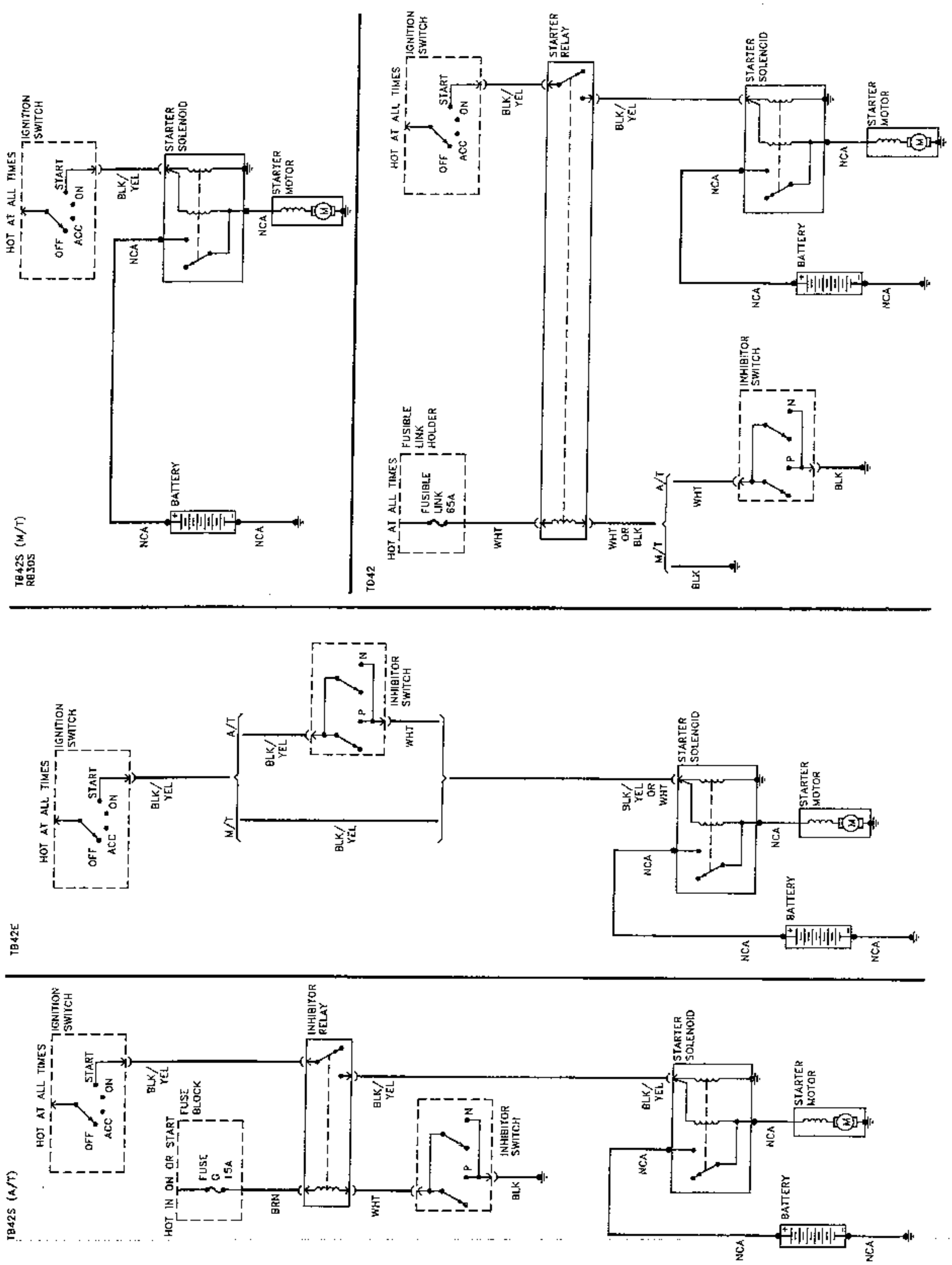


Starting, charging and ignition system - 1988 models

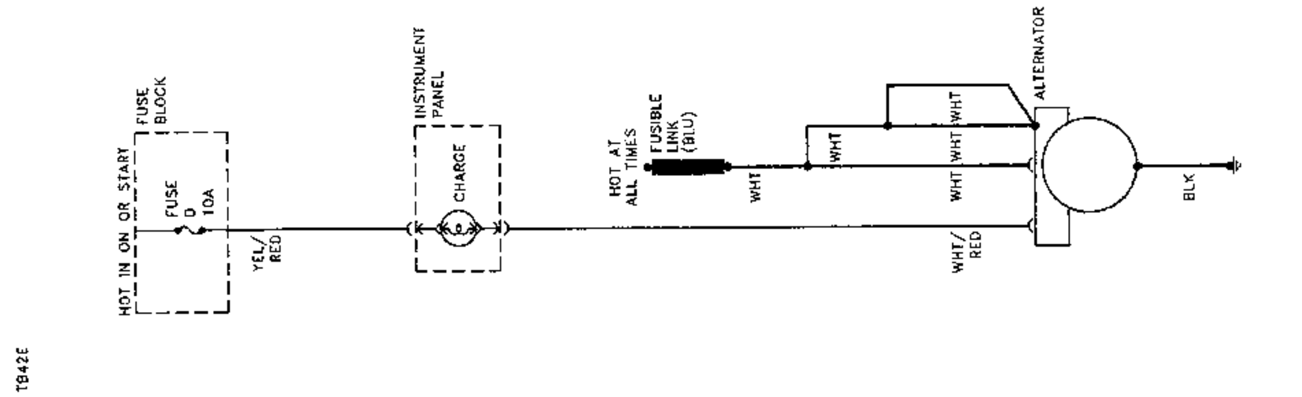


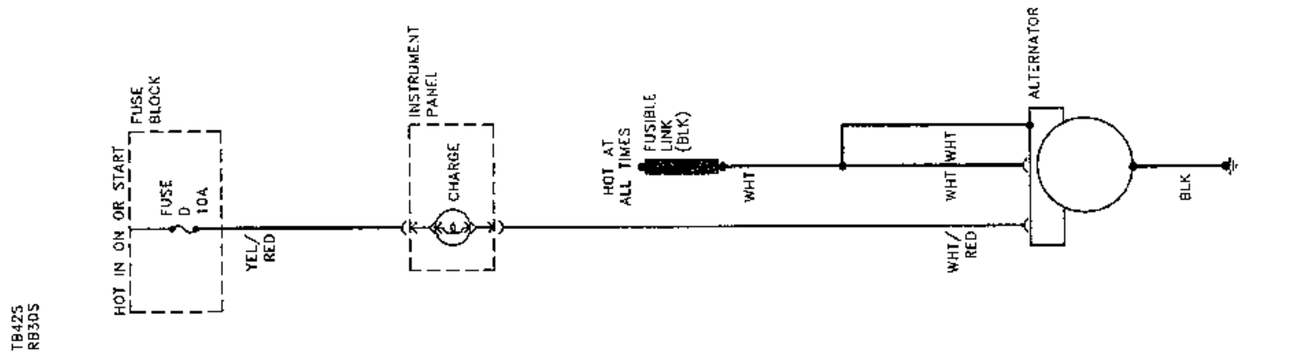
Starting, charging and ignition systems - 1990 and earlier models

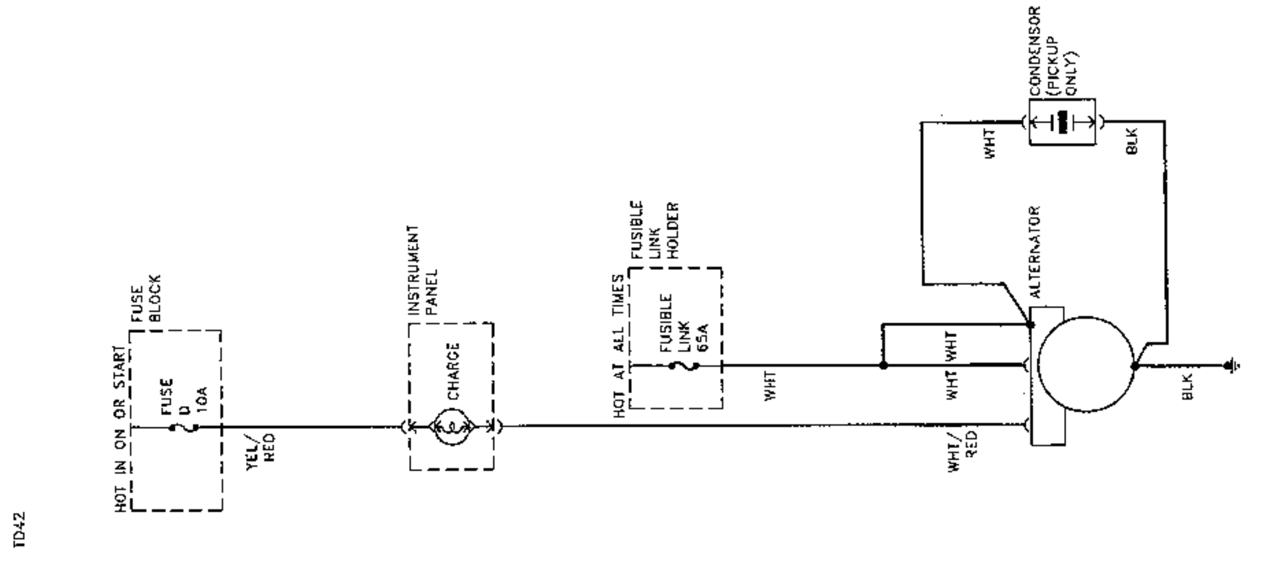
12



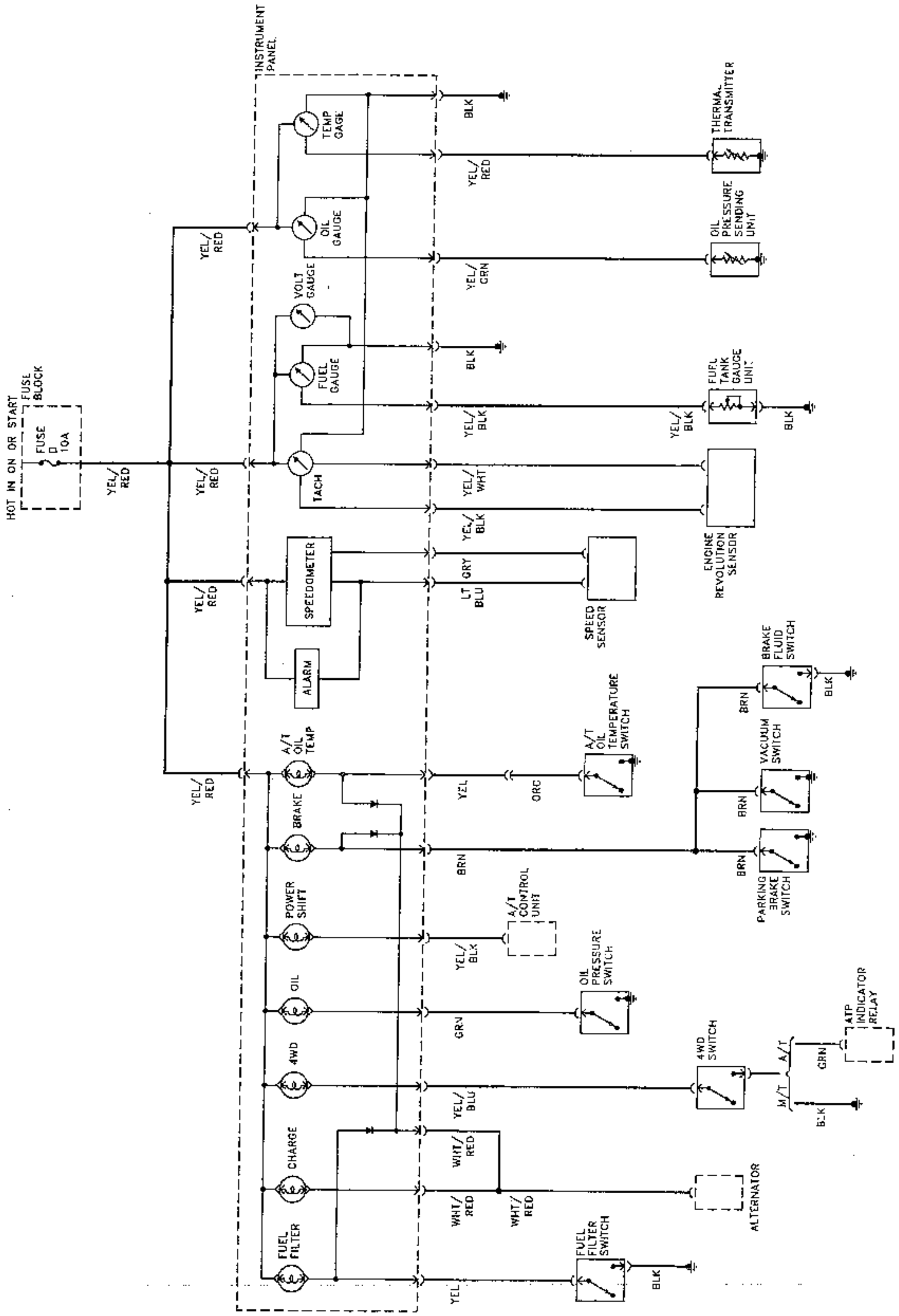
Starting system - 1991 and later models



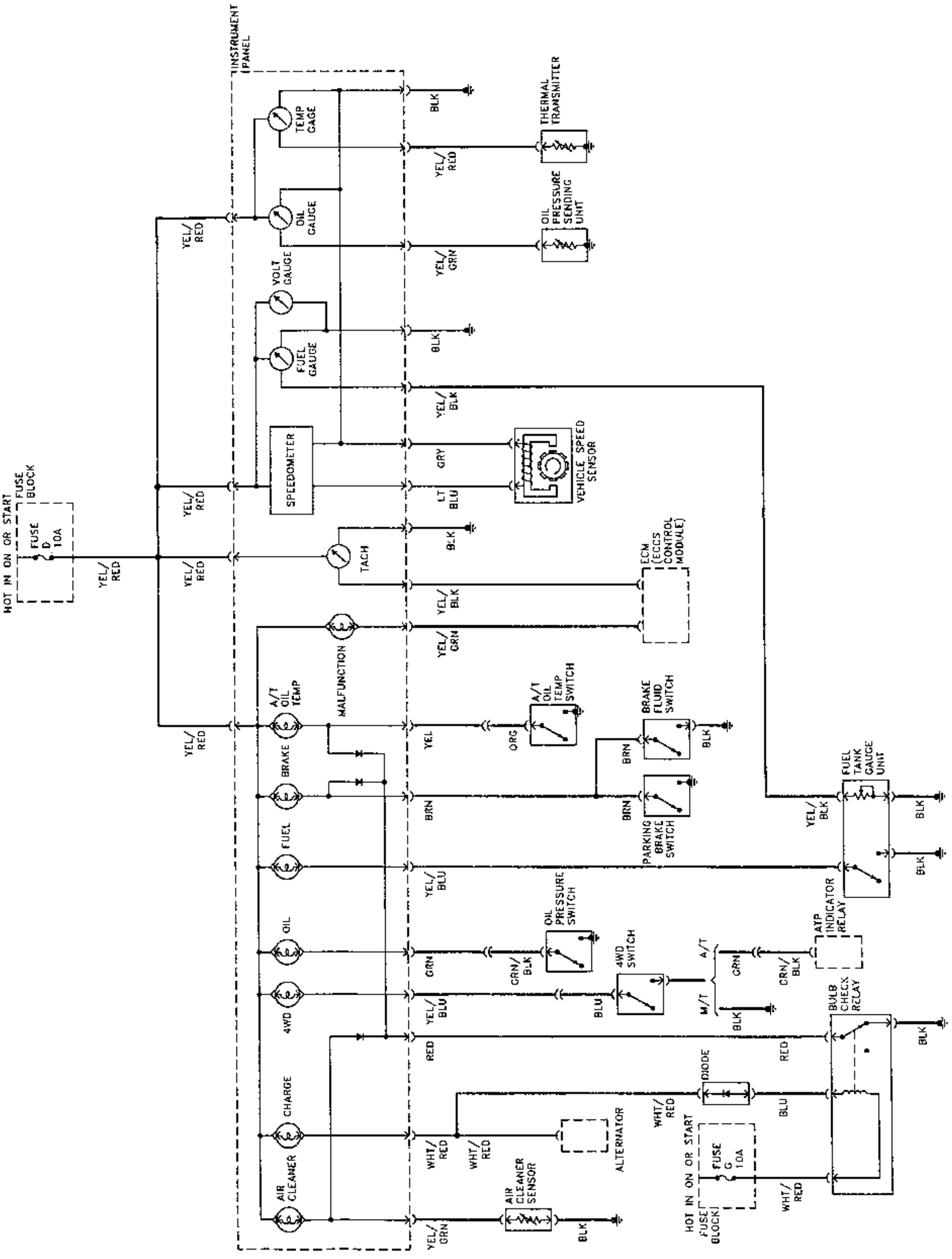




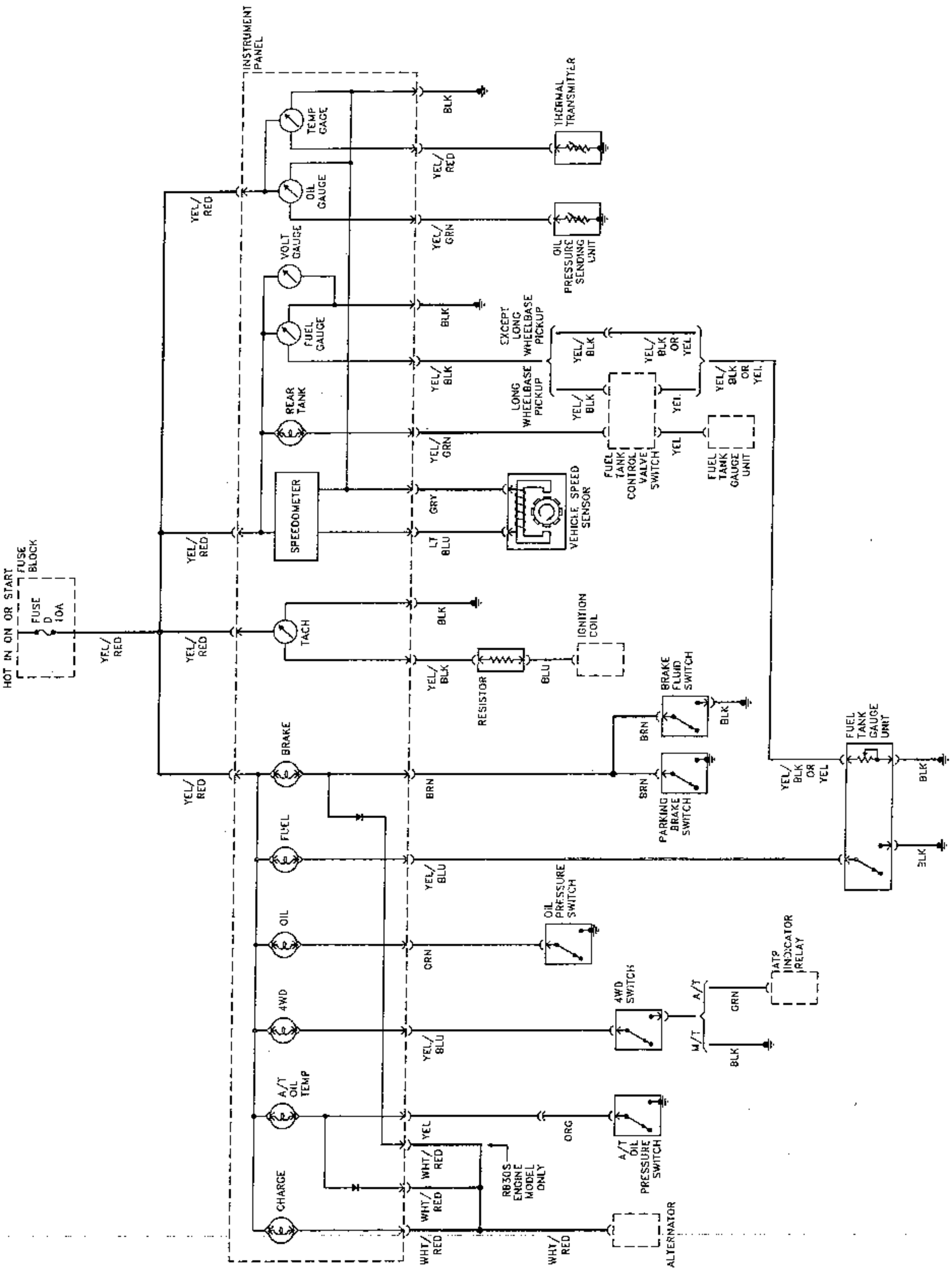
Charging system - 1991 and later models



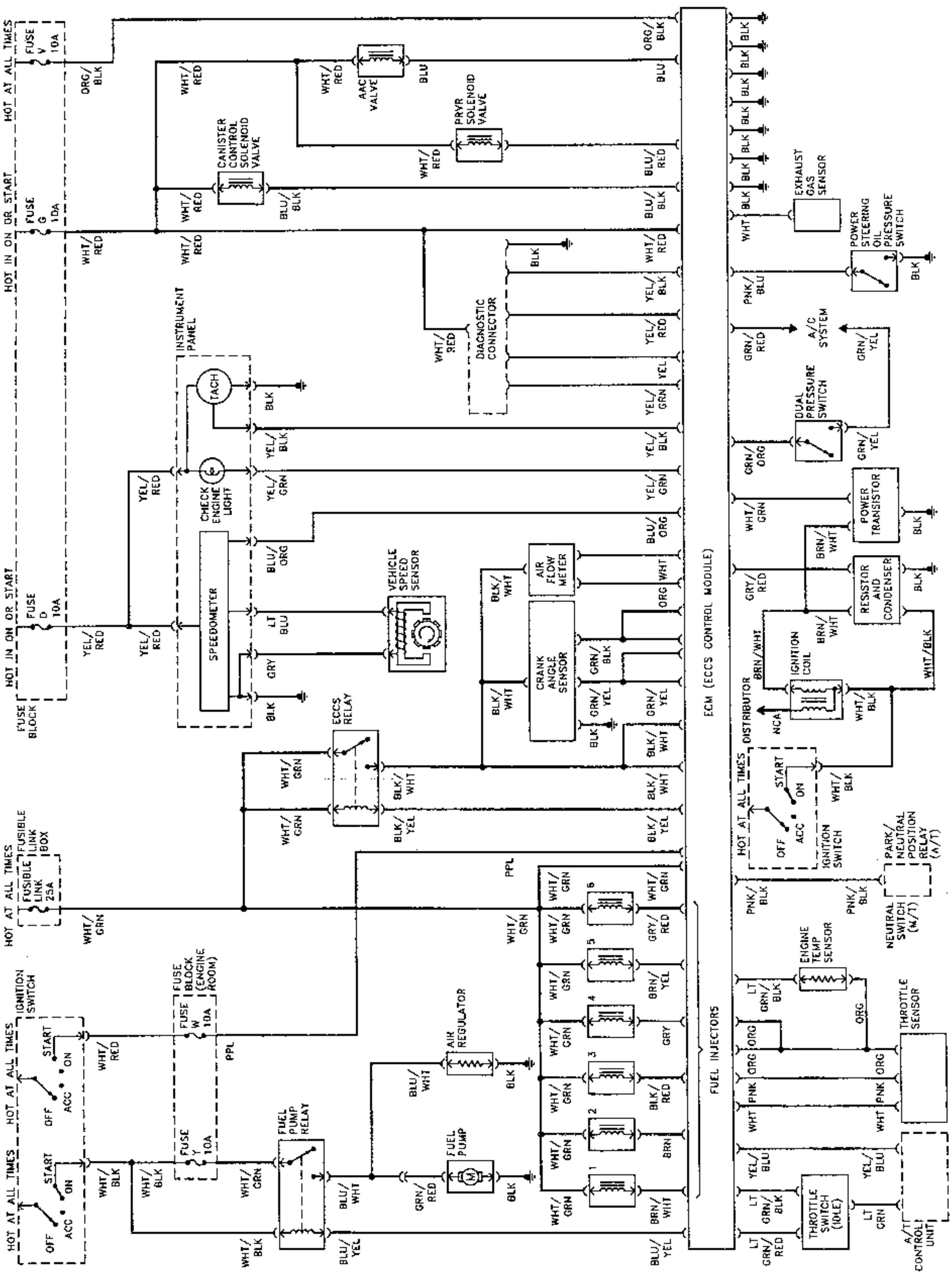
Gauges and warning light system - 1990 and earlier models



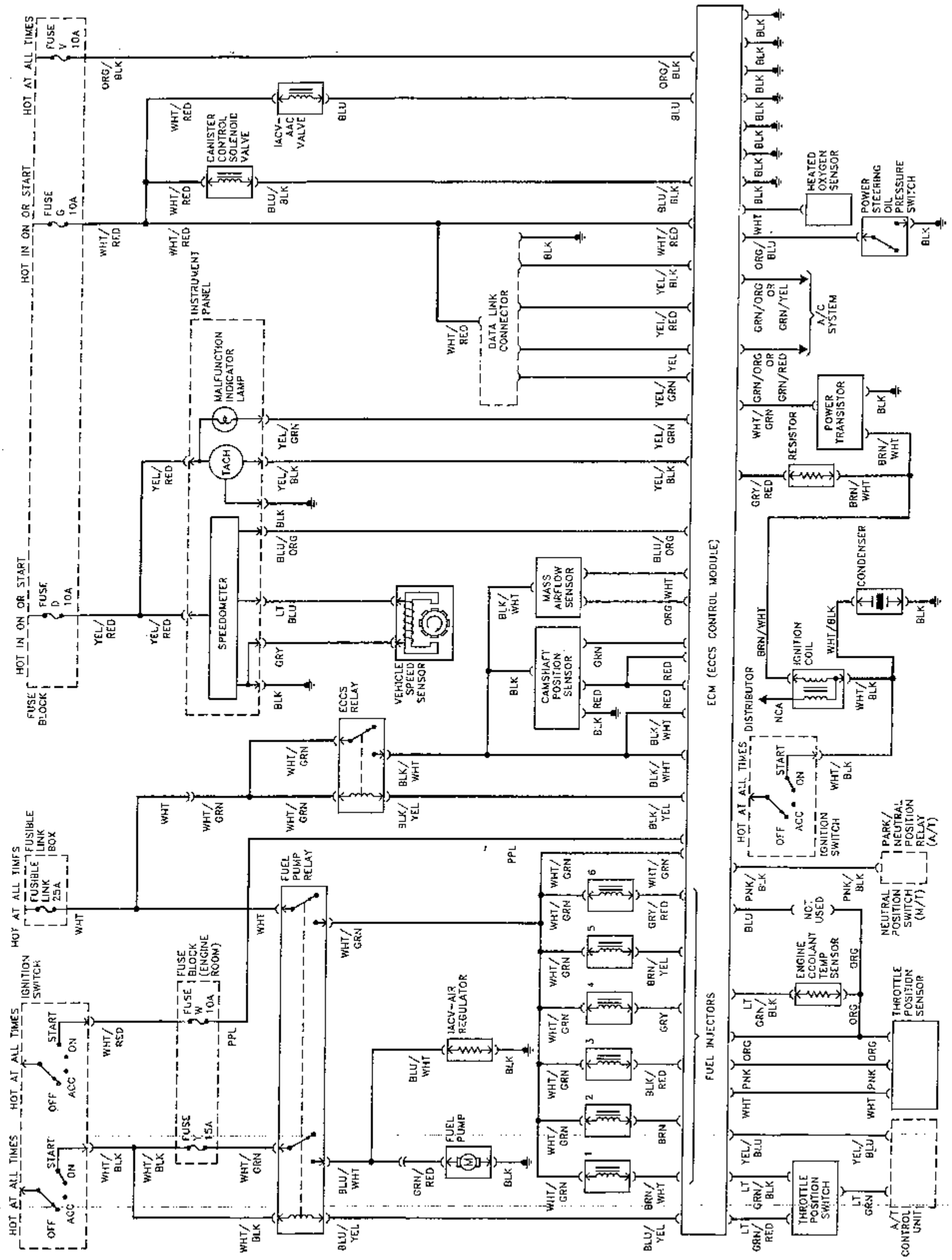
Gauges and warning light system - 1991 and later models with TB42E engine



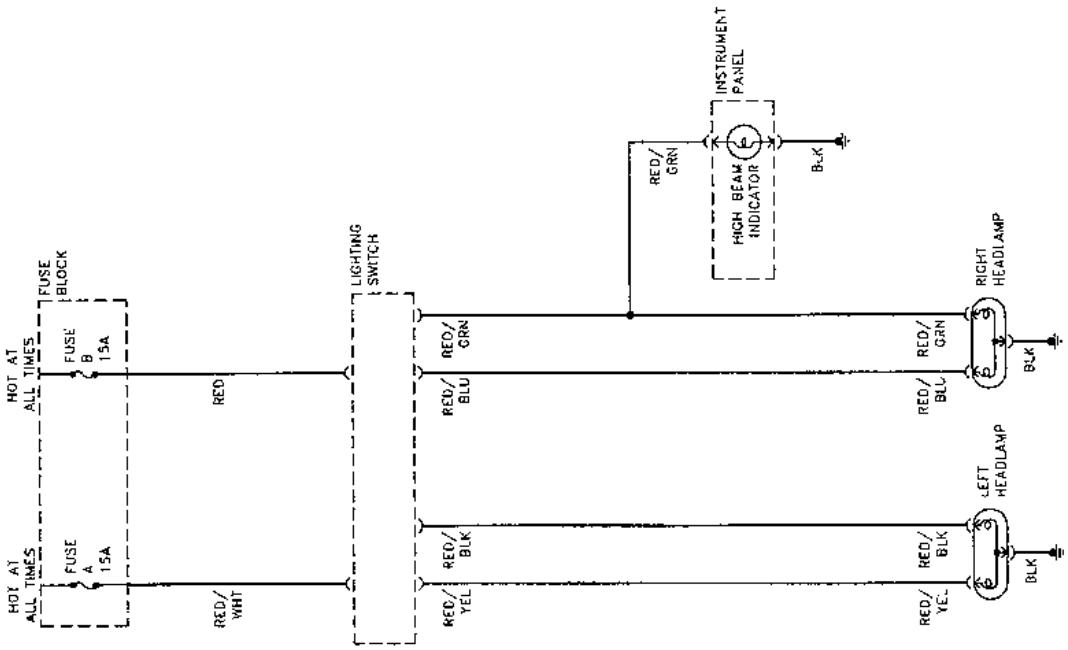
Gauges and warning light system - 1991 and later models with TB42S and RB30S engines



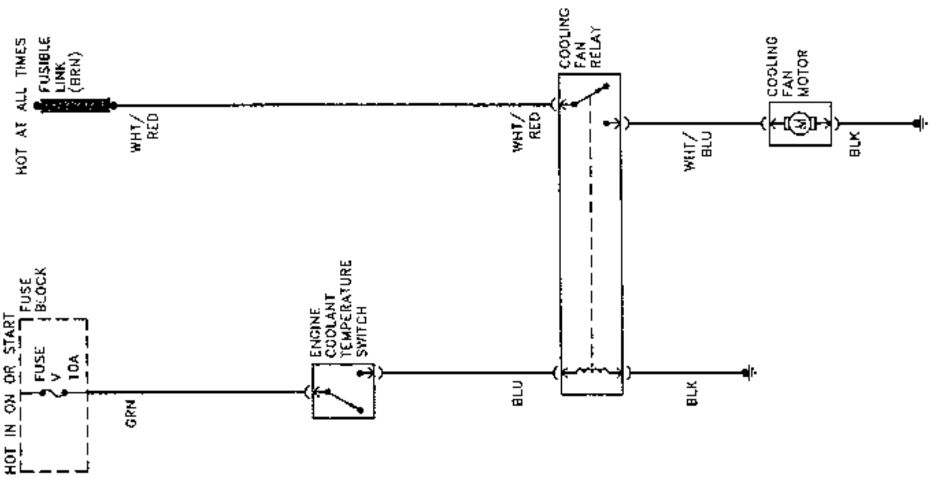
Engine control system - 1991 through 1994 fuel-injected models



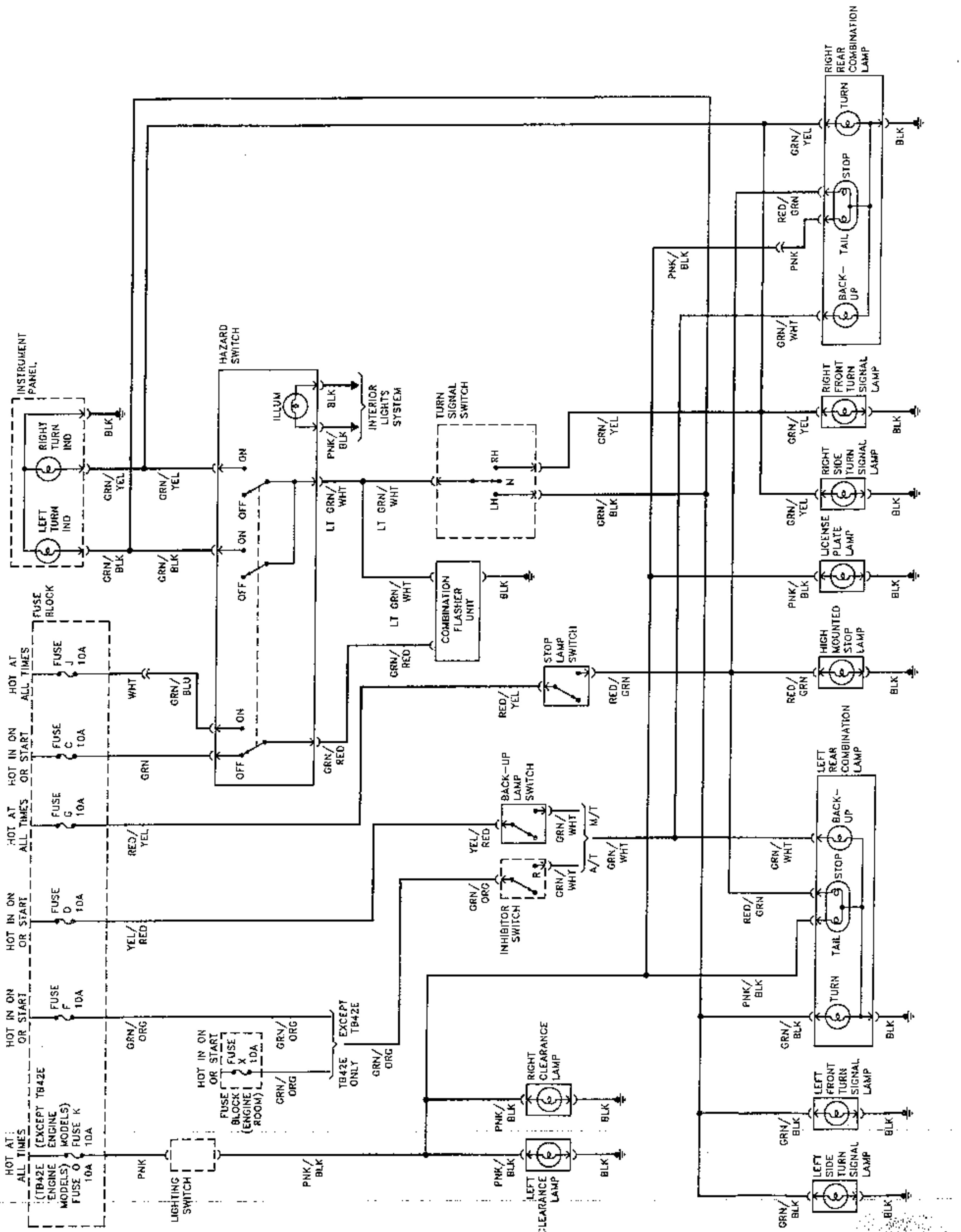
Engine control system - 1995 and later fuel-injected models



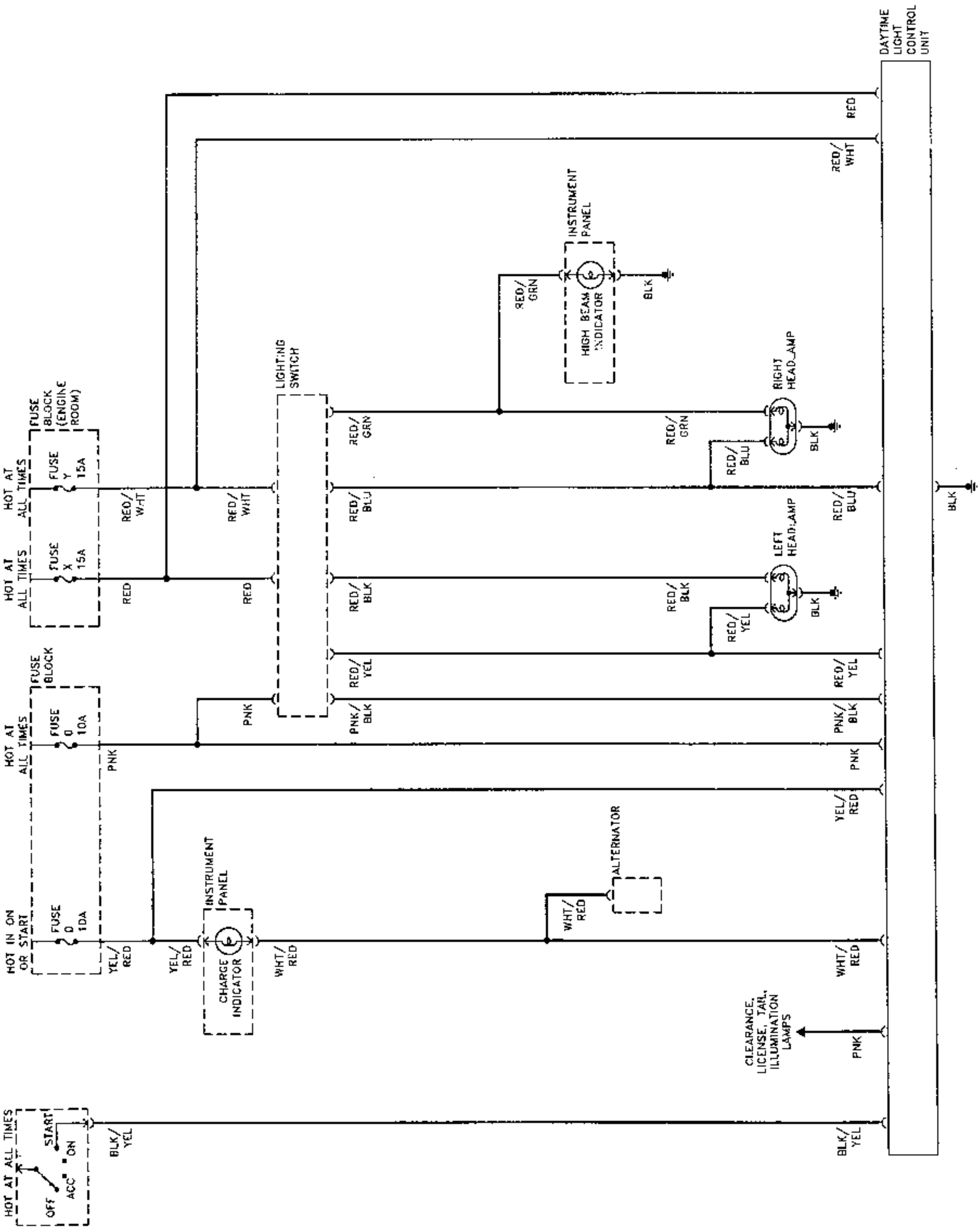
Headlight system (without daytime running lights or dim-dip system)



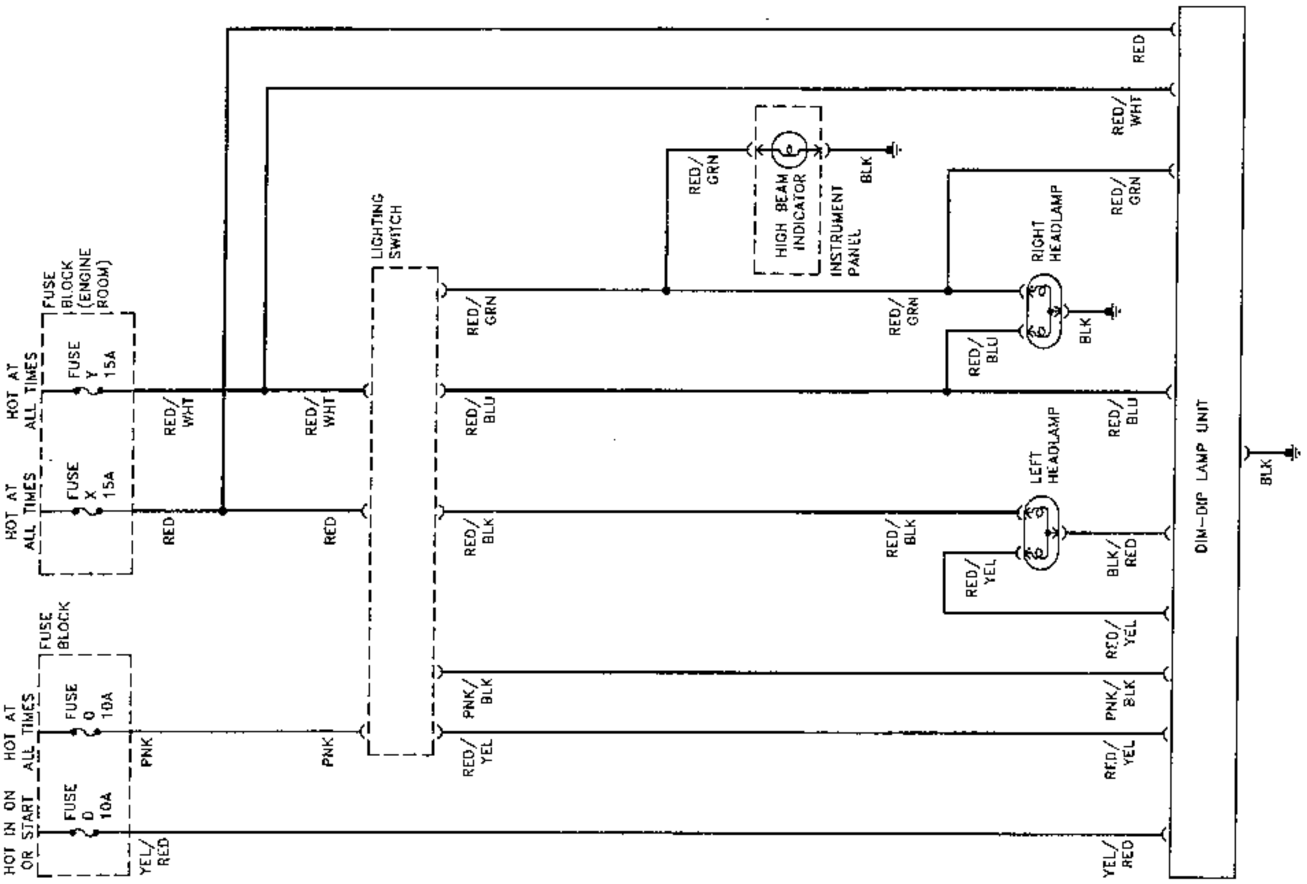
Electric cooling fan system



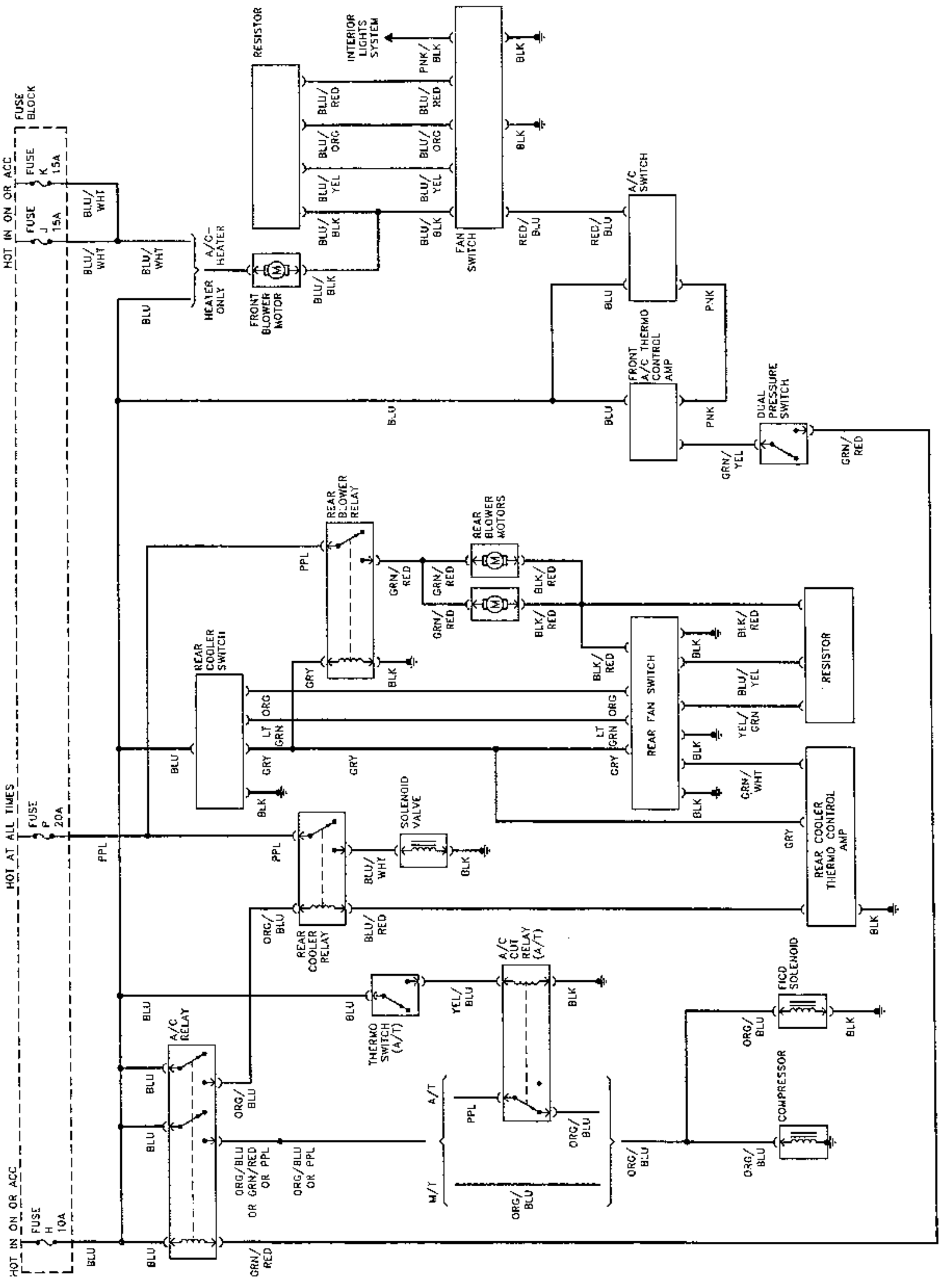
Exterior lighting system (except headlights)



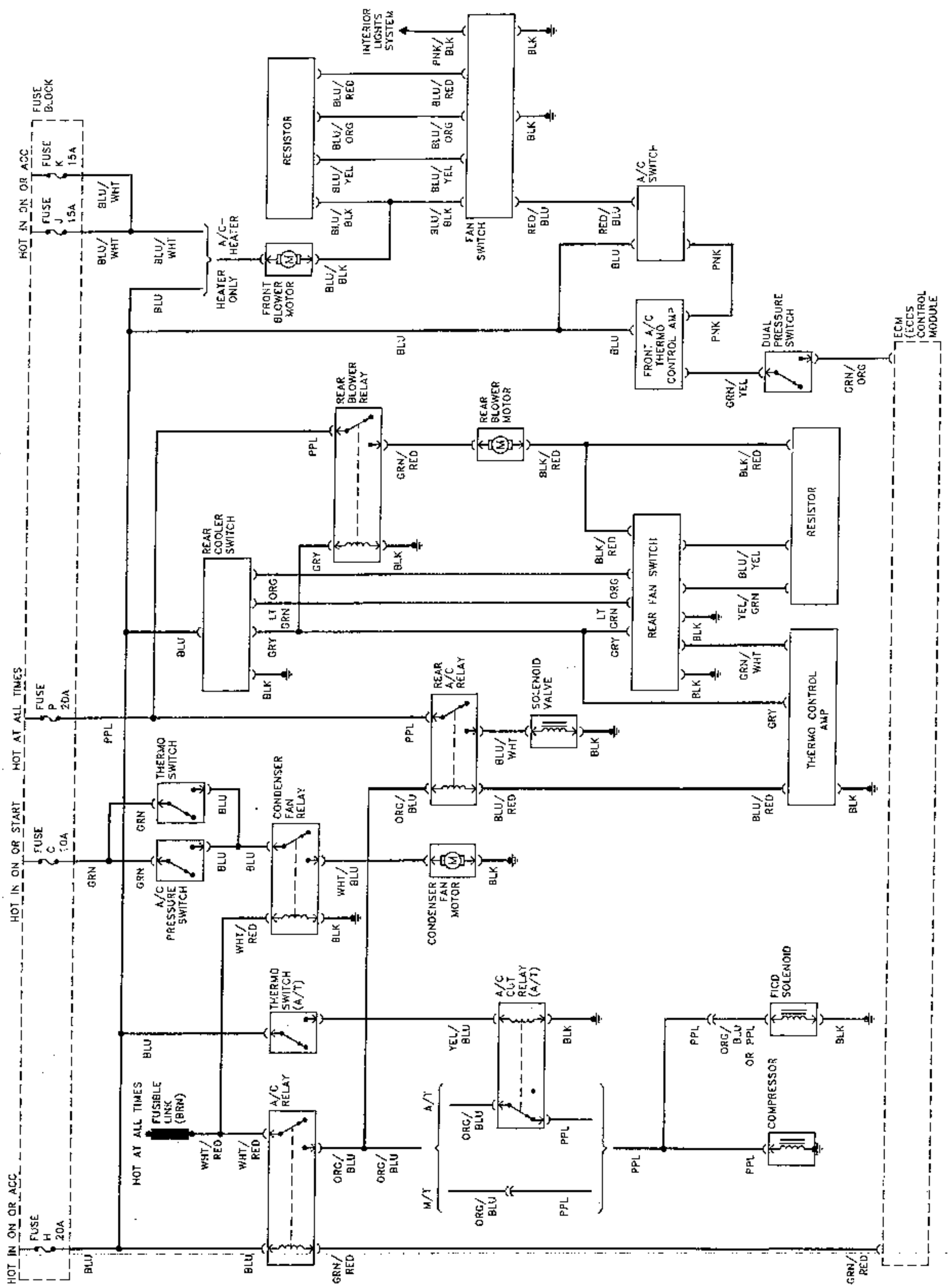
Headlight system (with daytime running lights)



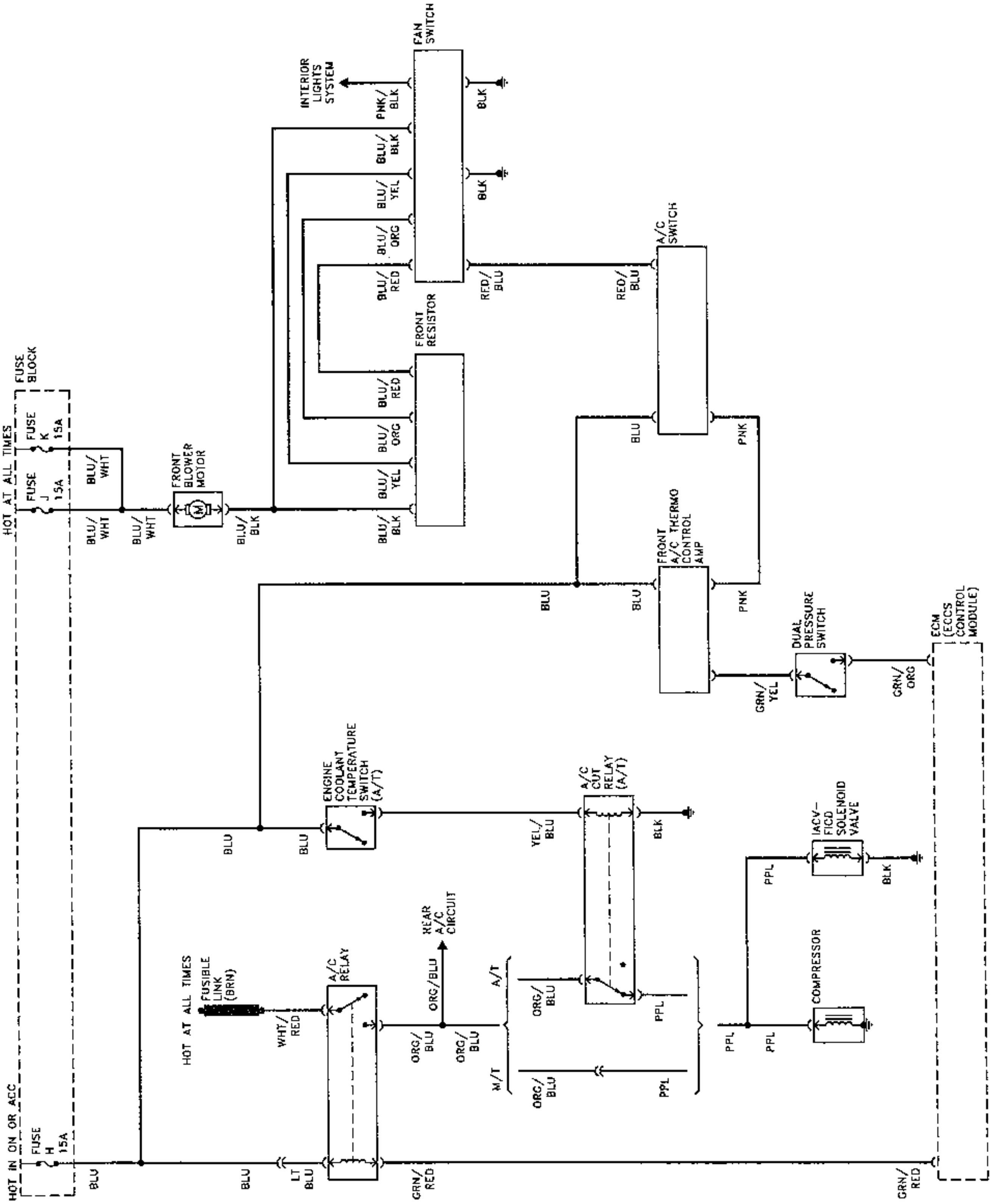
Headlight system (with dim-dip system)



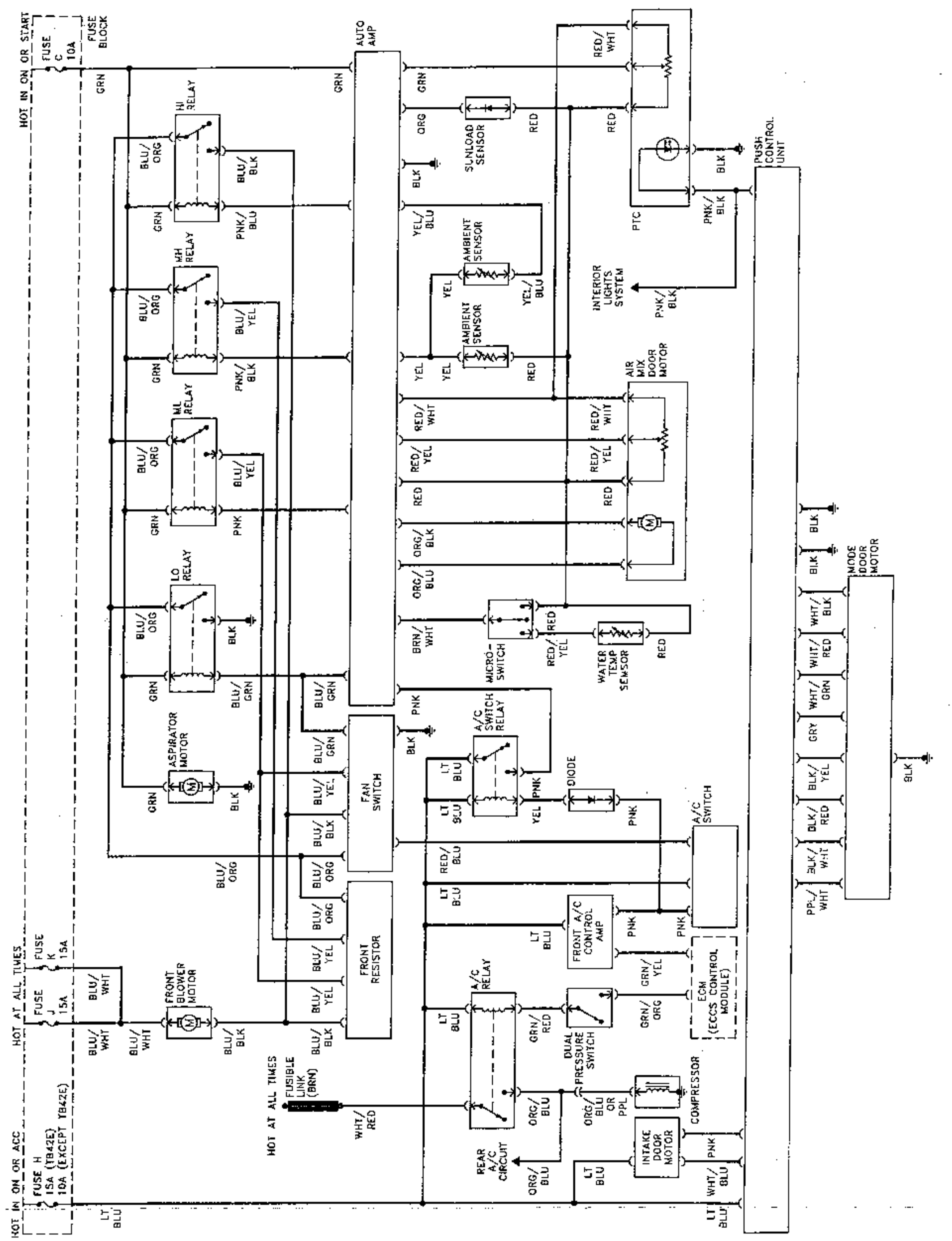
Heating and air conditioning system - 1990 and earlier models



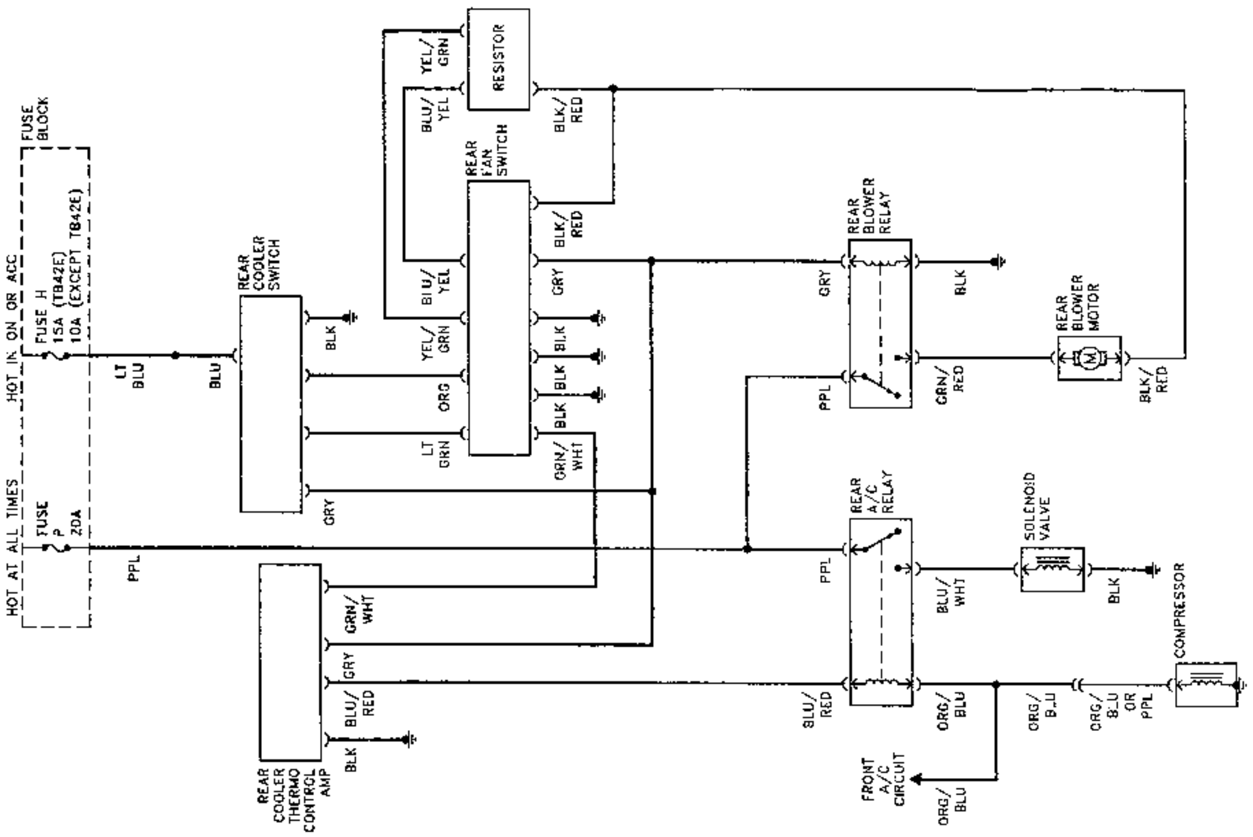
Heating and air conditioning system - 1991 through 1993 models



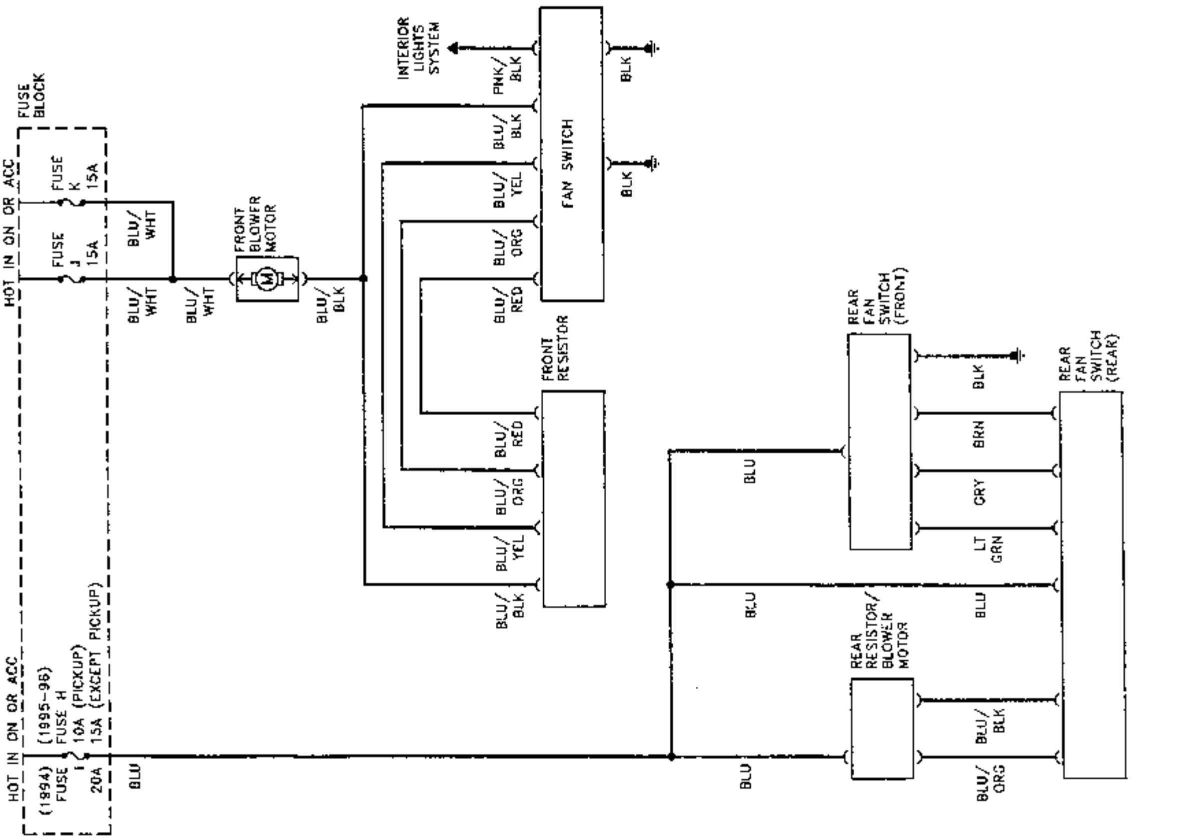
Manual air conditioning system - 1994 and later models



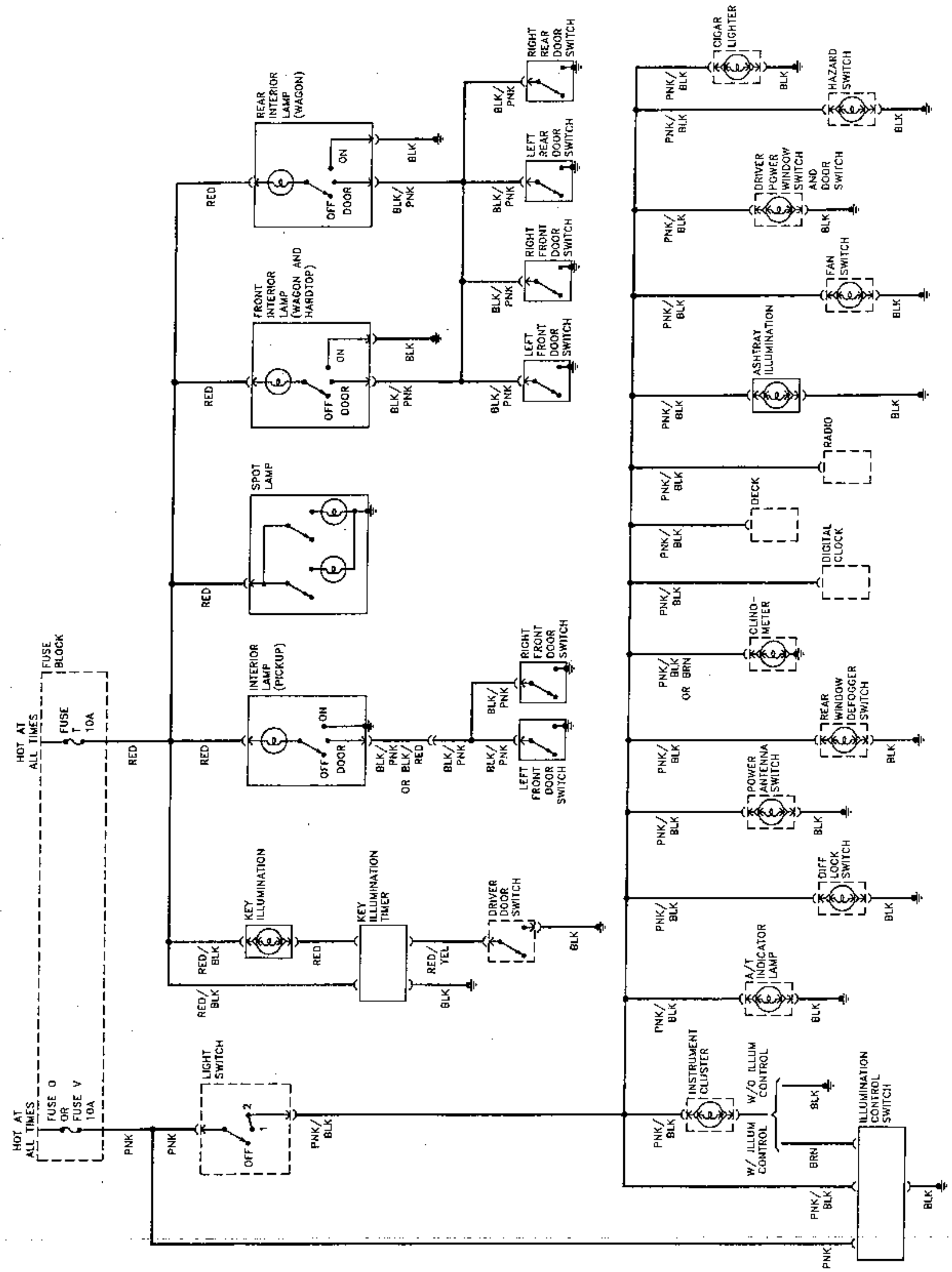
Automatic air conditioning system - 1994 and later models



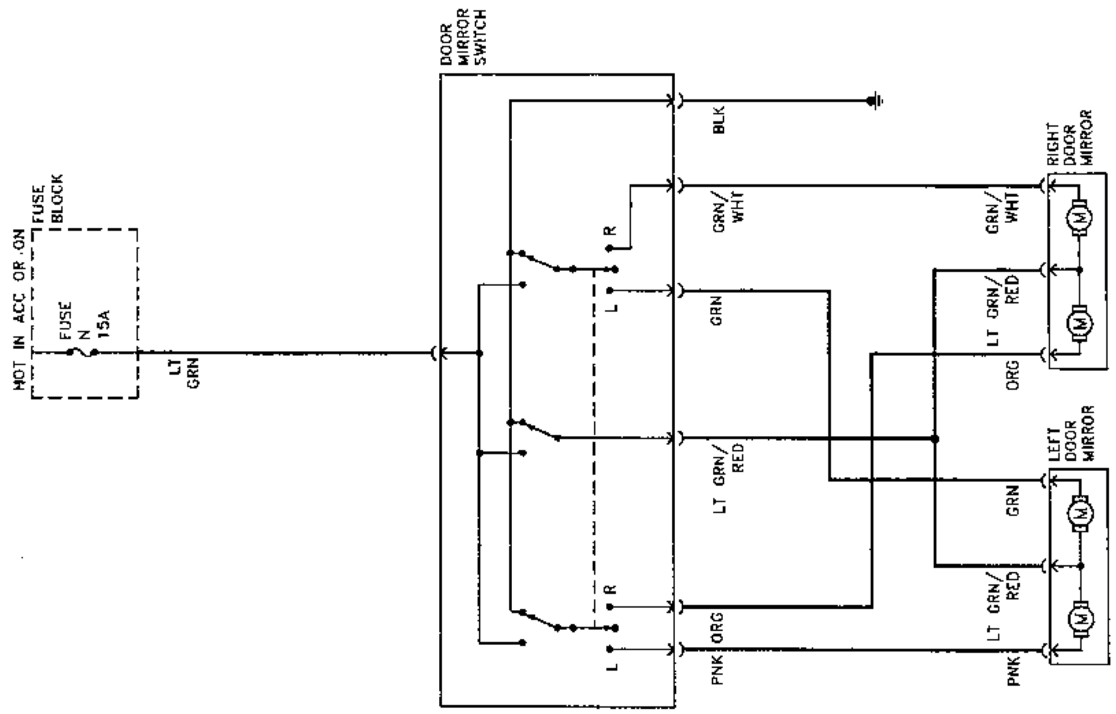
Rear air conditioning system - 1994 and later models



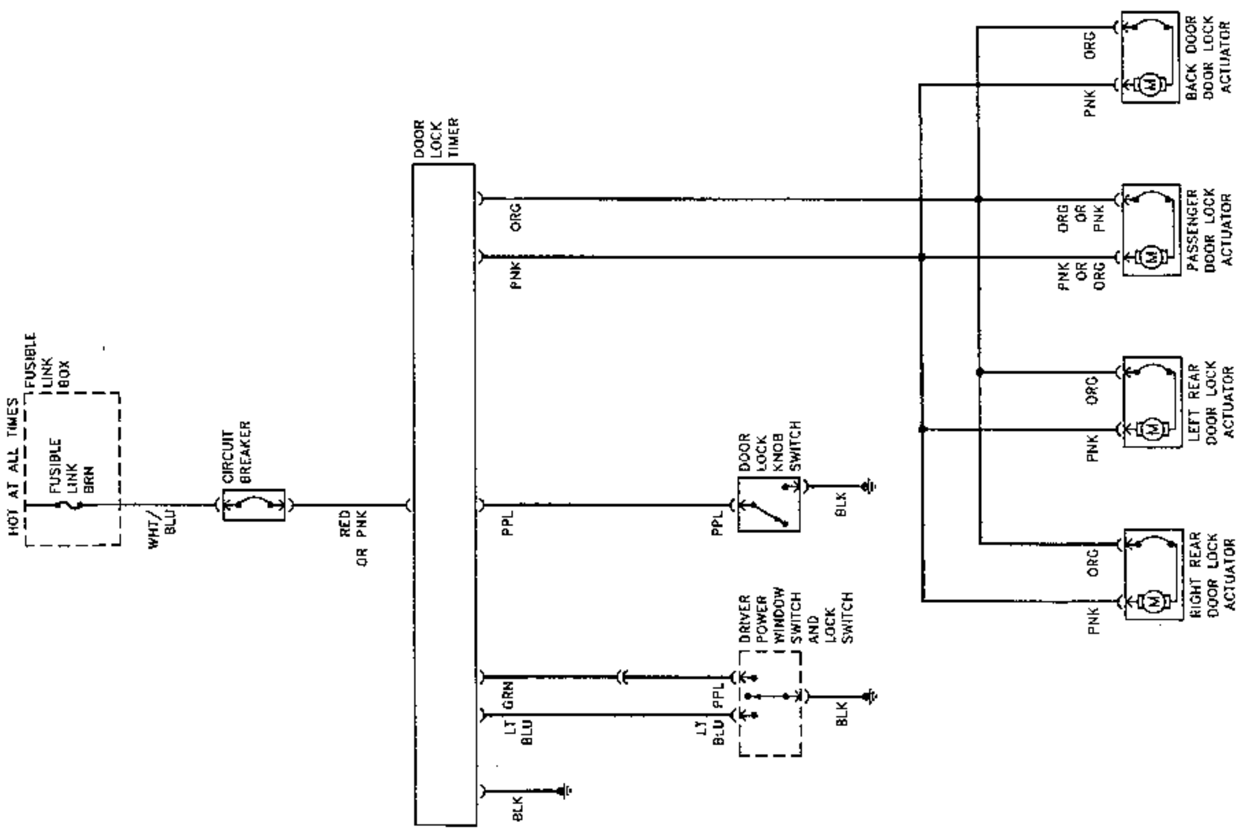
Heating system - 1994 and later models



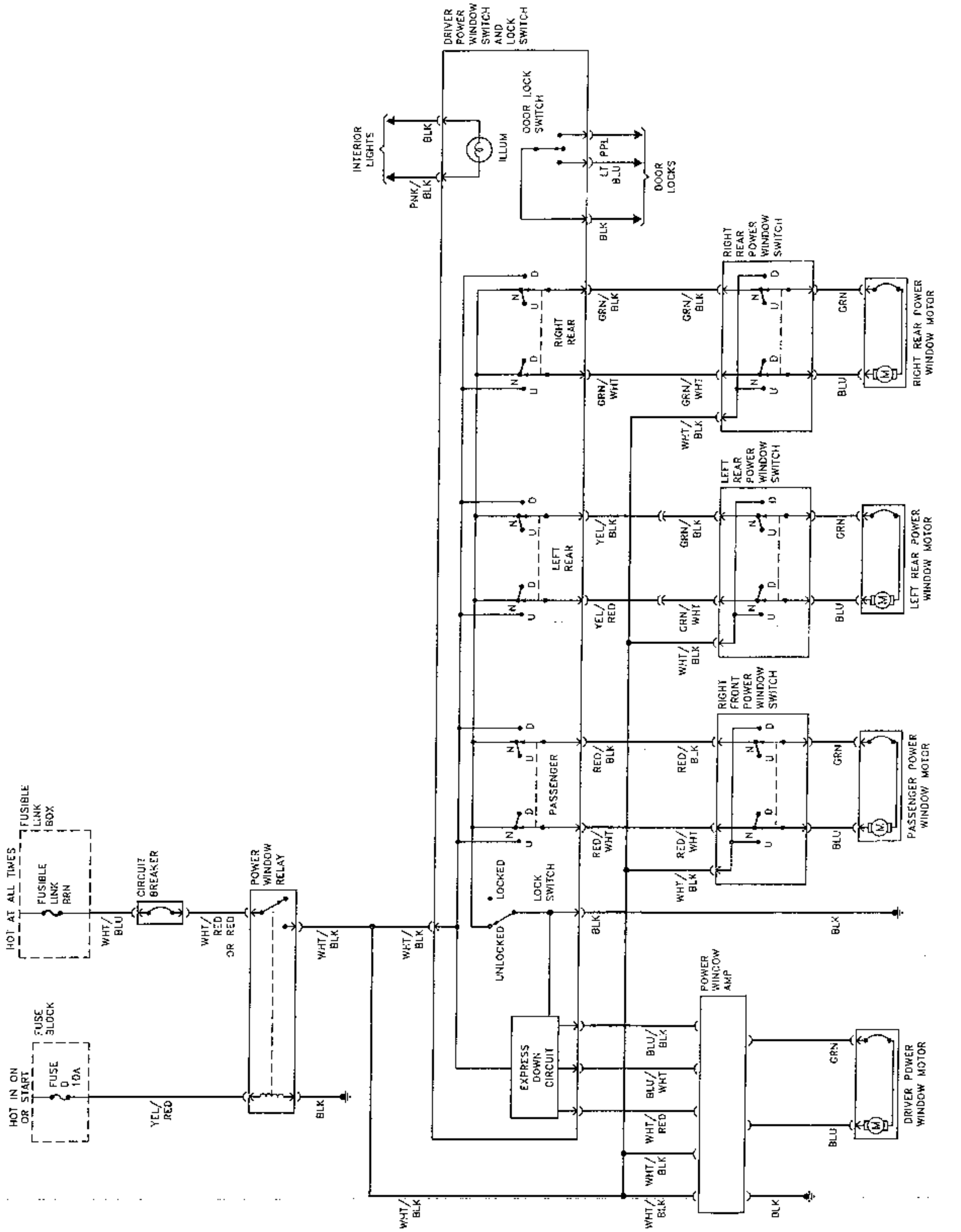
Interior lighting system



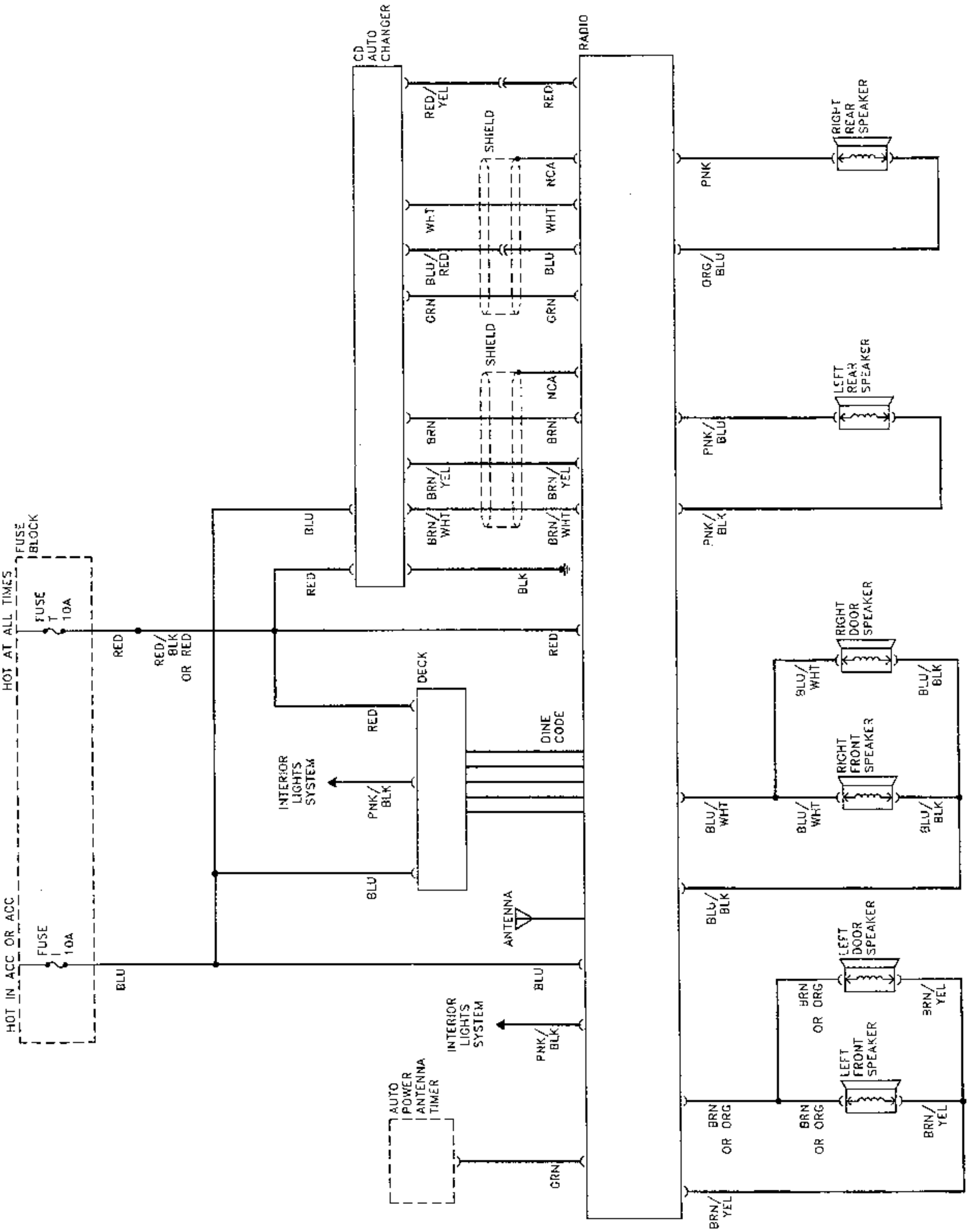
Power mirror system



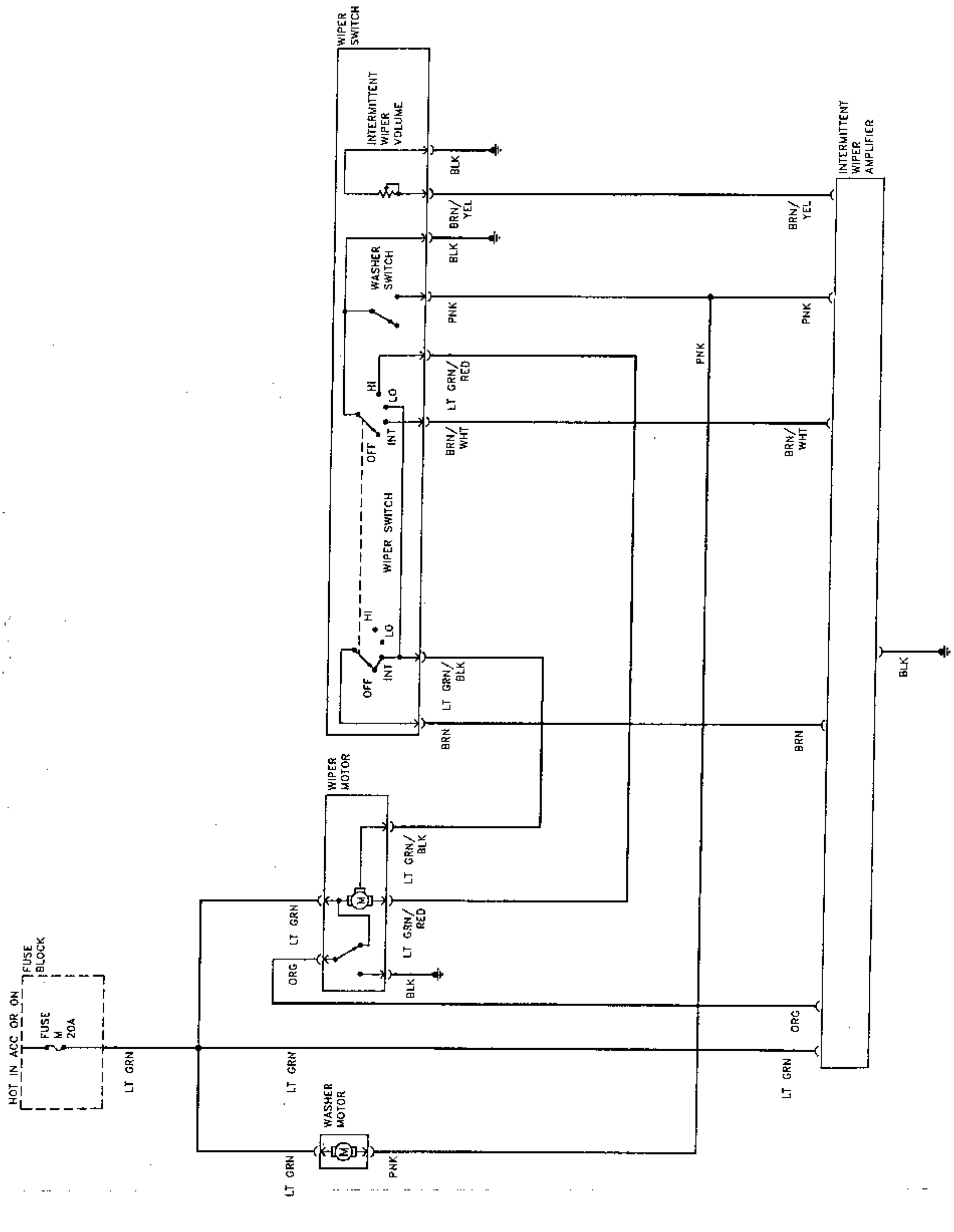
Power door lock system



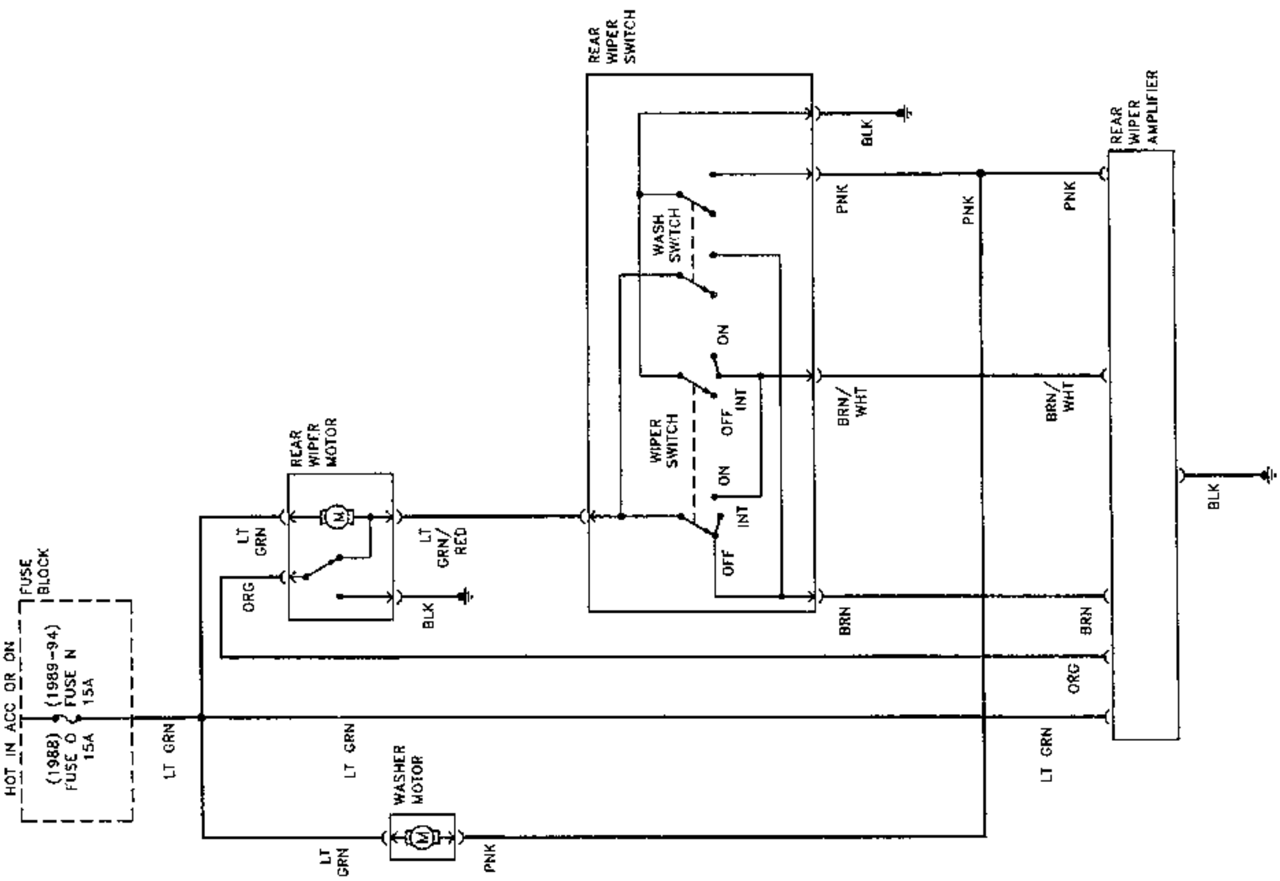
Power window system



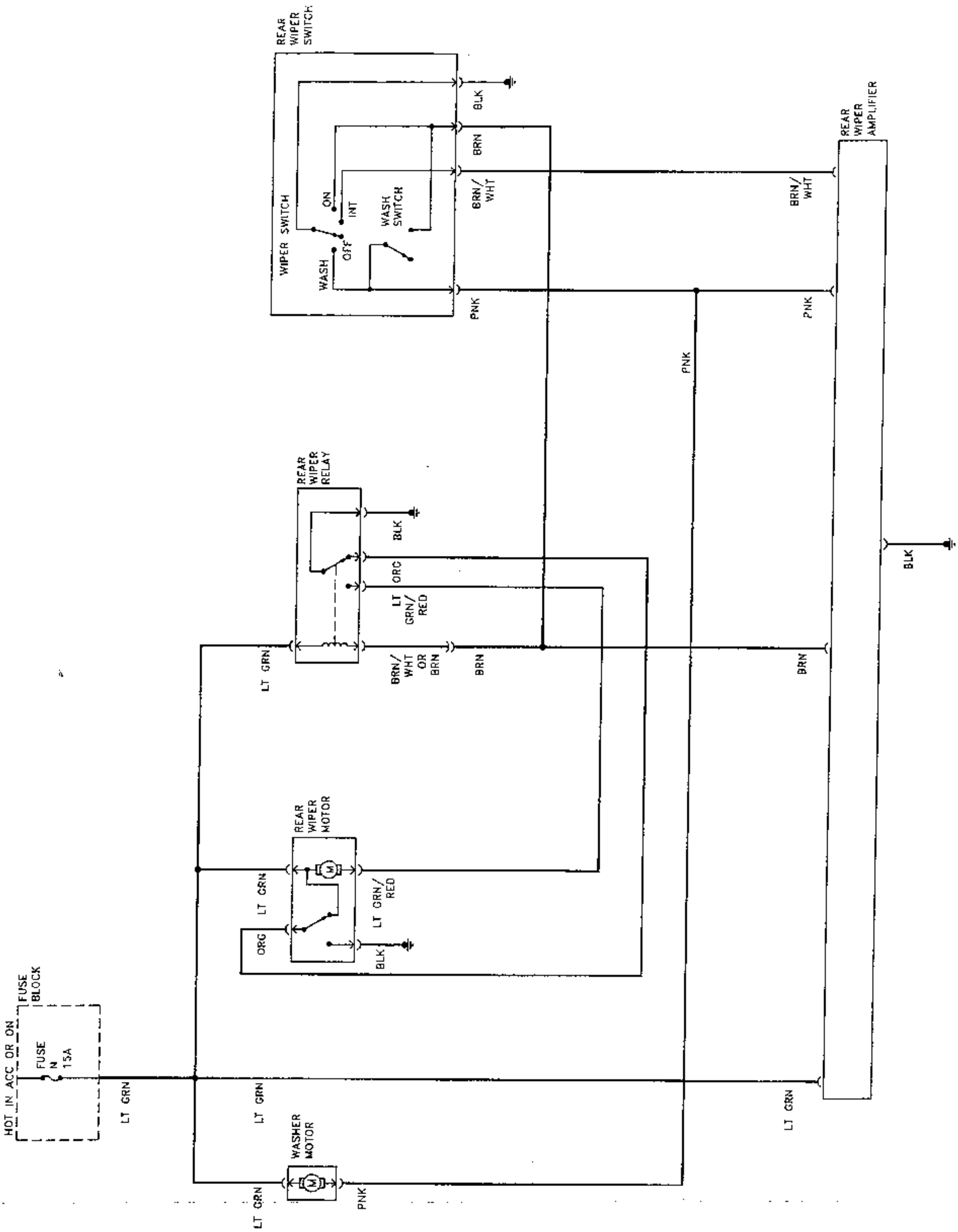
Audio system



Windshield wiper and washer system



Back glass wiper and washer system - 1994 and earlier



Back glass wiper and washer system - 1995 and later

Chapter 2 Part A
4.2 litre petrol engine

Contents

2A

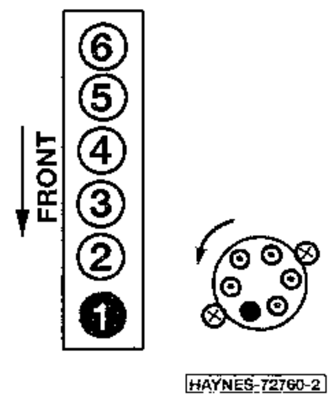
Specifications

General

Displacement	4169 cc
Bore	96 mm
Stroke	96 mm
Cylinder numbers (front-to-rear)	1-2-3-4-5-6
Firing order	1-5-3-6-2-4
Compression pressure	
Standard	1,177 kPa
Minimum	883 kPa
Maximum difference between cylinders	98 kPa

Camshaft

Number of bearing journals	7
Bearing oil clearance	
Standard	0.020 to 0.109 mm
Limit	0.15 mm
Journal diameter	
Front	50.721 to 50.740 mm
Second	50.521 to 50.540 mm
Third	50.321 to 50.340 mm
Fourth	50.121 to 50.140 mm
Fifth	49.921 to 49.940 mm
Sixth	49.721 to 49.740 mm
Rear	49.521 to 49.540 mm
Bend limit	0.06 mm
End play	
Standard	0.08 mm to 0.28 mm
Limit	0.5 mm
Cam lobe	
Total measurement	42.311 to 42.561 mm
Wear limit	0.15 mm



Cylinder location and distributor rotation

The blackened terminal shown on the distributor cap indicates the Number One spark plug wire position

Cylinder head

Allowable surface machining	0.2 mm
Warpage limit	0.2 mm

Oil pump

Outer rotor to body clearance	0.14 to 0.22 mm
Inner rotor to outer rotor clearance	0.0 to 0.12 mm
Rotor end clearance	0.050 to 0.110 mm

Torque specifications

	Nm
Camshaft sprocket bolt	132 to 142
Camshaft retainer bolts	7 to 8
Crankshaft pulley bolt	142 to 152
Cylinder head bolts	
First step	29
Second step	57 to 67
Third step	Loosen fully
Fourth step	29
Preferred fifth step	69 to 74-degrees additional rotation
Alternate fifth step	64 to 74
Exhaust manifold bolts	27 to 31
Front cylinder head bolt	7 to 8
Flywheel/driveplate-to-crankshaft bolts	147 to 167
Fuel pump cam nut (carburetted models)	16 to 19
Inlet manifold bolts	16 to 19
Sump mounting bolts	7 to 8
Oil cooler cover bolts	16 to 21
Oil cooler nuts	16 to 21
Oil pump chain tensioner bolts	7 to 8
Oil pump cover bolts	7 to 8
Oil pump pickup bolts	16 to 19
Oil pump relief plug	40 to 70
Oil pump sprocket bolt	24 to 28
Rear oil seal retainer bolts	21 to 26
Rocker arm lock nuts	16 to 22
Rocker shaft bolts	16 to 19
Timing chain guide bolt	7 to 8
Timing chain tensioner bolt	7 to 8
Timing chain cover-to-block bolts	21 to 26
Valve cover-to-cylinder head screws	1 to 3

1 General information

This Part of Chapter 2 is devoted to in-vehicle engine repair procedures for the 4.2 litre petrol six-cylinder pushrod engine. Information concerning engine removal and refitting, as well as engine block and cylinder head overhaul, can be found in Part D of this Chapter.

The following repair procedures are based on the assumption that the engine is fitted in the vehicle. If the engine has been removed from the vehicle and mounted on a stand, many of the steps included in this Part of Chapter 2 will not apply.

The specifications included in this Part of Chapter 2 apply only to the engine and procedures in this Part. The specifications necessary for rebuilding the block and cylinder head are found in Part D.

The engine uses pushrods and lifters with a timing chain as part of the valve train. The oil pump is mounted on the front of the block and is driven by a separate chain from the crankshaft.

2 Repair operations possible with the engine in the vehicle

Many major repair operations can be accomplished without removing the engine from the vehicle.

Clean the engine compartment and the exterior of the engine with some type of pressure washer before any work is done. A clean engine will make the job easier and will help keep dirt out of the internal areas of the engine.

If vacuum, exhaust, oil or coolant leaks have developed, indicating a need for gasket or seal renewal, the repairs can generally be made with the engine in the vehicle. The inlet and exhaust manifold gaskets, sump gasket and cylinder head gasket are all accessible with the engine in place.

Exterior engine components such as the inlet and exhaust manifolds, the sump (and the oil pump), the water pump, the starter motor, the alternator, the distributor and the carburettor or fuel injection components can be removed for repair with the engine in place.

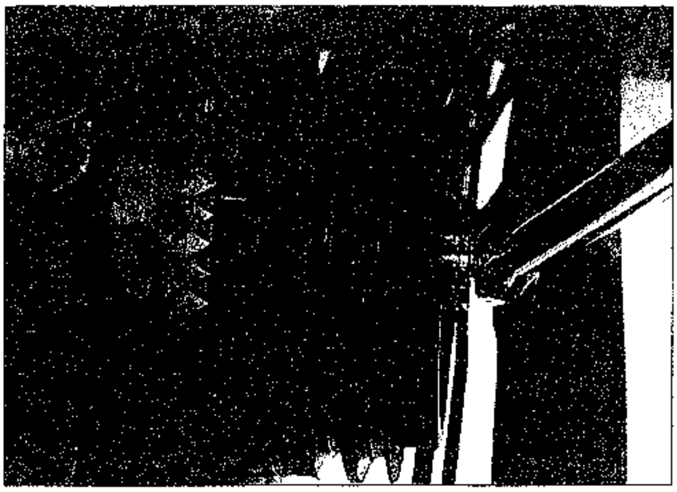
Since the cylinder head can be removed without pulling the engine, valve component servicing can also be accomplished with the engine in the vehicle.

In extreme cases caused by a lack of necessary equipment, repair or renewal of piston rings, pistons, connecting rods and rod bearings is possible with the engine in the vehicle. However, this practice is not recommended because of the cleaning and preparation work that must be done to the components involved.

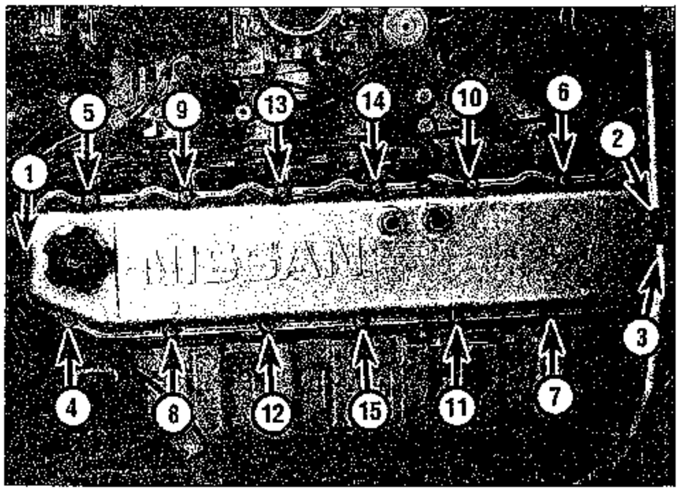
3 Top Dead Centre (TDC) for number one piston - locating

Refer to illustration 3.4

Note: *The following procedure is based on the assumption that the distributor is correctly fitted. If you are trying to locate TDC to refit the distributor correctly, piston position must be determined by feeling for compression at the number one spark plug hole as the engine is rotated, then aligning the ignition timing marks as described in Step 8.*



3.4 Use a large socket and breaker bar to rotate the crankshaft to TDC



4.7 Remove the valve cover bolts in this order. When tightening them, work in reverse

1 Top Dead Centre (TDC) is the highest point in the cylinder that each piston reaches as it travels up-and-down when the crankshaft turns. Each piston reaches TDC on the compression stroke and again on the exhaust stroke, but TDC generally refers to piston position on the compression stroke.
2 Positioning the piston(s) at TDC is an essential part of many procedures such as rocker arm removal, camshaft and timing chain/sprocket removal and distributor removal.
3 Before beginning this procedure, be sure to place the transmission in Neutral and apply the parking brake or block the rear wheels. Also, remove the spark plugs (see Chapter 1) and disable the ignition system. Detach the coil wire from the centre terminal of the distributor cap and earth it on the block with a jumper wire.
4 In order to bring any piston to TDC, the crankshaft must be turned using one of the methods outlined below. When looking at the front of the engine, normal crankshaft rotation is clockwise.

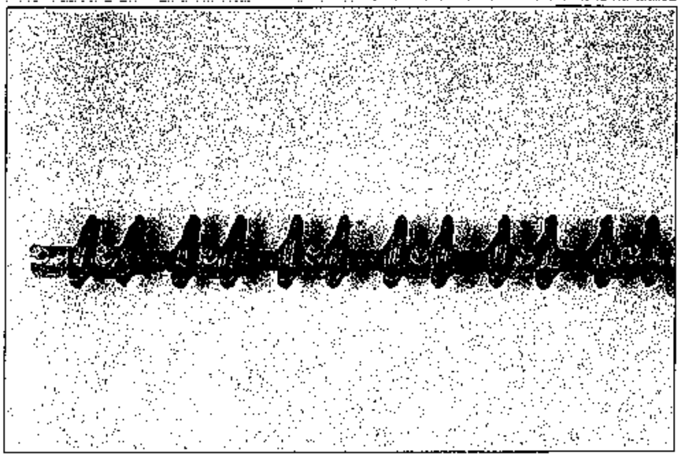
a) *The preferred method is to turn the crankshaft with a socket and ratchet attached to the bolt threaded into the front of the crankshaft* **(see illustration)**.
b) *A remote starter switch, which may save some time, can also be used. Follow the instructions included with the switch. Once the piston is close to TDC, use a socket and ratchet, as described in the previous paragraph.*
c) *If an assistant is available to turn the ignition switch to the Start position in short bursts, you can get the piston close to TDC without a remote starter switch. Make sure your assistant is out of the vehicle, away from the ignition switch, then use a socket and ratchet (as described in Paragraph a) to complete the procedure.*

5 Note the position of the terminal for the number one spark plug wire on the distributor cap. If the terminal isn't marked, follow the plug wire from the number one cylinder spark plug to the cap.
6 Use a felt-tip pen or chalk to make a mark on the distributor body directly under the terminal. Do not use a lead pencil.
7 Detach the cap from the distributor and set it aside (see Chapter 1 if necessary).
8 Turn the crankshaft (see Paragraph 3 above) until the notch in the crankshaft pulley is aligned with the 0 on the timing plate **(see illustration 3.4)**.
9 Look at the distributor rotor - it should be pointing directly at the mark you made on the distributor body. If it is, go to Step 12.
10 If the rotor is 180 degrees off, the number one piston is at TDC on the exhaust stroke. Go to Step 11.
11 To get the piston to TDC on the compression stroke, turn the crankshaft one complete turn (360 degrees) clockwise. The rotor should now be pointing at the mark on the distributor. When the rotor is pointing at the number one spark plug wire terminal in the distributor cap and the ignition timing marks are aligned, the number one piston is at TDC on the compression stroke. **Note:** *If it is impossible to align the ignition timing marks when the rotor is pointing to the alignment mark on the number 1 cylinder, the distributor may be refitted incorrectly, the timing chain or gears may be refitted incorrectly or the timing chain has jumped off the timing sprocket.*
12 After the number one piston has been positioned at TDC on the compression stroke, TDC for any of the remaining pistons can be located by turning the crankshaft and following the firing order. Mark the remaining spark plug wire terminal locations on the distributor body just like you did for the number one terminal, then number the marks to correspond with the cylinder numbers. As you turn the crankshaft, the rotor will also turn. When it's pointing directly at one of the marks on the distributor, the piston for that particular cylinder is at TDC on the compression stroke.

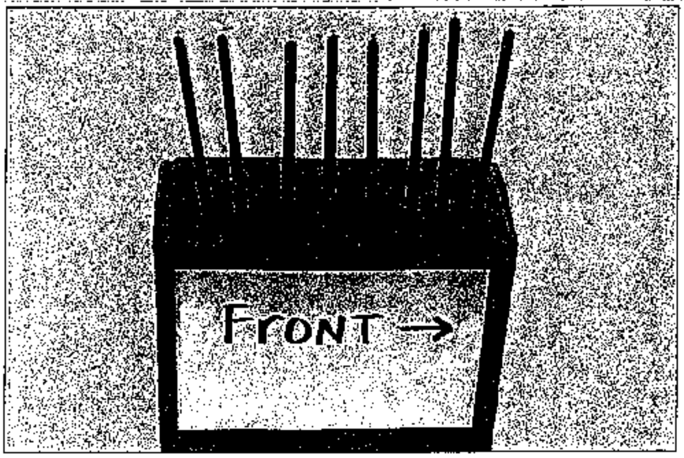
4 Valve cover - removal and refitting

Refer to illustration 4.7

1 Disconnect the negative cable from the battery.
2 On carburetted engines, remove the air cleaner. On fuel-injected models, remove the air inlet hose, the airflow meter and the air cleaner assembly (see Chapter 4B).
3 Label and then remove all hoses and/or wires necessary to provide clearance for valve cover removal.
4 If the spark plug wires can be disconnected from their brackets and moved aside, do so now. If not, label each spark plug wire, remove them and lay them aside individually.
5 Disconnect the throttle cable (see Chapter 4), the cruise control cable (if equipped) and the choke cable (if equipped).
6 Remove the alternator adjusting bracket if it interferes.
7 Loosen the valve cover screws, working in the proper sequence **(see illustration)**. Loosen them only a quarter turn at a time each until they are all loose.
8 Remove the valve cover retaining screws and lift off the cover. The cover may stick. If the valve cover is stuck to the cylinder head, bump the end with a wood block and hammer to jar it loose. If that doesn't work, try to detach the cover by breaking the seal with a putty knife or razor blade. **Caution:** *Don't prise at the valve cover-to-cylinder head joint or damage to the sealing surfaces may occur, leading to oil leaks after the valve cover is refitted.*
9 Prior to refitting, remove all traces of dirt, oil and old gasket material from the cover and cylinder head. Clean the mating surfaces with lacquer thinner or acetone and a clean rag.
10 Inspect the mating surface on the cover for damage and warpage. Straighten or renew it as necessary.
11 Fit a new gasket. Make sure that all the



5.4 Keep the rocker shaft in one piece when you lift it from the engine



5.5 A perforated cardboard box can be used to store the pushrods to ensure they are refitted in their original locations

parts are completely clean. If there is residue or oil around the mating surfaces when the valve cover is refitted, oil leaks may develop.

12 Apply a thin coating of RTV silicone sealer to the new gasket and adhere it to the valve cover. Apply a thin coating to the cylinder head side of the gasket.

13 Place the valve cover on the cylinder head while the sealant is still wet and refitting the mounting bolts. Tighten the bolts in the reverse of the removal sequence **(see illustration 4.8)**. Tighten the bolts a little at a time until the torque listed in this Chapter's Specifications is reached.

14 Complete the refitting procedure by reversing the removal procedure.

15 Start the engine and check for oil leaks.

5 Rocker arms and pushrods - removal, inspection and refitting

Refer to illustrations 5.4, 5.5, 5.7a and 5.7b

Note: *It is not possible to remove the lifters from this engine without first removing the cylinder head.*

Removal

1 Detach the valve cover from the cylinder head, referring to Section 4.

2 Loosen each valve adjusting lock-nut, then unscrew each adjusting screw all the way (but don't remove them from the rocker arms).

3 Gradually loosen the rocker shaft retaining bolts. Start with the outer bolts and work towards the centre until all of the bolts are free.

4 Remove the rocker arm assembly as a single unit. Be careful not to let any of the components slide off the rocker shaft **(see illustration)**.

5 Remove the pushrods and store them separately to make sure they don't get mixed up during refitting **(see illustration)**.

Inspection

6 Check each rocker arm for wear, cracks and other damage, especially where the pushrods and valve stems contact the rocker arm faces.

7 Make sure the oil holes in the rocker shaft are clear. Use a caliper to check the outside diameter of the shaft and the inside diameter of the rockers **(see illustrations)**. If the clearances vary or are excessive, renew the components.

8 Check each rocker arm pivot area for wear, cracks and galling. If the rocker arms are worn or damaged, renew them and use new pivots as well.

9 Inspect the pushrods for cracks and excessive wear at the ends. Roll each pushrod across a piece of plate glass to see if it's bent (if it wobbles, it's bent).

Refitting

10 Lubricate the lower ends of the pushrods with clean engine oil or moly-base grease and refit them in their original locations. Make sure each pushrod seats completely in the lifter socket.

11 Lubricate the rockers and the shaft with engine oil as you assemble them. Apply moly-base grease to the ends of the valve stems and the upper ends of the pushrods before positioning the rocker arms and refit the bolts.

12 Set the rocker arm assembly in place, then refit the bolts. Tighten the bolts, a little at a time, to the torque listed in this Chapter's Specifications. Begin with the centre bolts, then work outwards.

13 Refer to Chapter 1 and adjust the valves.

14 Refit the valve cover and run the engine. Check for oil leaks and unusual valve train noises.

6 Valve springs, retainers and seals - renewal

Refer to illustrations 6.4, 6.9, 6.10, 6.15 and 6.17

Note: *Broken valve springs and defective valve stem seals can be renewed without removing the cylinder head. Two special tools and a compressed air source are normally required to perform this operation, so read through this Section carefully and rent or buy the tools before beginning the job. If compressed air isn't available, a length of nylon rope can be used to keep the valves from falling into the cylinder during this procedure.*

1 Remove the valve cover referring to Section 4.

2 Remove the spark plug from the cylinder which has the defective component. If all of the valve stem seals are being renewed, all of the spark plugs should be removed.

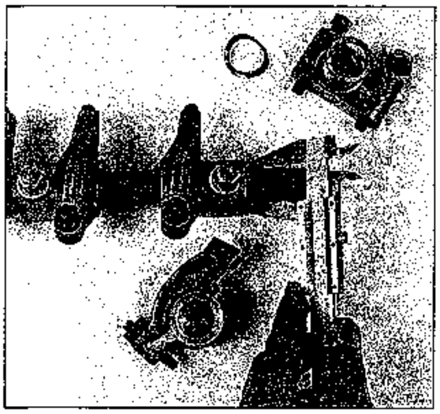
3 Turn the crankshaft until the piston in the affected cylinder is at top dead centre (TDC) on the compression stroke (see Section 3 for instructions). If you're renewing all of the valve stem seals, begin with cylinder number one and work on the valves for one cylinder at a time. Move from cylinder-to-cylinder following the firing order sequence (see the Specifications listed at the beginning of this Chapter). (If the piston is at TDC, then it will not be forced down when air pressure is applied. Having the piston at it's highest point may also prevent the valve from being completely lost if air pressure is suddenly removed.)

4 Thread an adapter into the spark plug hole **(see illustration)** and connect an air hose from a compressed air source to it. Most auto parts stores can supply the air hose adapter. **Note:** *Many cylinder compression gauges utilise a screw-in fitting that may work with your air hose quick-disconnect fitting.*

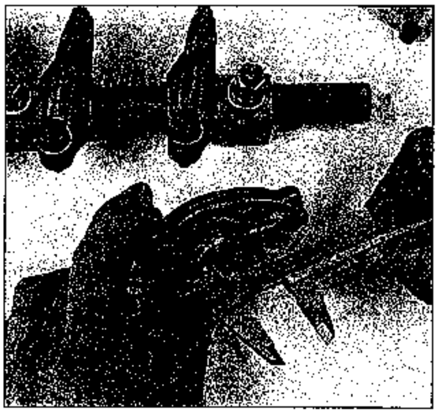
5 Remove the rocker shaft assembly (see Section 5).

6 Apply compressed air to the cylinder. **Warning:** *The piston may be forced down by compressed air, causing the crankshaft to turn suddenly. If the spanner used when positioning the number one piston at TDC is still attached to the bolt in the crankshaft nose, it could cause damage or injury when the crankshaft moves.*

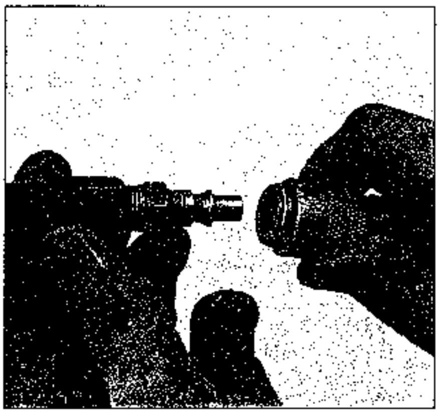
7 The valves should be held in place by the air pressure. If the valve faces or seats are in poor condition, leaks may prevent air pressure from retaining the valves - refer to the alternative procedure below.



5.7a Measure the rocker shaft in the area where each rocker arm rides . . .



5.7b . . . and the bore of each rocker arm



6.4 This is what the air hose adapter that threads into the spark plug looks like - they're commonly available from auto part stores

8 If you don't have access to compressed air, an alternative method can be used. Position the piston at a point approximately 45-degrees (1/8 turn) before TDC on the compression stroke, then feed a long piece of nylon rope through the spark plug hole until it fills the combustion chamber. Be sure to leave the end of the rope hanging out of the spark plug hole so it can be removed easily. Use a large ratchet and socket to rotate the crankshaft in the normal direction of rotation until slight resistance is felt.

9 Stuff shop rags into the cylinder head holes above and below the valves to prevent parts and tools from falling into the engine, then use a valve spring compressor to compress the spring. Remove the collets with small needle-nose pliers or a magnet **(see illustration)**. **Note:** *A couple of different types of tools are available for compressing the valve springs with the head in place. Consult a local tool store or rental yard for the correct tool.*

10 Remove the spring retainer and valve spring, then use a screwdriver or pliers to remove the guide seal **(see illustration)**. **Note:** *If air pressure fails to hold the valve in the closed position during this operation, the valve face and/or seat is probably damaged. If so, the cylinder head will have to be removed for additional repair operations.*

11 Wrap a rubber band or tape around the top of the valve stem so the valve won't fall into the combustion chamber, then release the air pressure.

12 Inspect the valve stem for damage. Rotate the valve in the guide and check the end for eccentric movement, which would indicate that the valve is bent.

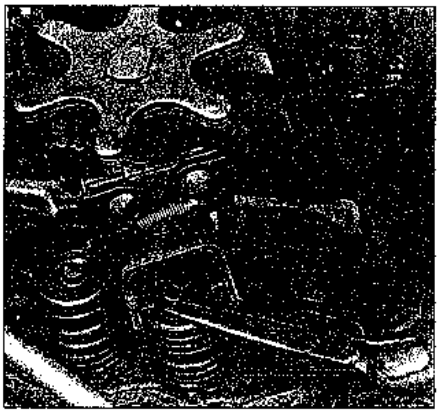
13 Move the valve up-and-down in the guide and make sure it doesn't bind. If the valve stem binds, either the valve is bent or the guide is damaged. In either case, the head will have to be removed for repair.

14 Reapply air pressure to the cylinder to retain the valve in the closed position, then remove the tape or rubber band from the valve stem.

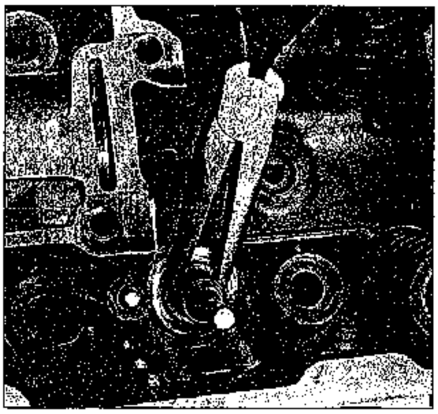
15 Lubricate the valve stem with engine oil and fit a new guide seal. Tap the new seal into position on the valve guide boss with a hammer and a deep socket of the appropriate size **(see illustration)**. Drive the seal onto the guide until the clearance between the bottom of the seal and the spring seat on the cylinder head surface is 4.6 mm. **Note:** *Most valve seals are supplied with a temporary cover for the end of the valve to protect the seal as it slides over the valve grooves.*

16 Refit the spring in position over the valve. The spring must be refitted with the closely spaced coils towards the cylinder head.

17 Refit the valve spring retainer. Compress the valve spring and carefully position the collets in the groove. Apply a small dab of grease to the inside of each collet to hold it in place **(see illustration)**.

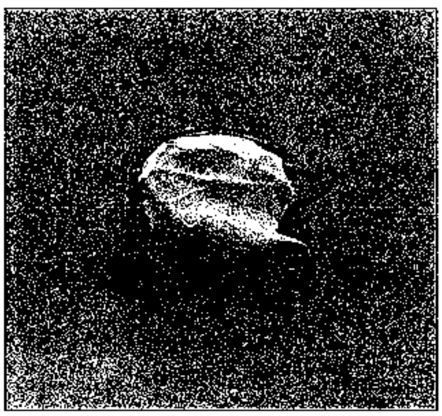


6.9 Once the spring is compressed, the collets can be removed with a magnet or needle-nose pliers

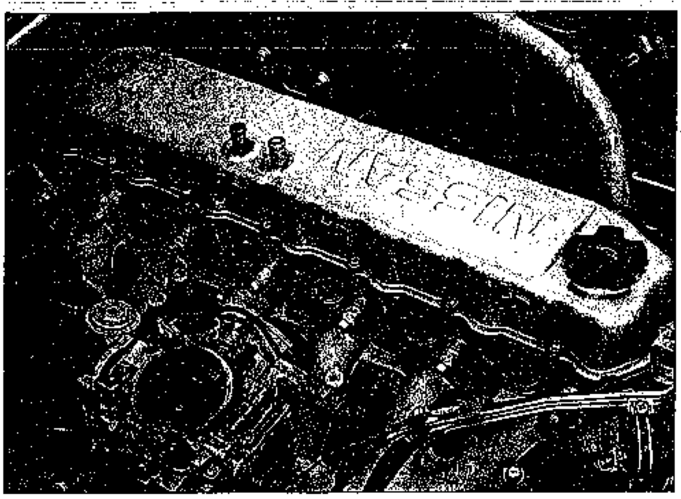


6.10 Use pliers to pull the valve seal from the valve guide boss - remember that the valve stem must not be damaged as you do this

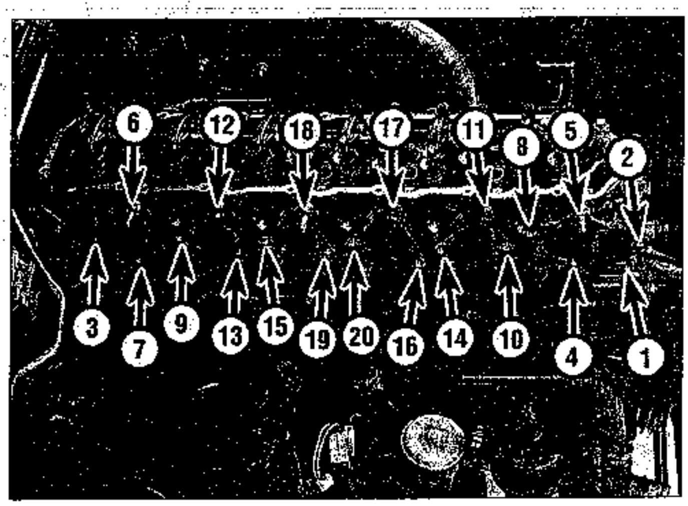
6.15 Gently tap the new seals into place - maintain the correct clearance between the bottom of the seal and the spring seat



6.17 Apply a small dab of grease to the collets before refitting - it will hold them in place on the valve stem as the spring is released



7.5 There are several hoses, wires and cables which must be tied out of the way prior to removing the manifold bolts



7.8 Remove the inlet manifold bolts in this sequence. When tightening them, simply work backwards (manifold removed for clarity)

18 Remove the pressure from the compressor and make sure the collets are seated.
19 Disconnect the air hose and remove the adapter from the spark plug hole. If a rope was used in place of air pressure, rotate the engine anti-clockwise and then pull it out of the cylinder.
20 Refer to Section 5 and refit the rocker shaft.
21 Refit the spark plug(s) and hook up the wire(s).
22 Refer to Section 4 and refit the valve cover.
23 Start and run the engine, then check for oil leaks and unusual sounds coming from the valve cover area.

7 Inlet manifold - removal and refitting

Refer to illustrations 7.5 and 7.8

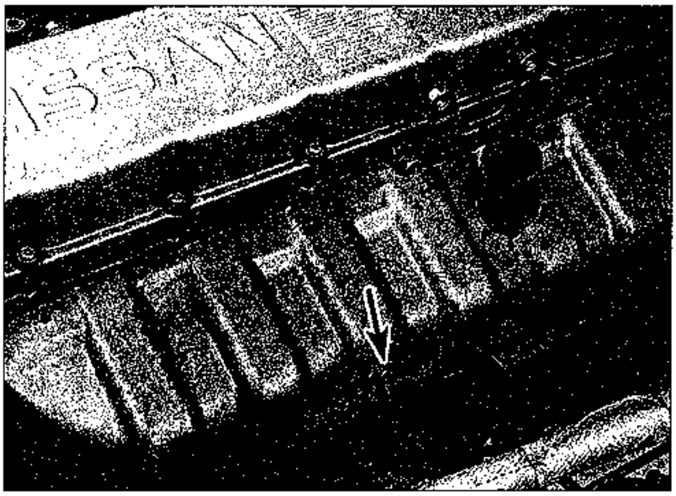
Carburetted models

1 Disconnect the negative battery cable from the battery.
2 Remove the air cleaner assembly.
3 Drain several litres of coolant from the radiator (refer to Chapter 1). Disconnect the upper radiator hose from the thermostat housing.
4 Disconnect the lower heater hose at the firewall.
5 Label and then disconnect all of the vacuum hoses, fuel hoses and wiring which interfere with the removal of the manifold. Use wire to secure them out of the way, if necessary **(see illustration)**.
6 Disconnect the accelerator cable (refer to Chapter 4).
7 Remove the oil dipstick and then unbolt and remove the dipstick tube.
8 Loosen the manifold bolts and nuts a little at a time. Follow the sequence shown **(see illustration)**.
9 Carefully remove the inlet manifold. The manifold can be stripped of the carburettor and other components at this time, if necessary.
10 Place clean rags into the inlet ports and water jacket opening to prevent the entrance of debris.
11 Check the manifold carefully for cracks or other damage. A precision machinist's straightedge can be used to check the sealing surface for warpage. If the manifold has become excessively warped, it may be possible for a machine shop to resurface it.
12 Refitting is the reverse of removal. Always use new gaskets.
13 Tighten the manifold fasteners gradually, working in the order opposite that of the loosening sequence **(see illustration 7.8)**. Tighten the fasteners to the torque listed in this Chapter's Specifications.

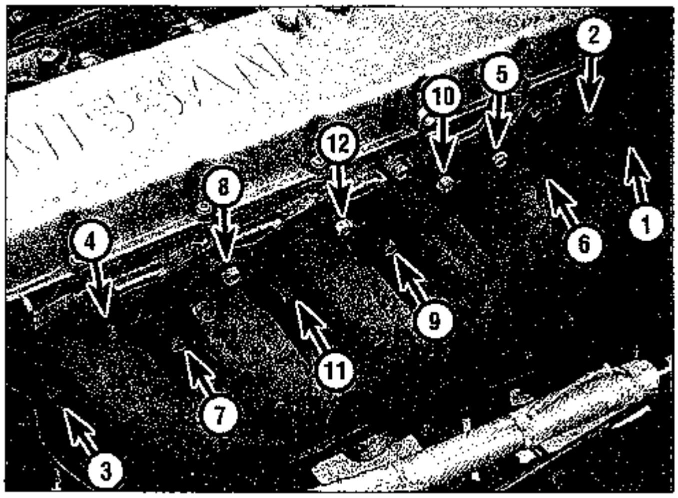
Fuel-injected models

14 Relieve the fuel system pressure (refer to Chapter 4B).
15 Disconnect the negative battery cable from the battery.
16 Label and then disconnect all of the vacuum hoses, fuel hoses and wiring which interfere with the removal of the manifold. Use wire to secure them out of the way, if necessary. It will be necessary to methodically examine the entire assembly for all interfering components and make certain that all hoses, etc. are disconnected.
17 Drain several litres of coolant from the radiator (refer to Chapter 1). Disconnect the upper radiator hose from the thermostat housing.
18 Disconnect the upper radiator hose from the engine. Disconnect the smaller coolant bypass hose from the front of the manifold.
19 Remove the air inlet tube. Refer to Chapter 4.
20 Disconnect the throttle cable. Refer to Chapter 4.
21 Remove the bolts from the heater hose tubes. Label the heater hoses and then disconnect them from the inlet manifold.
22 Loosen the manifold bolts and nuts a little at a time. Follow the reverse of the tightening sequence **(see illustration 7.8)**. until they are all removed.
23 Carefully remove the complete inlet manifold assembly. The upper plenum can be removed from the lower manifold at this time, if necessary.
24 Check the manifold carefully for cracks or other damage. A precision machinist's straightedge can be used to check the sealing surface for warpage. If the manifold has become excessively warped, it may be possible for a machine shop to resurface it.
25 Refitting is the reverse of removal. Always use new gaskets.
26 Tighten the manifold fasteners gradually, working in the order opposite that of the loosening sequence. Tighten the fasteners to the torque listed in this Chapter's Specifications.

8.3 You will have to work from beneath the vehicle in order to remove the bolts from the exhaust pipes - a long extension on your ratchet is very helpful



8.5 The earth strap (arrow) has to be disconnected before removing the heat shield - don't tuck it out of the way or you may forget to refit it later



8.6 Exhaust manifold nut and bolt removal sequence. Work in reverse when refitting it

8 Exhaust manifold - removal and refitting

Refer to illustrations 8.3, 8.5 and 8.6

1 Disconnect the negative battery cable from the battery.

2 Raise the vehicle and support it securely on jackstands.

3 Disconnect the exhaust pipes from the exhaust manifold **(see illustration)**. **Note:** *It may be necessary to apply penetrating oil to the fasteners if they are seized. Apply it liberally and allow it to soak in.*

4 Lower the vehicle. Remove the air inlet tube for access to the exhaust manifold. Refer to Chapter 4 if necessary.

5 Remove the heat shield and the earth cable from the manifold **(see illustration)**.

6 Loosen the manifold bolts and nuts a little at a time. Follow the proper sequence **(see illustration)** until they are all removed.

7 Carefully remove the manifold.

8 Check the manifold carefully for cracks or other damage. A precision machinist's straightedge can be used to check the sealing surface for warpage. If the manifold has become excessively warped, it may be possible for a machine shop to resurface it.

9 Refitting is the reverse of removal. Always use new gaskets.

10 Tighten the manifold fasteners gradually, working in the order opposite that of the loosening sequence **(see illustration 8.6)**. Tighten the fasteners to the torque listed in this Chapter's Specifications.

9 Cylinder head - removal and refitting

Refer to illustrations 9.7, 9.8 and 9.10

Warning: *The engine must be completely cool before starting this procedure.*

1 If you're working on a fuel-injected model, relieve the fuel system pressure (see Chapter 4B).

2 Drain the cooling system (refer to Chapter 1). Remove the inlet and exhaust manifolds (see Sections 7 and 8).

3 Label and then disconnect the spark plug wires from the spark plugs. Take the wires from their brackets and lay them out of the way. Keep them attached to the distributor.

4 Remove the alternator adjusting bar.

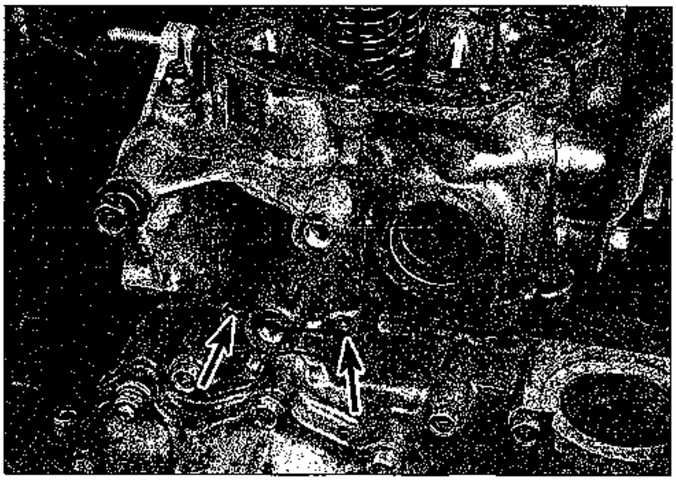
5 Remove the valve cover (refer to Section 4).

6 Remove the rocker shaft assembly and the pushrods (refer to Section 5).

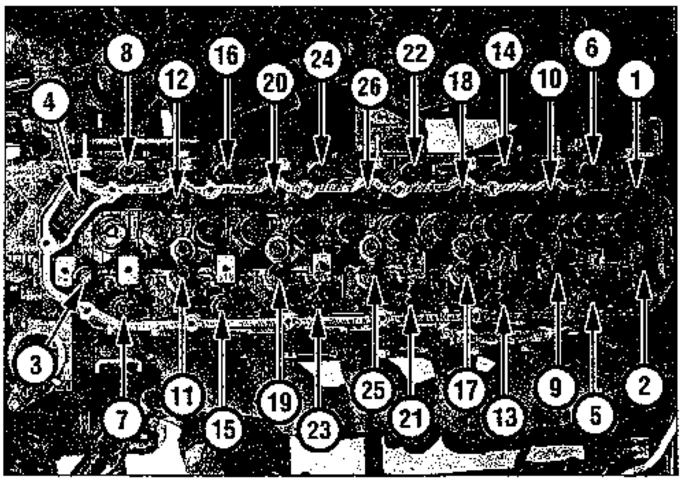
7 Remove the two bolts which secure the front cover to the head **(see illustration)**.

8 Loosen the cylinder head bolts in three gradual steps. Loosen the bolts in the proper sequence **(see illustration)**.

9 Carefully lift the cylinder head from the engine compartment. If the head is stuck to the engine block, it may be necessary to tap it with a soft-face hammer or a block of wood and a hammer to break the seal. **Caution:** *Because cylinder head bolts are often damaged by stretching and threads collapsing or stripping, have each head bolt examined by a qualified machinist. If in doubt about the integrity of the cylinder head bolts, renew them.*



9.7 It is easy to forget these two bolts - remove them before unscrewing the longer head bolts



9.8 Cylinder head bolt removal sequence - work in reverse when refitting the cylinder head

10 Stuff clean shop towels into the cylinders. Thoroughly clean the gasket surfaces, removing all traces of gasket material. Run an appropriate sized tap into the bolt holes in the cylinder head and run a die over the bolt threads **(see illustration)**. Ensure all bolt holes are clean and dry.

11 Inspect the cylinder head for cracks and check it for warpage. Refer to Chapter 2 Part D for cylinder head servicing procedures.

12 Fit the new gasket dry (without any sealing compound).

13 Make sure the gasket is refitted with the word TOP **(see illustration)** facing up. Place the cylinder head on the engine.

14 Place the washers on the head bolts. The chamfered side of the washers must face towards the bolt head. Refit the bolts and tighten them in the reverse of the removal sequence **(see illustration 9.8)**. Tighten them in the steps and to the torque listed in this Chapter's Specifications. The preferred last step requires an angle meter type torque wrench. If you cannot obtain one of these wrenches, it is acceptable to use a standard torque wrench for the final step.

15 Refit the remaining components in the reverse order of removal.

16 Change the oil and filter (see Chapter 1).

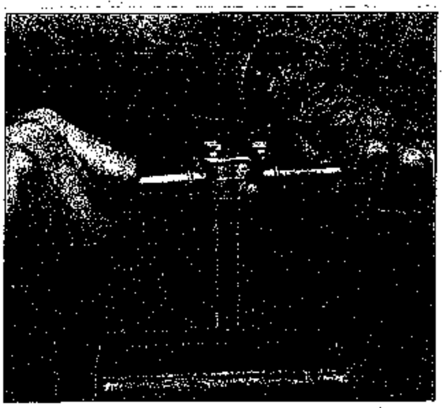
17 Refill the cooling system and run the engine, checking for leaks and proper operation.

10 Lifters - removal, inspection and refitting

Removal

Refer to illustrations 10.7a, 10.7b, 10.7c and 10.7d

1 A noisy valve lifter can be isolated when the engine is idling. Place a length of hose or tubing on the valve cover near the position of each valve while listening at the other end. Or remove the valve cover and, with the engine idling, place a finger on each of the valve spring retainers, one at a time. If a valve lifter is defective, it'll be evident from the shock felt at the retainer as the valve opens.



9.10 A die should be used to remove sealant and corrosion from the head bolt threads

2 The most likely cause of a noisy valve lifter is worn lifters or damaged camshaft lobes. It is recommended that the camshaft as well as the lifters be renewed if the lifters are diagnosed as worn and damaged.

3 Remove the cylinder head (refer to Section 9). Remove the head gasket if it is stuck to the block.

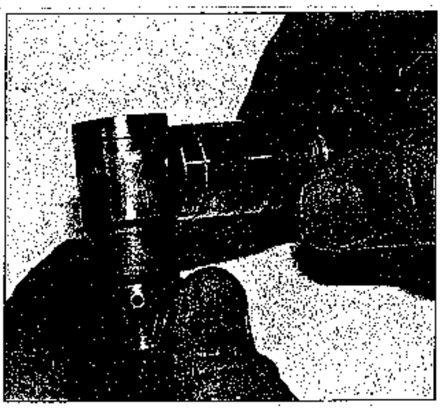
4 Remove the lifters from the block one at a time, keeping them in order.

5 Store the lifters in a clearly labeled box to insure their rerefitting in the same lifter bores.

Inspection

6 Clean the lifters with solvent and dry them thoroughly. Do this one lifter at a time to avoid mixing them up.

7 Check each lifter wall, pushrod seat and foot for scuffing, score marks and uneven wear. Each lifter foot (the surface that rides on the cam) must be slightly convex, although this can be difficult to determine by eye **(see illustration)**. If the base of the lifter is concave or rough **(see illustrations)**, the lifters and camshaft must be renewed. If the lifter walls are damaged or worn (which isn't very likely), inspect the lifter bores in the engine block as well. If the pushrod seats **(see illustration)** are worn, check the pushrod ends.



10.7a The foot of each lifter should be slightly convex - the side of another lifter can be used as a straightedge to check it; if it appears flat, it's worn and must not be reused

8 If new lifters are being fitted, a new camshaft should also be fitted. If a new camshaft is fitted, then always use new lifters as well. Never refit used lifters unless the original camshaft is used and the lifters can be refitted in their original locations!

Refitting

9 The used lifters must be refitted in their original bores. Coat them with moly-base grease or engine assembly lube.

10 Lubricate the bearing surfaces of the lifter bores with engine oil.

11 Refit the lifter(s) in the lifter bore(s).

12 The remainder of the assembly procedure is the reverse of disassembly.

11 Crankshaft pulley/vibration damper - removal and refitting

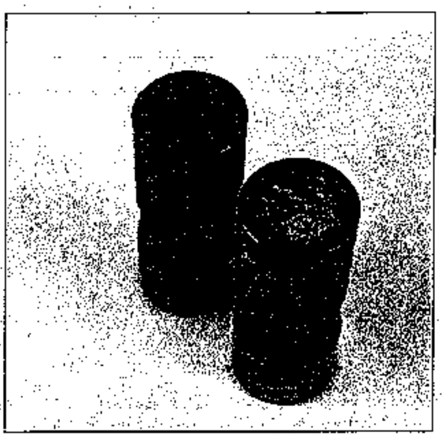
Refer to illustration 11.6

1 Remove the cable from the negative battery terminal.

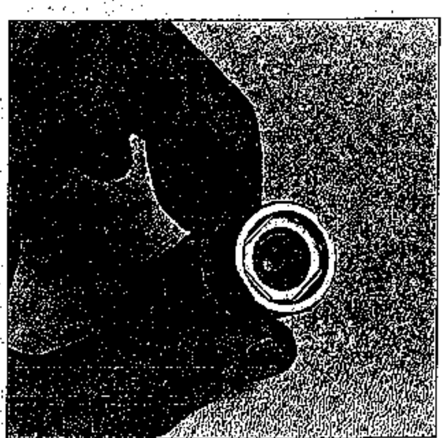
2 Raise the vehicle and support it securely on jackstands.

3 Use a long breaker bar and a socket to

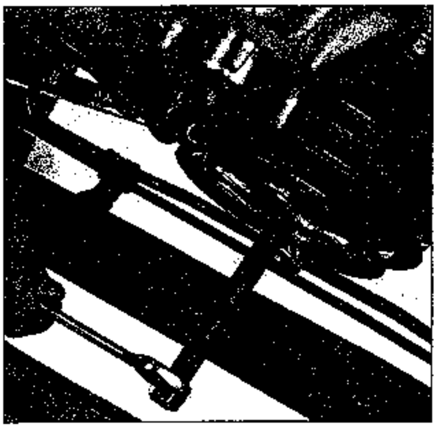
10.7b If the bottom (foot) of any lifter is worn concave (shown here), scratched or galled, renew the entire set of lifters



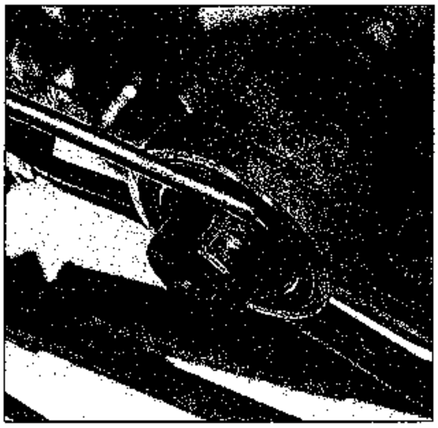
10.7c If the lifters are pitted or rough, they shouldn't be reused



10.7d The pushrod end of the lifter must be inspected also



11.6 Remove the vibration damper with a puller that attaches to the damper hub



12.2 The crankshaft front oil seal can be removed with a seal removal tool or a screwdriver

13.5 Check on all sides of the cover to ensure that all interfering brackets have been removed

remove the damper centre bolt. The drivebelts should hold the crankshaft from turning as you do this. If not, remove the torque converter access cover (automatic transmission) or starter (manual transmission) and wedge a screwdriver into the ring gear teeth to prevent the crankshaft from turning.

4 Remove the drivebelts (Chapter 1). Tag each belt as it is removed to simplify refitting. If the vehicle is equipped with a fan shroud, unscrew the mounting bolts and position the shroud out of the way.

5 On most models, it is necessary to remove the radiator in order to get adequate clearance for a puller to be used. Refer to Chapter 1 for the collant draining procedure and Chapter 3 for the radiator removal procedure. **Warning:** *Wait until the engine is completely cool before draining the coolant.*

6 Use a puller that threads into the holes provided in the damper to remove the vibration damper **(see illustration)**. Do not allow the puller to damage the threads in the crankshaft. If necessary, fit a narrow deep socket into the nose of the crankshaft for the puller screw to bear on. **Caution:** *Do not use a jaw-type puller that applies force to the outer portion of the pulley!*

7 Refer to Section 12 for the front oil seal renewal procedure if it appears to be leaking.

8 Inspect the surface of the damper that contacts the front seal. There may be a groove worn in this surface. If so, the damper can be renewed or a sleeve can be fitted over the damper hub. **Note:** *These sleeves are available at auto parts stores. If a worn damper is refitted with a new seal, the seal will probably leak.*

9 Apply a thin layer of multi-purpose grease to the seal contact surface of the vibration damper.

10 Slide the vibration damper onto the crankshaft. Note that the slot in the hub must be aligned with the Woodruff key in the end of the crankshaft. Once the key is aligned with the slot, tap the damper onto the crankshaft with a soft-face hammer. The retaining bolt can be used to press the damper into position, although a damper refitting tool is preferred.

11 Refitting is the reverse of removal.

12 Refit the drivebelt(s) (Chapter 1).

13 Tighten the damper centre bolt to the torque listed in this Chapter's Specifications.

12 Crankshaft front oil seal - renewal

Note: *The crankshaft front oil seal can be renewed with the timing chain cover in place. However, due to the limited amount of room available, you may conclude that the procedure would be easier if the cover were removed from the engine first. If so, refer to Section 13 for the cover removal and refitting procedure.*

Timing chain cover in place

Refer to illustration 12.2

1 Disconnect the negative battery cable from the battery, then remove the vibration damper (see Section 11).

2 Note how the seal is fitted - the new one must face the same direction! Carefully prise the oil seal out of the cover with a seal puller or a large screwdriver **(see illustration)**. Be very careful not to distort the cover or scratch the crankshaft!

3 Apply clean engine oil or multi-purpose grease to the outer edge of the new seal, then fit it in the cover with the lip (open end) facing in. Drive the seal into place with a large socket and a hammer (if a large socket isn't available, a piece of pipe will also work). Make sure the seal enters the bore squarely and stop when the front face is flush with the cover.

4 Refit the vibration damper (see Section 11).

Timing chain cover removed

5 Remove the timing chain cover as described in Section 13.

6 Support the front cover with blocks of wood and drive the old seal out from the inside with a hammer and punch. Be careful not to distort the cover or scratch the wall of the seal bore. If the engine has accumulated a lot of kilometres, apply penetrating oil to the seal-to-cover joint and allow it to soak in before attempting to remove the seal.

7 Clean the bore to remove any old seal material and corrosion. Support the cover on a block of wood and position the new seal in the bore with the lip (open end) of the seal facing in. A small amount of oil applied to the outer edge of the new seal will make refitting easier - don't overdo it!

8 Drive the seal into the bore with a large socket and hammer until it's completely seated. Select a socket that's the same outside diameter as the seal. A section of pipe or even a block of wood can be used if a socket isn't available.

9 Refit the timing chain cover.

13 Timing chain cover - removal and refitting

Refer to illustrations 13.5, 13.7 and 13.9

1 Remove the vibration damper (see Section 11).

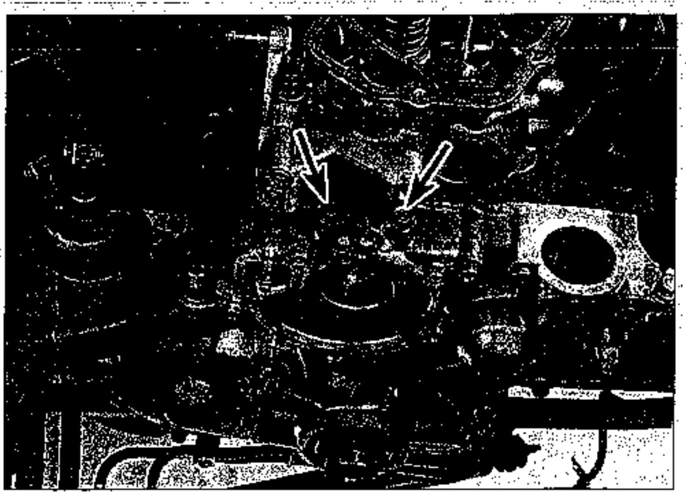
2 Remove the radiator and the fan assembly, if not already done (see Chapter 3).

3 Disconnect the coolant hoses from the timing cover and secure them out of the way.

4 Remove the power steering pump bracket bolts and position the complete power steering pump assembly out of the way.

5 Remove the air conditioning compressor from it's mounting bracket (refer to Chapter 3). Do not disconnect any air conditioning hoses. Position the compressor out of the way. Remove the air conditioning compressor bracket and any other brackets which interfere **(see illustration)**.

6 Remove the sump (see Section 17). **Note:** *The sump only needs to be lowered in the front enough to clear the timing cover. It is not necessary to remove it completely from the vehicle. An alternative procedure is to remove all of the sump bolts except the rear*



13.7 The cylinder head is secured to the cover by these two bolts

13.9 Slide the cover directly forward to remove it

ones. Break the seal and use wood wedges to gently lower the front of the sump. When the timing cover has been refitted, clean the sump sealing surface very thoroughly (with acetone or lacquer thinner) and seal it with RTV silicone sealer before refitting the sump bolts.

7 Remove the bolts which secure the cylinder head to the timing cover **(see illustration)**.

8 Remove the timing cover bolts.

9 Tap the timing cover with a soft-faced hammer to break the seal, then remove it **(see illustration)**.

10 Thoroughly clean the cover and all sealing surfaces, removing all traces of gasket material. Drive the old oil seal out from the rear of the timing chain cover and renew it (see Section 12).

11 Clean all the sealing surfaces again with lacquer thinner or acetone. Apply a 3 mm bead of RTV sealant to the cover, inboard of the bolt holes. Make sure that there is adequate sealer where the cover contacts the sump and the cylinder head.

12 Position the timing chain cover on the engine block and refit the bolts. Tighten the fasteners to the torque listed in this Chapter's Specifications.

13 Refit the sump, using RTV sealant as necessary to ensure a leak-proof seal. Refer to Section 17.

14 Refit the remaining parts in the reverse order of removal.

15 Run the engine and check for oil leaks.

14 Timing chain and sprockets - removal, inspection and refitting

Refer to illustrations 14.5a, 14.5b, 14.6, 14.7, 14.8, 14.9, 14.11, 14.14a, 14.14b, 14.16 and 14.23

1 Set the number one piston at Top Dead Centre (TDC) on the compression stroke (see Section 3).

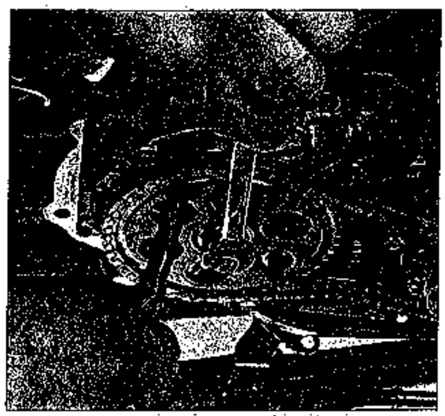
2 Remove the distributor (refer to Chapter 5). **Note:** *The rotor must be pointing to the spark plug wire for number one cylinder and the body of the distributor must be marked to in relation to the engine block before removal.*

3 Remove the timing chain cover (see Section 13).

4 Loosen the two bolts that secure the oil pump chain tensioner. Release the tension on the oil pump chain.

5 Remove the nut which secures the oil pump sprocket to the oil pump **(see illustration)**. Remove both oil pump chain sprockets along with the chain **(see illustration)**.

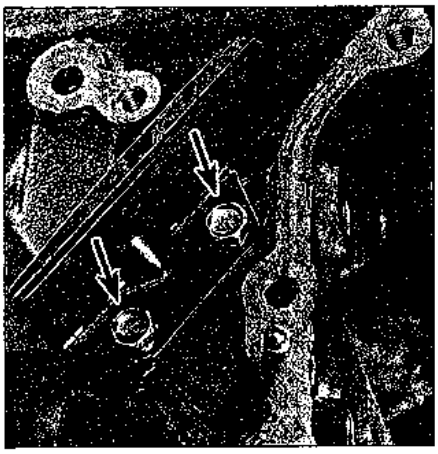
6 Remove the tensioner assembly **(see illustration)**.



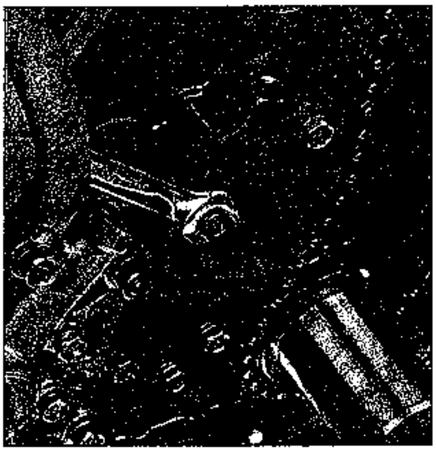
14.5a Lock the sprocket through one of its holes to remove the fastener

14.5b Slide the sprockets off simultaneously along with the chain

14.6 Remove the tensioner assembly



14.7 The guide can be removed at this time - remove the bolts (arrows)



14.8 Remove the timing chain tensioner assembly. There are small parts inside that can fall out - it is best to seal the top of the sump with a rag first

14.9 The camshaft bolt can be removed in the same way as the oil pump sprocket fastener was removed

7 Remove the timing chain guide **(see illustration)**.

8 Remove the timing chain tensioner assembly **(see illustration)**. **Caution:** *Do not drop the tensioner spring into the sump.*

9 Remove the camshaft sprocket bolt and remove the washer and distributor drive gear **(see illustration)**.

10 Prise off the timing chain sprockets along with the chain. **Warning:** *Do not rotate the engine with the timing chain removed. The pistons will contact the valves, resulting in valve damage.*

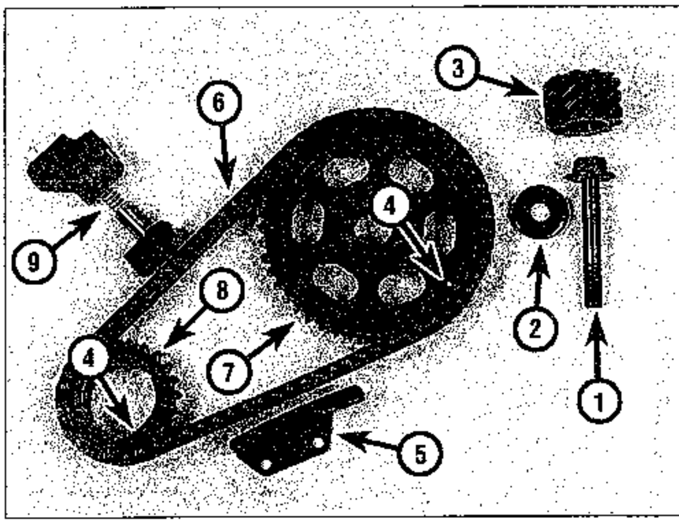
11 Clean the components and inspect for wear and damage **(see illustration)**. Timing gear teeth that are deformed, chipped, pitted or discoloured call for renewal. Always renew the timing gears as a set. Make sure the engine block is clean and the crankshaft does not have any burrs, scratches or damage that will prevent the timing gear from sliding over the surface easily.

12 Check the guide and the tensioners for wear and smooth operation. Renew them as necessary.

13 Before refitting the sprockets and chains, make certain that the crankshaft key and the camshaft key are near the 12 o'clock position.

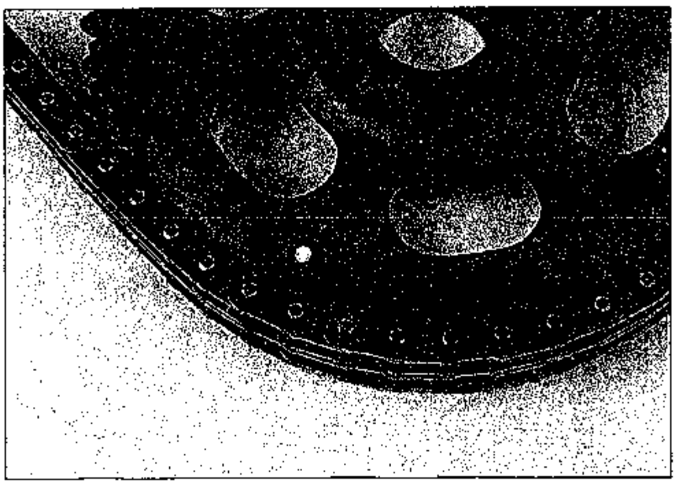
14 Loop the timing chain onto the sprockets. Line up the bright links in the chain with the dimple marks in the sprockets **(see illustrations)**.

15 Refit the chain and sprocket assembly onto the crankshaft and camshaft simultaneously. It may be necessary to slightly rotate the crankshaft during this procedure.

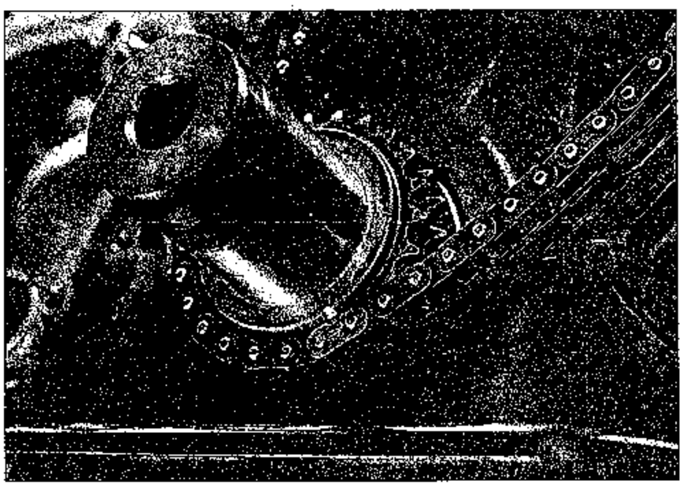


14.11 These are the components of the timing chain assembly

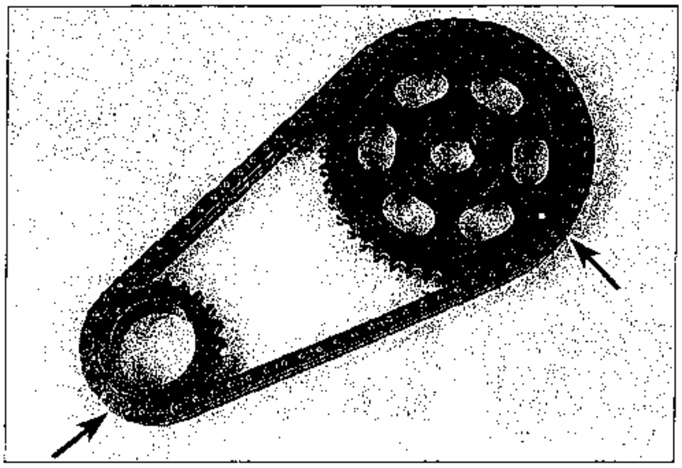
1 *Bolt*
2 *Washer*
3 *Distributor gear*
4 *Timing chain alignment marks*
5 *Chain guide*
6 *Chain*
7 *Camshaft gear*
8 *Crankshaft gear*
9 *Tensioner assembly*



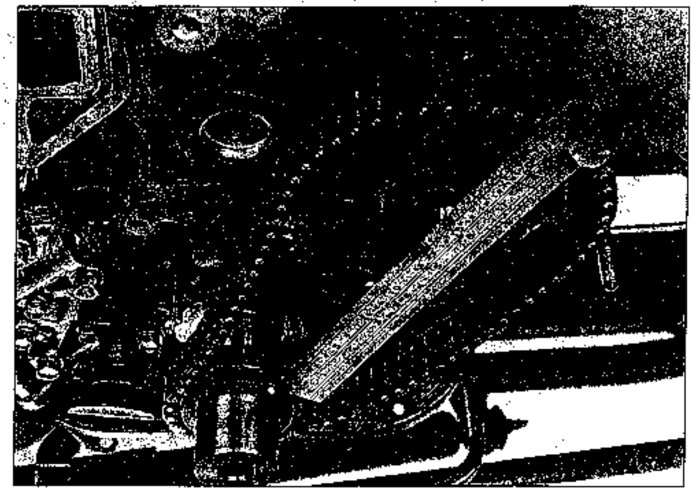
14.14a Align the bright link in the chain with the camshaft sprocket mark



14.14b The other bright link must align with the mark on the crankshaft sprocket



14.16 When both bright links are aligned correctly, they will be in this orientation (arrows)



14.23 The timing chain alignment can be double-checked like this

16 Check that the bright colored links are still properly lining up with the marks on the sprockets **(see illustration)**.

17 Refit the distributor drive gear, the washer and the camshaft bolt. Tighten the camshaft sprocket bolt to the torque listed in this Chapter's Specifications, using the same method as you did to prevent the camshaft from turning.

18 Refit the tensioner unit with the tensioner foot and plunger compressed into the tensioner body as far as it will go. Tighten the fasteners to the torque listed in this Chapter's Specifications.

19 Refit the guide and tighten the fasteners to the torque listed in this Chapter's Specifications.

20 Refit the oil pump chain and sprockets. Make certain that the longer hub on the oil pump sprocket faces towards the front of the vehicle.

21 Tighten the oil pump bolt to the torque listed in this Chapter's Specifications.

22 Refit the oil pump chain tensioner. Use a finger to force the tensioner against the chain while tightening the bolts. Tighten the fasteners to the torque listed in this Chapter's Specifications.

23 Refit the remaining parts in the reverse order of removal. Refer to the appropriate Sections and Chapters for instructions. **Note:** *After all of the internal components are fitted, it should be possible to line up the marks on the timing sprockets if the crankshaft is rotated* **(see illustration)**.

15 Oil pump - removal, inspection and refitting

Refer to illustrations 15.3a, 15.3b, 15.4, 15.5, 15.6, 15.7a, 15.7b, 15.8, 15.9, 15.10a, 15.10b, 15.12 and 15.13

Removal

1 Remove the oil pump chain and sprockets (refer to Section 14).

2 On carburetted models, remove the fuel pump (refer to Chapter 4).

3 Remove the oil pump bolts **(see illustration)**. Pull out the oil pump **(see illustration)**.

4 Remove the five bolts which retain the front cover **(see illustration)**.

5 Remove the four bolts which retain the rear cover **(see illustration)**.

6 On carburetted models, remove the small nut which retains the fuel pump cam **(see illustration)**. Disassemble the internal components and lay them carefully out in order.

7 Remove the plug from the pressure relief valve **(see illustration)**. Remove the washer, spring and the relief plunger. Keep all the parts in order **(see illustration)**.

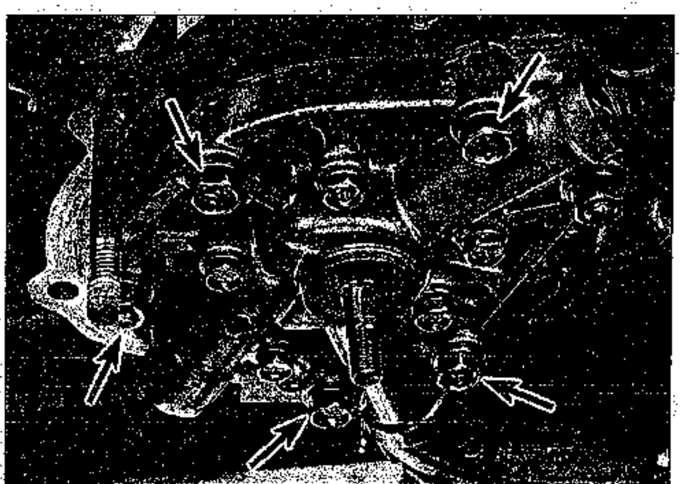
Inspection

8 Visually inspect all components for obvious wear or damage **(see illustration)**.

9 Use feeler gauges to measure the clearance between the ends of the rotors and a straightedge placed across the body of the pump **(see illustration)**. Compare the readings to the specifications in this Chapter.

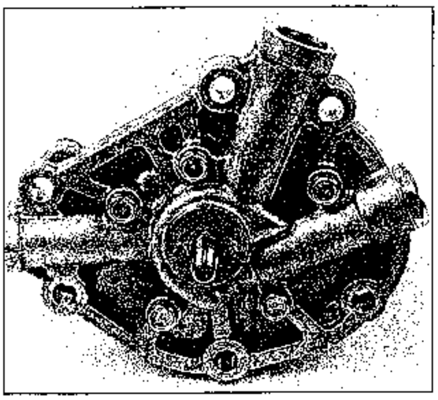
10 In a similar manner, check the clearances between the outer rotor and the body of the pump and between the apex of the inner rotor and the shoulder of the outer rotor **(see illustrations)**. Compare the reading to the specifications in this Chapter.

11 Check the relief mechanism components. Make certain that the plunger slides smoothly in it's bore.

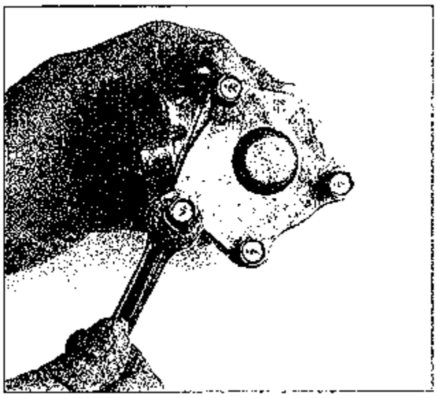


15.3a Remove these bolts to release the oil pump from the block

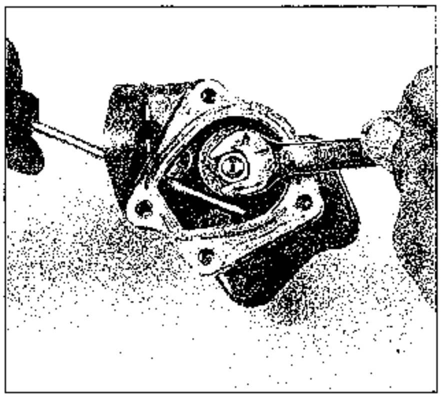
15.3b Pull the pump from the engine block



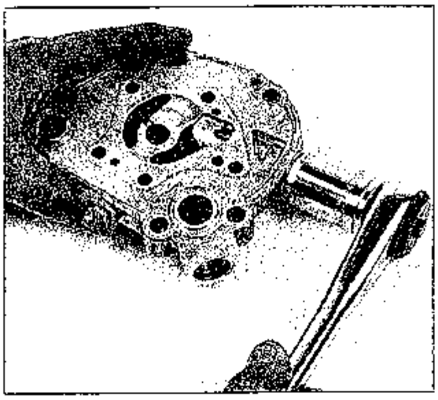
15.4 The five remaining bolts hold the front cover of the pump in place



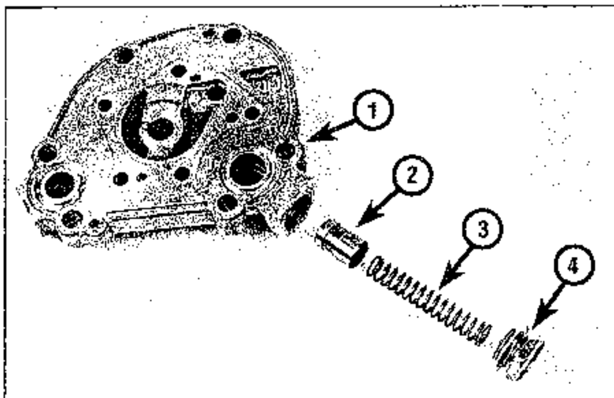
15.5 Remove the bolts from the rear cover plate



15.6 A screwdriver can be used to wedge the fuel pump cam so the nut can be removed from the shaft



15.7a The oil pressure relief mechanism is located beneath this cover - do not clamp the housing in a vice when removing the plug



15.7b The components of the pressure relief assembly

1 *Front cover*
2 *Plunger*
3 *Spring*
4 *Plug and washer*

12 Drive the bearing out of the body of the pump and renew it **(see illustration)**.

13 Renew all O-rings **(see illustration)**. Renew any worn components (or the complete pump) at this time.

Refitting

14 Tighten the fuel pump cam nut to the torque listed in this Chapter's Specifications.

15 Clean all of the cover sealing surfaces with lacquer thinner or acetone. Refit the front and rear covers. Tighten the fasteners to the torque listed in this Chapter's Specifications.

16 The remainder of the refitting is the reverse of the disassembly procedure.

16 Camshaft and bearings - removal, inspection and refitting

Refer to illustration 16.15, 16.19, 16.22 and 16.25

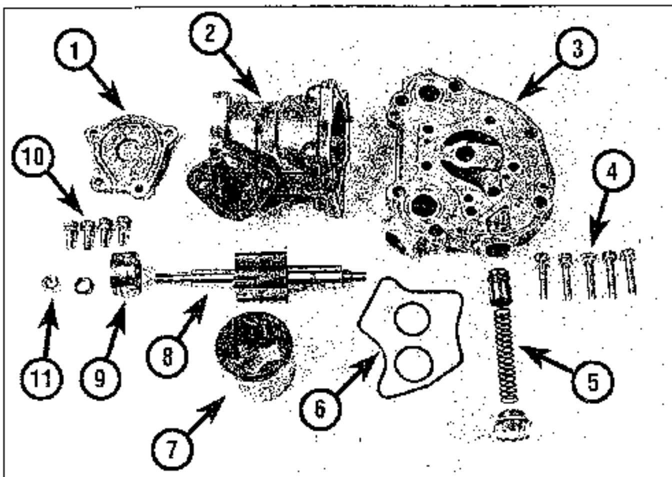
Camshaft lift check

1 To determine the extent of cam wear, the lobe lift should be checked prior to camshaft removal. Refer to Section 4 and remove the valve cover.

2 Position the number one piston at TDC on the compression stroke (see Section 3).

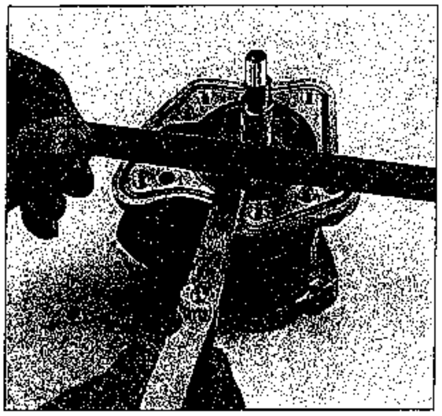
3 Beginning with the number one cylinder valves, mount a dial indicator on the engine and position the plunger against the top surface of the first rocker arm. The plunger should be directly above and in line with the pushrod.

4 Zero the dial indicator, then very slowly turn the crankshaft in the normal direction of rotation until the indicator needle stops and begins to move in the opposite direction. The point at which it stops indicates maximum

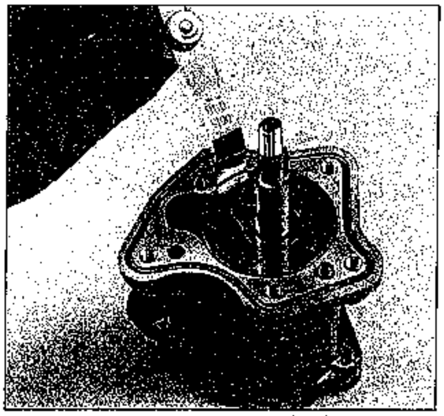


15.8 All of the components must be inspected carefully. Individual parts are available - the O-rings should always be renewed any time the pump is disassembled

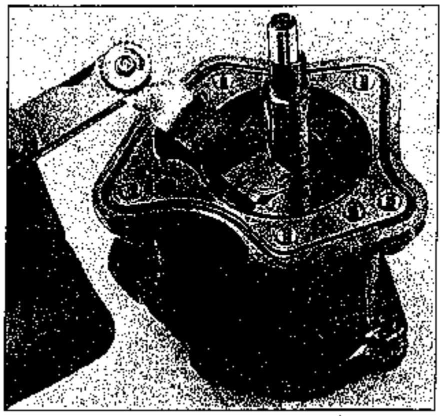
1 *Rear cover*
2 *Body*
3 *Front cover*
4 *Bolts*
5 *Pressure relief assembly*
6 *O-rings and seal*
7 *Outer rotor*
8 *Inner rotor*
9 *Cam and bearing*
10 *Bolts*
11 *Nut and washer*



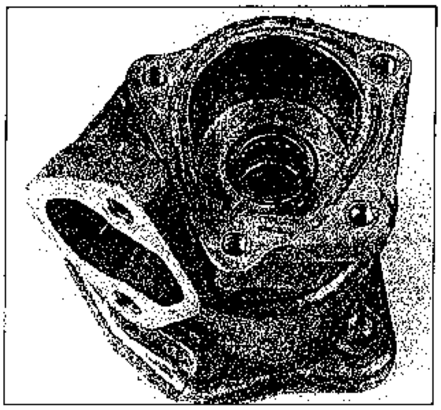
15.9 Check the pump end clearance like this



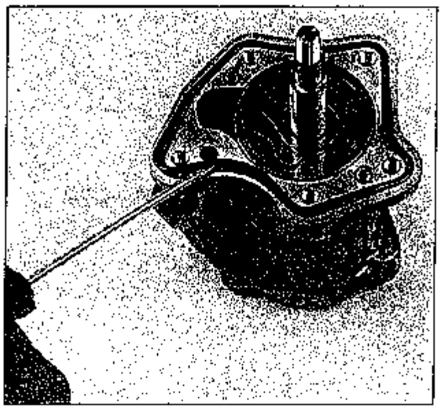
15.10a Insert the feeler gauge between the housing and the rotor and compare your reading with the Specifications



15.10b The clearance between the two rotors should also be checked



15.12 The inner bearing can be driven out with a hammer and punch - tap the new one in at its outer diameter only



15.13 The O-rings are very critical yet inexpensive - renew them whenever they are accessible

16.15 The camshaft retainer secures the camshaft in the engine block - after removing, check it for wear on its inner surface

cam lobe lift.

5 Record this figure for future reference, then reposition the piston at TDC on the compression stroke.

6 Move the dial indicator to the remaining number one cylinder rocker arm and repeat the check. Be sure to record the results for each valve.

7 Repeat the check for the remaining valves. Since each piston must be at TDC on the compression stroke for this procedure, work from cylinder-to-cylinder following the firing order sequence.

8 If the lift measurement is substantially lower on any one rocker arm (greater than 0.15 mm), the camshaft is excessively worn.

Removal

9 Disconnect the negative cable from the battery.

10 Remove the radiator (see Chapter 3), the grille (see Chapter 12) and the air conditioning condenser (see Chapter 3).

11 Remove the lifters (see Section 10).

12 Remove the timing chain and sprockets (see Section 14).

13 Mount a dial indicator on the front of the engine and place the indicator tip on the nose of the camshaft, in line with it.

14 Move the camshaft fore and aft and measure the freeplay. Compare your reading to the figure in the specifications in this Chapter.

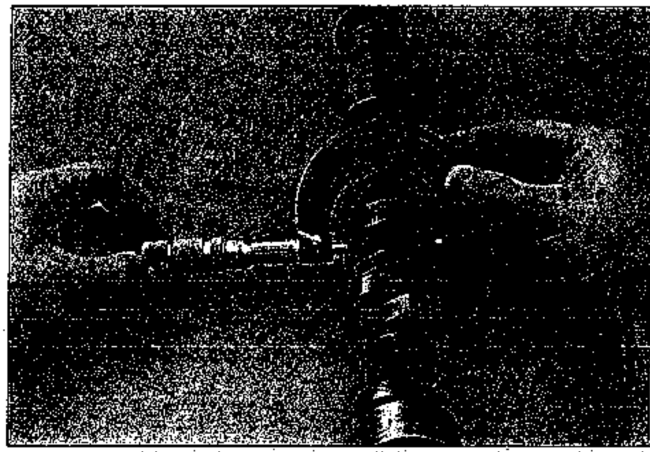
15 Remove the camshaft retainer **(see illustration)**.

16 Obtain a long bolt with the same thread as the nose of the camshaft. Thread this bolt into the camshaft to act as a handle when extracting the camshaft.

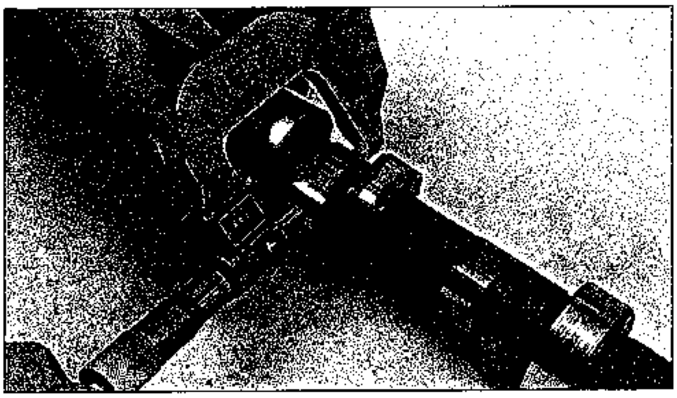
17 Carefully slide the camshaft out. Be very careful to avoid nicking the soft bearings as you do so. **Caution:** *To avoid damage to the camshaft bearings as the lobes pass over them, support the camshaft near the block as it is withdrawn.*

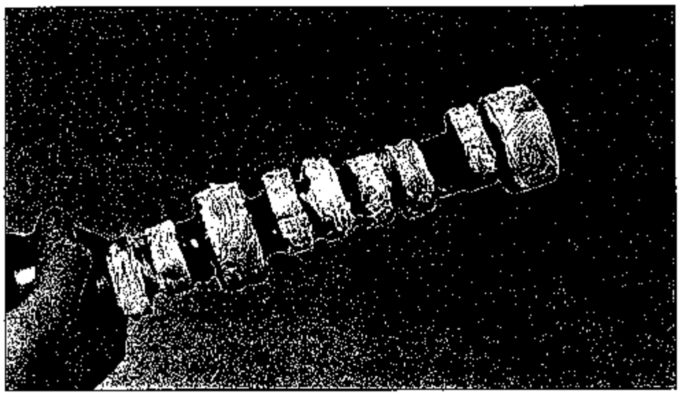
Inspection

18 After the camshaft has been removed from the engine, cleaned with solvent and dried, inspect the bearing journals for uneven wear, pitting and evidence of seizure. If the journals are damaged, the bearing inserts in the block are probably damaged also. Both the camshaft and bearings will have to be renewed.



16.19 The camshaft bearing journal diameters are checked to pinpoint excessive wear and out-of-round conditions


16.22 Measure the height of each cam lobe and compare your findings to the values listed in this Chapter's Specifications


16.25 Be sure to apply camshaft refitting lube to the cam lobes and bearing journals before refitting the camshaft

19 If the bearing journals are in good condition, measure them with a micrometer and record the measurements **(see illustration)**. Measure each journal at several locations around its circumference. If you get different measurements at different locations, the journal is out of round.

20 Check the inside diameter of each camshaft bearing with a telescoping gauge and measure the gauge with a micrometer. Subtract each cam journal diameter from the corresponding camshaft bearing inside diameter to obtain the bearing oil clearance. Compare the clearance for each bearing to the specifications. If it is excessive, for any of the bearings, have new bearings refitted by an automotive machine shop.

21 Inspect the distributor drive gear for wear. Renew the camshaft if the gear is worn.

22 Measure the cam lobe heights with a micrometer **(see illustration)** and compare your findings with the values listed in this Chapter's Specifications. Inspect the camshaft lobes for heat discolouration, score marks, chipped areas, pitting and uneven wear. If the lobes are in good condition and if the lobe measurements are as specified, the camshaft can be reused.

23 Inspect the retainer. If the retainer is worn or if the camshaft end play is excessive, renew it.

Bearing renewal

24 Camshaft bearing renewal requires special tools and expertise that place it outside the scope of the home mechanic. Take the engine block (see Chapter 2D) to an automotive machine shop to ensure the job is done correctly.

Refitting

25 Lubricate the camshaft bearing journals and lobes with camshaft refitting lube **(see illustration)**.

26 Refit the long bolt used previously into the front of the camshaft.

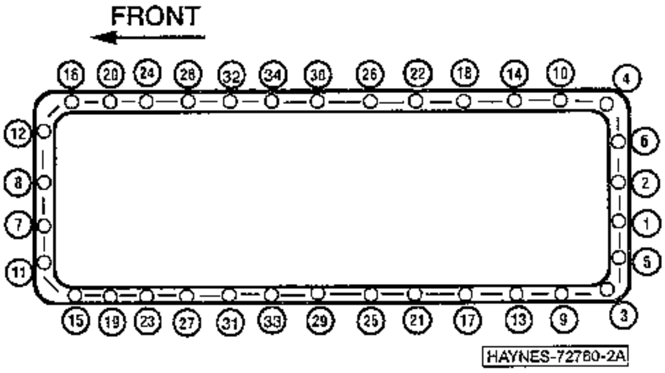
27 Slide the camshaft into the engine. Support the cam near the block and be careful not to scrape or nick the bearings.

28 Refit the remaining components in the reverse order of removal. Refer to the appropriate Sections for refitting instructions. **Note:** *If the original cam and lifters are being refitted, be sure to refit the lifters in their original locations. If a new camshaft was fitted, be sure to fit new lifters also.*

29 Add coolant and change the oil and filter (see Chapter 1).

30 Start the engine and check the ignition timing. Check for leaks and unusual noises.

17.6 The sump bolt removal sequence - when tightening the pan bolts, simply reverse the order



17 Sump - removal and refitting

Refer to illustration 17.6

1 Disconnect the cable from the negative battery terminal.

2 Raise the vehicle and support it securely on jackstands.

3 Drain the engine oil and remove the oil filter (refer to Chapter 1).

4 Remove the driveplate cover from the lower bellhousing.

5 Remove the transmission support brackets.

6 Remove the sump bolts in the proper order **(see illustration)** and detach the sump. **Note:** *Don't prise between the block and pan or damage to the sealing surfaces may result and oil leaks could develop. If the pan is stuck and is sealed with a gasket, dislodge it with a soft-face hammer or a block of wood and a hammer. If the pan was refitted with an RTV silicone seal, use a razor blade or knife to cut the seal.*

7 Use a scraper to remove all traces of sealant from the pan and block, then clean the mating surfaces with lacquer thinner or acetone. **Note:** *A new gasket or a 3 mm bead of RTV sealant can be used to seal the sump.*

8 Refit the sump and tighten the mounting bolts to the torque listed in this Chapter's Specifications. Tighten the bolts in the reverse of the order used to remove it.

9 The remainder of the refitting procedure is the reverse of disassembly.

10 Fit a new filter and add oil to the engine (see Chapter 1).

11 Reconnect the negative battery cable.

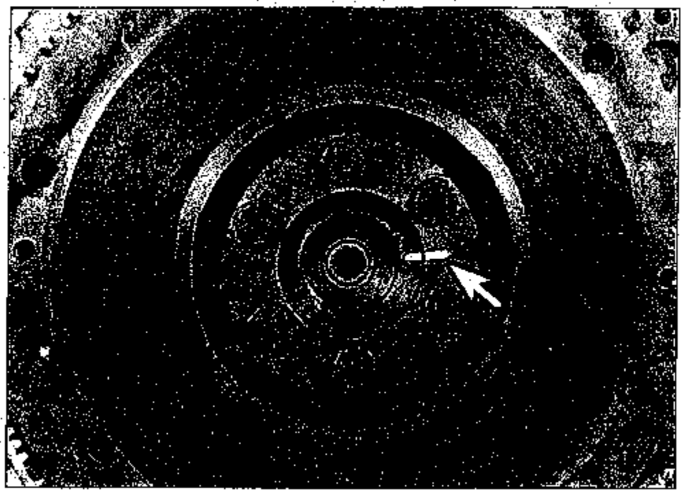
12 Start the engine and check for leaks.

18 Flywheel/driveplate - removal and refitting

Refer to illustration 18.3

1 Raise the vehicle and support it securely on jackstands, then refer to Chapter 7 and remove the transmission. If it's leaking, now would be a very good time to renew the front pump seal/O-ring (automatic transmission only).

2 Remove the pressure plate and clutch disc (see Chapter 8) (manual transmission equipped vehicles). Now is a good time to check/renew the clutch components and pilot bearing.



18.3 Make alignment marks on the flywheel/driveplate and crankshaft to ensure correct refitting

19.7 Drive the old seal from the retainer after supporting it with wood blocks

3 Make alignment marks on the flywheel/driveplate and crankshaft to ensure correct alignment during refitting **(see illustration)**.

4 Remove the bolts that secure the flywheel/driveplate to the crankshaft. If the crankshaft turns, hold the flywheel with a lever or wedge a screwdriver into the ring gear teeth to jam the flywheel.

5 Remove the flywheel/driveplate from the crankshaft. Since the flywheel is fairly heavy, be sure to support it while removing the last bolt.

6 Clean the flywheel/driveplate to remove grease and oil. Inspect the surface for cracks, rivet grooves, burned areas and score marks. Light scoring can be removed with emery cloth. Check for cracked and broken ring gear teeth or a loose ring gear. Lay the flywheel on a flat surface and use a straightedge to check for warpage.

7 Clean and inspect the mating surfaces of the flywheel/driveplate and the crankshaft. If the crankshaft rear seal is leaking, renew it before refitting the flywheel/driveplate.

8 Position the flywheel/driveplate against the crankshaft. Be sure to align the marks made during removal. Note that some engines have an alignment dowel or staggered bolt holes to ensure correct refitting. Before refitting the bolts, apply a non-hardening thread locking compound to the threads.

9 Wedge a screwdriver into the ring gear teeth to keep the flywheel/driveplate from turning. Using a criss-cross sequence, tighten the bolts to the torque listed in this Chapter's Specifications.

10 The remainder of refitting is the reverse of the removal procedure.

19 Rear main oil seal - renewal

Refer to illustrations 19.7 and 19.10

1 The rear main bearing oil seal can be renewed without removing the sump or crankshaft.

2 Remove the transmission (see Chapter 7).

3 If equipped with a manual transmission, remove the pressure plate and clutch disc (see Chapter 8).

4 Remove the flywheel or driveplate (see Section 18).

5 Remove the sump (see Section 17).

6 Remove the rear seal retainer. **Note:** It is also possible to simply loosen the sump bolts at the rear enough to allow it to drop slightly away from the rear seal retainer

7 Support the retainer on blocks of wood and drive out the old seal with a hammer and a punch **(see illustration)**.

8 Clean the bore in the retainer and the seal contact surface on the crankshaft. Check the crankshaft surface for scratches and nicks that could damage the new seal lip and cause oil leaks.

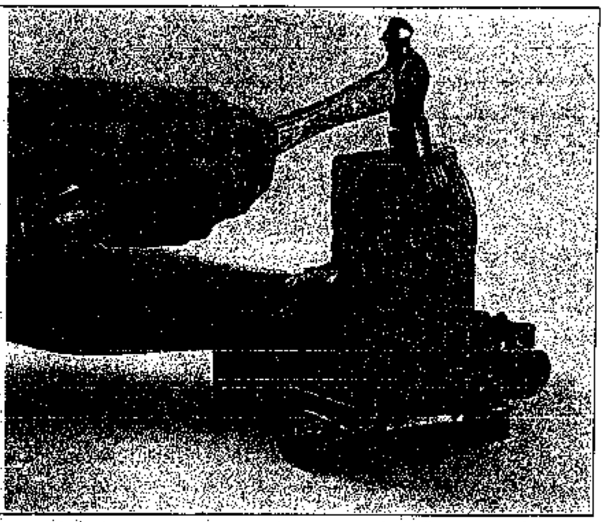
9 Apply a light coat of engine oil or multi-purpose grease to the outer edge of the new seal. Lubricate the seal lip with multi-purpose grease.

10 Drive the new seal into the retainer using a block of wood **(see illustration)**. **Note:** *Make certain that the seal is facing the correct direction. The outer dust seal lip must be at the rear and the inner oil seal lip must be near the centre of the seal and facing forward.*

11 Clean the retainer with lacquer thinner or acetone, then apply a bead of RTV silicone sealer to the sealing surfaces of the retainer, inboard of the bolt holes.

12 Refit the retainer. Tighten the fasteners to the torque listed in this Chapter's Specifications.

13 The remainder of the refitting is the reverse of the disassembly procedure.



19.10 A wood block is useful when fitting the new seal - make sure that the retainer is on a flat and hard surface

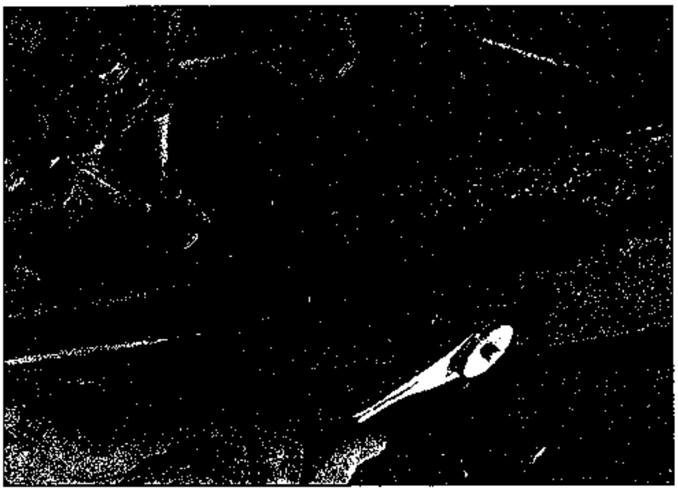
20 Engine oil cooler - removal and refitting

Note: *The engine oil cooler is not used on some 4.2 litre petrol engines. If the vehicle is not equipped with an oil cooler, a special block-off plate is fitted in its place, above the oil filter on the driver's side of the engine.*

1 Drain sufficient coolant from the radiator to lower its level below the oil cooler. Use a clean drain pan so that the coolant may be reused.

2 Remove the outer bolts and then

21.5 A long screwdriver or lever can be used to check the mounts



21.8 There are access holes provided in the crossmember to allow removal of the mount bolts - a long extension is needed

remove the cover from the engine. Do not remove the yellow nuts.

3 Remove the oil filter element by removing the four mounting nuts.

4 Check the oil cooler for signs of leaks. Blow through it to check for clogging. Renew it if necessary.

5 Renew the small O-rings and both gaskets when fitting the cooler to the housing.

6 Clean the sealing surfaces of the cooler cover and the engine with acetone or lacquer thinner. Apply a 3mm bead of RTV silicone sealer to the cover, inside of the bolt holes.

7 Refitting is the reverse of removal. Tighten the fasteners to the torque listed in this Chapter's Specifications.

21 Engine mounts - check and renewal

1 Engine mounts seldom require attention, but broken or deteriorated mounts should be renewed immediately or the added strain placed on the driveline components may cause damage or wear.

Check

Refer to illustration 21.5

2 During the check, the engine must be raised slightly to remove the weight from the mounts.

3 Raise the vehicle and support it securely on jackstands, then position a jack under the engine sump. Place a large block of wood between the jack head and the sump, then carefully raise the engine just enough to take the weight off the mounts. **Warning:** *DO NOT place any part of your body under the engine when it's supported only by a jack!*

4 Check the mounts to see if the rubber is cracked, hardened or separated from the metal plates. Sometimes the rubber will split right down the centre.

5 Check for relative movement between the mount plates and the engine or frame (use a large screwdriver or lever to attempt to move the mounts) **(see illustration)**. If movement is noted, lower the engine and tighten the mount fasteners.

6 Rubber preservative should be applied to the mounts to slow deterioration.

Renewal

Refer to illustration 21.8

7 Disconnect the negative battery cable from the battery, then raise the vehicle and support it securely on jackstands (if not already done).

8 Remove the nut on the engine mount stud **(see illustration)**.

9 Raise the engine slightly with a jack or hoist (make sure the fan doesn't hit the radiator or shroud). Remove the two mounting bolts and detach the mount from the engine.

10 Refitting is the reverse of removal. Use a non-hardening thread locking compound on the mount fasteners and be sure to tighten them securely.

Notes

Chapter 2 Part B
3.0 litre engine

Contents

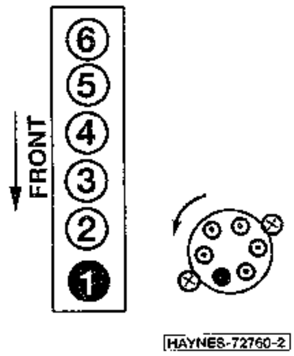
Specifications

General

Displacement	2962 cc
Cylinder numbers (front-to-rear)	1-2-3-4-5-6
Firing order	1-5-3-6-2-4

Camshaft

Endplay	0.03 to 0.06 mm
Camshaft journal-to-bearing (oil) clearance	
Numbers 1 to 6	0.045 to 0.090 mm
Number 7	0.065 to 0.110 mm
Maximum allowable, numbers 1 to 7	0.15 mm
Camshaft journal diameter	
Numbers 1 to 6	46.935 to 46.955 mm
Number 7	46.4125 to 46.435 mm
Camshaft runout limit	0.10 mm
Camshaft lobe height	39.242 to 39.432 mm
Camshaft lobe wear limit	0.15 mm
Lifter-to-guide clearance	0.043 to 0.066 mm
Rocker arm-to-rocker shaft clearance	0.007 to 0.049 mm



Cylinder location and distributor rotation

The blackened terminal shown on the distributor cap indicates the Number One spark plug wire position

Oil pump

Body to outer gear	0.11 to 0.20 mm
Inner gear to crescent	0.22 to 0.33 mm
Outer gear to crescent	0.21 to 0.32 mm
Cover-to-inner gear end clearance	0.05 to 0.09 mm
Cover-to-outer gear end clearance	0.05 to 0.11 mm
Inner gear-to-housing oil clearance	0.106 to 0.152 mm

Torque specifications

	Nm (unless otherwise indicated)
Camshaft front retainer bolts	6.3 to 8.3
Camshaft sprocket bolts	16 to 22
Crankshaft front pulley	142 to 152
Crankshaft rear seal housing bolts	6.3 to 8.3
Cylinder head bolts **(see illustration for tightening sequence)**	
First step	29
Second step	78
Third step	Loosen completely
Fourth step	29
Preferred fifth step	100 to 105 degrees additional rotation
Alternate fifth step	78 to 88
Cylinder head corner bolts	9 to 12
Exhaust manifold nuts	27 to 31
Flywheel/driveplate bolts	142 to 152
Inlet manifold to head bolts	18 to 22
Inlet manifold plenum to manifold bolts	18 to 22
Inlet manifold brace bolts	30 to 40
Main bearing cradle bolts (lubricated threads)	44 to 54
Sump mounting bolts	5 to 7
Oil pump assembly to block bolts	6.3 to 8.3
Oil pump cover screws	5
Oil pump pick-up bolts	21
Oxygen sensor	41 to 51
Rocker shaft bolts	18 to 22
Timing belt tensioner pulley nut	44 to 58
Timing cover bolts	3 to 5
Valve cover-to-cylinder head bolts	2 to 4

1 General information

This Part of Chapter 2 is devoted to in-vehicle repair procedures for the 3.0 litre inline six-cylinder engine. All information concerning engine removal and refitting and engine block and cylinder head overhaul can be found in Part C of this Chapter.

The following repair procedures are based on the assumption that the engine is fitted in the vehicle. If the engine has been removed from the vehicle and mounted on a stand, many of the steps outlined in this Part of Chapter 2 will not apply.

The Specifications included in this Part of Chapter 2 apply only to the procedures contained in this Part. Part C of Chapter 2 contains the Specifications necessary for cylinder head and engine block rebuilding.

2 Repair operations possible with the engine in the vehicle

Many major repair operations can be accomplished without removing the engine from the vehicle.

Clean the engine compartment and the exterior of the engine with some type of pressure washer before any work is done. It will make the job easier and help keep dirt out of the internal areas of the engine.

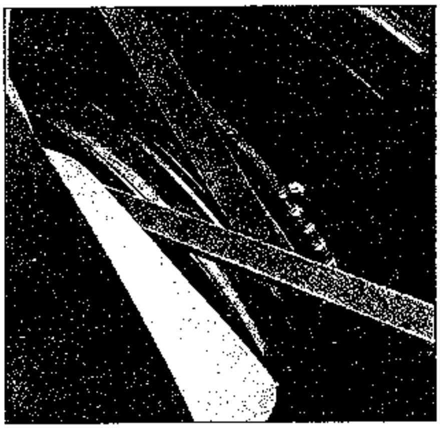
Remove the bonnet, if necessary, to improve access to the engine as repairs are performed (refer to Chapter 11 if necessary).

If vacuum, exhaust, oil or coolant leaks develop, indicating a need for gasket or seal renewal, the repairs can generally be made with the engine in the vehicle. The inlet and exhaust manifold gaskets, sump gasket, crankshaft oil seals and cylinder head gasket are all accessible with the engine in place.

Exterior engine components, such as the inlet and exhaust manifolds, the sump (and the oil pump), the water pump, the starter motor, the alternator, the distributor and the fuel system components can be removed for repair with the engine in place.

Since the cylinder head can be removed without pulling the engine, valve component servicing can also be accomplished with the engine in the vehicle. Renewal of the camshaft and timing belt is also possible with the engine in the vehicle.

In extreme cases caused by a lack of necessary equipment, repair or renewal of piston rings, pistons, connecting rods and rod bearings is possible with the engine in the vehicle. However, this practice is not recommended because of the cleaning and preparation work that must be done to the components involved.



3.8 Align the mark on the pulley with the zero on the timing scale

3 Top Dead Centre (TDC) for number one piston - locating

Refer to illustration 3.8

Note: *The following procedure is based on the assumption that the distributor is correctly fitted. If you are trying to locate TDC on cylinder number one to refit the distributor correctly, number one piston position must be determined by feeling for compression at the number one spark plug hole as the engine is slowly rotated by hand, then aligning the ignition timing marks as described in Step 8.*

1 Top Dead Centre (TDC) is the highest point in the cylinder that each piston reaches as it travels up-and-down when the crankshaft turns. Each piston reaches TDC on the compression stroke and again on the exhaust stroke, but TDC generally refers to piston position on the compression stroke only, when neither valve is open.

2 Positioning the piston(s) at TDC is an essential part of many procedures such as rocker arm removal, camshaft and timing belt/sprocket removal and distributor removal.

3 Before beginning this procedure, be sure to place the transmission in Neutral and apply the parking brake or block the rear wheels. Also, remove the spark plugs (see Chapter 1) and disable the ignition system. Detach the coil wire from the centre terminal of the distributor cap and earth it on the block with a jumper wire.

4 In order to bring any piston to TDC, the crankshaft must be turned using one of the methods outlined below. When looking at the front of the engine, normal crankshaft rotation is clockwise.

a) *The preferred method is to turn the crankshaft with a socket and ratchet attached to the bolt threaded into the front of the crankshaft.*

b) *A remote starter switch, which may save some time, can also be used. Follow the instructions included with the switch. Once the piston is close to TDC, use a socket and ratchet, as described in the previous paragraph.*

c) *If an assistant is available to turn the ignition switch to the Start position in short bursts, you can get the piston close to TDC without a remote starter switch. Make sure your assistant is out of the vehicle, away from the ignition switch, then use a socket and ratchet (as described in Paragraph a) to complete the procedure.*

5 Note the position of the terminal for the number one spark plug wire on the distributor cap. If the terminal isn't marked, follow the plug wire from the number one cylinder spark plug to the cap.

6 Use a felt-tip pen or chalk to make a mark on the distributor body directly under the terminal.

7 Detach the cap from the distributor and set it aside (see Chapter 1 if necessary).

8 Turn the crankshaft (see Paragraph 3 above) until the notch in the crankshaft sprocket is aligned with the 0 on the timing plate (located at the front of the engine) **(see illustration)**.

9 Look at the distributor rotor - it should be pointing directly at the mark you made on the distributor body. If it is, go to Step 12.

10 If the rotor is 180 degrees off, the number one piston is at TDC on the exhaust stroke. Go to Step 11.

11 To get the piston to TDC on the compression stroke, turn the crankshaft one complete turn (360 degrees) clockwise. The rotor should now be pointing at the mark on the distributor. When the rotor is pointing at the number one spark plug wire terminal in the distributor cap and the ignition timing marks are aligned, the number one piston is at TDC on the compression stroke.

12 After the number one piston has been positioned at TDC on the compression stroke, TDC for any of the remaining pistons can be located by turning the crankshaft clockwise and following the firing order. Mark the remaining spark plug wire terminal locations on the distributor body just like you did for the number one terminal, then number the marks to correspond with the cylinder numbers. As you turn the crankshaft, the rotor will also turn. When it's pointing directly at one of the marks on the distributor, the piston for that particular cylinder is at TDC on the compression stroke.

2B

4 Valve cover - removal and refitting

Refer to illustrations 4.8a, 4.8b and 4.11

1 Disconnect the negative battery cable.

2 Pull the crankcase breather tube and hose off the valve cover.

3 Disconnect or remove any accessories which interfere.

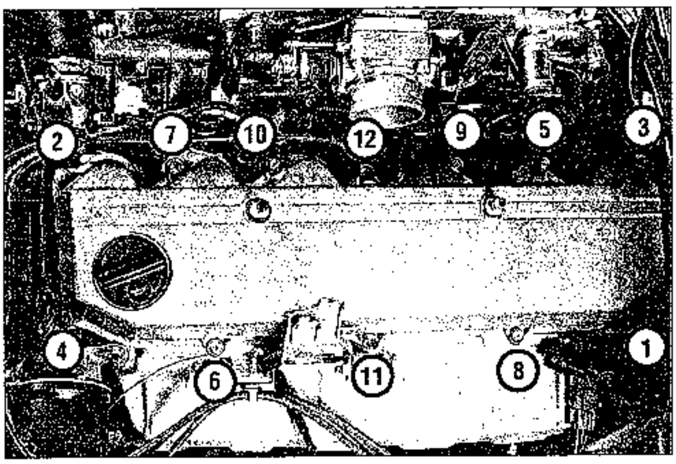
4 Remove the air cleaner assembly (see Chapter 4).

5 Remove the spark plug wires from the brackets, noting their locations.

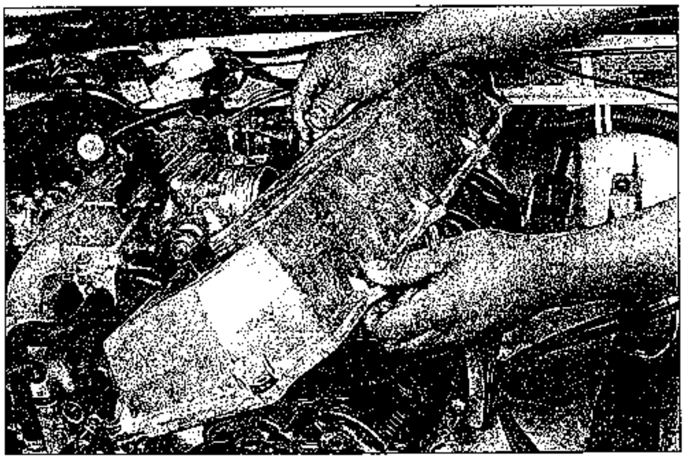
6 Remove the mounting bracket that connects to the head bolts.

7 Remove any wire harness clips, noting the locations of their studs for refitting.

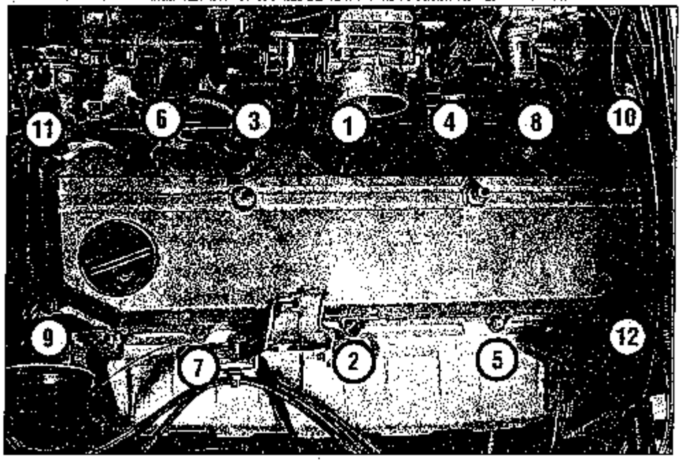
8 Remove the valve cover retaining bolts in the sequence shown **(see illustration)**. If the cover is stuck, tap on it gently with a soft-face mallet and then remove it **(see illustration)**.



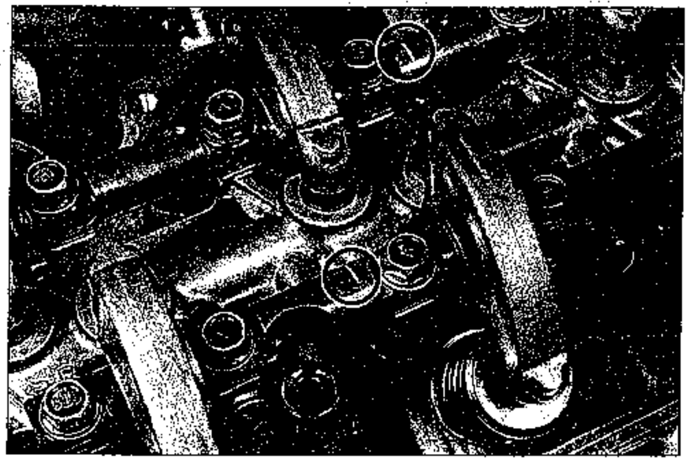
4.8a The valve cover bolts should be removed in this order



4.8b Place the bolts in a secure place and then lift the cover from the engine



4.11 Tighten the valve cover bolts in this sequence to avoid distorting the cover



5.3a The front rocker shafts are marked with a single line . . .

9 Clean the sealing surfaces, removing any traces of oil with lacquer thinner, brake cleaner or acetone with a clean rag.

10 Lay a new seal into the valve cover groove.

11 Refit the cover and bolts. Tighten the bolts to the torque listed in this Chapter's Specifications. Use the tightening sequence shown **(see illustration)**.

12 Refit the components previously removed.

13 Run the engine and check for oil leaks.

5 Rocker arm assemblies and lifters- removal, inspection and refitting

Removal

Refer to illustrations 5.3a, 5.3b, 5.4, 5.5a and 5.5b

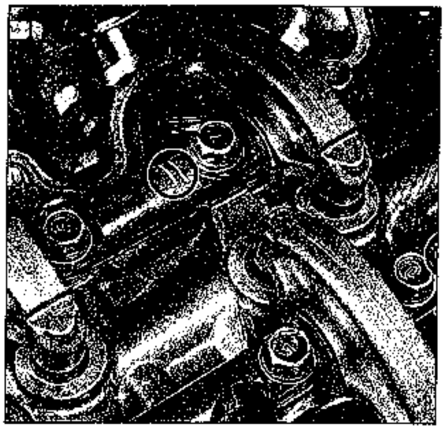
1 Remove the valve cover (see Section 4). Put number one cylinder on TDC with both valves closed (on the compression stroke) (see Section 3).

2 Remove the rocker shaft bolts.

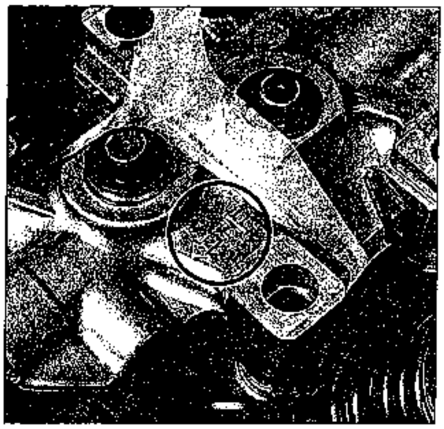
3 Remove the rocker arm assemblies. Keep everything in order so that they can be refitted in the same positions. **Note:** *The two front rocker shafts are marked with a I. The two rear ones are marked with a II* **(see illustrations)**.

4 Use wire or tape to secure the lifters so they do not drop when the lifter guides are removed. **Note:** *The front lifter guide is marked with a small F and an arrow pointing to the front* **(see illustration)**. *The rear one is marked with a small R and an arrow pointing to the rear.*

5 Lift off the two lifter guides with the lifters **(see illustration)**. Remove the lifters and carefully put them in order **(see illustration)**. Keep the lifters upright at all times.

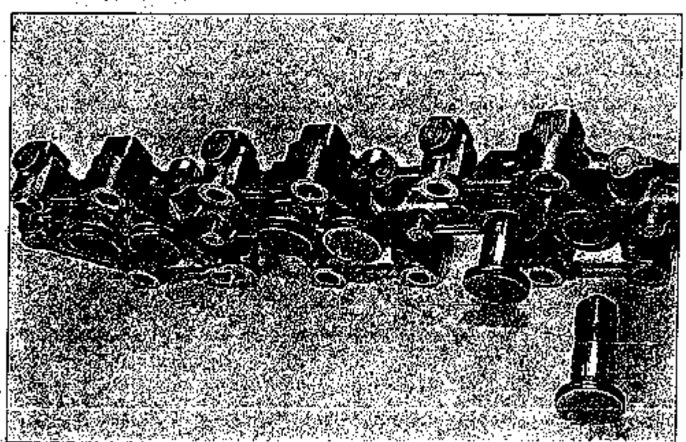


5.3b . . . while the rears have two lines

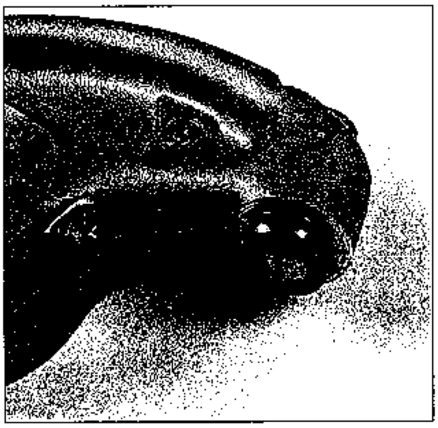


5.4 This arrow on the front lifter retainer must face forward. The rear retainer has an R which faces to the rear. Wire or tape the lifters in position . . .

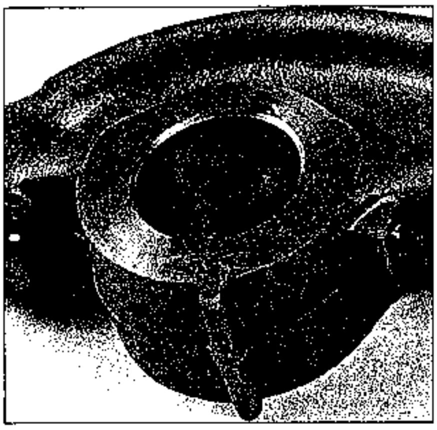
5.5a . . . and then lift the retainer off



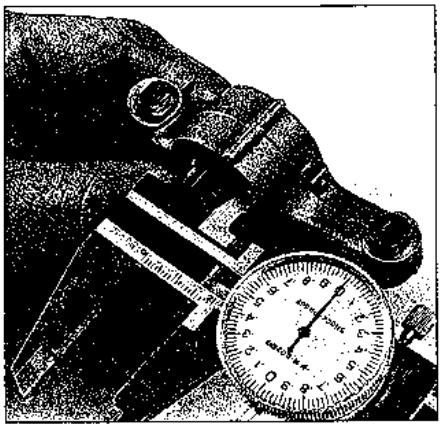
5.5b All the individual lifters must be kept in their original positions. Do not allow them to get out of order



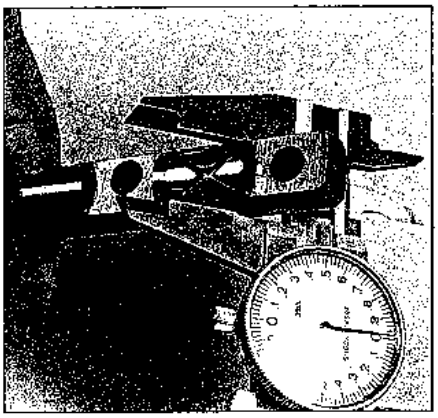
5.6a Each end of each rocker must be inspected for damage



5.6b Check the shaft hole for signs of obvious wear



5.6c Measure the rocker pivot holes

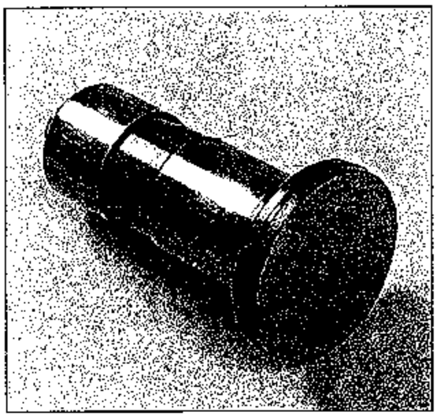


5.6d Also measure the rocker shafts in the areas where the rocker arms ride

Inspection

Refer to illustrations 5.6a, 5.6b, 5.6c, 5.6d and 5.7

6 Check each rocker arm for wear, cracks and other damage, especially where the lifters and valve stems contact the rocker arm faces. Check the pivot hole in each rocker arm. Look for galling, stress cracks and unusual wear patterns **(see illustrations)**. If the rocker arms are worn or damaged, renew them. **Caution:** *Keep the rockers in order at all times! The rocker arms for the front three cylinders are different from the others.*



5.7 Inspect each lifter one at a time so that they do not get out of order

7 Carefully examine each lifter for wear at the rocker arm end and especially at the cam end **(see illustration)**. If a lifter is severely eroded at the cam end, the camshaft may need to be renewed as well. Keep the lifters in the upright position at all times.

8 If any lifters were noisy, it is best to renew them as a set. They are not rebuildable.

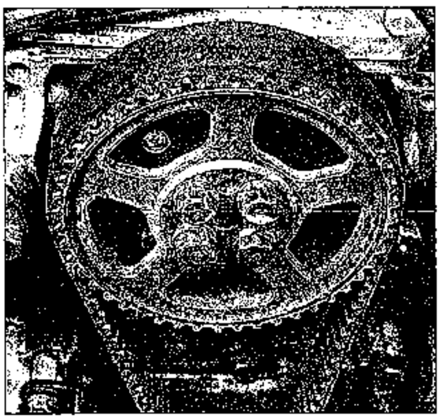
9 Check the bores in the lifter guides for wear. Measure them and the diameter of the lifters to obtain the oil clearance. The proper clearance is in the Specifications section of this Chapter.

10 Inspect the rocker shafts. If they appear worn, measure them and the rockers to obtain the oil clearance **(see illustration 5.6d)**. The proper clearance is in the Specifications of this Chapter.

Refitting

Refer to illustration 5.12

11 Apply moly-base engine assembly lube to the bases of the lifters to prevent damage to the mating surfaces. Lubricate all other wear surfaces with clean engine oil. Refit all the components in their original locations.



5.12 When the engine is at TDC on the compression stroke for the number one cylinder, the mark on the camshaft will be straight up

12 Make sure that the number one cylinder is at TDC on the compression stroke. The mark on the camshaft gear will be up **(see illustration)**. Tighten the rocker shaft bolts for the rear three cylinders to the torque listed in this Chapter's Specifications.

13 Rotate the crankshaft 360 degrees so the mark on the camshaft gear is pointing down. Repeat the tightening procedure for the front three cylinders.

14 Refit the valve cover (see Section 4).

15 Start the engine, listen for unusual valvetrain noises and check for oil leaks at the valve cover joint. Run the engine for at least ten minutes to allow any lifter noises to disappear.

6 Valve springs, retainers and seals - renewal

Refer to illustrations 6.4, 6.9, 6.10, 6.15, 6.16 and 6.17

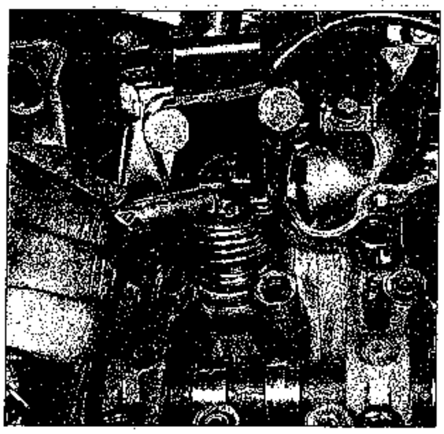
Note: *Broken valve springs and defective valve stem seals can be renewed without removing the cylinder heads. Two special tools and a compressed air source are normally required to perform this operation, so read through this Section carefully and rent or buy the tools before beginning the job. If compressed air isn't available, a length of nylon rope can be used to keep the valves from falling into the cylinder during this procedure.*

1 Remove the valve cover (Section 4).

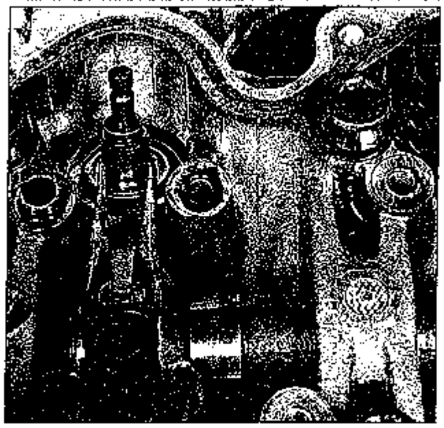
2 Remove the spark plug from the cylinder which has the defective component. If all of the valve stem seals are being renewed, all of the spark plugs should be removed.

3 Turn the crankshaft until the piston in the affected cylinder is at top dead centre (TDC) on the compression stroke (see Section 3 for instructions). If you're renewing all of the valve stem seals, begin with cylinder number one and work on the valves for one cylinder at a time. Move from cylinder-to-cylinder following the firing order sequence (see the Specifications listed at the beginning of this Chapter).

6.4 An adapter for applying air pressure through a spark plug hole



6.9 Compress the valve spring with a special tool. There are several types available



6.10 The valve seals can be pried off using pliers or two screwdrivers

4 Thread an adapter into the spark plug hole **(see illustration)** and connect an air hose from a compressed air source to it. Most auto parts stores can supply the air hose adapter. **Note:** *Many cylinder compression gauges utilise a screw-in fitting that may work with your air hose quick-disconnect fitting.*

5 Remove the rocker arm shaft assemblies (see Section 5).

6 Apply compressed air to the cylinder. **Warning:** *The piston may be forced down by compressed air, causing the crankshaft to turn suddenly. If the spanner used when positioning the number one piston at TDC is still attached to the bolt in the crankshaft nose, it could cause damage or injury when the crankshaft moves.*

7 The valves should be held in place by the air pressure. If the valve faces or seats are in poor condition, leaks may prevent air pressure from retaining the valves - refer to the alternative procedure below.

8 If you don't have access to compressed air, an alternative method can be used. Position the piston at a point approximately 45-degrees (1/8 turn) before TDC on the compression stroke, then feed a long piece of nylon rope through the spark plug hole until it fills the combustion chamber. Be sure to leave the end of the rope hanging out of the spark plug hole so it can be removed easily. Use a large ratchet and socket to rotate the crankshaft in the normal direction of rotation until slight resistance is felt.

9 Stuff shop rags into the cylinder head holes around the valves to prevent parts and tools from falling into the engine, then use a valve spring compressor to compress the spring **(see illustration)**. Remove the collets with small needle-nose pliers or a magnet. **Note:** *A couple of different types of tools are available for compressing the valve springs with the head in place. One type grips the lower spring coils and presses on the retainer as the knob is turned, while the other type, shown here, utilises the rocker arm capscrew for leverage. Both types work very well, although the lever type is usually less expensive.*

10 Remove the spring retainer and valve spring, then remove the seal. The seals must be pried off using two screwdrivers at the same time, or pliers **(see illustration)**. **Note:** *If air pressure fails to hold the valve in the closed position during this operation, the valve face and/or seat is probably damaged. If so, the cylinder head will have to be removed for additional repair operations.*

11 Wrap a rubber band or tape around the top of the valve stem so the valve won't fall into the combustion chamber, then release the air pressure. **Note:** *If a rope was used instead of air pressure, turn the crankshaft slightly in the direction opposite normal rotation.*

12 Inspect the valve stem for damage. Rotate the valve in the guide and check the end for eccentric movement, which would indicate that the valve is bent.

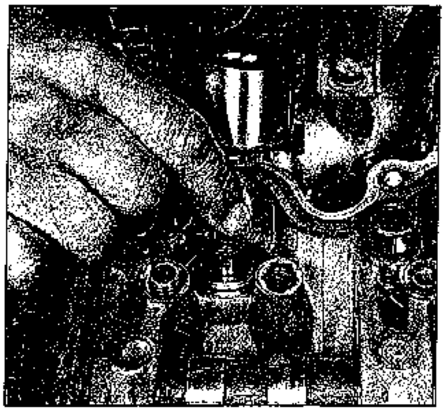
13 Move the valve up-and-down in the guide and make sure it doesn't bind. If the valve stem binds, either the valve is bent or the guide is damaged. In either case, the head will have to be removed for repair.

14 Reapply air pressure to the cylinder to retain the valve in the closed position, then remove the tape or rubber band from the valve stem. If a rope was used instead of air pressure, rotate the crankshaft in the normal direction of rotation until slight resistance is felt.

15 Lubricate the valve stem with engine oil and fit a new seal. Inlet and exhaust valve seals are different. The inlet seals must be tapped on with a hammer and a socket. Exhaust valve seals can be pushed onto the valve guide boss by hand **(see illustration)**.

16 Refit the spring in position over the valve. Make sure the proper spacer is under each spring. **Note:** *Cylinders one through three have specific exhaust valve springs that are different from the others. The inner spring is painted pink, the outer is painted green. On all valve springs, the painted side of the valve spring with the narrow winding pitch must be positioned down against the head* **(see illustration)**.

17 Refit the valve spring retainer. Compress the valve spring and carefully position

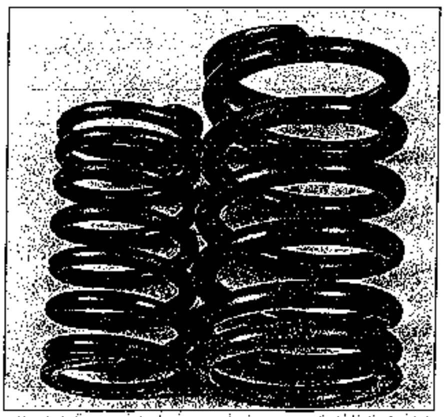


6.15 Tap the new seal on with a hammer and a socket

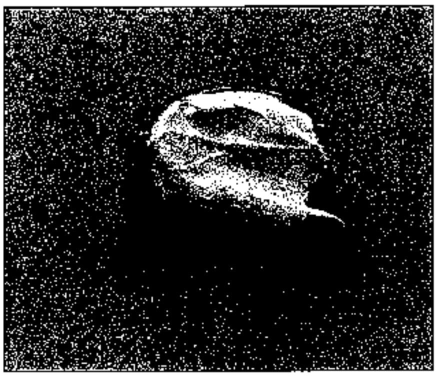
the collets in the groove. Apply a small dab of grease to the inside of each collet to hold it in place **(see illustration)**.

18 Remove the force from the spring tool and make sure the collets are seated.

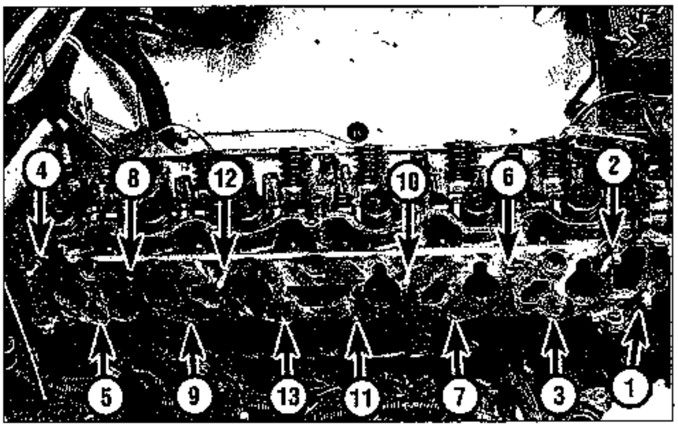
19 Disconnect the air hose and remove the adapter from the spark plug hole. If a rope was used in place of air pressure, pull it out of the cylinder.



6.16 The end of the valve spring with the paint mark and the more tightly wound coils faces down. Keep all the springs in order as you work. They must be returned to their original positions



6.17 A dab of grease will hold the collet in place while the spring is compressed



7.11 Loosen the inlet manifold bolts in this sequence

20 Refer to Section 5 and refit the rocker arm assemblies.
21 The rest of the refitting is the reverse of removal.
22 Start and run the engine, then check for oil leaks and unusual sounds coming from the valve cover area.

7 Inlet manifold - removal and refitting

Refer to illustration 7.11

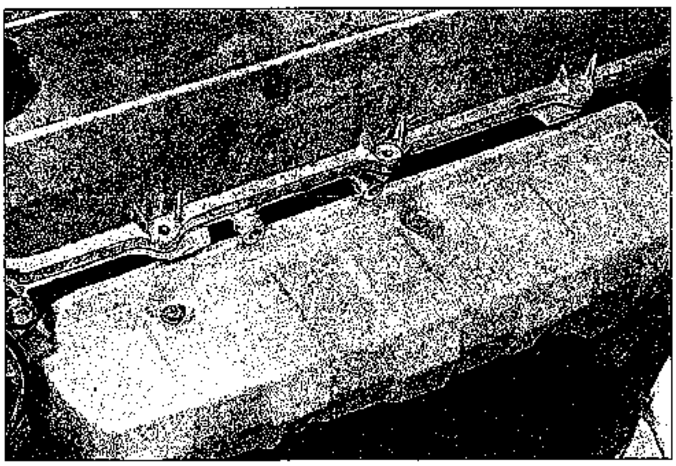
1 Disconnect the negative battery cable.
2 Remove the air cleaner assembly.
3 Drain the cooling system about halfway (see Chapter 3).
4 Remove the upper radiator hose and the heater hoses.
5 Label and then disconnect all of the vacuum lines from the inlet manifold.
6 Disconnect the throttle cable and the cruise control cable (see Chapter 4).
7 Label and remove all interfering wiring including the carburettor wires and the spark plug wires for the rear cylinders.
8 Remove the coil and its bracket from the manifold.
9 Disconnect the tubes from the EGR valve.
10 Remove the inlet manifold brace bolts. It is not necessary to remove the wiring from it or to remove the brace from the vehicle.
11 Remove the inlet manifold nuts and carefully remove the manifold. The bolts must be removed in the correct sequence **(see illustration)**.
12 Clean all gasket surfaces very carefully.
13 Refitting is the reverse of removal. Tighten the manifold nuts to the torque listed in the Specifications of this Chapter, tightening them in the opposite order of the loosening sequence.

8 Exhaust manifold - removal and refitting

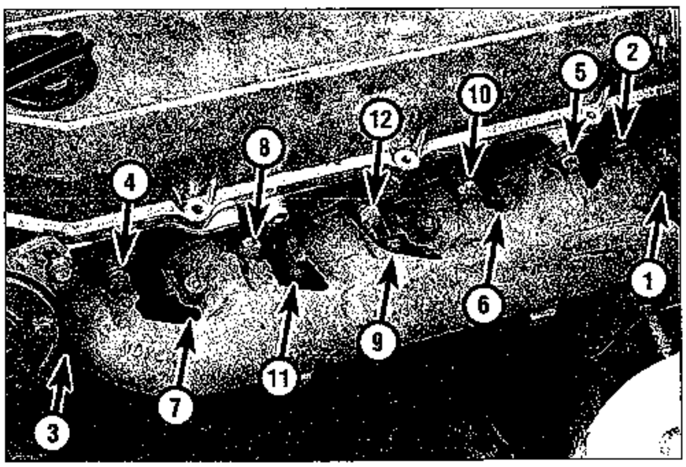
Refer to illustrations 8.4 and 8.6

Warning: *Allow the engine to cool completely before following this procedure.*

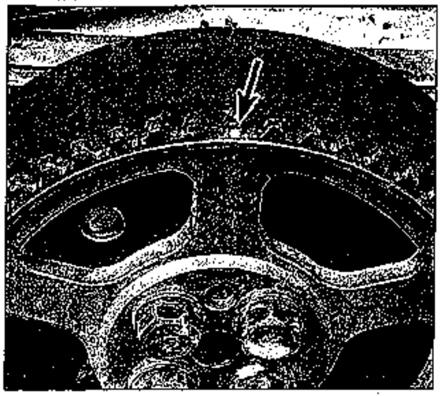
1 Raise the front of the vehicle and support it securely on jackstands.
2 Disconnect the negative battery cable from the battery.
2 Apply penetrating oil to the threads of the exhaust manifold attaching studs and the exhaust pipe-to-manifold attaching nuts.
3 Remove the nuts and pull the exhaust pipe down. **Note:** *If the studs break, you will have to have them removed by a machine shop or you may drill them out and renew them with through-bolts.*
4 Remove the heat shield from the exhaust manifold **(see illustration)**.
5 Disconnect the tube for the EGR system from the exhaust manifold.
6 Remove the nuts that secure the exhaust manifold to the cylinder head and pull the manifold off the engine. The nuts must be removed in the proper sequence **(see illustration)**.
7 Remove all traces of old gasket material from the mating surfaces.
8 If the manifold gasket was blown out, have the manifold checked for warpage by an automotive machine shop with a precision straightedge and machined as necessary.
9 Position a new gasket and slide the manifold on.
10 Refit the fasteners finger tight. Tighten them to the correct torque in the reverse of the order used for removal. **Note:** *Each stud uses a thick washer, a thin washer and a nut. The convex (domed) sides of the washers faces away from the engine. The thick washers with the larger outside diameter go onto the eight outer studs that have a larger stud hole.*
11 Fit a new exhaust pipe seal if necessary. Reconnect the exhaust pipe, run the engine and check for leaks.



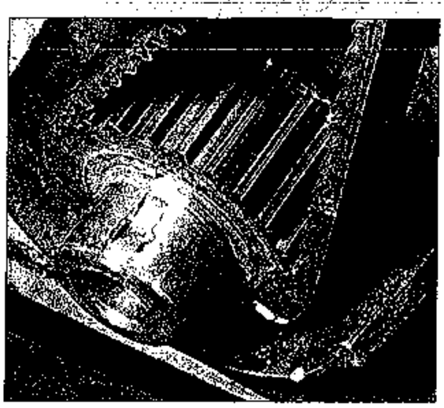
8.4 The exhaust manifold heat shield must be removed to get access to the manifold bolts



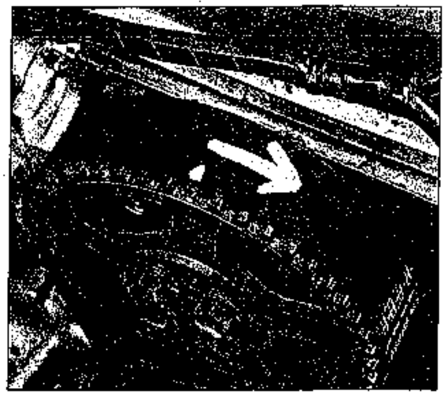
8.6 The exhaust manifold bolts must be loosened in this sequence



9.6 Make sure the cam mark is straight up . . .



9.8 . . . and the crankshaft mark is next to the mark on the oil pump



9.11 If you are going to refit the old belt, mark it for direction of rotation and where it mates with the marks on the sprockets

9 Timing belt - removal and refitting

Refer to illustrations 9.6, 9.8, 9.11 and 9.12

Removal

Note: *The timing belt should be renewed at 100,000 km intervals.*

1 Disconnect the negative battery cable.

2 Refer to Chapter 3 and remove the radiator, fan, fan clutch, water pump pulley and fan shroud.

3 Remove all of the drive belts (Chapter 1).

4 Remove all spark plug wires and other wiring from the timing belt cover.

5 Remove the upper timing belt cover.

6 Rotate the engine by hand to TDC (Section 3) for cylinder number one on the compression stroke. The mark on the camshaft sprocket will be pointing up **(see illustration)**.

7 Remove the crankshaft pulley (Section 11).

8 Remove the lower timing belt cover. The mark on the crankshaft sprocket should be lined up with the mark on the oil pump housing **(see illustration)**.

9 Slide off the plate from the front of the crankshaft.

10 If the belt is going to be refitted, mark it for direction of rotation **(see illustration)**. Also mark the belt at the points where the marks on the sprockets meet it.

11 Loosen the belt tensioner locknut.

12 Rotate the tensioner clockwise by using an Allen spanner **(see illustration)**. Remove the belt.

13 Refer to Section 5 and loosen all of the rocker shaft bolts. This will relieve pressure on the camshaft and allow the timing belt tension to be set properly.

Refitting

14 Make sure that the mark on the crankshaft sprocket is pointing at the mark on the oil pump housing. Make sure that the belt is being refitted in the proper rotation direction.

15 Refit the belt. If a new belt is being fitted, the marks on it must line up with the marks on the sprockets. If the old belt is being refitted, the marks you previously made must align.

16 Snap the tensioner into position. Using the 5 mm hex key, rock the tensioner a few times to seat it properly. The exhaust manifold side of the belt must be tight.

17 Tighten the tensioner nut to the correct torque.

18 The rest of refitting is the reverse of removal. Torque the rocker shaft bolts for the rear three cylinders first, then rotate the crankshaft one revolution so that the camshaft mark is pointing down. Torque the front rocker shaft bolts.

10 Cylinder head - removal and refitting

Refer to illustrations 10.9, 10.10 and 10.17

Caution: *Allow the engine to cool completely before following this procedure. The head may warp if it is removed when warm.*

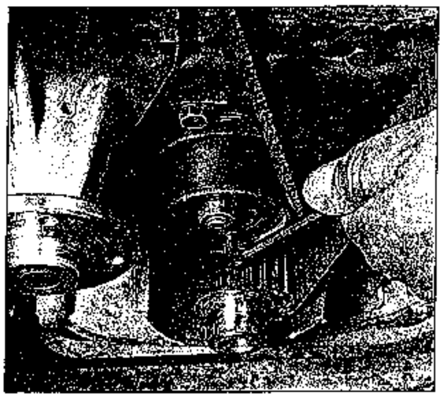
Removal

1 Disconnect the negative cable from the battery.

2 Drain about half of the coolant from the radiator (see Chapter 1). Remove the upper radiator hose.

3 Remove the valve cover (Section 4).

4 Detach any interfering electrical or vacuum lines. Make sure to label them as you remove them.



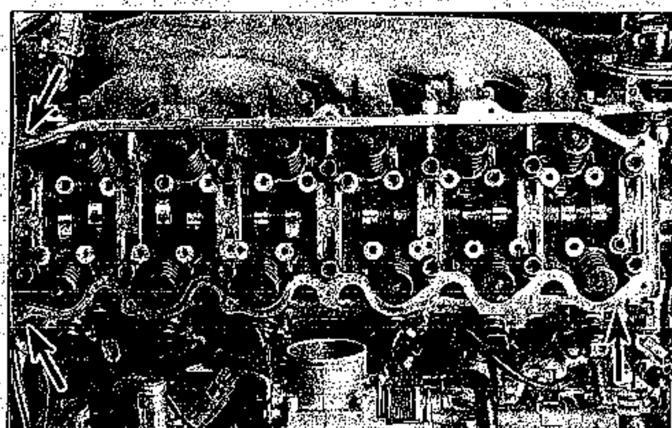
9.12 Rotate the spring loaded tensioner with a hex key

5 Remove the timing belt (Section 9).

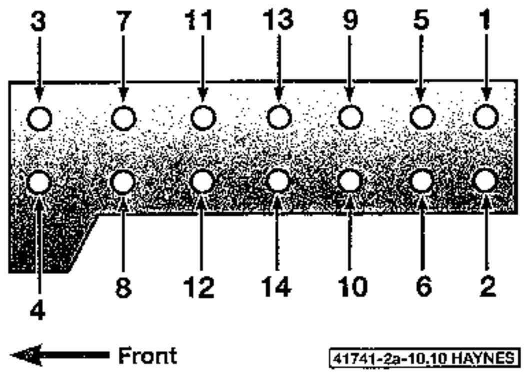
6 Remove the inlet manifold (Section 7). **Note:** *The inlet manifold can be left attached to the cylinder head if you have a hoist or an assistant to aid you in lifting the assembly from the vehicle. If you elect to leave it attached, disconnect all the interfering hoses, cables and wires* (see Section 7).

7 Raise the front of the vehicle and support it securely on jackstands. Disconnect the exhaust pipe from the exhaust manifold.

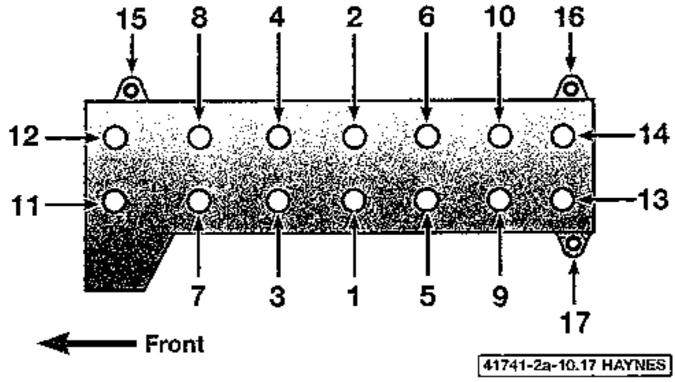
9 Remove the three cylinder head corner bolts **(see illustration)**. **Note:** *The two rear bolts are longer than the front one.*



10.9 There are three small outer cylinder head bolts (arrows)



10.10 Use this sequence for removing the head bolts



10.17 Use this sequence when you tighten the head bolts

10 Remove the cylinder head bolts in the correct order **(see illustration)**. A 10 mm Allen head socket will be required. Lift the head off the engine. **Warning:** *The cylinder head is heavy - to prevent injury, it's a good idea to have an assistant help you lift it off.*

11 Thoroughly clean the gasket mating surfaces, removing all traces of old gasket material. Stuff shop towels into each cylinder so scraped material doesn't fall in.

12 Inspect the head for cracks and warpage (see Chapter 2D). Also see Chapter 2D for cylinder head servicing information. If you are renewing the cylinder head, be sure to transfer all fittings, etc. to the new head.

Refitting

13 Position the new head gasket on the engine block, making sure it is fitted correctly.

14 Refit the cylinder head on the engine block.

15 Clean the head bolts with a wire wheel and apply a little engine oil to their threads before refitting. **Note:** *The chamfered side of the head bolt washers goes away from the engine.*

16 Refit the three corner bolts finger tight.

17 Tighten the main cylinder head bolts in sequence to the torque values listed in this Chapter's Specifications **(see illustration)**. The bolts must be tightened in five steps. **Note:** *A torque angle meter type torque spanner is the preferred tool for the final tightening procedure, However, the bolts can be tightened using a standard torque spanner if that is all that is available to you.*

18 Torque the three corner bolts to the value listed in the Specifications Section.

19 Refit the remaining components in the reverse order of removal. Refer to the appropriate Sections for the refitting of the various assemblies.

20 Add coolant and run the engine, checking for proper operation as well as coolant and oil leaks.

11 Crankshaft pulley - removal and refitting

Refer to illustration 11.5

1 Disconnect the negative battery cable from the battery.

2 Drain the cooling system (see Chapter 1). Remove the radiator (see Chapter 3).

3 Remove the centre crankshaft pulley bolt. This can usually be removed with a pneumatic impact spanner. If an impact spanner is not available the drivebelts should be able to hold the pulley from turning as you use a large ratchet. If they will not hold it, remove the starter and have an assistant lock the flywheel with a screwdriver while you loosen the pulley bolt.

4 Remove the drivebelts (see Chapter 1).

5 Remove the pulley using a puller that bolts to the pulley hub - NOT a jaw-type puller **(see illustration)**.

6 Inspect the surface of the damper that contacts the front seal. There may be a groove worn in this surface. If so, the damper can be renewed or a sleeve can be fitted over the damper hub. **Note:** *These sleeves are available at auto parts stores. If a worn damper is refitted with a new seal, the seal will probably leak.*

7 Apply a thin layer of multi-purpose grease to the seal contact surface of the vibration damper.

8 Slide the vibration damper onto the crankshaft. Note that the slot in the hub must be aligned with the Woodruff key in the end of the crankshaft. Once the key is aligned with the slot, tap the damper onto the crankshaft with a soft-face hammer. The retaining bolt can be used to press the damper into position, although a damper refitting tool is preferred.

9 Refitting is the reverse of removal. Tighten the bolt to the torque listed in this Chapter's Specifications after refitting the drivebelts.

12 Crankshaft front oil seal - renewal

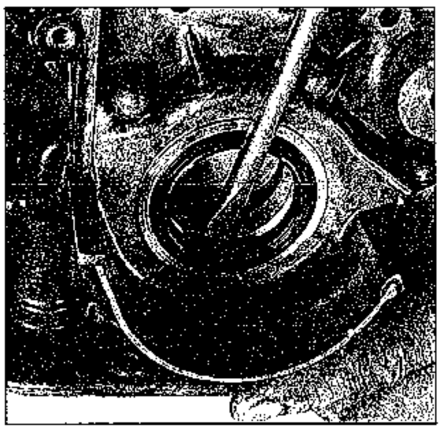
Refer to illustration 12.2

1 Remove the crankshaft pulley (see Section 11). Remove the timing belt (see Section 9) and the crankshaft sprocket. A puller may be required to remove the sprocket from the crankshaft.

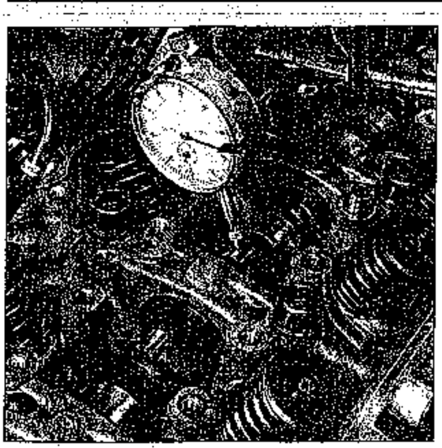
2 Carefully prise the oil seal out of the front cover with a seal removal tool or screwdriver **(see illustration)**. Don't scratch the cover bore or damage the crankshaft in the process (if the crankshaft is damaged the new seal will end up leaking).

3 Clean the bore in the cover and coat the outer edge of the new seal with sealer. Using a socket with an outside diameter slightly

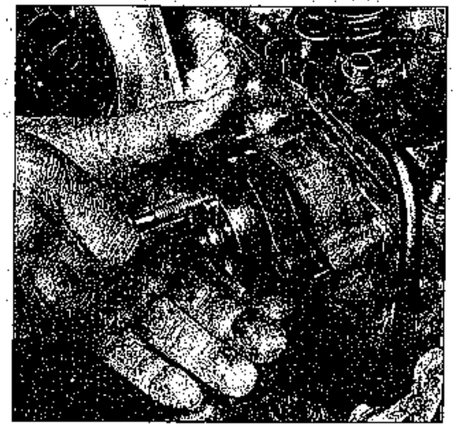
11.5 To remove the crankshaft pulley, use a puller that bolts to the hub



12.2 Prise the old seal out with a screwdriver or a seal puller. The cover is removed here for clarity

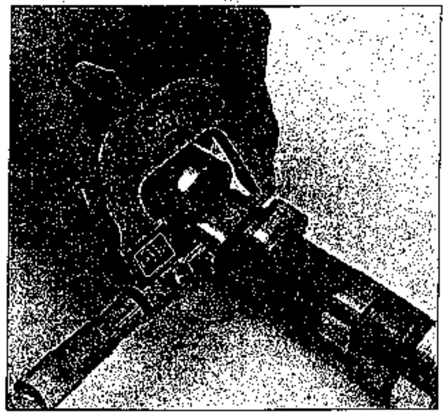


13.6 Mount a dial indicator firmly to the cylinder head to measure cam lift



13.17 Temporarily screw a long bolt into the camshaft to provide a better grip when sliding it out

13.19 The seal can be removed without removing the camshaft. Be careful to not damage the seal surface of the camshaft



13.20 Measure the height of each cam lobe - if any lobe height is less than the specified minimum, renew the camshaft

smaller than the outside diameter of the seal, carefully drive the new seal into place with a hammer. If a socket isn't available, a short section of large diameter pipe will work. Check the seal after refitting to be sure that the internal spring didn't pop out of place.

4 Refit the crankshaft sprocket, timing belt (see Section 9) and crankshaft pulley.

5 Run the engine and check for leaks.

13 Camshaft - removal, inspection and refitting

Pre-removal inspection

Refer to illustration 13.6

1 If you are unsure about the condition of the camshaft lobes, perform Steps 2 through 8.

2 Remove the valve cover (see Section 4).

3 Have an assistant operate the starter (ignition system disabled) while you observe the operation of the rocker arms.

4 If any rocker arm has substantially less movement than the others, the camshaft must be renewed.

5 If you are still not certain, remove the rocker arm assemblies and the lifters (Section 5).

6 Position a dial indicator as shown on each camshaft lobe, one at a time **(see illustration)**.

7 Using a spanner on the crankshaft bolt, slowly rotate the engine and note the minimum and maximum readings for each lobe. The difference between these two readings is the lift. If any lobe has a lift substantially less than the others, the camshaft must be renewed.

8 See the Specifications in this Chapter for the allowable wear limit.

Removal

Refer to illustrations 13.17 and 13.19

9 Remove the lifters (Section 5).

10 Remove the timing belt (Section 9).

11 Remove the distributor (Chapter 5).

12 Insert a screwdriver into a slot in the camshaft sprocket to hold it from turning. Remove the four sprocket bolts and remove the sprocket.

13 Remove the three camshaft retainer bolts.

14 Unbolt the fan shroud so it can be positioned out of the way.

15 Remove the radiator (Chapter 3).

16 It may be necessary to remove the front engine mount through-bolts and use a floor jack to raise the engine enough so the camshaft will clear the radiator core support. Use a block of wood on the head of the jack and be careful to not crush any upper engine components while jacking.

17 Temporarily refit a long bolt into one of the four camshaft front holes to use as a handle **(see illustration)**. Carefully slide the camshaft out of the cylinder head. It is easy to damage the camshaft bearings while doing this, so proceed slowly.

18 Remove the retainer O-ring from the rear of the retainer.

19 Drive the oil seal out of the retainer. Be very careful to avoid scratching the seal surface of the camshaft if it is to be refitted. The retainer can then be removed by sliding it across and then forward. The camshaft seal can also be removed without removing the camshaft **(see illustration)**.

Inspection

Refer to illustrations 13.20 and 13.27

20 If you are in doubt about wear to the camshaft lobes, use a micrometer to measure each lobe **(see illustration)**. Compare the readings to the Specifications in this Chapter.

21 If any of the readings are less than those specified, that lobe is bad and the camshaft must be renewed. If all the readings are almost identical, the camshaft is good. **Note:** *If the camshaft is to be renewed, you MUST Fit new lifters. Also, it is highly recommended that a new camshaft be fitted if the lifters are to be renewed.*

22 If you suspect that the camshaft is bent, build a pair of simple V-blocks out of wood.

23 Support each end of the camshaft in the blocks on the bearing journals.

24 Position a dial indicator with the tip on a centre journal.

25 Slowly rotate the camshaft and see if the needle moves more than the allowable limit shown in the Specifications in this Chapter.

26 To check the end play, refit the camshaft in the cylinder head and bolt the front retainer on.

27 Position a dial indicator on the camshaft **(see illustration)**.

28 Prise the camshaft forward and rearward. Compare the endplay with the value listed in this Chapter's Specifications. If the endplay is greater than the specified allowable maximum, then either the retainer or the camshaft is worn and must be renewed.

Refitting

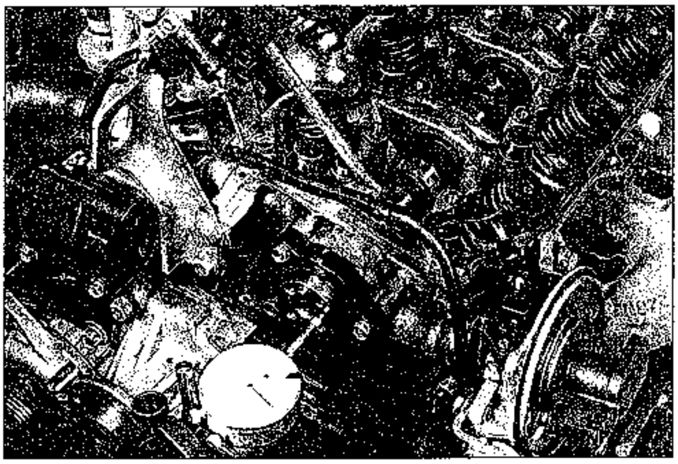
Refer to illustration 13.29

29 Lubricate the camshaft bearing journals and the lobes liberally with camshaft refitting lubricant **(see illustration)**.

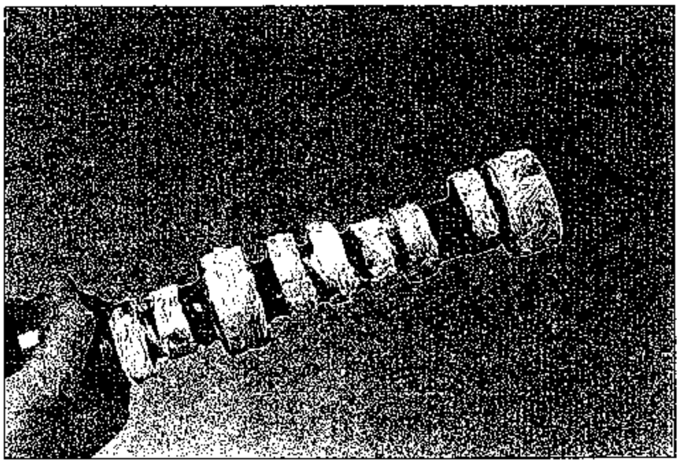
30 Very carefully slide the camshaft into place using the long bolt as before.

31 Refit the O-ring on the camshaft.

32 Refit the retainer without the seal. Make sure that the washers are refitted with the chamfered part of the hole towards the head of the bolt. Torque the bolts using the Speci-



13.27 This is the correct setup for checking camshaft endplay



13.29 Lubricate the camshaft thoroughly with camshaft lube

fications in this Chapter.

33 Apply engine oil to the lip of a new seal. Drive the seal into the retainer using a large socket and a hammer.

34 The rest of the refitting is the reverse of removal.

14 Sump - removal and refitting

Refer to illustration 14.12

Removal

1 Disconnect the negative cable from the battery.

2 Raise the vehicle and support it securely on jackstands.

3 Drain the oil (see Chapter 1).

4 Remove the sump shield if the vehicle is equipped with one.

5 Remove the transmission-to-engine reinforcing brackets that interfere.

6 Remove the sump bolts and lower the sump. Loosen the bolts in the reverse of the tightening sequence **(see illustration 14.12)**. Avoid levering on the sump flange. This will bend it. Strike the sump sideways with a soft-faced hammer if necessary to remove it. In extreme cases, the silicone seal will have to be cut with a blade.

7 Remove the sump from the vehicle.

Refitting

8 Scrape and clean all components thoroughly. Sealing surfaces must be cleaned with lacquer thinner, acetone or brake cleaner.

9 Check the flange of the sump and straighten it if necessary using a hammer and flat anvil.

10 Apply a 4 mm bead of RTV sealant around the pan inboard of the bolt holes. Fit a new O-ring on the oil pump pick-up flange.

11 The remainder of the operation is the reverse of removal.

12 Tighten the bolts to the correct torque listed in this Chapter's Specifications. Use the sequence shown **(see illustration)**.

15 Oil pump - removal, inspection and refitting

Refer to illustrations 15.3, 15.12a, 15.12b, 15.12d and 15.13

Removal

1 Remove the timing belt (see Section 9).

2 Remove the crankshaft sprocket and the guide plate from the crankshaft.

3 Remove the Woodruff key from the crankshaft snout **(see illustration)**. Set it aside in a safe place.

4 The oil pump cannot be removed from the engine without first lowering the sump approximately 25 mm at the front because of interference between the inner pressure relief assembly and the sump. If the sump needs to be removed for any other reason, do so now (see Section 14). If not, proceed with the next step.

5 Remove the bolts from the front two-thirds of the sump.

6 Prise the front lip of the sump down using two screwdrivers as wedges. The oil pump can now be removed.

7 To refit the sump (after refitting the oil pump), first clean the sealing surfaces extremely well with lacquer thinner or acetone. Apply a 4 mm bead of RTV silicone into the small opening along the sump rail.

8 Refit the sump bolts and tighten them to the torque listed in this Chapter's Specifications.

9 Remove the seven oil pump rear cover screws and take off the cover.

10 Remove the inner and outer gears. Note exactly how they were assembled. **Note:** *The grooved side of the inner gear goes towards the rear of the assembly. The larger chamfer on the outside of the outer gear goes towards the rear of the assembly.*

Inspection

11 Visually check the body, the cover and the gears for damage and obvious wear.

12 There are five internal measurements of the oil pump components which can be made at this time **(see illustrations)**. Consult the Specifications at the beginning of this Chapter.

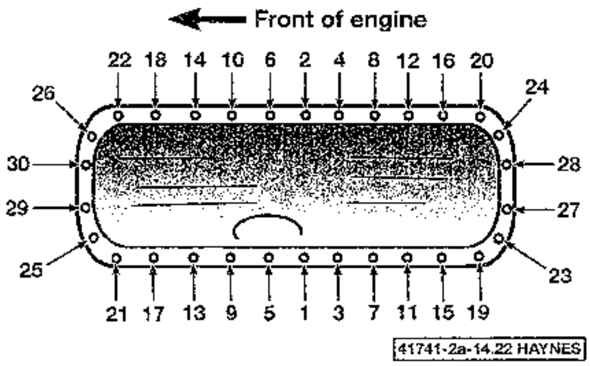
13 Disassemble the pressure relief assembly and check for damage **(see illustration)**.

Refitting

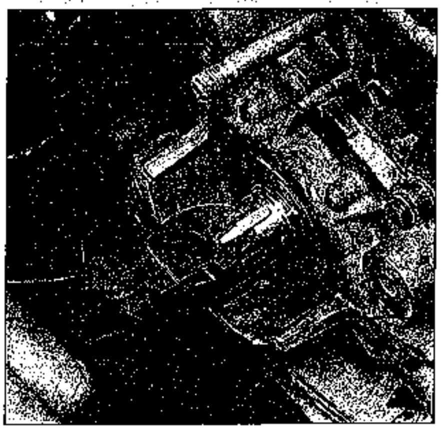
14 Fit a new seal into the pump housing. Apply sealant to the outer edge of the seal and oil to the inner lip. The front of the seal should be flush with the pump housing when it is fitted correctly.

15 Renew the necessary gaskets. Make sure that all sealing surfaces are perfectly clean.

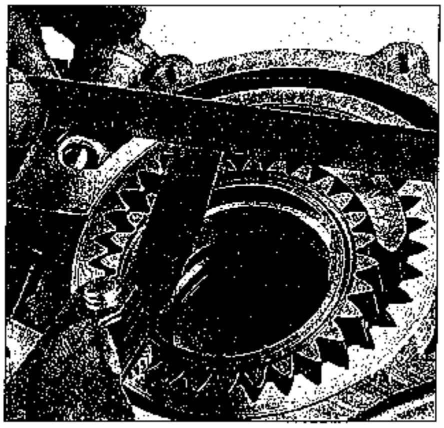
16 Refitting is the reverse of removal.



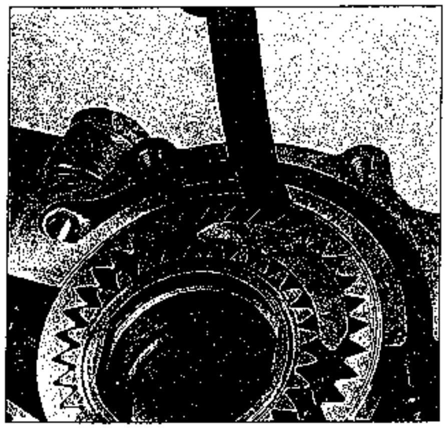
14.12 The sump should have its bolts tightened in this sequence



15.3 Use care when handling the Woodruff key. It can get lost very easily



15.12a Measure the housing to inner gear clearance like this. The housing to outer gear clearance is checked in a similar manner



15.12b Checking the housing-to-outer gear radial clearance

16 Flywheel/driveplate - removal and refitting

1 Remove the transmission (see Chapter 7A or 7B).

2 Remove the clutch (manual transmission models) (see Chapter 8).

3 Hold the flywheel/driveplate with a flywheel turning tool or a large screwdriver wedged into the ring gear teeth. Remove the bolts and then remove the flywheel/driveplate. **Warning:** *Manual transmission flywheels are heavy. Be very careful or better yet, get some assistance for this operation.*

4 Examine the teeth for damage. Check the surface of the manual transmission flywheel for wear and have it machined or renew it, if necessary. **Note:** *If the manual transmission flywheel ring needs to be renewed, take the flywheel to an automotive machine shop.*

5 Refitting is the reverse of removal. Tighten the bolts to the torque listed in this Chapter. **Note:** *The automatic transmission driveplate uses a reinforcing plate. It must be refitted so that the chamfer faces the engine.*

17 Rear main oil seal - renewal

Note: *Before renewing the rear oil seal, it may be worthwhile to try adding engine oil stop-leak fluid to the oil. This will swell the existing seal and may stop a leak.*

1 Remove the flywheel or driveplate (Section 16).

2 Prise out the old seal using a screwdriver.

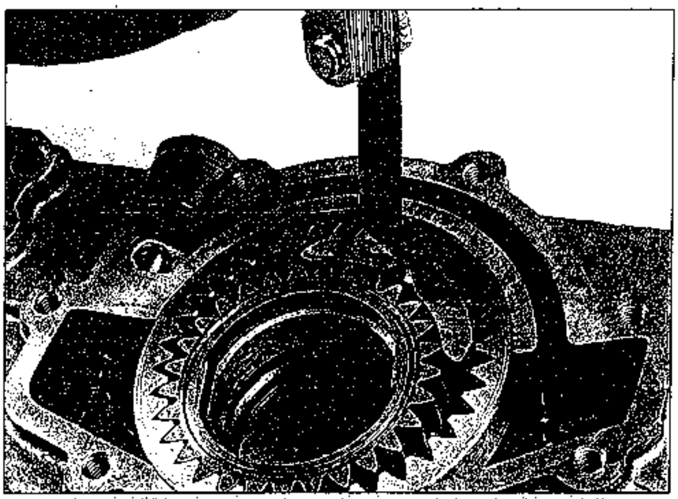
3 Lubricate the inside of the new seal with grease to help it slip over the crankshaft.

4 Coat the outside edge of the seal with sealant and refit it, tapping it into place with a hammer. **Note:** *The inner oil seal must face the front of the engine and the outer dust seal must be towards the rear.* Check that the small spring in the seal is still in place. Seat it fully using a blunt punch.

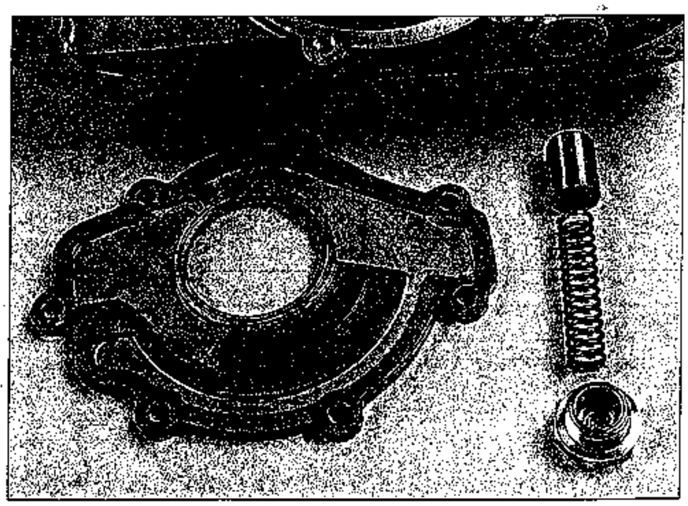
5 The remainder of the procedure is the reverse of removal.

18 Engine mounts - check and renewal

Refer to Chapter 2, Part A, for the engine mount check and renewal procedure.



15.12d Measure the inner gear-to-crescent clearance like this. The outer gear-to-crescent clearance is checked in a similar manner



15.13 The pressure relief assembly laid out for inspection

Chapter 2 Part C
4.2 litre diesel engine

Contents

Specifications

General

Displacement	4,169 cc
Cylinder numbers (front to rear)	1-2-3-4-5-6
Firing order	1-4-2-6-3-5

Camshaft

Endplay	
Standard	0.08 to 0.28 mm
Limit	0.50 mm
Camshaft journal-to bearing (oil) clearance	
Standard	0.020 to 0.109 mm
Limit	0.15 mm
Camshaft journal diameter	
Front	50.721 to 50.740 mm
Number 2	50.521 to 50.540 mm
Number 3	50.321 to 50.340 mm
Number 4	50.121 to 50.140 mm
Rear	49.921 to 49.940 mm
Camshaft runout limit	0.06 mm
Cam (lobe) height	
Inlet	
Standard	41.71 to 41.75 mm
Limit	41.20 mm
Exhaust	
Standard	41.88 to 41.92 mm
Limit	41.30 mm

Timing gears

Backlash	
Standard	0.06 to 0.12 mm
Maximum	0.20 mm
Idler gear to thrust plate clearance	
Standard	0.14 to 0.30 mm
Maximum	0.30 mm

Oil pump

Oil pressure	
At idle	78 kPa minimum
At 3,000 rpm	294 to 392 kPa
Gear side clearance	0.13 mm maximum
Gear backlash	0.30 mm maximum
Pump bush clearance	0.15 mm maximum
Pump bushing inside diameter	13.012 to 13.098 mm
Driveshaft outside diameter	12.974 to 12.992 mm

Torque specifications

	Nm (unless otherwise noted)
Camshaft gear bolt	78 to 88
Camshaft thrust plate bolts	4 to 6
Crankshaft pulley nut	294 to 324
Cylinder head bolts	
Step 1	49 to 59
Step 2	98 to 108
Exhaust head pipe nuts	43 to 50
Exhaust manifold fasteners	25 to 29
Flywheel bolts	147 to 167
Fuel injection pump drive gear bolt	43 to 51
Front cover fasteners	16 to 21
Inlet manifold fasteners	15 to 20
Oil cooler fasteners	16 to 21
Oil pump bolts	13 to 19
Oil pump relief valve bolts	16 to 21
Oil pump relief plug	29 to 49
Rear seal retainer bolts	16 to 21
Rocker arm lock nuts	15 to 20
Rocker shaft bolts	14 to 18
Sump bolts	7 to 9
Timing idler gear bolts	19 to 26
Valve cover bolts	1 to 2

1 General information

This Part of Chapter 2 is dedicated to in-vehicle repair procedures for the 4.2 litre diesel inline six-cylinder engine. All information regarding engine removal and refitting and engine block and cylinder head overhaul can be found in Part D of this Chapter.

The following repair procedures are based on the assumption that the engine is in the vehicle. If the engine has been removed and mounted on an engine stand, many of the Steps outlined in this Part of Chapter 2 will not apply.

The Specifications included in this Part of Chapter 2 apply only to the procedures contained in this Part. Part D of Chapter 2 contains the Specifications necessary for cylinder head and engine block rebuilding.

2 Repair operations possible with the engine in the vehicle

Many major repair operations can be accomplished without removing the engine from the vehicle.

Clean the engine compartment and the exterior of the vehicle with some type of pressure washer before any work is done. It will make the job easier and will help keep dirt out of the internal areas of the engine.

Remove the bonnet, if necessary, to improve access to the engine as repairs are performed (refer to Chapter 11 if necessary).

If exhaust, oil or coolant leaks develop, indicating a need for gasket or seal renewal, the repairs can generally be made with the engine in the vehicle. The inlet and exhaust manifold gaskets, sump gasket, crankshaft oil seals and cylinder head gasket are all accessible with the engine in place.

Other exterior components such as the oil pump, water pump, injection pump, starter and alternator can be removed for repair with the engine in place.

Since the cylinder head can be removed without pulling the engine, valve component servicing can also be accomplished with the engine in the vehicle. Renewal of the camshaft and the timing gears is also possible with the engine in the vehicle.

In extreme cases caused by a lack of necessary equipment, repair or renewal of piston rings, pistons, connecting rods and rod bearings can be performed with the engine in the vehicle. However, this practice is not recommended because of the cleaning and preparation work which must be done to the components involved.

3 Top Dead Centre (TDC) for number one piston - locating

Refer to illustration 3.7

1 Top Dead Centre (TDC) is the highest point in the cylinder that each piston reaches as it travels up and down as the crankshaft turns. Each piston reaches TDC on the compression stroke and again on the exhaust stroke, but TDC generally refers to piston position on the compression stroke only, when neither valve is open.

2 Positioning the pistons at TDC is an essential part of many procedures such as rocker arm removal and camshaft/timing gear removal.

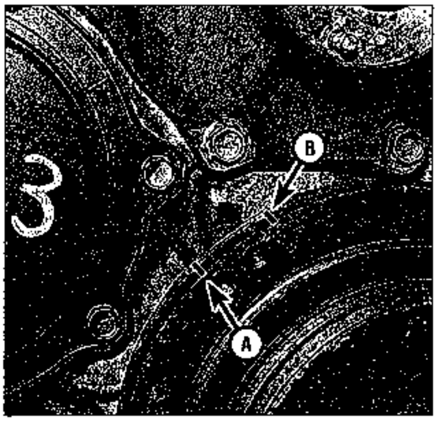
3 Before beginning this procedure, be sure to place the transmission in Neutral and apply the parking brake or block the rear wheels. Also, remove the fuel injectors (refer to Chapter 4C).

4 In order to bring any piston to TDC, the crankshaft must be turned using one of the methods outlined below. When looking at the front of the engine, normal crankshaft rotation is clockwise.

a) *The preferred method is to turn the crankshaft with a socket and ratchet attached to the nut on the front of the crankshaft.*
b) *A remote starter switch, which may save some time, can also be used. Follow the instructions included with the switch. Once the piston is close to TDC, use a socket and ratchet as described in the previous paragraph.*
c) *If an assistant is available to turn the ignition switch to the Start position in short bursts, you can get the piston close to TDC without a remote starter switch. Make sure your assistant is out of the vehicle, away from the ignition switch, then use a socket and ratchet (as described in Paragraph a) to complete the procedure.*

5 Slowly rotate the engine by hand as the timing marks on the crankshaft pulley come closer to the mark on the front cover. Place a finger over the fuel injector hole in the cylinder head and continue to slowly rotate the engine.

6 If engine compression forces your finger from the hole as the marks come into alignment, number one cylinder is on the compression stroke. If not, continue to rotate the engine an additional revolution until it does so.



3.7 Align the mark on the crankpulley (A) with the mark on the front cover (B)

7 Align the left pulley timing mark with the mark on the engine front cover **(see illustration)**.

8 After the number one piston has been positioned at TDC on the compression stroke, TDC for any of the remaining pistons can be located by turning the crankshaft clockwise (a third of a complete revolution at a time) and following the firing order. At every third of a revolution, the next cylinder in the firing order will arrive at TDC.

4 Valve cover - removal and refitting

Refer to illustration 4.8

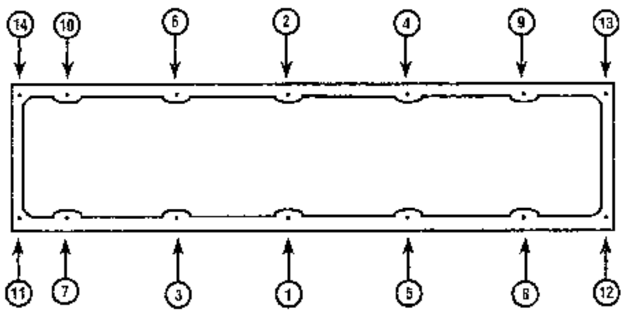
1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.

2 Remove the air cleaner components. Place a rag in the open engine air inlet to avoid dropping small parts inside.

3 Label and then disconnect any hoses which interfere with valve cover removal

4 Loosen the valve cover bolts a quarter turn at a time starting with the outer bolts and working towards the centre **(refer to Chapter 2A, illustration 4.7)**.

5 Remove the valve cover. If it is stuck, dislodge it by striking it from the side with a rubber mallet or a steel hammer with a block of wood.



4.8 Valve cover bolt tightening sequence

6 Clean the sealing surfaces with a scraper and lacquer thinner or acetone. Remove all oil traces.

7 Coat both the cylinder head surface and the valve cover with a thin film of RTV sealer and then fit a new gasket.

8 Refit the valve cover and hand tighten the screws. Tighten the screws to the torque listed in this Chapter's Specifications in two steps. Start with the centre screws and work towards the outer ones **(see illustration)**.

9 The rest of the refitting is the reverse of removal. Check closely for oil leaks before placing the vehicle in service.

5 Rocker arm assemblies and lifters - removal inspection and refitting

Refer to illustration 5.1

Refer to Chapter 2A, Section 5 for information on this procedure. **Caution:** *If it difficult to remove the rocker shaft supports from the shaft, soak the assembly in heated oil for five minutes. Do not strike the support with a hammer.* **Note:** *There is a small punch mark on the front of the rocker shaft which must face forward* **(see illustration)**.

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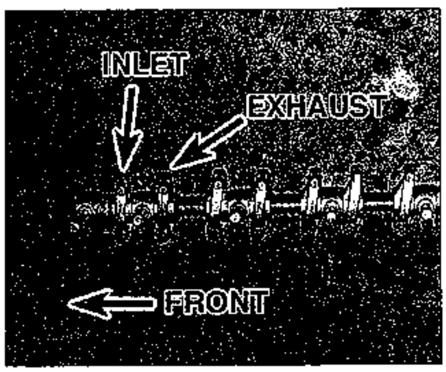
6 Valve springs, retainers and seals - renewal

Refer to Chapter 2A, Section 6 for information on this procedure. **Note:** *Use an adapter fitted to the fuel injector holes (rather than the spark plug holes) if you use compressed air to hold the valves in position.*

7 Inlet manifold - removal and refitting

1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.

2 Remove the air cleaner assembly (refer to Chapter 4C).



5.1 Make sure the punch mark on the front of the rocker shaft is facing forward

3 Disconnect the wiring and brackets from the manifold. Remove the restriction switch from the adapter.
4 Make notes of the locations of the various brackets used. Disconnect any interfering hose or injection tube brackets.
5 Loosen the mounting bolts a quarter turn at a time working from the outer ends towards the centre. Remove the manifold from the cylinder head.
6 Clean the sealing surfaces thoroughly and check the manifold for warpage using a precision straightedge. If it is warped, a machine shop may be able to resurface it.
7 Refitting is the reverse of removal. Use a new gasket and tighten the fasteners to the torque listed in this Chapter's Specifications. Tighten them in several stages, working in the reverse of the pattern used for removal.

8 Exhaust manifold - removal and refitting

Refer to Chapter 2A, Section 8 for information on this procedure.

9 Cylinder head - removal and refitting

1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.
2 Drain the cooling system (refer to Chapter 1). Remove the inlet and exhaust manifolds (refer to Section 7 and Section 8).
3 Remove the valve cover (refer to Section 4). Remove the rocker shaft assembly and the pushrods (refer to Section 5).
4 Position number one cylinder at TDC on the compression stroke (refer to Section 3).
5 Remove the alternator adjusting bolt.
6 Disconnect the coolant hose from the thermostat.
7 Remove the fuel injector tubes (refer to Chapter 4C). Make note of the positions of the clamps as you do so.
8 Remove the seal nuts from the fuel injectors (refer to Chapter 4C). Remove the injector fuel return tube.
9 Remove the fuel injectors (refer to Chapter 4).
10 Remove the thermostat cover from the housing.
11 Loosen the cylinder head bolts in three steps, working in the correct sequence (refer to Chapter 2A, illustration 9.8). Remove the bolts and lift the head from the vehicle.
12 Stuff clean towels into the cylinders. Thoroughly clean the gasket surfaces. Run an appropriate sized tap into the bolt holes in the cylinder head and run a die over the bolt threads (refer to Chapter 2A). Ensure that all bolt holes are clean and dry.
13 Inspect the cylinder head for cracks and check it for warpage. Refer to Chapter 2 Part D for cylinder head servicing procedures.
14 Fit a new cylinder head gasket dry (no sealer). **Caution:** *A grading (thickness) number is stamped on the corners of head gaskets. The number on the new gasket should match that on the old one. If the block has been machined or if pistons or liners have been renewed, piston protrusion must be measured and the appropriate head gasket selected. Refer to Chapter 2D for more information.*
15 Carefully set the cylinder head onto the block. Place washers (if used) on the head bolts with the chamfers facing towards the bolt heads. Lightly oil the threads and the bolt head bases.
16 Refit the bolts and tighten them in the steps and to the torques listed in this Chapter's Specifications. Work in the reverse of the sequence used in Step 11.
17 Refit the remaining components in the reverse order of removal.
18 Change the engine oil and filter (refer to Chapter 1).
19 Refill the cooling system and run the engine, checking for leaks and proper operation.

10 Lifters - removal, inspection and refitting

Refer to Chapter 2A, Section 10 for information on this procedure.

11 Crankshaft pulley/vibration damper - removal and refitting

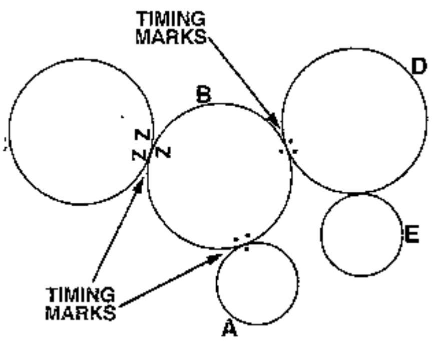
1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.
2 Raise the vehicle and support it securely on jackstands.
3 If the vehicle is equipped with a fan shroud, remove its mounting bolts and position it out of the way.
4 Remove the nut from the crankshaft pulley. This nut is very tight. If possible, use a pneumatic impact spanner. If one is not available, a long breaker bar will have to be used. In this case, it will probably be necessary to remove the torque converter access cover (automatic transmission) or the starter (manual transmission) to wedge the flywheel with a large screwdriver to prevent it from turning.
5 Remove the drivebelts (refer to Chapter 1). Label each belt as it is removed to simplify refitting. Remove any other components required for clearance.
6 Thread the nut on the crankshaft by hand. Tap it lightly with a hammer to loosen the cone from the pulley. Remove the nut and the cone.
7 Remove the pulley.
8 Refer to Section 12 for the front oil seal renewal procedure if it appears to be leaking. Inspect the surface of the pulley that contacts the seal. There may be a groove worn on this surface. If so, the pulley can be repaired by fitting a sleeve over its hub. **Note:** *These sleeves are available at auto parts stores. If a worn pulley is refitted with a new seal, the seal will probably leak.*
9 Apply a thin coating of multi-purpose grease to the seal contact surface of the pulley before refitting.
10 Refitting is the reverse of removal. Have an assistant prevent the flywheel from turning with a large screwdriver (refer to Step 4) and tighten the nut to the torque listed in this Chapter's Specifications.

12 Crankshaft front oil seal - renewal

Refer to Chapter 2A, Section 12 for information on this procedure.

13 Timing cover - removal and refitting

1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.
2 Raise the vehicle and support it securely on jackstands.
3 Drain the engine oil (refer to Chapter 1).
4 Remove any interfering stoneguards. Remove the support frame.
5 Disconnect the power steering pump from the engine and lay it out of the way. It is not necessary to disconnect the hoses.
6 Refer to Chapter 3 and remove the radiator, water pump, thermostat housing and the hoses.
7 Remove the gear cover from the fuel injection pump.
8 Set the engine at TDC for the number one cylinder. The left mark on the crankshaft pulley will be aligned with the mark on the front cover **(see illustration 3.7)**. Look through the hole in the front cover and check that the marks on the injection pump timing gears are also aligned.
9 Remove the fuel injection pump gear nut. Using a puller if necessary, remove the gear.
10 Remove the crankshaft pulley (refer to Section 11). **Caution:** *Do not rotate the engine after this point. The alignment of the timing gears and the crankshaft pulley must be maintained.*
11 Remove the belt tension pulleys from the front cover.
12 Remove the bolts which secure the sump to the front cover. Slightly loosen the remaining sump bolts to allow it to drop slightly from the cover. **Note:** *The sump only needs to be lowered in front enough to clear the timing cover. It is not necessary to remove it completely from the vehicle.*
13 Remove all the nuts and bolts which secure the front cover to the engine block including the alternator bracket bolt. **Note:** *There are fasteners which are difficult to see. Prise the cover from the engine block only after you are certain that all fasteners have*



14.4 Timing gear alignment diagram

A Crankshaft gear
B Timing idler gear
C Injection pump drive gear
D Camshaft drive gear
E Oil pump gear

been removed. Prise only at one of the six indentations in the cover.

14 Thoroughly clean the cover and all sealing surfaces, removing all traces of gasket material. Drive the old oil seal from the cover and renew it (refer to Section 12).

15 Renew the three O-ring seals. Clean the gasket surfaces with lacquer thinner or acetone, then apply a bead of RTV sealer. Also apply sealer around the seals.

16 The remainder of refitting is the reverse of removal. Tighten all fasteners to the torque listed in this Chapter's Specifications. Check the alignment of the crankshaft pulley marks and the timing gear marks.

14 Timing gears - removal, inspection and refitting

Refer to illustration 14.4

1 Remove the engine timing cover (refer to Section 12). The drive gear for the fuel injection pump will be removed during this procedure. Replace it at this time in order to check its backlash.

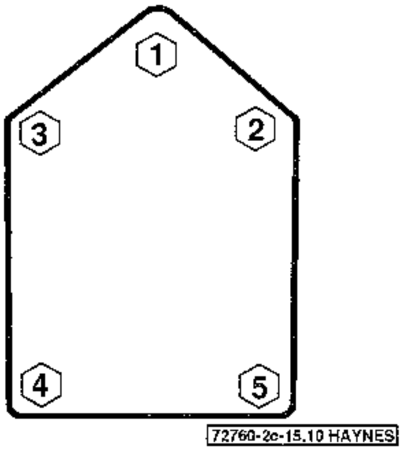
2 Mount a dial indicator to the engine block with the plunger perpendicular to and resting on one of the gear teeth. Rock the gear back and forth and measure the amount of backlash at the gear tooth. Using a feeler gauge, check the clearance between the rear of the idler gear and the thrust plate. Likewise check the clearance between the camshaft drive gear and its thrust plate.

3 Compare the readings to the values listed in this Chapter's Specifications. If they are more than that allowed, check the condition of the thrust plates, gears, the idler gear shaft and its bush. Renew components as required.

4 If any gears have been removed, check the positions of the alignment marks. All of the timing gears (with the exception of the oil pump) must be aligned so that the gear teeth with one dot or Z are meshed with a dot or Z on each side of it from a corresponding gear **(see illustration)**.

5 Before assembling the engine, verify that the oil jet is aimed at the crankshaft gear where it meets the idler gear. Use compressed air to clear the jet orifice if necessary.

6 The assembly sequence is the reverse of disassembly.



15.10 Tighten the bolts on the oil pump housing in this sequence

15 Oil pump - removal, inspection and refitting

Refer to illustration 15.10

1 Remove the front cover (refer to Section 13).

2 Rotate the engine so that all of the timing marks are aligned.

3 Remove the camshaft gear.

4 Remove the oil pump assembly.

5 Visually inspect the drive shaft body and gears for any damage.

6 Using a feeler gauge, measure the clearance between the oil pump gears and the pump body. If the clearance is more than that listed in this Chapter's Specifications, renew the pump.

7 Check the backlash between the pump gears using a feeler gauge. Renew the pump if the clearance is excessive.

8 If the proper measuring instruments are available, also check the drive shaft outside diameter, the drive shaft bush inside diameter and the clearance between the two. If the clearance is more than that listed in this Chapter's Specifications, renew the components.

9 Renew the O-ring on the pump housing and refit it on the engine block.

10 Tighten the bolts in several gradual steps to the torque listed in this Chapter's Specifications. Turn the drive gear frequently to ensure that the gears are not binding as you proceed. Follow the correct tightening sequence **(see illustration)**.

16.1 Typical oil cooler location (arrow)

11 The remainder of the refitting procedure is the reverse of removal.

2C

16 Oil cooler and oil pump relief valve - removal and refitting

Oil cooler

Removal

Refer to illustrations 16.1 and 16.6

1 The oil cooler is mounted to the right side of the diesel engine **(see illustration)**. It incorporates two oil filters and its own relief valve assembly.

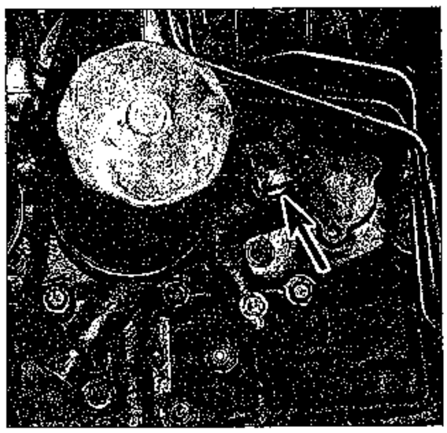
2 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.

3 Place a drain pan beneath the oil filters, then remove them (refer to Chapter 1).

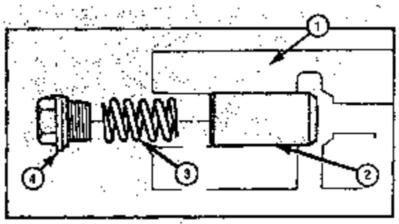
4 Drain the cooling system down to a sufficient level (refer to Chapter 1).

5 Remove the wiring harness clips from the engine. Pull the wiring out of the way and secure it.

6 Disconnect the oil pressure switch wiring and remove the switch **(see illustration)**.



16.6 Typical oil pressure switch location (arrow)



16.15 Typical oil pump pressure relief valve

1 *Body*
2 *Plug and gasket*
3 *Spring*
4 *Valve*

7 Remove the injector tube lower mounting bracket. It will be necessary to first remove the injector tube clamps.
8 Remove the dipstick tube.
9 Unbolt and remove the oil cooler. The unit can now be disassembled by removing both end plugs. Be certain to lay all parts out in order and clean them thoroughly as you proceed.
10 Use compressed air, if available, to blow out all passages. Check all components for damage and wear.

Refitting

11 Renew all gaskets and O-rings before assembly.
12 Refitting is the reverse of removal.

Oil pump relief valve

Removal

Refer to illustration 16.15

13 The oil pump relief valve is bolted to the left side of the engine near the rear of the block under the exhaust manifold.
14 Remove the three mounting bolts and lift the assembly from the engine.
15 To inspect the internal components, unscrew the plug and remove the gasket, seal and plunger **(see illustration)**.
16 Clean and inspect all components thoroughly. The plunger must slide freely in the bore and the spring must not be deformed. Check the plug washer for damage and renew it if necessary.

Refitting

17 Renew the two O-rings which seal the unit to the engine block. They can be held in place during assembly with petroleum jelly if required.
18 Tighten the fasteners to the torque listed in this Chapter's Specifications.

17 Camshaft and bearings - removal, inspection and refitting

Camshaft lift check

Refer to Chapter 2A, Section 16 for this procedure.

Removal

Note: *Camshaft renewal is much easier with the engine removed from the vehicle. Make certain that there will be adequate clearance at the front of your particular vehicle to slide the camshaft forward far enough for removal before beginning this procedure.*

1 Remove the radiator, grille and air conditioning condenser (refer to the appropriate Chapters for details on these procedures). Verify that there will be sufficient clearance for camshaft removal.
2 Remove the lifters (refer to Section 10).
3 Remove the front cover (refer to Section 13).
4 Remove the gear from the camshaft.
5 Remove the camshaft thrust plate.
6 Refit a long bolt of the correct thread into the front of the camshaft to act as a handle until it is moved far enough forward to be grasped. If a long bolt is not available, refit the drive gear and use it in the same manner.
7 Very carefully slide the camshaft out of the block. Do not damage the camshaft bearings as you maneuver it forward. It may be necessary to remove the front engine plate for clearance in some instances.

Inspection

Refer to Chapter 2A Section 16 for this procedure.

Bearing renewal

8 Camshaft bearing renewal requires special tools and expertise that place it outside the scope of the home mechanic. Take the engine block (refer to Chapter 2D) to an automotive machine shop to ensure that the job is done correctly.

Refitting

Refer to Chapter 2A Section 16 and Steps 1 through 7 in this Section for this procedure.

18 Sump - removal and refitting

Refer to Chapter 2A Section 17 for this procedure.

19 Flywheel/driveplate - removal and refitting

Refer to Chapter 2A Section 18 for this procedure.

20 Rear main oil seal - renewal

Refer to Chapter 2A Section 19 for this procedure.

21 Engine mounts - check and renewal

Refer to Chapter 2A Section 20 for this procedure.

Chapter 2 Part D
General engine overhaul procedures

Contents

Specifications

3.0 litre inline six-cylinder engine

General

Displacement	2,962 cc
Bore and stroke	86 mm x 85 mm
Cylinder compression	
Standard	1,196 kPa
Minimum	883 kPa
Difference limit	98 kPa

Cylinder block

Cylinder bore diameter (standard)	
Grade 1	86.000 to 86.010 mm
Grade 2	86.010 to 86.020 mm
Grade 3	86.020 to 86.030 mm
Grade 4	86.030 to 86.040 mm
Grade 5	86.040 to 86.050 mm
Wear limit	0.20 mm
Taper limit	0.010 mm
Out of round limit	0.015 mm
Deck flatness	
Standard	0.03 mm
Limit	0.10 mm

Pistons and rings

Piston diameter (measured at 47 mm below crown)	
Grade 1	85.975 to 85.985 mm
Grade 2	85.985 to 85.995 mm
Grade 3	85.995 to 86.005 mm
Grade 4	86.005 to 86.015 mm
Grade 5	86.015 to 86.025 mm
Piston to bore clearance	0.015 to 0.035 mm
Ring side clearance	
Top ring	0.040 to 0.073 mm
Second ring	0.030 to 0.063 mm
Ring end gap	
Top ring	0.24 to 0.31 mm
Second ring	0.18 to 0.28 mm

Crankshaft and connecting rods

Main bearing clearance	
Standard	0.020 to 0.047 mm
Limit	0.090 mm
Main journal diameter	
Grade 0	54.967 to 54.975 mm
Grade 1	54.959 to 54.967
Grade 2	54.951 to 54.959 mm
Connecting rod bearing clearance	
Standard	0.011 to 0.035 mm
Limit	0.090 mm
Rod journal diameter	
Grade 0	49.968 to 49.974 mm
Grade 1	49.961 to 49.968 mm
Out of round limit	0.005 mm
Taper limit	0.005 mm
Endplay	
Standard	0.05 to 0.17 mm
Limit	0.30 mm
Connecting rod side clearance	
Standard	0.20 to 0.30 mm
Limit	0.40 mm
Connecting rod bend limit	0.025 mm/100 mm

Cylinder head and valve train

Cylinder head thickness	
Standard	106.3 to 106.7 mm
Limit	106.1 mm
Surface flatness limit	0.2 mm
Valve stem diameter	
Inlet	6.965 to 6.980 mm
Exhaust	7.965 to 7.970 mm
Valve seat angle	45 degrees, 15 minutes to 45 degrees, 45 minutes
Valve margin minimum thickness	0.5 mm
Valve length	
Inlet	125.3 to 125.9 mm
Exhaust	124.2 to 124.8 mm
Valve stem tip grinding limit	0.2 mm
Valve spring free height	
Outer	51.2 mm
Inner	44.1 mm
Load at height	
Outer	524/30.0 kg/mm
Inner	255/25.0 kg/mm
Out of square limit	
Outer	2.2 mm
Inner	1.9 mm
Valve stem to guide clearance	
Inlet	0.020 to 0.053 mm
Exhaust	0.030 to 0.046 mm
Limit	0.1 mm
Valve deflection limit	0.2 mm

4.2 litre inline six-cylinder petrol engine

General

Displacement	4,169 cc
Bore and stroke	96 mm x 96 mm
Cylinder compression	
Standard	1,177 kPa
Minimum	883 kPa
Difference limit	98 kPa

Cylinder block

Cylinder bore diameter (standard)	
Grade 1	96.000 to 96.010 mm
Grade 2	96.010 to 96.020 mm
Grade 3	96.020 to 96.030 mm
Grade 4	96.030 to 96.040 mm
Grade 5	96.040 to 96.050 mm
Wear limit	0.20 mm
Taper limit	0.010 mm
Out of round limit	0.015 mm
Deck flatness	
Standard	0.03 mm
Limit	0.10 mm

Pistons and rings

Piston diameter (measured at 20 mm above bottom of piston)	
Grade 1	95.975 to 95.985 mm
Grade 2	95.985 to 95.995 mm
Grade 3	95.995 to 96.005 mm
Grade 4	96.005 to 96.015 mm
Grade 5	96.015 to 96.025 mm
Piston to bore clearance	0.015 to 0.035 mm
Ring side clearance	
Top ring	0,040 to 0,073 mm
Second ring	0.030 to 0.063 mm
Ring end gap	
Top ring	0.30 to 0.45 mm
Second ring	0.30 to 0.45 mm
Oil ring	0.20 to 0.60 mm

Crankshaft and connecting rods

Main bearing clearance	
Standard	0.041 to 0.087 mm
Limit	0.09 mm
Main journal diameter	70.907 to 70.920 mm
Connecting rod bearing clearance	
Standard	0.027 to 0.061 mm
Limit	0.09 mm
Rod journal diameter	56.913 to 56.926 mm
Main and rod journal out of round limit	0.0025 mm
Main and rod journal taper limit	0.0025 mm
Endplay	
Standard	0.05 to 0.17 mm
Limit	0.30 mm
Connecting rod side clearance	
Standard	0.20 to 0.30 mm
Limit	0.40 mm
Connecting rod bend limit	0.015 mm/100 mm

Cylinder head and valve train

Cylinder head thickness	
Standard	117.19 to 117.59 mm
Limit	116.99 mm
Surface flatness limit	0.2 mm
Valve stem diameter	
Inlet	7,965 to 7.980 mm
Exhaust	7.945 to 7.960 mm
Valve seat angle	45 degrees, 30 minutes
Valve margin minimum thickness	0.5 mm

Cylinder head and valve train

Valve length	
Inlet	116.7n to 117.0 mm
Exhaust	117.0 to 117.3 mm
Valve stem tip grinding limit	0.2 mm
Valve spring free height	
Outer	49.77 mm
Inner	44.10 mm
Load at height	
Outer	512.9/30.0 kg/mm
Inner	255.0/25.0 kg/mm
Assembled height	
Outer	40.0 mm
Inner	35.0 mm
Out of square limit	
Outer	2.2 mm
Inner	1.9 mm
Valve stem to guide clearance	
Inlet	0.020 to 0.053 mm
Exhaust	0.040 to 0.073 mm
Limit	0.1 mm
Valve deflection limit	0.2 mm

4.2 litre inline diesel six-cylinder engine

General

Displacement	4,169 cc
Bore and stroke	96 x 96 mm
Cylinder compression	
Standard	2,942 kPa
Minimum	2,452 kPa
Difference limit	294 kPa

Cylinder block

Cylinder bore (standard)	
Grade 1	96.000 to 96.010 mm
Grade 2	96.010 to 96.020 mm
Grade 3	96.020 to 96.030 mm
Wear limit	0.20 mm
Taper limit	0.020 mm
Out of round limit	0.20 mm
Deck flatness	
Standard	0.05 mm
Limit	0.20 mm
Cylinder liner protrusion	0.020 to 0.090 mm

Pistons and rings

Piston diameter (measured at 70 mm below top of piston)	
Grade 1	95.940 to 95.950 mm
Grade 2	95.950 to 95.960 mm
Piston to bore clearance	0.05 to 0.07 mm
Ring side clearance	
Top ring	0.06 to 0.10 mm
Second ring	0.04 to 0.08 mm
Oil ring	0.02 to 0.06 mm
Ring end gap	
Top ring	0.30 to 0.45 mm
Second ring	0.20 to 0.35 mm
Oil ring	0.30 to 0.50 mm

Crankshaft and connecting rods

Main bearing clearance	
Standard	0.035 to 0.087 mm
Limit	0.15 mm
Main journal diameter	70 907 to 70.920 mm
Connecting rod bearing clearance	
Standard	0.035 to 0.081 mm
Limit	0.15 mm
Rod journal diameter	56.919 to 56.926 mm
Main and rod journal out of round limit	0.02 mm

Main and rod journal taper limit	0.02 mm
Endplay	
Standard	0.055 to 0.14 mm
Limit	0.40 mm
Connecting rod side clearance	
Standard	0.10 to 0.22 mm
Limit	0.22 mm
Connecting rod bend limit	0.05 per 100 mm

Cylinder head and valve train

Surface flatness limit	0.07 mm
Valve stem diameter	
Inlet	7.962 to 7.977 mm
Exhaust	7.945 to 7.960 mm
Valve seat angle	45 to 45 -degrees
Valve margin minimum thickness	1.0 mm
Valve length	
Inlet	117 mm
Valve stem tip grinding limit	0.2 mm
Valve spring free height	
Red	52.15 mm
Yellow	53.0 mm
Load at height	
Red	32.3/672.8 mm/N
Yellow	31.8/697.3 mm/N
Assembled height	42.3 mm
Out of square limit	2.0 mm
Valve stem to guide clearance	
Inlet	0.023 to 0.053 mm
Exhaust	0.04 to 0.07 mm
Valve deflection limit	
Inlet	0.30 mm
Exhaust	0.40 mm

Torque specifications*

	Nm (unless otherwise specified)
Main bearing cap bolts	
3.0 litre	46 to 52
4.2 litre petrol	162 to 172
4.2 litre diesel	167 to 177
Connecting rod cap nuts	
3.0 litre	
Step 1	14 to 16
Preferred step 2	tighten an additional 60 to 65-degrees
Alternate step 2	38 to 44
4.2 litre petrol	
Step 1	38 to 40
Preferred step 2	tighten an additional 40 to 45-degrees
Alternate step 2	67 to 71
4.2 litre diesel	78 to 83

***Note:** *Refer to either Part A, Part B or Part C for additional specifications.*

***Using an angle-meter torque wrench.*

1 General information

Included in this portion of Chapter 2 are the general overhaul procedures for cylinder heads and internal engine components. The information ranges from advice concerning preparation for an overhaul and the purchase of new parts to detailed, step-by-step procedures covering removal and refitting of internal engine components and the inspection of parts.

The following Sections have been written based on the assumption that the engine has been removed from the vehicle. For information concerning in-vehicle engine repair, as well as removal and refitting of the external components necessary for the overhaul, see Parts A, B and C of this Chapter and Section 8 of this Part.

The Specifications included here in Part D are only those necessary for the inspection and overhaul procedures which follow. Refer to Parts A, B and C for additional specifications.

2 Engine removal - methods and precautions

If you have decided that an engine must be removed for overhaul or major repair work, several preliminary steps should be taken.

Locating a suitable work area is extremely important. A shop is, of course, the most desirable place to work. Adequate work space, along with storage space for the vehicle, will be needed. If a shop or garage is not available, at the very least a flat, level, clean work surface made of concrete or asphalt is required.

Cleaning the engine compartment and engine before beginning the removal procedure will help keep tools clean and organised.

An engine hoist or A-frame will be needed. Make sure that the equipment is rated in excess of the combined weight of the engine and its accessories. Safety is of primary importance, considering the potential hazards involved in lifting the engine out of the vehicle.

If the engine is being removed by a novice, a helper should 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 out of the vehicle.

Plan the operation ahead of time. Arrange for or obtain all of the tools and equipment you will need prior to beginning the job. Some of the equipment necessary to perform engine removal and refitting safely and with relative ease are (in addition to an engine hoist) a heavy duty floor jack, complete sets of wrenches and sockets as described in the front of this manual, wooden blocks and plenty of rags and cleaning solvent for mopping up spilled oil, coolant and petrol. If the hoist is to be rented, make sure that you arrange for it in advance and perform beforehand all of the operations possible without it. This will save you money and time.

Plan for the vehicle to be out of use for a considerable amount of time. A machine shop will be required to perform some of the work which the do-it-yourselfer cannot accomplish due to a lack of special equipment. These shops often have a busy schedule, so it would be wise to consult them before removing the engine in order to accurately estimate the amount of time required to rebuild or repair components that may need work.

Always use extreme caution when removing and refitting the engine. Serious injury can result from careless actions. Plan ahead, take your time and a job of this nature, although major, can be accomplished successfully.

3 Engine overhaul - general information

It is not always easy to determine when, or if, an engine should be completely overhauled, as a number of factors must be considered.

A high number of kilometres is not necessarily an indication that an overhaul is needed, while a low number of kilometres does not preclude the need for an overhaul. Frequency of servicing is probably the most important consideration. An engine that has had regular and frequent oil and filter changes, as well as other required maintenance, will most likely give many thousands of kilometres 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 and/or valve guides are in need of attention. Make sure that oil leaks are not responsible before deciding that the rings and/or guides are bad. Test the cylinder compression (see Section 4) or have a leak-down test performed by an experienced tune-up mechanic to determine the extent of the work required.

If the engine is making obvious knocking or rumbling noises, the connecting rod and/or main bearings are probably at fault. To accurately test oil pressure, temporarily connect a mechanical oil pressure gauge in place of the oil pressure sending unit. Compare the reading to the pressure listed in this Chapter's Specifications. If the pressure is extremely low, the bearings and/or oil pump are probably worn out.

Loss of power, rough running, excessive valve train noise and high fuel consumption rates may also point to the need for an overhaul, especially if they are all present at the same time. If a complete tune-up does not remedy the situation, major mechanical work is the only solution.

An engine overhaul involves restoring the internal parts to the specifications of a new engine. During an overhaul, the piston rings are renewed and the cylinder walls are reconditioned (rebored and/or honed). If a rebore is done, new pistons are required. The main bearings, connecting rod bearings and camshaft bearings are generally renewed and, if necessary, the crankshaft may be reground to restore the journals. Generally, the valves are 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 rebuilt as well. The end result should be a like-new engine that will give many thousands of trouble-free kilometres. **Note:** *Critical cooling system components such as the hoses, the drivebelts, the thermostat and the water pump MUST be renewed with new parts when an engine is overhauled. Some professional engine rebuilders will not guarantee their rebuilt short-blocks or long-blocks unless the customer has the radiator reconditioned at a radiator shop. The radiator should be professionally cleaned. If in doubt, renew it.*

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 take your time and follow all procedures carefully. But it is time consuming. Plan on the vehicle being tied up for a minimum of two weeks, especially if parts must be taken to an automotive machine shop 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 an automotive machine shop will handle the inspection of parts and offer advice concerning reconditioning and renewal. **Note:** *Always wait until the engine has been completely disassembled and all components, especially the engine block, have been inspected before deciding what service and repair operations must be performed by an automotive machine shop.* Since the block's condition will be the major factor to consider when determining whether to overhaul the original engine or buy a rebuilt one, never purchase parts or have machine work done on other components until the block has been thoroughly inspected. As a general rule, time is the primary cost of an overhaul, so it does not pay to refit worn or sub-standard parts.

As a final note, to ensure maximum life and minimum trouble from a rebuilt engine, everything must be assembled with care in a spotlessly clean environment.

4 Compression check

Refer to illustration 4.4

1 A compression check will tell you what mechanical condition the pistons, rings,

valves and head gaskets of your engine are in. Specifically, it can tell you if the compression is down due to leakage caused by worn piston rings, defective valves and seats or a blown head gasket. **Note:** *The engine must be at normal operating temperature for this check and the battery must be fully charged.*

2 On petrol engines, begin by cleaning the area around the spark plugs before you remove them (compressed air works best for this). On diesel engines, the injectors must be removed (refer to Chapter 4C). **Warning:** *Always wear eye protection when using compressed air!* This will prevent dirt from getting into the cylinders as the compression check is being done. Remove all of the spark plugs from the engine.

3 On petrol engines, block the throttle wide open and disconnect the primary wires from the coil. On diesel engines, disconnect the fuel cut solenoid wire at the injection pump. In either case, prevent unnecessary fuel or spark while the engine is being cranked.

4 With the compression gauge threaded in the number one spark plug hole, crank the engine over at least four compression strokes and watch the gauge **(see illustration)**. 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). Record the highest gauge reading obtained.

5 Repeat the procedure for the remaining cylinders and compare the results to the Specifications.

6 Add some engine oil (about three squirts from a plunger-type oil can) to each cylinder, through the spark plug hole, and repeat the test.

7 If the compression increases after the oil is added, the piston rings are definitely worn. If the compression does not increase significantly, the leakage is occurring at the valves or head gasket. Leakage past the valves may be caused by burned valve seats and/or faces or warped, cracked or bent valves.

8 If two adjacent cylinders have equally low compression, there is a strong possibility that the head gasket between them is blown. The appearance of coolant in the combustion chambers or the oil would verify this condition. Generally, coolant will cause the oil on the dipstick to look light-coloured (milky).

9 If the compression is unusually high, the combustion chambers are probably coated with carbon deposits. If that is the case, the cylinder heads should be removed and decarbonised.

10 If compression is way down or varies greatly between cylinders, it would be a good idea to have a leak-down test performed by an automotive repair shop. This test will pinpoint exactly where the leakage is occurring and how severe it is.

4.4 A compression gauge with a threaded fitting for the spark plug hole is preferred over the type that requires hand pressure to maintain the seal - be sure to open the throttle valve as far as possible during the compression check

5 Vacuum gauge diagnostic checks (petrol engines)

Refer to illustration 5.4

A vacuum gauge provides valuable information about what is going on in the engine at a low cost. You can check for worn rings or cylinder walls, leaking head or inlet manifold gaskets, incorrect carburettor adjustments, restricted exhaust, stuck or burned valves, weak valve springs, improper ignition or valve timing and ignition problems.

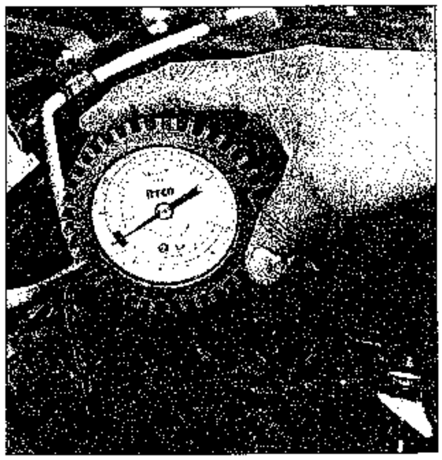
Unfortunately, vacuum gauge readings are easy to misinterpret, so they should be used in conjunction with other tests to confirm the diagnosis.

Both the gauge readings and the rate of needle movement are important for accurate interpretation. Most gauges measure vacuum in inches of mercury (in-Hg). As vacuum increases (or atmospheric pressure decreases), the reading will increase. Also, for every 305-metre) (1,000-foot) increase in elevation above sea level, the gauge readings will decrease about one inch of mercury.

Connect the vacuum gauge directly to inlet manifold vacuum, not to ported (carburettor) vacuum **(see illustration)**. Be sure no hoses are left disconnected during the test or false readings will result.

Before you begin the test, allow the engine to warm up completely. Block the wheels and set the parking brake. With the transmission in Park, start the engine and allow it to run at normal idle speed. **Warning:** *Carefully inspect the fan blades for cracks or damage before starting the engine. Keep your hands and the vacuum tester clear of the fan and do not stand in front of the vehicle or in line with the fan when the engine is running.*

Read the vacuum gauge; an average, healthy engine should normally produce about 60 to 75 kPa of vacuum with a fairly steady needle. Refer to the following vacuum gauge readings and what they indicate about the engine's condition:



5.4 A simple vacuum gauge connected to manifold vacuum can tell you a lot about a petrol engine's condition

1 A low, steady reading usually indicates a leaking gasket between the inlet manifold and carburettor or throttle body, a leaky vacuum hose, late ignition timing or incorrect camshaft timing. Check ignition timing with a timing light and eliminate all other possible causes, utilising the tests provided in this Chapter before you remove the timing chain cover to check the timing marks.

2 If the reading is 10 to 25 kPa below normal and it fluctuates at that low reading, suspect an inlet manifold gasket leak at an intake port.

3 If the needle has regular drops of about two to four inches at a steady rate, the valves are probably leaking. Perform a compression or leak-down test to confirm this.

4 An irregular drop or down-flick of the needle can be caused by a sticking valve or an ignition misfire. Perform a compression or leak-down test and read the spark plugs.

5 A rapid vibration of about 10 kPa vibration at idle combined with exhaust smoke indicates worn valve guides. Perform a leak-down test to confirm this. If the rapid vibration occurs with an increase in engine speed, check for a leaking inlet manifold gasket or head gasket, weak valve springs, burned valves or ignition misfire.

6 A slight fluctuation, say one inch up and down, may mean ignition problems. Check all the usual tune-up items and, if necessary, run the engine on an ignition analyser.

7 If there is a large fluctuation, perform a compression or leak-down test to look for a weak or dead cylinder or a blown head gasket.

8 If the needle moves slowly through a wide range, check for a clogged PCV system, incorrect idle fuel mixture, carburettor/throttle body or inlet manifold gasket leaks.

9 Check for a slow return after revving the engine by quickly snapping the throttle open until the engine reaches about 2,500 rpm and

let it shut. Normally the reading should drop to near zero, rise above normal idle reading (about 15 kPa over) and then return to the previous idle reading. If the vacuum returns slowly and doesn't peak when the throttle is snapped shut, the rings may be worn. If there is a long delay, look for a restricted exhaust system (often the muffler or catalytic converter). An easy way to check this is to temporarily disconnect the exhaust ahead of the suspected part and re-test.

6 Engine rebuilding alternatives

The do-it-yourselfer is faced with a number of options when performing an engine overhaul. The decision to renew the engine block, piston/connecting rod assemblies and crankshaft depends on a number of factors, with the number one consideration being the condition of the block. Other considerations are cost, access to machine shop facilities, parts availability, time required to complete the project and the extent of prior mechanical experience on the part of the do-it-yourselfer.

Some of the rebuilding alternatives include:

Individual parts - If the inspection procedures reveal that the engine block and most engine components are in reusable condition, purchasing individual parts may be the most economical alternative. The block, crankshaft and piston/connecting rod assemblies should all be inspected carefully. Even if the block shows little wear, the cylinder bores should be surface honed.

Crankshaft kit - This rebuild package consists of a reground crankshaft and a matched set of pistons and connecting rods. The pistons will already be refitted on the connecting rods. Piston rings and the necessary bearings will be included in the kit. These kits are commonly available for standard-size cylinder bores, as well as for engine blocks which have been bored to a standard oversize. These kits are not assembled.

Short block - A short block consists of an engine block with a camshaft, timing chain and gears, crankshaft and piston/connecting rod assemblies already refitted. All new bearings are incorporated and all clearances will be correct. The existing cylinder head(s), valve train components and external parts can be bolted to the short block with little or no machine shop work necessary.

Long block - A long block consists of a short block plus an oil pump, cylinder head(s) and valve train components. All components are refitted with new bearings, seals and gaskets incorporated throughout. The refitting of manifolds and external parts is all that is necessary.

Give careful thought to which alternative is best for you and discuss the situation with local automotive machine shops, auto parts dealers or parts store counter people before ordering or purchasing renewal parts.

7 Engine - removal and refitting

Refer to illustrations 7.10, 7.21 and 7.22

Warning: *Petrol is extremely flammable, so take extra precautions when disconnecting any part of the fuel system. Don't smoke or allow open flames or bare light bulbs in or near the work area and don't work in a garage where a natural gas appliance (such as a clothes dryer or water heater) is refitted. If you spill petrol on your skin, rinse it off immediately. Have a fire extinguisher rated for petrol fires handy and know how to use it! Also, the air conditioning system is under high pressure - have a dealer service department or service station discharge the system and recapture the refrigerant before disconnecting any of the hoses or fittings.*

Note: *Read through the following steps carefully and familiarise yourself with the procedure before beginning work.*

Removal

1 On air-conditioned models, inspect the compressor mounting to determine if the compressor can be unbolted and moved aside without disconnecting the refrigerant lines (see Chapter 3). If this is not possible, have the system discharged by a dealer or service station (see the **Warning** at the beginning of this Section).

2 Remove the bonnet (see Chapter 11). Relieve the fuel system pressure on fuel injected models (see Chapter 4).

3 Remove the air cleaner or air inlet duct assembly and all hoses connected to it (see Chapter 4).

4 Drain the cooling system and remove the drivebelts (see Chapter 1). **Note:** *Mark all the accessory drivebelts with markers to indicate which components they drive, i.e. alternator, air conditioning compressor, power steering pump, and also number the belts to indicate which order they go onto the pulleys. This will eliminate confusion on reassembly, which might be days or weeks later.*

5 Remove the radiator, shroud and fan (see Chapter 3).

6 Detach the radiator and heater hoses from the engine.

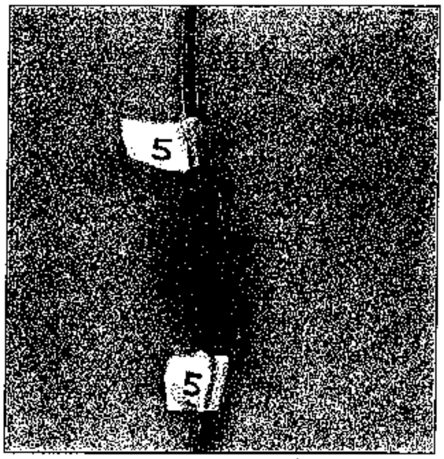
7 Disconnect the accelerator cable (see Chapter 4) and throttle rod (automatic transmission only - see Chapter 7B) from the carburettor.

8 Remove the power steering pump and brackets (if equipped) without disconnecting the hoses and tie it out of the way (see Chapter 10).

9 Remove the alternator (see Chapter 5).

10 Label and disconnect all wires from the engine **(see illustration)**. Masking tape and/or a touch-up paint applicator work well for marking items. **Note:** *Take instant photos or sketch the locations of components and brackets to help with reassembly.*

11 Disconnect the fuel lines at the engine (see Chapter 4) and plug the lines to prevent fuel loss.



7.10 Label each wire before disconnecting the connector

12 Label and detach all vacuum lines from the inlet manifold.

13 Raise the vehicle and support it securely on jackstands.

14 Drain the engine oil (see Chapter 1).

15 Refer to Chapter 4 and disconnect the exhaust pipe from the exhaust manifold.

16 Support the transmission with a floor jack or use a length of chain to keep it in place when the engine is separated for removal. **Note:** *On automatic-transmission models, unbolt the transmission dipstick tube from the cylinder head, but leave it attached to the transmission.*

17 On some early models, the heater core/blower motor housing on the firewall must be removed for clearance (see Chapter 3).

18 Disconnect the wires from the starter solenoid and remove the starter (see Chapter 5).

19 Remove the flywheel or torque converter inspection cover (see Chapter 7B).

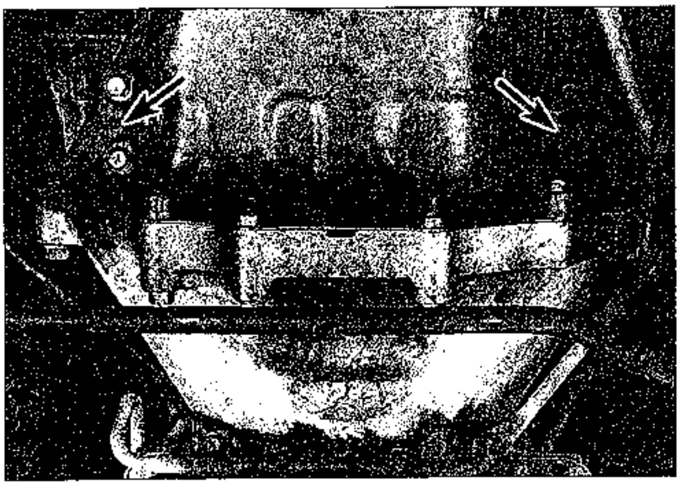
20 If equipped with an automatic transmission, remove the torque converter-to-driveplate bolts (see Chapter 7B). In order to turn the engine to reach all the bolts, use a socket and breaker bar on the bolt in the front end of the crankshaft to turn the driveplate to the needed positions.

21 Remove the transmission-to-engine bolts and the transmission support bracket **(see illustration)**.

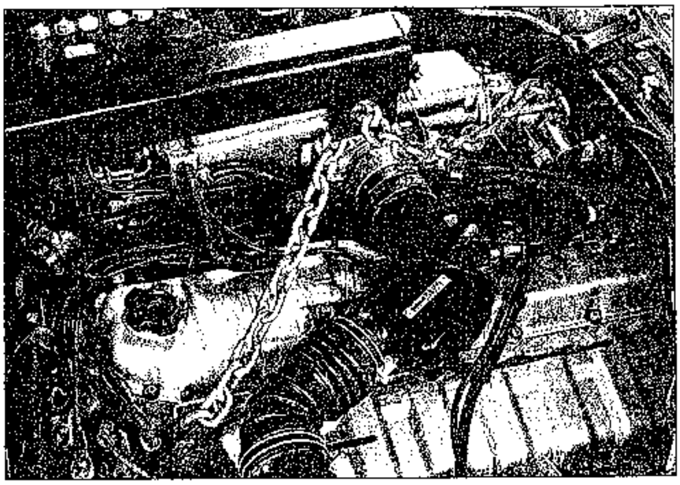
22 Attach an engine hoist to the engine and raise the engine slightly to remove the weight from the engine mounts **(see illustration)**.

23 Remove the engine mount bolts or stud nuts (see Chapter 2A, 2B or 2C). On most models, disconnect the earth strap connected to one of the engine mounts or the exhaust manifold heat shield.

24 Lift the engine slightly and separate the engine from the transmission. Carefully work it forward to separate it from the transmission. If you're working on a vehicle with an automatic transmission, be sure the torque converter stays in the transmission (clamp a pair of locking pliers to the housing to keep



7.21 There are two engine-to-transmission brackets (arrows) which will have to be removed when you disconnect the transmission



7.22 Use longer bolts in the inlet and exhaust manifold bolt holes to attach the engine hoist like this

the converter from sliding out). If you're working on a vehicle with a manual transmission, the input shaft must be completely disengaged from the clutch.

25 Check to make sure everything is disconnected, then lift the engine out of the vehicle. The engine will probably need to be tilted and/or manoeuvred as it's lifted out, so have an assistant handy. **Warning:** *Do not place any part of your body under the engine when it is supported only by a hoist or other lifting device.*

26 Remove the flywheel/driveplate and mount the engine on an engine stand or set the engine on the floor and support it so it doesn't tip over. Then disconnect the engine hoist.

Refitting

27 Check the engine mounts. If they're worn or damaged, renewal them.

28 On manual transmission models, inspect the clutch components (see Chapter 8). On automatic models, inspect the converter seal and bush.

29 Apply a dab of grease to the pilot bush on manual transmission models, or to the torque converter hub on automatic transmission models.

30 Attach the hoist to the engine and carefully lower the engine into the engine compartment.

31 Carefully guide the engine into place. Follow the procedure outlined in Chapter 7 for transmission attachment. **Caution:** *Do not use the bolts to force the engine and transmission into alignment. It may crack or damage major components.*

32 Align the engine to the engine mounts. Refit the nuts or bolts and tighten them securely. **Note:** *If it was detached from the engine, reconnect the automatic transmission dipstick to the engine.*

33 Refit the remaining components in the reverse order of removal.

34 Add coolant, oil, power steering and transmission fluid as needed (see Chapter 1).

35 Run the engine and check for proper operation and leaks. Shut off the engine and recheck fluid levels. See Section 25 for procedures to break-in a new engine.

8 Engine overhaul - disassembly sequence

1 It is much easier to disassemble and work on the engine if it is mounted on a portable engine stand. These stands can often be rented quite cheaply from an equipment rental yard. Before the engine is mounted on a stand, the flywheel/driveplate should be removed from the engine (refer to Chapter 2A, 2B or 2C).

2 If a stand is not available, it is possible to disassemble the engine with it blocked up on a sturdy workbench or on the floor. Be extra careful not to tip or drop the engine when working without a stand.

3 If you are going to obtain a rebuilt engine, all external components must come off first, to be transferred to the renewal engine, just as they will if you are doing a complete engine overhaul yourself. These include:

Alternator and brackets
Emissions control components
Distributor, spark plug wires and spark plugs (petrol engines)
Injection pump (diesel engines)
Thermostat and housing cover
Water pump
Carburettor or fuel injection components
Intake/exhaust manifolds
Oil pump assembly
Engine mounts
Clutch and flywheel/driveplate

Note: *When removing the external components from the engine, pay close attention to details that may be helpful or important during refitting. Note the refitted position of gaskets, seals, spacers, pins, washers, bolts and other small items.*

4 If you are obtaining a short-block, which consists of the engine block, crankshaft, pistons and connecting rods all assembled, then the cylinder heads, sump and oil pump will have to be removed as well. See *Engine rebuilding alternatives* for additional information regarding the different possibilities to be considered.

5 If you are planning a complete overhaul, the engine must be disassembled and the internal components removed in the general following order:

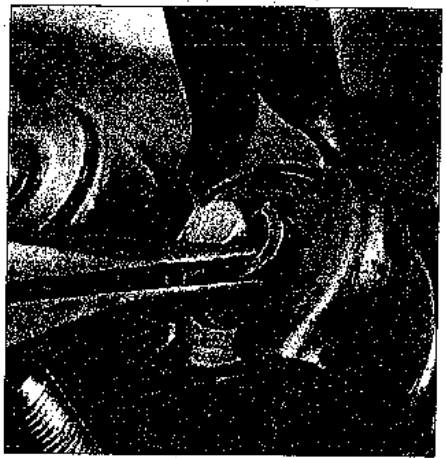
Valve cover
Intake and exhaust manifolds
Rocker shaft assembly
Cylinder head
Valve lifters
Sump
Fuel pump (carburetted models)
Timing cover
Timing chain and sprockets
Oil pump
Camshaft
Piston/connecting rod assemblies
Crankshaft and main bearings

6 Critical cooling system components such as the hoses, the drivebelts, the thermostat and the water pump MUST be renewed parts when an engine is overhauled. If you are buying a rebuilt engine or short-block, some rebuilders will not guarantee their engines unless you have proof that the radiator has been professionally cleaned. Also, new components should be used in the oil pump housing.

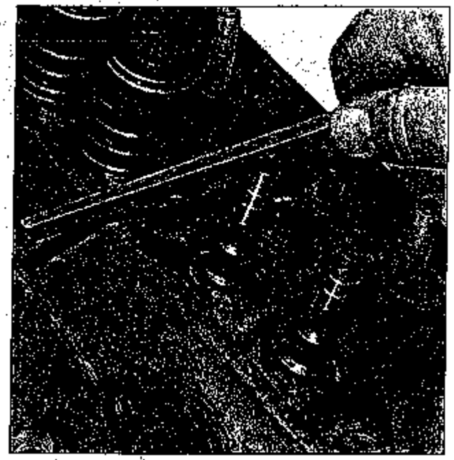
7 Before beginning the disassembly and overhaul procedures, make sure the following items are available:

Common hand tools
Small cardboard boxes or plastic bags for storing parts
Gasket scraper
Ridge reamer
Vibration damper puller
Micrometers
Telescoping gauges
Dial indicator set

9.2 A small plastic bag, with an appropriate label, can be used to store the valve train components so they can be kept together and refitted in the original position



9.3a Use a valve spring compressor to compress the spring, then remove the collets from the valve stem with a magnet or needle-nose pliers



9.3b If the valve won't pull through the guide, deburr the edge of the stem end and the area around the top of the collet groove with a file or whetstone

Valve spring compressor
Cylinder surfacing hone
Piston ring groove cleaning tool
Electric drill motor
Tap and die set
Wire brushes
Oil gallery brushes
Cleaning solvent

9 Cylinder head - disassembly

Refer to illustrations 9.2, 9.3a and 9.3b

Note: *New and rebuilt cylinder heads are commonly available for most engines at dealerships and auto parts stores. Due to the fact that some specialised tools are necessary for the disassembly and inspection procedures, and renewal parts may not be readily available, it may be more practical and economical for the home mechanic to purchase new cylinder heads rather than taking the time to disassemble, inspect and recondition the originals.*

1 Cylinder head disassembly involves removal of the intake and exhaust valves and related components. If it is still in place, remove the rocker arm shaft assembly. Label the parts or store them separately so they can be refitted in their original locations.

2 Before the valves are removed, arrange to label and store them, along with their related components, so they can be kept separate and refitted in the same valve guides they are removed from **(see illustration)**.

3 Compress the springs on the first valve with a spring compressor and remove the collets **(see illustration)**. Carefully release the valve spring compressor and remove the retainer and (if used) rotators, the shield, the springs and the spring seat or shims (if used). Rotators are generally used only on the exhaust valves. Remove the oil seal(s) from the valve stem and the umbrella-type seal from over the guide boss (if used), then pull the valve from the head. If the valve binds in the guide (won't pull through), push it back into the head and deburr the area around the collet groove with a fine file or whetstone **(see illustration)**.

4 Repeat the procedure for the remaining valves. Remember to keep all the parts for each valve together so they can be refitted in the same locations.

5 Once the valves and related components have been removed and stored in an organised manner, the head should be thoroughly cleaned and inspected. If a complete engine overhaul is being done, finish the engine disassembly procedures before beginning the cylinder head cleaning and inspection process.

10 Cylinder head - cleaning and inspection

1 Thorough cleaning of the cylinder heads and related valve train components, followed by a detailed inspection, will enable you to decide how much valve service work must be done during the engine overhaul.

Cleaning

2 Scrape away all traces of old gasket material and sealing compound from the head gasket, inlet manifold and exhaust manifold sealing surfaces. Be very careful not to gouge the cylinder head. Special gasket-removal solvents, which soften gaskets and make removal much easier, are available at auto parts stores.

3 Remove any built-up scale from the coolant passages.

4 Run a stiff wire brush through the various holes to remove any deposits that may have formed in them.

5 Run an appropriate-size tap into each of the threaded holes to remove any corrosion and thread sealant that may be present. If compressed air is available, use it to clear the holes of debris produced by this operation.

6 Check the condition of the spark plug threads.

7 Clean the cylinder head with solvent and dry it thoroughly. Compressed air will speed the drying process and ensure that all holes and recessed areas are clean. **Note:** *Decarbonising chemicals are available and may prove very useful when cleaning cylinder heads and valve train components. They are very caustic and should be used with caution. Be sure to follow the instructions on the container.*

8 Clean the rocker arms, shafts and pushrods (if used) with solvent and dry them thoroughly (don't mix them up during the cleaning process). Compressed air will speed the drying process and can be used to clean out the oil passages.

9 Clean all the valve springs, shields, collets and retainers with solvent and dry them thoroughly. Do the components from one valve at a time to avoid mixing up the parts.

10 Scrape off any heavy deposits that may have formed on the valves, then use a wire brush mounted in a drill motor to remove deposits from the valve heads and stems. Again, make sure the valves do not get mixed up.

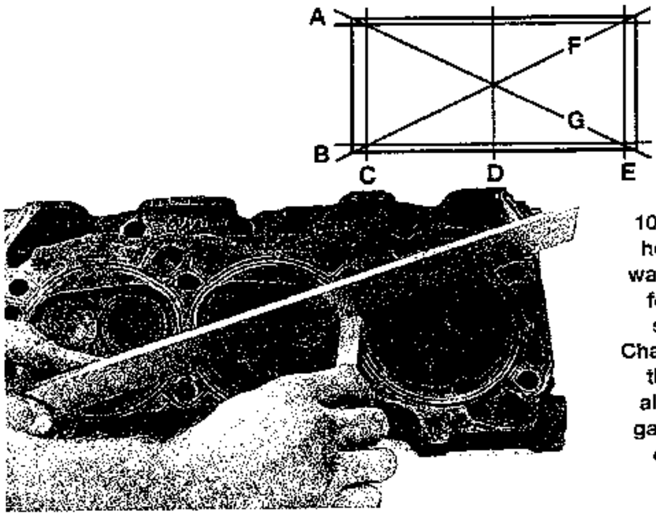
Inspection

Cylinder head

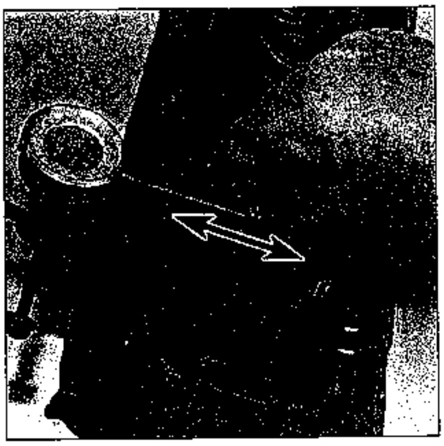
Refer to illustrations 10.12 and 10.14

11 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.

12 Using a precision straightedge and feeler gauge, check the head gasket mating surface for warpage **(see illustration)**. If the warpage exceeds the limit specified in this Chapter's Specifications, it can be resurfaced at an automotive machine shop. Make certain that the head is not machined to a thickness less than that listed in this Chapter's Specifications.



10.12 Check the cylinder head gasket surface for warpage by trying to slip a feeler gauge under the straightedge (see this Chapter's Specifications for the maximum warpage allowed and use a feeler gauge of that thickness) - check straight across and diagonally



10.14 A dial indicator can be used to determine the valve stem-to-guide clearance - move the valve stem as indicated by the arrows

13 Examine the valve seats in each of the combustion chambers. If they are pitted, cracked or burned, the head will require valve service with special equipment that is beyond the scope of most home mechanics, especially from an equipment stand point.

14 Check the valve stem-to-guide clearance by measuring the lateral movement of the valve stem with a dial indicator attached securely to the head **(see illustration)**. The valve must be in the guide and approximately 1 mm off the seat. The total valve stem movement indicated by the gauge needle must be divided by two to obtain the actual clearance. After this is done, if there is still some doubt regarding the condition of the valve guides they should be checked by an automotive machine shop (the cost should be minimal). The guide dimensions can also be checked with a small-hole gauge, which can detect taper in the guide. When using a small-hole gauge or telescoping snap gauge, put the gauge down to the middle portion of the guide (where wear should be minimal) and tighten the gauge. Move the gauge up and down and if the guide isn't worn the feel of the gauge should stay the same all the way. Loose areas indicate wear. If they are worn, they can often be restored at a machine shop or renewed.

Valves

Refer to illustrations 10.15 and 10.16

15 Carefully inspect each valve face for uneven wear, deformation, cracks, pits and burned spots **(see illustration)**. Check the valve stem for scuffing and galling and the neck for cracks. Rotate the valve and check for any obvious indication that it is bent. Look for pits and excessive wear on the end of the stem. The presence of any of these conditions indicates the need for valve service by an automotive machine shop.

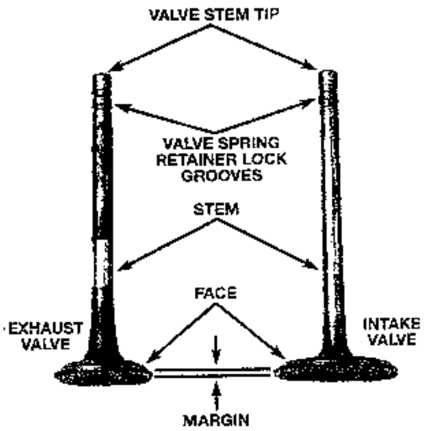
16 Measure the margin width on each valve. Any valve with a margin that is narrower than listed in the Specifications in this Chapter should be discarded and renewed **(see illustration)**.

Valve components

Refer to illustrations 10.17 and 10.18

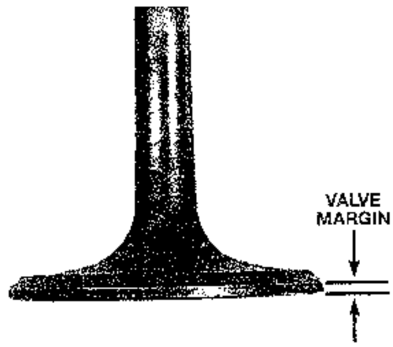
17 Check each valve spring for wear (on the ends) and pits. Measure the free length and compare it to the Specifications in this Chapter **(see illustration)**. Any springs that are shorter than specified have sagged and should not be reused. The tension of all springs should be checked with a special fixture before deciding that they are suitable for use in a rebuilt engine (take the springs to an automotive machine shop for this check).

18 Stand each spring on a flat surface and check it for squareness **(see illustration)**. If any of the springs are distorted or sagged, renew all of them.

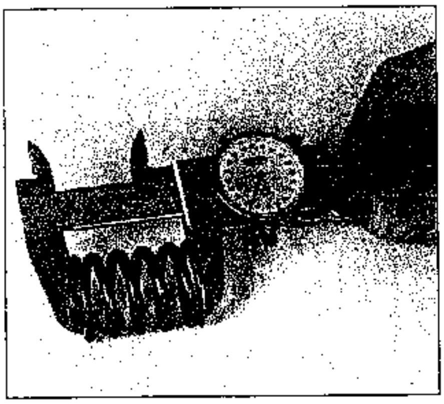


10.15 Check for valve wear at the points shown here

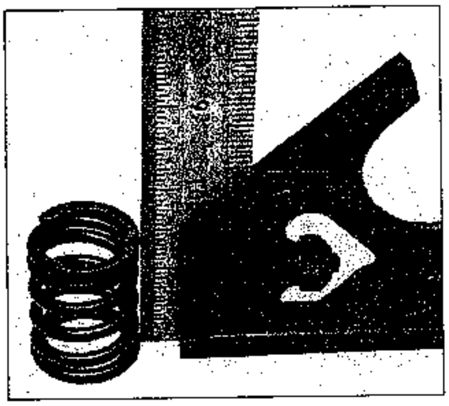
2D



10.16 The margin width on each valve must be as specified (if no margin exists, the valve cannot be reused)

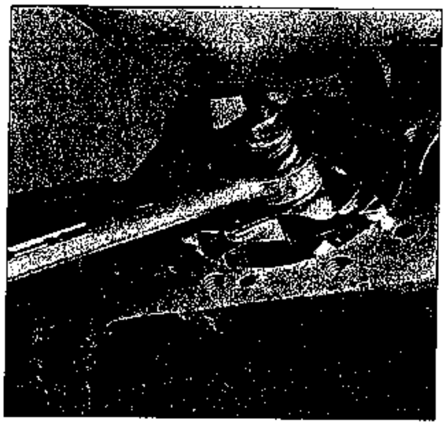


10.17 Measure the free length of each valve spring with a dial or vernier caliper



10.18 Check each valve spring for squareness - if it is bent, it should be renewed

12.8 Valve spring refitted height is the distance from the spring seat to the top of the spring (not including the retainer or rotator)



13.1 A ridge reamer is required to remove the ridge from the top of each cylinder - do this before removing the pistons!

13.3 Check the connecting rod side clearance (endplay) with a feeler gauge as shown here

19 Check the spring retainers and collets for obvious wear and cracks. Any questionable parts should be renewed, as extensive damage will occur if they fail during engine operation.

Rocker arm components

20 Check the rocker arm faces (the areas that contact the pushrod ends and valve stems) for pits, wear, galling, cracks, score marks and rough spots.

21 On 4.2 litre engines, inspect the pushrod ends for scuffing and excessive wear. Roll each pushrod on a flat surface, such as plate glass, to determine if it is bent.

22 Check the rocker shaft bolt holes in the cylinder heads for damaged threads.

23 Any damaged or excessively worn parts must be renewed.

24 If the inspection process indicates that the valve components are in generally poor condition and worn beyond the limits specified in this Chapter, which is usually the case in an engine that is being overhauled, reassemble the valves in the cylinder head and refer to Section 11 for valve servicing recommendations.

11 Valves - servicing

1 Because of the complex nature or the job and the special tools and equipment needed, servicing of the valves, the valve seats and the valve guides (commonly known as a "valve job") is best left to a professional.

2 The home mechanic can remove and disassemble the cylinder heads, do the initial cleaning and inspection, then reassemble and deliver the cylinder heads to a dealer service department or an automotive machine shop for the actual valve servicing.

3 The dealer service department, or automotive machine shop, will remove the valves and springs, recondition or renew the valves and valve seats, recondition the valve guides, check and renew the valve springs, spring retainers or rotators and collets (as necessary), renew the valve seals, reassemble the valve components and make sure the refitted spring height is correct. The cylinder head gasket surface will also be resurfaced if it is warped.

4 After the valve job has been performed by a professional, the head will be in like-new condition. When the head is returned, be sure to clean it again before refitting on the engine to remove any metal particles and abrasive grit that may still be present from the valve service or head resurfacing operations. Use compressed air, if available, to blow out all the oil holes and passages.

12 Cylinder head - reassembly

Refer to illustration 12.8

1 Regardless of whether or not the cylinder heads were sent to an automotive machine shop for valve servicing, make sure they are clean before beginning reassembly.

2 If the cylinder heads were sent out for valve servicing, the valves and related components will already be in place. Begin the reassembly procedure with Step 8.

3 Beginning at one end of the head, lubricate and refit the first valve. Apply moly-base grease or clean engine oil to the valve stem.

4 Different types of valve stem oil seals are used on the intake and exhaust. On some applications, an umbrella type seal which extends down over the valve guide boss is used over the valve stem.

5 Drop the spring seat or shim(s), if used, over the valve guide and set the valve spring and retainer (or rotator) in place.

6 Compress the springs with a valve spring compressor. Position the collets in the upper groove, then slowly release the compressor and make sure the collets seat properly. Apply a small dab of grease to each collet to hold it in place if necessary.

7 Repeat the procedure for the remaining valves. Be sure to return the components to their original locations - do not mix them up!

8 Check the refitted valve spring height with a ruler graduated in fine increments or a dial caliper **(see illustration)**. If the cylinder heads were sent out for service work, the refitted height should be correct (but don't automatically assume that it is). The measurement is taken from the top of each spring seat or shim(s) to the bottom of the retainer/rotator. If the height is greater than listed in this Chapter's Specifications, shims can be added under the springs to correct it. **Caution:** *Do not, under any circumstances, shim the springs to the point where the refitted height is less than specified. A condition called "coil bind" will be caused when the spring is compressed.*

13 Piston/connecting rod assembly - removal

Refer to illustrations 13.1, 13.3, 13.4 and 13.5

Note: *Prior to removing the piston/connecting rod assemblies, remove the cylinder head(s), the sump and the oil pump pickup screen assembly by referring to the appropriate Sections in Chapter 2, Part A, Part B or Part C.*

1 Completely remove the ridge at the top of each cylinder with a ridge reaming tool **(see illustration)**. Follow the manufacturer's instructions provided with the tool. Failure to remove the ridge before attempting to remove the piston/connecting rod assemblies could result in piston breakage.

2 After the cylinder ridges have been removed, turn the engine upside-down so the crankshaft is facing up.

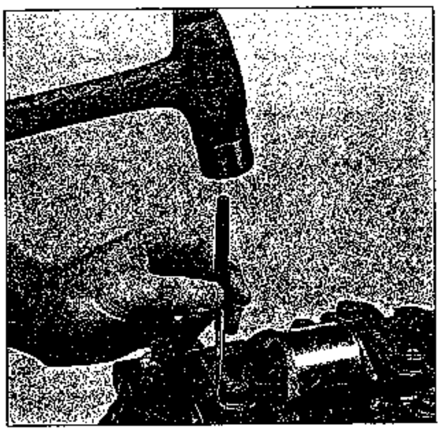
3 Before the connecting rods are removed, check the endplay (side clearance) with a feeler gauge. Slide the feeler gauge between the first connecting rod and the crankshaft throw until the play is removed **(see illustration)**. The endplay is equal to the thickness of the feeler gauge. If the endplay exceeds the service limit listed in this Chapter's Specifications, new connecting rods will

13.4 The connecting rods should be marked with numbers at the parting line of each rod and cap - the number corresponds to the engine cylinder number - on reassembly, be sure the numbers are on the same side, facing each other, as shown

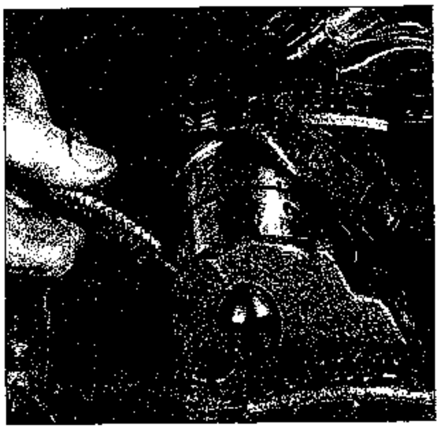
be required. If new rods (or a new crankshaft) are refitted, the endplay may fall under the specified minimum. If it does, the rods will have to be machined to restore it - consult an automotive machine shop for advice if necessary. Repeat the procedure for the remaining connecting rods.

4 Check the connecting rods and caps for identification marks **(see illustration)**. If they are not plainly marked, use a small centre-punch to make the appropriate number of indentations on each rod and cap.

5 Loosen each of the connecting rod cap nuts 1/2-turn at a time until they can be removed by hand. Remove the number one connecting rod cap and bearing insert. Do not drop the bearing insert out of the cap. Slip a short length of plastic or rubber hose over each connecting rod cap bolt to protect



14.4 The 4.2 litre engine main bearing caps are marked to indicate their locations - they should be numbered consecutively from the front of the engine to the rear, and have arrows to indicate which way faces the front of the engine - if they're not marked, mark them with a punch and hammer



13.5 To prevent damage to the crankshaft journals and cylinder walls, slip sections of rubber hose over the rod bolts before removing the piston/rod assemblies

the crankshaft journal and cylinder wall when the piston is removed **(see illustration)**. Push the connecting rod/piston assembly out through the top of the engine. Use a wooden hammer handle to push on the upper bearing insert in the connecting rod. If resistance is felt, double-check to make sure that all of the ridge was removed from the cylinder.

6 Repeat the procedure for the remaining cylinders. After removal, reassemble the connecting rod caps and bearing inserts in their respective connecting rods and refit the cap nuts finger tight. Leaving the old bearing inserts in place until reassembly will help prevent the connecting rod bearing surfaces from being accidentally nicked or gouged.

14 Crankshaft - removal

Refer to illustrations 14.3, 14.4, 14.5a and 14.5b

Note: *The crankshaft can best be removed only after the engine has been removed from the vehicle. It is assumed that the flywheel or driveplate, vibration damper or crankshaft pulley, timing chain, sump and piston/connecting rod assemblies have already been removed.*

1 Before the crankshaft is removed, check the endplay. Mount a dial indicator with the

14.3 Checking crankshaft endplay with a feeler gauge

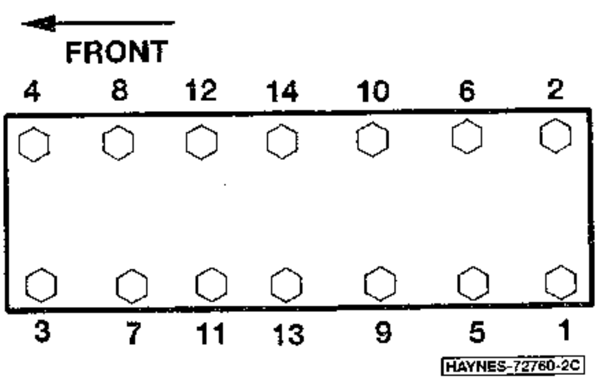
stem in line with the crankshaft and touching one of the crank throws or the end of the crank.

2 Push the crankshaft all the way to the rear and zero the dial indicator. Next, prise the crankshaft to the front as far as possible and check the reading on the dial indicator. The distance that it moves is the endplay. If it is greater than the maximum listed in this Chapter's Specifications, check the crankshaft thrust surfaces for wear. If no wear is evident, new main bearings should correct the endplay.

3 If a dial indicator is not available, a feeler gauge can be used. Gently prise or push the crankshaft all the way to the front of the engine. Slip the feeler gauge between the crankshaft and the front face of the thrust main bearing to determine the clearance **(see illustration)**.

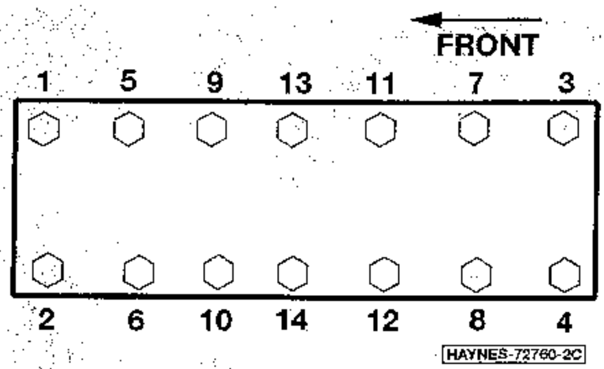
4 Check the main bearing caps (on 4.2 litre engines) to see if they are marked to indicate their locations. They should be numbered consecutively from the front of the engine to the rear. If they aren't, mark them with number stamping dies or a centre-punch **(see illustration)**.

5 On 4.2 litre engines, loosen the main cap bolts in three steps, following the correct sequence **(see illustration)**. On 3.0 litre engines, loosen the main cap bolts in three steps, following the correct sequence **(see illustration)**.



14.5a 4.2 litre engine main bearing cap bolt removal sequence

6 **Note:** *3.0 litre engines use a one-piece main bearing support rather than individual main bearing caps. This manual refers to the caps as being individual ones as on 4.2 litre engines.* On 4.2 litre engines, gently tap the caps with a soft-face hammer, then separate them from the engine block. If necessary, use the bolts as levers to remove the caps. Try not to drop the bearing inserts if they come out with the caps.
7 Carefully lift the crankshaft out of the engine. It is a good idea to have an assistant available, since the crankshaft is quite heavy. With the bearing inserts in place in the engine block and main bearing caps, return the caps to their respective locations on the engine block and tighten the bolts finger tight.

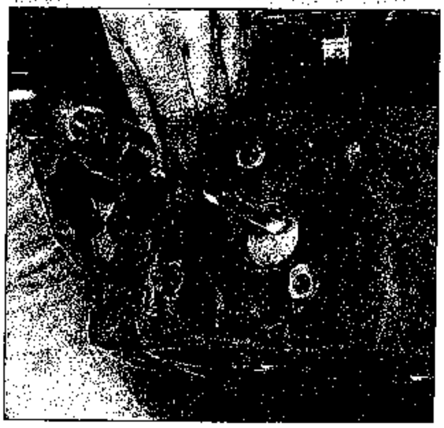


14.5b 3.0 litre engine main bearing cap removal sequence

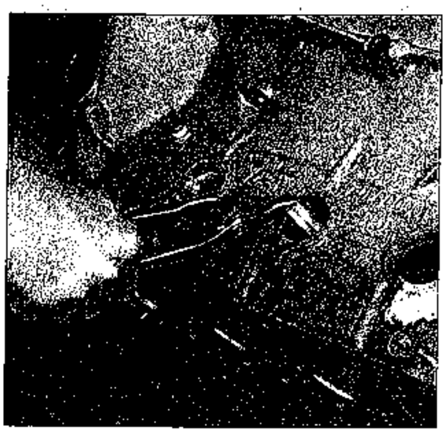
15 Engine block - cleaning

Refer to illustrations 15.1a, 15.1b, 15.8 and 15.10

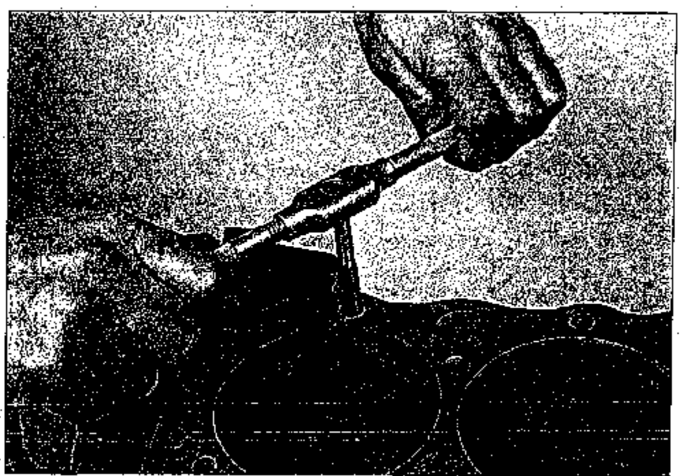
1 Using the wide end of a punch tap in on the outer edge of the core plug to turn the plug sideways in the bore. Then, using a pair of pliers, pull the core plug from the engine block **(see illustrations)**. Don't worry about the condition of the old core plugs as they are being removed because they will be renewed on reassembly with new plugs.
2 Using a gasket scraper, remove all traces of gasket material from the engine block. On diesel engines, remove all six piston-cooling oil jet assemblies. Each jet must be blown out with air and checked for damage. Each jet plug/valve must be cleaned and the small valve tested by pressing in on it with a soft object. If it does not operate smoothly, renew it.
3 Remove the main bearing caps or cap assembly and separate the bearing inserts from the caps and the engine block. Tag the bearings, indicating which cylinder they were removed from and whether they were in the cap or the block, then set them aside.
4 Remove all of the threaded oil gallery plugs from the block. The plugs are usually very tight - they may have to be drilled out and the holes retapped. If drilled out or damaged during removal, use new plugs when the engine is reassembled.
5 If the engine is extremely dirty it should be taken to an automotive machine shop to be steam cleaned or hot tanked.
6 After the block is returned, clean all oil holes and oil galleries one more time. Brushes specifically designed for this purpose are available at most auto parts stores. Flush the passages with warm water until the water runs clear, dry the block thoroughly and wipe all machined surfaces with a light, rust preventive oil. 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!*
7 If the block isn't extremely dirty or sludged up, you can do an adequate cleaning job with hot soapy water and a stiff brush. Take plenty of time and do a thorough job.



15.1a A hammer and a large punch can be used to knock the core plugs sideways in their bores

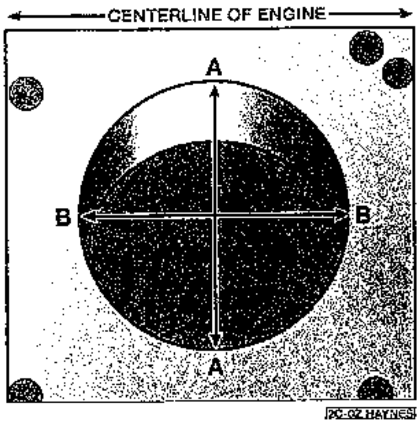


15.1b Pull the core plugs from the block with pliers

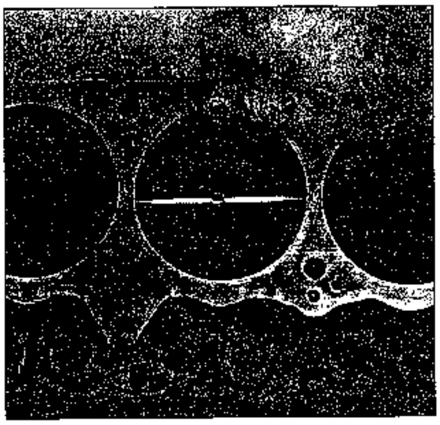


15.8 All bolt holes in the block - particularly the main bearing cap and head bolt holes - should be cleaned and restored with a tap (be sure to remove debris from the holes after this is done)

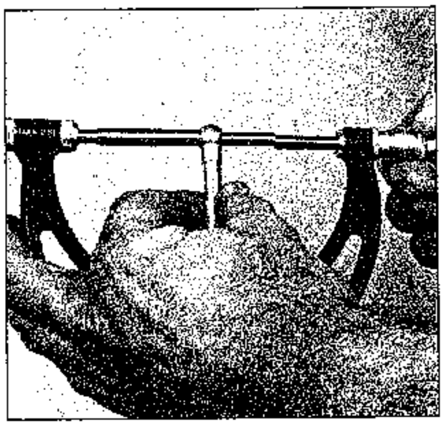
15.10 A large socket on an extension can be used to drive the new core plugs into the bores



16.4a Measure the diameter of each cylinder at a right angle to the engine centreline (A), and parallel to engine centreline (B) - out-of-round is the difference between A and B; taper is the difference between A and B at he top of the cylinder and A and B at the bottom of the cylinder



16.4b Use a telescoping gauge to measure the bore - the ability to "feel" when it is at the correct point will be developed over time, so work slowly and repeat the check until you're satisfied the bore measurement is accurate



16.4c The gauge is then measured with a micrometer to determine the bore size

Regardless of the cleaning method used, be sure to clean all oil holes and galleries very thoroughly, dry the block completely and coat all machined surfaces with light oil.
8 The threaded holes in the block must be clean to ensure accurate torque readings during reassembly. Run the proper size tap into each of the holes to remove rust, corrosion, thread sealant or sludge and restore damaged threads **(see illustration)**. If possible, use compressed air to clear the holes of debris produced by this operation. Now is a good time to clean the threads on the head bolts and the main bearing cap bolts as well.
9 Refit the main bearing caps and tighten the bolts finger tight.
10 After coating the sealing surfaces of the new core plugs with a good sealant, refit them in the engine block **(see illustration)**. Make sure they're driven in straight or leakage could result. Special tools are available for this purpose, but a large socket, with an outside diameter that will just slip into the core plug, a 1/2-inch drive extension and a hammer will work just as well.
11 Apply non-hardening sealant to the new oil gallery plugs and thread them into the holes in the block. Make sure they're tightened securely.
12 If the engine isn't going to be reassembled right away, cover it with a large plastic trash bag to keep it clean.

16 Engine block - inspection

Refer to illustrations 16.4a, 16.4b and 16.4c

1 Before the block is inspected, it should be cleaned (see Section 15).
2 Visually check the block for cracks, rust and corrosion. Look for stripped threads in the threaded holes and make plans to have them repaired as required. It's also a good idea to have the block checked for hidden cracks by an automotive machine shop that has the special equipment to do this type of work. If defects are found, have the block repaired, if possible, or renewed.
3 Check the cylinder bores for scuffing and scoring.
4 Check the cylinders for taper and out-of-round conditions as follows **(see illustrations)**.
5 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.
6 Next measure each cylinder's diameter at the same three locations perpendicular to the crankshaft axis.
7 The taper of the cylinder is the difference between the bore diameter at the top of the cylinder and the diameter at the bottom. The out-of-round specification of the cylinder bore is the difference between the parallel and perpendicular readings. Compare your results to those listed in this Chapter's Specifications.
8 If the cylinder walls are badly scuffed or scored, or if they're out-of-round or tapered beyond the specified limits, have the engine block rebored and honed at an automotive machine shop.
9 If a rebore is done, new pistons and rings will be required.
10 Using a precision straightedge and feeler gauge, check the block deck (the surface that mates with the cylinder head(s) for distortion as you did with the cylinder head(s) **(see illustration 10.12)**. If it's distorted beyond the specified limit, it can be resurfaced by an automotive machine shop.
11 If the cylinders are in reasonably good condition and not worn to the outside of the limits, and if the piston-to-cylinder clearances can be maintained, then they don't have to be rebored. Honing is all that's necessary (see Section 17).

17 Cylinder honing

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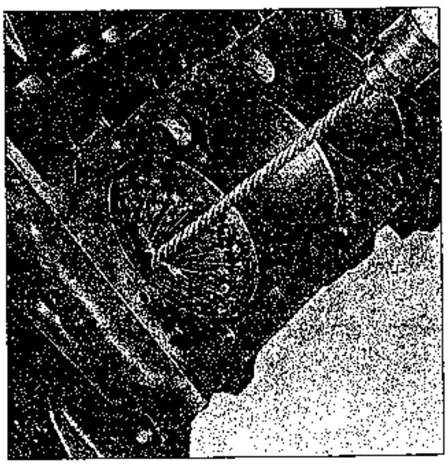
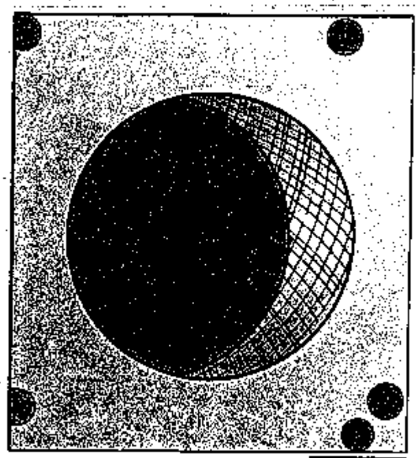
Refer to illustrations 17.3a and 17.3b

1 Prior to engine reassembly, the cylinder bores must be honed so the new piston rings will seat correctly and provide the best possible combustion chamber seal. **Note:** *If you do not have the tools or do not want to tackle the honing operation, most automotive machine shops will do it for a reasonable fee.*
2 Before honing the cylinders, refit the main bearing caps and tighten the bolts to the specified torque.
3 Two types of cylinder hones are commonly available - the flex hone or "bottle brush" type and the more traditional surfacing hone with spring-loaded stones. Both will do the job, but the "bottle brush" hone will be easier to use and will produce a superior finish. You will also need plenty of light oil or honing oil, some rags and an electric drill motor. Proceed as follows:

a) *Mount the hone in the drill motor, compress the stones and slip it into the first cylinder* **(see illustration)**.



17.3a A "bottle brush" hone will produce better results than the spring-loaded stone type



17.3b The cylinder hone should leave a smooth, crosshatch pattern with the lines intersecting at approximately a 60-degree angle

b) *Lubricate the cylinder with plenty of oil, turn on the drill and move the hone up-and-down in the cylinder at a pace which will produce a fine crosshatch pattern on the cylinder walls. Ideally, the crosshatch lines should intersect at approximately a 60-degree angle* **(see illustrations)**. *Be sure to use plenty of lubricant and do not take off any more material than is absolutely necessary to produce the desired finish.* **Note:** *Piston ring manufacturers may specify a smaller crosshatch angle than the traditional 60-degrees, typically 45-degrees, so read and follow any instructions printed on the piston ring packages.*
c) *Do not withdraw the hone from the cylinder while it is running. Instead, shut off the drill and continue moving the hone up-and-down in the cylinder until it comes to a complete stop, then compress the stones and withdraw the hone. If you are using a "bottle brush" type hone, stop the drill motor, then turn the chuck in the normal direction of rotation while withdrawing the hone from the cylinder.*
d) *Wipe the oil out of the cylinder and repeat the procedure for the remaining cylinders.*

4 After the honing job is complete, chamfer the top edges of the cylinder bores with a small file so the rings will not catch when the pistons are refitted. Be very careful not to nick the cylinder walls with the end of the file.
5 The entire engine block must be washed again very thoroughly with warm, soapy water to remove all traces of the abrasive grit produced during the honing operation. **Note:** *The bores can be considered clean when a white cloth - dampened with clean engine oil - used to wipe down the bores does not pick up any more honing residue, which will show up as grey areas on the cloth. Be sure to run a brush through all oil holes and galleries and flush them with running water.*

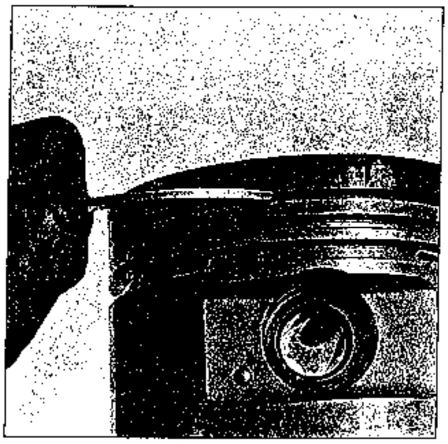
18.4a The piston ring grooves can be cleaned with a special tool, as shown here . . .

6 After rinsing, dry the block and apply a coat of light rust-preventive oil to all machined surfaces. Wrap the block in a plastic trash bag to keep it clean and set it aside until reassembly.

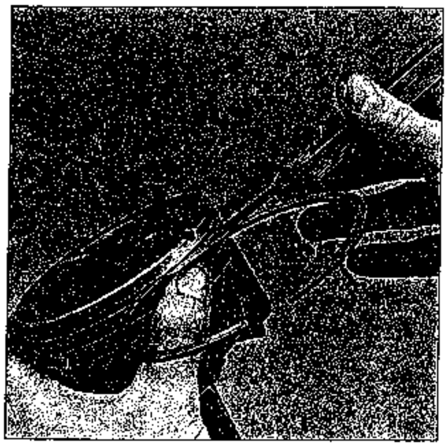
18 Piston/connecting rod assembly - inspection

Refer to illustrations 18.4a, 18.4b, 18.10 and 18.11

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. **Note:** *Always use new piston rings when the engine is reassembled.*
2 Using a piston ring refitting tool, carefully remove the rings from the pistons. Be careful not to nick or gouge the pistons in the process.
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. Do not, under any circumstances, use a wire brush mounted in a drill motor to remove deposits from the pistons. The piston material is soft and may be eroded away by the wire brush.
4 Use a piston ring groove-cleaning tool to remove carbon deposits from the ring grooves. If a tool isn't available, a piece broken off an old ring will do the job. Be very careful to remove only the carbon deposits - don't remove any metal and do not nick or scratch the sides of the ring grooves **(see illustrations)**.
5 Once the deposits have been removed, clean the piston/rod assemblies with solvent and dry them with compressed air (if available). **Warning:** *Wear eye protection when using compressed air!* Make sure the oil return holes in the back sides of the ring grooves and the oil hole in the lower end of each rod are clear.
6 If the pistons and cylinder walls aren't damaged or worn excessively, and if the engine block is not rebored, new pistons won't be necessary. 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, however, should always be used when an engine is rebuilt.

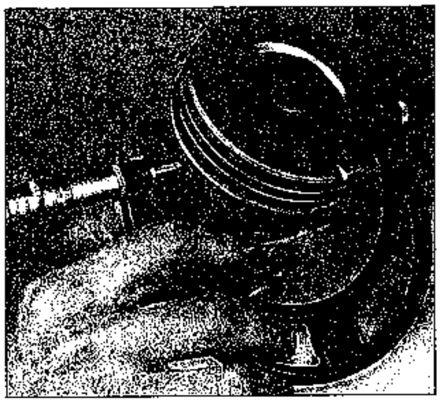


18.4b . . . or a section of a broken ring



18.10 Check the ring side clearance with a feeler gauge at several points around the groove

7 Carefully inspect each piston for cracks around the skirt, at the pin bosses and at the ring lands.
8 Look for scoring and scuffing on the thrust faces of the 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. A hole in the piston crown is an indication that abnormal combustion (preignition) was occurring. Burned areas at the edge of the piston crown are usually evidence of spark knock (detonation). If any of the above problems exist, the causes must be corrected or the damage will occur again. The causes may include intake air leaks, incorrect fuel/air mixture, incorrect ignition timing and EGR system malfunctions.



18.11 Measure the piston at the point listed in the Specifications at the start of this Chapter - the point is different for all three engines

9 Corrosion of the piston, in the form of small pits, indicates that coolant is 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 Measure the piston ring side clearance by laying a new piston ring in each ring groove and slipping a feeler gauge in beside it **(see illustration)**. Check the clearance at three or four locations around each groove. Be sure to use the correct ring for each groove - they are different. If the side clearance is greater than specified, new pistons will have to be used.

11 Check the piston-to-bore clearance by measuring the bore (see Section 16) and the piston diameter. Make sure the pistons and bores are correctly matched. Measure the piston across the skirt, at a 90-degree angle to the piston pin, at the point listed in the Specifications in this Chapter **(see illustration)**. Subtract the piston diameter from the bore diameter to obtain the clearance. If it's greater than specified, the block will have to be rebored and new pistons and rings refitted.

12 Check the piston-to-rod clearance by twisting the piston and rod in opposite directions. Any noticeable play indicates excessive wear, which must be corrected. The piston/connecting rod assemblies should be taken to an automotive machine shop to have the pistons and rods re-sized and new pins refitted.

13 If the pistons must be removed from the connecting rods for any reason, they should be taken to an automotive machine shop. While they are there, have the connecting rods checked for bend and twist, since automotive machine shops have special equipment for this purpose. They must also be checked for size at the big end. **Note:** *Unless new pistons and/or connecting rods must be refitted, do not disassemble the pistons and connecting rods.*

14 Check the connecting rods for cracks and other damage. Temporarily remove the rod caps, lift out the old bearing inserts, wipe the rod and cap bearing surfaces clean and inspect them for nicks, gouges and scratches.

19.1 The oil holes should be chamfered so sharp edges don't gouge or scratch the new bearings

After checking the rods, renew the old bearings, slip the caps into place and tighten the nuts finger tight. **Note:** *If the engine is being rebuilt because of a connecting rod knock, be sure to check with an automotive machine shop on the possibility of re-sizing the rods. If this isn't possible, refit new rods.*

19 Crankshaft - inspection

Refer to illustrations 19.1, 19.2, 19.5 and 19.7

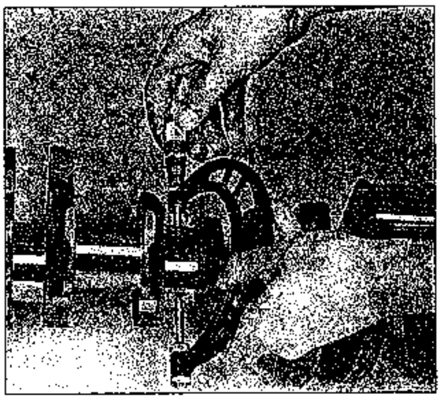
1 Remove all burrs from the crankshaft oil holes with a stone, file or scraper **(see illustration)**.

2 Clean the crankshaft with solvent and dry it with compressed air (if available). Be sure to clean the oil holes with a stiff brush and flush them with solvent **(see illustration)**.

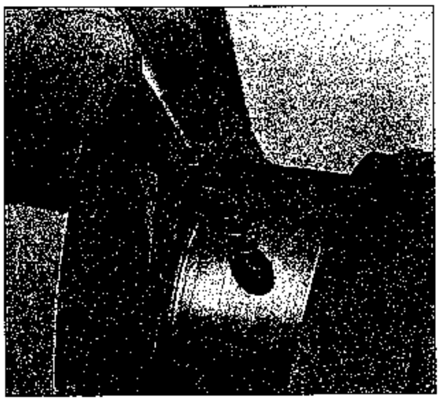
3 Check the main and connecting rod bearing journals for uneven wear, scoring, pits and cracks.

4 Check the rest of the crankshaft for cracks and other damage. It should be magnafluxed to reveal hidden cracks - an automotive machine shop will handle the procedure.

5 Using a micrometer, measure the diameter of the main and connecting rod journals and compare the results to the Specifications **(see illustration)**. By measuring the diameter at a number of points around each journal's circumference, you'll be able to determine whether or not the journal is out-of-round. Take the measurement at each end of the journal, near the crank throws, to determine if the journal is tapered. Crankshaft runout should be checked also, but large V-blocks and a dial indicator are needed to do it correctly. If you don't have the equipment, have a machine shop check the runout.



19.5 Measure the diameter of each crankshaft journal at several points to detect taper and out-of-round conditions



19.2 Use a wire or stiff plastic bristle brush to clean the oil passages in the crankshaft - flush the passages out with solvent

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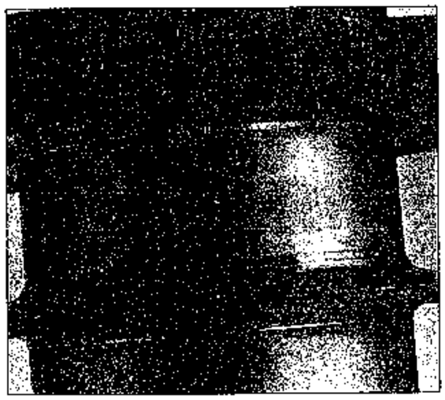
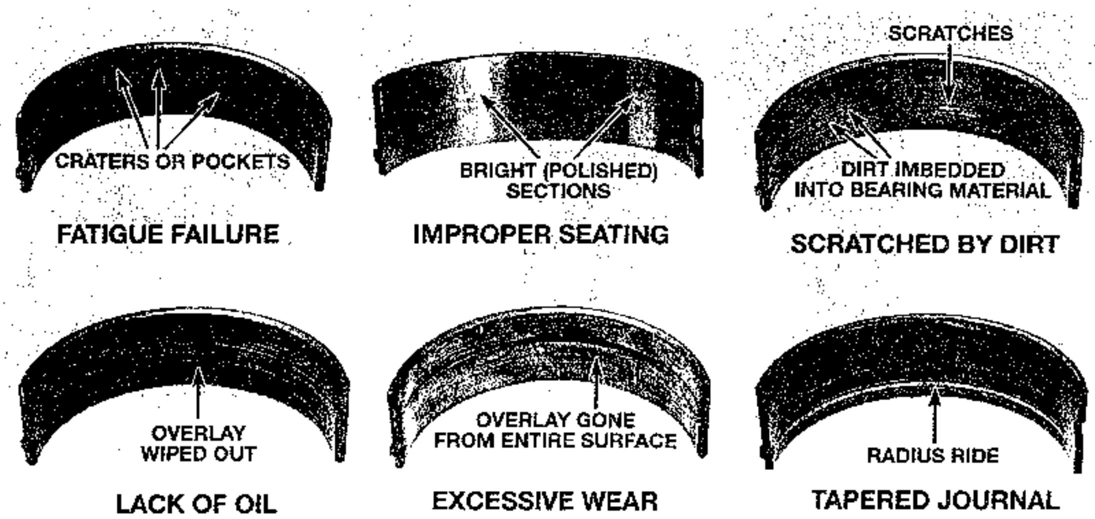
6 If the crankshaft journals are damaged, tapered, out-of-round or worn beyond the limits given in the Specifications, have the crankshaft reground by an automotive machine shop. Be sure to use the correct size bearing inserts if the crankshaft is reconditioned.

7 Check the oil seal journal at the rear of the crankshaft for wear and damage. If the seal has worn a groove in the journal, or if it's nicked or scratched, the new seal may leak when the engine is reassembled. In some cases, an automotive machine shop may be able to repair the journal by pressing on a thin sleeve. If repair isn't feasible, a new or different crankshaft should be refitted **(see illustration)**.

8 Examine the main and rod bearing inserts (see Section 20).



19.7 If the seals have worn grooves in the crankshaft journals, or if the seal contact surfaces are nicked or scratched, the new seals will leak



20.1 Before discarding the used bearings, examine them for indications of any possible problems with the crankshaft, noting the bearing location it came from. Here are some typical bearing failures

20 Main and connecting rod bearings - inspection and selection

Inspection

Refer to illustration 20.1

1 Even though the main and connecting rod bearings should be renewed during the engine overhaul, the old bearings should be retained for close examination, as they may reveal valuable information about the condition of the engine **(see illustration)**.

2 Bearing failure occurs because of lack of lubrication, the presence of dirt or other foreign particles, overloading the engine and corrosion. Regardless of the cause of bearing failure, it must be corrected before the engine is reassembled to prevent it from happening again.

3 When examining the bearings, remove them from the engine block, the main bearing caps, the connecting rods and the rod caps and 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.

4 Dirt and other foreign particles get 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 PCV 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 bearing and will score or gouge the bearing and journal. The best prevention for this cause of bearing failure is to clean all parts thoroughly and keep everything spotlessly clean during engine assembly. Frequent and regular engine oil and filter changes are also recommended.

5 Lack of lubrication (or lubrication breakdown) has a number of interrelated causes. Excessive heat (which thins the oil), overloading (which squeezes the oil from the bearing face) and oil leakage or throw-off (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 oil starve a bearing and destroy it. When lack of lubrication is the cause of bearing failure, the bearing material is wiped or extruded from the steel backing of the bearing. 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. Low speed operation in too high a gear (lugging the engine) puts very high loads on bearings, which tends to squeeze out the oil film. These loads cause the bearings 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. Short trip driving leads to corrosion of bearings because insufficient engine heat is produced to drive off the 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.

7 Incorrect bearing refitting during engine assembly will lead to bearing failure as well. Tight fitting bearings leave insufficient bearing oil clearance and will result in oil starvation. Dirt or foreign particles trapped behind a bearing insert result in high spots on the bearing which lead to failure.

Selection

8 If a new or original crankshaft is refitted, the size of each journal should be indicated by a colour coded mark on the adjacent counterweight cheek, toward the rear end of the crankshaft. The bearing inserts are colour coded on the edge of the insert. The accompanying charts should be consulted to determine the correct bearings. **Caution:** *Always check the bearing oil clearance with Plastigage during final refitting of the crankshaft and piston/connecting rod assemblies.*

9 If necessary to achieve the desired oil clearance, different size upper and lower bearing inserts may be used on the same journal, but the size difference must never exceed 0.025 mm. **Caution:** *The odd size inserts, if used, must all be placed in the same locations - i.e. all in the caps or all in the block/rod.*

10 If a reground crankshaft is used, the automotive machine shop or parts store will supply the correct size bearing inserts.

11 Remember, the oil clearance is the final judge when selecting new bearing sizes for either main or rod bearings. If you have any questions or are unsure which bearings to use, get help from a dealer parts or service department or other parts supplier. **Note:** *Some engines have factory oversized or undersized components, see Section 16.*

21 Engine overhaul - reassembly sequence

1 Before beginning engine reassembly, make sure you have all the necessary new parts, gaskets and seals as well as the following items on hand:

Common hand tools
A torque wrench
Piston ring refitting tool
Piston ring compressor
Short lengths of rubber or plastic hose to fit over connecting rod bolts
Plastigage
Feeler gauges
A fine-tooth file
New engine oil
Engine assembly lube or moly-base grease
Gasket sealant
Thread locking compound

22.3 When checking piston ring end gap, the ring must be square in the cylinder bore (this is done by pushing the ring down with the top of a piston as shown)

2 In order to save time and avoid problems, engine reassembly must be done in the following general order:

Piston rings
Crankshaft and main bearings
Rear main oil seal
Piston/connecting rod assemblies
Camshaft
Oil pump
Timing chain and gears
Lifters
Cylinder head, pushrods (if used) and rocker arms
Oil pick-up tube
Sump
Valve cover
Intake and exhaust manifolds
Flywheel/driveplate

22 Piston rings - refitting

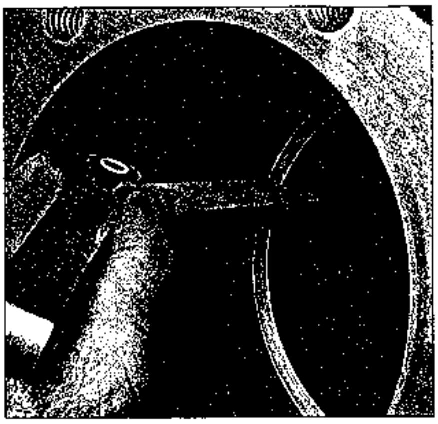
Refer to illustrations 22.3, 22.4, 22.5, 22.10a, 22.10b and 22.13

1 Before refitting the new piston rings, the ring end gaps must be checked. It's assumed that the piston ring side clearance has been checked and verified correct (see Section 22).

2 Lay out the piston/connecting rod assemblies and the new ring sets so the ring sets will be matched with the same piston and cylinder during the end gap measurement and engine assembly.

3 Insert the top (number one) ring into the first cylinder and square it up with the cylinder walls by pushing it in with the top of the piston **(see illustration)**. The ring should be near the bottom of the cylinder, at the lower limit of ring travel.

4 To measure the end gap, slip feeler gauges between the ends of the ring until a gauge equal to the gap width is found **(see illustration)**. The feeler gauge should slide between the ring ends with a slight amount of drag. Compare the measurement to this Chapter's Specifications. If the gap is larger



22.4 With the ring square in the cylinder, measure the ring end gap with a feeler gauge

or smaller than specified, double-check to make sure you have the correct rings before proceeding.

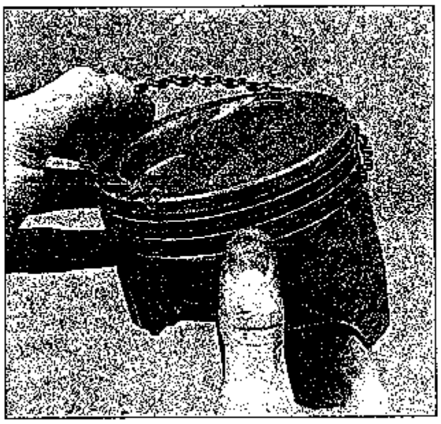
5 If the gap is too small, it must be enlarged or the ring ends may come in contact with each other during engine operation, which can cause serious damage to the engine. The end gap can be increased by filing the ring ends very carefully with a fine file. Mount the file in a vice equipped with soft 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 **(see illustration)**. **Caution:** *When performing this operation, file only from the outside in.*

6 Excess end gap is not critical unless it is greater than that listed in the Specifications in this Chapter. Again, double-check to make sure you have the correct rings for your engine.

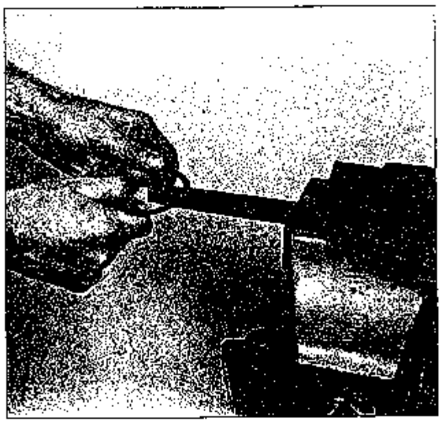
7 Repeat the procedure for the rest of the rings. Remember to keep rings, pistons and cylinders matched up.

8 Repeat the procedure for each ring that will be refitted in the first cylinder and for each ring in the remaining cylinders. Remember to keep rings, pistons and cylinders matched up.

9 Once the ring end gaps have been



22.10a Refitting the spacer/expander in the oil control ring groove . . .



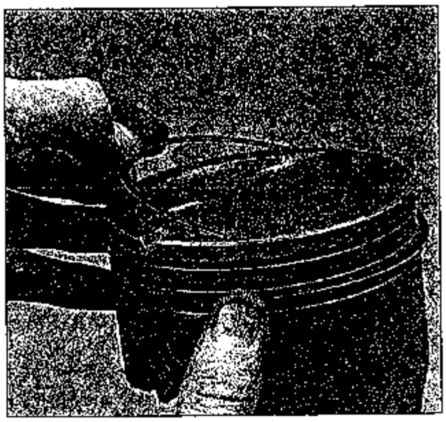
22.5 If the end gap is slightly too small, clamp a file in a vice and file the ring ends by pushing the ring over the file toward the vice - after filing to correct size, deburr the ring ends with fine emery cloth or a whetstone

checked/corrected, the rings can be refitted on the pistons.

10 The oil control ring (lowest one on the piston) is usually refitted first. It's composed of three separate components. Slip the spacer/expander into the groove **(see illustration)**. If an anti-rotation tang is used, make sure it's inserted into the drilled hole in the ring groove. Next, refit the lower side rail. Don't use a piston ring refitting tool on the oil ring side rails, as they may be damaged. Instead, place one end of the side rail into the groove between the spacer/expander and the ring land, hold it firmly in place and slide a finger around the piston while pushing the rail into the groove **(see illustration)**. Next, refit the upper side rail in the same manner.

11 After the three oil ring components have been refitted, check to make sure that both the upper and lower side rails can be turned smoothly in the ring groove.

12 The number two (middle) ring is refitted next. It's usually stamped with a mark which must face up, toward the top of the piston. **Note:** *Always follow the instructions printed on the ring package or box - different manu-*



22.10b . . . followed by the side rails - DO NOT use a piston ring refitting tool when refitting the oil ring side rails

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facturers may require different approaches. Do not mix up the top and middle rings, as they have different cross sections.

13 Use a piston ring refitting tool and make sure the identification mark is facing the top of the piston, then slip the ring into the middle groove on the piston. Don't expand the ring any more than necessary to slide it over the piston **(see illustration)**.

14 Refit the number one (top) ring in the same manner. Make sure the mark is facing up. Be careful not to confuse the number one and number two rings.

15 Repeat the procedure for the remaining pistons and rings.

22.13 Refitting the compression rings with a ring expander - the mark (arrow) must face up

23.10 Lay the Plastigage strips on the main bearing journals, parallel to the crankshaft centreline

23 Crankshaft - refitting and main bearing oil clearance check

1 Crankshaft refitting is the first major step in engine reassembly. It's assumed at this point that the engine block and crankshaft have been cleaned, inspected and repaired or reconditioned.

2 Position the engine with the bottom facing up.

3 Remove the main bearing cap bolts and lift out the caps. Lay the caps out in the proper order to ensure correct refitting.

4 If they're still in place, remove the old bearing inserts from the block and the main bearing caps. Wipe the main bearing surfaces of the block and caps with a clean, lint-free cloth. They must be kept spotlessly clean!

Main bearing oil clearance check

Refer to illustrations 23.10, 23.12a, 23.12b, and 23.14

5 Clean the back sides of the new main bearing inserts and lay the bearing half with the oil groove and hole in each main bearing saddle in the block (on all engines covered by this manual, the bearings with oil holes go in the block and those without oil holes go in the caps). Lay the other bearing half from each bearing set in the corresponding main bearing cap. Make sure the tab on each bearing insert fits into the recess in the block or cap. Also, the oil holes in the block must line up with the oil holes in the bearing insert.

Caution: *Do not hammer the bearings into place and don't nick or gouge the bearing faces. No lubrication should be used at this time.*

6 The thrust bearings must be refitted in the correct position.

7 Clean the faces of the bearings 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.

8 Once you're certain the crankshaft is clean, carefully lay it in position in the main bearings. No lubricant should be used at this time.

9 Before the crankshaft can be permanently refitted, the main bearing oil clearance must be checked.

10 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 journal axis **(see illustration)**.

11 Clean the faces of the bearings in the caps and refit the caps in their respective positions (don't mix them up) with the arrows pointing toward the front of the engine. Don't disturb the Plastigage. Apply a light coat of oil to the bolt threads and the under sides of the bolt heads, then refit them.

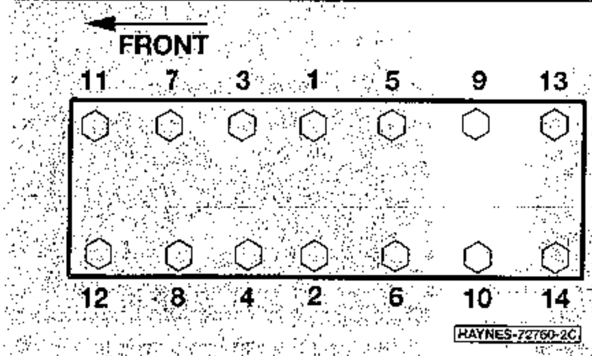
12 On 4.2 litre engines tighten the main bearing cap in three steps, working in the correct sequence with each step **(see illustration)**. Don't rotate the crankshaft at any time during this operation! On 3.0 litre engines tighten the main bearing cap in three steps, working in the correct sequence with each step **(see illustration)**

13 Remove the bolts and carefully lift off the main bearing caps. Keep them in order. Don't disturb the Plastigage or rotate the crankshaft. If any of the main bearing caps are difficult to remove, tap them gently from side-to-side with a soft-face hammer to loosen them.

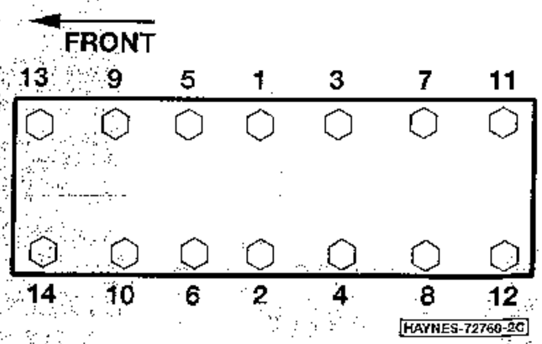
14 Compare the width of the crushed Plastigage on each journal to the scale printed on the Plastigage envelope to obtain the main bearing oil clearance **(see illustration)**. Check the Specifications to make sure it's correct.

15 If the clearance is not as specified, the bearing inserts may be the wrong size which means different ones will be required. Before deciding that different inserts are needed, make sure that no dirt or oil was between the bearing inserts 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 (see Section 20).

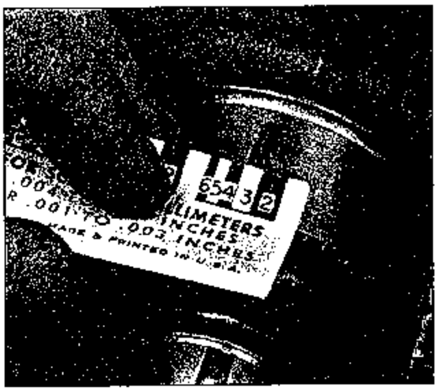
16 Carefully scrape all traces of the Plastigage material off the main bearing journals and/or the bearing faces. Don't nick or scratch the bearing faces.



23.12a 4.2 litre engine main bearing cap bolt tightening sequence



23.12b 3.0 litre engine main bearing cap bolt tightening sequence



23.14 Compare the width of the crushed Plastigage to the scale on the envelope to determine the main bearing oil clearance (always take the measurement at the widest point of the Plastigage); be sure to use the correct scale - standard and metric ones are included

Final crankshaft refitting

17 Carefully lift the crankshaft out of the engine. Clean the bearing faces in the block, then apply a thin, uniform layer of clean moly-base grease or engine assembly lube to each of the bearing surfaces. Coat the thrust washers as well.

18 Lubricate the crankshaft surfaces that contact the oil seals with moly-base grease, engine assembly lube or clean engine oil.

19 Make sure the crankshaft journals are clean, then lay the crankshaft back in place in the block. Clean the faces of the bearings in the caps or cap assembly, then apply the same lubricant to them. Refit the caps in their respective positions with the arrows pointing toward the front of the engine.

20 Apply a light coat of oil to the bolt threads and the under sides of the bolt heads, then refit them. Tap the ends of the crankshaft forward and backward with a lead or brass hammer to line up the thrust bearings and crankshaft surfaces. Tighten all main bearing cap bolts to the specified torque, following the recommended sequence.

21 Rotate the crankshaft a number of times by hand to check for any obvious binding.

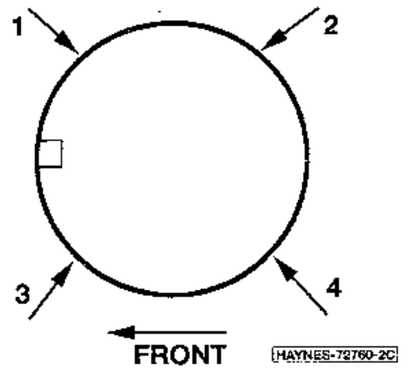
22 Check the crankshaft endplay with a feeler gauge or a dial indicator (see Section 19). The endplay should be correct if the crankshaft thrust faces aren't worn or damaged and new bearings have been refitted.

24 Pistons/connecting rods - refitting and rod bearing oil clearance check

Refer to illustrations 24.5a, 24.5b, 24.9, 24.11, 24.13, 24.17 and 24.31

1 Before refitting the piston/connecting rod assemblies, the cylinder walls must be perfectly clean, the top edge of each cylinder must be chamfered, and the crankshaft must be in place.

2 Remove the cap from the end of the number one connecting rod (refer to the marks made during removal). Remove the original bearing inserts and wipe the bearing surfaces of the connecting rod and cap with a clean, lint-free cloth. They must be kept spotlessly clean.



24.5a Piston ring spacing for 3.0 litre and 4.2 litre petrol engines

1 *Oil ring expander*
2 *Top ring and oil ring upper rail*
3 *Second ring*
4 *Oil ring lower rail*

Connecting rod bearing oil clearance check

3 Clean the back side of the new upper bearing insert, then lay it in place in the connecting rod. Make sure the tab on the bearing fits into the recess in the rod so the oil holes align. Don't hammer the bearing insert into place and be very careful not to nick or gouge the bearing face. Don't lubricate the bearing at this time.

4 Clean the back side of the other bearing insert and refit it in the rod cap. Again, make sure the tab on the bearing fits into the recess in the cap, and don't apply any lubricant. It's critically important that the mating surfaces of the bearing and connecting rod are perfectly clean and oil free when they're assembled.

5 Position the piston ring gaps at the proper spacing around the piston **(see illustrations)**.

6 Slip a section of plastic or rubber hose over each connecting rod cap bolt **(see illustration 13.5)**.

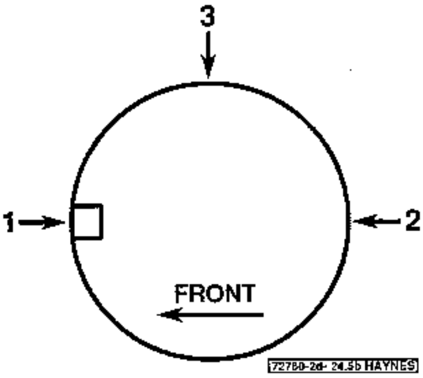
7 Lightly lubricate the piston and rings with clean engine oil and attach a piston ring compressor to the piston. Leave the skirt protruding about 6 mm to guide the piston into the cylinder. The rings must be compressed until they're flush with the piston.

8 Rotate the crankshaft until the number one connecting rod journal is at BDC (bottom dead centre) and apply a light coat of engine oil to the cylinder walls.

9 With the mark on top of the piston **(see illustration)** facing the front (timing chain end) of the engine, gently insert the piston/connecting rod assembly into the number one cylinder bore and rest the bottom edge of the ring compressor on the engine block.

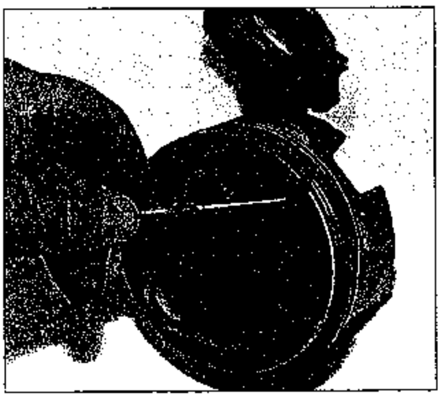
10 Tap the top edge of the ring compressor to make sure it's contacting the block around its entire circumference.

11 Gently tap on the top of the piston with the end of a wooden or plastic hammer handle **(see illustration)** while guiding the end of

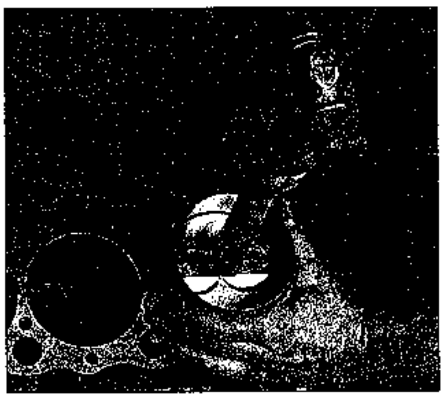


24.5b Piston ring gap spacing for the 4.2 litre diesel engine

1 *Top ring and upper oil ring gaps*
2 *Second ring and lower oil ring gaps*
3 *Oil ring expander gap*



24.9 When refitted, the arrow or notch on the piston must face the front of the engine



24.11 The piston can be driven gently into the cylinder bore with the end of a wooden or plastic hammer handle the connecting rod into place on the crankshaft journal. 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's hanging up 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.

12 Once the piston/connecting rod assembly is refitted, the connecting rod bearing oil clearance must be checked before the rod cap is permanently bolted in place.

13 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 number one connecting rod journal, parallel with the journal axis **(see illustration)**.

14 Clean the connecting rod cap bearing face, remove the protective hoses from the connecting rod bolts and refit the rod cap. Make sure the mating mark on the cap is on the same side as the mark on the connecting rod. Check the cap to make sure the front mark is facing the timing chain end of the engine.

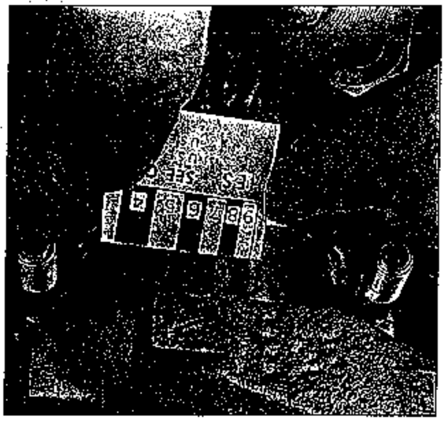
15 Apply a light coat of oil to the undersides of the nuts, then refit and tighten them to the torque listed in this Chapter's Specifications. Use a thin-wall socket to avoid erroneous torque readings that can result if the socket is wedged between the rod cap and nut. If the socket tends to wedge itself between the nut and the cap, lift up on it slightly until it no longer contacts the cap. Do not rotate the crankshaft at any time during this operation.

16 Remove the nuts and detach the rod cap, being very careful not to disturb the Plastigage.

17 Compare the width of the crushed Plastigage to the scale printed on the Plastigage envelope to obtain the oil clearance **(see illustration)**. Compare it to the Specifications to make sure the clearance is correct.

18 If the clearance is not as specified, the bearing inserts may be the wrong size (which means different ones will be required). Before deciding that different inserts are needed, make sure that no dirt or oil was between the bearing inserts and the connecting rod or cap when the clearance was measured. Also, recheck the journal diameter. If the Plastigage was wider at one end than the other, the journal may be tapered (see Section 20).

24.13 Lay the Plastigage strips on each rod bearing journal, parallel to the crankshaft centreline



24.17 Measuring the width of the crushed Plastigage to determine the rod bearing oil clearance (be sure to use the correct scale - standard and metric ones are included)

Final connecting rod refitting

19 Carefully scrape all traces of the Plastigage material off the rod journal and/or bearing face. Be very careful not to scratch the bearing - use your fingernail or the edge of a credit card.

20 Make sure the bearing faces are perfectly clean, then apply a uniform layer of clean moly-base grease or engine assembly lube to both of them. You'll have to push the piston into the cylinder to expose the face of the bearing insert in the connecting rod - be sure to slip the protective hoses over the rod bolts first.

21 Slide the connecting rod back into place on the journal, remove the protective hoses from the rod cap bolts, refit the rod cap and tighten the nuts to the torque listed in this Chapter's Specifications.

22 Repeat the entire procedure for the remaining pistons/connecting rods.

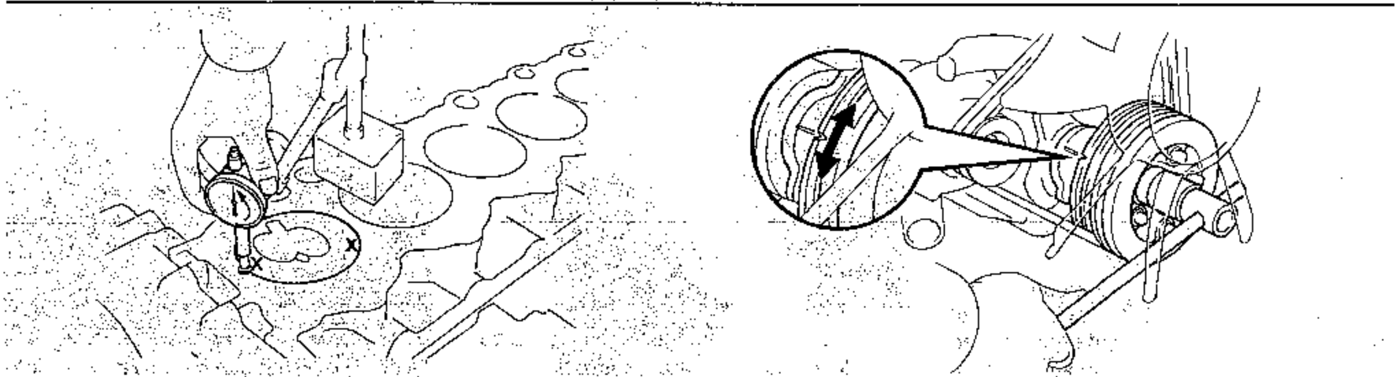
23 The important points to remember are:

a) *Keep the back sides of the bearing inserts and the insides 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/notch on the piston must face the front (timing chain end) of the engine.*
d) *Lubricate the cylinder walls with clean engine oil.*
e) *Lubricate the bearing faces when refitting the rod caps after the oil clearance has been checked.*

24 After all the piston/connecting rod assemblies have been properly refitted, rotate the crankshaft a number of times by hand to check for any obvious binding. **Note:** *On diesel engines, the small swirl chambers on the piston crowns must face the right (injection pump) side of the engine. The connecting rod numbers must be on the opposite side.*

25 As a final step, the connecting rod side clearance (endplay) must be checked (see Section 13).

26 Compare the measured side clearance to the Specifications to make sure it's correct. If it was correct before disassembly and the original crankshaft and rods were refitted, it should still be right. If new rods or a new crankshaft were refitted, the side clearance may be inadequate. If so, the rods will have to be removed and taken to an automotive



24.31 Install the dial indicator and check piston protrusion at the spots marked with an "X"

machine shop for re-sizing.
27 The rest of the assembly procedure is the reverse of the removal procedure.

Diesel piston protrusion measurement

28 It is critical on diesel engines to measure the piston protrusion (the distance that the crown of the piston rises above the top of the cylinder block when the piston is at top dead centre. This measurement is required to select a head gasket of the correct thickness. To do this, the short block must first be assembled with all six pistons/rods.
29 Obtain a dial indicator and a solid (non-adjustable) stand (sometimes called a bridge if it spans the cylinder bore).
30 Place the apparatus on the cylinder block deck and zero the dial indicator.
31 Now position the plunger of the indicator directly over one of the proper areas of the number one piston indicated **(see illustration)**.
32 Slowly rotate the crankshaft while observing the dial indicator. As the piston rises and begins to exit the top of the cylinder, the dial indicator will begin to move. At the point that the needle slows and then stops and begins to reverse, stop turning the engine. This is TDC for that cylinder.
33 Make a note of the dial indicator reading. The difference between this reading and the reading you took from the deck surface is the piston protrusion. Make several measurements in the proper areas of the piston and average the readings.
34 Perform this procedure for all six pistons. The largest protrusion will be used by your parts supplier to select the correct head gasket.

25 Initial start-up and break-in after overhaul

Warning: *Have a fire extinguisher handy when starting the engine for the first time.*
1 Once the engine has been refitted in the vehicle, double-check the engine oil and coolant levels.
2 Start the engine. It may take a few moments for the petrol to reach the carburettor on models without fuel injection but the engine should start without a great deal of effort.
3 After the engine starts, it should be allowed to warm up to normal operating temperature. While the engine is warming up, make a thorough check for oil and coolant leaks.
4 Shut the engine off and recheck the engine oil and coolant levels.
5 Drive the vehicle to an area with no traffic, accelerate from 50 to 70 kph, then allow the vehicle to slow to 50 kph with the throttle closed. Repeat the procedure 10 or 12 times. This will load the piston rings and cause them to seat properly against the cylinder walls. Check again for oil and coolant leaks.
6 Drive the vehicle gently for the first 1,000 km (no sustained high speeds) and keep a constant check on the oil level. It is not unusual for an engine to use oil during the break-in period.
7 At approximately 1,000 km, change the oil and filter.
8 For the next few hundred kilometres, drive the vehicle normally. Do not pamper it or abuse it.
9 After 4,000 kilometres, change the oil and filter again and consider the engine fully broken in.

Notes

Chapter 3 Cooling, heating and air conditioning systems

Contents

3

Specifications

General

Radiator cap pressure rating	78 to 98 kPa
Thermostat rating	
3.0 litre	
Start to open	76 degrees C
Fully open	90 degrees C
4.2 litre	
Start to open	82 degrees C
Fully open	95 degrees C
A/C refrigerant type*	
Early systems	R-12
Later systems	R-134a

*Consult engine compartment decal

Torque specifications

	Nm
Fan bolts	
3.0 litre	7 to 8
4.2 litre	9 to 11
Fan clutch nuts	
3.0 litre	7 to 8
4.2 litre	9 to 11
Radiator bolts	4 to 5

Torque specifications (continued)

	Nm
Thermostat housing bolts	
3.0 liter	16 to 21
4.2 litre	21 to 26
Water pump-to-block bolts and nuts	
3.0 litre engine	
6 mm bolts	7 to 8
8 mm bolts	16 to 21
10 mm bolts	30 to 40
4.2 litre engine	
Bolts	16 to 19
Nuts	30 to 40

1 General information

Engine cooling system

All vehicles covered by this manual employ a pressurized engine cooling system with thermostatically controlled coolant circulation. An impeller type water pump mounted on the front of the block pumps coolant through the engine. The coolant flows around each cylinder and toward the rear of the engine. Cast-in coolant passages direct coolant around the intake and exhaust ports, near the spark plug areas and in proximity to the exhaust valve guides.

A wax-pellet type thermostat is located in the thermostat housing at the front of the engine. During warm up, the closed thermostat prevents coolant from circulating through the radiator. When the engine reaches normal operating temperature, the thermostat opens and allows hot coolant to travel through the radiator, where it is cooled before returning to the engine.

The cooling system is sealed by a pressure-type radiator cap. This raises the boiling point of the coolant, and the higher boiling point of the coolant increases the cooling efficiency of the radiator. If the system pressure exceeds the cap pressure-relief value, the excess pressure in the system forces the spring-loaded valve inside the cap off its seat and allows the coolant to escape through the overflow tube into a coolant reservoir. When the system cools, the excess coolant is automatically drawn from the reservoir back into the radiator.

The coolant reservoir serves as both the point at which fresh coolant is added to the cooling system to maintain the proper fluid level and as a holding tank for overheated coolant.

This type of cooling system is known as a closed design because coolant that escapes past the pressure cap is saved and reused.

Heating system

The heating system consists of a blower fan and heater core located within the heater box under the dashboard, the inlet and outlet hoses connecting the heater core to the engine cooling system and the heater/air conditioning control head on the dashboard. Hot engine coolant is circulated through the heater core. When the heater mode is activated, a flap door opens to expose the heater box to the passenger compartment. A fan switch on the control head activates the blower motor, which forces air through the core, heating the air.

Air conditioning system

The air conditioning system consists of a condenser mounted in front of the radiator, an evaporator mounted adjacent to the heater core, a compressor mounted on the engine, a filter-drier which contains a high pressure relief valve and the plumbing connecting all of the above.

A blower fan forces the warmer air of the passenger compartment through the evaporator core (sort of a radiator-in-reverse), transferring the heat from the air to the refrigerant. The liquid refrigerant boils off into low pressure vapour, taking the heat with it when it leaves the evaporator. The compressor keeps refrigerant circulating through the system, pumping the warmed coolant through the condenser where it is cooled and then circulated back to the evaporator.

Some models are equipped with a rear air conditioner which uses its own evaporator core.

2 Antifreeze - general information

Refer to illustration 2.4

Warning: *Do not allow antifreeze to come in contact with your skin or painted surfaces of the vehicle. Rinse off spills immediately with plenty of water. Antifreeze is highly toxic if ingested. Never leave antifreeze lying around in an open container or in puddles on the floor; children and pets are attracted by it's sweet smell and may drink it. Check with local authorities about disposing of used antifreeze. Many communities have collection centres which will see that antifreeze is disposed of safely. Never dump used antifreeze on the ground or into drains.*

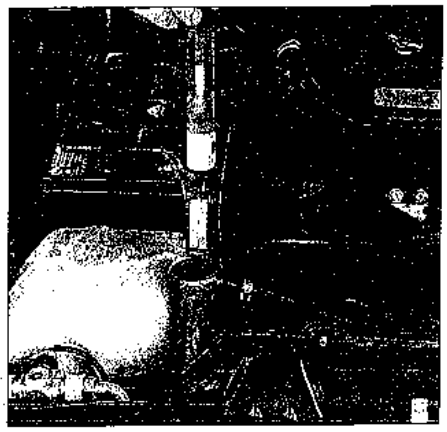
Note: *Non-toxic antifreeze is now manufactured and available at most auto parts stores, but even these types should be disposed of properly.*

The cooling system should be filled with a water/ethylene-glycol based antifreeze solution, which will prevent freezing down to at least -29 degrees C, or lower if local climate requires it. It also provides protection against corrosion and increases the coolant boiling point.

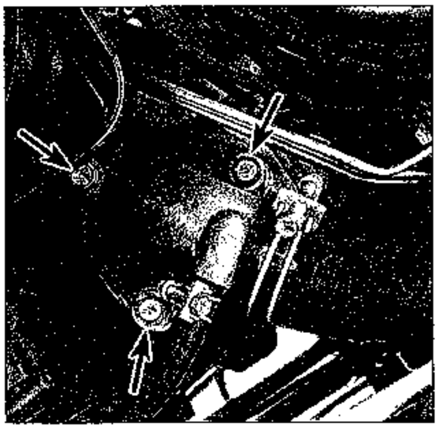
The cooling system should be drained, flushed and refilled every 48,000 kilometers or every two years (see Chapter 1). The use of antifreeze solutions for periods of longer than two years is likely to cause damage and encourage the formation of rust and scale in the system. If your tap water is "hard", i.e. contains a lot of dissolved minerals, use distilled water with the antifreeze.

Before adding antifreeze to the system, check all hose connections, because antifreeze tends to leak through very minute openings. Engines do not normally consume coolant. Therefore, if the level goes down, find the cause and correct it.

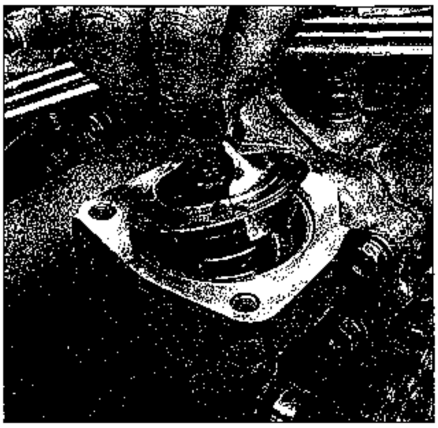
The exact mixture of antifreeze-to-water you should use depends on the relative weather conditions. The mixture should contain at least 50-percent antifreeze, but should never contain more than 70-percent antifreeze. Consult the mixture ratio chart on the antifreeze container before adding coolant. Hydrometers are available at most auto parts stores to test the ratio of antifreeze to water **(see illustration)**. Use antifreeze which meets the vehicle manufacturer's specifications.



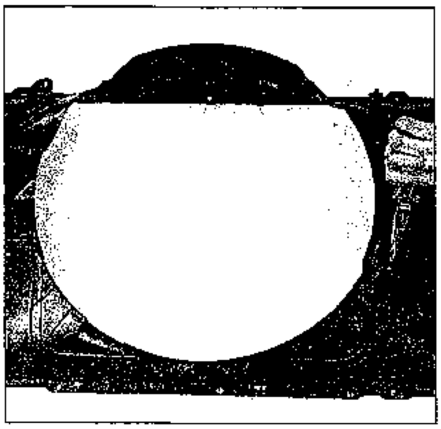
2.4 An inexpensive hydrometer can be used to test the condition of your coolant



3.7 The thermostat housing is retained by three bolts - some models have a small bypass hose attached to the top of the housing (4.2L petrol engine shown)



3.9 The thermostat is refitted with the spring end directed towards the engine



4.5a Remove the two clips . . .

3 Thermostat - check and renewal

Warning: *Do not attempt to remove the radiator cap, coolant or thermostat until the engine has cooled completely.*

Check

1 Before assuming the thermostat is responsible for a cooling system problem, check the coolant level (Chapter 1), drivebelt tension (Chapter 1) and temperature gauge (or light) operation.

2 If the engine takes a long time to warm up (as indicated by the temperature gauge or heater operation), the thermostat is probably stuck open. Renew the thermostat.

3 If the engine runs hot, use your hand to check the temperature of the lower radiator hose. If the hose is not hot, but the engine is, the thermostat is probably stuck in the closed position, preventing the coolant inside the engine from traveling through the radiator. Renew the thermostat. **Caution:** *On models equipped with fuel injection, do not drive the vehicle without a thermostat. The computer may stay in open loop and emissions and fuel economy will suffer. Carburetted models will suffer poor driveability and shortened piston ring life.*

4 If the lower radiator hose is hot, it means that the coolant is flowing and the thermostat is open. Consult the *Troubleshooting* Section at the front of this manual for further diagnosis.

Renewal

Refer to illustrations 3.7 and 3.9

5 Disconnect the negative cable from the battery.

6 Drain the coolant from the radiator (see Chapter 1). Loosen the air bleed on the thermostat housing (if equipped).

7 Disconnect the small bypass hose from the thermostat housing on 4.2 litre models **(see illustration)**.

8 Detach the housing from the engine. Be prepared for some coolant spillage as the gasket seal is broken. The radiator hose can be left attached to the housing, unless the housing itself is to be renewed.

9 Remove the thermostat, noting the direction in which it was refitted in the housing, and thoroughly clean the sealing surfaces **(see illustration)**.

10 Fit a new gasket onto the thermostat.

11 Refit the thermostat and housing.

12 Tighten the housing fasteners to the torque listed in this Chapter's Specifications and refit the remaining components in the reverse order of removal.

13 Refill the cooling system (refer to *Cooling system servicing* in Chapter 1), run the engine and check for leaks and proper operation.

4 Engine cooling fan/clutch assembly - check, removal and refitting

Check

1 Check the fan carefully for cracks, especially around the base of each blade. If any cracks are evident, renew the fan.

2 Check the fan clutch for fluid leakage. If it's leaking, renew the clutch.

3 Try to move the fan blades in a front-to-rear direction. If they wobble, renew the fan clutch.

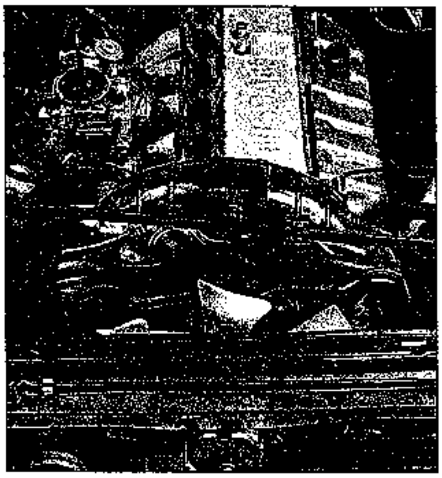
4 Spin the fan by hand. It should resist spinning (more resistance when the engine is hot). If it spins freely, or won't spin at all, renew the fan clutch.

Removal

Refer to illustrations 4.5a, 4.5b, 4.6 and 4.7

5 Remove the upper half of the radiator shroud. It is retained by screws to the body and by clips to the lower half **(see illustrations)**.

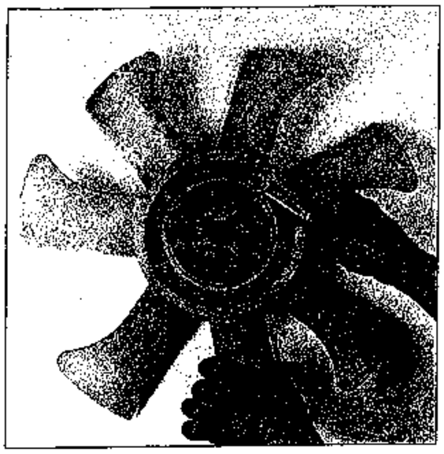
6 Remove the fan clutch mounting nuts **(see illustration)** and separate the fan/clutch assembly from the water pump.



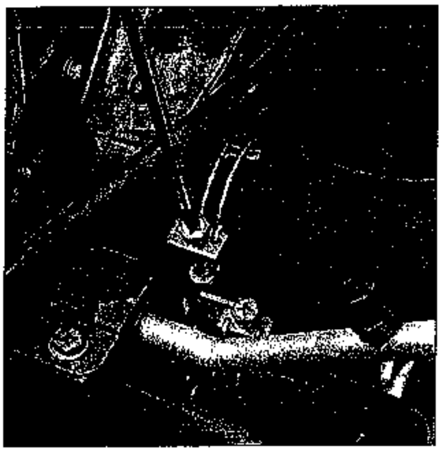
4.5b . . . then remove the fan shroud mounting bolts and lift the upper half off

4.6 Remove the four nuts that retain the fan to the water pump and separate the fan assembly from the pump (to prevent the hub from turning, wedge a screwdriver between a nut and the fan clutch hub)

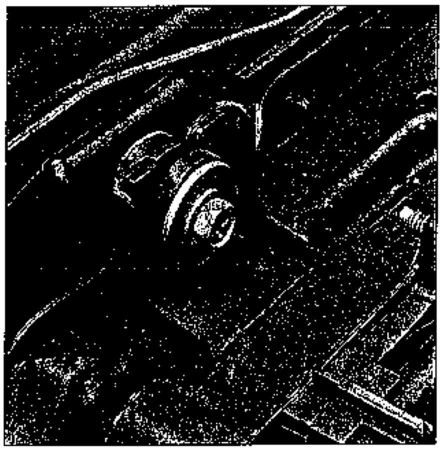
3



4.7 Remove the four bolts that retain the fan to the fan clutch



5.3 Loosen the clamps and detach the hoses from the radiator



5.8 Remove the radiator mounting bolts

7 Place the fan/clutch assembly on the bench and remove the fan mounting bolts **(see illustration)**.
8 Refitting is the reverse of removal.

5 Radiator and coolant reservoir - removal and refitting

Warning: *Do not start this procedure until the engine is completely cool. Wait at least two hours after running the engine.*

Radiator

Refer to illustrations 5.3 and 5.8

1 Disconnect the negative battery cable.
2 If the coolant is in good condition, drain the coolant into a clean container for reuse (see Chapter 1).
3 Disconnect both the upper and lower radiator hoses **(see illustration)**.
4 Disconnect the other hoses from the radiator (various models use different combinations of lower hoses and bypass hoses).
5 Disconnect the wiring from the temperature switch (if equipped).
6 If equipped with an automatic transmission, disconnect the cooler lines from the radiator. Place a drip pan underneath the fittings to catch the fluid, then plug the lines and fittings.
7 Remove the upper radiator shroud (see Section 4). Remove the lower shroud also.
8 Remove the radiator mounting bolts **(see illustration)**, then lift out the radiator.
9 With the radiator removed, it can be inspected for leaks, damage and internal blockage. If in need of repairs, have a professional radiator shop or dealer service department perform the work as special techniques are required.
10 Bugs and dirt can be cleaned from the radiator with compressed air and a soft brush. Don't bend the cooling fins as this is done. **Warning:** *Wear eye protection when using compressed air.*
11 Refitting is the reverse of the removal procedure. Be sure the rubber mounts are in place on the posts at the bottom of the radiator.
12 After refitting, fill the cooling system with the proper mixture of antifreeze and water. Refer to Chapter 1 if necessary.
13 Start the engine and check for leaks. Allow the engine to reach normal operating temperature, indicated by both radiator hoses becoming hot. Recheck the coolant level and add more if required.
14 On automatic transmission equipped models, check and add fluid as needed.

Coolant reservoir

15 On most models, the coolant reservoir is mounted to the inner fender by one or two screws. Remove the screw(s) and lift the reservoir from the engine compartment.
16 Pour the coolant into a container. Wash out and inspect the reservoir for cracks and chafing. Renew it if it's damaged.
17 Refitting is the reverse of removal.

6 Water pump - check

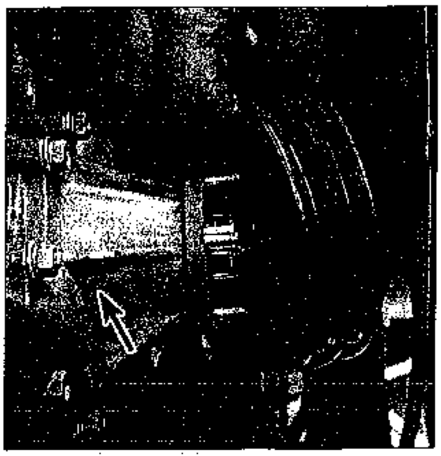
1 A failure in the water pump can cause serious engine damage due to overheating.
2 With the engine running and warmed to normal operating temperature, squeeze the upper radiator hose. If the water pump is working properly, a pressure surge should be felt as the hose is released. **Warning:** *Keep hands away from fan blades!*
3 Water pumps are equipped with "weep" or vent holes **(see illustration 7.4)**. If a failure occurs in the pump seal, coolant will leak from this hole. In most cases it will be necessary to use a flashlight to find the hole on the water pump by looking through the space behind the pulley just below the water pump shaft.
4 If the water pump shaft bearings fail there may be a howling sound at the front of the engine while it is running. Bearing wear can be felt if the water pump pulley is rocked up and down. Do not mistake drivebelt slippage, which causes a squealing sound, for water pump failure. Spray automotive drivebelt dressing on the belts to eliminate the belt as a possible cause of the noise.

7 Water pump - removal and refitting

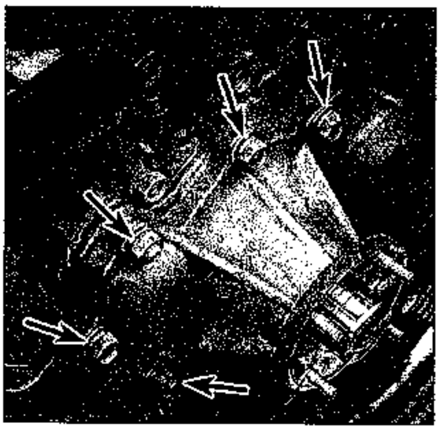
Refer to illustrations 7.4 and 7.5

Warning: *Do not start this procedure until the engine is completely cool.*

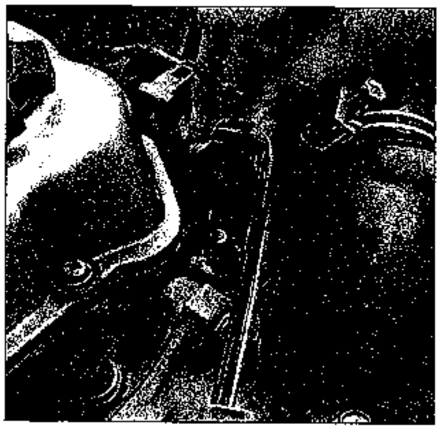
1 Disconnect the negative battery cable and drain the cooling system (see Chapter 1).
2 Remove the fan and clutch assembly (refer to Section 4). Remove the drivebelts (refer to Chapter 1).
3 If you're working on a model with a 3.0L engine, remove the timing belt (see Chapter 2).
4 Remove the water pump pulley **(see illustration)**.



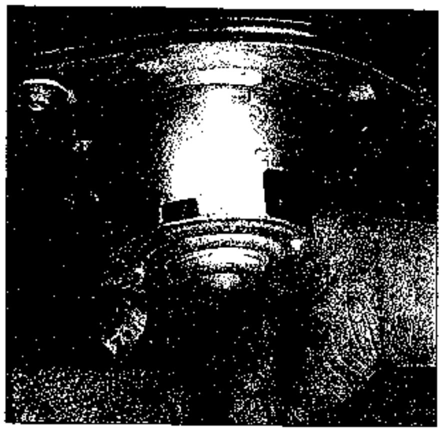
7.4 Remove the pulley from the water pump (arrow points to the weep hole) - 4.2L engine



7.5 Water pump mounting bolts - 4.2L petrol engine (two bolts not visible in this photo



8.7 The coolant temperature sending unit is located at the front of the engine, near the thermostat housing



9.3 Disconnect the electrical connector from the blower motor

5 Remove the water pump mounting bolts and nuts and remove the pump from the engine **(see illustration)**. If the pump sticks to the engine, knock it loose with a soft-face hammer or a hammer and a block of wood. If you're working on a 3.0 litre engine, remove the water pump bolts one at a time and lay them out on a clean surface in the exact positions in which they were removed (there are four different bolt sizes used in this application).

6 Clean the engine and (if the same pump is to be refitted) water pump sealing surfaces thoroughly with lacquer thinner or acetone, making sure to remove all traces of gasket material. Apply a 3 mm bead of RTV sealant to the pump, inboard of the mounting bolt holes, and refit it while the sealant is still wet.

7 Refitting is the reverse of removal. Tighten the fasteners to the torque(s) listed in this Chapter's Specifications.

8 Coolant temperature sending unit - check and renewal

Check

1 If the coolant temperature gauge is inoperative, check the fuses first (see Chapter 12).

2 If the temperature gauge indicates excessive temperature after running awhile, see the *Troubleshooting* Section in the front of the manual.

3 If the temperature gauge indicates HOT as soon as the engine is started cold, disconnect the wire at the coolant temperature sender. If the gauge reading drops, renew the sending unit. If the reading remains high, the wire to the gauge may be shorted to earth or the gauge may be faulty.

4 If the coolant temperature gauge fails to show any indication after the engine has been warmed up, (approximately 10 minutes) and the fuses checked out OK, shut off the engine. Disconnect the wire at the sending unit and, using a jumper wire, connect the wire to a good earthing point on the engine. Briefly turn on the ignition without starting the engine. If the gauge now indicates Hot, renew the sending unit.

5 If the gauge fails to respond, the circuit may be open or the gauge may be faulty - see Chapter 12 for additional information.

Renewal

Refer to illustration 8.6

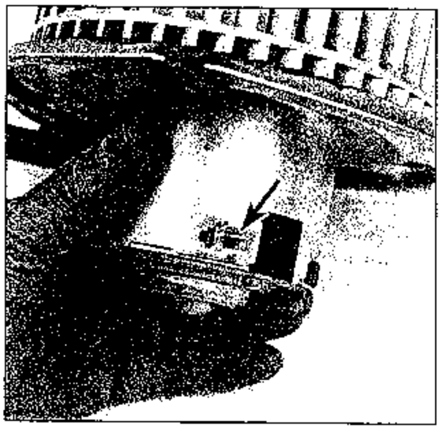
Warning: *Do not start this procedure until the engine is completely cool.*

6 Remove the radiator cap to relieve any residual pressure in the cooling system, then refit the cap.

7 Disconnect the wiring connector from the sending unit **(see illustration)**.

8 Using a deep socket, remove the old sending unit.

9 Quickly refit the new unit (to minimize coolant loss) and tighten it securely. Do not use thread sealer, as it may electrically insulate the sending unit.



9.4 Connect a fused jumper wire from a battery positive source to one of the blower motor terminals, then connect the other terminal to a good earth point - the blower motor should operate

10 Reconnect the wiring connector and check for coolant leakage and proper gauge function.

9 Blower motor - check and renewal

3

Refer to illustrations 9.3, 9.4, 9.8, 9.9a and 9.9b

Note: *Models not equipped with rear air conditioning use only one blower, mounted under the dash on the passenger side. Models with overhead rear air conditioning use two additional small blowers located overhead in the front passenger compartment. Models with conventional rear air conditioning use one large rear blower mounted in the right rear side panel behind the air inlet grille.*

Check

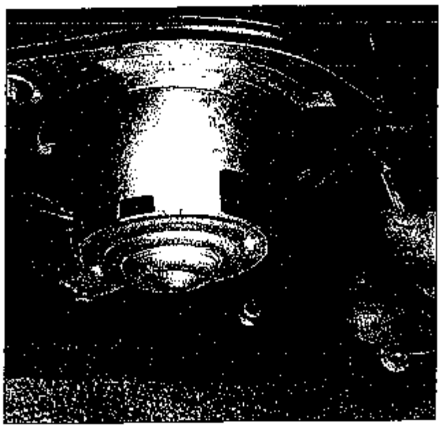
1 If the blower doesn't work, check the fuse and all connections in the circuit for looseness and corrosion. Make sure the battery is fully charged.

2 Locate the blower motor electrical connector for the blower in question.

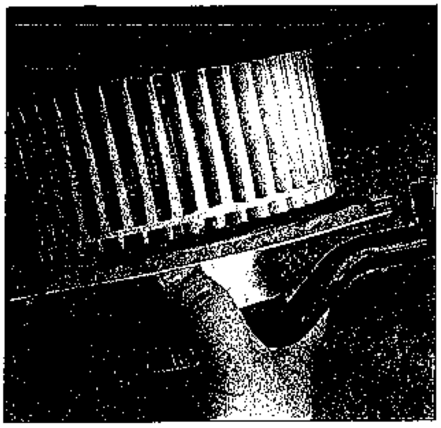
3 If the blower motor does not operate, disconnect the electrical connector at the blower motor **(see illustration)**, turn the ignition key On (engine not running) and check for battery voltage with the blower speed switch ON. If battery voltage is not present, there is a problem in the ignition feed circuit.

4 If battery voltage is present, reconnect the terminal to the blower motor and backprobe the correct terminal with a jumper wire connected to a good earth point. If the motor still does not operate, the motor is probably faulty. Apply fused power and earth connections to the blower motor terminals **(see illustration)**, if the motor does not operate, renew the motor.

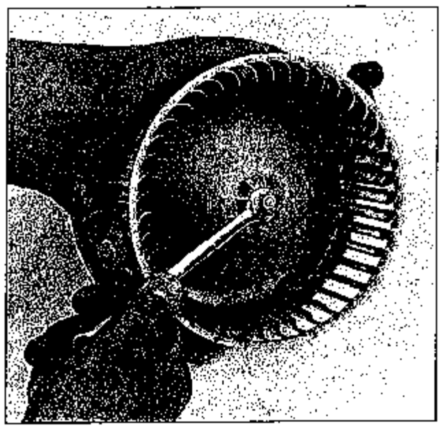
5 If the motor is good, but doesn't operate at any speed, the heater/air conditioning control switch is probably faulty. Remove the control assembly (see Section 12) and check



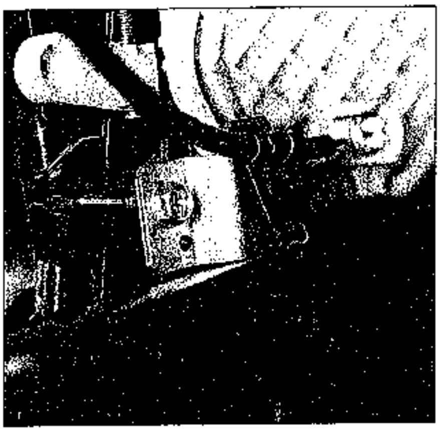
9.8 Detach the cooling hose (arrow) and remove the screws . . .



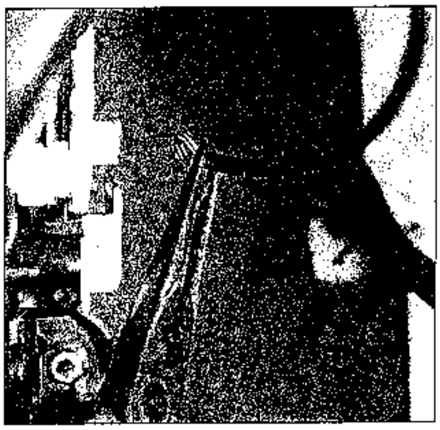
9.9a . . . remove the blower motor and fan assembly . . .



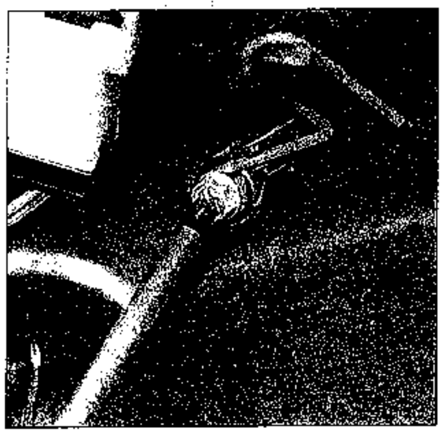
9.9b . . . then remove the retaining nut and slip the fan off the motor shaft



10.5a To detach the control cables, remove the retaining clip . . .



10.5b . . . then pull the cable end off the post



10.6a Disconnect any brackets and harness from the ducting . . .

for continuity through the switch in each position.

6 If the blower motor must be renewed, first disconnect the negative battery cable.

Renewal

7 The front blower is readily accessible. The blowers for the rear air conditioning units require removal of interior panels for access.

8 Disconnect the wiring from the motor **(see illustration 9.3)**. Disconnect the cooling hose and remove the mounting screws **(see illustration)**.

9 Lift the motor and fan out of the blower housing **(see illustration)**. The fan can be removed and reused on the new blower motor **(see illustration)**.

10 Refitting is the reverse of removal. Check for proper operation.

10 Heater core - removal and refitting

Refer to illustrations 10.5a, 10.5b, 10.6a through 10.6f, 10.8a, 10.8b, 10.9, 10.10, 10.11 and 10.12

1 Disconnect the negative cable from the battery.

2 Drain the cooling system (see Chapter 1).

3 Remove the entire instrument panel (refer to Chapter 11).

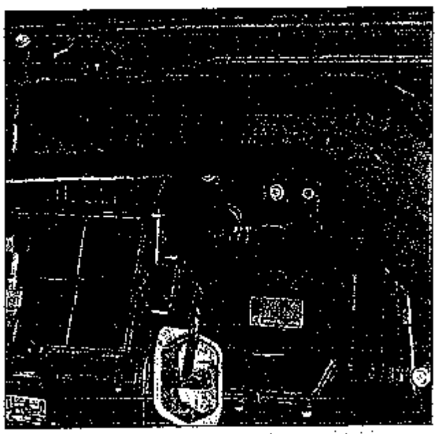
4 Working in the engine compartment, disconnect the heater hoses at the firewall.

5 Detach the heater/air conditioning control cables **(see illustrations)**. Label the cables as you disconnect them to avoid confusion later. **Note:** *Mark the cables with dabs of paint so that they may be refitted in their exact original positions.*

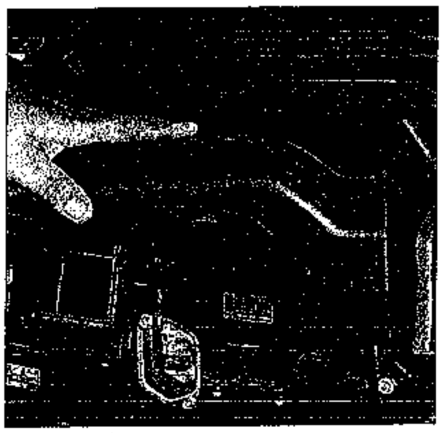
6 Remove the air ducts **(see illustrations)**.

7 Disconnect any wiring that would interfere with removal of the heater unit.

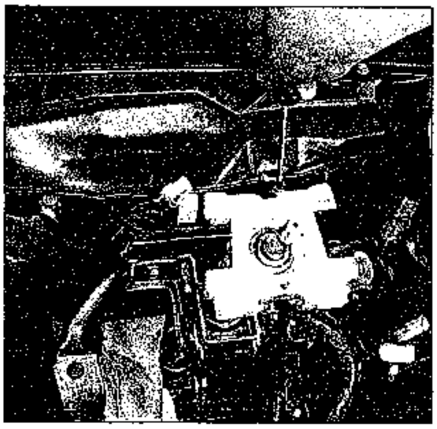
8 Remove the screws which retain the



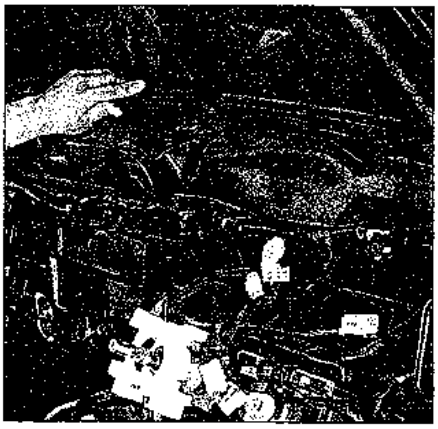
10.6b . . . remove the screws . . .



10.6c . . . and detach the left air duct

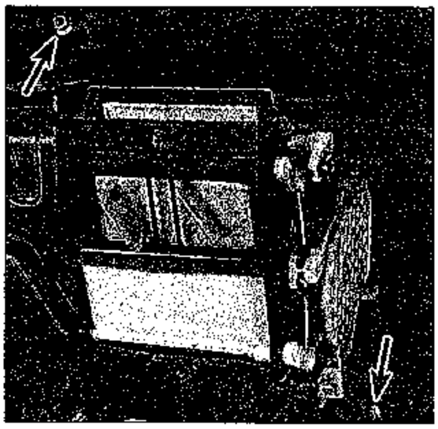


10.6d Remove the screws . . .

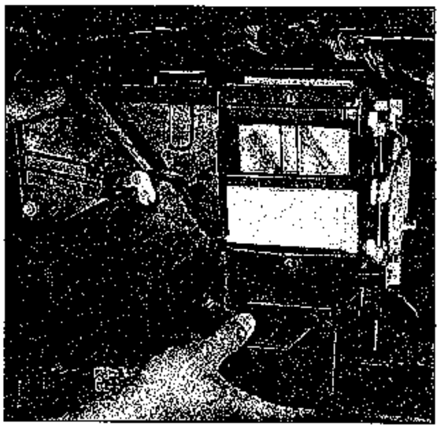


10.6e . . . and detach the defroster duct

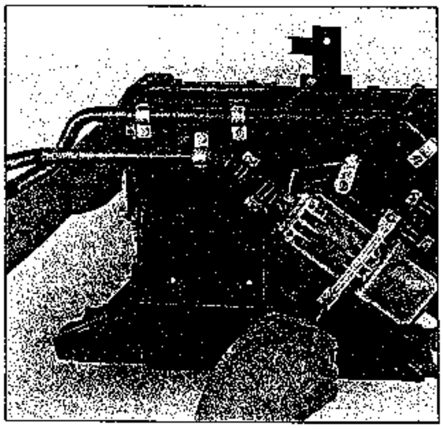
10.6f Carefully remove the centre plenum



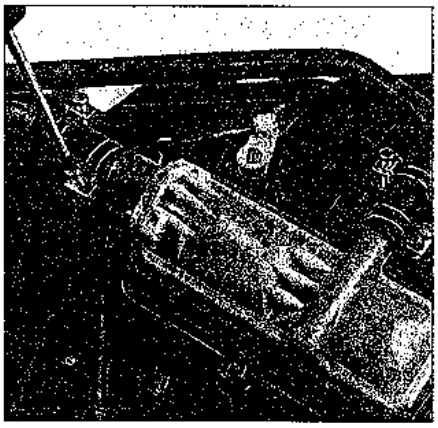
10.8a Remove the screws (arrows) . . .



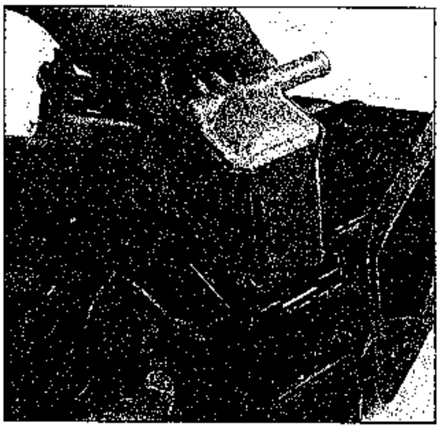
10.8b . . . and detach the heater unit from the firewall



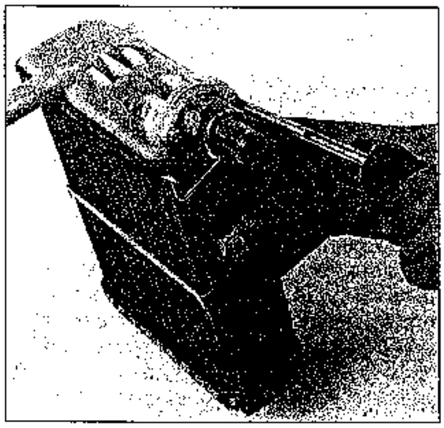
10.9 Remove the retaining strap . . .



10.10 . . . loosen the clamps and detach the hoses . . .



10.11 . . . then lift the heater core out of the case



10.12 Remove the screws and detach the water spigot from the heater core

heater unit and remove the unit from the vehicle (**see illustrations**). Keep plenty of towels or rags on the carpeting to catch any coolant that may drip. **Caution:** *Work slowly and carefully to avoid breaking any plastic components during removal.*

9 Remove the retaining strap from the heater core (**see illustration**).

10 Disconnect the rubber hoses from the heater core (**see illustration**).

11 Slide the heater core out of the case (**see illustration**).

12 Remove the water spigot from the core (**see illustration**).

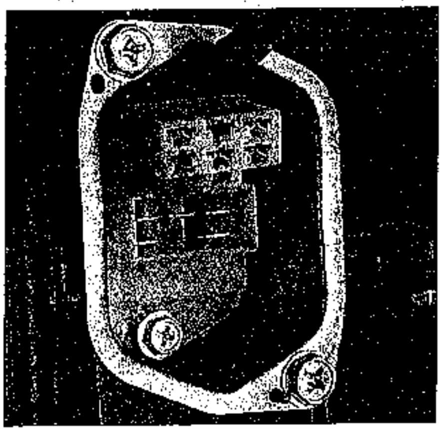
13 Refitting is the reverse order of removal.

14 Refill the cooling system, reconnect the battery and run the engine. Check for leaks and proper system operation.

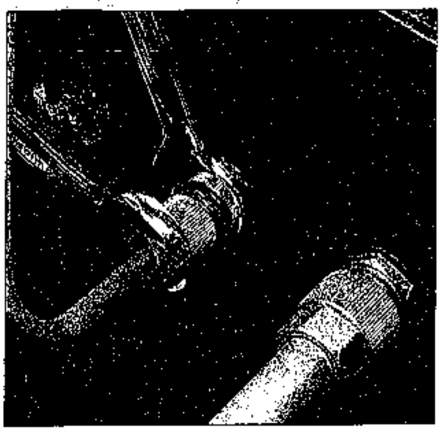
11 Air conditioning evaporator core(s) - removal and refitting

Refer to illustrations 11.4, 11.5, 11.6a, 11.6b, 11.7, 11.8, 11.9a, 11.9b, 11.10 and 11.11

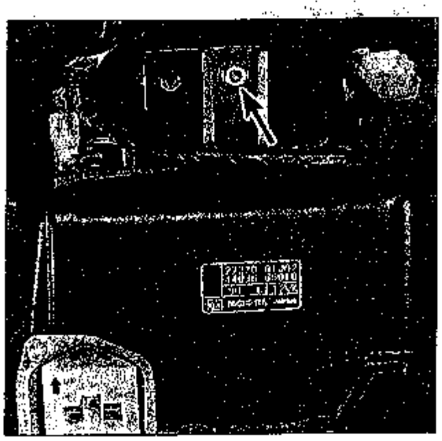
Warning: *The air conditioning system is under high pressure. Do not loosen any hose fittings or remove any components until the*



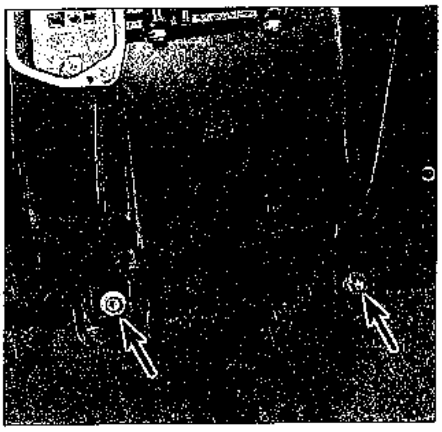
11.4 Disconnect the electrical connector from the evaporator case



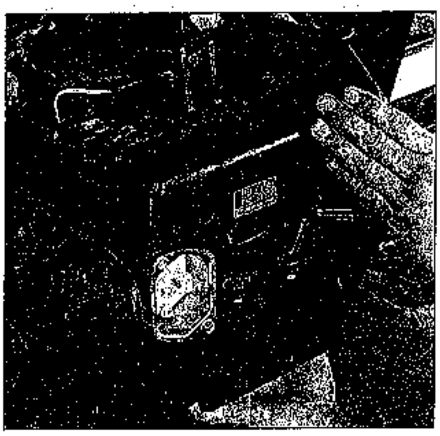
11.5 Working in the engine compartment, detach the refrigerant lines from the evaporator (use two spanners to avoid twisting the lines)



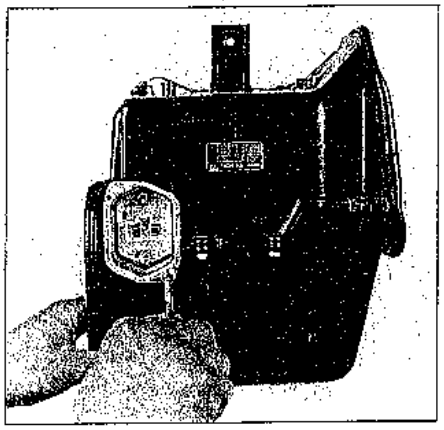
11.6a The evaporator case is secured by one nut at the top (arrow) . . .



11.6b . . . and two screws at the bottom (arrows)



11.7 Carefully guide the evaporator case out from the firewall and heater case



11.8 Remove the electrical connector

system has been discharged. Air conditioning refrigerant should be properly discharged into an approved recovery/recycling unit by a dealer service department or an automotive air conditioning repair facility. Always wear eye protection when disconnecting air conditioning system fittings.

Note: *Models not equipped with rear air conditioning use only one evaporator core, mounted under the dash on the passenger side. Models with overhead rear air conditioning use an additional evaporator core located overhead in the front passenger compartment. Models with conventional rear air conditioning use a rear evaporator core mounted in the right rear side panel to the rear of the control panel.*

Front evaporator core

1 Take the vehicle to an authorized repair facility to have the air conditioning system refrigerant recovered.

2 Disconnect the negative battery cable.

3 Remove the entire instrument panel (refer to Chapter 11).

4 Disconnect the wiring from the evaporator case **(see illustration)**.

5 Disconnect the refrigerant lines from the evaporator **(see illustration)**.

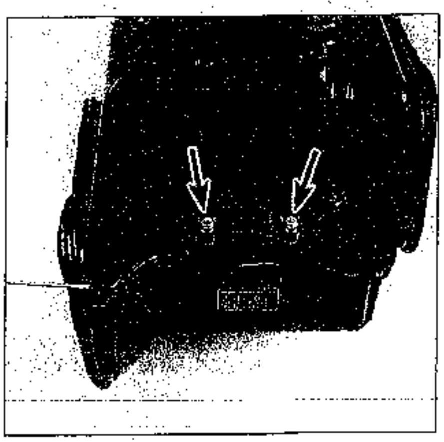
6 Remove the nut and screws which secure the evaporator housing to the firewall **(see illustrations)**.

7 Pull the evaporator case carefully away from the firewall **(see illustration)**.

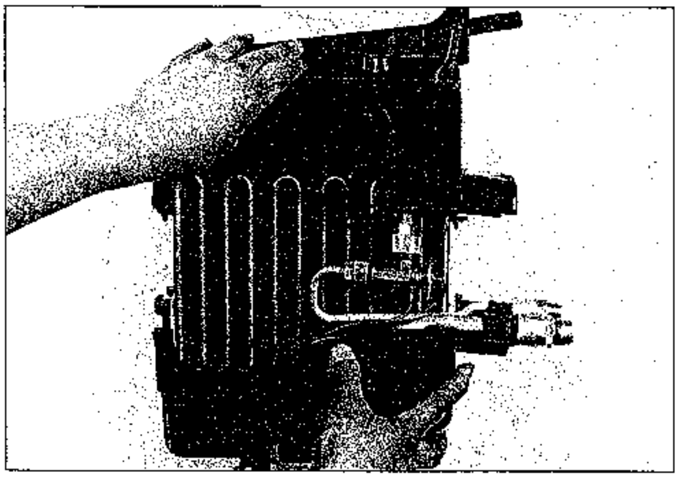
8 Remove the electrical connector **(see illustration)**.

9 Peel off the rubber seal **(see illustration)**. Release the clips and remove the screws which hold the case halves together **(see illustration)**.

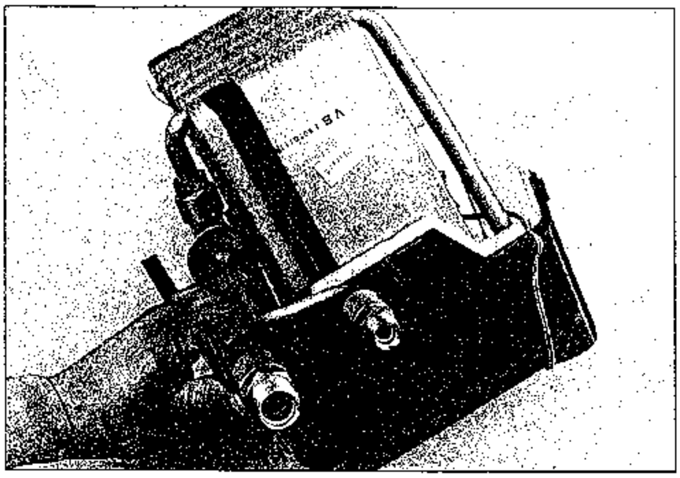
11.9a Carefully peel off the rubber seal . . .



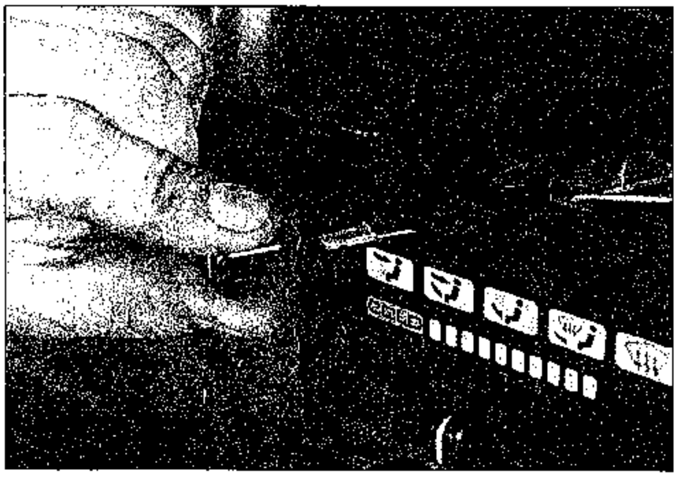
11.9b . . . then prise off the clips and remove the screws securing the case halves together



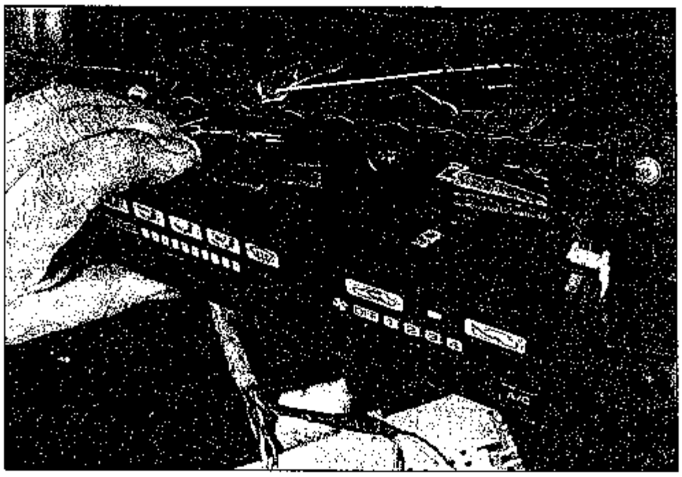
11.10 Remove the upper case half



11.11 Carefully remove the evaporator core from the lower case half



12.3a Remove the control knobs by pulling them straight off their levers



12.3b Remove the face plate and unplug the A/C switch electrical connector (if equipped)

10 Separate the two case halves **(see illustration)**.
11 Carefully remove the evaporator core **(see illustration)**.
12 Refitting is the reverse of removal. Take the vehicle to an authorized repair facility to have the air conditioning system evacuated, charged and leak tested.

Rear evaporator core

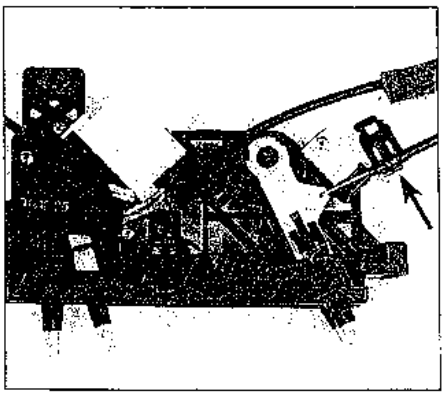
13 Take the vehicle to an authorized repair facility to have the air conditioning system refrigerant recovered.
14 Disconnect the negative battery cable.
15 Remove the interior panels over the evaporator assembly.
16 Disconnect the wiring to the unit.
17 Disconnect the refrigerant lines at the evaporator core.
18 Remove the screws which secure the evaporator case to the overhead mount or the rear wheel housing mount.
19 Remove the case from the vehicle.
20 Separate the case halves and carefully pull out the evaporator core.
21 Refitting is the reverse of removal. Take the vehicle to an authorized repair facility to have the air conditioning system evacuated, charged and leak tested.

12 Heater and air conditioning control assembly - check, removal and refitting

Removal and refitting

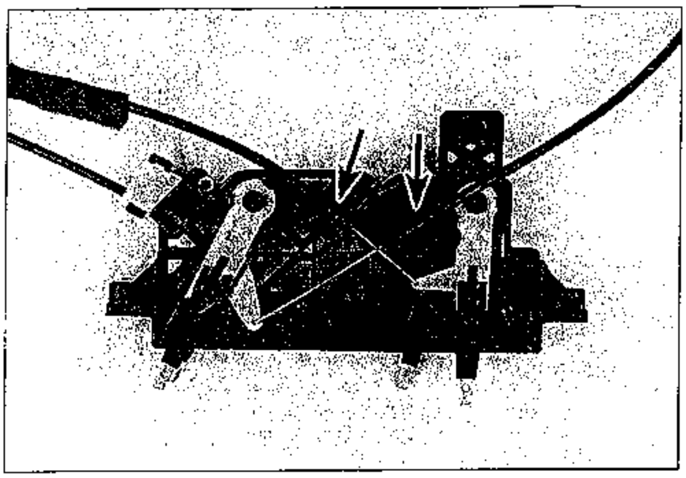
Refer to illustrations 12.3a, 12.3b, 12.7 and 12.8

1 Disconnect the negative cable from the battery.
2 Remove the centre dash panel (see Chapter 11).
3 Pull off the control knobs and remove the face plate **(see illustrations)**.
4 Remove the mounting screws located on the front of the control assembly (see Chapter 12).
5 Pull the control out slightly. Disconnect the electrical connectors.
6 Remove the inner glove compartment.
7 Disconnect the temperature control cable from the control lever **(see illustration)**. **Note:** *Mark each cable with a dab of paint before disconnecting it. This will eliminate the need to perform the adjustment procedures upon reassembly.*

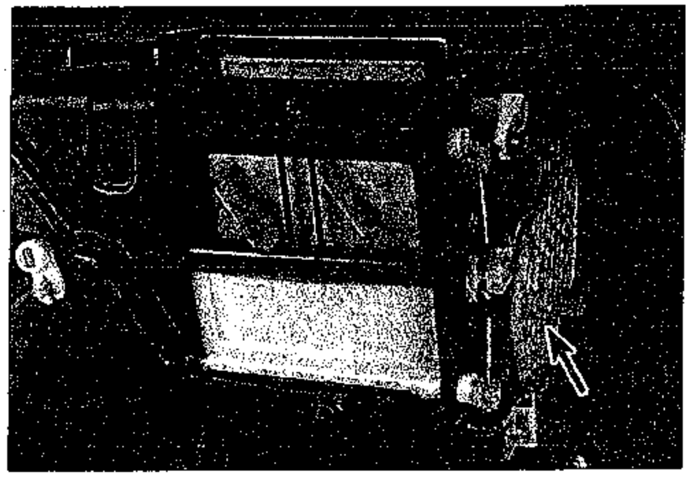


12.7 Remove the clip (arrow) and detach the temperature control cable

3



12.8 On the other side of the control unit, remove the clips (arrows) and detach the other cables from their levers



12.13 Move the link plate (arrow) fully clockwise

8 Disconnect both of the other cables from their retaining clips and from the levers which they operate **(see illustration)**.
9 Remove the bracket from the rear of the heater control unit.
10 Remove the control assembly.
11 Refitting is the reverse of the removal procedure. Adjust the cables if necessary.
12 Run the engine and check for proper functioning of the heater (and air conditioning, if equipped).

Cable and rod adjustments

Refer to illustration 12.13

Air control cable

13 Move the large side link plate fully clockwise **(see illustration)**.
14 Pull the cable casing rearward to remove all slack from the inner cable, then connect the cable and refit the clamp.

Water valve rod

15 Disconnect the temperature control cable from the air mixture door lever.
16 Push the air mix door lever away from the hose clamp.
17 Pull the control rod on the water valve towards the air mix door lever and adjust it so that there is about 2 mm between the end of the rod and the water valve lever.
18 Connect the rod to the air mix door lever.
19 Adjust the temperature control cable.

Temperature control cable

20 Set the temperature control to MAX HOT.
21 Push the cable casing and the air mix door lever to the left. Clamp the cable.

Inlet door cable

22 Set the air inlet to the RECIRC position.
23 Pull the cable casing downward. Push the inlet door lever upward.
24 Clamp the cable.

13 Air conditioning and heating system - check and maintenance

Air conditioning system

Warning: *The air conditioning system is under high pressure. Do not loosen any hose fittings or remove any components until the system has been discharged. Air conditioning refrigerant should be properly discharged into an approved recovery/recycling unit by a dealer service department or an automotive air conditioning repair facility. Always wear eye protection when disconnecting air conditioning system fittings.*

1 The following maintenance checks should be performed on a regular basis to ensure that the air conditioner continues to operate at peak efficiency.

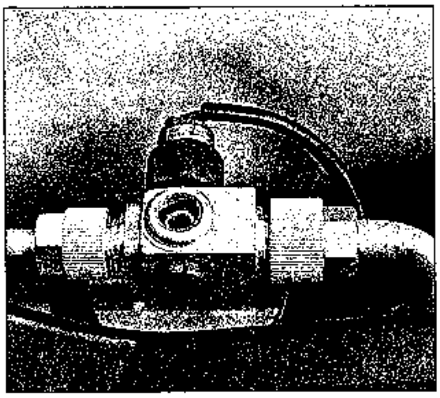
- a) *Inspect the condition of the compressor drivebelt. If it is worn or deteriorated, renew it (see Chapter 1).*
- b) *Check the drivebelt tension and, if necessary, adjust it (see Chapter 1).*
- c) *Inspect the system hoses. Look for cracks, bubbles, hardening and deterioration. Inspect the hoses and all fittings for oil bubbles or seepage. If there is any evidence of wear, damage or leakage, renew the hose(s).*
- d) *Inspect the condenser fins for leaves, bugs and any other foreign material that may have embedded itself in the fins. Use a "fin comb" or compressed air to remove debris from the condenser.*
- e) *Make sure the system has the correct refrigerant charge.*

2 It's a good idea to operate the system for about ten minutes at least once a month. This is particularly important during cold weather because long term non-use can cause hardening, and subsequent failure, of the seals.
3 Leaks in the air conditioning system are best spotted when the system is brought up to operating temperature and pressure, by running the engine with the air conditioning ON for five minutes. Shut the engine off and inspect the air conditioning hoses and connections. Traces of oil usually indicate refrigerant leaks.
4 Because of the complexity of the air conditioning system and the special equipment required to effectively work on it, accurate troubleshooting of the system should be left to a professional technician.
5 If the air conditioning system doesn't operate at all, check the fuse panel and the air conditioning relay, located in the fuse/relay box in the engine compartment. Refer to the appropriate Sections in this Chapter for electrical checks of heating/air conditioning system components.
6 The most common cause of poor cooling is simply a low system refrigerant charge. If a noticeable drop in cool air output occurs, the following quick check will help you determine if the refrigerant level is low. For more complete information on the air conditioning system, refer to the *Haynes Automotive Heating and Air Conditioning Manual*.

Checking the refrigerant charge

Refer to illustration 13.11

7 Warm the engine up to normal operating temperature.
8 Place the air conditioning temperature selector at the coldest setting and put the blower at the highest setting. Open the doors (to make sure the air conditioning system doesn't cycle off as soon as it cools the passenger compartment).
9 With the compressor engaged - the clutch will make an audible click and the centre of the clutch will rotate. After the system reaches operating temperature, feel the two pipes connected to the evaporator at the firewall.
10 The pipe leading from the condenser outlet to the evaporator (small tubing) should be cold, and the evaporator outlet line (the larger tubing that leads back to the compressor) should be slightly colder. If the evapora-



13.11 The sight glass is located on top of the receiver/drier

15.4 Disconnect the electrical connector at the compressor, then unbolt the refrigerant line manifold from the compressor

15.5 Remove the compressor mounting bolts (arrows indicate the two bottom bolts; two more are on the top of the compressor) and remove the compressor

tor outlet is considerably warmer than the inlet, the system needs a charge. Insert a thermometer in the centre air distribution duct while operating the air conditioning system - the temperature of the output air should be 15 to 20-degrees C below the ambient air temperature (down to approximately 5-degrees C). If the ambient (outside) air temperature is very high, say 45-degrees C, the duct air temperature may be as high as 16-degrees C, but generally the air conditioning is 15 to 20-degrees C cooler than the ambient air. If the air isn't as cold as it used to be, the system probably needs a charge. Further inspection or testing of the system is beyond the scope of the home mechanic and should be left to a professional.

11 Inspect the sight glass If the refrigerant looks foamy when running, it's low **(see illustration)**. When ambient temperatures are very hot, bubbles may show in the sight glass even with the proper amount of refrigerant. With the proper amount of refrigerant, when the air conditioning is turned off, the sight glass should show refrigerant that foams, then clears.

Heating systems

12 If the air coming out of the heater vents isn't hot, the problem could stem from any of the following causes:

- a) *The thermostat is stuck open, preventing the engine coolant from warming up enough to carry heat to the heater core. Renew the thermostat* (see Section 3).
- b) *A heater hose is blocked, preventing the flow of coolant through the heater core. Feel both heater hoses at the firewall. They should be hot. If one of them is cold, there is an obstruction in one of the hoses or in the heater core, or the heater control valve is shut. Detach the hoses and back flush the heater core with a water hose. If the heater core is clear but circulation is impeded, remove the two hoses and flush them out with a water hose.*
- c) *If flushing fails to remove the blockage from the heater core, the core must be renewed* (see Section 11).

13 If the blower motor speed does not correspond to the setting selected on the blower switch, the problem could be a bad fuse, circuit, switch, blower motor resistor or motor.

14 If there isn't any air coming out of the vents:

- a) *Turn the ignition ON and activate the fan control. Place your ear at the heating/air conditioning register (vent) and listen. Most motors are audible. Can you hear the motor running?*
- b) *If you can't (and have already verified that the blower switch and the blower motor resistor are good), the blower motor itself is probably bad* (see Section 9).

15 If the carpet under the heater core is damp, or if antifreeze vapour or steam is coming through the vents, the heater core is leaking. Remove it (see Section 10) and refit a new unit (most radiator shops will not repair a leaking heater core).

16 Inspect the drain hose from the heater/air conditioning assembly, make sure it is not clogged.

14 Air conditioning receiver/drier - removal and refitting

Warning: *The air conditioning system is under high pressure. Do not loosen any hose fittings or remove any components until the system has been discharged. Air conditioning refrigerant should be properly discharged into an approved recovery/recycling unit by a dealer service department or an automotive air conditioning repair facility. Always wear eye protection when disconnecting air conditioning system fittings.*

1 Have the refrigerant discharged and recovered by an air conditioning technician.

2 Remove any interfering panels. Disconnect the wiring to the dual-pressure switch on top of the receiver/drier.

3 Disconnect the refrigerant lines from the receiver/drier and cap the open fittings to prevent entry of moisture.

4 Remove the bolts and lift the receiver/drier out of the engine compartment.

5 Refitting is the reverse of removal.

6 Have the system evacuated, charged and leak tested by the shop that discharged it. If the receiver was renewed, have them add new refrigeration oil to the system, about 20 grams for R-12 systems, or 10 grams for R-134a systems. Use only the refrigerant oil compatible with the refrigerant of your system (R-12 vs. R-134a).

15 Air conditioning compressor - removal and refitting

Refer to illustrations 15.4 and 15.5

Warning: *The air conditioning system is under high pressure. Do not loosen any hose fittings or remove any components until the system has been discharged. Air conditioning refrigerant should be properly discharged into an approved recovery/recycling unit by a dealer service department or an automotive air conditioning repair facility. Always wear eye protection when disconnecting air conditioning system fittings.*

1 Have the refrigerant discharged by an automotive air conditioning technician.

2 Disconnect the negative cable from the battery.

3 Remove the drivebelt from the compressor (see Chapter 1).

4 Detach the wiring connector and disconnect the refrigerant lines **(see illustration)**.

5 Unbolt the compressor and lift it from the vehicle **(see illustration)**.

6 If a new or rebuilt compressor is being refitted, follow the directions supplied with the compressor regarding the proper level of oil prior to refitting.

7 Refitting is the reverse of removal. Renew any O-rings with new ones specifically made for the type of refrigerant in your system and lubricate them with refrigerant oil, also designed specifically for your system (R-12 vs. R-134a).

8 Have the system evacuated, recharged and leak tested by the shop that discharged it.

16 Air conditioning condenser - removal and refitting

Refer to illustration 16.3

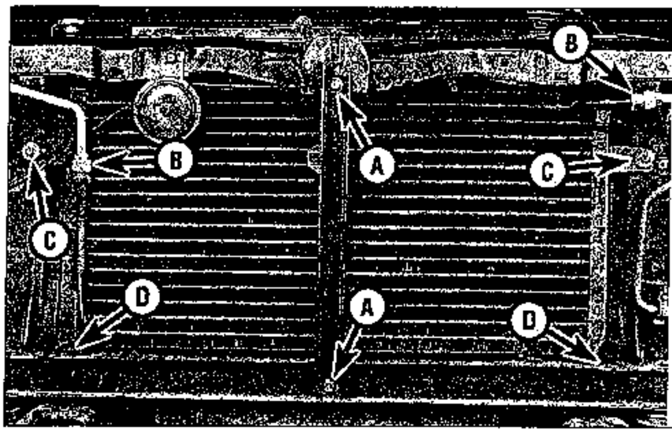
Warning: *The air conditioning system is under high pressure. Do not loosen any hose fittings or remove any components until the system has been discharged. Air conditioning refrigerant should be properly discharged into an approved recovery/recycling unit by a dealer service department or an automotive air conditioning repair facility. Always wear eye protection when disconnecting air conditioning system fittings.*

1 Have the refrigerant discharged by an air conditioning technician.

2 Remove the grille (refer to Chapter 11).

3 Remove the centre support brace and the horn for access. Disconnect the condenser inlet and outlet fittings **(see illustration)**. Cap the open fittings immediately to keep moisture and contamination out of the system.

4 Remove the condenser mounting bolts, pull the condenser up and forward at the top, then lift it out **(see illustration 16.3)**.



16.3 Remove the radiator support brace bolts (A) and remove the brace, detach the refrigerant lines from the condenser (B) and remove the condenser mounting bolts (C). Don't lose the lower mounting cushions (D)

5 Refit the condenser, brackets and bolts, making sure the rubber cushions fit on the mounting points properly.

6 Reconnect the refrigerant lines, using new O-rings where needed. If a new condenser has been refitted, add approximately 50 cc (1.4 to 1.7 ounces) of new refrigerant oil of the correct type (R-12 vs. R-134a).

7 Refit the remaining parts in the reverse order of removal.

8 Have the system evacuated, charged and leak tested by the shop that discharged it.

Chapter 4 Part A
Fuel and exhaust systems - carburetted engines

Contents

Specifications

Carburettor make	Nikki
Carburettor model	
3.0 litre models	21J360-38
4.2 litre models	
Manual	21J360-23
Automatic	21J360-24
Fuel pump pressure	
3.0 litre engine	20 kPa (approx.)
4.2 litre engine	25 to 36 kPa
Fuel pump volume, 4.2 litre	2.6 L/minute
Fast idle speed	
3.0 litre engine	1850 to 2150 rpm
4.2 litre engine	
Automatic	1800 to 2200 rpm
Manual	1600 to 2000 rpm
Fast idle actuator engine speed (A/C on)	
3.0 litre engine	750 to 850 rpm
4.2 litre engine	
Automatic	1,050 to 1,150 rpm
Manual	850 to 950 rpm
Fast idle dash pot contact engine speed	
3.0 litre engine	1,900 to 2,100 rpm
4.2 litre engine	1,600 to 1,800 rpm
Vacuum break clearance	
3.0 litre models	3 mm
4.2 litre models	5 mm

1 General information

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or a clothes dryer) with a pilot light is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

The fuel system on all carburetted models consists of a fuel tank mounted in the rear, a fuel pump and a carburettor. The fuel pump is a mechanical unit mounted on the engine and driven from the fuel pump on 4.2 litre engines. On 3.0 litre engines, the fuel pump is electric, mounted in the fuel tank. A combination of metal and rubber fuel hoses is used to connect these components.

The carburettor is a two-barrel type, operated by a cable. There is also a hand-operated throttle cable located on the dash.

2 Fuel pump/fuel pressure check

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. See* **Warning** *in Section 1.*

Note: *It is a good idea to check the fuel pump and lines for any obvious damage or fuel leakage. Also check all hoses from the tank to the pump, particularly the suction hoses at the fuel tank and pump which, if they have are cracked, may not allow fuel to the fuel pump. It is also possible for the fuel pump diaphragm to rupture internally and leak fuel into the crankcase. If you have excess fuel consumption or fuel smell, and you can't find any external leaks, check the condition of the engine oil for any signs of fuel mixing with the engine oil; the oil level will usually be abnormally high and the oil will be thinned out and have a fuel smell.*

3.0 litre engine

1 Relieve the fuel system pressure by removing the fuel pump fuse from the driver side kick panel fuse box.

2 Start the engine and allow it to idle until it stalls.

3 Crank the engine for another three seconds.

4 Refit the fuel pump fuse. This completes the procedure for relieving the fuel pressure. It is now safe to disconnect fuel fittings on this model.

5 Disconnect the fuel supply hose where it connects to the vapour separator at the carburettor. Cap the outlet of the vapour separator. The vapour separator resembles a small fuel filter with three spigots located at the carburettor.

6 Connect a fuel pressure gauge to the fuel supply hose.

7 Turn the ignition switch ON and read the fuel pressure. The pressure must be approximately the value listed in this Chapter's Specifications.

8 Remove the gauge and place the fuel hose into an approved petrol container.

9 Energise the fuel pump again and observe the quantity of fuel pumped into the container to check the fuel pump volume.

10 If the fuel pump does not appear to operate, turn the ignition switch to ON and listen for its buzzing from the area of the fuel tank. If it operates, check for a clogged fuel filter or a collapsed line.

11 If you cannot hear it run, remove the access cover from the fuel tank (refer to Section 4).

12 Disconnect the wiring from the fuel pump and check for voltage between the green and red wire and earth with the ignition switch ON. If there is no voltage, check the fuel pump fuse and the engine control fuse in the fuse box. Also check the fuel pump electronic control unit, located below the fuse box.

13 If there is voltage, yet the fuel pump will not operate, renew it.

4.2 litre engine

Refer to illustration 2.14

14 Disconnect the fuel line from the carburettor and refit a T-fitting. Connect a fuel pressure gauge to the T-fitting with a section of fuel hose **(see illustration)**.

15 Pinch the small fuel return hose at the fuel pump using locking pliers or remove the hose and plug it.

16 Start the engine and allow it to idle. The pressure on the gauge should fall within the values listed in this Chapter's Specifications. It should remain constant and return to zero slowly when the engine is shut off. **Note:** *If the engine will not start, crank the engine until you get a reading on the gauge.*

17 An instant pressure drop indicates a faulty outlet valve and the fuel pump must be renewed.

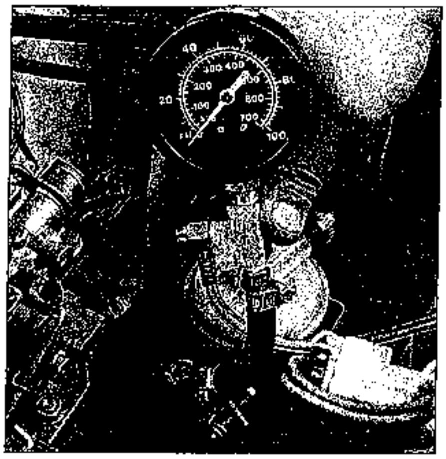
18 If the pressure is too high, check the air vent to see if it is plugged before renewing the pump.

19 If the pressure is too low, be sure the fuel hoses and lines are in good shape and not plugged, then renew the pump.

20 Remove the gauge and place the fuel hose into a container.

21 Crank the engine with the starter and observe the quantity of fuel pumped into the container to check the fuel pump volume. Compare the reading to the Specifications listed in this Chapter.

22 Observe the fuel pump to see if there is any fuel escaping from the weep hole. If there is, it must be renewed at once.



2.14 Connect the fuel pressure gauge into the fuel inlet line with a T-fitting

3 Fuel lines and fittings - inspection and renewal

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. See* **Warning** *in Section 1.*

Inspection

1 Once in a while, you will have to raise the vehicle to service or renew some component (an exhaust pipe hanger, for example). Whenever you work under the vehicle, always inspect the fuel lines and fittings for possible damage or deterioration.

2 Check all hoses and pipes for cracks, kinks, deformation or obstructions.

3 Make sure all hose and pipe clips attach their associated hoses or pipes securely to the underside of the vehicle.

4 Verify all hose clamps attaching rubber hoses to metal fuel lines or pipes are snug enough to insure a tight fit between the hoses and pipes.

Renewal

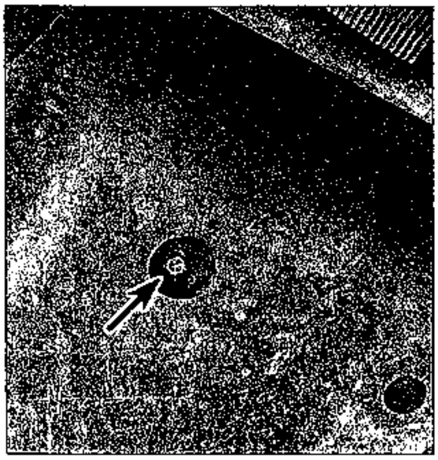
5 If you must renew any damaged sections, use hoses approved for use in fuel systems or pipes made from steel only (it's best to use an original-type pipe from a dealer that's already flared and pre-bent). Do not refit substitutes constructed from inferior or inappropriate material, as this could result in a fuel leak and a fire.

6 Always, before detaching or disassembling any part of the fuel line system, note the routing of all hoses and pipes and the orientation of all clamps and clips to insure that renewal sections are refitted in exactly the same manner.

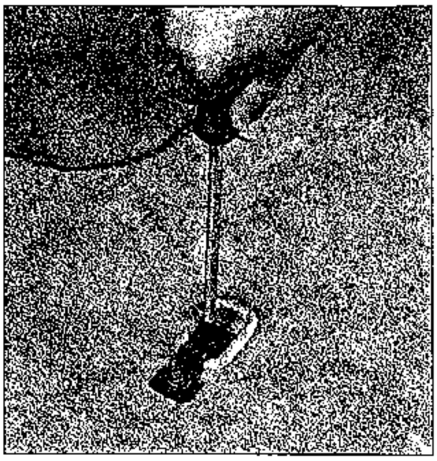
7 Before detaching any part of the fuel system, be sure to relieve the fuel tank pressure by removing the fuel filler cap.

8 Always use new hose clamps after loosening or removing them.

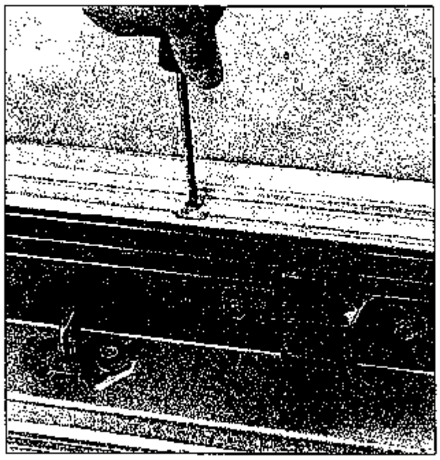
9 While you're under the vehicle, it's a



4.3 The fuel tank is equipped with a drain plug (arrow) - drain it into an approved safety container

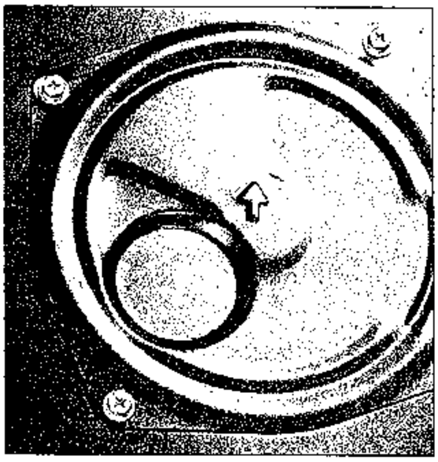


4.4 Remove the tie-downs from the rear floor area

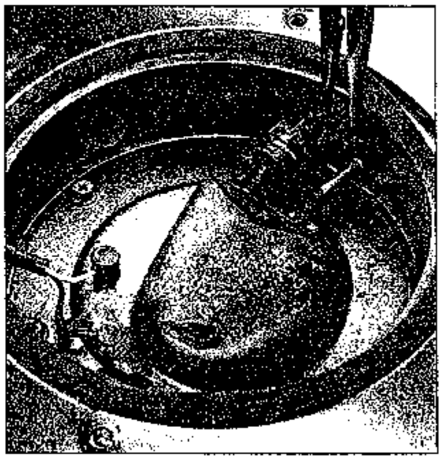


4.5a The rear trim strip must be removed

4.5b When the carpet is folded back, the access panel is revealed



4.6 Remove the four screws securing the access panel



4.7a Disconnect the hoses at the tank

good idea to check the following related components:

a) *Check the condition of the fuel filter - make sure that it's not clogged or damaged (see Chapter 1).*
b) *Inspect the evaporative emission control (EVAP) system. Verify that all hoses are attached and in good condition* (see Chapter 6).

4 Fuel tank - removal and refitting

Refer to illustrations 4.3, 4.4, 4.5a, 4.5b, 4.6, 4.7a and 4.7b

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. See* **Warning** *in Section 1.*

Note: *The following procedure is much easier to perform if the fuel tank is empty. Most tanks have a drain plug for this purpose. If the tank does not have a drain plug, or if the drain plug is damaged, drain the fuel into an approved fuel container using a commercially available siphoning kit (NEVER start the siphoning action by mouth) or wait until the fuel tank is nearly empty.*

1 Remove the fuel tank filler cap to relieve fuel tank pressure. On 3.0 litre models, relieve the fuel system pressure (refer to Section 2).

2 Detach the cable from the negative terminal of the battery.

3 If the tank has a drain plug, remove it and allow the fuel to collect in an approved petrol container **(see illustration)**.

4 Remove the tie-downs from the floor of the rear of the vehicle **(see illustration)**.

5 Remove the carpet edge trim from the rear door area **(see illustration)**. Fold the carpet forward **(see illustration)**.

6 Remove the fuel tank access cover and set it aside **(see illustration)**.

7 Disconnect the hoses and the wiring **(see illustrations)**. **Note:** *Be sure to plug the hoses to prevent leakage and contamination of the fuel system.*

8 Raise the vehicle and place it securely on jackstands.

9 Remove the stone shield from the right side wheel housing.

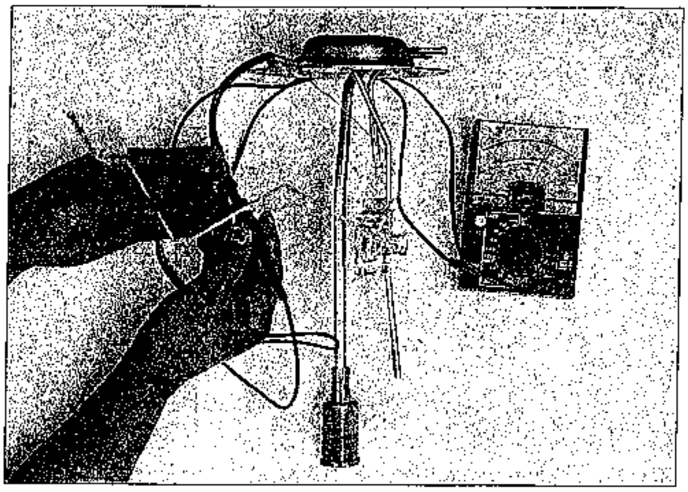
10 Loosen the clamps which secure the filler and vapour tubes.

11 Remove the fuel tank protector from the bottom of the fuel tank.

12 Support the fuel tank with a floor jack or have an assistant help you to steady it. Position a piece of wood between the jack head

4.7b Disconnect the wiring at this connector - not at the tank itself

6.9 The 4.2 litre fuel pump is a conventional mechanical unit mounted to the side of the engine with an insulator



7.8a Hold the float in the FULL position and record the ohmmeter reading

and the fuel tank to protect the tank. Remove the fuel tank retaining bolts and lower the tank carefully. Make certain that the tubes and hoses are free as it comes out.

13 Refitting is the reverse of removal.

5 Fuel tank cleaning and repair - general information

1 All repairs to the fuel tank or filler neck should be carried out by a professional who has experience in this critical and potentially dangerous work. Even after cleaning and flushing of the fuel system, explosive fumes can remain and ignite during repair of the tank.

2 If the fuel tank is removed from the vehicle, it should not be placed in an area where sparks or open flames could ignite the fumes coming out of the tank. Be especially careful inside garages where a natural gas-type appliance is located, because the flame could cause an explosion.

6 Fuel pump - removal and refitting

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. See* **Warning** *in Section 1.*

3.0 litre engine

1 Remove the access cover from the floor of the rear of the vehicle (refer to Section 4). Relieve the fuel system pressure (refer to Section 2).

2 Disconnect the fuel hoses and the wiring (see Section 4).

3 Remove the fuel pump/fuel level sender bolts from the fuel tank cover.

4 Very slowly and carefully lift the entire assembly from the fuel tank. Do not allow the float arm to become bent while removing it (see Section 7).

5 Remove the fuel pump from the assembly.

6 Refitting is the reverse of removal. Check the condition of the cover O-ring and renew it if necessary.

4.2 litre engine

Refer to illustration 6.9

7 Disconnect the negative battery cable.

8 Remove the hoses from the fuel pump. Label the two larger hoses to avoid confusion later.

9 Remove the fuel pump and its insulator from the engine **(see illustration)**.

10 Check the insulator for damage and renew it if necessary.

11 Clean the fuel pump, insulator and engine mounting surfaces thoroughly. Renew the gaskets.

12 Refitting is the reverse of removal.

7 Fuel level sending unit - check and renewal

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. See* **Warning** *in Section 1.*

Check

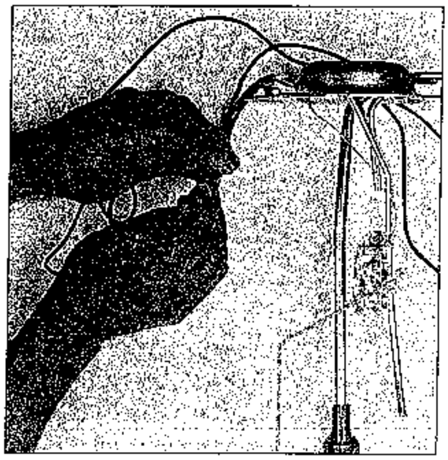
Refer to illustrations 7.8a and 7.8b

1 Before performing any tests on the fuel level sending unit, completely fill the tank with fuel.

2 Remove the access cover from the floor of the rear of the vehicle (refer to Section 4).

3 Disconnect the fuel level sending unit electrical connector located near the top of the fuel tank. Do not disconnect the wires from the fuel tank itself.

4 Position the ohmmeter probes onto the G and E terminals of the electrical connector and check the resistance. On 3.0 litre models, these are the two terminals closest to the tab on the connector.



7.8b With the float in the EMPTY position, again record the ohmmeter reading

5 With the fuel tank completely full, the resistance should be about 5 ohms.

6 Drive it until the tank is nearly empty and then reconnect the ohmmeter.

7 Check the resistance. The resistance of the sending unit should be about 80 ohms.

8 If the readings are incorrect, renew the sending unit. **Note:** *The test can also be performed with the fuel level sending unit removed from the fuel tank. Using an ohmmeter, check the resistance of the sending unit with the swing arm completely down (tank empty) and with the arm up (tank full). The resistance should change steadily from 80 ohms to approximately 5 ohms* **(see illustrations)**.

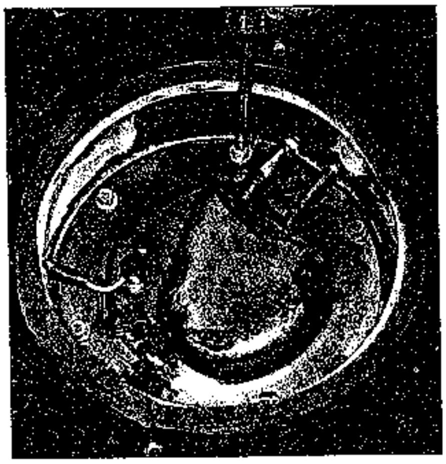
Renewal

Refer to illustrations 7.11, 7.12a and 7.12b

9 On 3.0 litre vehicles, relieve the fuel system pressure (refer to Section 2).

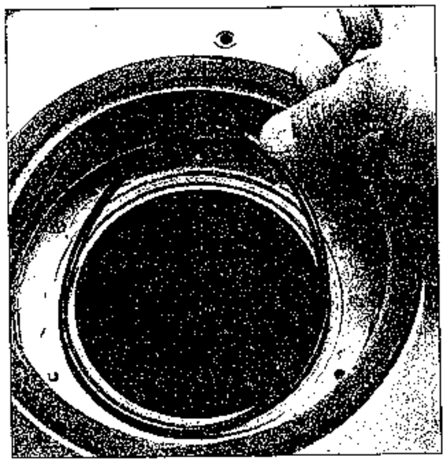
10 Disconnect the hoses and wiring (see Section 4).

11 Remove the cover screws from the top of the fuel tank **(see illustration)**.

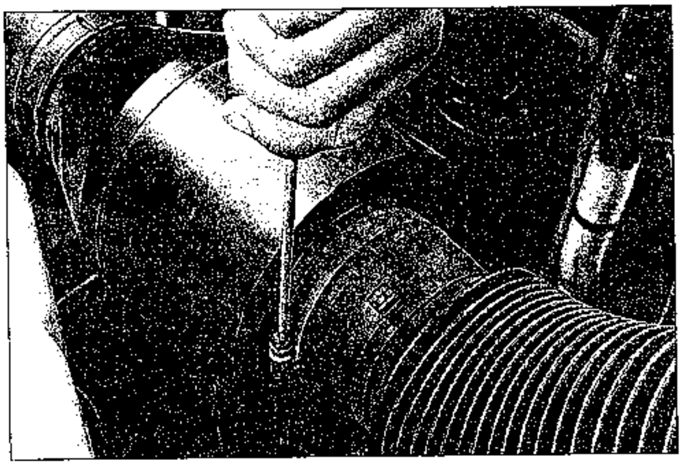


7.11 The fuel tank cover can be removed after disconnecting the wiring and hoses

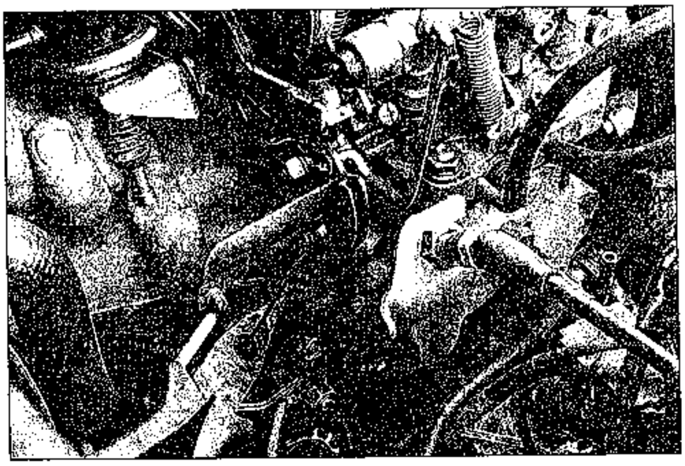
7.12a Be extremely careful as you lift the assembly from the fuel tank - it is very delicate



7.12b Always check the condition of the O-ring - it must not be cracked or hardened



8.6 Loosen the cyclone pre-air filter clamps and pull the duct and the air pre-heater off before unbolting it from the wheel housing



9.1 Hold the throttle fully open and then disconnect the cable from it

12 Carefully angle the sending unit out of the opening without damaging the fuel level float located at the bottom of the assembly **(see illustrations)**.

13 Disconnect the electrical connectors from the sending unit.

14 Remove the screw from the side of the sending unit bracket and separate the sending unit from the assembly.

15 Refitting is the reverse of removal.

8 Air cleaner housing - removal and refitting

Refer to illustration 8.6

Note: *Refer to Chapter 1 for removal and service procedures for the air filter and the cyclone pre-air filter.*

1 Remove the air filter from the air cleaner housing (see Chapter 1).

2 Remove the bolt securing the air cleaner to the heat riser.

3 Disconnect any vacuum hoses or electrical connectors that would interfere with air cleaner removal and mark them with pieces of numbered tape for reassembly purposes.

4 Remove the bolts from the air cleaner bracket to the engine.

5 Lift the air cleaner assembly from the engine compartment.

6 Loosen the clamp at the cyclone pre-air cleaner and then remove the heat riser unit **(see illustration)**.

7 Remove the cyclone pre-air cleaner from the inner wheel housing.

8 Refitting is the reverse of removal.

9 Accelerator cable and hand throttle cable - removal, refitting and adjustment

Accelerator cable

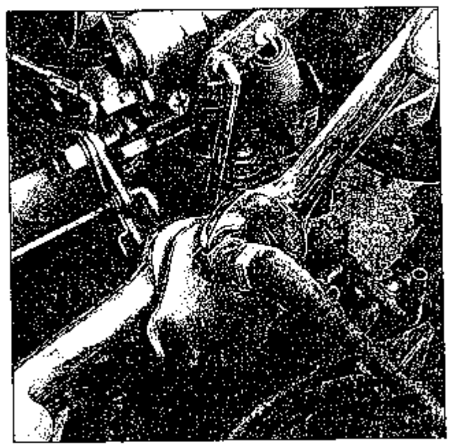
Refer to illustrations 9.1 and 9.2

Removal

1 Remove the accelerator cable from the throttle linkage by first opening the throttle full and then disconnecting the cable **(see illustration)**.

2 Loosen the accelerator cable locknuts and remove the cable from the bracket assembly **(see illustration)**.

3 Remove the cable from the throttle pedal inside the vehicle.



9.2 Two spanners will be needed to remove the cable housing from the adjustment bracket

4 Remove the cable brackets.
5 Pull the cable assembly through the firewall into the vehicle.

Refitting

6 Refitting is the reverse of removal. **Note:** *To prevent possible interference, flexible components (hoses, wires, etc.) must not be routed within 50 mm of moving parts, unless routing is controlled by brackets, etc.*
7 Operate the accelerator pedal and check for any binding condition by completely opening and closing the throttle.
8 If necessary, at the engine compartment side of the firewall, apply sealant around the accelerator cable to prevent water and hot air from entering the passenger compartment.

Adjustment

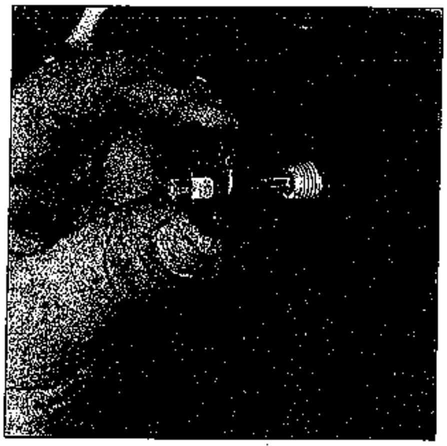
9 There is no specific adjustment on this type of accelerator cable but it is necessary to check that there is a small amount of freeplay in the cable when the throttle pedal is released completely and that the carburettor throttle is near full open when the pedal is pressed to the floor.
10 Have an assistant operate the throttle pedal while you observe the carburettor and the cable. Make certain that the hand throttle is fully released.

Hand throttle cable

Refer to illustrations 9.12a and 9.12b

11 The hand throttle cable is removed and refitted in a similar manner. Disconnect the lower end from the throttle pedal.
12 Remove the hand throttle control knob from the cable end shaft by removing the outer cover of the knob first **(see illustrations)**.
13 Unscrew the retaining nut from the dash.
14 Pull the shaft through the dash opening.
15 Make certain that the adjustment of the hand throttle cable allows adequate freeplay in the cable so that the carburettor can fully return to the idle position when the knob is turned fully counter-clockwise.

9.12a Pull the cover from the hand throttle knob and then remove the knob



9.12b The retainer unscrews to allow the cable to be pushed through the dash

10 Carburettor - diagnosis and overhaul

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. See* **Warning** *in Section 1.*

Diagnosis

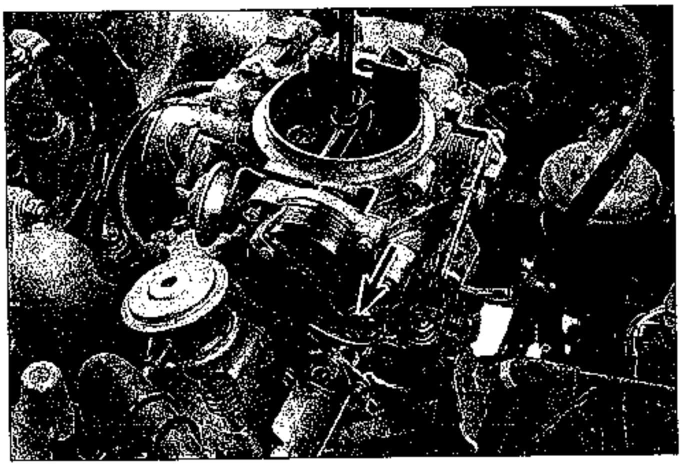
1 A thorough road test and check of carburettor adjustments should be done before any major carburettor service. Specifications for some adjustments are listed on the Vehicle Emissions Control Information (VECI) label found in the engine compartment.
2 Carburettor problems usually show up as flooding, hard starting, stalling, severe backfiring and poor acceleration. A carburettor that's leaking fuel and/or covered with wet looking deposits definitely needs attention.
3 Some performance complaints directed at the carburettor are actually a result of loose, out-of-adjustment or malfunctioning engine or electrical components. Others develop when vacuum hoses leak, are disconnected or are incorrectly routed. The proper approach to analysing carburettor problems should include the following items:

a) *Inspect all vacuum hoses and actuators for leaks and correct refitting* (see Chapters 1 and 6).
b) *Tighten the inlet manifold and carburettor mounting nuts/bolts evenly and securely.*
c) *Perform a compression test and vacuum test* (see Chapter 2C).
d) *Clean or renew the spark plugs as necessary* (see Chapter 1).
e) *Check the spark plug wires* (see Chapter 1).
f) *Inspect the ignition primary wires.*
g) *Check the ignition timing (follow the instructions printed on the Emissions Control Information label).*
h) *Check the fuel pump pressure/volume* (see Section 2).
i) *Check the heat control valve in the air cleaner for proper operation* (see Chapter 1).
j) *Check/renew the air filter element* (see Chapter 1).
k) *Check the PCV system* (see Chapter 6).
l) *Check/renew the fuel filter* (see Chapter 1). *Also, the strainer in the tank could be restricted.*
m) *Check for a plugged exhaust system.*
n) *Check EGR valve operation* (see Chapter 6).
o) *Check the choke - it should be completely open at normal engine operating temperature* (see Chapter 1).
p) *Check for fuel leaks and kinked or dented fuel lines* (see Chapters 1 and 4).
q) *Check accelerator pump operation with the engine off (remove the air cleaner cover and operate the throttle as you look into the carburettor throat - you should see a stream of petrol enter the carburettor).*
r) *Check for incorrect or bad petrol.*
s) *Check the valve clearances (if applicable) and camshaft lobe lift* (see Chapters 1 and 2).
t) *Have a dealer service department or other repair shop check the electronic engine and carburettor controls.*

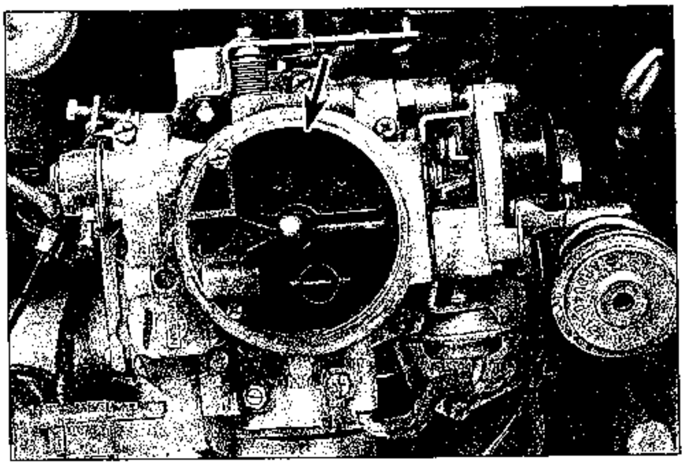
4 Diagnosing carburettor problems may require that the engine be started and run with the air cleaner off. While running the engine without the air cleaner, backfires are possible. This situation is likely to occur if the carburettor is malfunctioning, but just the removal of the air cleaner can lean the fuel/air mixture enough to produce an engine backfire. **Warning:** *Do not position any part of your body, especially your face, directly over the carburettor during inspection and servicing procedures. Wear eye protection!*

Overhaul

5 Once it's determined that the carburettor needs an overhaul, several options are available. If you're going to attempt to overhaul the carburettor yourself, first obtain a good-quality carburettor rebuild kit (which will include all necessary gaskets, internal parts, instructions and a parts list). You'll also need some special solvent and a means of blowing out the internal passages of the carburettor with air.
6 An alternative is to obtain a new or rebuilt carburettor. They are readily available from dealers and auto parts stores. Make absolutely sure the exchange carburettor is identical to the original. A tag is usually attached to the top of the carburettor or a number is stamped on the float bowl. It will help determine the exact type of carburettor you have. When obtaining a rebuilt carburettor or a rebuild kit, make sure the kit or carburettor matches your application exactly. Seemingly insignificant differences can make a large difference in engine performance.
7 If you choose to overhaul your own carburettor, allow enough time to disassemble it



11.8 Test the choke wire (arrow) for battery voltage with the engine running



11.14 Take the measurement for the vacuum break adjustment between the choke blade and the wall of the air horn (arrow)

carefully, soak the necessary parts in the cleaning solvent (usually for at least one-half day or according to the instructions listed on the carburettor cleaner) and reassemble it, which will usually take much longer than disassembly. When disassembling the carburettor, match each part with the illustration in the carburettor kit and lay the parts out in order on a clean work surface. Overhauls by inexperienced mechanics can result in an engine which runs poorly or not at all. To avoid this, use care and patience when disassembling the carburettor so you can reassemble it correctly.

8 Because carburettor designs are constantly modified by the manufacturer in order to meet increasingly more stringent emissions regulations, it isn't feasible to include a step-by-step overhaul of each type. You'll receive a detailed, well illustrated set of instructions with the carburettor overhaul kit.

11 Carburettor adjustments and checks

Note: *These carburettor adjustments are strictly in-vehicle adjustments. During overhaul, refer to the instructions included in the overhaul kit for complete procedures and any additional adjustments that are required.*

Fast idle speed

1 Warm up the engine.

2 With the engine turned off, open the throttle slightly and then position the fast idle cam to the second step.

3 Start the engine but do not operate the throttle or the fast idle cam setting will be lost.

4 Check the idle speed with an accurate tachometer. Compare the reading with the value listed in this Chapter's Specifications.

5 Adjust the fast idle speed by turning the fast idle adjustment screw until the engine rpm is correct.

Idle mixture

Note: *Be sure to check the ignition timing, the condition of the spark plugs and spark plug wires and, if necessary, perform a complete tune-up before attempting to make the following carburettor adjustment. Often, problems with the mixture are due to a vacuum leak (see* Troubleshooting *at the front of this manual and the vacuum gauge checks in Chapter 2C).*

6 Refer to Chapter 1 for idle speed and mixture adjustments.

Automatic choke

Refer to illustration 11.8

7 Refer to Chapter 1 for basic maintenance checks of the automatic choke. It should be fully closed when the engine is cold and not running and fully open when it is warm. The index marks on the cover of the choke thermostat must be aligned.

8 If the choke does not open, check for battery voltage at the wire connected to the choke **(see illustration)**. The engine must be running for this test.

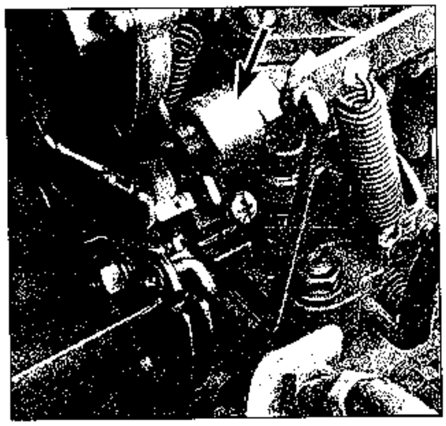
9 If there is power to the choke and the choke fails to open, then the choke thermostat is defective. Renew it.

10 If there is no power to the choke, check the wiring in the circuit and the choke relay. The choke relay is located in the relay centre near the battery.

Vacuum break

Refer to illustration 11.14

11 Make certain that the engine is cold. Open the throttle and allow it to return. The choke should be totally closed.



11.15 The fuel cut solenoid (arrow) is located on the side of the carburettor body

12 Use a hand vacuum pump to apply vacuum to the vacuum break diaphragm.

13 Gently push the rod towards the choke breaker.

14 Use the shank of a drill bit to measure the clearance between the bore and the choke blade **(see illustration)**. Compare it to the figure listed in the Specifications in this Chapter.

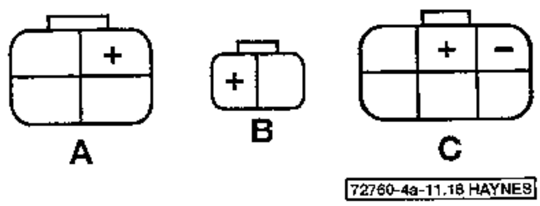
Fuel cut solenoid valve

Refer to illustrations 11.15 and 11.16

15 Disconnect the wiring to the fuel cut solenoid **(see illustration)**.

16 Touch fused jumper wires from the battery to the terminals shown **(see illustration)**. The fuel cut solenoid should energise when the power is applied. If it does not, renew it.

4A



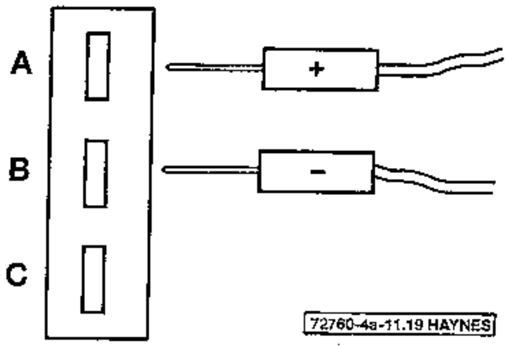
11.16 The fuel cut wiring connectors with the terminal positions

A *4.2 litre manual transmission*
B *4.2 litre automatic transmission*
C *3.0 litre model*

Throttle valve switch (automatic transmission models)

Refer to illustration 11.19

17 Warm-up the engine and check the idle speed (refer to Chapter 1). Turn the engine off.
18 Disconnect the wiring from the throttle sensor and also the throttle valve switch.
19 Attach an ohmmeter as shown **(see illustration)**. Start the engine and allow it to idle,,there should be continuity (zero resistance) between terminals A and B.
20 Raise the engine RPM slightly (100 to 400 RPM) and check that it switches open (infinite resistance).
21 If it doesn't, rotate the throttle switch until it the meter indicates an open circuit. Connect all of the wiring after rechecking the setting.



11.19 The throttle switch test connections

Choke manual control

22 Check that the choke is completely open when the knob is pushed in and that it is fully closed when it is pulled out.

Accelerator pump

23 Operate the throttle manually with the engine turned off.
24 Look into the top of the carburettor with the choke held fully open. There should be a steady stream of fuel sprayed.
25 If the fuel stream is poor in quality, the accelerator pump must be serviced.

Fast idle actuator

Refer to illustration 11.28

26 Warm-up the engine and allow it to idle in neutral with the air conditioner off.
27 Turn the air conditioner on. The idle speed should increase. Refer to the Specifications in this Chapter for the correct fast idle actuator engine speed.
28 Turn the adjusting screw to make an adjustment **(see illustration)**. The screw is located on the top of the actuator on automatic transmission models. On manual models, it is at the actuator lever.

Fast idle dashpot

29 Warm-up the engine. Check the idle speed and mixture (refer to Chapter 1).
30 Rotate the throttle by hand and observe the engine speed when the tip of the dash pot touches the lever on the throttle. Compare the speed to the value listed in this Chapter's Specifications.
31 Turn the adjusting screw on the end of the dash pot to make adjustments.
32 Rev the engine and check that the engine speed drops from 2,000 rpm to 1,000 rpm in about three seconds.

Fuel level check

Refer to illustration 11.33

33 With the vehicle level and the engine idling, observe the level of the fuel through the sight glass in the carburettor side cover. It should be approximately in the middle of the glass **(see illustration)**.

Fuel return solenoid (3.0 litre engine)

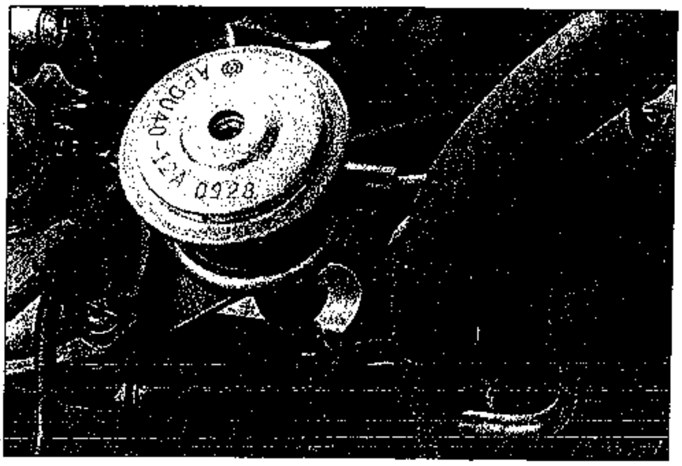
34 The fuel return solenoid should allow a large quantity of fuel to be returned to the fuel tank at low engine speeds. As the engine speed increases above 1,250 to 1,400 rpm, the amount returned should diminish.
35 To check the solenoid, remove the return hose and observe the flow of fuel into a container as the engine speed is raised above idle.
36 Connect a fused jumper wire to the wiring connector. With battery voltage applied, it should be easy to blow through the hose. With battery power removed, it should be difficult.

12 Carburettor - removal and refitting

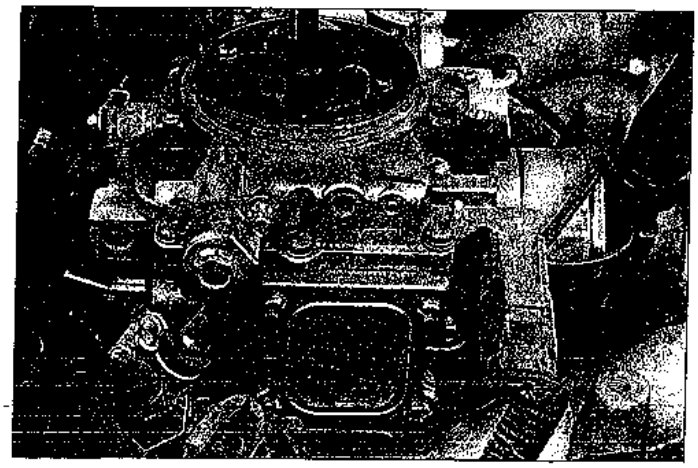
Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. See* **Warning** *in Section 1.*

Removal

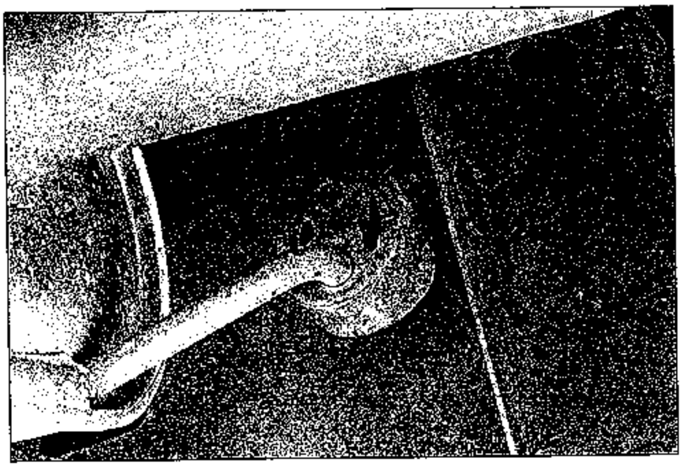
1 Disconnect the negative battery cable.
2 Remove the fuel filler cap to relieve fuel tank pressure. On 3.0 litre models, follow the fuel pressure relief procedure in Section 2.
3 Remove the air cleaner housing (see Section 8).
4 Disconnect the accelerator cable from the throttle lever (see Section 9).
5 Clearly label all vacuum hoses and fittings, then disconnect the hoses.
6 Disconnect the fuel line from the carburettor.
7 Label the wires and terminals, then unplug all the electrical connectors.
8 Remove the mounting fasteners and detach the carburettor from the inlet mani-



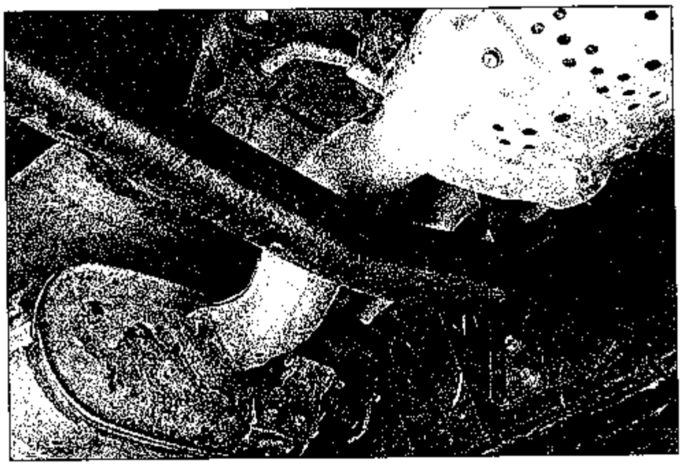
11.28 Location of the fast idle actuator



11.33 The fuel level can be seen through the sight glass located on the side cover



13.2a Check all of the rubber mounts for deterioration



13.2b Inspect the ends of the muffler for signs of rust - a screwdriver can be used as a probe if the material looks thin

fold. Remove the carburettor mounting gasket. Stuff a rag into the inlet manifold openings to prevent debris from entering.

Refitting

9 Use a gasket scraper to remove all traces of gasket material and sealant from the inlet manifold (and the carburettor, if it's being refitted), then remove the shop rag from the manifold openings. Clean the mating surfaces with lacquer thinner or acetone.
10 Place a new gasket on the inlet manifold.
11 Position the carburettor on the gasket and refit the mounting fasteners.
12 To prevent carburettor distortion or damage, tighten the fasteners securely in a criss-cross pattern, 1/4-turn at a time.
13 The remaining refitting steps are the reverse of removal.
14 Check and, if necessary, adjust the idle speed (see Chapter 1).
15 If the vehicle is equipped with an automatic transmission, refer to Chapter 7B for the kickdown linkage adjustment procedure.
16 Start the engine and check carefully for fuel leaks.

13 Exhaust system - servicing and general information

Refer to illustrations 13.2a, 13.2b and 13.2c

Warning: *Inspection and repair of exhaust system components should be done only after enough time has elapsed after driving the vehicle to allow the system components to cool completely. Also, when working under the vehicle, make sure it is securely supported on jackstands.*

1 The exhaust system consists of the exhaust manifold, the exhaust pipe, the muffler, the tailpipe and all connecting pipes, brackets, hangers and clamps. The exhaust system is attached to the body with mounting brackets and rubber hangers. If any of the parts are improperly refitted, excessive noise and vibration will be transmitted to the body.
2 Conduct regular inspections of the exhaust system to keep it safe and quiet. Look for any damaged or bent parts, open seams, holes, loose connections, excessive corrosion or other defects which could allow exhaust fumes to enter the vehicle **(see illustrations)**. Deteriorated exhaust system components should not be repaired; they should be renewed.
3 If the exhaust system components are extremely corroded or rusted together, welding equipment will probably be required to remove them. The convenient way to accomplish this is to have a muffler repair shop remove the corroded sections with a cutting torch. If, however, you want to save money by doing it yourself (and you don't have a welding outfit with a cutting torch), simply cut off the old components with a hacksaw. If you have compressed air, special pneumatic cutting chisels can also be used. If you do decide to tackle the job at home, be sure to wear safety goggles to protect your eyes from metal chips and work gloves to protect your hands.
4 Here are some simple guidelines to follow when repairing the exhaust system:

a) Work from the back to the front when removing exhaust system components.

13.2c Look at the steel mounts (arrow) to see if they are beginning to crack

b) Apply penetrating oil to the exhaust system component fasteners to make them easier to remove.
c) Use new gaskets, hangers and clamps when refitting exhaust system components.
d) Apply anti-seize compound to the threads of all exhaust system fasteners during reassembly.
e) Be sure to allow sufficient clearance between newly refitted parts and all points on the underbody to avoid overheating the floor pan and possibly damaging the interior carpet and insulation. Pay particularly close attention to the catalytic converter and heat shield.

4A

Notes

Chapter 4 Part B
Fuel and exhaust systems - fuel injected petrol engines

Contents

Specifications

Fuel pressure, engine idling	
Vacuum sensing hose detached	294 kPa
Vacuum sensing hose attached	214 to 255 kPa
Fuel injector resistance	10 to 14 ohms
Fuel pump resistance	0.5 ohms (approx.)
Idle Speed	See Chapter 1
Throttle position sensor resistance	
Throttle closed	1,000 ohms
Throttle open	9,000 ohms
Throttle valve switch operation point (in neutral)	750 to 1,050 rpm
AAC valve resistance	10 ohms (approx.)
Air regulator resistance	70 to 80 ohms

Torque specifications

	Nm
Throttle body mounting bolts	
First step	9 to 11
Second step	18 to 22
Fuel rail mounting bolts	10 to 12
Inlet manifold plenum bolts	16 to 19

1 General information

The fuel system consists of a fuel tank, an electric fuel pump (located in the fuel tank), fuel injectors, a fuel pressure regulator, an air cleaner assembly and a throttle body unit.

Electronic Combustion Control System (ECCS)

Electronic fuel injection uses timed impulses to inject the fuel directly into the intake port of each cylinder. The injectors are controlled by the Electronic Control Unit (ECU). The ECU monitors various engine parameters and delivers the exact required amount of fuel, into the intake ports. The throttle body serves only to control the amount of air passing into the system. Because each cylinder is equipped with an injector mounted immediately adjacent to the inlet valve, much better control of the fuel/air mixture ratio is possible.

Fuel pump and lines

Fuel is circulated from the fuel tank to the fuel injection system, and back to the fuel tank, through a pair of metal lines running along the underside of the vehicle. An electric fuel pump is attached to the fuel sending unit inside the fuel tank. A vapour return system routes all vapours and hot fuel back to the fuel tank through a separate return line.

The fuel pump will operate as long as the engine is cranking or running and the ECU is receiving ignition reference pulses from the electronic ignition system (see Chapter 5). If there are no reference pulses, the fuel pump will shut off after 5 seconds.

Exhaust system

The exhaust system includes an exhaust manifold fitted with an exhaust oxygen sensor, a catalytic converter, an exhaust pipe, and a muffler.

The catalytic converter is an emission control device added to the exhaust system to reduce pollutants. A single-bed converter is used in combination with a three-way (reduction) catalyst. Refer to Chapter 6 for more information regarding the catalytic converter.

2 Fuel pressure relief

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or a clothes dryer) is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. The fuel system is under constant pressure, so, if any fuel lines are to be disconnected, the fuel pressure in the system must be relieved first. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

1 Before servicing any fuel system component, you must relieve the fuel pressure to minimise the risk of fire or personal injury.

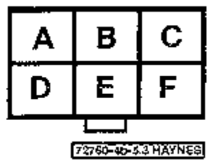
2 Remove the fuel filler cap - this will relieve any pressure built up in the tank.

3 Locate the fuel pump fuse. It is located in the electrical relay centre near the battery. Remove the fuse.

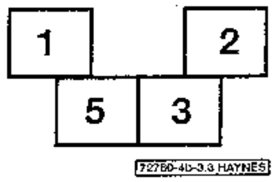
4 Start the engine and wait for the engine to stall, then operate the starter for approximately ten seconds. Refit the fuel pump fuse.

5 The fuel system is now depressurised. **Note:** *Place a rag around the fuel line before removing any hose clamp or fitting to prevent any residual fuel from spilling onto the engine.*

6 Before working on the fuel system, disconnect the cable from the negative terminal of the battery.



3.2 Connect an voltmeter to terminals A (+) and B (-) of the fuel pump chassis harness connector - battery voltage should be present for 5 seconds when the ignition key is switched ON



3.3 Fuel pump relay terminal locations. Connect a fused 12 volt jumper wire to terminal 1 and an earth jumper to terminal 2 - there should then be continuity across terminals 3 and 5

3 Fuel pump/fuel pressure - check

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or a clothes dryer) with a pilot light is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. The fuel system is under constant pressure, so, if any fuel lines are to be disconnected, the fuel pressure in the system must be relieved first. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

Fuel pump circuit check

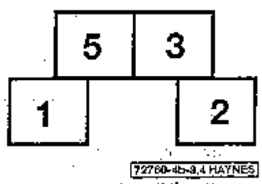
Refer to illustrations 3.2, 3.3 and 3.4

1 Turn the ignition ON and listen at the fuel tank for the sound of the fuel pump running. The fuel pump should operate for 5 second after the ignition is switched on, then shut off.

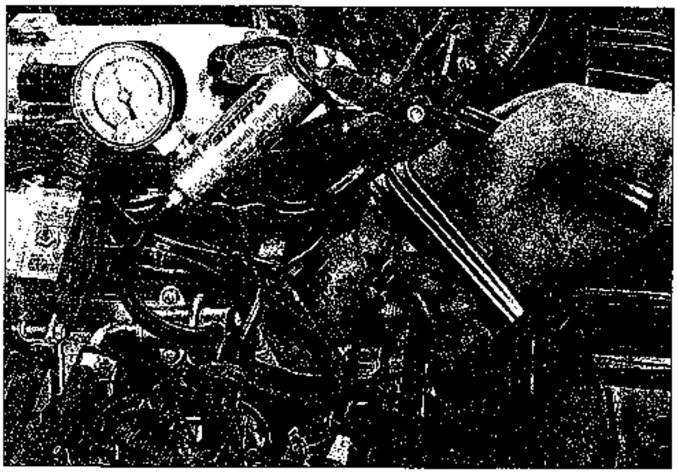
2 If the fuel pump does not operate, locate the fuel pump connector at the fuel tank, disconnect the connector and connect a voltmeter to terminals A (negative) and B (positive) of the chassis harness connector **(see illustration)**. Turn the ignition On, battery voltage should be indicated on the meter. If battery voltage is indicated and the fuel pump does not operate when connected, renew the fuel pump. If battery voltage is not indicated, check for continuity between the chassis harness terminal A and earth. If continuity is not present, repair the earth circuit and retest (the fuel pump earthing point is located inside the passenger compartment behind the right kick panel).

3 If the fuel pump is not receiving battery voltage on terminal B of the fuel pump connector, check the fuel pump relay in the engine compartment. Remove the relay and connect an ohmmeter to terminals 3 and 5 **(see illustration)**. Using fused jumper wires, apply battery voltage and earth connections to terminals 1 and 2 of the relay. The relay should click and continuity should be indicated on the meter (zero resistance). If the relay does not operate, renew the relay.

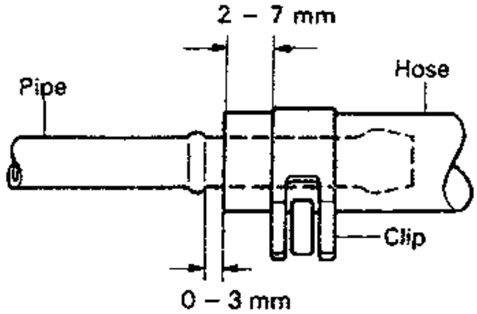
4 If the relay is good, check for battery voltage to the relay. With the ignition switched ON and the relay removed, there should be battery voltage at terminals 1 and 5 in the relay socket **(see illustration)**. If no



3.4 With the ignition ON there should be battery voltage at terminals 1 and 5 of the fuel pump relay socket



3.7 A hand vacuum pump like this is the best way to apply vacuum to the fuel pressure regulator



4.6 When attaching a section of rubber hose to a metal fuel line, be sure to overlap the hose as shown and secure it to the line with a new hose clamp of the proper type

voltage is present at the relay socket, check for an open circuit between the relay socket and the ignition switch and/or fuse box (don't forget to check the fuses and fusible links). Check for continuity between terminal number 2 of the relay socket and the ECU. If the circuits are good the ECU is probably defective.

Fuel pressure check

Refer to illustration 3.7

5 Relieve the fuel system pressure (see Section 2).

6 Disconnect the fuel inlet hose at the fuel rail and connect a fuel pressure gauge with a T-fitting and short section of hose between the fuel inlet hose and the fuel rail.

7 Disconnect and plug the vacuum hose from the fuel pressure regulator and connect a hand-held vacuum pump to the regulator **(see illustration)**. Start the engine and read the fuel pressure gauge without vacuum applied to the fuel pressure regulator. Apply vacuum to the regulator and check the fuel pressure again. The fuel pressure should decrease as vacuum increases. Compare your readings with the values listed in this Chapter's Specifications. **Note:** *On 1994 and previous models, there is a vacuum cut-off switch (PRVR. switch) refitted between the fuel pressure regulator and the vacuum source. If it is functioning properly, it will increase the fuel pressure during the first few minutes after hot start-up to 294 kPa.*

8 Reconnect the vacuum hose to the regulator and check the fuel pressure at idle, comparing your reading with the value listed in this Chapter's Specifications. Disconnect the hose and watch the gauge - the pressure should jump up to the maximum specified pressure as soon as the hose is disconnected. If the pressure at idle was too high (with the hose disconnected), connect a vacuum gauge to the hose and check for vacuum. If there is no reading on the gauge, check the air intake plenum and inlet manifold for a vacuum leak.

9 If the fuel pressure is LOW, pinch the fuel return line shut and watch the gauge. If the pressure doesn't rise, the fuel pump is defective or there is a restriction in the fuel feed line (possibly the fuel filter).

10 If the indicated fuel pressure is too high, relieve the fuel pressure (see Section 2), disconnect the fuel return line and blow through it to check for blockage. If there is no blockage, renew the fuel pressure regulator (see Section 11).

11 Carefully remove the fuel pressure gauge. Be sure to cover the fitting with a rag before loosening it. Wipe up any spilled petrol.

12 Start the engine and check for leaks.

4 Fuel lines and fittings - inspection and renewal

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or a clothes dryer) t is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. The fuel system is under constant pressure, so, if any fuel lines are to be disconnected, the fuel pressure in the system must be relieved first. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

Inspection

1 Once in a while, you will have to raise the vehicle to service or renew some component (an exhaust pipe hanger, for example). Whenever you work under the vehicle, always inspect fuel lines and all fittings and connections for damage or deterioration.

2 Check all hoses and pipes for cracks, kinks, deformation or obstructions.

3 Make sure all hoses and pipe clips attach their associated hoses or pipes securely to the underside of the vehicle.

4 Verify all hose clamps attaching rubber hoses to metal fuel lines or pipes are snug enough to assure a tight fit between the hoses and pipes.

Renewal

4B

Refer to illustration 4.6

5 If you must renew any damaged sections, use original equipment renewal hoses or pipes constructed from exactly the same material as the section you are refitting. Do not refit substitutes constructed from inferior or inappropriate material or you could cause a fuel leak or a fire.

6 Always, before detaching or disassembling any part of the fuel line system, note the routing of all hoses and pipes and the orientation of all clamps and clips to assure that renewal sections are refitted in exactly the same manner. When attaching hoses to metal lines, overlap them as shown **(see illustration)**.

7 Before detaching any part of the fuel system, be sure to relieve the fuel line and tank pressure by removing the fuel tank cap and following the procedure in Section 2. Cover the fitting being disconnected with a rag to absorb any fuel that may spray out.

5 Fuel pump - removal and refitting

Refer to illustration 5.3

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or a clothes dryer is present. Since* *petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. The fuel system is under constant pressure, so, if any fuel lines are to be disconnected, the fuel pressure in the system must be relieved first. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

1 Relieve the fuel system pressure (refer to Section 2).

2 The fuel pump used on fuel injected models is very similar to that used on 3.0 litre carburetted models. Refer to Chapter 4A for this procedure.

6 Fuel level sending unit - check and renewal

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or a clothes dryer) is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. The fuel system is under constant pressure, so, if any fuel lines are to be disconnected, the fuel pressure in the system must be relieved first. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

1 Relieve the fuel system pressure (refer to Section 2).

2 The fuel level sending unit used on fuel injected models is very similar to that used on 3.0 litre carburetted models. Refer to Chapter 4A for this procedure.

7 Air cleaner assembly - removal and refitting

1 Detach the clips and remove the air filter element from the housing (see Chapter 1).

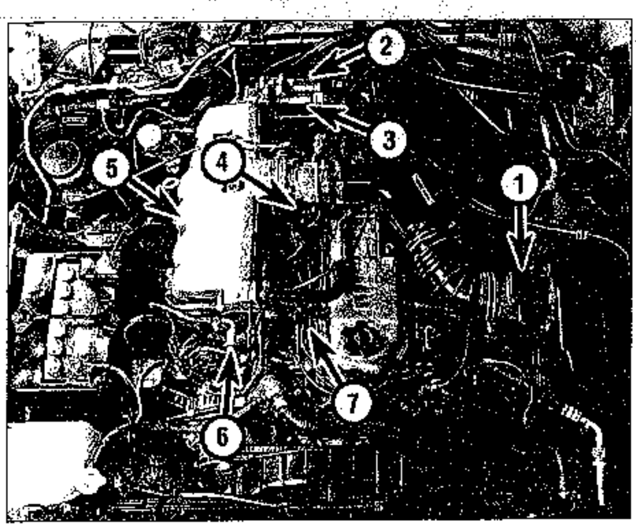
2 Disconnect the wiring at the air flow meter.

3 Loosen the clamp and disconnect the air intake hose from the air flow meter assembly.

4 Remove the housing from the engine compartment.

5 Remove the fasteners and remove the lower air cleaner assembly from the engine compartment.

6 Refitting is the reverse of removal.



9.1 Locations of the fuel system components in the engine compartment

1 *Air flow meter*
2 *Auxiliary Air Control (AAC) valve*
3 *Fast Idle Compensating Device (FICD) solenoid valve*
4 *Throttle sensor*
5 *Air regulator (below)*
6 *Fuel pressure regulator*
7 *Fuel injector (one of six)*

8 Accelerator cable - removal, refitting and adjustment

The throttle cable used on fuel injected models is very similar in function to that used on carburetted models. Refer to Chapter 4A for this procedure.

9 Electronic Combustion Control System (ECCS) - general information

Refer to illustration 9.1

1 These models are equipped with an Electronic Combustion Control System (ECCS). The ECCS system is composed of three basic subsystems: fuel system, air induction system and electronic control system **(see illustration)**.

Fuel system

2 An electric fuel pump located inside the fuel tank supplies fuel under constant pressure to the fuel rail, which distributes fuel evenly to all injectors. From the fuel rail, fuel is injected into the intake ports, just above the inlet valves, by fuel injectors. The amount of fuel supplied by the injectors is precisely controlled by an Electronic Control Unit (ECU). A pressure regulator controls system pressure in relation to inlet manifold vacuum. A fuel filter between the fuel pump and the fuel rail filters fuel to protect the components of the system. The ECU controls the fuel pump by earthing the coil of the fuel pump relay, energising the fuel pump.

Air induction system

3 The air induction system consists of an air filter housing, the throttle body and the duct connecting the two. The throttle plate inside the throttle body is controlled by the driver. There is an air flow meter located in the inlet air duct which informs the ECU of the quantity of air passing into the engine. The ECU then adjusts injector opening duration ignition timing based on this information as well as information from several other sensors.

Electronic control system

4 This system controls the fuel injection and other systems by means of an Electronic Control Unit (ECU), which employs a microcomputer. The ECU receives signals from a number of information sensors which monitor such variables as intake air flow, throttle angle, coolant temperature, engine rpm, vehicle speed and exhaust oxygen content. These signals help the ECU determine the injection duration and ignition timing necessary for the optimum air/fuel ratio. Some of these sensors and their corresponding ECU-controlled relays are not contained within EFI components, but are located throughout the engine compartment. For further information regarding the ECU and its relationship to the engine electrical and ignition system, see Chapter 6.

10 Electronic Combustion Control System - check

Refer to illustrations 10.6a, 10.6b, 10.7, 10.8 and 10.9

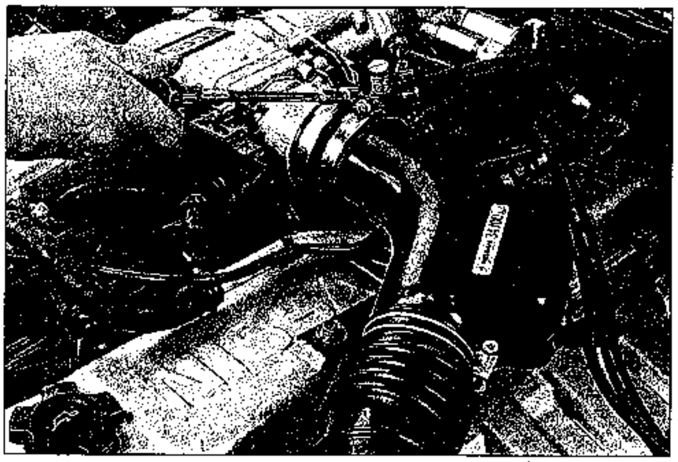
1 Check the earth wire connections for tightness. Check all wiring and electrical connectors that are related to the system. Loose electrical connectors and poor grounds can cause many problems that resemble more serious malfunctions.

2 Check to see that the battery is fully charged, as the control unit and sensors depend on an accurate supply voltage in order to properly meter the fuel.

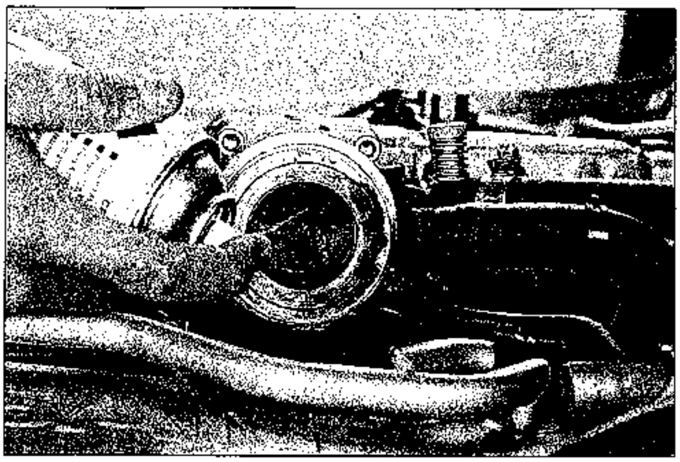
3 Check the air filter element - a dirty or partially blocked filter will severely impede performance and economy (see Chapter 1).

4 If a blown fuse is found, renew it and see if it blows again. If it does, search for a earthed wire in the harness related to the system.

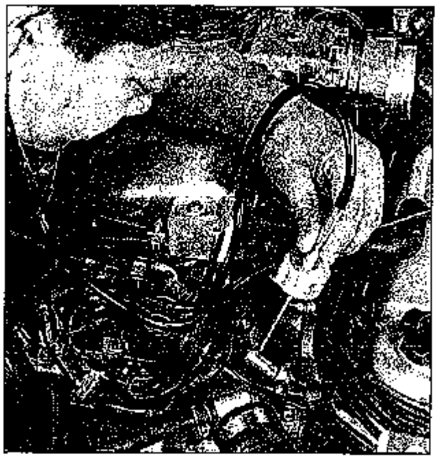
5 Check the air intake duct from the air



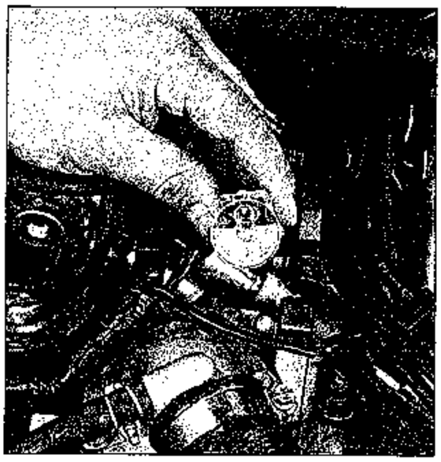
10.6a Disconnect the air inlet duct from the throttle body - it should be possible to pull it gently aside to allow servicing of the throttle body



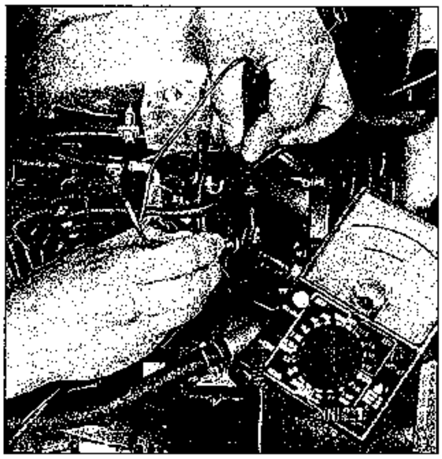
10.6b Use carburettor cleaner with a rag or toothbrush to remove all traces of carbon and debris from the bore of the throttle body - it must be kept clean to allow proper performance



10.7 Place a stethoscope on each injector - they should all make an audible clicking as they operate. Be careful of getting the equipment entangled in the fan as you do this



10.8 A "noid" light is the best way to check if an injector is receiving power - the noid will flash with every injector pulse



10.9 If an injector fails to click even though it is getting power, check its resistance with an ohmmeter

cleaner housing to the inlet manifold for leaks, which will result in an excessively lean mixture. Also check the condition of the vacuum hoses connected to the inlet manifold.

6 Remove the air intake duct from the throttle body and check for carbon and residue build-up inside the throttle body. If it's dirty, clean it with aerosol carburettor cleaner (make sure the can says it's safe for use with oxygen sensors and catalytic converters) and a toothbrush **(see illustrations)**.

7 With the engine running, place a stethoscope against each injector, one at a time, and listen for a clicking sound, indicating operation **(see illustration)**. If you don't have an automotive stethoscope you can use a long screwdriver; just place the tip of the screwdriver against the injector body and press your ear against the handle.

8 If there is a problem with an injector, purchase a special injector test light ("noid" light) and refit it into the injector electrical connector **(see illustration)**. Start the engine and make sure that each injector connector flashes the noid light. This will test for the proper voltage signal to the injector.

9 With the engine OFF and the fuel injector electrical connectors disconnected, measure the resistance of each injector **(see illustration)**. Each injector should read near the figure listed in this Chapter's Specifications. If not, the injector is probably faulty.

10 The remainder of the system checks should be left to a dealer service department or other qualified repair shop, as there is a chance that the control unit may be damaged if the tests are not performed properly.

11 Electronic Combustion Control System (ECCS)- component check and renewal

Warning: *Petrol is extremely flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area, and don't work in a garage where a natural gas-type appliance (such as a water heater or a clothes dryer) is present. Since petrol is carcinogenic, wear latex gloves when there's a possibility of being exposed to fuel, and, if you spill any fuel on your skin, rinse it off immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. The fuel system is under constant pressure, so, if any fuel lines are to be disconnected, the fuel pressure in the system must be relieved first. When you perform any kind of work on the fuel system, wear safety glasses and have a Class B type fire extinguisher on hand.*

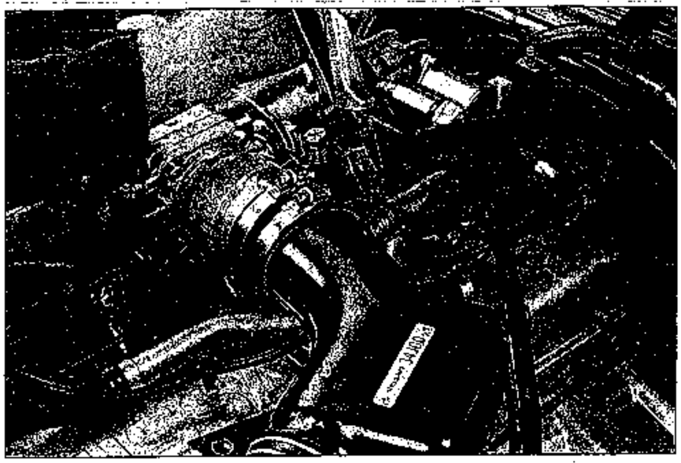
Caution: *If the stereo in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery.*

Throttle body

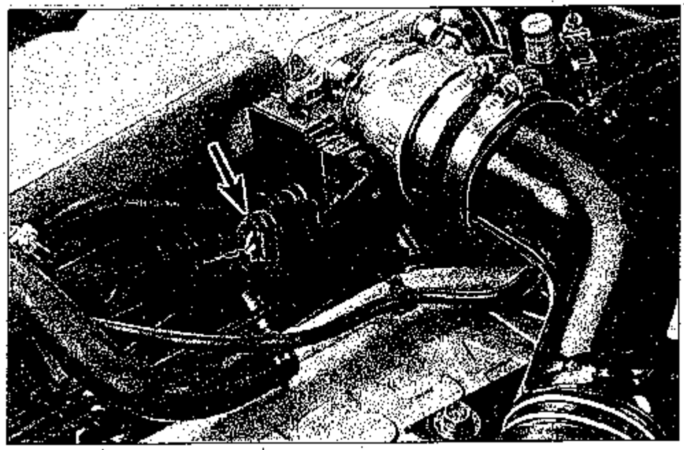
Refer to illustration 11.5

Check

1 Verify that the throttle linkage operates smoothly.



11.5 Disconnect the breather hose from the air intake duct, loosen the clamps and remove the duct from the throttle body



11.14 There are two wiring connectors on the throttle sensor, The one with the pigtail (arrow) is for the throttle sensor - the other is for the idle switch

2 Start the engine, then closely inspect the sealing surfaces of the throttle body for signs of a vacuum leak. Spraying an aerosol carburettor cleaner on the area will help - if the engine speed rises when cleaner is applied to a certain area, then there is a vacuum leak there.

3 Check the mounting bolts for the proper torque.

Renewal

Warning: *Wait until the engine is completely cool before beginning this procedure.*

4 Detach the cable from the negative terminal of the battery.

5 Loosen the hose clamps and remove the air intake duct **(see illustration)**.

6 Detach the accelerator cable from the throttle lever by holding the throttle open and then removing the cable from the throttle body.

7 Drain about half of the coolant in the system (refer to Chapter 1). Disconnect the coolant hoses that attach to the throttle body. Disconnect the vacuum hose.

8 Disconnect the wiring from the two sensors on the throttle body.

9 Remove the throttle body mounting bolts.

10 Detach the throttle body and gasket from the inlet manifold.

11 Using a soft brush and carburettor cleaner, thoroughly clean the throttle body casting, then blow out all passages with compressed air. **Caution:** *Do not clean the throttle position sensor with anything. Just wipe it off carefully with a clean, soft cloth.*

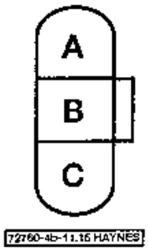
12 Refitting of the throttle body is the reverse of removal.

13 Be sure to tighten the throttle body mounting bolts to the torque listed in this Chapter's Specifications.

Throttle sensor

Refer to illustrations 11.14, 11.15 and 11.20

Note: *There are two wiring connectors attached to the throttle sensor. The connector at the end of the short harness is for the throttle sensor. The connector located directly on the throttle sensor is for the idle switch.*



11.15 The connector for the throttle sensor looks like this - connect your ohmmeter between terminals B and C

Check

14 Disconnect the electrical connector at the end of the short harness from the throttle sensor **(see illustration)**.

15 Connect an ohmmeter to terminals B and C **(see illustration)**.

16 Measure the resistance between the indicated terminal pairs with the throttle closed and with the throttle fully open. Compare your readings to those listed in this Chapter's Specifications. Renew the sensor if the readings are not within specifications.

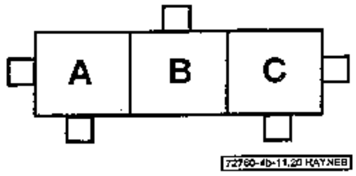
17 If there is a spike in the reading as you rotate the throttle, renew the sensor.

18 The sensor can be backprobed while it is connected and with the ignition turned ON. Measure the voltage at terminal B. It should vary smoothly from 0.3 to 5 volts as the throttle is opened.

19 To test the idle switch portion of the sensor, disconnect the connector from the body of the sensor.

20 Connect an ohmmeter between terminals A and B **(see illustration)**. With the throttle closed, there should be continuity (zero resistance).

21 Open the throttle slightly, the meter should switch to an open circuit (infinite resistance). If the operation of the switch is not correct, attempt to adjust the sensor before renewing it.



11.20 Idle switch connector - the ohmmeter should be connected to terminals A and B for testing and adjustment

Adjustment

22 Connect an ohmmeter to terminals A and B of the idle switch **(see illustration 11.20)**. Disconnect the AAC valve wiring.

23 Connect a hand held tachometer to the engine. Start the engine.

24 Slowly open the throttle and note the speed at which the idle switch opens as indicated on the ohmmeter. Compare your readings to the value listed in this Chapter's Specifications.

25 If the idle switch does not open within the specified range, loosen the mounting bolts and rotate the switch to adjust it. If it cannot be adjusted to specifications, renew the sensor.

Renewal

26 Disconnect both wiring connectors. Remove the mounting screws.

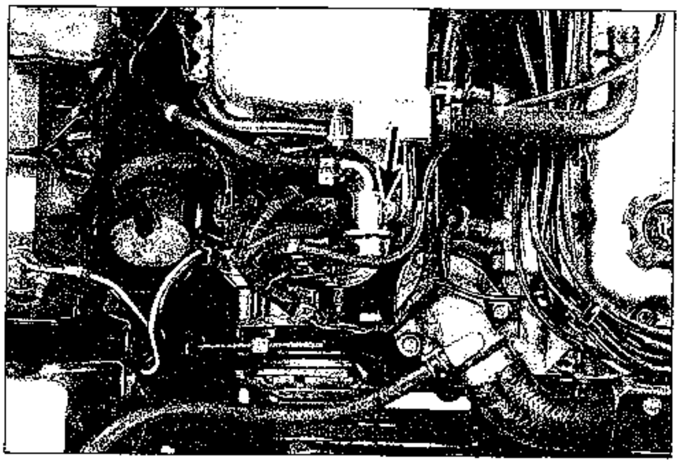
27 Refitting is the reverse of removal. Make certain that the shaft of the sensor registers correctly on the throttle shaft as you refit it.

28 Adjust the sensor.

Fuel pressure regulator

Check

29 Refer to the fuel pump/fuel pressure check procedure (see Section 3).



11.31 The fuel pressure regulator is mounted on the front of the engine - disconnect the vacuum and fuel lines, then remove the mounting bolts

11.37 The AAC valve (arrow) is located at the rear of the inlet plenum

Renewal

Refer to illustration 11.31

30 Relieve the fuel system pressure (see Section 2) and detach the cable from the negative terminal of the battery (see the **Caution** at the beginning of this Section).

31 Detach the vacuum sensing hose from the regulator **(see illustration)**.

32 Place a metal container or shop towel under the fuel return hose.

33 Remove the fuel line from the fuel pressure regulator.

34 Remove the pressure regulator mounting screws and detach the pressure regulator from the fuel rail.

35 Use a new O-ring and make sure that the pressure regulator is refitted properly on the fuel rail.

36 The remainder of refitting is the reverse of removal.

Auxiliary Air Control (AAC) valve

Check

Refer to illustration 11.37

37 Disconnect the wiring from the AAC valve **(see illustration)**.

38 Connect an ohmmeter across the two terminals of the unit. Compare the reading to the value listed in this Chapter's Specification.

39 Remove the unit and check it for smooth operation of the plungers and an unbroken spring.

40 Make certain that all passages are clear.

Renewal

41 Disconnect the hose and the wiring harness.

42 Remove the mounting bolts and lift the valve from the idle air adjusting unit.

43 Refitting is the reverse of removal. Renew the gasket.

Fast Idle Compensating Device (FICD)

Check

44 Disconnect the wiring harness from the unit.

45 Connect one of the terminals to earth and apply battery voltage with a fused jumper wire to the other.

46 There should be a clear clicking sound from the FICD.

47 Remove the unit and check for a sticky plunger and a broken spring.

Renewal

48 Disconnect the wiring connector.

49 Unscrew the FICD from the idle air adjusting unit.

50 Refitting is the reverse of removal. Renew the gasket.

Air regulator

Check

51 Disconnect the wiring harness from the unit. (It is beneath the inlet manifold).

52 Use an ohmmeter to test the resistance between the two terminals. Compare the reading to the figure listed in the Specifications in this Chapter.

53 Remove the air regulator and check it for clogging.

Renewal

54 Disconnect the wiring harness.

55 Disconnect the hoses.

56 remove the mounting bolts and lift the regulator from the inlet manifold.

Fuel rail

Check

57 Refer to the fuel injection system checking procedure (see Section 10).

Renewal

58 Relieve the fuel system pressure (see Section 2).

59 Detach the cable from the negative terminal of the battery.

60 Disconnect the throttle cable from the throttle body.

61 Remove the throttle body.

62 Remove the earth cable and the bracket for the injector harness connector.

63 Disconnect the fuel supply and return hoses.

64 Disconnect the spark plug wires from the spark plugs. Label them, if necessary and position them aside.

65 Disconnect the injector wiring connectors and the fuel temperature harness connector.

66 Remove the fuel rail mounting bolts.

67 Remove the fuel rail with the fuel injectors attached.

Fuel injector renewal

68 Use a knife which has been heated to cut through the braided reinforcement on the injector connecting hose. Do not cut into the injector.

69 Pull the hose off.

70 To refit a new injector, lubricate both ends of the new fuel hose and push it firmly onto the injector and the fuel rail by hand.

71 Refitting is the reverse of removal. Renew the grommets and O-rings.

72 Tighten the fuel rail mounting bolts to the torque listed in this Chapter's Specifications.

Air inlet plenum

73 Remove the inlet manifold from the engine (refer to Chapter 2A).

74 Invert the manifold and remove the bolts securing the plenum to the lower inlet manifold. There are bolts which are accessible from below and above.

75 Refitting is the reverse of removal. Make certain to use a new gasket and to tighten the fasteners to the torque listed in this Chapter's specifications.

Notes

Chapter 4 Part C
Fuel and exhaust systems - diesel engines

Contents

Specifications

Coolant temperature sensor resistance	
At 0-degrees C	5,600 ohms
At 20-degrees C	2,500 ohms
At40-degrees C	1,200 ohms

Torque specifications

	Nm
Fuel injectors	54 to 64
Coolant temperature sensor	15 to 25
Glow plugs	15 to 20
Fuel injection pump nuts	19 to 25
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Fuel injection tube nuts	20 to 25
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1 General information, precautions and fuel system cleaning

General information

The fuel system is comprised of a fuel tank, a fuel injection pump, an engine compartment-mounted fuel filter, fuel supply and return lines and eight fuel injectors.

The injection pump is driven at half crankshaft speed by a gear train at the front of the engine. Fuel is drawn from the fuel tank through the filter by the injection pump, which then distributes the fuel under very high pressure to the injectors via separate lines.

The injectors are spring loaded mechanical valves which open when the pressure of the fuel supplied to them exceeds a specific limit. Fuel is then sprayed into the combustion chamber. The high compression developed by the rising piston superheats the mixture to the point of combustion.

The basic injection timing is set by the position of the injection pump on the engine. When the engine is running, the pump is advanced and retarded by the pump itself. It is influenced primarily by the accelerator position and engine speed.

The engine is stopped by means of a fuel cut solenoid which interrupts the flow of fuel to the injection pump when it is de-energized.

The engine idle speed can be raised by using a hand throttle which is located on the dash.

Precautions

Many of the operations described in this Chapter involve the disconnection of fuel lines which may cause fuel to leak. Before commencing work, refer to the Warnings and Cautions given below and the information in Safety first at the beginning of this manual.

Warning 1: *Diesel fuel is flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area. Don't work in a garage where a natural gas appliance such as a water heater or a clothes dryer is present. Since diesel fuel is carcinogenic, wear latex gloves when there is a possibility of being exposed to fuel. If you spill fuel on your skin, rinse it immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. When you perform any work on the fuel system, wear safety glasses and keep a Class B type fire extinguisher on hand.*

Warning 2: *Fuel injectors operate at extremely high pressures and the jet of fuel produced at the nozzle is capable of piercing the skin with potentially fatal results. Never work with pressurized injectors - any pressure testing of the fuel system must be done by a diesel fuel systems specialist.*

Caution: *Under no circumstance should diesel fuel be allowed to come in contact with coolant hoses - wipe off accidental spillage immediately. Hoses that have been contaminated with fuel for an extended period should be renewed. Diesel fuel systems are particularly sensitive to contamination from dirt, air and water. Pay particular attention to cleanliness when working on any part of the fuel system to prevent the entry of dirt. Thoroughly clean the area around fuel fittings before disconnecting them. Store dismantled components in sealed containers to prevent contamination and the formation of condensation. Use only lint-free rags and clean fuel for cleaning. Avoid using compressed air when cleaning components in place.*

Diesel fuel contamination

Before you renew an injection pump or some other expensive component, find out what caused the failure. If water contamination is present, buying a new pump or other component won't do much good. The following procedure will help you pinpoint whether water contamination is present:

a) Remove the fuel filter and inspect the contents for the presence of water or petrol (refer to Chapter 1).
b) If the vehicle has been stalling, performance has been poor or the engine has been knocking loudly, suspect fuel contamination. Petrol or water must be removed by flushing (see below).
c) If you find a lot of water in the fuel filter, remove the injection pump fuel return line and check for water there. If the pump has water in it, flush the system.
d) Small quantities of surface rust won't create a problem. If contamination is excessive, the vehicle will probably stall.
e) Sometimes, contamination in the system becomes severe enough to cause damage to the internal parts in the pump. If the damage reaches this stage, have the damaged parts renewed and the pump rebuilt by an authorized fuel injection shop or buy a rebuilt pump.

Storage

Good quality diesel fuel contains inhibitors to stop the formation of rust in the fuel lines and the injectors. So long as there are no leaks in the fuel system, it is generally safe from water contamination. Diesel fuel is usually contaminated from water as a result of careless storage. There is little you can do about the storage practices of service stations where you buy diesel fuel, but if you keep a small supply of diesel fuel on hand at home, as many diesel owners do, follow these simple rules:

a) Diesel fuel "ages" and goes stale. Don't store containers of diesel fuel for long periods of time. Use it up regularly and replace it with fresh fuel.
b) Keep fuel storage containers out of direct sunlight. Variations in heat and humidity promote condensation inside fuel containers.
c) Don't store diesel fuel in galvanized containers. It may cause the galvanizing to flake off, contaminating the fuel and clogging filters when the fuel is used.
d) Label containers properly as containing diesel fuel.

Fighting fungi and bacteria with biocides

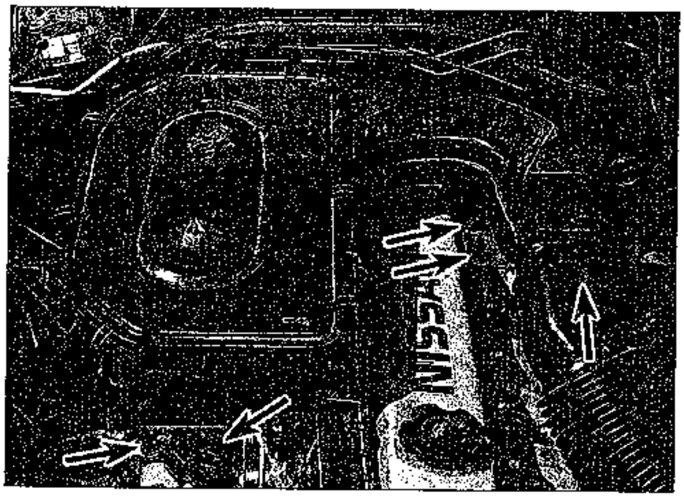
If there is water in the fuel, fungi and/or bacteria can form in diesel fuel in warm or humid weather. Fungi and bacteria plug fuel lines, fuel filters and injection nozzles; they can also cause corrosion in the fuel system.

If you've had problems with water in the fuel system and you live in a warm and humid climate, have your dealer correct the problem. Then use a diesel fuel biocide to sterilize the fuel system in accordance with the manufacturer's instructions. Biocides are available from your dealer, service stations and auto parts stores. Consult your dealer for advice on using biocides in your area and for recommendations on which ones to use.

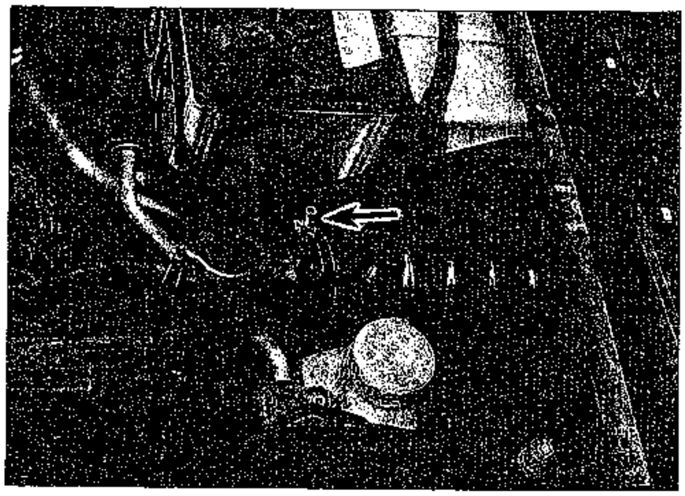
Cleaning the fuel system

Water in the fuel system

1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.
2 Drain the fuel tank into an approved container and dispose of it properly.
3 Remove the fuel sending unit (refer to Chapter 4A).
4 Thoroughly clean the fuel tank. If it is rusted inside, send it to a repair shop or renew it. Clean or renew the fuel pick-up screen in the fuel tank.
5 Refit the fuel tank but do not connect the fuel lines to it yet.
6 Remove the fuel filter (refer to Chapter 1).
7 Temporarily disconnect the fuel return line at the injection pump and again, using low air pressure, blow out the lines toward the rear of the vehicle.
8 Reconnect the main fuel and return lines at the tank. Fill the tank to a fourth of its capacity. Refit the cap.
9 Discard the fuel filter.
10 Connect the fuel line to the fuel pump.
11 Reconnect the battery cable.
12 Purge the fuel pump and pump-to-filter line by cranking the engine until clean fuel runs out. Catch the fuel in a closed metal container.
13 refit a new fuel filter.
14 Refit a hose from the fuel return line (from the injection pump) to a closed metal container with a capacity of at least eight litres.
15 Crank the engine until clear fuel appears at the return line. Don't crank the engine for more than 30 seconds at a time. If it is necessary to crank it again, allow a three-minute interval before resuming.
17 Crank the engine until clear fuel appears at each nozzle. Don't crank the engine for more than 30 seconds at a time. If it is necessary to crank it again, allow a three-minute interval before resuming.



2.3 Remove the air cleaner mounting screws (arrows)



2.6 Loosen the precleaner duct clamp (arrow)

Petrol in the fuel system

Warning: *Diesel fuel is flammable, so take extra precautions when you work on any part of the fuel system. Don't smoke or allow open flames or bare light bulbs near the work area. Don't work in a garage where a natural gas appliance such as a water heater or a clothes dryer is present. Since diesel fuel is carcinogenic, wear latex gloves when there is a possibility of being exposed to fuel. If you spill fuel on your skin, rinse it immediately with soap and water. Mop up any spills immediately and do not store fuel-soaked rags where they could ignite. When you perform any work on the fuel system, wear safety glasses and keep a Class B type fire extinguisher on hand.*

If petrol has been accidentally pumped into the fuel tank, it should be drained immediately. Petrol in the fuel in small amounts, up to 30 percent, isn't usually noticeable. At higher ratios, the engine may make a knocking noise which will get louder as the ratio of petrol increases. Here is how to rid the fuel system of petrol:

18 Drain the fuel tank into an approved container and fill the tank with clean, fresh diesel fuel.

19 Detach the fuel line between the fuel filter and the injection pump.

20 Connect a short pipe and hose to the fuel filter outlet and run it to a closed metal container.

21 Crank the engine to purge petrol out of the fuel pump and fuel filter. Do not crank the engine for more than 30 seconds at a time. Allow three minutes between interval to allow the starter to cool.

22 Remove the pipe and hose and refit the fuel line previously removed.

23 Try to start the engine. If it doesn't start, purge the injection pump and lines: Crack the fuel line fittings open a little, just enough for fuel to leak out. Depress the accelerator pedal to the floor and, holding it there, crank the engine until all petrol is removed, i.e. diesel fuel leaks from the fittings. Tighten the fittings. Limit cranking to 30 seconds with three minute intervals between cranking. **Warning:** *Avoid sources of ignition and have a fire extinguisher nearby.*

24 Start the engine and run it at idle for fifteen minutes.

2 Air cleaner and precleaner - removal and refitting

Refer to illustrations 2.1 and 2.6

Air cleaner

1 Disconnect the hose which attaches to the valve cover **(see illustration)**.

2 Disconnect the air duct from the air cleaner.

3 Unbolt the air cleaner from the engine.

4 Loosen the clamp which secures the air cleaner assembly to the inlet manifold. Lift it from the engine compartment.

5 Refitting is the reverse of removal.

Precleaner

6 Disconnect the air duct from the precleaner **(see illustration)**.

7 Unbolt the precleaner from the engine. Lift it from the engine compartment.

8 Refitting is the reverse of removal.

3 Accelerator cable and hand throttle cable - removal, refitting and adjustment

Accelerator cable

Removal and refitting

Refer to illustration 3.2

1 Disconnect the cable jacket from the bracket on the fuel injection pump.

2 Disconnect the cable from the injection pump while turning the throttle arm to allow slack **(see illustration)**.

3 Unclip the cable at its attachment points.

4 Disconnect the cable assembly from the accelerator pedal.

5 Unbolt the cable mounting bracket from the bulkhead. Pull it into the vehicle.

6 Refitting is the reverse of removal. Adjust the cable as follows.

Adjustment

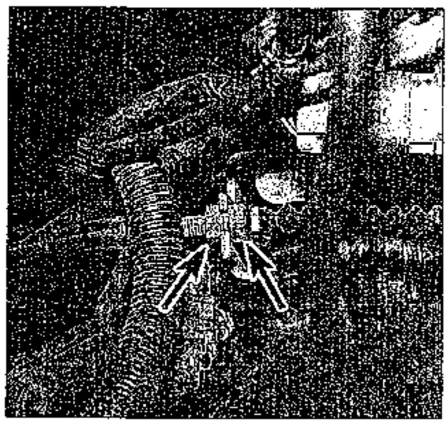
Note: *Before beginning, verify that the hand throttle cable is totally slack and that the lever on the fuel injection pump is seated on the idle stop screw.*

4C

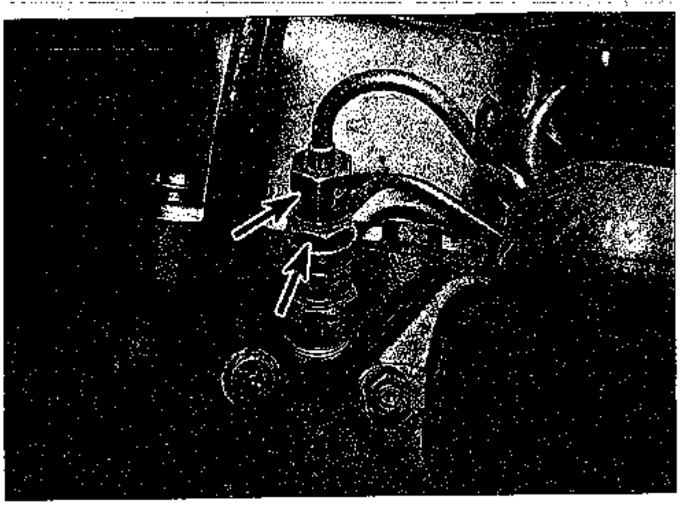
7 Have an assistant hold the accelerator pedal to the floor. Check that the injection pump arm touches the max engine speed screw.

8 If the arm does not touch the screw, loosen the adjustment lock-nuts on the cable and adjust them until it does.

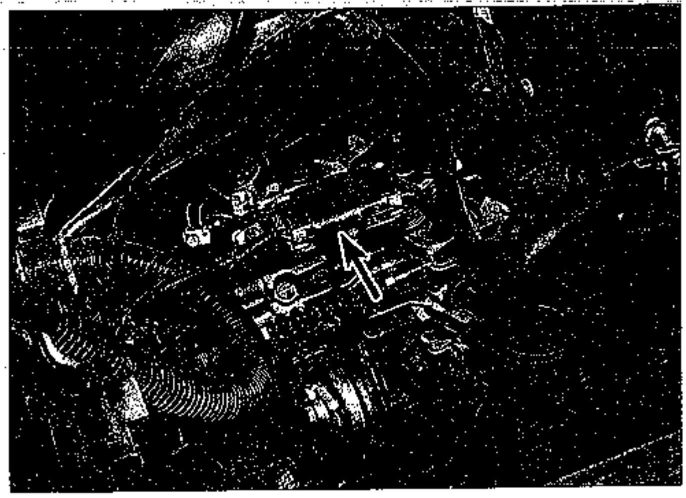
9 Release the accelerator pedal. Verify that there is a small amount of slack at the pedal. Again adjust the lock-nuts, if required, to give the required free play.



3.2 Loosen the cable lock nuts and remove the cable from the injection pump



6.1 Remove the line to the injector using two spanners at the points shown by the arrows



7.2 Disconnect the electrical connections at the injection pump (arrow)

Hand throttle cable

Removal and refitting

10 Disconnect the cable from the accelerator pedal.
11 Disconnect the cable assembly from the mounting bracket.
12 Pull out on the hand throttle control knob.
13 Hold the portion of the cable immediately behind the knob with pliers. Twist the knob clockwise while pushing it in to remove it.
14 Remove the mounting nut at the dash.
15 Pull the cable into the vehicle.
16 Refitting is the reverse of removal. **Note:** *There is no adjustment procedure for the hand throttle cable.*

4 Fuel tank - removal and refitting

Warning 1: *Diesel fuel is flammable, so take extra precautions when you work on any part of the fuel system. See* **Warnings** *in Section 1.*
Warning 2: Repairs to the fuel tank or filler neck should only be performed by a professional with the proper training to carry out this critical and potentially dangerous work. Even after cleaning and flushing, fumes can remain and could explode during repair of the tank.
Warning 3: If the fuel tank is removed from the vehicle, it should not be placed in an area where sparks or open flames could ignite the fumes coming out of the tank. Be especially careful inside garages where a gas appliance is located because the pilot light or flame could cause an explosion.

1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.
2 Raise the vehicle and support it securely on jackstands.
3 Remove the tie-down hooks and the carpet edge retainers from the rear of the vehicle. Pull the carpet forward to expose the fuel tank access panel.
4 Remove the access panel.
5 Label and then disconnect the fuel hoses from the sending unit.
6 Disconnect the wiring from the fuel tank.
7 Using the drain plug, drain the fuel tank into an approved metal container.
8 Remove the shield mounting bolts from the fuel filler tube in the right wheel housing.
9 Remove the clamps from the filler tube and the vapor line where they attach to the fuel tank. Pull the hoses free.
10 Remove the filler tube shield.
11 Have an assistant support the empty tank or place a floor jack beneath it.
12 Remove the tank mounting bolts. Carefully lower the tank.
13 Refitting is the reverse of removal.

5 Fuel tank cleaning and repair - general information

1 Repairs to the fuel tank or filler neck should only be performed by a professional with the proper training to carry out this critical and potentially dangerous work. Even after cleaning and flushing, fumes can remain and could explode during repair of the tank.
2 If the fuel tank is removed from the vehicle, it should not be placed in an area where sparks or open flames could ignite the fumes coming out of the tank. Be especially careful inside garages where a gas appliance is located because the pilot light or flame could cause an explosion.

6 Fuel injectors - removal and refitting

Warning: *Diesel fuel is flammable, so take extra precautions when you work on any part of the fuel system. See* **Warnings** *in Section 1.*

Removal

Refer to illustration 6.1

1 Loosen the nuts which secure the fuel lines to the injectors and the fuel injector. It will be necessary to hold the injector or pump with one spanner while the nut is loosened with another **(see illustration)**.
2 After removing the brackets, remove the fuel lines from the engine.
3 Remove the union retaining nuts on each injector. It will be necessary to hold the injector with one spanner while the nut is loosened with another.
4 Disconnect the fuel return hose from its tube. Remove the tube.
5 Clean around each injector thoroughly to prevent debris from falling into the engine after the injectors are removed.
6 Remove the injectors using a deep socket.

Refitting

7 Make sure that there is no debris on any of the sealing surfaces of the injectors or the cylinder head.
8 Refit two new washers to the bottom of each injector. A dab of grease will hold them in position while they are being refitted.
9 Refitting is the reverse of removal. Tighten the injectors to the torque listed in the Specifications in this Chapter.

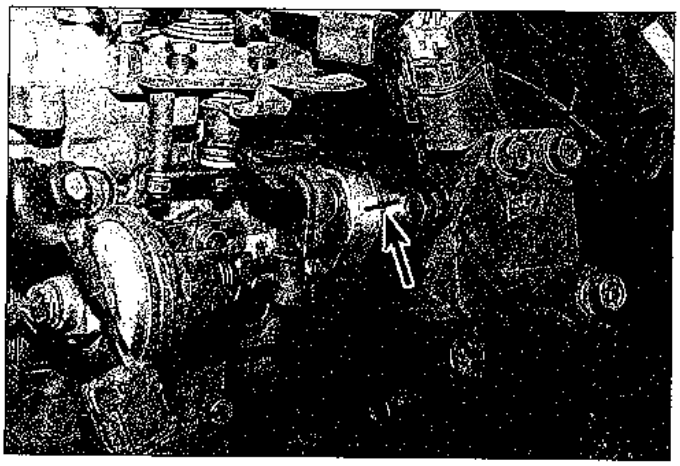
7 Fuel injection pump - removal and refitting

Warning: *Diesel fuel is flammable, so take extra precautions when you work on any part of the fuel system. See* **Warnings** *in Section 1.*
Caution: *Do not attempt to disassemble the injection pump. All repairs to the pump should be carried out by a dealer service department or a diesel engine specialist.*

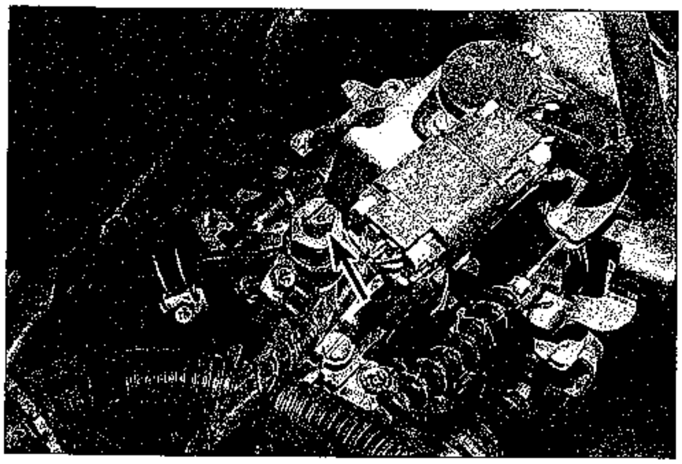
Removal

Refer to illustration 7.2

1 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.
2 Disconnect the wiring harness from the pump **(see illustration)**.



7.13 Align the pump housing mark with the mark on the front engine plate (arrow)



9.1 To bleed the system loosen the bleed screw on top of the injection pump (arrow)

3 Place a container or rags under the injection pump.
4 Disconnect both suction and discharge hoses from the pump. Plug both fittings to avoid contamination of the pump.
5 Disconnect and remove all of the injector tubes from the engine (refer to Section 6).
6 Disconnect the throttle cable from the pump arm (refer to Section 3).
7 Position the number one cylinder at TDC on the compression stroke (refer to Chapter 2).
8 Remove the cover from the front of the pump. The Z mark on the idler gear must be positioned between the two Zs on the injection pump gear.
9 Remove the injection pump drive gear using a puller if required. **Caution:** *Do not drop the gear key does not drop into the engine.*
10 Remove the pump mounting fasteners.
11 Pull the pump toward the rear of the vehicle to remove it.

Refitting

Refer to illustration 7.13

12 Renew all gaskets. Make certain that the timing marks on the gears are aligned as the pump is placed into position. The left mark on the crankshaft pulley must still be aligned with the mark on the front cover.
13 Refitting is the reverse of removal. To set the injection pump timing, align the timing mark on the outside of the injection pump with the mark on the rear of the front engine plate **(see illustration)**.
14 Tighten all fasteners to the torques listed in the Specifications in this Chapter. Check the pump timing (refer to Step 13).
15 Bleed the fuel system (refer to Section 9).

8 Fuel cut solenoid - check and renewal

Check

1 Turn the ignition OFF.
2 Disconnect the wiring harness from the fuel cut solenoid.
3 Connect a test light to the non-injector side of the connector. The test light should not be illuminated.
4 Turn the ignition ON. The test light should now be illuminated. If it is not, check the wiring to the connector and the engine control fuse.

Removal and refitting

5 The solenoid is housed inside the fuel injection pump assembly. Remove the pump and have it repaired by an approved shop or replace it with a rebuilt unit. Refer to Section 7.

9 Fuel system - bleeding

Refer to illustrations 9.1, 9.3 and 9.5

1 Loosen the bleed screw located at the uppermost part of the fuel injection pump **(see illustration)**.
2 Place rags or a metal container beneath the pump.
3 Slowly use the pump on top of the fuel filter assembly to force fuel through the system **(see illustration)**.
4 When clear fuel which does not contain foam or bubbles comes out of the pump, tighten the screw.
5 Place the rags or container beneath the fuel filter assembly. Loosen the bleed screw on the fuel filter housing, immediately below the pump knob **(see illustration)**.
6 Perform the same operation as above.

9.3 Use the lift pump on the fuel filter head to bleed the air through the system (arrow)

9.5 Loosen the bleed screw from the filter head (arrow)

Tighten the bleed screw.
7 Keep pumping until you can feel that there is resistance in the system.
8 Clean up any spilled fuel.

10 Preheat system - general information

To assist cold starting, diesel engines are equipped with a preheat system. This is comprised of a glow plug for each cylinder, a preheat control module, a coolant temperature sensor, a relay and a light on the instrument panel.

The glow plugs are small electrical heating elements, encapsulated in a metal case with a probe at one end and an electrical connector at the other. Each inlet port has a glow plug threaded into it. The glow plug probe is positioned directly in line with the incoming air charge. When the glow plug is energized, the air passing over it is heated, allowing its optimum combustion temperature to be achieved more readily after it reaches the cylinder.

The duration of the preheating is governed by the preheat control unit which monitors the temperature of the engine via the coolant temperature sensor. It alters the preheating conditions to suit the engine temperature.

Preheating is triggered by the ignition key being turned ON. A dash-mounted lamp informs the driver that preheating is taking place. The lamp turns off when sufficient preheating has taken place to allow the engine to start. The control unit will switch off the glow plug's power if the engine is not started within a short time to prevent battery drain and glow plug burn-out.

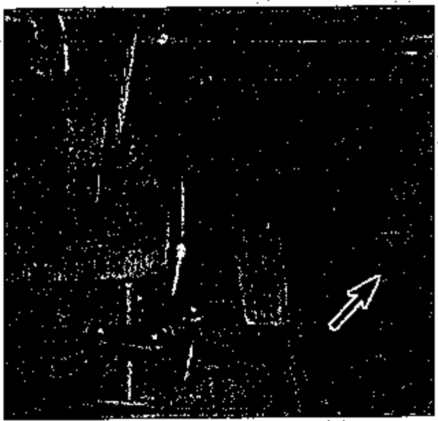
After the engine has been started, the glow plugs continue to operate for a period of time. This helps to improve fuel combustion while the engine is warming up. This results in quieter, smoother running and reduced exhaust emissions.

11 Preheat system control unit - check and renewal

Check

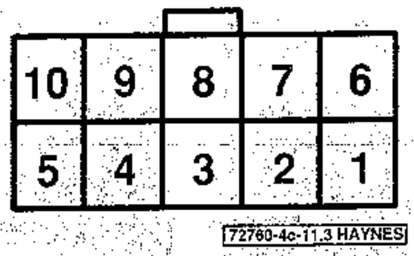
Refer to illustration 11.1 and 11.3

1 The control unit is located behind the driver's interior kick panel directly below the relay and fuse centers **(see illustration)**. Release the panel clips and remove the panel.
2 Disconnect the wiring harness from the control unit.
3 Connect an ohmmeter between terminals 2 and 4 on the wiring harness **(see illustration)**. The resistance should approximately equal that of the coolant temperature sensor. If it is not, check the sensor wiring circuit and the sensor itself.
4 Connect the ohmmeter between terminal 4 and a good earth on the body of the vehicle. With the ignition OFF, there should be near zero resistance.



11.1 Remove the right kick panel (arrow) to gain access to the controller on the bottom of the kick panel

5 Connect a voltmeter between terminals 4 and 7. When the ignition is OFF, there should be zero. When the key is turned ON, there should be approximately 12 volts.
6 Connect the voltmeter between terminals 1 and 4. When the starter is energized, there should be 12 volts indicated.
7 If any of the above tests do not check out, correct the electrical problem that exists outside of the control unit.
8 Connect the wiring harness to the control unit for the remaining tests.
9 Backprobe a test light into terminals 4 and 9.
10 Turn the ignition ON. The light should be illuminated for several seconds and then go out.
11 with the harness still connected, connect the test light between terminals 3 and 7. Turn the ignition ON. The test light should be illuminated for several seconds and then go out.
12 Turn the ignition OFF, then reconnect the test light to terminals 4 and 9. Turn the ignition ON. The test light should blink several times and then stay on.
13 Turn the key briefly to START but do not allow the engine to start. Turn the key back to ON. The test light should blink several times.
14 If any of the tests performed with the wiring harness connected do not check out, renew the control unit.



11.3 Terminal numbering for the fuel injection control unit wiring connector

Renewal

15 Disconnect the wiring harness from the control unit and remove the mounting screws.
16 Refitting is the reverse of removal.

12 Glow plug relay - check and renewal

Check

1 The glow plug relay is a conventional electrical relay located next to the battery behind an access cover on the inner fender. To check it, first remove the cover and then remove the relay from the fender.
2 Hold the relay in your hand while an assistant turns the ignition ON. It should have a noticeable click. If it does not click, proceed with the remaining tests.
3 Disconnect the wiring harness from the relay.
4 Connect an ohmmeter between the black wire in the connector and earth. There should be almost zero resistance. If resistance exists, check the earth wiring circuit.
5 Connect a test light to the red and white wire. With the ignition ON, there should be power present. This wire is fed by a fusible link adjacent to the battery.
6 Connect the test light to the green and white wire. With the ignition ON, there should be power present. This circuit is controlled by fuses in the underbonnet fuse center and the kick panel fuse center.

Renewal

7 If the relay is defective, connect a new one into the wiring harness and test it before proceeding.
8 If it checks good, secure it to the inner fender panel and refit the access cover.

13 Coolant temperature sensor - check and renewal

Check

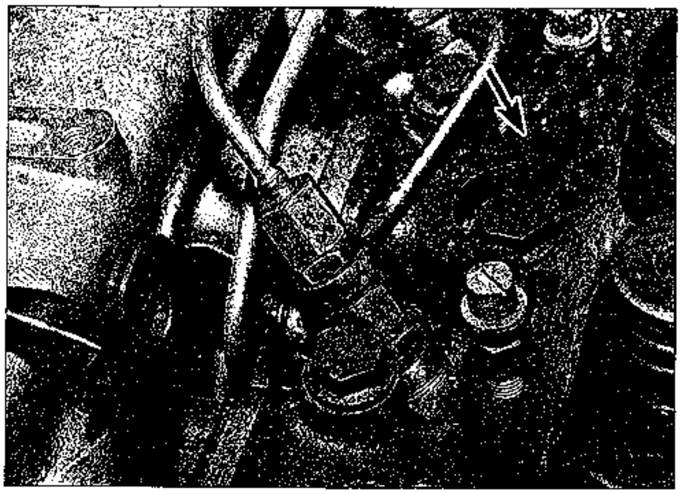
Refer to illustration 13.1

1 The sensor is located in the thermostat housing **(see illustration)**. Disconnect the wiring from the sensor.
2 Using an ohmmeter, check the resistance of the sensor. Compare your reading to those listed in the Specifications in this Chapter. Renew it if necessary.
3 If you are unsure about the results, refer to Step 5 and remove the sensor.
4 Place it in a pan of water which can be heated. Compare the resistances at various temperatures to those listed in the Specifications in this Chapter.

Renewal

5 Wait until the vehicle has completely cooled.

13.1 Typical coolant temperature sensor location (arrow)



14.1 Check for power at the bridging strap (arrow)

6 Place a container and rags under the sensor to catch coolant spillage. Alternatively, some coolant can be drained from the engine (refer to Chapter 1).
7 Apply sealer to the threads of the new sensor and place it close at hand.
8 Disconnect the wiring, then remove the sensor from the thermostat housing.
9 To minimize coolant loss, quickly refit the new sensor.
10 Tighten it to the torque listed in this Chapter's Specifications.

14 Glow plugs - check and renewal

Check

Refer to illustration 14.1

1 Use a test light on the glow plug bridging strap to verify that power is reaching the glow plug in question **(see illustration)**.
2 Disconnect the negative battery cable. Position it so that it cannot contact the positive cable.
3 Remove the bridging straps from the glow plugs. Do not lose the washers used.
4 Using an ohmmeter or a self-powered test light, check to see if there is continuity between the glow plug post and earth. Continuity (near zero resistance) should exist. If it does, not renew the glow plug.

Renewal

5 Remove the glow plug straps if not already done (refer to Steps 2 and 3).
6 Clean around the glow plugs so that debris does not fall into the engine. Use a deep socket to unscrew the glow plugs.
7 Refitting is the reverse of removal. Tighten the glow plugs to the torque listed in this Chapter's Specifications.
8 When connecting the strap and the feed cable, make sure that the insulators are properly positioned. There should be no contact between the strap/feed wire and the post. Tighten the nut securely.

Notes

Chapter 5
Engine electrical systems

Contents

Specifications

Ignition system (petrol engines)

Ignition timing	See Chapter 1
Ignition coil resistance	
3.0 litre engine	
Primary	0.8 to 1.0 ohm
Secondary	7,600 to 11,400 ohm
4.2 litre engine	
Points ignition	
Primary	1.08 to 1.32 ohms
Secondary	9,000 to 13,400 ohms
Electronic ignition	
Primary	1 ohm
Secondary	10,000 ohms
Distributor air gap (3.0 litre engine)	0.3 to 0.5 mm

Charging system

Charging voltage	13.9 to 15.1 volts
Alternator maximum output	
Type 1	50 amps
Type 2	60 amps
Minimum brush length	6 mm

1 General information

The engine electrical systems include all ignition, charging and starting components. Because of their engine related functions, these components are discussed separately from chassis electrical devices such as the lights, the instruments, etc. (which are included in Chapter 12).

Always observe the following precautions when working on the electrical systems:

a) *Be extremely careful when servicing engine electrical components. They are easily damaged if checked, connected or handled improperly.*
b) *Never leave the ignition switch on for long periods of time (10 minutes maximum) with the engine off.*
c) *Don't disconnect the battery cables while the engine is running.*
d) *Maintain correct polarity when connecting a battery cable from another vehicle during jump starting.*
e) *Always disconnect the negative cable first and hook it up last or the battery may be shorted by the tool being used to loosen the cable clamps.*

It's also a good idea to review the safety-related information regarding the engine electrical systems located in the *Safety first* Section near the front of this manual before beginning any operation included in this Chapter.

2 Battery - emergency jump starting

Refer to the *Booster battery (jump) starting* procedure at the front of this manual.

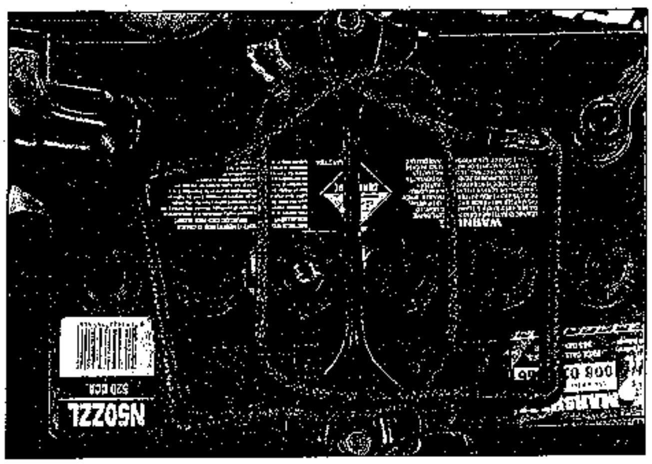
3 Battery - removal and refitting

Refer to illustration 3.1

1 Starting with the negative battery cable, disconnect both cables from the battery terminals **(see illustration)**.
2 Remove the battery hold-down clamp.
3 Lift out the battery. Be careful, it's heavy.
4 While the battery is out, inspect the carrier (tray) for corrosion.
5 If you are renewing the battery, make sure that you get one that's identical, with the same dimensions, terminal locations, amperage rating, cold cranking rating, etc. as the original.
6 Refitting is the reverse of removal.

4 Battery cables - check and renewal

1 Periodically inspect the entire length of each battery cable for damage, cracked or burned insulation and corrosion. Poor battery cable connections can cause starting problems and decreased engine performance.
2 Check the cable-to-terminal connections at the ends of the cables for cracks, loose wire strands and corrosion. The presence of white, fluffy deposits under the insulation at the cable terminal connection is a sign that the cable is corroded and should be renewed. Check the terminals for distortion, missing mounting bolts and corrosion.
3 When removing the cables, always disconnect the negative cable first and hook it up last or the battery may be shorted by the tool used to loosen the cable clamps. Even if only the positive cable is being renewed, be sure to disconnect the negative cable from the battery first (see Chapter 1 for further information regarding battery cable removal).
4 Disconnect the old cables from the battery, then trace each of them to their opposite ends and detach them from the starter solenoid and earth terminals. Note the routing of each cable to ensure correct refitting.
5 If you are renewing either or both of the old cables, take them with you when buying new cables. It is vitally important that you renew the cables with identical parts. Cables have characteristics that make them easy to identify: positive cables are usually red, larger in cross-section and have a larger diameter battery post clamp; earth cables are usually black, smaller in cross-section and have a slightly smaller diameter clamp for the negative post.
6 Clean the threads of the solenoid or earth connection with a wire brush to remove rust and corrosion. Apply a light coat of battery terminal corrosion inhibitor, or petroleum jelly, to the threads to prevent future corrosion.
7 Attach the cable to the solenoid or earth connection and tighten the mounting nut/bolt securely.
8 Before connecting a new cable to the battery, make sure that it reaches the battery post without having to be stretched.
9 Connect the positive cable first, followed by the negative cable.
10 If only the terminal at the battery end of a cable is damaged, it can be easily renewed without having to renew the entire cable. Obtain a new battery cable end.
11 Disconnect the negative cable from the battery, then disconnect the positive cable if that is the one being repaired.
12 Cut the old end from the cable and strip back about 25 mm of insulation from the cable. Remove any corrosion at this time.
13 Clamp the new cable end to the cable and attach both cables to the battery terminals, positive first.



3.1 The uncovered battery terminal on the right is the negative post. It is important that it be the one disconnected first and connected last when servicing the battery. Damage to expensive electronic components can occur if this is not done

5 Ignition system - general information and precautions

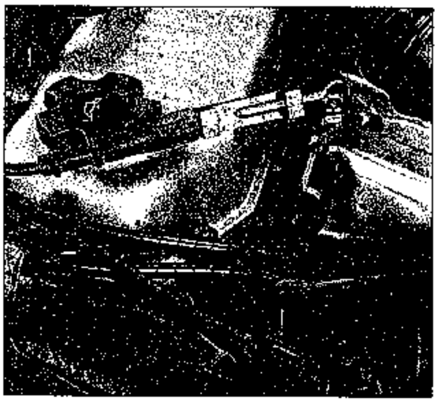
1 The ignition system is designed to ignite the fuel/air charge entering each cylinder at just the right moment. It does this by producing a high voltage spark between the electrodes of each spark plug.
2 The types of ignition systems refitted on these vehicles evolved over the years to accommodate more strict emissions standards adopted by the major automotive manufacturers.

Breaker points type ignition system

3 This system controls the ignition spark using the conventional points and condenser arrangement and timing is controlled by mechanical advance components. This system is refitted on carburetted 4.2 litre engines.

Breakerless type ignition systems

4 The electronic ignition system includes the ignition switch, the battery, the power transistor, the control unit (on 3.0 litre engines), the ignition coil, the primary (low voltage) and secondary (high voltage) wiring circuits, the distributor and the spark plugs. On fuel injected 4.2 litre engines the ignition system is controlled by the Electronic Control Unit (ECU). Using data provided by information sensors which monitor various engine functions (such as rpm, intake air volume, engine temperature, etc.), the ECU ensures a perfectly timed spark under all conditions. The ignition coil is mounted externally to the distributor.
5 3.0 litre engines use an electronic ignition system similar to that used on the fuel



6.1 An inexpensive spark tester like this is the proper tool to use when checking for spark - a used spark plug has much too small of a gap to check for full coil output

injected 4.2 litre engine, except that there is no ECU. The distributor has its own vacuum and centrifugal advance mechanisms. Its timing is not ECU-controlled and the distributor has a module and stator.

a) *Do not keep the ignition switch on for more than 10 seconds if the engine will not start.*
b) *Always connect a tachometer in accordance with the manufacturer's instructions. Some tachometers may be incompatible with this ignition system. Consult a dealer service department before buying a tachometer for use with this vehicle.*
c) *Never allow the ignition coil terminals to touch the ground. Earthing the coil could result in damage to the power transistor and/or the ignition coil.*
d) *Do not disconnect the battery when the engine is running.*
e) *Make sure the power transistor is properly earthed.*

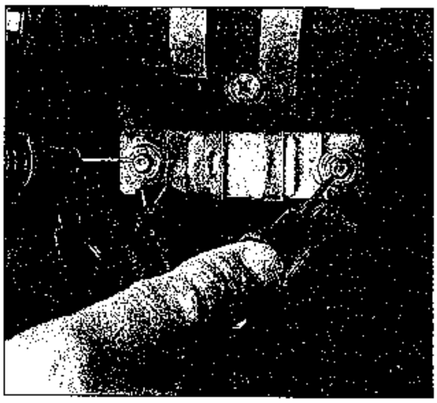
6 Ignition system - check

Refer to illustration 6.1

Warning: *Because of the high voltage generated by the ignition system, extreme care should be taken whenever an operation is performed involving ignition components. This not only includes the power transistor, coil, distributor and spark plug wires, but related components such as plug connectors, tachometer and other test equipment also.*

All ignition systems

1 If the engine turns over but won't start, disconnect the spark plug wire from any spark plug and attach it to a calibrated tester (available at most auto parts stores) **(see illustration)**. Connect the clip on the tester to a bolt or metal bracket on the engine. If you're unable to obtain a calibrated ignition tester, remove the wire from one of the spark plugs and using an insulated tool, pull back the boot and hold the end of the wire about 6 mm from a good earth.



6.10 Test the ballast resistor with an ohmmeter - there must not be infinite resistance across the terminals

2 Crank the engine and watch the end of the tester or spark plug wire to see if a bright blue, well-defined sparks occur.

3 If sparks occur, sufficient voltage is reaching the plug to fire it (repeat the check at the remaining plug wires to verify that the distributor cap and rotor are OK). However, the plugs themselves may be fouled, so remove and check them as described in Chapter 1.

4 If no sparks or intermittent sparks occur, remove the distributor cap and check the cap and rotor as described in Chapter 1. If moisture is present, dry out the cap and rotor, then refit the cap and repeat the spark test.

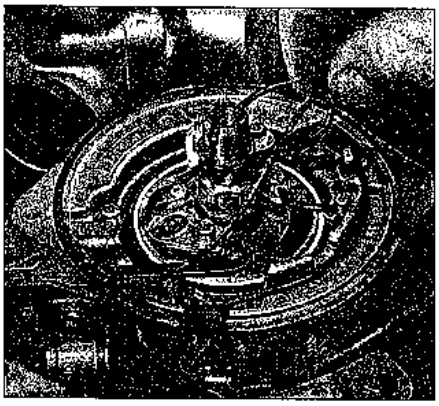
5 If there's still no spark, detach the coil secondary wire from the distributor cap and hook it up to the tester (reattach the plug wire to the spark plug), then repeat the spark check. Again, if you don't have a tester, hold the end of the wire about 6 mm from a good earth.

6 If sparks now occur, the distributor cap, rotor or plug wire(s) may be defective.

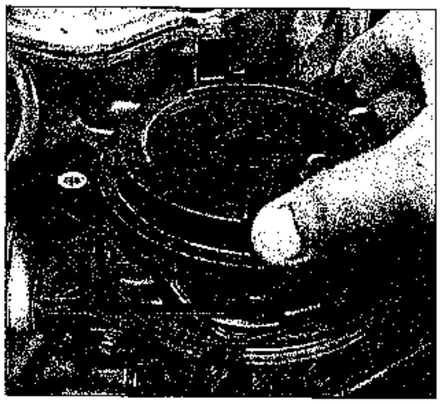
7 If no sparks occur, the coil-to-cap wire may be bad (check the resistance with an ohmmeter and compare it to the spark plug wire resistance Specifications found in Chapter 1).

8 If there's still no spark, check the primary wire connections at the coil to make sure they're clean and tight. Check for voltage to the coil on the primary circuit from the ignition switch. On engines equipped with an electronic ignition system, check for battery voltage to the power transistor with the ignition key ON, engine not running; if voltage is present, check the power transistor (see Section 10). Check the ignition coil primary and secondary resistance (see Section 7), the breaker points on 4.2 litre carburetted models (see below), the distributor stator and control unit on 3.0 litre models (see Sections 10 and 11) or the crank angle sensor on 4.2 litre fuel injected models (see Chapter 6).

9 Make any necessary repairs, then repeat the check again.



6.11b The two distributor cover O-rings should be renewed if they appear deteriorated - water can enter the distributor and cause extensive damage



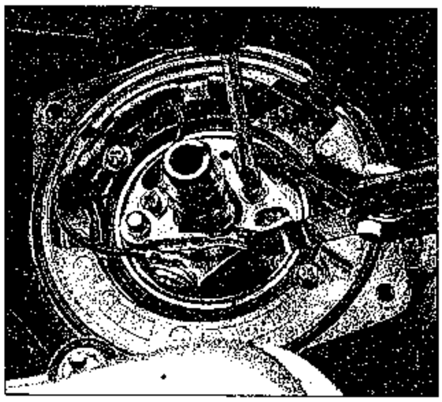
6.11a As you remove the internal distributor cover, check all visible components for signs of damage

Breaker points type ignition systems

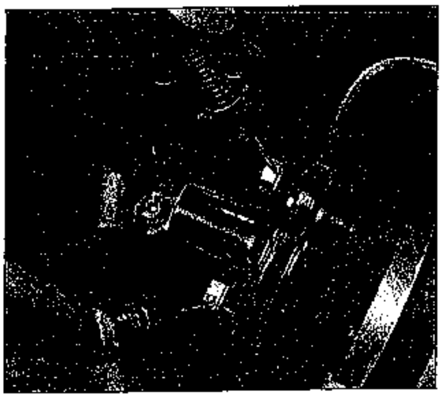
Refer to illustrations 6.10, 6.11a, 6.11b and 6.11c

10 If no sparks occur, check the ignition ballast resistor. There must be continuity between the two terminals **(see illustration)**.

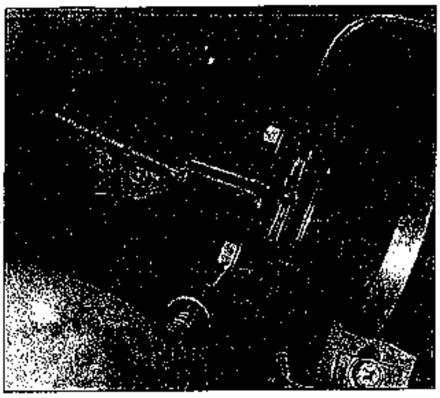
11 Inspect the ignition points (see Chapter 1). If the points appear to be in good shape (no pitting or burn spots), check the point gap or dwell **(see illustrations)**.



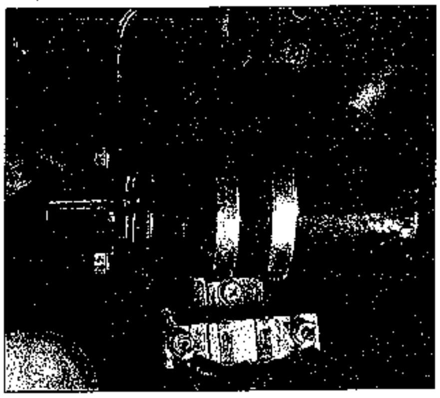
6.11c Use a clean feeler gauge when you are adjusting the points - it is best to use a dwell meter to obtain an exact setting



7.2a Connect an ohmmeter to the two primary terminals to measure the coil primary resistance



7.2b The secondary resistance is measured from the secondary terminal to the positive primary terminal - if either of the readings are greatly outside of the specifications, renew the coil



7.4 The coil must be securely mounted in order to resist vibration. Check it closely for indications that the internal oil has begun to leak from a defective housing

12 Measure the voltage at the points with a voltmeter. With the ignition ON (engine not running), the points should produce a voltmeter reading of approximately 10.5 volts. If not, the battery must be recharged or renewed.

13 Check for an short or open in the distributor points circuit. There may be a damaged points terminal that is causing the ignition voltage to be shorted or diminished.

14 Check the condition of the vacuum advance system (refer to Section 9).

7 Ignition coil - check and renewal

Refer to illustrations 7.2a, 7.2b and 7.4

1 Detach the cable from the negative terminal of the battery.

2 Using an ohmmeter:

a) *Measure the resistance between the positive and negative terminals of the coil* **(see illustration)**. *Compare your reading with the specified coil primary resistance listed in this Chapter's Specifications.*

b) *Measure the resistance between the positive terminal and the high tension terminal* **(see illustration)**. *Compare your reading with the specified coil secondary resistance listed in this Chapter's Specifications.*

3 If either of the above tests yield resistance values outside the specified amount, renew the coil.

4 Carefully inspect the coil housing for signs of leakage or damage. If any abnormality is observed, renew the coil **(see illustration)**.

Renewal

5 Detach the cable from the negative terminal of the battery.

6 Remove the shield from the coil, if equipped.

7 Label and then disconnect the wires from the coil terminals.

8 Remove the coil mounting screws.

9 Refitting is the reverse of removal.

8 Distributor - removal and refitting

Refer to illustrations 8.4, 8.5 and 8.6

1 Detach the cable from the negative battery terminal.

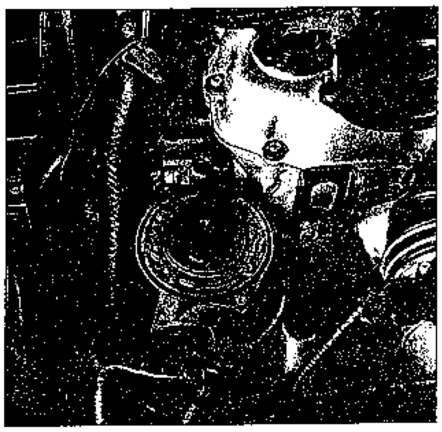
2 Disconnect the electrical connectors from the distributor.

3 Look for a raised "1" on the distributor cap. This marks the location for the number one cylinder spark plug wire terminal. If the cap does not have a mark for the number one terminal, locate the number one spark plug and trace the wire back to the terminal on the cap.

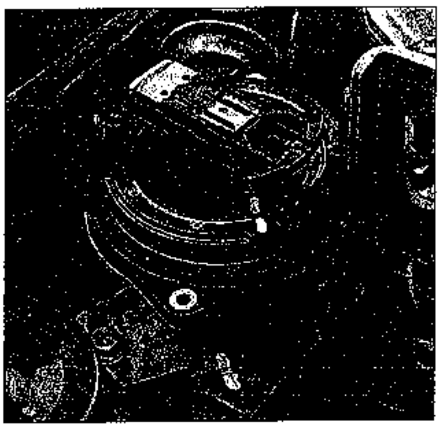
4 Remove the distributor cap (see Chapter 1) and turn the engine over until the rotor is pointing toward the number one spark plug terminal **(see illustration)**. The timing mark on the crankshaft pulley must be aligned with the zero (see locating TDC procedure in Chapter 2A).

5 Make a mark on the edge of the distributor base directly below the rotor tip and in line with it. Also, make alignment marks on the distributor base and the engine block or hold-down bolt to ensure that the distributor is refitted correctly **(see illustration)**.

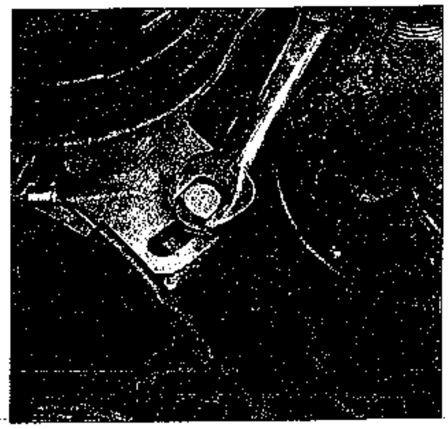
6 Remove the distributor hold-down bolt **(see illustration)**, then pull the distributor



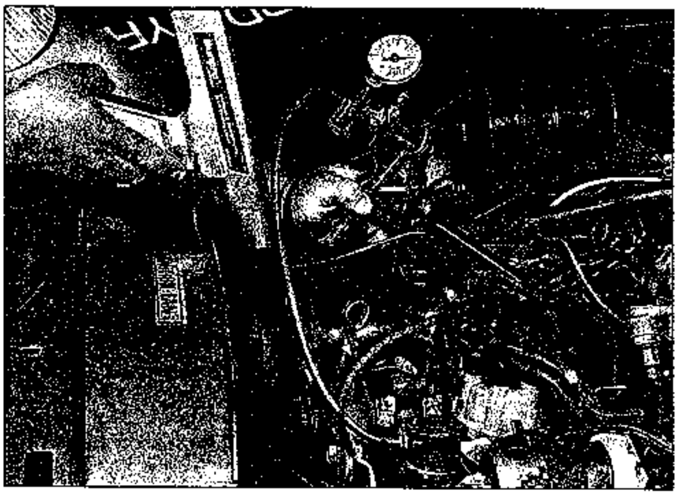
8.4 The rotor must point to the number one spark plug wire before the distributor is removed - it is easiest to operate the starter in bursts to get it close, then turn the engine with a breaker bar on the crankshaft pulley to align the timing marks at zero



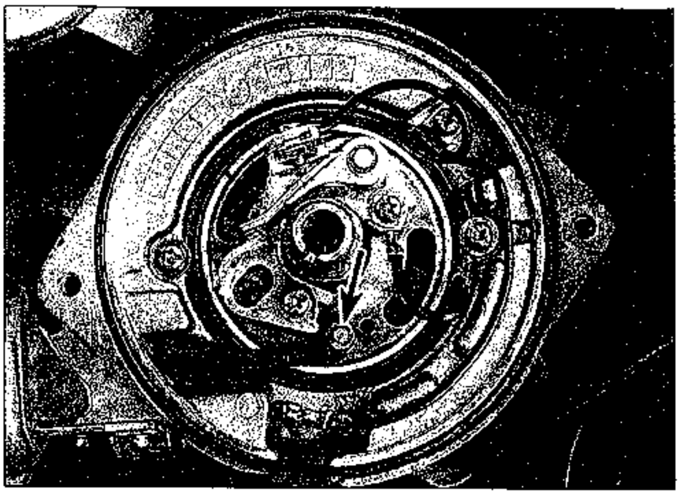
8.5 Use paint to mark the exact positions of the rotor in relation to the distributor housing and the housing in relation to the engine block



8.6 Remove the distributor hold-down bolt and lift the distributor straight up



9.6 Watch the timing marks using the timing light while applying vacuum to the vacuum advance unit with a hand-held pump. The ignition should advance as vacuum is applied



9.11 Be very careful to not drop the small clip into the distributor or some other inaccessible place when you remove it

straight out to remove it. **Caution:** *DO NOT turn the crankshaft while the distributor is out of the engine, or the alignment marks will be useless.*

Refitting

Note: *If the crankshaft has been moved while the distributor is out, locate Top Dead Centre (TDC) for the number one piston* (see Chapter 2A) *and position the distributor and the rotor accordingly.*

7 Refit a new O-ring onto the distributor housing.

8 Insert the distributor into the engine in exactly the same relationship to the block that it was in when removed. **Note:** *4.2 litre fuel injected engine distributors have alignment marks on the base of the housing and the driven gear. Line up the gear mark with the shorter housing mark prior to refitting. As the distributor is refitted, the shaft will rotate slightly to align the gear mark with the longer housing mark.*

9 If the distributor does not seat completely, recheck the alignment marks between the distributor base and the block to verify that the distributor is in the same position it was in before removal. Also check the rotor to see if it's aligned with the mark you made on the edge of the distributor base.

10 Loosely refit the distributor hold-down bolt.

11 Refitting is the reverse of removal.

12 Check the ignition timing (see Chapter 1) and tighten the distributor hold-down bolt securely.

9 Distributor advance systems - general information, check and renewal

Note: *Vacuum and centrifugal advance systems are used on the 3.0 litre engine and the 4.2 litre breaker-point ignition engine. 4.2 litre fuel injected engines have ECU-controlled ignition timing.*

General information

1 To provide the proper spark timing under all conditions, these distributors are equipped with a vacuum advance and a centrifugal advance mechanism. The vacuum advance controls timing according to engine load (available vacuum), while the centrifugal unit controls timing according to engine speed.

2 The centrifugal advance parts may stick, wear out or become defective after years of service. The vacuum advance diaphragm may rupture, rendering it inoperative. Each mechanism can be checked independent of the other using the procedures below.

Check

Refer to illustrations 9.6 and 9.11

3 Connect a timing light according to the manufacturer's instructions.

4 Connect a hand-held vacuum pump to the vacuum advance unit on the side of the distributor.

5 Apply vacuum to the unit and check that it will hold the vacuum when the pump is stopped. If it will not hold vacuum, it must be renewed.

6 Start the engine and allow it to idle. Apply vacuum while observing the timing marks with the timing light **(see illustration)**. As more vacuum is applied, the timing should advance gradually. If not, disassemble the distributor and repair the mechanism as required. **Note:** *3.0 litre engines are equipped with a vacuum switch which will not allow engine vacuum to reach the vacuum advance unit until the engine is warm.*

7 Remove the vacuum pump and do not reconnect the engine vacuum hose to the unit.

8 Start the engine and observe the timing marks with the timing light. Increase the engine speed gradually to about 3,000 RPM. The timing should advance gradually and smoothly. If it doesn't advance or if it advances in jumps, service the centrifugal advance mechanism or renew the distributor.

Vacuum advance unit renewal

9 Remove the stator (3.0 litre engines) (refer to Section 11) or the points (4.2 litre engines) (refer to Chapter 1).

10 On 3.0 litre engines, mark the top of the reluctor and remove it from the distributor shaft by prising it up carefully with two screwdrivers or by using a battery cable puller. The reluctor is a tight press fit. Do not lose the small roll pin which indexes the reluctor to the shaft.

11 Remove the vacuum advance screws and the clip **(see illustration)**. Remove the vacuum advance unit.

12 Refitting is the reverse of removal.

Centrifugal advance mechanism renewal

13 On 3.0 litre engines remove the control unit (refer to Section 12). On 4.2 litre engines, remove the vacuum advance unit.

14 Remove the base plate.

15 Remove the reluctor shaft or distributor cam retaining screw.

16 Remove the reluctor shaft or distributor cam.

17 Remove the advance springs.

18 Remove the clips and lift off the weights.

19 Carefully inspect all moving parts for wear, binding and elongation of holes. The advance mechanism can be cleaned thoroughly and lubricated with a small amount of high temperature grease. Operate the assembled mechanism by hand to test for free movement.

20 If definite wear is noticed, it is best to renew the complete distributor with a new or rebuilt unit. Refitting is the reverse of removal.

10 Power transistor (electronic ignition models) - check and renewal

Refer to illustration 10.2

1 Disconnect the wiring from the power transistor.

2 Using an ohmmeter, perform the tests as shown (see **illustration**).

3 If not all of the readings are as indicated, renew the power transistor.

Renewal

4 Detach the cable from the negative terminal of the battery.

5 Disconnect the electrical connector from the power transistor.

6 Remove the screws from the bracket assembly and remove the power transistor/bracket assembly.

7 Refitting is the reverse of removal.

11 Stator (3.0 litre engines) - renewal and air gap adjustment

1 Remove the distributor cap with the wires attached and set it aside.

2 Loosen the rotor screw and remove the rotor.

3 Remove the inner distributor cover and the O-rings.

4 Disconnect the internal wiring and then remove the wiring harness from the distributor body.

5 Remove the stator.

6 Refitting is the reverse of removal.

Air gap adjustment

7 Detach the cable from the negative terminal of the battery.

8 Using a brass feeler gauge, measure the gap between a tip of the reluctor and the stator. Compare your measurement to the air gap listed in this Chapter's Specifications. If the air gap is not as specified, loosen the stator mounting screws and position it to the correct dimension. Excessive air gap is usually a sign of wear in the distributor shaft bush.

12 Control unit (3.0 litre engines) - removal and refitting

Note: *It is very difficult to verify a defective ignition control unit on a 3.0 litre engine. If there is no spark from the coil and all other components in the system test good, assume that the control unit may be defective.*

1 Remove the stator (refer to Section 10).

2 Mark the top of the reluctor and remove it from the distributor shaft by prising it up carefully with two screwdrivers or by using a battery cable puller. The reluctor is a tight press fit. Do not lose the small roll pin which indexes the reluctor to the shaft.

3 Remove the vacuum advance unit.

10.2 Perform the following four tests to check the power transistor

1 Ohmmeter positive lead to A terminal, negative lead to B terminal - continuity should exist.
2 Ohmmeter positive lead to B terminal, negative lead to A terminal - continuity should not exist.
3 Ohmmeter positive lead to A terminal, negative lead to C terminal - continuity should exist.
4 Ohmmeter positive lead to C terminal, negative lead to A terminal - continuity should not exist.

4 Remove the two control unit mounting screws and lift it from the distributor.

5 Refitting is the reverse of removal.

13 Charging system - general information and precautions

The charging system includes the alternator, an internal voltage regulator, a charge indicator light, the battery, a fusible link and the wiring between all the components. The charging system supplies electrical power for the ignition system, the lights, the radio, etc. The alternator is driven by a drivebelt at the front of the engine.

The purpose of the voltage regulator is to limit the alternator's voltage to a preset value. This prevents power surges, circuit overloads, etc., during peak voltage output.

The fusible link is a short length of insulated wire integral with the engine compartment wiring harness (see Chapter 12). The fusible link is several wire gauges smaller in diameter than the circuit it protects. See Chapter 12 for additional information regarding fusible links.

The charging system doesn't ordinarily require periodic maintenance. However, the drivebelt, battery and wires and connections should be inspected at the intervals outlined in Chapter 1.

The dashboard warning light should come on when the ignition key is turned to Start, then should go off immediately. If it remains on, there is a malfunction in the charging system. Some vehicles are also equipped with a voltage gauge. If the voltage gauge indicates abnormally high or low voltage, check the charging system (see Section 12).

Be very careful when making electrical circuit connections to a vehicle equipped with an alternator and note the following:

a) *When reconnecting wires to the alternator from the battery, be sure to note the polarity.*
b) *Before using arc welding equipment to repair any part of the vehicle, disconnect the wires from the alternator and the battery terminals.*
c) *Never start the engine with a battery charger connected.*
d) *Always disconnect both battery leads before using a battery charger.*
e) *The alternator is driven by an engine drivebelt which could cause serious injury if your hand, hair or clothes become entangled in it with the engine running.*
f) *Because the alternator is connected directly to the battery, it could arc or cause a fire if overloaded or shorted out.*
g) *Wrap a plastic bag over the alternator and secure it with rubber bands before steam cleaning the engine.*

14 Charging system - check

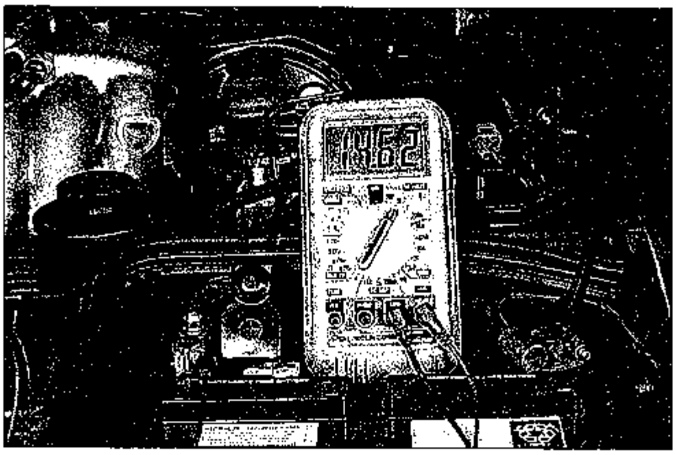
Refer to illustrations 14.3 and 14.9

1 If a malfunction occurs in the charging circuit, don't automatically assume that the alternator is causing the problem. First check the following items:

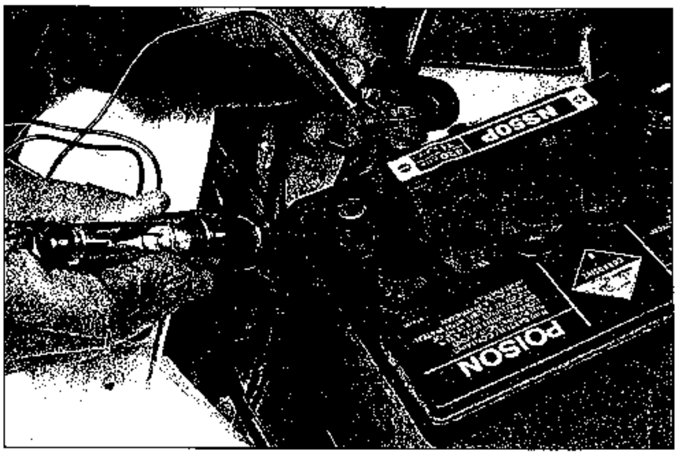
a) *Check the drivebelt tension and its condition. Renew it if worn or deteriorated.*
b) *Make sure the alternator mounting and adjustment bolts are tight.*
c) *Inspect the alternator wiring harness and the electrical connectors at the alternator and voltage regulator. They must be in good condition and tight.*
d) *Check the fusible link located at the positive battery cable or the large main fuses in the engine compartment. If it's burned, determine the cause, repair the circuit and renew the link or fuse (the vehicle won't start and/or the accessories won't work if the fusible link or fuse blows).*
e) *Check all the fuses that are in series with the charging system circuit. The location of these fuses and fusible links may vary from year and model so refer to Chapter 12 and the wiring schematics at the end of Chapter 12 for additional information.*
f) *Start the engine and check the alternator for abnormal noises (a shrieking or squealing sound indicates a bad bush or bearing).*
g) *Check the specific gravity of the battery electrolyte. If it's low, charge the battery (doesn't apply to maintenance free batteries).*
h) *Make sure that the battery is fully charged (one bad cell in a battery can cause overcharging by the alternator).*
i) *Disconnect the battery cables (negative first, then positive. Inspect the battery posts and the cable clamps for corrosion. Clean them thoroughly if necessary* (see Section 4 and Chapter 1). *Reconnect the positive cable, then the negative cable.*

2 Using a voltmeter, check the battery voltage with the engine off. It should be approximately 12 volts.

3 Start the engine and check the battery



14.3 Battery voltage should increase to approximately 14.5 volts after the engine has been started



14.9 Checking for a key-off battery drain can be easily done by disconnecting the negative battery cable and bridging it to the battery terminal with a test light. Make sure that all power such as the interior lights are turned off first

voltage again. It should now be approximately 13.5 to 15.1 volts **(see illustration)**.

4 Turn on the headlights. The voltage should drop and then come back up, if the charging system is working properly.

5 If the voltage reading is greater than the specified charging voltage, renew the alternator (see Section 15). The internal voltage regulator is malfunctioning.

6 If you have an ammeter, hook it up to the charging system as shown. If you don't have an ammeter, you can also use an inductive-type current indicator (clamp-on ammeter). This device is inexpensive, readily available at auto parts stores and accurate enough to perform simple amperage checks like the following test.

7 With the engine running at 2,000 rpm, check the reading on the ammeter with all accessories and lights off, then again with the high-beam headlights on and the heater blower switch turned to the HI position. Compare your readings to the standard amperage listed in this Chapter's Specifications.

8 If the ammeter reading is much less than the standard amperage, renew the alternator.

Note: *This manual does not recommend that the owner attempt to disassemble and repair an alternator. If the alternator has developed a problem with a particular component, then it is very likely that it has neared the end of its service life as far as its other components are concerned also. Since rebuilt alternators are relatively inexpensive, it is not usually worth the effort and time to overhaul an alternator at home.*

9 If the battery is discharging due to a current drain with the ignition turned off, check for a draw as follows:

Disconnect both battery cable (negative cable first). Inspect the battery posts and the cable clamps for corrosion. Clean them thoroughly if necessary (refer to Chapter 1).

Reconnect the positive terminal to its post. Remove the fuse for the clock, if so equipped. With the key off and the doors closed, insert a test light between the negative battery post and the disconnected negative battery cable **(see illustration)**.

If the test light does not glow, then there is no key-off battery drain.

If the test light glows, then remove one fuse at a time from the fuse panel until the light goes out. The circuit for the fuse is causing the draw. Investigate the circuit and correct the problem.

If the light will not go out with all the fuses removed, then disconnect the wiring from the alternator. If the light goes out, the alternator is bad.

15 Alternator - removal and refitting

Refer to illustrations 15.3 and 15.4

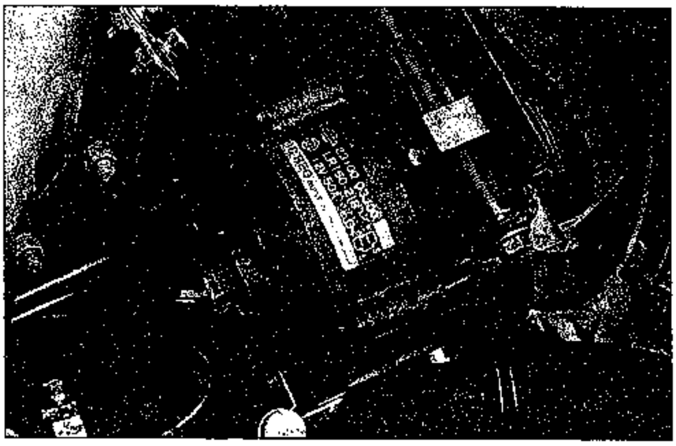
1 Detach the cable from the negative terminal of the battery.

2 Detach all of the electrical connectors from the alternator.

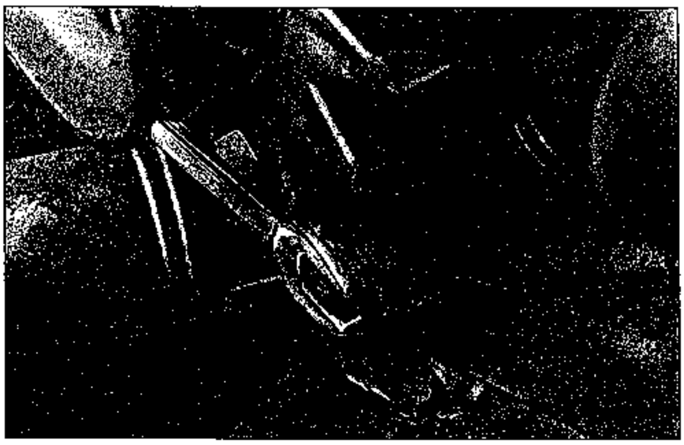
3 On diesel models, disconnect both vacuum hoses from the alternator and move them out of the way.

4 Place some rags beneath the rear of the alternator and disconnect the oil supply and return lines on diesel models.

5 Loosen the alternator adjustment, then remove the adjustment assembly **(see illustration)** and detach the drivebelts.

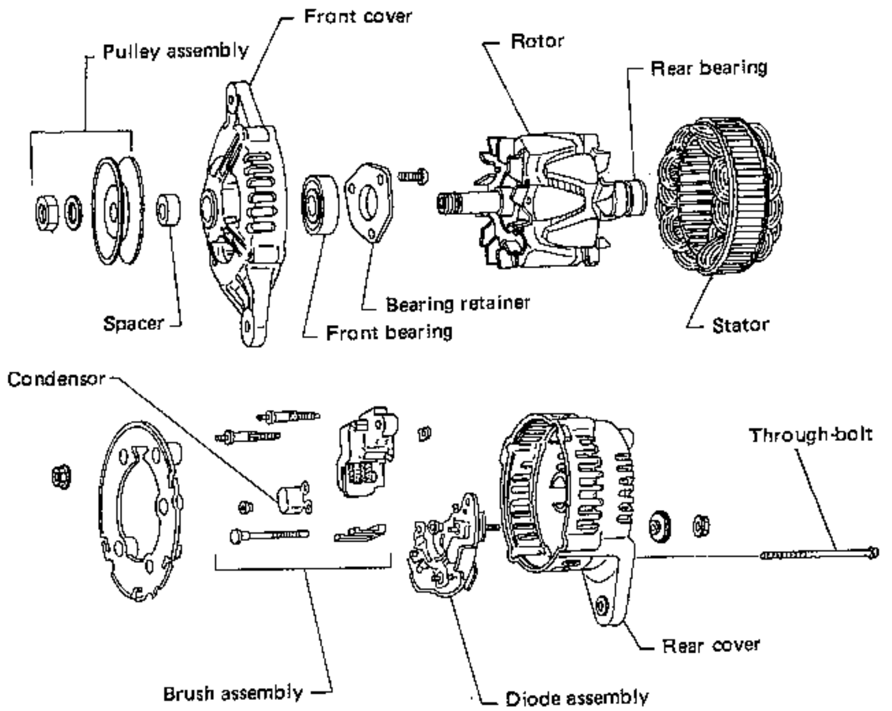


15.5 Be certain to disconnect the negative battery cable before you attempt to disconnect the wiring from the alternator. The adjustment mechanism will have to be removed also



15.6 Get a firm hold of the alternator as you remove the mounting bolt - it is heavy and should not be dropped

6 Remove the mounting bolt(s) while holding the weight of the unit **(see illustration)**.
7 Remove the alternator from the engine compartment.
8 If you are renewing the alternator, take the old alternator with you when purchasing a renewal unit. Make sure that the new/rebuilt unit is identical to the old alternator. Look at the terminals - they should be the same in number, size and locations as the terminals on the old alternator. Finally, look at the identification markings - they will be stamped in the housing or printed on a tag or plaque affixed to the housing. Make sure that these numbers are the same on both alternators.
9 Many new/rebuilt alternators do not have a pulley refitted, so you may have to switch the pulley from the old unit to the new/rebuilt one. When buying an alternator, find out the shop's policy regarding refitting of pulleys - some shops will perform this service free of charge.
10 Refitting is the reverse of removal.
11 After the alternator is refitted, adjust the drivebelt tension (see Chapter 1).
12 Check the charging voltage to verify proper operation of the alternator (see Section 14).



16.2 Exploded view of a typical Hitachi alternator

16 Alternator - overhaul

Disassembly

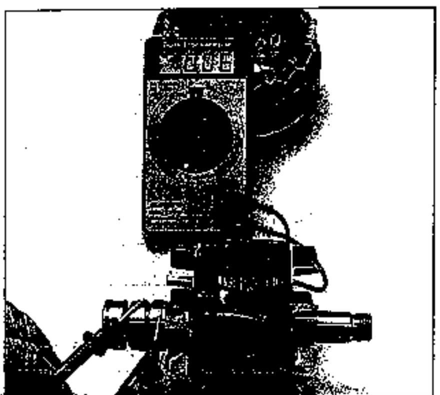
Refer to illustration 16.2

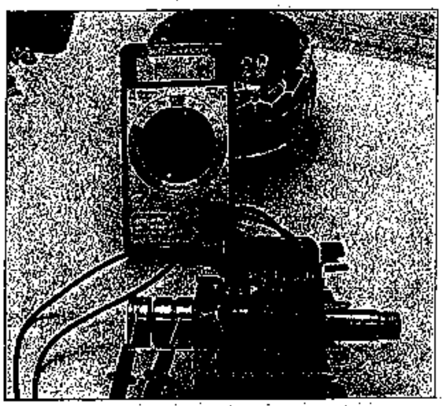
1 Remove the alternator (refer to Section 15). Remove the vacuum pump from the rear housing of the alternator on diesel models.
2 Scribe or paint alignment marks on the end frame housings to ease reassembly **(see illustration)**.
3 Remove the nut retaining the fan pulley to the rotor shaft and remove the pulley.
4 Remove the four through-bolts holding the front and rear covers together, then separate the rear cover assembly from the front cover. Remove the rotor.
5 Remove the nuts securing the stator and separate the stator and diode assembly from the rear end frame.
6 Remove the screws attaching the regulator and the brush holder to the diode assembly and remove the brush holder and regulator.
7 Remove the diode assembly from the stator. If necessary, use a solder gun and a heat sink to melt the solder joints that connect the stator leads to the diode assembly.

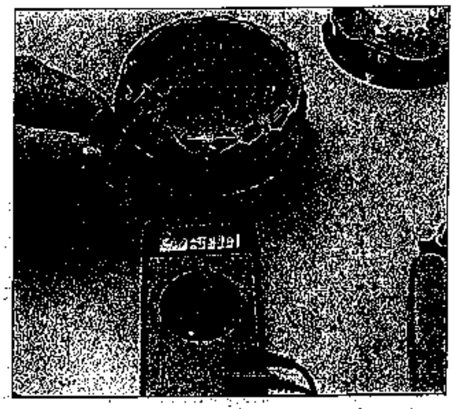
Component checks

Refer to illustrations 16.8a, 16.8b, 16.9 and 16.10

8 Check the rotor for an open between the two slip rings **(see illustration)**. There should be continuity between the slip rings. Check for earths between each slip ring and the rotor shaft **(see illustration)**. There should be no continuity (infinite resistance) between the rotor shaft and either slip ring. If the rotor fails either test or if the slip rings are worn, the rotor is defective.
9 Check for opens between the center terminal of the stator and each end terminal of the stator windings **(see illustration)**. If either reading is high (infinite resistance), the stator is defective. Check for an earthed stator winding between each stator terminal and the frame. If there is continuity between any stator winding and the frame, then the stator is defective.
10 Start the checks on the diode assembly by touching one probe of the ohmmeter to the diode plate and the other to one of the other designated diode terminals **(see illustration)**. Then reverse the probes and check again. Follow the chart carefully. The diode should have continuity with the ohmmeter one way and no continuity when the probes are reversed. Check each of the terminals in

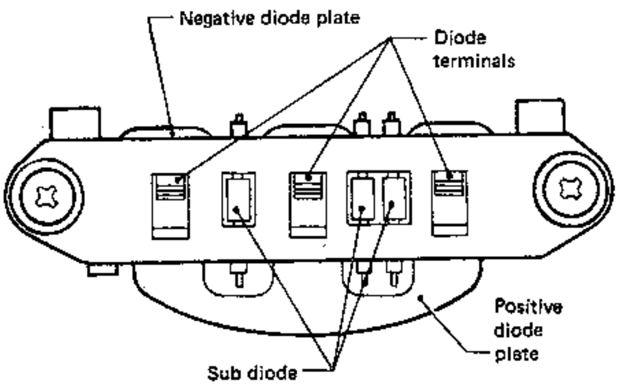

16.8a Continuity should exist between the rotor slip rings


16.8b No continuity should exist between the slip ring(s) and the rotor shaft

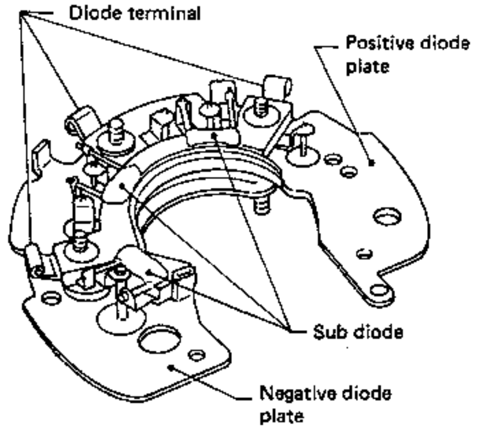

16.9 Check for continuity on each stator lead. There should be no breaks in the windings, therefore continuity should exist between each terminal

	Ohmmeter probes		Continuity
	Positive ⊕	Negative ⊖	
Diodes check (Positive side)	Positive diode plate	Diode terminals	Yes
	Diode terminals	Positive diode plate	No
Diodes check (Negative side)	Negative diode plate	Diode terminals	No
	Diode terminals	Negative diode plate	Yes

[MITSUBISHI make]



[HITACHI make]

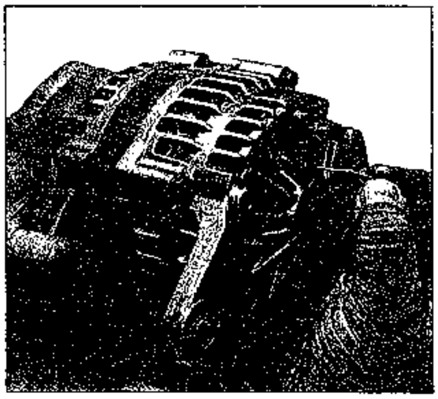


16.10 Check each diode to make sure continuity exists only in ONE direction

this manner. If any of the diodes fails the test, the diode assembly is defective.

11 To check the sub diodes, refit the probes of the ammeter into the sub diode terminals and check for continuity in the same way as the previous diode checks. Be sure to probe only the sub diode terminals. If any sub diode fails the test, the diode assembly is defective.

12 Measure the lengths of the brushes and renew them if they are at or near the minimum brush length found in this Chapter's Specifications. **Note:** *On some models, the brush leads are soldered onto the voltage regulator assembly.*



16.14 Fit a paper clip into the rear of the alternator to hold the brushes in place during refitting – after refitting, simply pull the paper clip out

Reassembly

Refer to illustration 16.14

13 Refit the components in the reverse order of removal, noting the following:

14 Before refitting the brush holder, push the brushes into the holder and slip a straightened paper clip into the hole in the brush holder to hold them in retracted position. After the end frames have been bolted together, remove the paper clip **(see illustration)**.

17 Starting system - general information and precautions

The sole function of the starting system is to turn over the engine quickly enough to allow it to start.

The starting system consists of the battery, the starter motor, the starter solenoid and the electrical circuit connecting the components. The solenoid is mounted directly on the starter motor.

The solenoid/starter motor assembly is refitted on the upper part of the engine, next to the transmission bellhousing.

When the ignition key is turned to the START position, the starter solenoid is actuated through the starter control circuit. The starter solenoid then connects the battery to the starter. The battery supplies the electrical energy to the starter motor, which does the actual work of cranking the engine.

The starter motor on a vehicle equipped with a manual transmission can be operated only when the clutch pedal is depressed; the starter on a vehicle equipped with an automatic transmission can be operated only when the transmission selector lever is in Park or Neutral.

Always observe the following precautions when working on the starting system:

a) *Excessive cranking of the starter motor can overheat it and cause serious damage. Never operate the starter motor for more than 15 seconds at a time without pausing to allow it to cool for at least two minutes.*
b) *The starter is connected directly to the battery and could arc or cause a fire if mishandled, overloaded or short circuited.*
c) *Always detach the cable from the negative terminal of the battery before working on the starting system.* **Caution:** *If the stereo in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery.*

18 Starter motor - testing in vehicle

Note: *Before diagnosing starter problems, make sure the battery is fully charged.*

1 If the starter motor does not turn at all when the switch is operated, make sure that the shift lever is in Neutral or Park (automatic

transmission) or that the clutch pedal is depressed (manual transmission).
2 Make sure that the battery is charged and that all cables, both at the battery and starter solenoid terminals, are clean and secure.
3 If the starter motor spins but the engine is not cranking, the overrunning clutch in the starter motor is slipping and the starter motor must be renewed.
4 If, when the switch is actuated, the starter motor does not operate at all but the solenoid clicks, then the problem lies with either the battery, the main solenoid contacts or the starter motor itself (or the engine is seized).
5 If the solenoid lever and pinion gear cannot be heard when the switch is actuated, the battery is bad, the fusible link is burned (the circuit is open), the starter relay is defective or the starter solenoid itself is defective. **Note:** *Follow the relay testing procedure in Chapter 12 to diagnose a defective relay.*
6 To check the solenoid, connect a jumper lead between the battery (+) and the ignition switch terminal (the small terminal) on the solenoid. If the starter motor now operates, the solenoid is OK and the problem is in the ignition switch, Neutral start switch or in the wiring.
7 If the starter motor still does not operate, remove the starter/solenoid assembly for disassembly, testing and repair.
8 If the starter motor cranks the engine at an abnormally slow speed, first make sure that the battery is charged and that all terminal connections are tight. If the engine is partially seized, then it will crank slowly.
9 Run the engine until normal operating temperature is reached, then disconnect the coil wire from the distributor cap and earth it on the engine.
10 Connect a voltmeter positive lead to the battery positive post and connect the negative lead to the negative post.
11 Crank the engine and take the voltmeter readings as soon as a steady figure is indicated. Do not allow the starter motor to turn for more than 15 seconds at a time. A reading of nine volts or more, with the starter motor turning at normal cranking speed, is normal. If the reading is nine volts or more but the cranking speed is slow, the motor is faulty. If the reading is less than nine volts and the cranking speed is slow, the solenoid contacts are probably burned, the starter motor is bad, the battery is discharged or there is a bad connection.

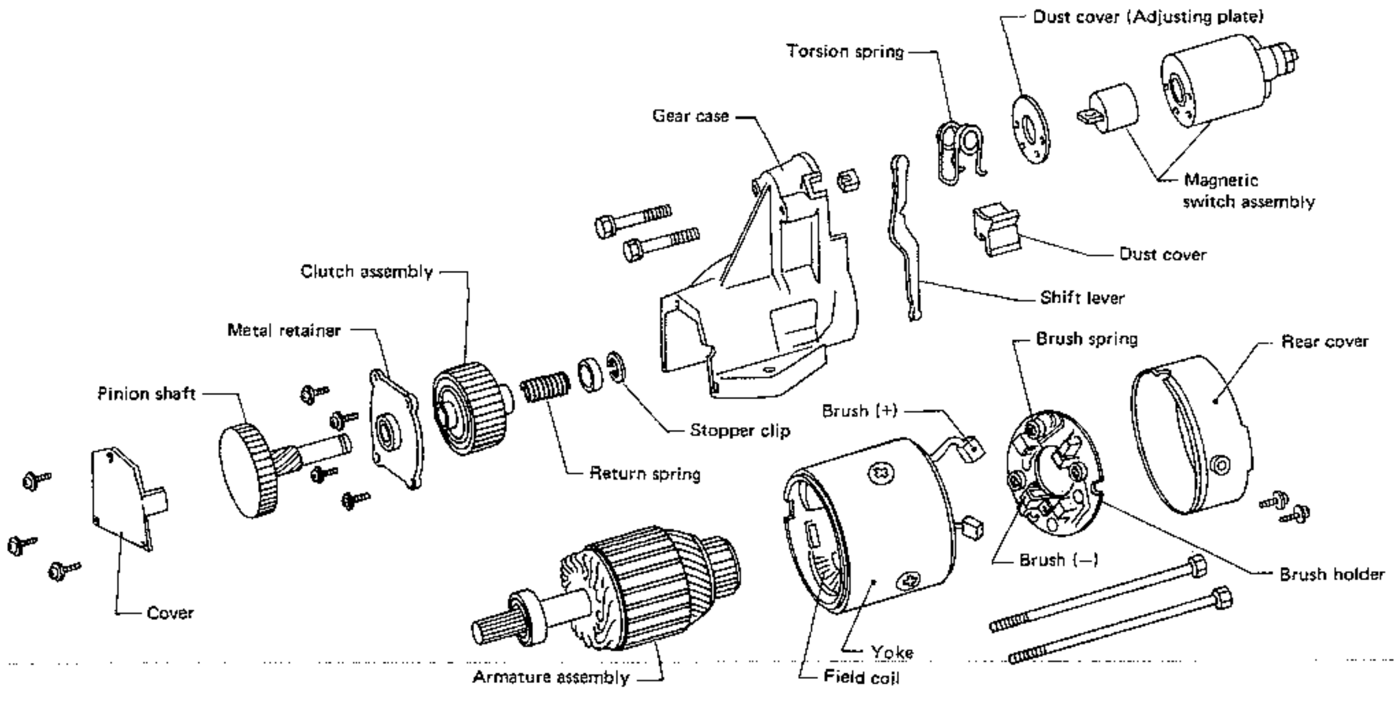
19 Starter motor - removal and refitting

1 Detach the cable from the negative terminal of the battery.
2 Raise the vehicle and support it securely with jackstands.
3 Disconnect all of the wiring from the solenoid. Label the smaller wires if necessary.
4 Remove the starter motor mounting bolts.
5 Use a sharp screwdriver to carefully prise the starter out. It may be sealed to the bellhousing with RTV silicone sealer.
6 Refitting is the reverse of removal. Apply a 3 mm bead of RTV silicone sealer to the sealing surface of the starter before refitting it.

20 Starter motor - overhaul

Refer to illustration 20.3

1 Remove the starter motor from the vehicle (refer to Section 19).
2 Disconnect the cable from the solenoid terminal.
3 Use dabs of paint to make alignment marks on all housing components including the solenoid **(see illustration)**. This is required for correct reassembly.
4 Remove the end housing.
5 Remove the yoke and the brush holder as a unit.
6 Pull back the brushes and then remove the yoke from the brush holder.
7 Remove the armature from the drive housing.
8 Disassemble all of the solenoid components and lay them out carefully in order.
9 Remove the mounting screws, then lift the pinion gear housing and the gear assembly from the end of the drive housing.
10 Mount the pinion gear assembly in a solid vice and remove the clip or cap from the end of the pinion shaft.
11 Remove the small bearing behind the clip or cap.
12 Remove the snap-ring or retainer from the pinion shaft. Lift off the return spring and then remove the pinion gear from the opposite end of the clutch assembly.
13 The bearings on the clutch assembly



20.3 Typical exploded view Hitachi starter motor

and the armature can be removed with a puller (armature)or by prising carefully with screwdrivers (clutch assembly).
14 Renew all components which are found to be defective. Check the brush length. They must be at least 10mm long. Check the price and availability of a new or remanufactured unit if yours has several worn components.
15 During assembly, apply wheel bearing grease to the armature bearings only. Other areas of wear such as gears, splines on shafts and bearing cavities should also receive grease.
16 Assembly of the unit is the reverse of disassembly.
17 After assembly, check the pinion gear endplay by first energising the solenoid very briefly with 12 volts. Measure the distance the pinion gear protrudes from the housing.
18 Disconnect the 12 volts as soon as possible and then pull the gear out manually. Measure the same distance. The difference should be from 0.2mm to 1.7mm. The endplay can be adjusted, if necessary, by adding or removing shims from the end of the solenoid.

21 Starter solenoid - removal and refitting

1 Remove the solenoid mounting screws.
2 Slide the solenoid rearward and disconnect the fork.
3 Remove the solenoid.
4 Refitting is the reverse of removal.

4.2 litre engines

5 Make an alignment mark on the solenoid housing and the starter so that it can be refitted in the same position.
6 Remove the mounting bolts and remove the solenoid with its plunger.
7 Remove the spring and lever along with the seal.
8 Refitting is the reverse of removal.

Notes

Chapter 6
Emissions and engine control systems

Contents

6

Specifications

Air flow sensor voltages	
Engine stopped, ignition ON	0.5 volts or less
Idling, warm	1.0 to 1.3 volts, approximately
ATC vacuum motor operating points	
3.0 litre engine	
Start to open	4.7 to 8.7 kPa
Opens fully	10.0 to 16.6 kPa
4.2 litre engine	
Start to open	9.6 kPa
opens fully	19.5 kPa
BCDD set level	
4.2 litre engine	
Manual	75 to 78 kPa
Automatic	78 to 80 kPa
3.0 litre engine	76 to 78 kPa
Engine temperature sensor values	
At 20 degrees C	2,100 to 2,900 ohms
At 50 degrees C	680 to 1,000 ohms
At 80 degrees C	300 to 330 ohms
EGR gas temperature sensor resistance	
44.4 degrees C	69 to 89 K-ohms
100 degrees C	11 to 15 K-ohms
150 degrees C	2 to 4 K-ohms
Exhaust gas temperature sensor resistance at 100 degrees C	77 to 94 ohms

1 General information

Note: *The systems discussed in this Chapter pertain to petrol engines only.*

To prevent pollution of the atmosphere from burned and evaporating gases, a number of major and auxiliary emission control systems are incorporated on Nissan Patrol/Ford Maverick petrol vehicles. The combination of systems used depends on the year in which the vehicle was manufactured, the locality to which it was originally delivered and the engine type. Check the Vehicle Emissions Control Information (VECI) label in your engine compartment to determine which systems are used on your vehicle. The major systems incorporated on these vehicles include:

Boost Controlled Deceleration Device (BCDD) system
Catalytic Converter (CAT) system
Evaporative Emission Control (EVAP) system
Exhaust Gas Recirculation (EGR) system
Intake air temperature control system
Positive Crankcase Ventilation (PCV) system
Spark Control (SC) system

The auxiliary systems incorporated include:

Hot Idle Compensation (HIC) system
Positive temperature coefficient (PTC) heater system

The Sections in this Chapter include general descriptions, checking procedures (where possible) and component renewal procedures (where applicable) for each of the systems listed above.

Before assuming that an emission control system is malfunctioning, check the fuel and ignition systems carefully. In many cases, special tools and equipment, as well as specialised training, are required to accurately diagnose the causes of a rough running or difficult to start engine. If checking and servicing become too difficult or if a procedure is beyond the scope of the home mechanic, consult a dealer service department. This does not necessarily mean however, that the emission control systems are particularly difficult to maintain and repair. You can quickly and easily perform many checks and do most (if not all) of the regular maintenance at home with common tune-up and hand tools. **Note:** *The most frequent cause of emission system problems is simply a loose or broken vacuum hose or wiring connection. Therefore, always check hose and wiring connections first.*

Pay close attention to any special precautions outlined in this Chapter (particularly those concerning the catalytic converter). It should be noted that the illustrations of the various systems may not exactly match the systems refitted in your particular vehicle, due to changes made by the manufacturer during production or from year to year.

2 Spark Control (SC) system

General description

1 The spark control system is designed to reduce HC and NOX emissions by delaying the ignition timing only when the engine is cold. By delaying the vacuum advance, combustion temperatures are not increased. This system is fitted on 3.0 litre engines only.

2 The SC system includes the conventional distributor-mounted vacuum unit, and a thermal vacuum switch.

3 At cold engine temperatures, the thermal vacuum switch does not allow engine vacuum to reach the diaphragm in the distributor vacuum unit and the ignition timing is thereby retarded to reduce emissions.

Check

4 Refit a T-fitting between the vacuum gauge and the main vacuum advance control unit and the thermal vacuum switch and observe that, with the engine cold (coolant temperature 30 degrees C or less), there is no vacuum to the distributor.

5 Warm the engine to normal operating temperature and observe that vacuum is allowed past the TVS and on to the vacuum advance. If no vacuum is available, remove the thermal vacuum switch and check it.

6 If vacuum is correct, check the operation of the vacuum advance (see Chapter 5).

Component renewal

Vacuum advance unit

7 See Chapter 5.

Thermal vacuum switch

8 Drain the coolant from the engine block (see Chapter 1), remove the vacuum hoses from the TVS, then remove the TVS and renew it. Refitting is the reverse of the removal procedures. **Note:** *Be sure to apply liquid sealer to the threads of the new TVS before refitting it.*

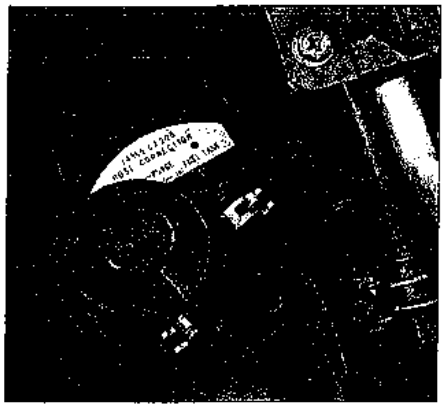
3 Evaporative Emission Control (EVAP) system

General description

1 This system is designed to trap and store fuel that evaporates from the fuel tank, throttle body and inlet manifold that would normally enter the atmosphere in the form of hydrocarbon (HC) emissions.

2 The Evaporative Emission Control (EVAP) system consists of a charcoal-filled canister, the lines connecting the canister to the fuel tank and a check valve. On some models, there is also a thermal vacuum switch.

3 Fuel vapours are transferred from the fuel tank and throttle body/carburettor to a canister where they are stored when the engine isn't running. When the engine is running, the fuel vapours are purged from the canister by intake airflow and consumed in the normal combustion process.



3.8 Inspect the EVAP canister for damage or leaks - if there is a fuel odour in the engine compartment, check the canister first. The purge control valve is located on top of the canister

4 There is a purge control valve on the canister which is activated by engine vacuum. When vacuum increases, the valve opens and allows the engine to draw in vapours. The thermal vacuum switch prevents the canister from receiving this vacuum signal vacuum at low engine temperatures.

Check

Refer to illustration 3.8

5 Poor idle, stalling and poor driveability can be caused by an inoperative purge control valve, a damaged canister, split or cracked hoses or hoses connected to the wrong fittings. Check the fuel filler cap for a damaged or deformed gasket (see Chapter 1).

6 Evidence of fuel loss or fuel odour can be caused by liquid fuel leaking from fuel lines, a cracked or damaged canister, an inoperative purge control valve, disconnected, misrouted, kinked, deteriorated or damaged vapour or control hoses.

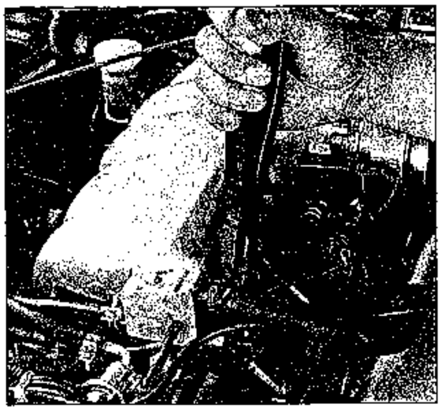
7 Inspect each hose attached to the canister for kinks, leaks and cracks along its entire length. Repair or renew as necessary.

8 Look for fuel leaking from the bottom of the canister **(see illustration)**. If fuel is leaking, renew the canister and check the hoses and hose routing.

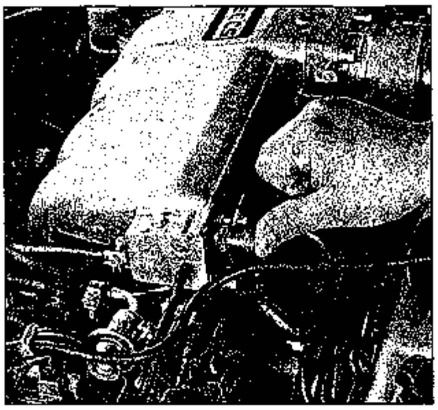
9 Inspect the canister. If it's cracked or damaged, renew it.

10 Check for a clogged filter or a stuck purge control valve. Blow into the canister at the upper of the paired tubes. There should be no leakage. Now blow into the other two tubes. There should be leakage. If a problem is found, renew the canister.

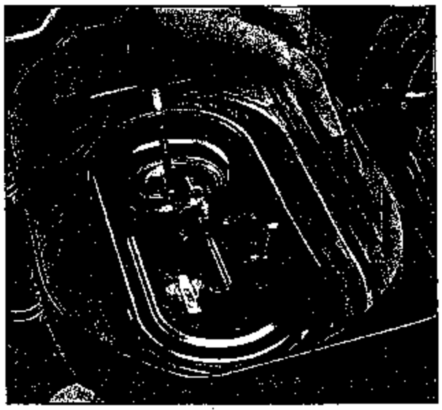
11 Check the operation of the thermal vacuum switch. With the engine completely cold, use a hand-held pump and direct air into the thermal vacuum switch from the manifold side. Air should not pass through the thermal vacuum switch. Now warm the engine to operating temperature (above 54 degrees C) and observe that air passes through the thermal vacuum switch. Renew the valve if the test results are incorrect.



5.5 Loosen the hose clamp and remove the hose from the PCV valve



5.6 With the engine running there should be a strong vacuum present at the PCV valve - if there is not, renew the valve



5.10 The PCV system draws air through this filter (carburetted engines) - if it is missing or dirty, contaminated air will flow throughout the engine

Fuel check valve

12 The fuel check valve is in the fuel vapour vent line between the canister and the fuel tank.

13 Remove the valve and blow air through it from the canister side. There should be little resistance.

14 Blow through it from the fuel tank side. There should be substantial resistance, although some air should go through. If it doesn't perform properly, renew it.

Fuel tank cap

15 Remove the fuel tank cap and clean it with soap and water.

16 Apply vacuum to the bottom of the cap. There should be some resistance which decrease and some clicking. If there is no resistance or no flow, renew the cap.

Charcoal canister renewal

17 Clearly label, then detach the vacuum hoses from the canister.

18 Remove the mounting clamp bolts, lower the canister with the bracket, disconnect the hoses from the check valve and remove it from the vehicle.

19 Refitting is the reverse of removal.

4 Exhaust Gas Recirculation (EGR) system

General description

1 To reduce NOX emissions, part of the exhaust gases are recirculated through the EGR valve into the inlet manifold to lower the maximum combustion temperature.

2 The main component of the system is the EGR valve. It operates in conjunction with the thermal vacuum switch and the Back Pressure Transducer (BPT) valve.

3 At low engine temperatures, the thermal vacuum switch and EGR valve are shut and the exhaust gas is not being recirculated. At higher engine temperatures, the thermal vacuum switch allows vacuum to reach the BPT valve.

4 The BPT valve senses exhaust pressure and adjusts the amount of vacuum going to the EGR valve. When exhaust pressure is high, full vacuum flow is permitted and full exhaust gas recirculation takes place.

Check

5 If the engine runs roughly at idle, hesitates under acceleration, accelerates poorly or has poor fuel economy, the EGR system is probably not shutting off.

6 Before checking the EGR valve, always inspect the condition of all vacuum hoses in the system. Make sure they're all properly attached and are in good condition. If any of the hoses are cracked or otherwise damaged, renew them.

7 Also inspect the BPT valve filter for contamination or damage. If it's dirty, clean it with compressed air.

8 Disconnect the vacuum hose from the EGR valve and connect a vacuum pump to it.

9 Apply vacuum directly to the EGR valve. The engine should run roughly or die. If it doesn't, renew the EGR valve.

Component renewal

10 Disconnect the vacuum hose, remove the retaining bolts and the valve, renew the faulty valve with a new one, refit the bolts and reconnect the vacuum hoses.

5 Positive Crankcase Ventilation (PCV) system

General information

1 The Positive Crankcase Ventilation (PCV) system reduces hydrocarbon emissions by scavenging crankcase vapours. It does this by circulating fresh air from the air cleaner through the crankcase, where it mixes with blow-by gases and is then rerouted through a PCV valve to the inlet manifold.

2 The main components of the PCV system are the PCV valve, a fresh air intake filter and the hoses connecting these components to the engine.

3 To maintain idle quality, the PCV valve restricts the flow when the inlet manifold vacuum is high. If abnormal operating conditions (such as piston ring problems) arise, the system is designed to allow excessive amounts of blow-by gases to flow back through the crankcase vent tube into the air cleaner to be consumed by normal combustion.

4 This system directs the blow-by into the throttle body which, over time, can cause an oily residue build up in the area near the throttle plate. Consequently, it's a good idea to periodically clean this residue from the throttle body. Refer to Chapter 4B for this cleaning procedure.

Check

Refer to illustrations 5.5 and 5.6

5 To check the valve, first remove it and shake the valve **(see illustration)**. It should rattle, indicating that it's not clogged with deposits. If the valve does not rattle, renew it.

6 Start the engine and allow it to idle, then place your finger over the valve opening **(see illustration)**. If strong vacuum is felt, the PCV valve is working properly. Also, check for vacuum leaks at the valve, filler cap and all the hoses.

Renewal

Refer to illustration 5.10

7 Unscrew the valve to remove it.

8 If necessary, refit a new PCV valve.

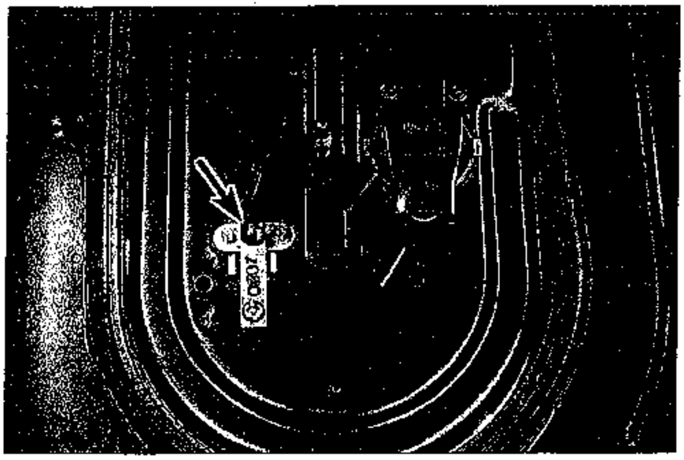
9 Clean and refit the PCV hoses. Make sure that the PCV valve and hoses are secure.

10 Check the condition of the filter used on some carburetted models. It is located in the air cleaner housing **(see illustration)**.

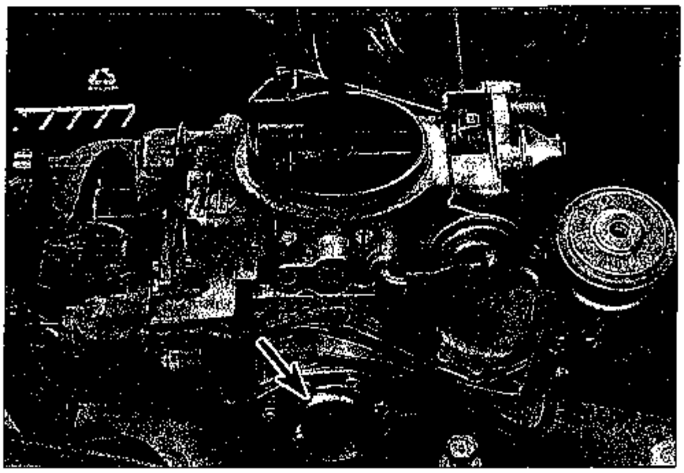
6 Hot Idle Compensation (HIC) system

General information

1 The HIC system allows controlled air to enter the inlet manifold to maintain proper air/fuel mixture during high temperatures at idle.



6.6 The Hot Idle Compensation valve (arrow) is located in the air cleaner housing - the temperature sensor for the hot air intake system is adjacent to the HIC valve



7.1 The BCCD valve is mounted on the side of the carburettor - the rubber cap (arrow) covers the adjusting screw

2 The HIC valve opening will vary as the temperature of the air changes from cold (27 to 60 degrees C) to hot (above 75 degrees C). The HIC valve starts out closed (cold) then gradually opens (hot) as the heated air is passed over the valve.

Check

3 Disconnect the HIC hose from the inlet manifold and attempt suck through it. At temperatures below 60 degrees C, the HIC valve should be closed.

4 Remove the HIC valve, turn it upside down and place the top section in a pan of heated water with a thermometer. With the valve temperature above 75 degrees C, air should be able to pass through it.

5 If the test results are incorrect, renew the HIC valve.

Renewal

Refer to illustration 6.6

6 Remove the mounting clip and lift the HIC valve from the air cleaner housing **(see illustration)**.

7 Boost Controlled Deceleration Device (BCDD) system

General information

Refer to illustration 7.1

1 The BCDD valve is mounted on the carburettor **(see illustration)**. Its purpose is to open a small fuel passage in the carburettor under heavy deceleration conditions in order to prevent HC emissions caused by excessive inlet vacuum.

2 The device is controlled by a control solenoid valve. This valve stops operation of the BCDD when vehicle speed is low, when the clutch pedal is depressed or when the inlet manifold vacuum is below 80 kPa.

Check and adjustment

3 Disconnect the wiring from the control solenoid, if equipped.

4 Loosen the dashpot adjustment screw completely. **Note:** *After checking the BCDD valve, readjust the dashpot* (refer to Chapter 4A).

5 Connect a hand vacuum gauge to inlet manifold vacuum.

6 Start the engine. Quickly rev it and then fully release the throttle. The vacuum should rise quickly and then drop to a predetermined level and hold briefly. It should then drop off to the normal idle level. Refer to the Specifications in this Chapter for the correct vacuum level.

7 If the unit requires adjustment, remove the cap from the BCDD unit and turn the screw gently in small increments.

8 If there is no valve action, remove the valve and check for a stuck plunger.

9 To test the control solenoid, disconnect the wiring from the solenoid.

10 Connect fused jumper wires from the battery to the solenoid. There should be a click heard at the carburettor. If not, renew the solenoid. **Note:** *The solenoid receives inputs from the clutch switch (if equipped) and the speed detecting switch. If it tests good yet still refuses to operate under driving conditions, check these components.*

Renewal

11 Remove the three large screws retaining the cover and remove the BCDD.

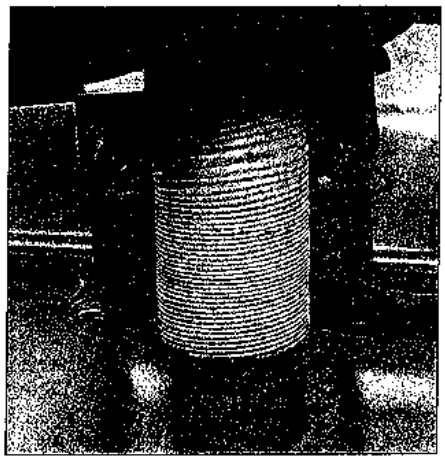
12 Refitting is the reverse of removal.

8 Automatic Temperature Control (ATC) system

General information

Refer to illustration 8.2

1 The automatic temperature control system is used on carburetted engines to control the temperature of the air inducted to the carburettor. This improves warm-up and drivability as well as permitting leaner calibration of the carburettor.



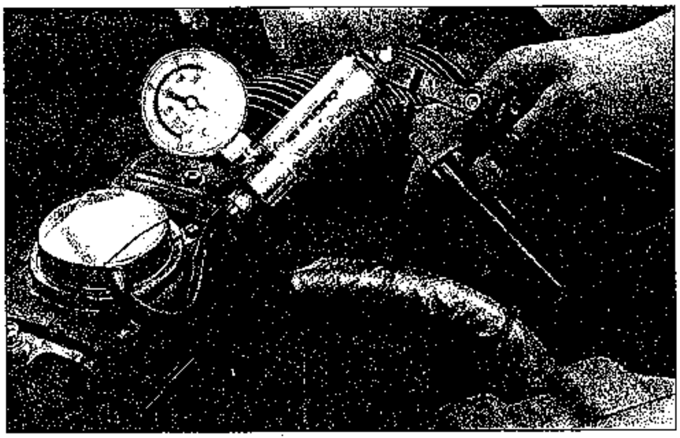
8.2 The hot air duct which connects the air cleaner to the exhaust manifold heat source must be kept in good condition in order for the vehicle to perform properly during warm-up

2 Under cold inlet air conditions, the air temperature sensor does not permit engine vacuum to reach the vacuum motor. The motor keeps the air door in the closed position and the engine draws in air that has been heated by the exhaust manifold heat stove by way of a hot air duct **(see illustration)**.

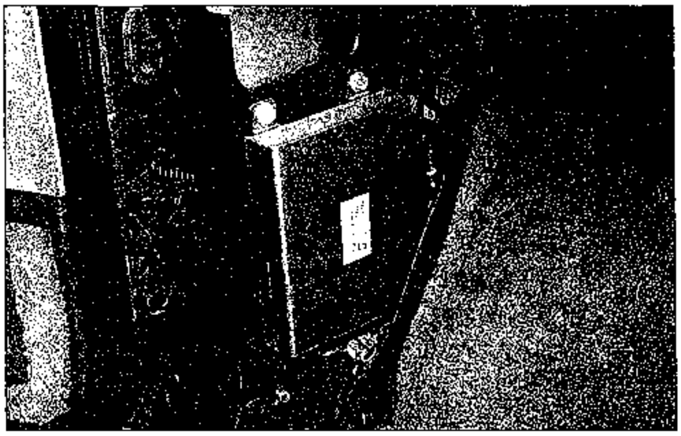
3 When the inlet air has warmed sufficiently, the air temperature sensor allows vacuum to reach the vacuum motor. This operates the air door and it then opens the normal inlet path so that the engine draws in unheated air.

4 The components of this system include the vacuum motor and air door, the temperature sensor and the hoses.

5 On 3.0 litre engines , there is also a Positive Temperature Coefficient (PTC) heater refitted beneath the carburettor. This is an electrically heated grid which warms the incoming air. It is controlled by a mixture heater relay.



8.10 Check the operation of the vacuum motor on the hot air intake system with a hand vacuum pump



9.8 The ECU is located behind the left kick panel

Check

Refer to illustration 8.10

6 With the engine completely cool, look into the air snorkel and observe the position of the air door. It should be positioned to allow cool air to enter the carburettor.

7 Start the engine. The door should move to block cool air from entering and expose the duct to the exhaust.

8 Warm the engine completely. The door should move to allow cool air to enter the carburettor.

9 If the door does not act as described, proceed with the test.

10 Connect a hand vacuum pump to the vacuum motor **(see illustration)**. The door should begin to open at the vacuum level listed in this Chapter's Specifications. It should be fully open at the full open specification. If not renew it.

11 With the engine cool, disconnect the vacuum hose from the vacuum motor. There should be vacuum present at the hose. If not, check the hoses for cracks and other damage.

12 With the engine warm, there should be no vacuum to the motor. If either of the above conditions are not met, renew the temperature sensor.

13 To check the PTC heater, connect an ohmmeter between the terminals of the heater unit. Continuity should be present, if there is infinite resistance, renew it.

14 Check for battery voltage at the wiring to the heater wit the ignition ON. If there is no voltage, check the heater relay and the wiring.

Renewal

15 To renew the vacuum motor, remove the screws which secure the retention strap over it.

16 Refit the new vacuum motor and fasten the strap back into position.

17 To renew the temperature sensor, unclip it from its retainer and clip in the new unit.

18 To renew the PTC heater, remove the carburettor (refer to Chapter 4A). Disconnect the wiring to the heater and remove it.

19 Refitting is the reverse of removal.

9 Electronic Combustion Control System (ECCS) - general information and ECU removal and refitting

General information

1 The fuel injection system is controlled by means of a microcomputer known as the Electronic Control Unit (ECU).

2 The ECU receives signals from various sensors which monitor changing engine operating conditions such as intake air volume, coolant temperature, engine rpm, exhaust oxygen content, etc. These signals are utilised by the ECU to determine the correct fuel injection duration and ignition timing.

3 The system is analogous to the central nervous system in the human body: The sensors (nerve endings) constantly relay signals to the ECU (brain), which processes the data and, if necessary, sends out a command to change the operating parameters of the engine (body).

4 Here's a specific example of how one portion of this system operates: An oxygen sensor, located in the exhaust manifold, constantly monitors the oxygen content of the exhaust gas. If the percentage of oxygen in the exhaust gas is incorrect, an electrical signal is sent to the ECU. The ECU takes this information, processes it and then sends a command to the fuel injection system telling it to change the air/fuel mixture. This happens in a fraction of a second and it goes on continuously when the engine is running. The end result is an air/fuel mixture ratio which is constantly maintained at a proper ratio, regardless of driving conditions.

5 In the event of a sensor malfunction, a backup circuit will take over to provide driveability until the problem is identified and fixed.

Precautions

6 Follow these steps:

a) *Always disconnect the power by either turning off the ignition switch or disconnecting the battery terminals before unplugging any electrical connectors.* **Caution:** *If the stereo in your vehicle is equipped with an anti-theft system, make sure you have the correct activation code before disconnecting the battery.*

b) *When refitting a battery, be particularly careful to avoid reversing the positive and negative battery cables.*

c) *Do not subject EFI components, emissions-related components or the ECU to severe impact during removal or refitting.*

d) *Do not be careless during troubleshooting. Even slight terminal contact can invalidate a testing procedure and damage one of the numerous transistor circuits.*

e) *Never attempt to work on the ECU or open the ECU cover. The ECU is protected by a government-mandated extended warranty that will be nullified if you tamper with or damage the ECU.*

f) *If you are inspecting electronic control system components during rainy weather, make sure that water does not enter any part. When washing the engine compartment, do not spray these parts or their electrical connectors with water.*

6

ECU removal and refitting

Refer to illustration 9.8

7 Disconnect the negative cable from the battery (see Chapter 5).

8 Remove the passenger side kick panel **(see illustration)**.

9 Remove the bolt from the ECU wiring harness connector. **Note:** *If necessary, remove the ECU and then disconnect the harness connector to ease removal.*

10 Remove the bolts from the ECU brackets and remove the ECU from the vehicle.

11 Refitting is the reverse of removal. Be very careful to not bend any of the pins as you connect the harness. When tightening the wiring harness connector bolt, only tighten it until the red protrusion lines up with the connector side.

10 On Board Diagnosis (OBD) system - description and trouble code access

General information

1 The ECU contains a built-in self-diagnosis system which detects and identifies malfunctions occurring in the network. The system has two levels at which it will communicate with the technician. Mode I is the normal operation mode of the vehicle. When the ignition switch is turned ON, the CHECK ENGINE lamp is illuminated in order for you to make sure that the bulb is working (bulb check).

2 When the engine is started, the warning light should go out. When the engine is running, the CHECK ENGINE light will illuminate in the case of a detected malfunction to inform you that there is a problem.

3 When mode II has been activated and the engine is stopped with the ignition switch turned ON, the ECU will display the trouble codes of all detected faults.

4 When mode II is activated and the engine is running, the CHECK ENGINE light will monitor the performance of the oxygen sensor.

5 When the ECU detects a problem, three things happen: the CHECK ENGINE light comes on, the trouble is identified and a diagnostic code is recorded and stored. The ECU stores the failure code assigned to the specific problem area until the diagnosis system is canceled by switching from self-diagnostic mode II (code retrieval) to mode I.

Note: *It is a good idea to check for any trouble codes when the engine exhibits driveability problems.*

Obtaining diagnostic code output

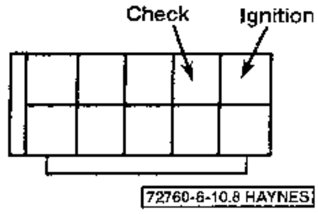
Refer to illustration 10.8

6 To obtain an output of diagnostic codes, verify first that the battery voltage is above 11 volts, the throttle is fully closed, the transmission is in Neutral, the accessory switches are off and the engine is at normal operating temperature.

7 Turn the ignition switch to ON (engine not running). Do not start the engine. Locate the test connector harness under the dash at the extreme right side.

8 Use a jumper wire to bridge the CHECK and IGNITION terminals of the test connector **(see illustration)**. Wait at least two seconds. Disconnect the wire.

9 Read the diagnosis code as indicated by the number of flashes of the "CHECK ENGINE" light on the dash. Normal system operation is indicated by Code No. 55 (no malfunctions) for all models. The "CHECK ENGINE" light displays a Code No. 55 by blinking five times for 0.6 seconds and then five times for 0.3 seconds. Each code will be displayed by first blinking the first digit of the code, then pause, and blink the second digit of the code. For example; Code 13 (engine temperature sensor circuit) will flash one long flash, pause, and then flash three quick flashes.



10.8 To activate the diagnostic modes, bridge the CHECK and IGNITION terminals of the diagnostic connector - it's located behind the right side of the dash

10 If there are any malfunctions in the system, their corresponding trouble codes are stored in computer memory and the light will blink the requisite number of times for the indicated trouble codes. If there's more than one trouble code in the memory, they'll be displayed in numerical order (from lowest to highest) with a pause between each one. Should it become necessary to work on engine components requiring removal of the battery terminal, always check to see if a diagnostic code has been recorded before disconnecting the battery.

11 To exit diagnostic mode II, reconnect the CHECK and IGNITION terminals for at least two seconds.

Diagnostic Trouble Codes

Code	Circuit or system	Diagnosis
Code 11	Crank angle sensor circuit.	Check the wiring connectors and the harness before renewing the sensor.
Code 12	Air flow meter circuit.	Check the wiring connectors and the Harness before renewing the sensor.
Code 13	Engine temperature sensor circuit.	Check the wiring connectors and the Harness before renewing the sensor.
Code 21	Ignition signal circuit.	Check the wiring connectors and the Harness before renewing the power transistor.
Code 43	Throttle sensor circuit.	Check the wiring connectors and the Harness before renewing the sensor.
Code 55	System functioning properly	No trouble codes present.

Note: *If codes 11 and 21 are both displayed, check the crank angle sensor circuit first.*

11 Information sensors

Note 1: *Most of the components described in this Section are protected by a Federally mandated extended warranty. See your dealer for the details regarding your vehicle.*

Note 2: *Refer to Chapters 4B and 5 for additional information on the location and the diagnostic procedures for the sensors that are not directly covered in this Section.*

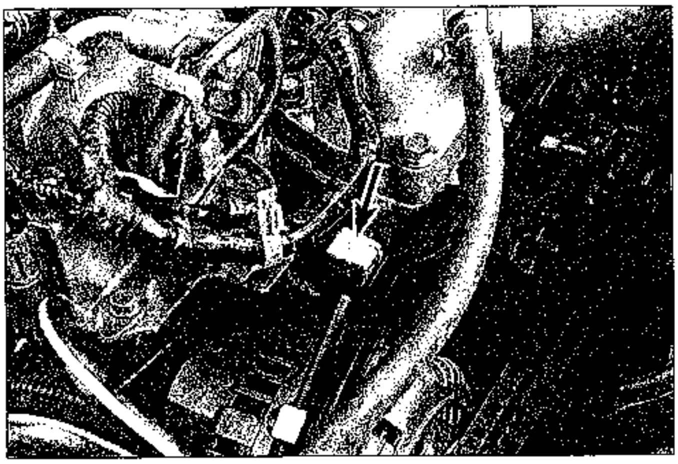
Engine temperature sensor

General description

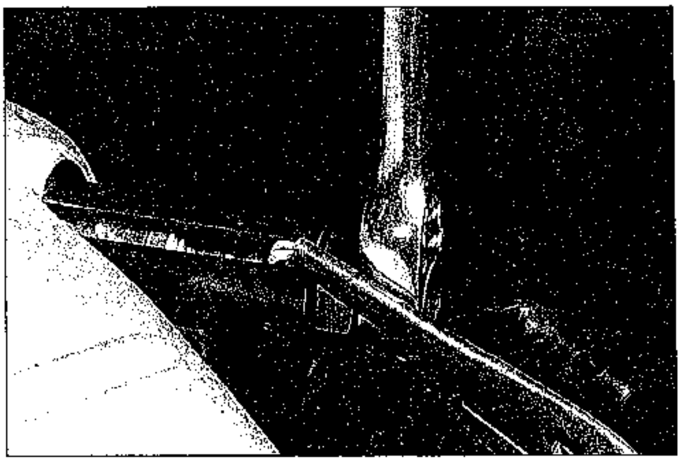
1 The engine temperature sensor is a thermistor (a resistor which varies the value of its voltage output in accordance with temperature changes). As the sensor temperature DECREASES, the resistance values will INCREASE. As the sensor temperature INCREASES, the resistance values will DECREASE. A failure in this sensor circuit should set a Code 13. This code indicates a failure in the engine temperature sensor circuit, so in most cases the appropriate solution to the problem will be either repair of a connector or wire, or renewal of the sensor.

Check

2 To check the sensor, disconnect the electrical connector and measure the resistance across the sensor terminals. With the engine completely cold (20 degrees C) the



11.4 The engine temperature sensor is located in the thermostat housing



11.19 Slotted sockets are available to ease oxygen sensor removal

resistance should be as listed in this Chapter's Specifications. Next, start the engine and warm it up until it reaches operating temperature (82 degrees C) - check the resistance again and compare it to the specifications. **Note:** *If necessary, remove the sensor and perform the tests in a pan of heated water to simulate the conditions.*

Renewal

Refer to illustration 11.4

3 Make sure that the engine is completely cool, then place the new sensor at hand so that it can be refitted quickly and with a minimum of coolant loss.

4 Before refitting the new sensor, wrap the threads with Teflon sealing tape to prevent leakage and thread corrosion.

5 To remove the sensor, unplug the electrical connector, then carefully unscrew the sensor **(see illustration)**.

6 Refit the new sensor. **Caution:** *Handle the coolant sensor with care. Damage to this sensor will affect the operation of the entire fuel injection system.*

Oxygen sensor

General description

7 The oxygen sensor is located in the exhaust manifold. The oxygen content in the exhaust reacts with the oxygen sensor to produce a voltage output which varies from 0.1-volt (high oxygen, lean mixture) to 0.9-volts (low oxygen, rich mixture). The ECU constantly monitors this variable voltage output to determine the ratio of oxygen to fuel in the mixture. The ECU alters the air/fuel mixture ratio by controlling the pulse width (open time) of the fuel injectors. A mixture ratio of 14.7 parts air to 1 part fuel is the ideal mixture ratio for minimising exhaust emissions, thus allowing the catalytic converter to operate at maximum efficiency. It is this ratio of 14.7 to 1 which the ECU and the oxygen sensor attempt to maintain under normal driving conditions.

8 The oxygen sensor produces no voltage when it is below its normal operating temperature of about 293-degrees C. During this initial period before warm-up, the ECU operates in open loop mode.

9 When there is a problem with the oxygen sensor or its circuit, the ECU operates in the open loop mode - that is, it controls fuel delivery in accordance with a programmed default value instead of feedback information from the oxygen sensor.

10 The proper operation of the oxygen sensor depends on four conditions:

a) ***Electrical*** *- The low voltages generated by the sensor depend upon good, clean connections which should be checked whenever a malfunction of the sensor is suspected or indicated.*
b) ***Outside air supply*** *- The sensor is designed to allow air circulation to the internal portion of the sensor. Whenever the sensor is removed and refitted or renewed, make sure the air passages are not restricted.*
c) ***Proper operating temperature*** *- The ECU will not react to the sensor signal until the sensor reaches approximately 296-degrees C. This factor must be taken into consideration when evaluating the performance of the sensor.*
d) ***Unleaded fuel*** *- The use of unleaded fuel is essential for proper operation of the sensor. Make sure the fuel you are using is of this type.*

11 In addition to observing the above conditions, special care must be taken whenever the sensor is serviced.

a) *The oxygen sensor has a permanently attached pigtail and electrical connector which should not be removed from the sensor. Damage to or removal of the pigtail or electrical connector can adversely affect operation of the sensor.*
b) *Grease, dirt and other contaminants should be kept away from the electrical connector and the louvred end of the sensor.*
c) *Do not use cleaning solvents of any kind on the oxygen sensor.*
d) *Do not drop or roughly handle the sensor.*
e) *The silicone boot must be refitted in the correct position to prevent the boot from being melted and to allow the sensor to operate properly.*

Check

12 Checking the operation of the oxygen sensor is done very easily and accurately using the capabilities of the on-board ECU in self-diagnostic mode II. Warm the engine to the normal operating temperature.

13 Locate the computer diagnostic wiring connector under the dash at the extreme right side. Use a jumper wire to bridge the CHECK and the IGNITION terminals of the connector for at least two seconds **(see illustration 10.8)**. Disconnect the jumper.

14 Start the engine. The check engine lamp will now display oxygen sensor performance. Run the engine under no load at 2,000 RPM for two minutes.

15 Hold the engine at 2,000 RPM. Count the number of times the check engine lamp flashes during a ten second interval. If the number of flashes is less than five, then the oxygen sensor must be renewed. 6

16 To exit diagnostic mode II, turn the ignition off and disconnect the negative terminal from the battery.

Renewal

Refer to illustration 11.19

Note: *Because it is refitted in the exhaust manifold or pipe, which contracts when cool, the oxygen sensor may be very difficult to loosen when the engine is cold. Rather than risk damage to the sensor (assuming you are planning to reuse it in another manifold or pipe), start and run the engine for a minute or two, then shut it off. Be careful not to burn yourself during the following procedure.*

17 Disconnect the cable from the negative terminal of the battery. Raise the vehicle and place it securely on jackstands.

18 Carefully disconnect the electrical connector from the sensor pigtail lead.

19 Remove the oxygen sensor from the exhaust system **(see illustration)**. **Caution:** *Excessive force may damage the threads.*

11.24 The throttle sensor is located on the side of the throttle body

Note: *Some oxygen sensors are threaded directly into the exhaust manifold while others are mounted in the exhaust manifold or pipe.*

20 Anti-seize compound must be used on the threads of the sensor to facilitate future removal. The threads of new sensors will already be coated with this compound, but if an old sensor is removed and refitted, re-coat the threads.

21 Refit the sensor and tighten it securely.

22 Reconnect the electrical connector of the pigtail lead to the main engine wiring harness.

23 Lower the vehicle and reconnect the cable to the negative terminal of the battery.

Throttle sensor

General description

Refer to illustration 11.24

24 The throttle sensor is located on the end of the throttle shaft on the throttle body **(see illustration)**. By monitoring the output voltage from the throttle sensor, the ECU can alter fuel delivery based on throttle valve angle (driver demand). A broken or loose sensor can cause intermittent bursts of fuel from the injector and an unstable idle because the ECU thinks the throttle is moving. See Chapter 4B for the check and renewal procedures.

Airflow sensor

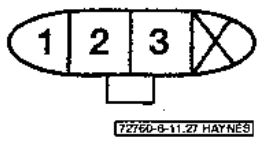
General Information

25 The Airflow sensor measures the volume of air that enters the intake system using a heated film principle. The sensor measures the amount of heat lost by a film placed in the air stream. This information is relayed to the computer to inject the correct amount of the fuel into the combustion chambers for the volume of air (load) that is demanded.

Check

Refer to illustration 11.27

26 With the engine idling, tap softly on the sensor with you knuckles or a screwdriver handle. If the engine stumbles when tapped, the sensor is bad.



11.27 Backprobe the air flow meter electrical connector with a voltmeter - connect the positive lead to terminal 2 and the negative lead to earth

27 Without disconnecting the wiring connector from the sensor, peel back the rubber and using a suitable probe, connect a voltmeter to the sensor connector as shown **(see illustration)**. Refer to the Specifications in this Chapter for the correct voltage readings under the various conditions.

28 If the sensor doesn't meet the required specifications, renew it.

29 If the voltage readings are correct, yet there is still a diagnostic trouble code for this item, check the wiring harness for open circuits or a damaged harness (see Chapter 12).

Renewal

Refer to illustration 11.30

30 Disconnect the electrical connector from the airflow sensor **(see illustration)**. Disconnect the air duct from the sensor.

31 Remove the air cleaner lid with air flow sensor attached.

32 Disconnect the air flow sensor from the lid by removing the bolts and the retainer late inside the air cleaner housing.

33 Refitting is the reverse of removal.

Exhaust gas temperature sensor

General Description

34 The exhaust gas temperature sensor is mounted near the EGR valve. This sensor detects the temperature of the exhaust as it moves through the EGR valve. The information is sent to the ECU and in turn the EGR on/off time is regulated precisely and more efficiently.

Check

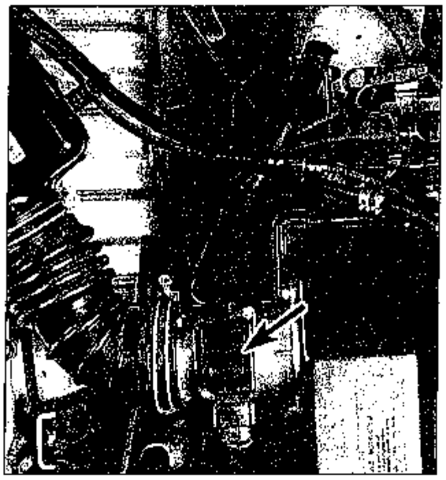
35 Remove the sensor and place it in a pan of water which can be heated.

36 Connect an ohmmeter to the terminals of the sensor. Observe the change in resistance as the water is heated.

37 The resistance should decrease evenly as the temperature rises. When the water boils, read the resistance. If the resistance is not as listed in the Specifications in this Chapter or if the response is not smooth, renew it.

Renewal

38 Disconnect the harness connector for the temperature sensor and using an open-end spanner, remove the sensor from the manifold.



11.30 The air flow sensor (arrow) is located in the inlet duct - inspect the entire air inlet assembly for loose clamps or damage

39 Refitting is the reverse of removal. Apply anti-seize to the threads before refitting.

Vehicle speed sensor

General description

40 The Vehicle Speed Sensor (VSS) is located in the speedometer. The sensor is electronically controlled and sends a pulsing voltage signal to the ECU, which the ECU converts to kilometres per hour.

41 Checking the VSS involves tapping into the ECU main wiring harness. Have the vehicle speed sensor, circuit and the ECU diagnosed by a dealership service department or other qualified repair shop.

Knock sensor

General Description

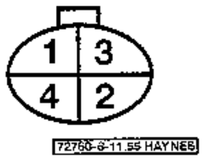
42 Irregular octane levels in modern petrol can cause detonation in an engine. Detonation is sometimes referred to as "spark knock". The knock sensor sends a voltage signal to the ECU when no spark knock is occurring and the ECU provides normal ignition advance. When the knock sensor detects abnormal shock waves (spark knock), it turns off the circuit to the ECU, and distributor timing is retarded until the knock is eliminated.

43 When the knock sensor circuit fails, the ECU reverts to a retarded timing setting for all driving conditions. Have the knock sensor, circuit and the ECU diagnosed by a dealership service department or other qualified repair shop.

Power steering pressure switch

General description

44 The power steering pressure switch is located on the steering pump. It senses when



11.55 Backprobe the distributor connector and connect a voltmeter between terminal 3 and earth, then between terminal 4 and earth. When the shaft is rotated, the voltmeter should register every time a slot in the rotor passes the sensor

the front wheels are turning and sends a signal to the ECU. The ECU then instructs the Auxiliary Air Control valve to increase the idle speed.

Check

45 Disconnect the switch wiring. Connect an ohmmeter to the terminals of the switch.
46 Start the engine and allow it to idle.
47 There should be infinite resistance with the wheels straight ahead.
48 When the wheels are turned, there should be zero resistance. If the switch fails either test, renew it.

Renewal

49 Place a rag beneath the power steering pump and remove the switch.
50 Refitting is the reverse of removal. Check the fluid level before starting the vehicle.

Crank angle sensor

General description

51 The crank angle sensor is a fundamental component in the ignition system. It informs the ECU of crankshaft position, which stroke the number one piston is on and also engine speed. The crank angle sensor is located in the distributor.
52 The sensor uses a flat rotor plate with two sets of slits in it. One array consists of 360 slits, the other of 6. As he rotor rotates, an L.E.D. passes light through the slits to a photo diode. This signal is then passed to the ECU.

Check

Refer to illustration 11.55

53 Remove the distributor (refer to Chapter 5). Leave the wiring harness connected to the distributor and the engine harness.
54 Turn the ignition ON.
55 Using suitable probes, backprobe the connector and connect an analog voltmeter as shown **(see illustration)**. Slowly turn the distributor shaft.
56 As it is turned, the reading should vary from 0 and 5 volts, six times per revolution at terminal 3 and 360 times per revolution at terminal 4.
57 Disassemble the distributor and inspect the signal plate for dirt or damage (refer to Chapter 5). Clean it if necessary.

Renewal

58 The crank angle sensor is an integral part of the distributor and is not serviced separately. Refer to Chapter 5 for distributor renewal.

12 Catalytic converter system

Note: *Because of a federally mandated extended warranty which covers emissions-related components such as the catalytic converter, check with a dealer service department before renewing the converter at your own expense.*

General description

1 To reduce hydrocarbon, carbon monoxide and oxides of nitrogen emissions, vehicles are equipped with a three-way catalyst system which oxidises and reduces these chemicals, converting them into harmless nitrogen, carbon dioxide and water.
2 The catalytic converter is mounted in the exhaust system much like a muffler.

Check

3 Periodically inspect the catalytic converter-to-exhaust pipe mating flanges and bolts. Make sure that there are no loose bolts and no leaks between the flanges.
4 Look for dents in or damage to the catalytic converter protector. If any part of the protector is damaged or dented enough to touch the converter, repair or renew it.
5 Inspect the heat insulator for damage. Make sure that there is adequate clearance between the heat insulator and the catalytic converter.

Renewal

6 To renew the catalytic converter, refer to Chapter 4A.

Notes

Chapter 7 Part A
Manual transmission

Contents

Specifications

Model number

4.2 litre engine	
4 speed	FN4R50A
5 speed	FS5R50A
3.0 litre engine	FS5R30A

FS5R30A

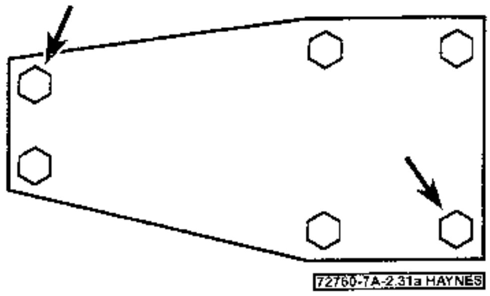
Gear end play	
All except reverse main gear	0.23 to 0.33 mm
Reverse main gear	0.33 to 0.43 mm
Reverse idler shaft end play	0.30 to 0.53 mm

FS5R50A

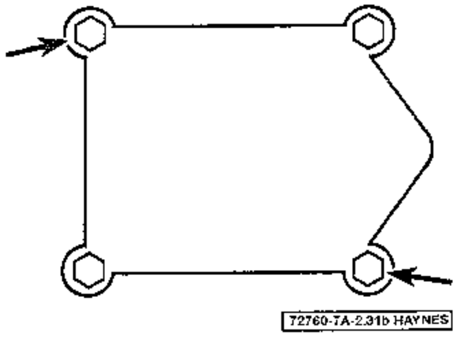
Gear end play	
All except second gear	0.20 to 0.45 mm
Second gear	0.20 to 0.60 mm
Snap-ring clearance limit (except synchro hubs)	0.15 mm
Synchro hub snap-ring clearance limit	
First and second	0.13 mm
Third and fourth	0.10 mm
Baulk ring to gear/cone minimum	0.7 mm

Torque specifications

	Nm
Clutch housing-to-engine bolts	
4.2 litre engine	
65 mm bolts	29 to 39
Except 65 mm bolts	83 to 113
3.0 litre engine	
To 10/94 production date	
65 mm bolts	39 to 49
Except 65 mm bolts	29 to 39
After 10/94 production date	
40 mm bolts	29 to 39
Except 40 mm bolts	39 to 49
Lever housing bolts	19 to 21
Transmission-to-clutch housing bolts	54 to 72
Front cover-to-transmission bolts	
FS5R30A	12 to 15
FS5R50A	19 to 21
Rear extension-to transmission bolts	
FS5R30A	23 to 31
FS5R50A	57 to 72
FS5R50A bearing retainer bolts	16 to 21
FS5R50A control housing bolts	16 to 21



2.31a On 4.2 litre engines, refit the longer bolts in these locations (arrows) in the control housing cover



2.31b On 3.0 litre engines, refit the bolts with the 13 mm heads in these locations (arrows) in the control housing cover. The 12 mm bolts go in the other two holes

1 General information

All vehicles covered in this manual are equipped with either a 4 or 5-speed manual transmission or an automatic transmission. All information on the manual transmission is included in this Part of Chapter 7. Information on the automatic transmission can be found in Part B. Information on the transfer case can be found in Part C.

Due to the complexity, unavailability of replacement parts and the special tools necessary, internal repair of the manual transmission is not recommended for the home mechanic. The information contained within this Section will be limited to general information and removal and refitting procedures.

Depending on the expense involved in having a faulty transmission overhauled, it may be an advantage to consider renewing the unit with either a new or rebuilt one. Your local dealer or transmission shop should be able to supply you with information concerning cost, availability and exchange policy. Regardless of how you decide to remedy a transmission problem, you can still save considerable expense by removing and refitting the unit yourself.

2 Manual transmission - removal and refitting

Removal

1 Disconnect the negative cable at the battery.
2 Raise the vehicle and support it securely with jackstands. It should be as high as possible while still being safe.
3 Remove both front seats and the console (refer to Chapter 11).
4 Remove the door sill covers and remove the front carpet.
5 Remove the knobs from the gear shift lever and the transfer case lever.
6 Remove the floor access panel along with the two lever boots.
7 Remove the gear shift control housing from the top of the transmission. On 3.0 litre engines, use a magnet to draw out the ball and spring from the transmission.
8 Disconnect the parking brake cable from the lever assembly, disconnect it from the retainers and pull it through the floor to the outside of the vehicle.
9 Remove the transfer case from the vehicle (refer to Chapter 7C).
10 Remove the transfer case shift lever from the transmission.
11 Remove the clutch slave cylinder and tie it out of the way with a wire. Do not disconnect the hydraulic line.
12 Remove the starter (refer to Chapter 5).
13 Remove the PTO from the side of the transmission, if equipped.
14 Drain the oil from the transmission (refer to Chapter 1).
15 Disconnect all interfering wiring harnesses and hoses.
16 Remove the rubber mounts from the exhaust bracket.
17 Support the transmission with a jack - preferably a special jack made for this purpose. Safety chains will help steady the transmission on the jack.
18 Remove the bolts securing the transmission mount to the rear crossmember.
19 Raise the transmission slightly, then detach the nuts and bolts securing the rear crossmember to the frame rails, and remove the crossmember.
20 Remove the bolts securing the transmission to the engine.
21 Make a final check that all wires and hoses have been disconnected from the transmission and then move the transmission and jack toward the rear of the vehicle until the clutch housing is clear of the engine dowel pins. Keep the transmission level as this is done.
22 Lower the transmission assembly and remove it from under the vehicle. **Caution:** *Do not depress the clutch pedal while the transmission is removed from the vehicle.*
23 The clutch components now can be inspected (see Chapter 8). In most cases, new clutch components should be refitted as a matter of course if the transmission is removed.

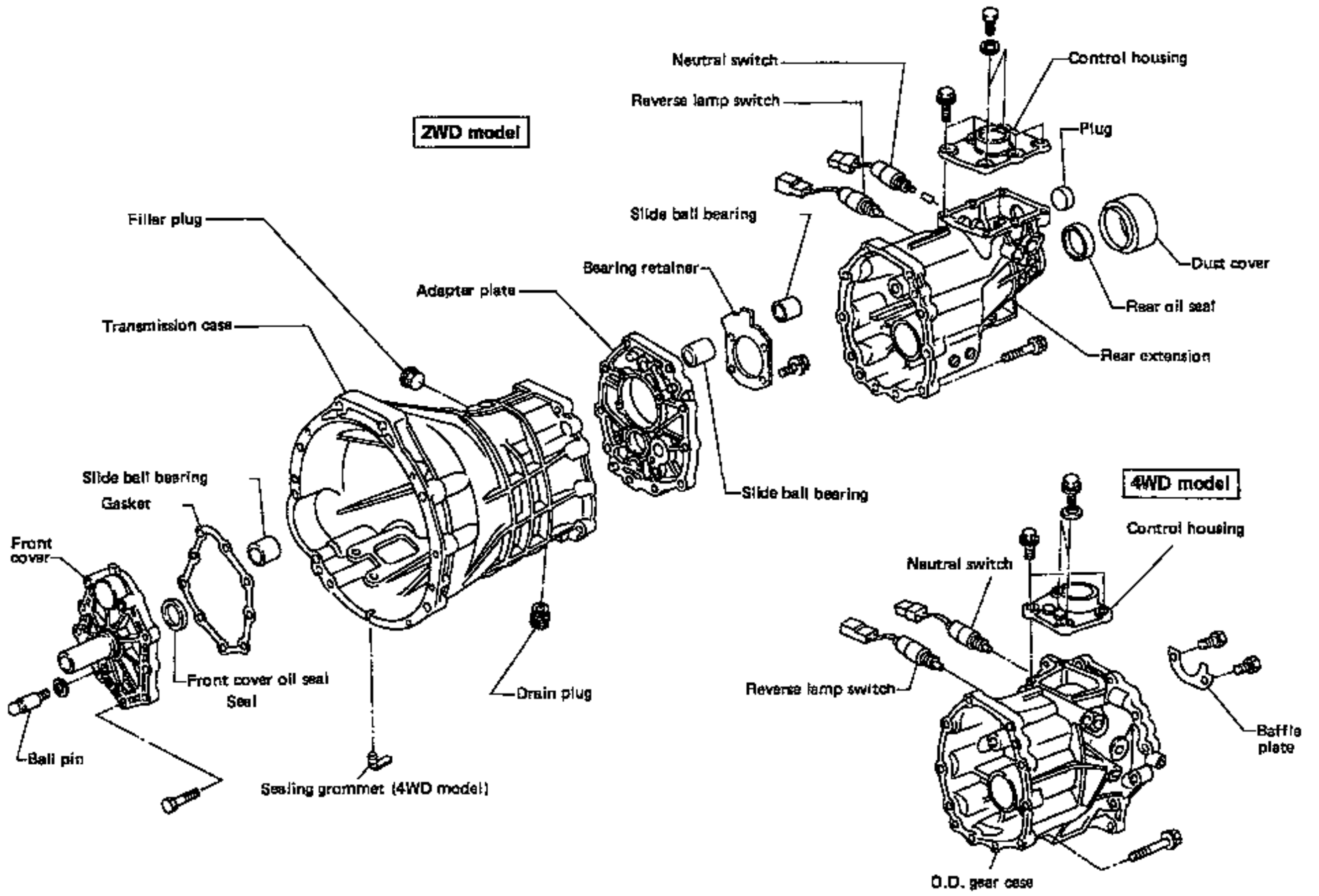
Refitting

Refer to illustrations 2.31a and 2.31b

24 If removed, refit the clutch components (see Chapter 8). Apply sealer to the sealing surface of the clutch housing. Lightly grease the transmission splines and the pilot bearing.
25 With the transmission clutch housing secured to the jack as on removal, raise it into position behind the engine and then carefully slide it forward, engaging the clutch housing over the dowel pins. Do not use excessive force to refit the transmission-if it does not slide into place, readjust the angle of the transmission so it is level.
26 Refit the transmission/clutch housing-to-engine bolts. Tighten the bolts to the specified torque.
27 Refit the crossmember and transmission support. Tighten all nuts and bolts securely.
28 Remove the jacks supporting the transmission and the engine.
29 Refit the various items removed previously, referring to Chapter 8 for the refitting of the driveshafts and Chapter 5 for information regarding the starter.
30 Make a final check that all wires, hoses and the speedometer cable have been connected and that the transmission and transfer case have been filled with lubricant to the proper level (see Chapter 1). Lower the vehicle.
31 From inside the vehicle refit the shift lever. Make sure to renew the gasket and refit the bolts in the correct positions **(see illustrations)**.
32 Connect the negative battery cable. Road test the vehicle for proper operation and check for leakage.

3 Manual transmission overhaul - general information

Overhauling a manual transmission is a difficult job for a do-it-yourselfer. It involves the disassembly and reassembly of many small parts. Numerous clearances must be precisely measured and, if necessary, changed with select-fit spacers and snap-



4.3 FS5R30A 5-speed transmission case details

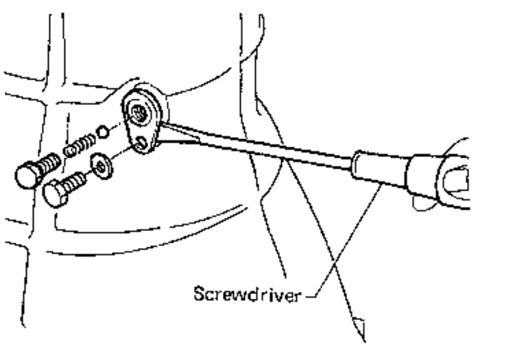
rings. As a result, if transmission problems arise, it can be removed and refitted by a competent do-it-yourselfer, but overhaul should be left to a transmission repair shop. Rebuilt transmissions may be available-check with your dealer parts department and auto parts stores. At any rate, the time and 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 if 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 snap-ring pliers, a bearing puller, a slide hammer, a set of pin punches, a dial indicator and possibly a hydraulic press. In addition, a large, sturdy workbench and a vice or transmission stand will be required.

During disassembly of the transmission, make careful notes of how each piece comes off, where it fits in relation to other pieces and what holds it in place. Exploded views are usually included in the rebuild kit to show how the transmission is assembled, but actually noting how they are refitted when you remove the parts will make it much easier to get the transmission back together.

Before taking the transmission apart for repair, it will help if you have some idea what area of the transmission is malfunctioning. Certain problems can be closely tied to specific areas in the transmission, which can make component examination and renewal easier. Refer to the *Troubleshooting section* at the front of this manual for information regarding possible sources of trouble.



4.5 FS5R30A transmission interlock assembly removal details

4 FS5R30A 5-speed transmission - overhaul

Initial disassembly

Refer to illustrations 4.3, 4.5, 4.6 and 4.9

1 With the transmission removed (Section 3), thoroughly clean the exterior of the cases.

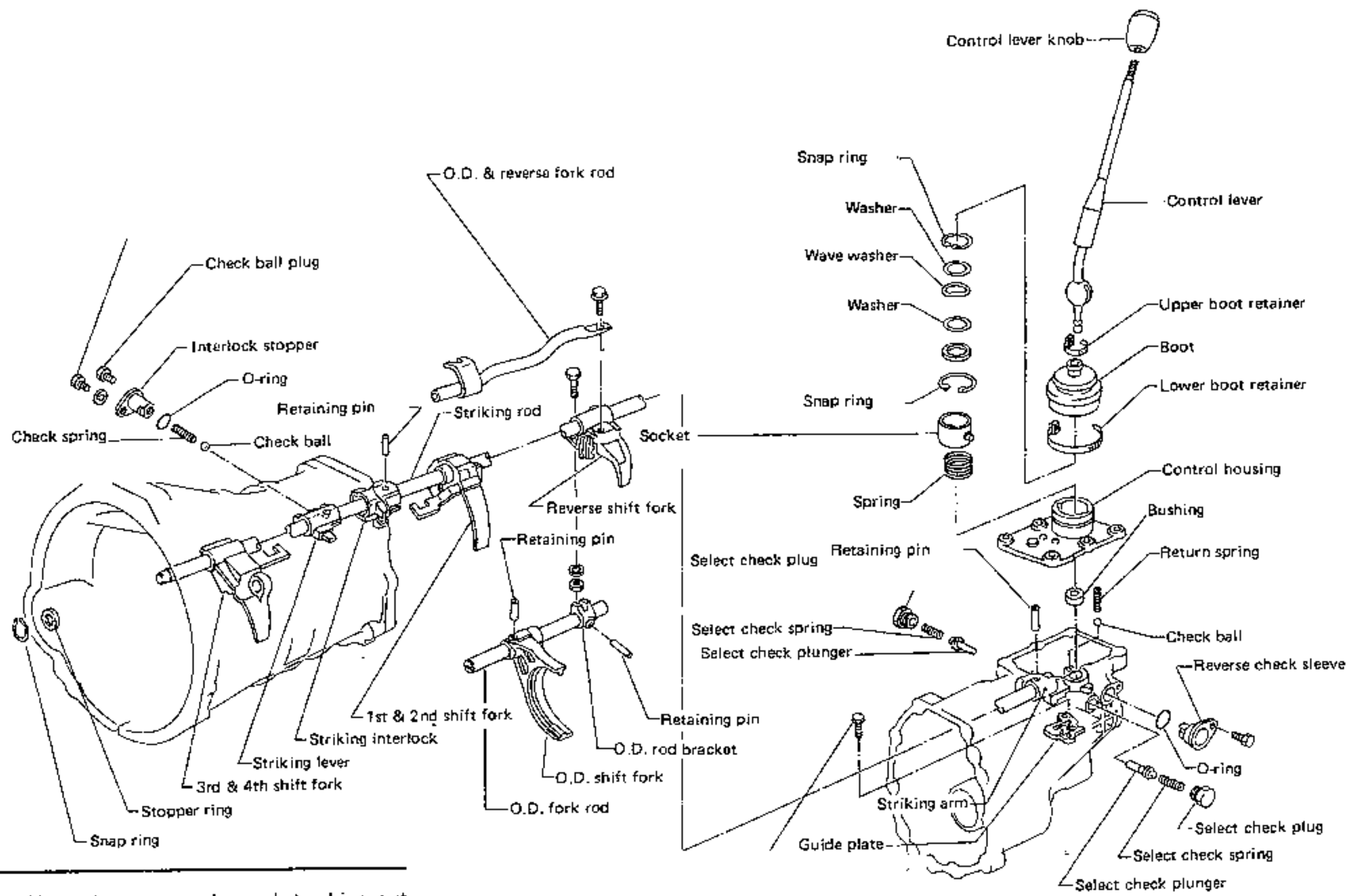
2 Remove the clutch release assembly.

3 Unscrew the electrical switches from the transmission case **(see illustration)**.

4 With the transmission in Neutral, remove the clamp bolt and lift out the speedometer pinion.

5 Remove the bolts and use a screwdriver to pry the check ball plug, spring and interlock assembly out of the case **(see illustration)**.

6 Remove the shift control housing, return spring and check ball assembly **(see illustration)**.



4.6 FS5R30A 5-speed transmission shift assembly details

7 Use a hammer and punch to drive out the striking arm roll pin.

8 Remove the bolts and use a soft faced hammer to tap on the case to separate the extension housing or overdrive gearcase.

9 Remove the bolts and separate the front cover from the case. Remove the stopper ring and use snap-ring pliers to remove the main bearing snap-ring **(see illustration)**.

Adapter plate and mainshaft disassembly

Refer to illustrations 4.16, 4.17, 4.19a and 4.19b

10 Place the case securely in a vise, using blocks of wood or cloth to protect the surface.

11 Remove the overdrive/reverse shift rod.

12 Drive out the striking lever roll pin, using a suitable punch and hammer.

13 Remove the striking rod, striking lever and interlock assembly from the adapter plate.

14 Remove the 1st/2nd, 3rd/4th and reverse shift forks.

15 Drive out the overdrive shift fork using a suitable punch and hammer and remove the rod and shift fork.

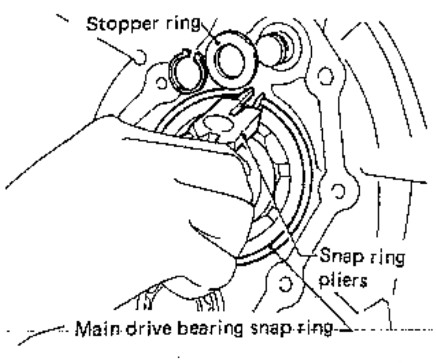
16 Use a feeler gauge to measure the gear end play **(see illustration)**. Compare the end play measurements to Specifications. Selective snap-rings (available from a dealer) are used to correct excessive end play. Inspect the mainshaft thrust washers for damage or wear.

17 Remove the reverse coupling sleeve and components from the main countershaft and countergear rear side **(see illustration)**.

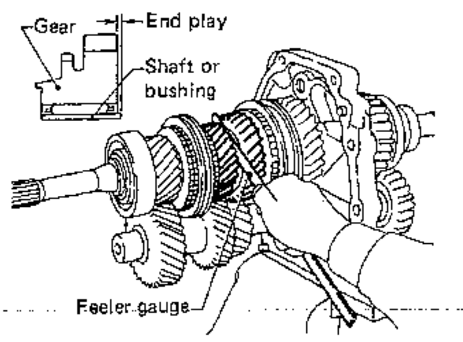
18 Remove the rear mainshaft and countergear snap-rings.

19 Use a hammer and suitable punch to remove the C-ring holder and the mainshaft C-rings **(see illustrations)**.

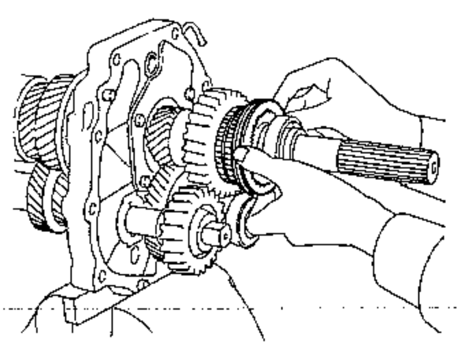
20 Use a suitable gear puller tool to remove the countershaft gear rear bearing and then



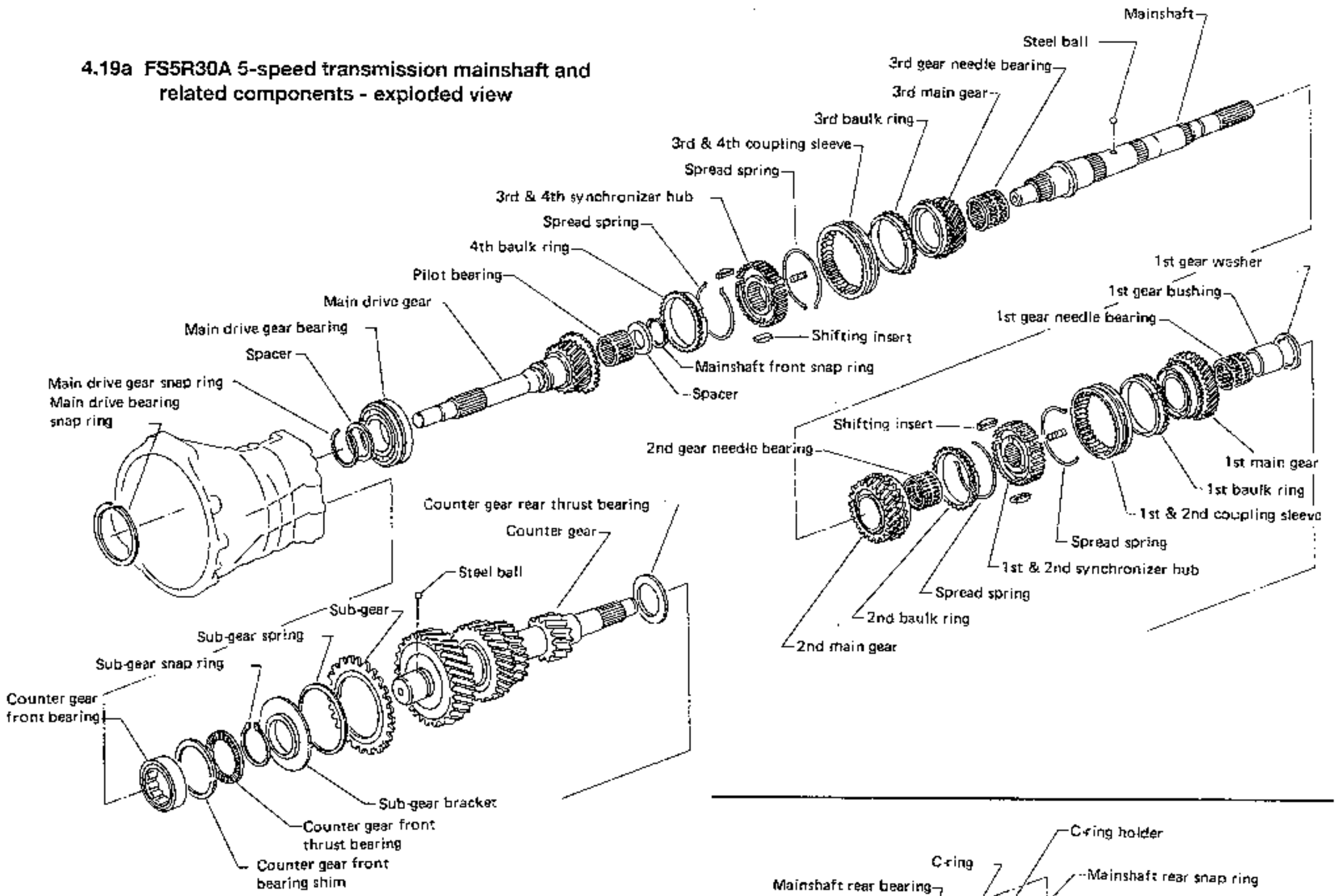
4.9 Remove the stopper ring and main drive bearing snap ring with snap ring pliers



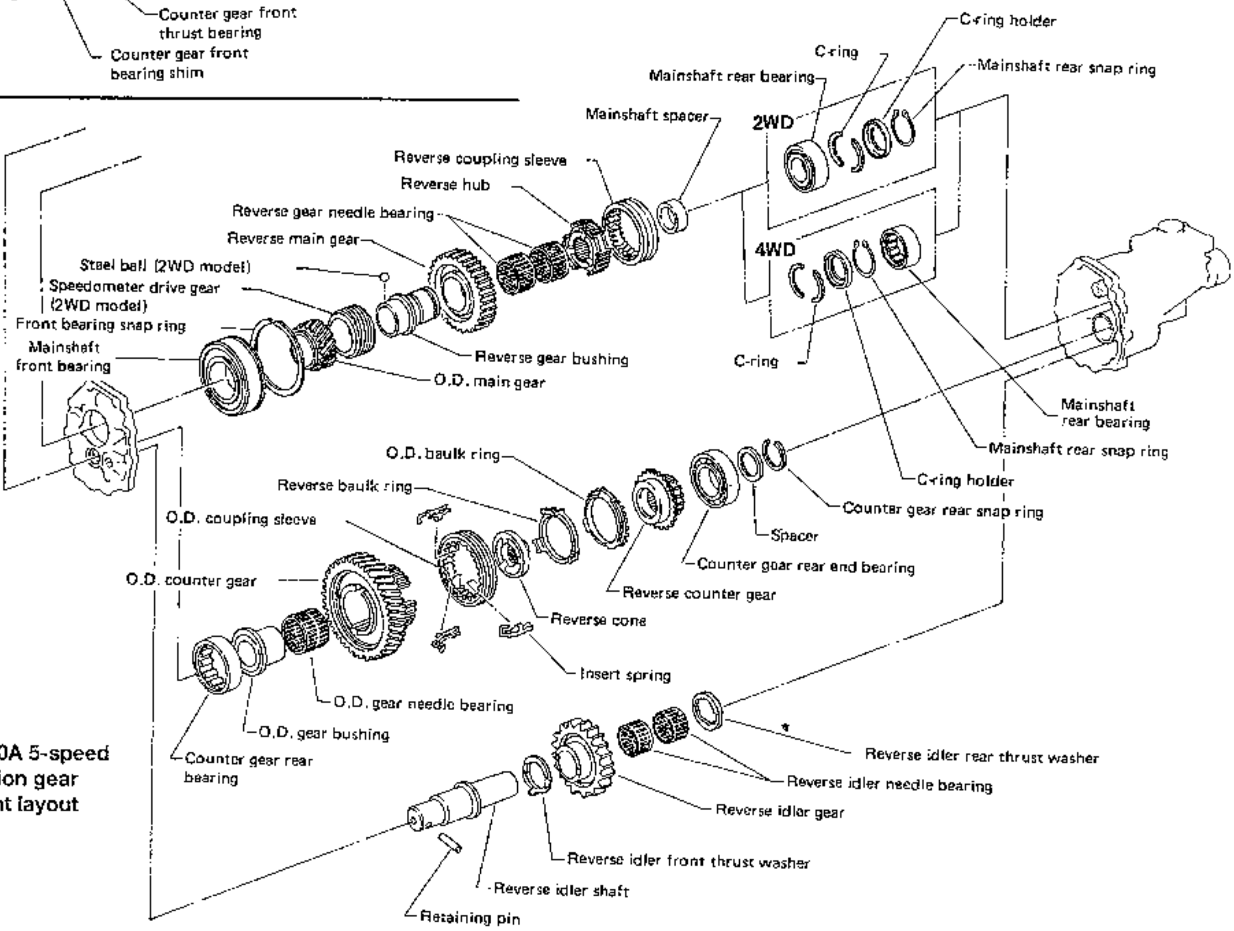
4.16 Check the gear end play with a feeler gauge



4.17 Main countershaft and countergear removal



4.19a FS5R30A 5-speed transmission mainshaft and related components - exploded view



4.19b FS5R30A 5-speed transmission gear component layout

7A

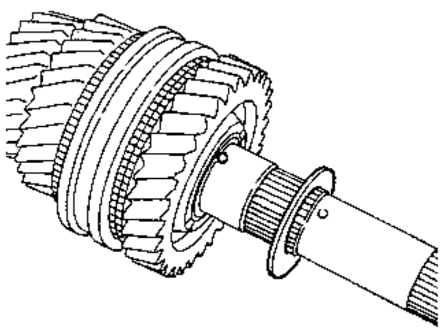
remove the reverse idler gear and thrust washers.
21 On 2WD models, use a puller tool to remove the mainshaft rear bearing.
22 Remove the reverse main gear, spacer and reverse synchroniser hub, using a puller tool. Remove the reverse gear needle bearings.
23 Use a puller tool to remove the reverse countergear, followed by the overdrive synchroniser.
24 Take the adapter plate to a suitable machine shop to have the mainshaft and countergear removed from the plate using a hydraulic press and suitable adapter tool.
25 Remove the 1st gear washer, steel ball and 1st gear and needle bearing from the mainshaft.
26 Have the 2nd gear, 1st gear bushing and 1st/2nd synchroniser pressed off the mainshaft.
27 Remove the front snap ring from the mainshaft.
28 Have the 3rd gear, the 3rd/4th synchroniser and the 3rd gear needle bearing pressed off the mainshaft.

Countershaft and gear disassembly

29 Remove the sub-gear snap ring.
30 Remove the sub-gear spring, sub-gear and the steel ball from the front of the countershaft. Refitting is the reverse of removal.

Input shaft and gear disassembly

31 The input shaft and gear assembly is serviced as a unit and only the bearing is replaceable. If it is necessary to replace the bearing, remove the snap ring and spacer. Take the assembly to a properly equipped machine shop to have the old bearing pressed off and a new one refitted.

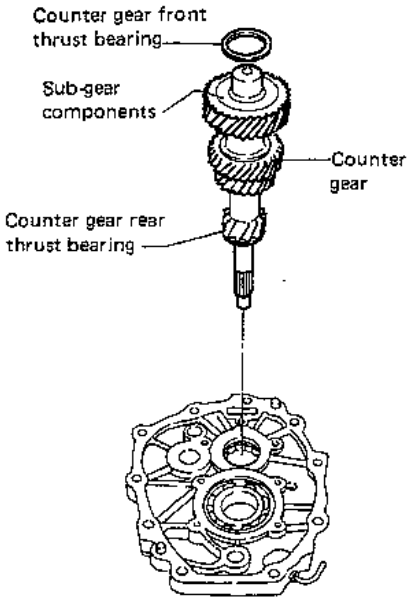


4.35 Lubricate the mainshaft with multipurpose grease at the points shown

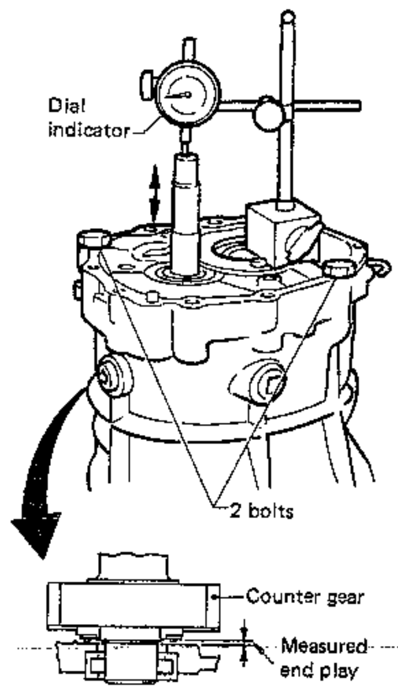
Adapter plate and mainshaft reassembly

Refer to illustrations 4.35, 4.36, 4.37, 4.38, 4.39, 4.42, 4.43, 4.44 and 4.45

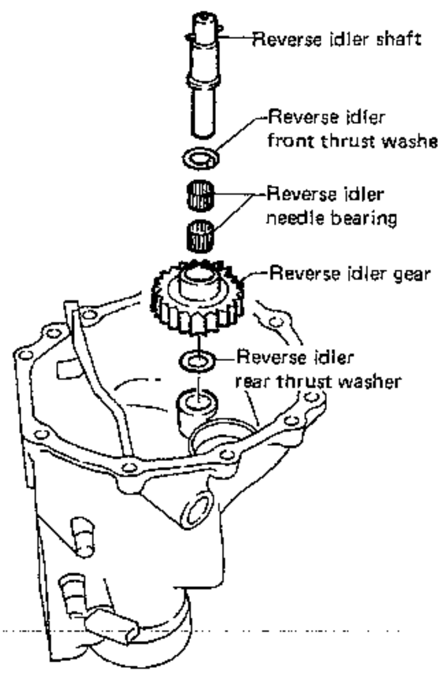
32 Have the 3rd/4th gear synchroniser, 3rd gear and needle bearing pressed on the shaft with a hydraulic press. Refit the thickest selective snap ring which will fit in the groove. Check the snap ring clearance with a feeler gauge to make sure it does not exceed 0.004 inch (0.1 mm).
33 Have the 1st/2nd synchroniser, 2nd gear and needle bearing pressed on the mainshaft with a hydraulic press.
34 Have the 1st gear bushing and washer press on with a hydraulic press and then refit the 1st gear and needle bearing.
35 Coat the steel ball and washer with petroleum jelly or multi-purpose grease and refit on the mainshaft **(see illustration)**.
36 Assemble the countershaft and refit it in the adapter plate **(see illustration)**.
37 Refit the adapter plate on the transmission plate using 2 bolts. Refit a dial indicator, set it a zero and then lift and release the countergear **(see illustration)**. Make a note of the reading and subtract 0.0039 to 0.0098 inch (0.10 to 0.25 mm) to determine the



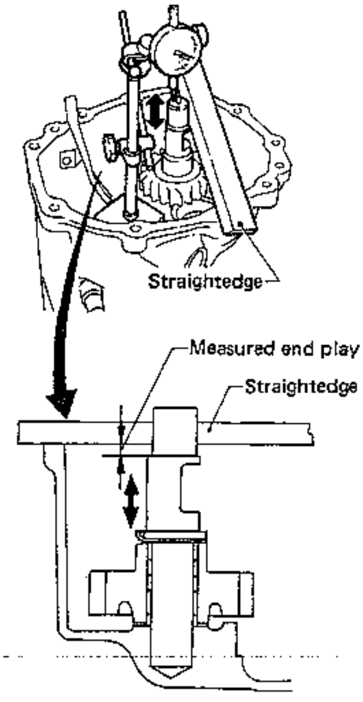
4.36 Countershaft refitting details



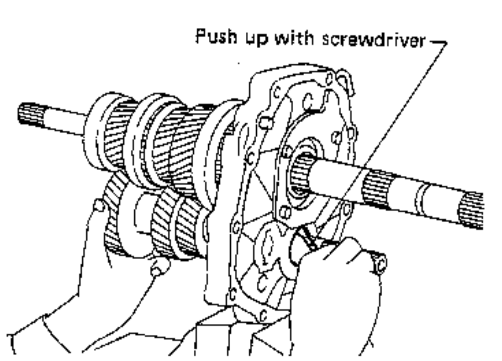
4.37 Use a dial indicator to check the countergear end play



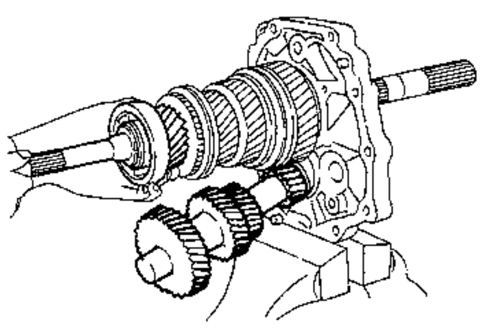
4.38 Reverse idler component layout



4.39 Checking the reverse idler shaft end play



4.42 Use a screwdriver to seat the countergear assembly



4.43 Refitting the input shaft and pilot bearing on the mainshaft

proper size countergear front bearing shim to be refitted.

38 Refit the reverse idler gear, needle bearing, thrust washers and shaft in the extension housing (2WD) or overdrive gearcase (4WD) **(see illustration)**.

39 Refit a dial indicator on the front of the reverse idler shaft and use a ruler or straightedge **(see illustration)**. Set the indicator to zero, lift and release the idler shaft and measure the end play. The end play should be between 0.118 to 0.209 in (0.30 to 0.35 mm). If the end play is not within specification, replace the rear thrust washer with a new one.

40 Unbolt the transmission case from the adapter plate and place it securely in a vise, using blocks of wood or cloths to protect the surface.

41 Lubricate the surface of the countergear rear bearing with multipurpose grease and refit the mainshaft partially on its front bearing in the adapter plate.

42 Refit the countergear on the countergear rear bearing in the adapter plate and then push it upward on the upper roller of the bearing, using a screwdriver to seat the assembly **(see illustration)**.

43 Refit the input shaft with the pilot bearing and spacer on the mainshaft **(see illustration)**.

44 Refit tool J-26349-3 on the adapter plate with the C-ring and C-ring holder on the mainshaft and then refit tool J-34328. Extend the tool to refit the mainshaft and countershaft gear **(see illustration)**.

45 Refit the overdrive gear bushing by tapping it in place with a hammer while pushing on the back of the countergear **(see illustration)**.

46 Refit the overdrive gear.

47 Refit the adapter plate complete with the gear assembly in the transmission case.

48 Refit the overdrive gear needle bearing followed by the overdrive countergear and reverse idler shaft.

49 On 2WD models, refit the reverse gear bushing with the speedometer gear drive.

50 Refit the reverse cone.

51 Refit the overdrive blocker ring on the overdrive countergear.

52 Refit the reverse countergear, needle bearing, reverse main gear, reverse idler gear and thrust washer, followed by the reverse hub.

53 On 2WD models, refit the mainshaft spacer and rear bearing.

54 Refit the countershaft gear rear bearing.

55 Remove the adapter plate assembly from the transmission case and mount it in the vise again.

56 Refit a new mainshaft C-ring and countershaft gear rear snap ring. With the proper ring refitted, the groove clearance should not exceed 0.004 in (0.1 mm).

57 Refit the reverse synchroniser assembly.

58 Measure the gear end play as described in Step 16.

59 Refit the overdrive rod and shift fork, line up the rod and fork holes and refit a new roll pin, using a hammer and suitable punch.

60 Refit the 1st/2nd, 3rd/4th and reverse shift forks on their synchroniser grooves.

61 Refit the striking rod to engage the shift forks, striker lever and interlock. Line up the rod and lever pin holes and refit a new roll pin, using a hammer and suitable punch.

Transmission case assembly

62 Apply suitable sealant to the contact surfaces of the transmission case.

63 Refit the adapter plate and gear assembly on the transmission case.

64 Coat the interlock check ball with multipurpose grease and insert the check ball and spring in the interlock stopper.

65 Apply sealant to the plug threads, refit the plug and tighten it to the specified torque.

66 Refit the stopper ring and secure it with a new main drive bearing snap ring.

67 Refit the front cover, using a new gasket. Coat the threads of the bottom 3 cover bolts with sealer and refit all of the front cover bolts. Tighten the bolts to the specified torque.

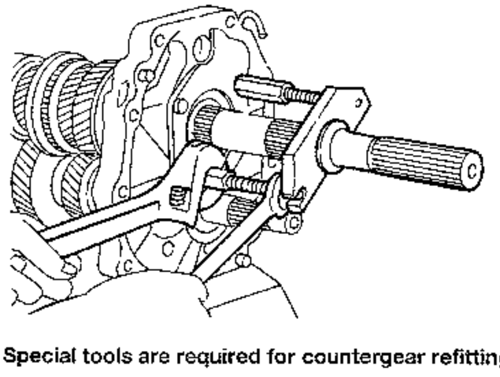
68 Apply suitable sealer to the contact surfaces of the adapter plate.

69 Refit the extension housing (2WD) or overdrive housing (4WD) to the adapter plate with the striking arm.

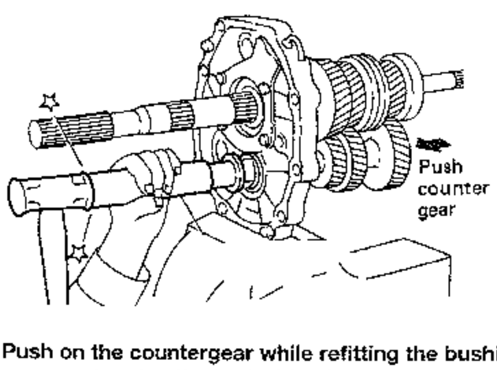
70 Line up the pin holes and refit a new roll pin in the striking arm, using a hammer and suitable size punch. 7A

71 Refit the control housing check ball and return spring (refer to illustration 6.6).

72 Apply sealer to the extension housing or overdrive gearcase mounting surfaces and refit the control housing and bolts. Tighten the bolts to the specified torque.



4.44 Special tools are required for countergear refitting



4.45 Push on the countergear while refitting the bushing by tapping the tool with a hammer

5 FS5R50A 5-speed transmission - overhaul

Note: *The FS4R50A 4-speed transmission is very similar to the FS5R50A unit. Follow the procedures in this Section to overhaul the 4-speed model.*

Disassembly

1 Remove all of the external components from the transmission. These include the Shifter assembly, clutch housing, PTO assembly and the transfer case.

2 Remove the overdrive components from the rear, then remove the overdrive housing.

3 Remove the snap-ring from the rear of the unit, then remove the C-rings and their holder.

4 Use a gear puller to remove the main-shaft rear bearing. Remove the spacer behind it.

5 Remove the countergear snap-ring.

6 Use a puller to remove the overdrive countergear and the overdrive synchro assembly.

7 Use a special puller to extract the over-drive gear bush.

8 Remove the bearing retainer.

9 Remove the overdrive main gear using a gear puller.

10 Remove the mainshaft bearing snap-ring. Remove the mainshaft bearing using a puller.

11 Suspend the mainshaft assembly with two ropes from a secure work bench, then remove the front cover.

12 Remove the countergear front and rear bearing outer races. Allow the countergear assembly to rest on the bottom of the trans-mission housing.

13 Remove the main drive gear assembly, positioning the flat portion of the clutch gear to the top as you do so.

14 Lift the mainshaft assembly from the case.

15 Lift the countergear assembly from the case.

16 Remove the small lock tab from the end of the reverse idler shaft.

17 Remove the reverse idler assembly components.

18 Use a press and a bearing separator to disassemble the components from the assemblies you have removed.

19 Lay the components of each assembly out in order on a clean work surface. **Caution: Many components must face one direction only!** *It is critical that all components are laid out so that the direction they were facing is maintained.*

Component check

20 Check the endplay of all gears. Refer to the Specifications in this Chapter.

21 Check the clearance between each baulk ring and its gear. Refer to the Specifications in this Chapter.

22 Carefully inspect every component for wear and damage. Renew all components as required.

Assembly

23 Reverse the disassembly procedure to reassemble the transmission.

24 The open areas of the shift insert springs in the synchroniser assemblies must be positioned so that they are not in align-ment.

25 The first and second gear baulk rings are different. Do not interchange them.

26 Choose selective-fit snap-rings to min-imise groove clearance wherever possible. Refer to the Specifications in this Chapter.

27 Check the clearance between the baulk ring and the synchroniser cone on the coun-tergear. Apply white grease to the steel ball used in the subgear assembly.

28 Apply sealer to the threads of the five lower front cover bolts and the upper three bolts in the overdrive gear (extension) hous-ing.

29 Also apply sealer to the threads of the bolts in the gear selector housing.

30 Renew all seals and fill the unit with the lubricant listed in the Specifications in Chap-ter 1.

Chapter 7 Part B
Automatic transmission

Contents

Specifications

Model number	RE4R03A

Torque specifications

	Nm
Transmission-to-engine bolts	50
Torque converter to driveplate bolts	39 to 49
Transmission mount-to-rear crossmember bolts	59
Rear crossmember-to-frame rail bolts	59

1 General information

All models which are equipped with automatic transmissions use an electronically-controlled 4 speed automatic over drive unit with a lock-up torque converter. The operation of the transmission is controlled by several electronic sensors such as the vehicle speed sensor, engine speed sensor, throttle sensor, etc.

Because of the complexity of the clutch mechanisms and the hydraulic control systems, and because of the special tools and expertise needed to rebuild an automatic transmission, this work is usually beyond the scope of the home mechanic. The procedures in this Chapter are therefore limited to general diagnosis, routine maintenance, adjustments and transmission removal and refitting.

Should the transmission require major repair work, take it to a dealer service department or a transmission repair shop. You can, however, save the expense of removing and refitting the transmission by doing it yourself.

2 Diagnosis - general

Note: *Automatic transmission malfunctions may be caused by five general conditions: sensor malfunction, poor engine performance, improper adjustments, hydraulic malfunctions or mechanical malfunctions. Diagnosis of these problems should always begin with a check of the easily repaired items: fluid level and condition* (see Chapter 1), *shift linkage adjustment and throttle linkage adjustment. Next, perform a road test to determine if the problem has been corrected or if more diagnosis is necessary. If the problem persists after the preliminary tests and corrections are completed, additional diagnosis should be done by a dealer service department or transmission repair shop. Refer to the* Troubleshooting section *at the front of this manual for information on symptoms of transmission problems.*

Preliminary checks

1 Drive the vehicle to warm the transmission to normal operating temperature.

2 Check the fluid level as described in Chapter 1:

a) *If the fluid level is unusually low, add enough fluid to bring the level within the designated area of the dipstick, then check for external leaks* (see below).

b) *If the fluid level is abnormally high, drain off the excess, then check the drained fluid for contamination by coolant. The presence of engine coolant in the automatic transmission fluid indicates that a failure has occurred in the internal radiator walls that separate the coolant from the transmission fluid* (see Chapter 3).

c) *If the fluid is foaming, drain it and refill the transmission, then check for coolant in the fluid or a high fluid level.*

3 Check the engine idle speed. **Note:** *If the engine is malfunctioning, do not proceed with the preliminary checks until it has been repaired and runs normally.*

4 Inspect the shift linkage (see Section 3). Make sure that it's properly adjusted and that the linkage operates smoothly.

Fluid leak diagnosis

5 Most fluid leaks are easy to locate visually. Repair usually consists of renewing a seal or gasket. If a leak is difficult to find, the following procedure may help.

6 Identify the fluid. Make sure it's transmission fluid and not engine oil or brake fluid (automatic transmission fluid is a deep red colour).

7 Try to pinpoint the source of the leak. Drive the vehicle several kilometres, then park it over a large sheet of cardboard. After a minute or two, you should be able to locate the leak by determining the source of the fluid dripping onto the cardboard.

8 Make a careful visual inspection of the suspected component and the area immediately around it. Pay particular attention to gasket mating surfaces. A mirror is often helpful for finding leaks in areas that are hard to see.

9 If the leak still cannot be found, clean the suspected area thoroughly with a degreaser or solvent, then dry it.

10 Drive the vehicle for several kilometres at normal operating temperature and varying speeds. After driving the vehicle, visually inspect the suspected component again.

11 Once the leak has been located, the cause must be determined before it can be properly repaired. If a gasket is renewed but the sealing flange is bent, the new gasket will not stop the leak. The bent flange must be straightened.

12 Before attempting to repair a leak, check to make sure that the following conditions are corrected or they may cause another leak. **Note:** *Some of the following conditions cannot be fixed without highly specialised tools and expertise. Such problems must be referred to a transmission repair shop or a dealer service department.*

Gasket leaks

13 Check the pan periodically. Make sure the bolts are tight, no bolts are missing, the gasket is in good condition and the pan is flat (dents in the pan may indicate damage to the valve body inside).

14 If the pan gasket is leaking, the fluid level may be too high, the vent may be plugged, the pan bolts may be too tight, the pan sealing flange may be warped, the sealing surface of the transmission housing may be damaged, the gasket may be damaged or the transmission casting may be cracked or porous. If sealant instead of gasket material has been used to form a seal between the pan and the transmission housing, it may be the wrong sealant.

Seal leaks

Refer to illustration 2.15

15 If a transmission seal is leaking, the fluid level or pressure may be too high, the vent may be plugged, the seal bore may be damaged, the seal itself may be damaged or improperly refitted, the surface of the shaft protruding through the seal may be damaged or a loose bearing may be causing excessive shaft movement **(see illustration)**.

2.15 Many transmission fluid leaks are caused by bad connections, damaged hoses, loose clamps, etc. Always check these fittings before investigating more difficult components

16 Make sure the dipstick tube seal is in good condition and the tube is properly seated. Periodically check the area around the revolution sensor for leakage. If transmission fluid is evident, check the O-ring for damage.

Case leaks

17 If the case itself appears to be leaking, the casting is porous and will have to be repaired or renewed.

18 Make sure the oil cooler hose fittings are tight and in good condition.

Fluid comes out of the vent pipe or fill tube

19 If this condition occurs, the transmission is overfilled, there is coolant in the fluid, the case is porous, the dipstick is incorrect, the vent is plugged or the drain back holes are plugged.

Road test

DRIVE range

20 While stopped, position the lever in the DRIVE range and accelerate. Check for a 1-2 shift, 2-3 shift and 3-OD shift. Also, the converter should lock-up in second, third or OD gear when it is warm, depending on calibration. Check for part throttle downshift by depressing the accelerator 3/4 of the way - the transmission should downshift. Check for full detent downshift by depressing the throttle all the way - the transmission should immediately downshift.

Range 2

21 At speed, shift the transmission to Range 2. The transmission should down shift immediately. It should not shift back to Overdrive. Also check for part throttle and full throttle downshifts in this range.

Low range

22 Position the lever in Low position and check the operation.

Overrun braking

23 This can be checked by manually shifting to a lower range. Engine rpm should increase and a braking effect should be noticed.

Reverse

24 Position the shifter in Reverse and check operation.

25 Verify that the engine is not at fault. If the engine has not received a tune-up recently, refer to Chapter 1 and make sure all engine components are functioning properly.

26 Check the condition of all electrical lines

and fittings at the transmission, or leading to it.
27 Check for proper adjustment of the shift linkage (see Section 3).
28 If at this point a problem remains, there is one final check before the transmission is removed for overhaul. The vehicle should be taken to a transmission specialist who will connect a special oil pressure gauge and check the line pressure in the transmission.

Self diagnosis system

29 The self diagnostic system is built into the electronic control system of the transmission. A malfunction is indicated by the power shift light on the dash.
30 To access the self diagnostic codes for the transmission, start by warming the engine and transmission fully, then turn the ignition OFF.
31 Set the power shift switch to the AUTO position.
32 Select PARK.
33 Turn the key ON. The power shift light should come on for about two seconds. If it does not, go to Step 30 again.
34 If the light came on, turn the key OFF. Select D.
35 Set the power shift switch to POWER. Turn the key ON.
36 Select 2. Set the power shift switch to AUTO.
37 Select 1. Set the power shift switch to POWER.
38 Push the throttle pedal to the floor and then release it fully.
39 Read the power shift light on the dash to check the trouble codes. There will be a long flash which is the start signal, followed by ten shorter flashes. Study the following chart to determine which, if any, trouble code(s) are present in your system.

Problem	Cause
10 short flashes	All systems are functioning properly
First flash is longer than the others	Revolution sensor circuit failure
Second flash is longer than the others	Speed sensor circuit failure
Third flash is longer than the others	Throttle sensor circuit failure
Fourth flash is longer than the others	Shift solenoid A circuit failure
Fifth flash is longer than the others	Shift solenoid B circuit failure
Sixth flash is longer than the others	Overrun clutch solenoid circuit failure
Seventh flash is longer than the others	Lock-up solenoid circuit failure
Eighth flash is longer than the others	Fluid temperature sensor circuit failure
Ninth flash is longer than the others	Engine revolution signal circuit failure
Tenth flash is longer than the others	Line pressure solenoid circuit failure
Five long flashes	Battery is low, connected improperly or has been disconnected a long time
Light stays on steadily	Inhibitor switch, power shift switch, kickdown switch or idle switch circuit is disconnected or the control unit is damaged

40 Most of these trouble codes will require an automatic transmission specialist to properly diagnose and repair the problem. Running the self diagnosis test, however, will allow you to know if the problem is in the electronic controls area or in some other area of the vehicle.

3 Shift linkage - check and adjustment

1 This adjustment should not be considered routine and does not have to be done unless wear in the linkage or misalignment of the shift position indicator occurs.

Check

2 Move the shift lever through the gear ranges and make sure the transmission responds accordingly. Position the lever in Neutral and see if the transmission shifts to Neutral. Check to see if the shift position indicator registers correctly with the lever in each detent position.
3 If adjustment is required, the vehicle must be raised and supported securely on jackstands.

Adjustment

Refer to illustration 3.5

4 Select PARK with the gear shift lever in the vehicle.

3.5 Loosen this lock-nut (arrow) to make adjustments to the shift control mechanism. There must be a definite click or detent felt as the lever is moved between all gears

5 Loosen the lock-nut on the linkage at the transmission **(see illustration)**. Make sure that the transmission lever is solidly in the PARK position.
6 Pull the rod to the rear and release it. Make sure that the select lever moves forward a little.
7 Tighten the lock-nut.
8 Make sure that the gear shift handle will move slightly forward and rearward without pushing the button.
9 Operate the vehicle in all gears and check for correct alignment of the indicator and proper transmission operation.

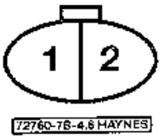
4 Inhibitor switch - check, renewal and adjustment

1 The inhibitor switch is located on the right side of the transmission housing. One of its purposes is to allow the starter to operate only when the selector lever is in Neutral or Park. It also operates the back-up lights when the lever is in Reverse and informs the ECU of the gear selected.
2 If the engine can be started with the shift lever in any position other than Park or Neutral, the inhibitor switch should be checked and adjusted and, if necessary, renewed.

Check

Refer to illustrations 4.6 and 4.7

3 Raise the vehicle and support it securely with jackstands.
4 Disconnect the negative battery cable.
5 Disconnect the inhibitor switch wiring connectors.
6 Connect an ohmmeter between termi-



4.6 This is the inhibitor switch wiring connector for the neutral start switch

nals 1 and 2 as shown **(see illustration)**. There should be zero resistance when the transmission is in NEUTRAL and PARK. There should be infinite resistance in all other gears.

7 Check the resistance between terminal 3 and terminal 4, then terminal 3 and terminal 5, terminal 3 and terminal 6, etc **(see illustration)**.

8 There should be continuity (zero resistance) when the lever is in PARK, REVERSE, NEUTRAL, D, 2 and 1.

9 If the switch does not respond correctly, try the adjustment procedure. If it does not help, renew the switch.

Adjustment

Refer to illustration 4.10

10 Disconnect the shift linkage assembly from the transmission **(see illustration)**.

11 Place the transmission in NEUTRAL.

12 Loosen the switch mounting screws and put a 4 mm drill through the adjustment hole in the lever.

13 Rotate the switch until the drill drops easily into the hole in the switch.

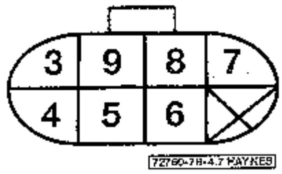
14 Tighten the switch screws and connect the shift linkage rod.

Renewal

15 Disconnect the wiring from the switch.

16 Place the transmission into first gear and then remove the switch.

17 Refitting is the reverse of removal.



4.7 This other wiring connector is for providing information to the ECU as to the gear which has been selected

5 Transmission mount - check and renewal

Refer to illustration 6.3

1 Insert a large screwdriver or lever into the space between the transmission mount and the bracket and try to prise the transmission up slightly.

2 The transmission should not move away from the bracket very far.

3 If it is necessary to renew the mount, support the transmission with a jack and remove the mount-to-crossmember bolts and nuts, then separate the mount and lower it from the vehicle **(see illustration)**.

4 Refitting is the reverse of removal.

6 Transmission rear oil seal - renewal

1 Remove the transfer case (refer to Chapter 7C).

2 Place a drain pan beneath the rear of the transmission.

3 Use a seal puller or a large screwdriver to remove the seal.

4 Apply transmission fluid to the new seal and use a large socket with a hammer to drive it squarely onto place.

5 The remainder of refitting is the reverse of removal.

7 Power shift (mode) switch - check and renewal

Check

Models with power shift switch on lever

1 Remove the switch from the lever and disconnect the wiring.

2 Connect an ohmmeter to the terminals. With the switch set to POWER, there should be zero resistance. With the switch set to AUTO, there should be infinite resistance.

3 If the readings are not close, renew the unit.

Models with mode switch on dash

4 Remove the switch from the dash and disconnect the wiring.

5 Connect an ohmmeter between terminals 2 and 7. There should be continuity (zero resistance) when the switch is set to POWER.

6 Connect the ohmmeter between terminals 2 and 3. There should be continuity (zero resistance) when the switch is set to HOLD.

7 If the readings are not close, renew the unit.

Note: *On later models with the mode switch in the dash, there is an overdrive switch in the shift lever. This switch can be tested by levering it out of the handle and then using an ohmmeter to verify that it has continuity only in the OFF position.*

Renewal

Models with power shift switch on lever

8 Use a small screwdriver to carefully lever the power shift assembly from the shift lever.

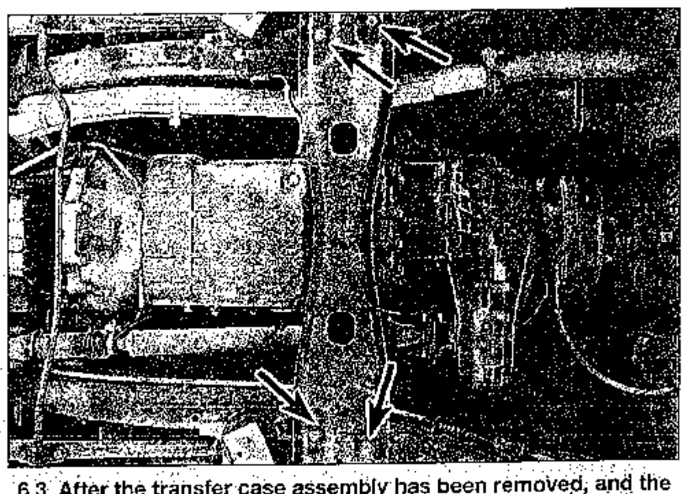
9 Disconnect the wiring from the switch and pull it from the lever.

Models with mode switch on dash

10 Use a small screwdriver to carefully lever the switch from the dash.

11 Disconnect the wiring from the switch.

4.10 Remove this nut (arrow) to disconnect the shift linkage and expose the inhibitor switch components



6.3 After the transfer case assembly has been removed, and the transmission supported, remove these bolts (arrows) to release the rear crossmember

8 Automatic transmission - removal and refitting

1 Disconnect the cable from the negative battery terminal.
2 Raise the vehicle and support it securely with jackstands.
3 Remove the console (refer to Chapter 11).
4 Disconnect the parking brake cable from the lever.
5 Disconnect the cable housing from the retainer and push it through the floor.
6 Remove the transfer case (refer to Chapter 7C).
7 Disconnect the interfering wiring and hoses from the transmission.
8 Remove the dipstick tube.
9 Remove the starter (refer to Chapter 5).
10 Remove the rear engine cover plate.
11 Use a dab of paint to mark the alignment of the torque converter to the driveplate. Remove the four torque converter bolts. It will be necessary to rotate the engine with a flywheel turning tool or a ratchet on the front crankshaft pulley in order to reach all four bolts.
12 Disconnect the shift linkage at the transmission.
13 Drain the transmission fluid (refer to Chapter 1).
14 Remove the insulators from the exhaust bracket.
15 Disconnect the transmission fluid cooler lines from the transmission. Plug the lines and the transmission ports to prevent debris from entering.
16 Support the transmission with a jack - preferably a special jack made for this purpose. Safety chains will help steady the transmission on the jack. A flat piece of wood on he jack will prevent the transmission pan from being pushed inward against the valve body.
17 Remove the bolts securing the transmission mount to the rear crossmember.
18 Raise the transmission slightly, then detach the nuts and bolts securing the rear crossmember to the frame rails and remove the crossmember.
19 Remove the remaining bolts securing the transmission to the engine. **Caution:** *The transmission is heavy and awkward. It is best to have an assistant available to help in maneuvering the unit away from the engine and out from under the vehicle. If it is dropped, the case may be cracked and the entire unit may have to be renewed.*
20 Make a final check that all wires and hoses have been disconnected from the transmission and transfer case and then move the transmission and jack toward the rear of the vehicle until the torque converter housing is clear of the engine dowel pins. Make sure the torque converter is detached from the driveplate. Secure the torque converter to the transmission with wire so that it will not fall out during removal. Lower the transmission and remove it from under the vehicle.
21 Make sure the torque converter is fully engaged in the transmission prior to refitting. The faces of the torque converter nuts must be at least 25 mm to the rear of the housing flange. If they are not al least this far recessed, spin the converter while pushing it deeper onto the front pump assembly.
22 The remainder of the refitting the reverse of removal. Be sure to refill the cooling system and the transmission with the required fluids (see Chapter 1). Adjust the shift linkage as described in this Chapter before road testing the vehicle. Refer to the appropriate Chapters for refitting of the starter and other components.

Notes

Chapter 7 Part C
Transfer case

Contents

Specifications

Model number	TX12A
Front drive sprocket endplay	0.20 to 0.35 mm
Low gear endplay	0.20 to 0.35 mm
Baulk ring to gear clearance minimum	0.5 mm
Snap-ring-to-groove clearance maximum	0.15 mm
Countergear endplay	0 to 0.2 mm

Torque specifications

	Nm
Detent plugs	19 to 25
Front companion flange nut	225 to 325
Housing bolts	26 to 36
Input shaft bearing retainer bolts	19 to 21
Mainshaft bearing retainer screws	16 to 21
Parking brake backing plate bolts	42 to 52
Rear companion flange nut	295 to 450
Transfer case-to-engine bolts	32 to 42

1 General information

All models are equipped with a transfer case mounted on the rear of the transmission. Drive is passed from the engine through the transmission and the transfer case to the rear and/or front wheels by the driveshafts.

Because of the special tools and techniques required, disassembly and overhaul of the transfer case should be left to a dealer or properly equipped shop. You can, however, remove and refitting the transfer case yourself and save the expense, even if the repair work is done by a specialist.

2 Transfer case oil seals - renewal

Front and rear oil seals

1 Raise the vehicle and support it on jackstands. Remove the transfer case rock guard (if equipped) and drain the oil.

2 Mark the position of the appropriate driveshaft flange in relation to the transfer case flange. Remove the bolts and disconnect the driveshaft (refer to Chapter 8).

3 Remove the locknut from the transfer case companion flange. To keep the flange from turning, refitting two of the driveshaft mounting bolts and engage a strong lever between them. The nuts are very tight. It may be necessary to use a large breaker bar or a section of pipe on the end of the breaker bar.

4 Using a conventional gear puller, remove the companion flange.

5 Carefully prise the oil seal out with a seal puller or a screwdriver, being sure not to scratch or damage the seal bore in the case. A block of wood placed between the screwdriver and case can provide additional leverage. **Note:** *If available, it is better to use a seal puller specifically designed for this purpose. This type of device uses a screw mechanism and operates similar to a gear puller. Check your local rental facility and obtain one if possible.*

6 Lubricate the lip of the new seal with gear oil and tap it into position with a socket and a hammer.

7 Place the companion flange into position. Refitting the lock-nut and tighten it to the specified torque.

8 Refitting the driveshaft, being sure the flange marks made during removal are aligned.

9 Refill the transfer case with oil, referring to Chapter 1 if necessary.

Shift shaft oil seal

10 Disconnect the control rod from the transfer case outer shift lever.

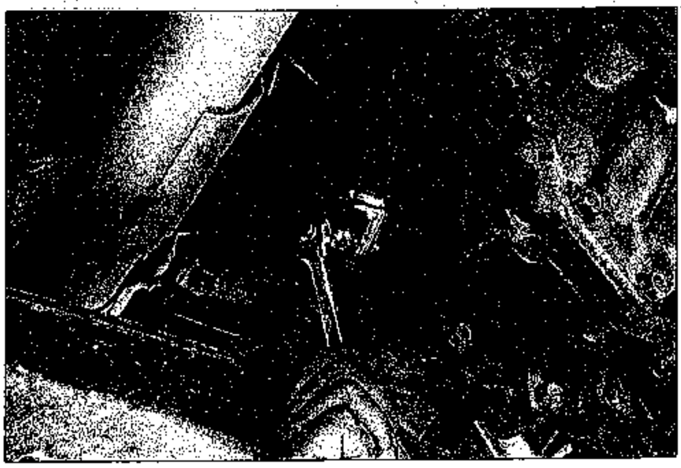
11 Remove the outer shift lever.

12 Carefully prise the oil seal out with a seal puller or a screwdriver, being sure not to scratch or damage the seal bore in the case. A block of wood placed between the screwdriver and case can provide additional leverage.

13 Lubricate the lip of the new seal with gear oil and tap it into position with a socket and a hammer.

14 Refitting the components previously removed.

3.4a Peel back this rubber cover to access the transfer case shift linkage rod connection



3.4b Remove the lock-nut to disconnect the linkage from the transfer case

3 Transfer case - removal and refitting

Refer to illustrations 3.4a and 3.4b

1 Raise the vehicle and support it securely with jackstands.

2 Drain both the transfer case and the transmission (refer to Chapter 1).

3 Remove both driveshafts (refer to Chapter 8).

4 Peel back the rubber boot and disconnect the shift control lever from the transfer case **(see illustrations)**. Do not lose the spacer or washer.

5 Release the parking brake. Remove the parking brake drum.

6 Remove the locknut from the transfer case companion flange. To keep the flange from turning, refitting two of the driveshaft mounting bolts and engage a strong lever between them. The nuts are very tight. It may be necessary to use a large breaker bar or a section of pipe on the end of the breaker bar. Using a conventional gear puller, remove the companion flange.

7 Remove the parking brake assembly and hang it out of the way with a wire.

8 Place a floor jack under the rear of the transmission with a piece of wood between them.

9 Unbolt the rear crossmember from the frame rails.

10 Lower the transmission/transfer case assembly as much as possible.

11 Disconnect any interfering wiring and hoses from the transfer case.

12 Unbolt the transfer case from the transmission. Leave one bolt in to hold the units together temporarily.

13 Jack up the transmission and refitting the bolts in the crossmember.

14 Move the floor jack to the transfer case and tie the transfer case to the jack for safety.

15 Remove the last bolt and remove the transfer case from the vehicle. **Note:** *The unit is heavy and difficult to balance. Get an assistant to help you if possible.*

16 Refitting is the reverse of removal.

4 Transfer case - overhaul

Disassembly

1 Remove the speedometer drive. Remove the nuts from the front and the rear companion flanges. It will be necessary to hold the shafts from turning with a special tool.

2 Remove the parking brake drum.

3 Use a puller to remove both companion flanges.

4 Remove the parking brake components.

5 Carefully separate the rear case using two large screwdrivers.

6 Remove the speedometer drive gear and also the oil tube.

7 Remove the snap-ring from the shift rod.

8 Measure the endplay in the front drive sprocket. Compare your reading to that listed in the Specifications in this Chapter.

9 Use a puller to remove the mainshaft rear bearing.

10 Lift out the two/four shift fork and coupling sleeve assembly.

11 Tap out the entire chain drive assembly complete with the drive shaft and front drive sprocket.

12 Remove the bearing retainer.

13 Unbolt and separate the front and center cases.

14 Use a feeler gauge to measure the low gear endplay. Compare your reading to that listed in the Specifications in this Chapter.

15 Remove the snap-ring from the mainshaft.

16 Use a puller to remove the low gear and low/high hub assembly.

17 Tap the mainshaft out from the front.

18 remove the check balls, springs, plugs and switches from the front case.

19 Lift out the two/four shift rod from the front case.

20 Remove the low/high shift rod and fork assembly.

21 Lift the bearing from the main gear.

22 Remove the front case cover.

23 Use a soft-face hammer to tap out the countergear, main gear and the shift levers.

24 Use a press and a bearing separator as required to disassemble the individual components from the assemblies you have removed.

25 Lay the components of each assembly out in order on a clean work surface. **Caution:** *Many components must face one direction only! It is critical that all components are laid out so that the direction they were facing is maintained.*

Check

26 Check the endplay of low gear and the front drive sprocket. Refer to the Specifications in this Chapter.

27 Check the clearance between the baulk ring and its gear. Refer to the Specifications in this Chapter.

28 Carefully inspect every component for wear and damage. Renew all components as required.

Assembly

29 Reverse the disassembly procedure to reassemble the transfer case.

30 Choose selective-fit snap-rings to minimize groove clearance wherever possible. Refer to the Specifications in this Chapter.

31 Use sealer on the threads of the front cover bolts.

32 Renew all seals and fill the unit with the lubricant listed in the Specifications in Chapter 1.

Chapter 8
Clutch and driveline

Contents

Specifications

8

Clutch

Fluid type	DOT 3 brake fluid
Clutch disc maximum runout	0.8 mm
Clutch disc to rivet head depth minimum	0.3 mm
Diaphragm spring maximum tip out-of-alignment	0.5 mm
Flywheel maximum runout	0.1 mm

Rear axle shaft

Endplay (drum brakes)	0.02 to 0.15 mm
Maximum shaft runout	0.8 mm

Differential

Drive pinion preload (within backlash)	1.8 to 2.5 Nm

Torque specifications

	Nm
Automatic-lock hub cover bolts	54 to 59
Clutch pedal pivot nut	16 to 22
Clutch pressure plate-to-flywheel bolts	22 to 29
Clutch master cylinder mounting bolt	8 to 12
Clutch slave cylinder mounting bolt	30 to 40
Driveshaft to transfer case companion flange bolts	78 to 88
Driveshaft to front axle companion flange bolts	78 to 88
Driveshaft to rear axle companion flange bolts	93 to 108
Freewheel hub bolts	54 to 59
Front axle pinion nut	196 to 285
Front hub dust seal bolts	30 to 40
Front hub wheel hub bolts	50 to 68
Front hub drive flange bolts	54 to 64
Front hub bearing lock-nut	167 to 196
Manual -lock hub cover bolts	54 to 59
Rear axle flange to hub bolts (full-floating)	49 to 57
Rear axle hub lock-nut (full-floating)	167 to 196*
Rear axle shaft nuts (semi-floating)	53 to 63
Rear axle bearing nut (semi-floating)	441 to 490
Rear axle pinion nut	
Hardtop and station wagon	196 to 284
Utility and cab chassis	167 to 245
Swivel hub bearing cap bolts	30 to 40
Vacuum power booster nuts	8 to 12

**Use this torque only to seat the bearing, final torque should be 4 Nm.*

1 General information

The information in this Chapter deals with the components from the rear of the transfer case to the drive wheels. For the purposes of this Chapter, these components are grouped into three categories; clutch, driveshafts and axles. Separate Sections within this Chapter offer general descriptions and checking procedures for components in each of the three groups.

Since nearly all the procedures covered in this Chapter involve working under the vehicle, make sure it's securely supported on sturdy jackstands or on a hoist where the vehicle can be easily raised and lowered.

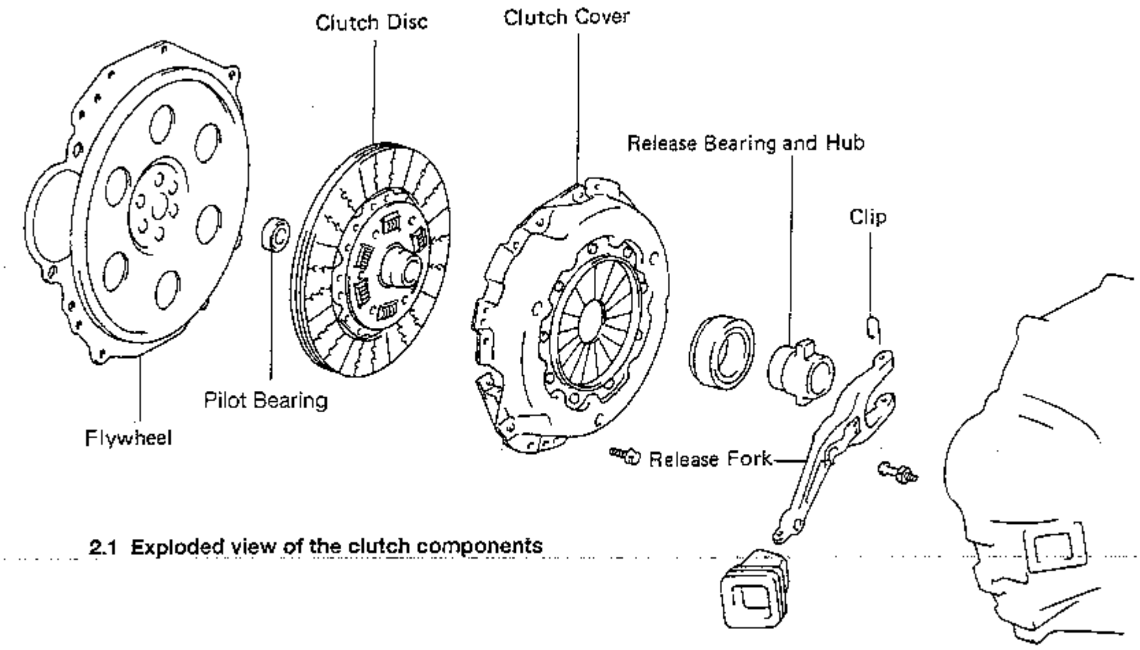
2 Clutch - description and check

Refer to illustration 2.1

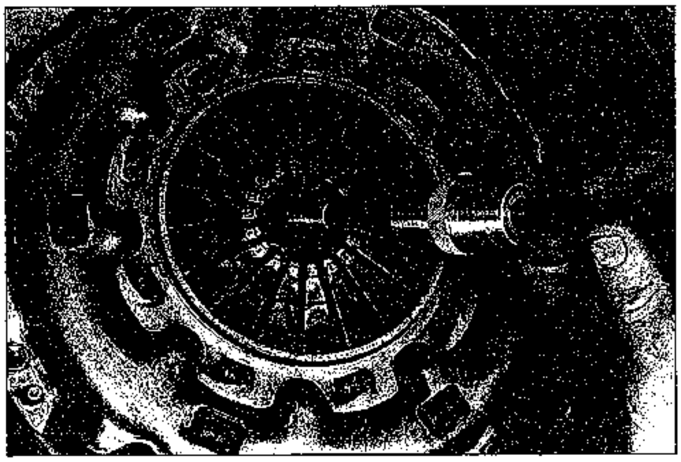
1 All models equipped with a manual transmission feature a single dry plate, diaphragm spring-type clutch. The actuation is through a hydraulic system. 4.2 litre models also use a vacuum power booster unit to decrease pedal effort **(see illustration)**.

2 When the clutch pedal is depressed, hydraulic fluid (under pressure from the clutch master cylinder) flows into the slave cylinder. Because the slave cylinder is connected to the clutch fork, the fork moves the release bearing into contact with the pressure plate release diaphragm, disengaging the clutch plate.

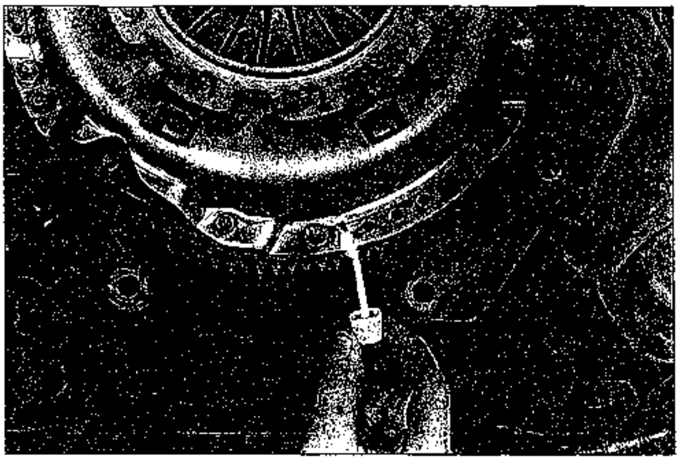
3 The hydraulic system locates the clutch pedal and provides clutch adjustment automatically, so no adjustment is required.



2.1 Exploded view of the clutch components



3.4 A clutch alignment tool can be used to prevent the disc from dropping out as the pressure plate is removed



3.5 Be sure to mark the pressure plate and flywheel in order to ensure proper alignment during refitting

4 Terminology can be a problem regarding the clutch components because common names have in some cases changed from that used by the manufacturer. For example, the driven plate is also called the clutch plate or disc, the clutch release bearing is sometimes called a throwout bearing or release bearing, the slave cylinder is sometimes called the operating or release cylinder. Also, the pilot bearing is sometimes called the spigot bearing.

5 Due to the slow wearing qualities of the clutch, it is not easy to decide when to go to the trouble of removing the transmission in order to check the wear on the friction lining. The only positive indication that something should be done is when it starts to slip or when squealing noises during engagement indicate that the friction lining has worn down to the rivets. In such instances it can only be hoped that the friction surfaces on the flywheel and pressure plate have not been badly worn or scored.

6 A clutch will wear according to the way in which it is used. Much intentional slipping of the clutch while driving - rather than the correct selection of gears - will accelerate wear. It is best to assume, however, that the disc will need renewal at about 120,000 km.

7 Because of the clutch's location between the engine and transmission, it cannot be worked on without removing either the engine or transmission. If repairs which would require removal of the engine are not needed, the quickest way to gain access to the clutch is by removing the transmission, as described in Chapter 7A.

8 Other than to renew components with obvious damage, some preliminary checks should be performed to diagnose a clutch system failure.

a) *The first check should be of the fluid level in the clutch master cylinder. If the fluid level is low, add fluid as necessary and re-test. If the master cylinder runs dry, or if any of the hydraulic components are serviced, bleed the hydraulic system as described in Section 8.*
b) *To check "clutch spin down time", run the engine at normal idle speed with the transmission in Neutral (clutch pedal up-engaged). Disengage the clutch (pedal down), wait nine seconds and shift the transmission into Reverse. No grinding noise should be heard. A grinding noise would indicate component failure in the pressure plate assembly or the clutch disc.*
c) *To check for complete clutch release, run the engine (with the brake on to prevent movement) and hold the clutch pedal approximately 12 mm from the floor mat. Shift the transmission between 1st gear and Reverse several times. If the shift is not smooth, component failure is indicated. Measure the slave cylinder pushrod travel. With the clutch pedal completely depressed the slave cylinder pushrod should extend substantially. If the pushrod will not extend very far or not at all, check the fluid level in the clutch master cylinder.*
d) *Visually inspect the clutch pedal bush at the top of the clutch pedal to make sure there is no sticking or excessive wear.*
e) *Under the vehicle, check that the clutch fork is solidly mounted on the ball stud.*

Note: *Because access to the clutch components is an involved process, any time either the engine or transmission is removed, the clutch disc, pressure plate assembly and release bearing should be carefully inspected and, if necessary, renewed. Since the clutch disc is normally the item of highest wear, it should be renewed as a matter of course if there is any question about its condition.*

3 Clutch components - removal, inspection and refitting

Warning: *Dust produced by clutch wear and deposited on clutch components contains asbestos, which is hazardous to your health. DO NOT blow it out with compressed air and DO NOT inhale it. DO NOT use petrol or petroleum-based solvents to remove the dust. Brake system cleaner should be used to flush the dust into a drain pan. After the clutch components are wiped clean with a rag, dispose of the contaminated rags and cleaner in a covered container.*

Removal

Refer to illustrations 3.4 and 3.5

1 Access to the clutch components is normally accomplished by removing the transmission, leaving the engine in the vehicle. If, of course, the engine is being removed for major overhaul, then the opportunity should always be taken to check the clutch for wear and renew worn components as necessary. The following procedures assume that the engine will stay in place.

2 Referring to Chapter 7A, remove the transmission from the vehicle. Support the engine while the transmission is out. Preferably, an engine hoist should be used to support it from above. However, if a jack is used underneath the engine, make sure a piece of wood is used between the jack and sump to spread the load. **Caution:** *The pickup for the oil pump is very close to the bottom of the sump. If the pan is bent or distorted in any way, engine oil starvation could occur.*

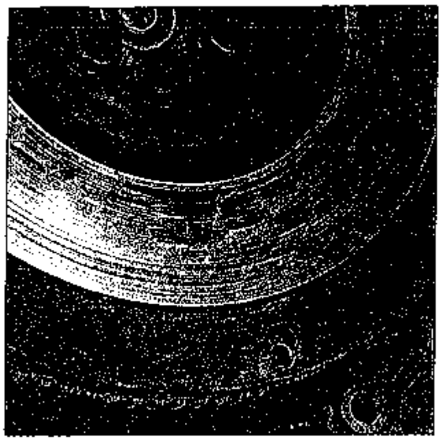
3 Remove the release fork and the release bearing from the clutch housing.

4 Disconnect the release bearing from the fork. To support the clutch disc during removal, refit a clutch alignment tool through the clutch disc hub **(see illustration)**.

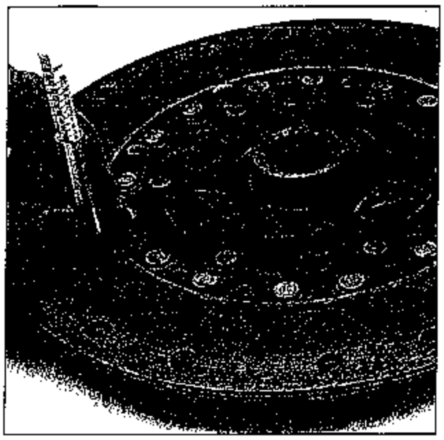
5 Carefully inspect the flywheel and pressure plate for indexing marks. The marks are usually an X, an O or a white letter. If they cannot be found, apply marks yourself so the pressure plate and the flywheel will be in the same alignment during refitting **(see illustration)**. (This applies only if you will be refitting the same clutch).

6 Turning each bolt only 1/2-turn at a time, slowly loosen the pressure plate-to-flywheel bolts. Work in a diagonal pattern and loosen each bolt a little at a time until all spring pressure is relieved. Then hold the pressure plate securely and completely remove the bolts, followed by the pressure plate and clutch disc.

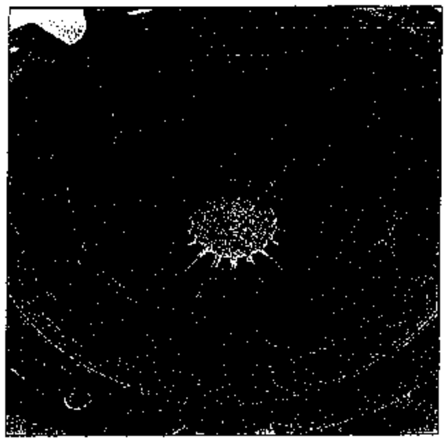
8



3.8 Check the flywheel for cracks, hot spots (as seen in this photo) and other obvious defects. Slight imperfections can be removed by a machine shop



3.10 Once the clutch disc is removed, the rivet depth can be measured and compared to the Specifications



3.12a Examine the pressure plate friction surface for score marks, cracks and evidence of overheating

Inspection

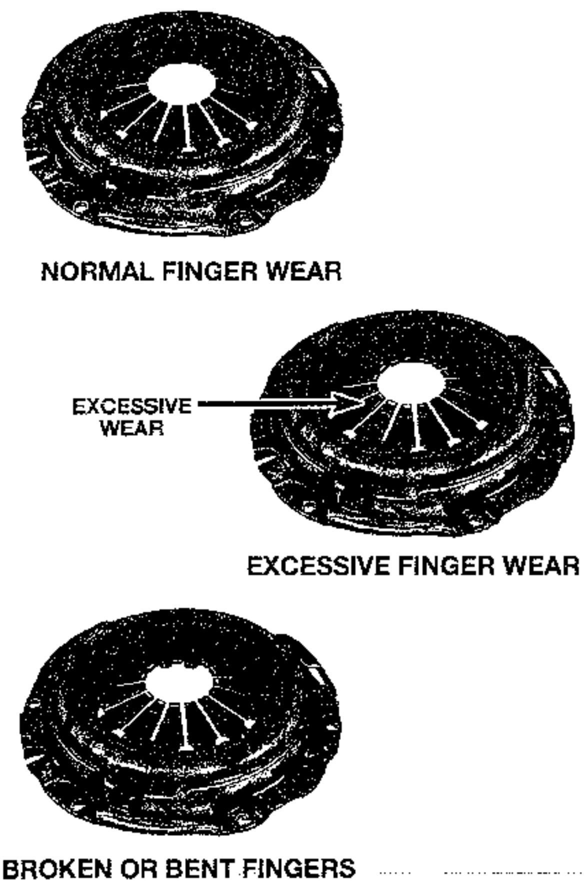
Refer to illustrations 3.8, 3.10, 3.12a and 3.12b

7 Ordinarily, when a problem occurs in the clutch, it can be attributed to wear of the clutch driven disc assembly. However, all components should be inspected at this time.

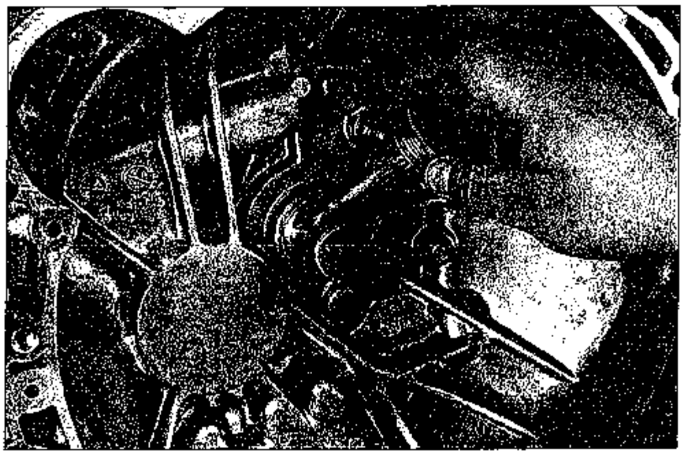
8 Inspect the flywheel for cracks, heat checking, grooves or other signs of obvious defects **(see illustration)**. If the imperfections are slight, a machine shop can machine the surface flat and smooth, which is highly recommended regardless of the surface appearance. Refer to Chapter 2 for the flywheel removal and refitting procedure.

9 Inspect the pilot bearing (see Section 5).

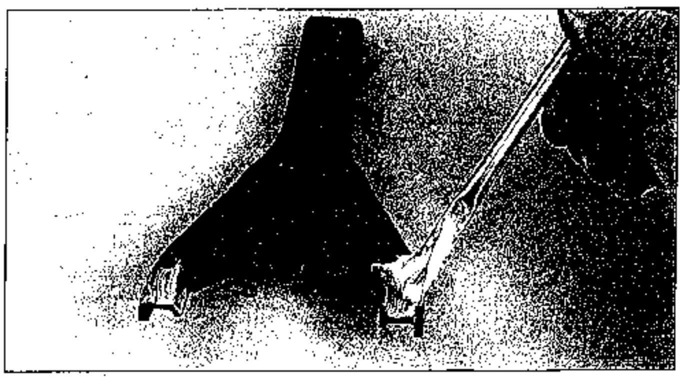
10 Inspect the lining on the clutch disc. There should be at least 0.3 mm of lining above the rivet heads **(see illustration)**. Check for loose rivets, warpage, cracks, distorted springs or damper bushes and other



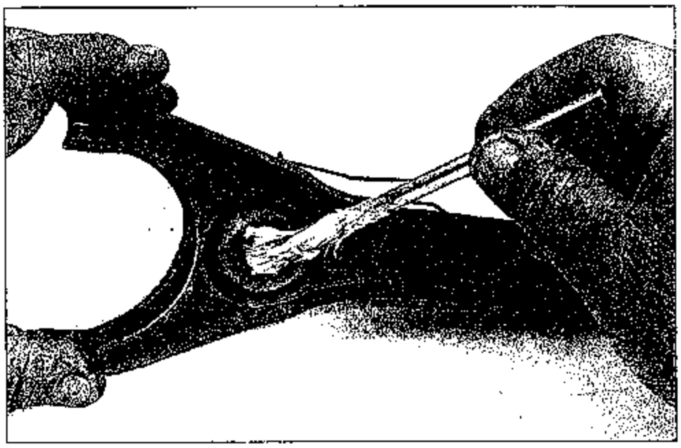
3.12b Renew the pressure plate if excessive wear is noted



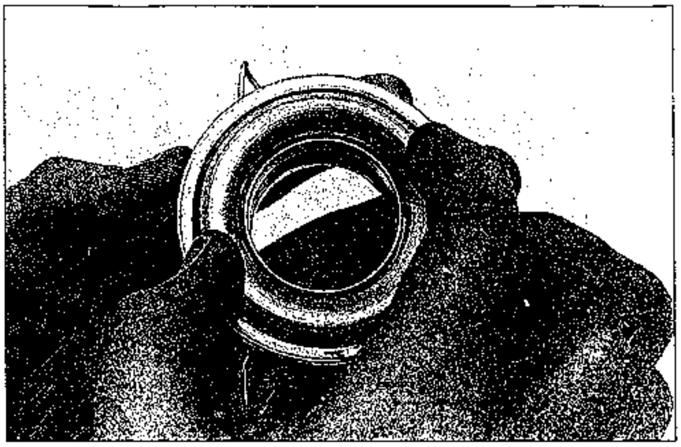
3.17a Apply a light coat of high-temperature grease to the bearing surface of the retainer . . .



3.17b . . . the lever ends and the depression for the release cylinder pushrod (before refitting the transmission, apply the same grease to the input shaft splines to help the shaft slide through the clutch hub)



3.17c Use high-temperature grease to lubricate the ball stud socket in the back of the release lever



4.6 To check the bearing, hold it by the outer race and rotate the inner race while applying pressure; if the bearing doesn't turn smoothly or if it's noisy, renew the bearing

obvious damage. As mentioned above, ordinarily the clutch disc is renewed as a matter of course, so if in doubt about the condition, renew.

11 Ordinarily, the release bearing is also renewed along with the clutch disc (see Section 4).

12 Check the machined surfaces and the diaphragm spring fingers of the pressure plate **(see illustrations)**. If the surface is grooved or otherwise damaged, renew the pressure plate. Also check for obvious damage, distortion, cracking, etc. Light glazing can be removed with medium grit emery cloth. If a new pressure plate is indicated, new or factory-rebuilt units are available.

Refitting

Refer to illustrations 3.17a, 3.17b and 3.17c

13 Before refitting, carefully wipe the flywheel and pressure plate machined surfaces clean with a rubbing-alcohol dampened rag. It's important that no oil or grease is on these surfaces or the lining of the clutch disc. Handle these parts only with clean hands.

14 Position the clutch disc and pressure plate with the clutch held in place with an alignment tool. Make sure it's refitted properly (most new clutch discs will be marked "flywheel side" or something similar-if not marked, refit the clutch with the damper springs or bushes toward the transmission).

15 Tighten the pressure plate-to-flywheel bolts only finger tight, working around the pressure plate.

16 Centre the clutch disc by ensuring the alignment tool is through the splined hub and into the pilot bearing in the crankshaft. Wiggle the tool up, down or side-to-side as needed to bottom the tool in the pilot bush. Tighten the pressure plate-to-flywheel bolts a little at a time, working in a criss-cross pattern to prevent distorting the cover. After all of the bolts are snug, tighten them to the specified torque. Remove the alignment tool.

17 Using high temperature grease, lubricate the inner groove of the release bearing (refer to Section 4) and the front bearing retainer **(see illustration)**. Also place grease on the fork fingers **(see illustrations)**.

18 Refit the clutch release bearing as described in Section 4.

19 Refit the transmission, clutch release cylinder and all components removed previously, tightening all fasteners to the proper torque specifications.

20 Check the pedal height and freeplay and adjust them if necessary (refer to Chapter 1).

4 Clutch release bearing - renewal

Warning: *Dust produced by clutch wear and deposited on clutch components may contain asbestos, which is hazardous to your health. DO NOT blow it out with compressed air and DO NOT inhale it. DO NOT use petrol or petroleum-based solvents to remove the dust. Brake system cleaner should be used to flush it into a drain pan. After the clutch components are wiped clean with a rag, dispose of the contaminated rags and cleaner in a labeled, covered container.* **Note:** *Because of its relatively low cost and the amount of work required for access, it is good practice to renew the release bearing any time the clutch assembly is exposed.*

Removal

1 Disconnect the negative cable from the battery.

2 Remove the transmission (see Chapter 7A).

3 The release fork which holds the release bearing is retained to the pivot stud by a clip. Remove this clip and take the fork assembly from the clutch housing.

4 The release bearing is held to the fork by another clip. Note the position of this clip and then remove it. The bearing can now be serviced separately.

5 Use a conventional gear puller to pull the bearing from the release sleeve, if necessary.

Inspection

Refer to illustration 4.6

6 Hold the bearing by the outer race and rotate the inner race while applying force **(see illustration)**. If the bearing doesn't turn smoothly or if it's noisy, renew the bearing/hub assembly. Wipe the bearing with a clean rag and inspect it for damage, wear and cracks. Don't immerse the bearing in solvent; it's sealed for life, to do so would ruin it. Also check the release lever for cracks and bends.

Refitting

7 The bearing can be refitted onto the release sleeve by a shop with a hydraulic press and the correct adapter. It is possible to do this without a press if care is taken and the proper size pipe or other adapter is used to drive the bearing onto the sleeve.

8 Lubricate the bearing surface of the retainer with high-temperature grease.

9 Lubricate the release lever ball socket, lever ends and release cylinder pushrod socket with small amounts of high-temperature grease.

10 Attach the retaining clip and the release bearing to the release lever.

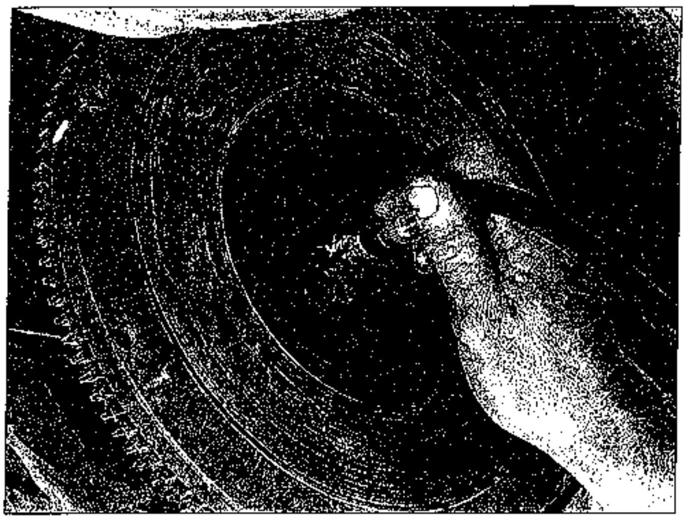
11 Slide the release bearing onto the transmission input shaft bearing retainer while passing the end of the release lever through the opening in the clutch housing. Push the clutch release lever onto the ball stud until it's firmly seated and refit he clip.

12 The remainder of refitting is the reverse of removal.

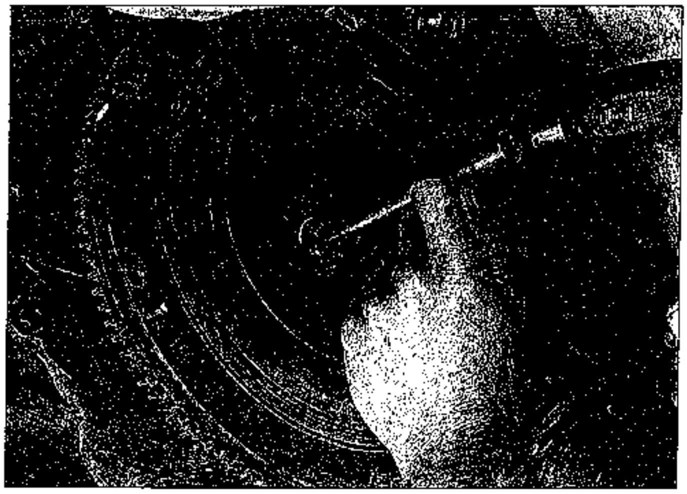
5 Pilot bearing - inspection, removal and refitting

Refer to illustrations 5.9, 5.10 and 5.11

1 The clutch pilot bearing is pressed into the rear of the crankshaft. Its primary purpose is to support the front of the transmission input shaft. The pilot bearing should be inspected whenever the clutch components



5.9 To remove the pilot bearing without a puller, fill the opening behind the bearing with grease . . .



5.10 . . . then force the bearing out hydraulically with a steel rod slightly smaller than the bore in the bearing - when the hammer strikes the rod, the grease will transmit force to the backside of the bearing and push it out

are removed from the engine. Due to its inaccessibility, if you are in doubt as to its condition, renew it. **Note:** *If the engine has been removed from the vehicle, disregard the following steps which do not apply.*

2 Remove the transmission (see Chapter 7A).

3 Remove the clutch components (see Section 3).

4 Using a clean rag, wipe the bearing clean and inspect for any excessive wear, scoring or obvious damage. A flashlight will be helpful to direct light into the recess.

5 If the transmission input shaft contact surface is worn or damaged a new unit should be refitted. **Note:** *Ordinarily, the pilot bearing is also renewed along with the clutch disc. A bearing is inexpensive and provides insurance against having to do the job over again.*

6 Removal can be accomplished with a special puller but an alternative method also works well.

7 Find a solid steel bar which is slightly smaller in diameter than the bearing. Alternatives to a solid bar would be a wood dowel or a socket with a bolt fixed in place to make it solid.

8 Check the bar for fit - it should just slip into the bearing with very little clearance.

9 Pack the bearing and the area behind it (in the crankshaft recess) with heavy grease **(see illustration)**. Pack it tightly to eliminate as much air as possible.

10 Insert the bar into the bearing bore and lightly hammer on the bar, which will force the grease to the backside of the bearing and push it out **(see illustration)**. Remove the bearing and clean all grease from the crankshaft recess.

11 To refit the new bearing, lubricate the outside surface with oil, then drive it into the recess with a hammer and a socket with an outside diameter that matches the bearing outer race **(see illustration)**. The end of the bearing should be 5.8 mm inside of the crankshaft flange.

12 Refit the clutch components, transmission and all other components removed to gain access to the pilot bearing.

6 Clutch master cylinder - removal, overhaul and refitting

Caution: *Do not allow brake fluid to contact any painted surfaces of the vehicle, as damage to the finish may result.* **Note:** *Before beginning this procedure, contact local parts stores and dealer service departments concerning the purchase of a rebuild kit or a new master cylinder. Availability and cost of the necessary parts may dictate whether the cylinder is rebuilt or a brand new one is refitted. If you decide to rebuild the cylinder, inspect the bore as described in Step 8 before purchasing parts.*

Removal

1 Disconnect the hydraulic line from the master cylinder and drain the fluid into a suitable container.

2 On models without a vacuum power booster, disconnect the master cylinder pushrod from the clutch pedal.

3 Remove the master cylinder flange mounting nuts and withdraw the unit from the engine compartment.

Overhaul

4 Detach the reservoir from the unit by loosening the clamp.

5 Remove the rubber seal from the pushrod end of the cylinder.

6 Push the piston inward with a screwdriver and remove the snap-ring. **Note:** *On early models, there is a valve stopper which must be removed from the bottom of the cylinder in order for the internal parts to be released.*

5.11 Using a hammer and socket to carefully drive the new bearing into place

7 Tap the internal components out onto a block of wood. Keep them in order.

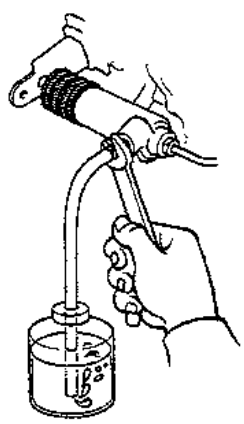
8 Pull out the pushrod, washer and piston.

8 Examine the inner surface of the cylinder bore. If it is scored or exhibits bright wear areas, the entire master cylinder should be renewed.

9 If the cylinder bore is in good condition, obtain a clutch master cylinder rebuild kit.

10 Renew all parts included in the rebuild kit, following any instructions in the kit. Clean all reused parts with new brake fluid, brake system cleaner or denatured alcohol. **Warning:** *Do not use any petroleum-based solvents. During reassembly, lubricate all parts liberally with clean brake fluid.*

11 Refitting of the parts in the cylinder is the reverse of removal. **Note:** *On early models with a valve stopper, align the groove in the piston with the valve stopper when reassembling the unit.*



8.4 When bleeding the clutch hydraulic system, a hose is connected to the bleeder valve at the release cylinder and then submerged in brake fluid - when the pedal is depressed and the valve is opened, air will be seen as bubbles in the hose and container

Refitting

12 Refitting is the reverse of removal, but check the pedal height and freeplay as described in Chapter 1 and bleed the hydraulic system (see Section 8).

7 Clutch release cylinder - removal, overhaul and refitting

Note: *Before beginning this procedure, contact local parts stores and dealer service departments concerning the purchase of a rebuild kit or a new release cylinder. Availability and cost of the necessary parts may dictate whether the cylinder is rebuilt or a new one is refitted. If you decide to rebuild the cylinder, inspect the bore as described in Step 8 before purchasing parts.*

Removal

1 Disconnect the cable from negative terminal of the battery.
2 Raise the vehicle and support it securely on jackstands. Remove the heat shield, if equipped.
3 Disconnect the hydraulic line at the release cylinder. If available, use a flare-nut wrench on the fitting, which will prevent the fitting from being rounded off. Have a small can and rags handy, as some fluid will be spilled as the line is removed.
4 Remove the release cylinder mounting bolts.
5 Remove the release cylinder.

Overhaul

6 Remove the pushrod and the boot.
7 Tap the cylinder on a block of wood to eject the piston and seal. Remove the spring and the seat from inside the cylinder. Make noes of the refitted positions of all of the components.
8 Carefully inspect the bore of the cylinder. Check for scratches, score marks and ridges. The bore must be perfectly smooth to the touch. If any imperfections are found, the release cylinder must be renewed.
9 Using the new parts in the rebuild kit, assemble the components using plenty of fresh brake fluid for lubrication. Note the refitted direction of the spring and the seal.

Refitting

10 Refit the release cylinder on the clutch housing. Make sure the pushrod is seated in the release fork pocket.
11 Connect the hydraulic line to the release cylinder. Tighten the connection.
12 Fill the clutch master cylinder with brake fluid (conforming to DOT 3 specifications).
13 Bleed the system (see Section 8).
14 Lower the vehicle and connect the cable to the negative terminal of the battery.

8 Clutch hydraulic system - bleeding

Refer to illustration 8.4

1 The hydraulic system should be bled of all air whenever any part of the system has been removed or if the fluid level has been allowed to fall so low that air has been drawn into the master cylinder. The procedure is very similar to bleeding a brake system.
2 Fill the master cylinder with new brake fluid conforming to DOT 3 specifications. **Caution:** *Do not re-use any of the fluid coming from the system during the bleeding operation or use fluid which has been inside an open container for an extended period of time.*
3 Raise the vehicle and place it securely on jackstands to gain access to the release cylinder, which is located on the clutch housing.
4 Remove the dust cap which fits over the bleeder valve and push a length of plastic hose over the valve. Place the other end of the hose into a clear container with about 50 mm of brake fluid in it. The hose end must be submerged in the fluid **(see illustration)**.
5 Have an assistant operate the clutch pedal slowly several times. Then have the assistant depress the clutch pedal and hold it. Open the bleeder valve on the release cylinder, allowing fluid to flow through the hose. Close the bleeder valve when fluid stops flowing from the hose. Once closed, have your assistant release the pedal.
6 Continue this process until all air is evacuated from the system, indicated by a full, solid stream of fluid being ejected from the bleeder valve each time and no air bubbles in the hose or container. Keep a close watch on the fluid level inside the clutch master cylinder reservoir; if the level drops too low, air will be sucked back into the system and the process will have to be started all over again.
7 Tighten the bleeder valve, refit the dust cap and lower the vehicle. Check carefully for proper operation before placing the vehicle in normal service.

9 Clutch pedal assembly - removal and refitting

1 Disconnect the master cylinder pushrod from the pedal by removing the spring clip and pulling out the pushrod pin.
2 Remove the pivot bolt. Note how the return spring is positioned.
3 Remove the pedal shaft.
4 Remove the clutch pedal with its spring, bushes and collar.
5 Clean the parts in solvent and renew any that are damaged or excessively worn.
6 Refitting is the reverse of the removal procedure. During refitting, apply multi-purpose grease to the pedal boss, return spring, pedal shaft and pushrod pin.

10 Clutch vacuum power booster unit - check, renewal and adjustment

Check

1 Check all vacuum hoses including those to the inlet manifold and the brake booster for cracks and other damage. Renew any that show wear.
2 Remove the tee check valve from the vacuum system and note the positions of the hoses.
3 Blow through the clutch vacuum port. Air should flow through the other ports freely. If it does not, renew the check valve. It should not be possible to suck air through the clutch port.
4 Start the engine and allow it to idle. Pull the vacuum hose from the clutch power booster and place a finger over the end of the hose. There should be strong vacuum present.

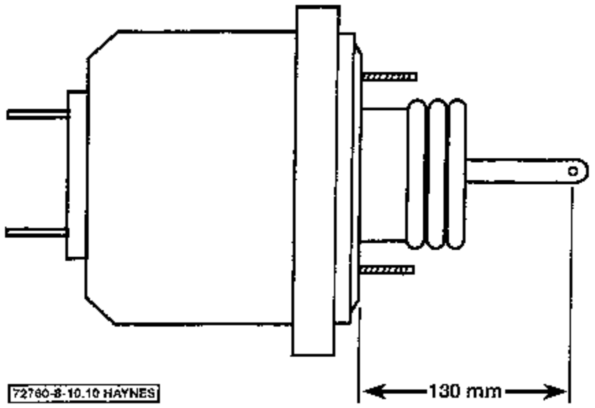
Renewal

5 Remove the clutch master cylinder (refer to Chapter 6).
6 Disconnect the clutch pushrod from the clutch pedal.
7 Remove the mounting nuts from under the dash.
8 Disconnect the vacuum hose from the unit.
9 Refitting is the reverse of removal.

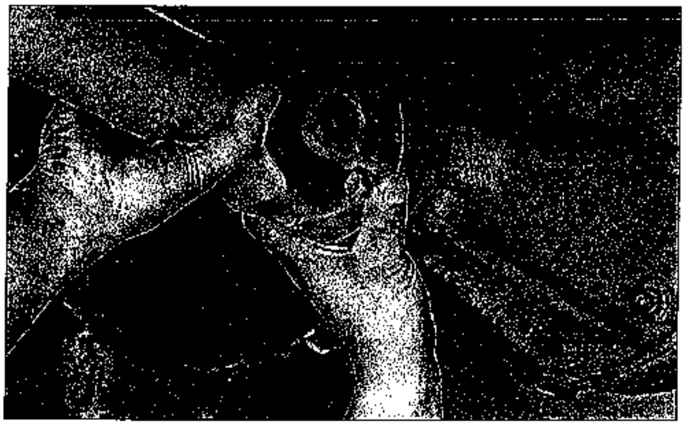
Adjustment

Refer to illustration 10.10

10 Loosen the lock-nut on the input rod and adjust the distance from the centre of the clutch pedal pin hole to the firewall mounting surface as shown **(see illustration)**.



10.10 Adjust the clutch power booster input rod to 130 mm. The measurement must be taken from the centre of the pivot pin hole to the surface that seats against the firewall



12.5 Use a twisting motion to check for freeplay in the U-joint - any movement is evidence of wear

11 Measure the distance from the end of the output rod to the master cylinder mounting surface. This distance should be 130 mm to 1.55 mm. If adjustment is required, hold the pushrod rod with pliers and adjust the tip.

11 Driveshafts, differentials and axles - general information

All 4WD vehicles use two driveshafts; one shaft runs between the transfer case and the front differential and the rear driveshaft runs between the transfer case and the rear differential.

All universal joints are of the solid type and can be renewed separate from the driveshaft. Some models use a double Cardan type front joint.

The driveshafts are finely balanced during production and whenever they are removed or disassembled, they must be reassembled and refitted in the exact manner and positions they were originally in, to avoid excessive vibration.

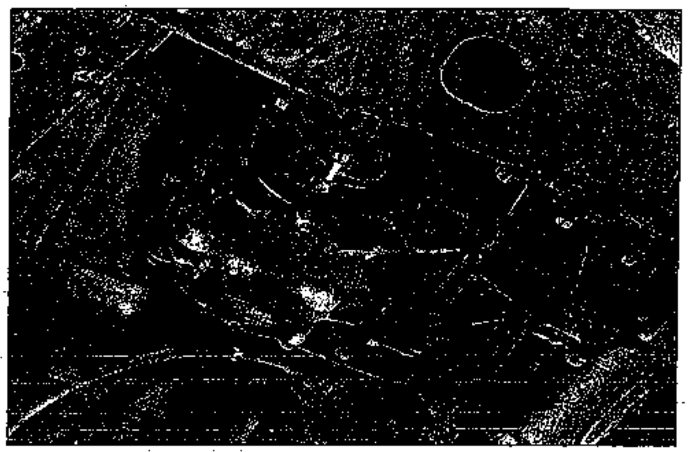
Both front and rear axles have a 'banjo' style differential which transfers the turning torque of the driveshaft to the axleshafts. The axleshafts are splined at their inner ends to fit into the splines in the differential gears and the outer ends of the rear axles are either of the full-floating or semi-floating design. All front axles are of the full floating design.

Because of the complexity and critical nature of the differential adjustments, as well as the special equipment needed to perform the operations, we recommend any disassembly of the differential be done by a Nissan/Ford dealer service department or other qualified repair facility.

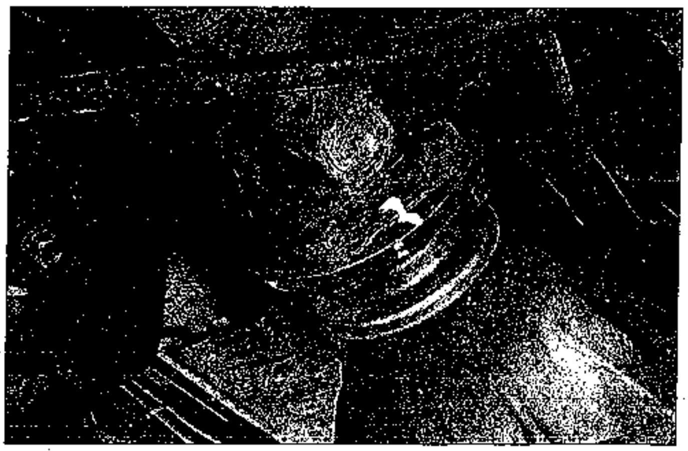
12 Driveline inspection

Refer to illustration 12.5

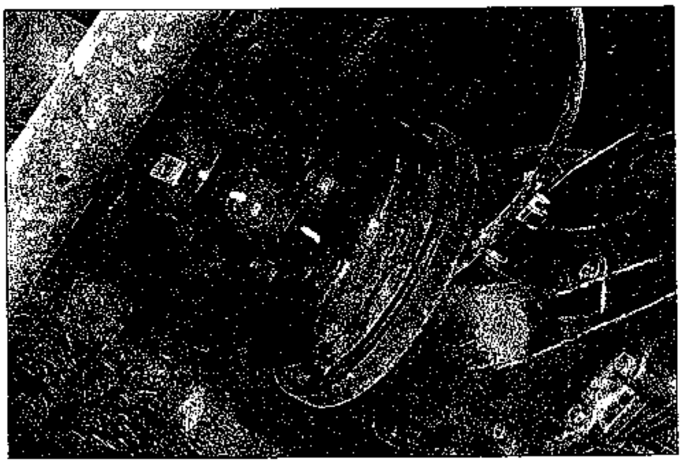
1 Raise the vehicle and support it securely on jackstands.
2 Slide under the vehicle and visually inspect the condition of the driveshafts. Look for any dents or cracks in the tubing. If any are found, the driveshaft must be renewed.
3 Check for any oil leakage at the front and rear of the driveshaft. Leakage at the transfer case indicates a defective output shaft seal (see Chapter 7C). Leakage from the differential indicates a defective pinion seal (see Section 17).
4 While you're under the vehicle, have an assistant turn a rear wheel so the driveshaft will rotate. As it rotates, make sure the U-joints are functioning properly; they should not be binding, noisy or loose.
5 The U-joints can also be checked with the driveshaft motionless. First, make sure the U-joint bolts at both ends are tight, then grip each side of each joint and try to twist it **(see illustration)**. Any movement in the U-joint is evidence of considerable wear. Lifting up on the shaft will also indicate movement in the universal joints.
6 Inspect for leakage around both sliding yokes. Grease in this area indicates failure of the yoke seal.
7 While you're under the vehicle, inspect both ends of both axle tubes for leaks. Gear oil leakage onto the brake backing plate or brakes indicates a leaking axleshaft seal.
8 The front hub assemblies of these vehicles are quite complex. Inspect the front axle carefully for leaks and other signs of wear.
9 Remove the jackstands and lower the vehicle.



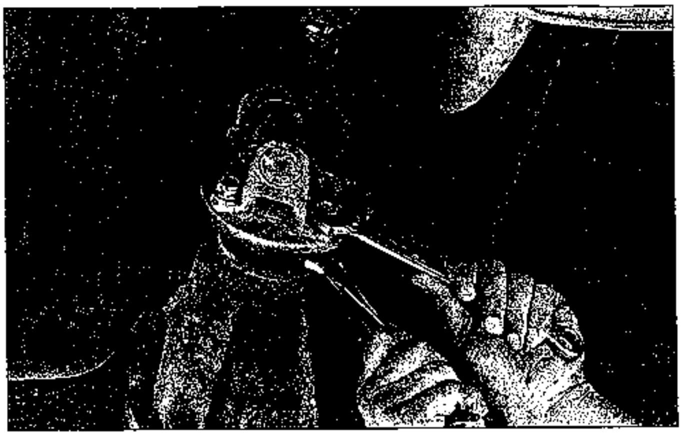
13.2a Make sure you mark the U-joint trunnion and companion flange . . .



13.2b . . . at both ends of the driveshaft to ensure the driveshaft retains its balance when you refit it



13.2c Note how all the removable parts are marked clearly



13.3 Use two spanners to immobilise the driveshaft when you break the flange nuts loose

13 Driveshafts - removal and refitting

Refer to illustrations 13.2a, 13.2b, 13.2c and 13.3

1 Raise the vehicle and support it securely on jackstands. Place the transmission and transfer case in Neutral with the parking brake off.

2 Use a scribe, white paint or a hammer and punch to place alignment marks on all driveshaft flanges and slip joints **(see illustrations)** to ensure that the driveshaft is refitted in the same position so its dynamic balance is maintained.

3 Detach the bolts from the differential and transfer case flanges and remove the drive shaft(s) from the vehicle **(see illustration)**. Because the bolts are very tight, it will be necessary to hold the driveshaft with a long bar to prevent it from turning.

4 While the driveshaft is removed, check the U-joints: While pushing and pulling on them, try to move them back and forth and side to side simultaneously. If there is any play in the U-joints, renew the U-joints (see Section 14).

5 Refitting is the reverse of removal.

a) *Make sure you match up the marks you made on all flanges.*

b) *Tighten all fasteners to the torque listed in this Chapter's Specifications.*

14 Universal joint - renewal

Refer to illustrations 14.2, 14.3a and 14.3b

Note: *A press or large vice will be required for this procedure. It may be a good idea to take the driveshaft to a repair or machine shop where the U-joints can be renewed for you, usually at a reasonable charge.*

1 Remove the driveshaft (see Section 13).

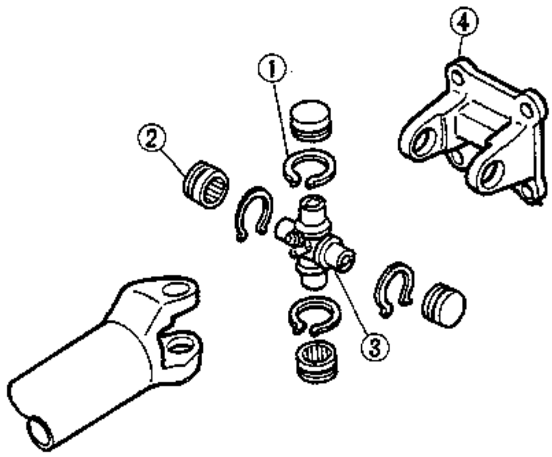
2 Place the driveshaft in a sturdy vice, mark the shaft and yoke for proper reassembly and, using a hammer and punch, drive the snap rings off the bearing cups **(see illustration)**.

3 Place a piece of pipe or a large socket with the same inside diameter over one of the bearing cups. Position a socket which is of slightly smaller diameter than the cup on the opposite bearing cup **(see illustration)** and use the vice to force the cup out (inside the pipe or large socket), stopping just before it comes completely out of the yoke. Use the vice or large pliers to work the cup the rest of the way out **(see illustration)**.

4 Transfer the sockets to the other side and press the opposite bearing cup out in the same manner.

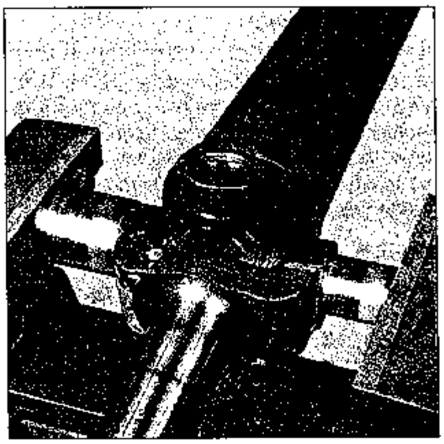
5 After the bearing cups have been removed, lift the U-joint from the yoke and thoroughly clean all dirt and debris from the yokes on both ends of the driveshaft. Be sure to remove any metal burrs from the yoke bores.

6 Pack the new U-joint bearing cups with

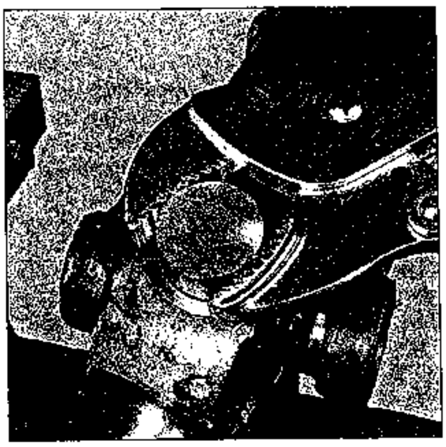


14.2 An exploded view of a U-joint assembly

1 Snap-ring
2 Bearing cup
3 U-joint body
4 U-joint yoke

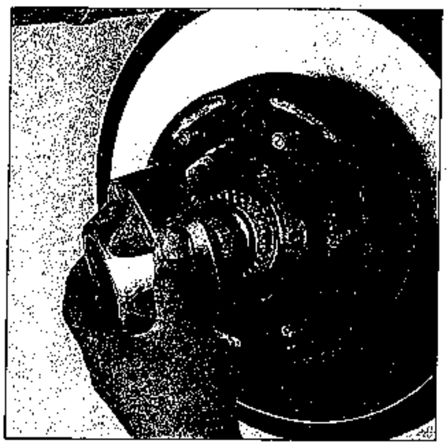


14.3a Press out the U-joint bearing cups with a vice and sockets

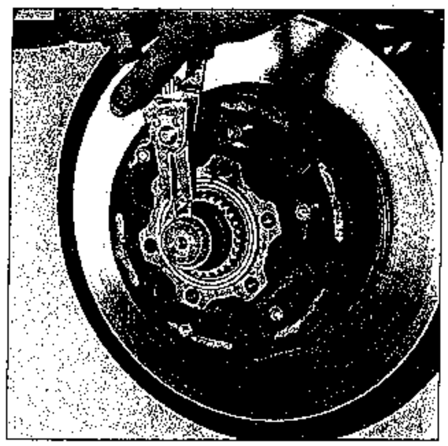


14.3b Extract the bearing cup with locking pliers

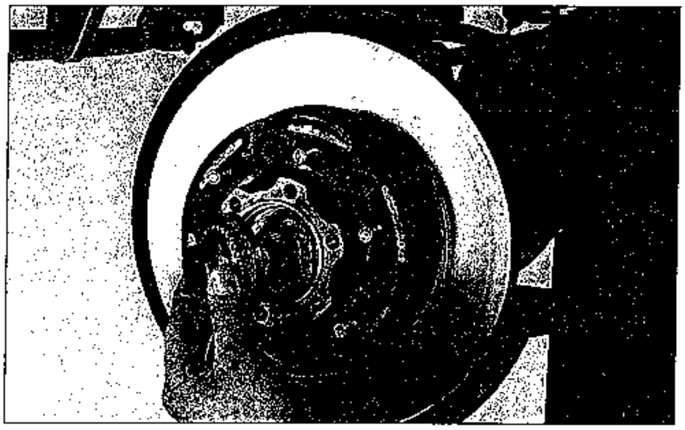
15.6a Remove the manual locking hub outer assembly bolts . . .



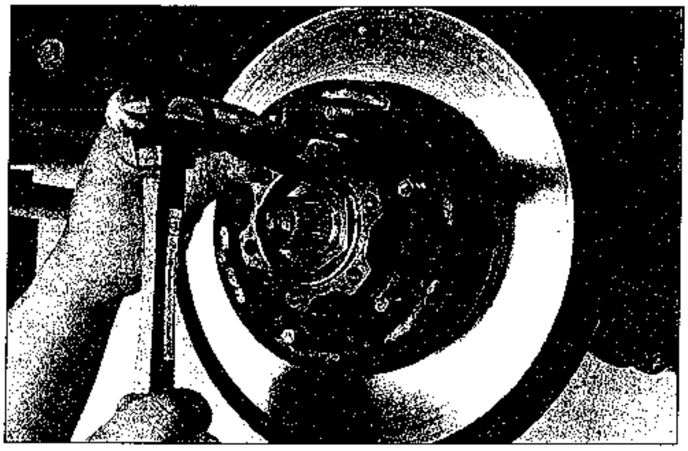
15.6b . . . and lift the unit off



15.7 Snap-ring pliers are necessary to remove the outer snap-ring



15.8 The drive clutch is removed next. Place all of the components in order on a clean working area to avoid confusion later



15.10a The locking washer will have to be flattened with a hammer and drift

grease, this will allow the needle bearings to be held in place while you're refitting the bearing cups. Ordinarily, specific instructions for lubrication will be included with the U-joint servicing kit and should be followed carefully.

7 Position the U-joint body in the yoke and partially refit one bearing cup in the yoke. If the U-joint is equipped with a grease fitting, be sure it points in the same direction as the grease fitting on the opposite end of the driveshaft.

8 Start the U-joint body into the bearing cup and then partially refit the other cup. Align the U-joint body between the bearing cups and press the bearing cups into position, being careful not to damage the dust seals.

9 Refit the snap-rings. Tap the unit sharply with a hammer to centre the U-joint after assembly. **Note:** *If you have difficulty seating the snap-rings, one of the small needle bearings may have become stuck between the bearing cap and the end of the spider. Disassemble and inspect.*

10 Check the endplay of the assembly. Endplay should not exceed 0.02 mm. Snap-rings of various sizes are available to obtain the proper endplay. The difference between the thicknesses of the two snap-rings used on opposite ends of a trunnion should not exceed 0.06 mm.

11 Refit the driveshaft (see Section 13). If the U-joint is equipped with a grease fitting, lubricate it as described in Chapter 1.

15 Front hub, bearings and axle assembly - check, lubrication and renewal

Note: *Models with front automatic locking hubs require a special factory tool for disassembly. Both the manual and automatic hub assemblies are quite complex and may require the renewal of seals and snap-rings during this procedure.*

Disassembly and repack

Refer to illustrations 15.6a, 15.6b, 15.7, 15.8, 15.10a, 15.10b, 15.10c, 15.16, 15.17a, 15.17b, 15.17c, 15.17d, 15.18, 15.19, 15.21a, 15.21b, 15.26a and 15.26b

1 In most cases the front wheel bearings will not need servicing until the brake pads are changed. However, the bearings should be checked whenever the front of the vehicle is raised for any reason. Several items, including a torque wrench and special grease, are required for this procedure.

2 With the vehicle securely supported on jackstands, spin each wheel and check for noise, rolling resistance and freeplay.

3 Grasp the top of each tyre with one hand and the bottom with the other. Move the wheel in and out on the spindle. If there's any noticeable movement, the bearings should be checked and then repacked with grease, or renewed if necessary.

4 Remove the wheel.

5 Unbolt the disc brake caliper (see Chapter 9) and hang it out of the way on a piece of wire. **Caution:** *Do not touch the brake pedal while the caliper is removed. The caliper piston will be ejected.*

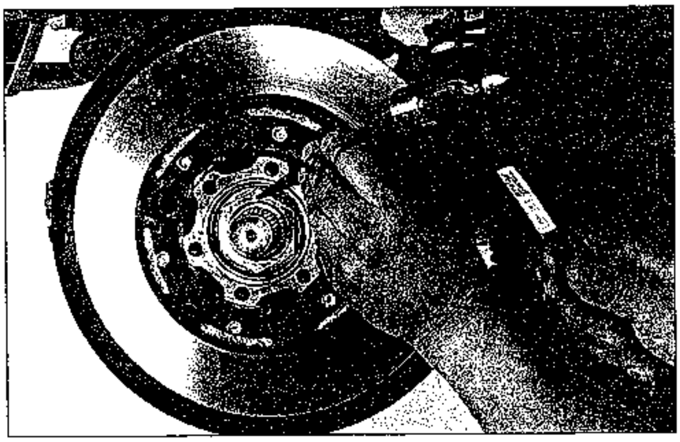
Models with manual locking hubs

6 Turn the hub to the FREE setting. Remove the retaining bolts and remove the locking hub assembly **(see illustrations)**.

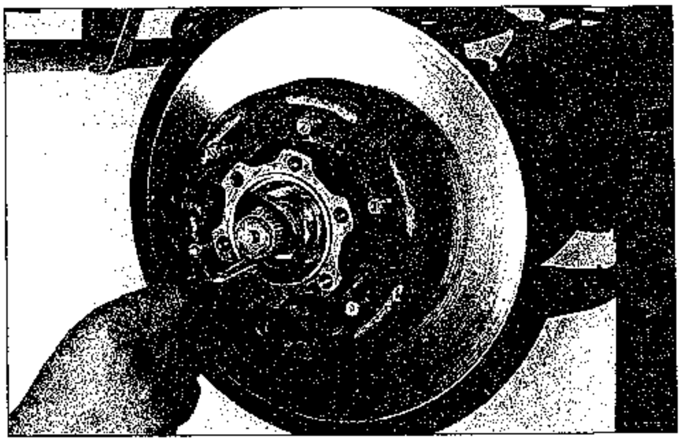
7 Use snap-ring pliers to remove the snap-ring from the end of the axle shaft **(see illustration)**.

8 Remove the drive clutch assembly **(see illustration)**.

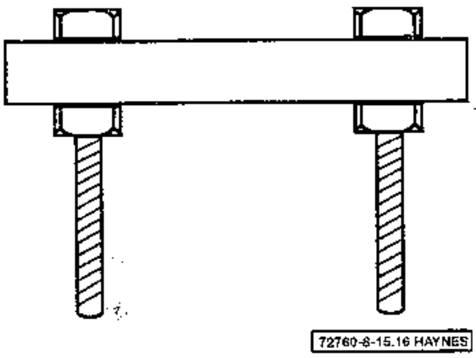
9 Remove the bush and the spacer behind it.



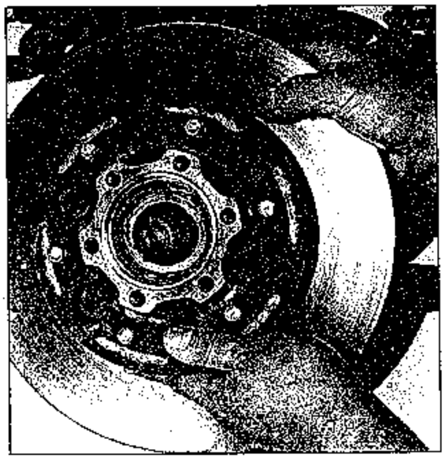
15.10b This nut may be tight. It is best to use the proper socket to remove it, but a hammer and drift will also work



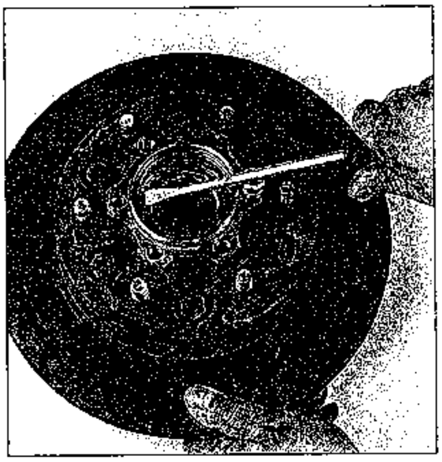
15.10c Use a magnet to extract the lock washer



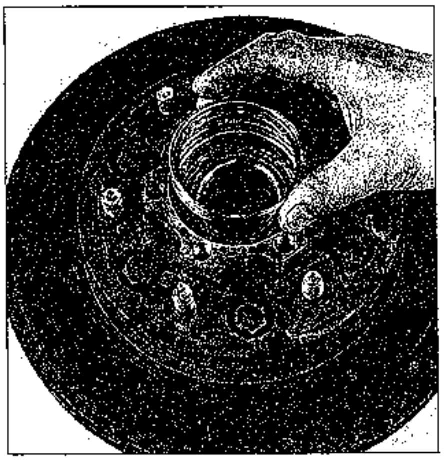
15.16 To properly tighten the adjusting nut for models with automatic locking front hubs, you will have to purchase a special tool or else fabricate one out of scrap to these specifications. Use a stout piece of steel for the main body, then drill it for two bolts as shown. The distance between the bolts has to match the spacing of the holes in the nut. Use an adjustable spanner to turn the tool



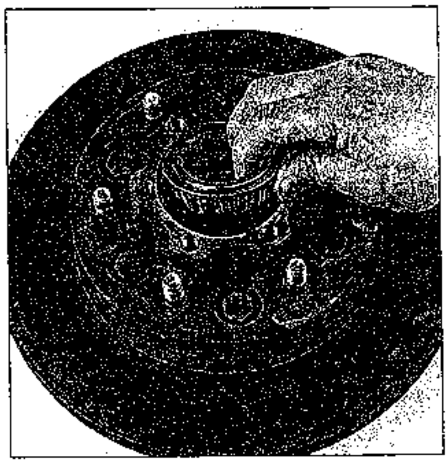
15.17a Lift the rotor assembly from the spindle



15.17b A screwdriver can be used to prise out the spacer



15.17c Lift the spacer from the hub . . .



15.17d . . . then pull out the outer wheel bearing

8

10 Release the tab on the lock washer and then remove the outer lock nut **(see illustrations)**. It is screwed on very tightly. Remove the lock washer **(see illustration)**.

11 Remove the inner adjusting nut and the washer.

Models with automatic locking hubs

12 Adjust the hub to the LOCK setting. Remove the retaining bolts and remove the locking hub, the O-ring, the spring and the outer brake.

13 Use snap-ring pliers to remove the snap-ring from the end of the axle shaft.

14 Remove the hub brake unit. This consists of two washers and the inner brake. Place all the components on a clean surface in order so that they can be easily reassembled in the correct sequence.

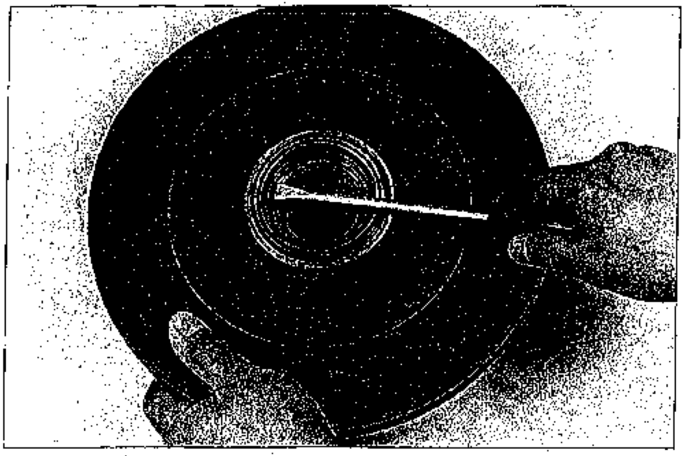
15 Remove the lock washer.

16 Obtain the special tool shown or fabricate an equivalent **(see illustration)**. Use it to loosen and then remove the adjusting nut.

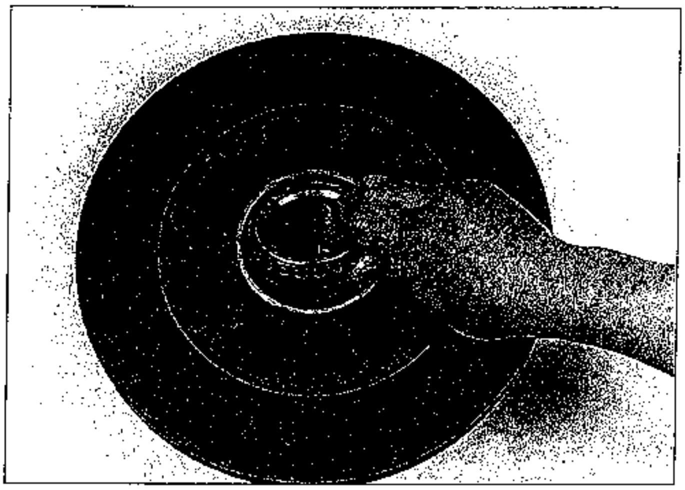
Note: *It may be possible to remove this nut with other means, but the tool will be needed to tighten it upon reassembly.*

All models

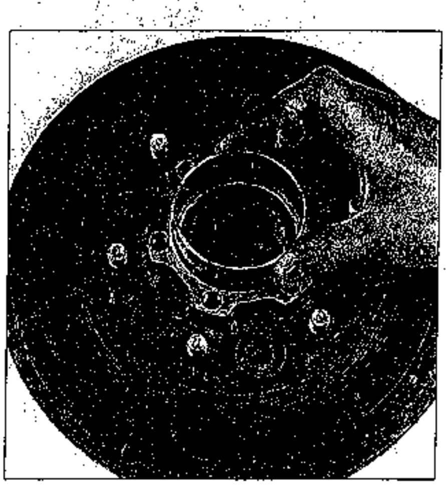
17 Support the outer bearing to prevent it from falling and remove the hub/rotor assembly from the vehicle **(see illustration)**. Unbolt



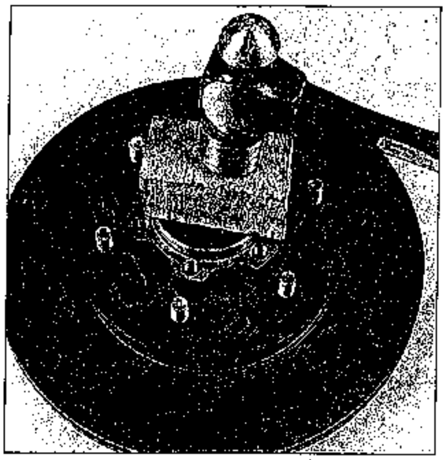
15.18 The seal can be pulled from the inside of the hub with a seal puller or a screwdriver. It will have to be renewed, so don't worry about damaging it



15.19 Lift the inner wheel bearing from its race



15.21a Both inner and outer races can be driven out with a drift and renewed if required



15.21b Fit new races with a block of wood. They are precision components and cannot be tapped directly with a hammer

15.26a It is good practice to always renew the grease seals

the rotor from the hub if necessary. Remove the outer bearing assembly **(see illustrations)**.

18 Use a screwdriver or a seal puller tool to prise the seal out of the inside of the brake disc or drum **(see illustration)**. Note how the seal is refitted. The seal should be marked "bearing side".

19 Remove the inner wheel bearing from the disc **(see illustration)**.

20 Use solvent to remove all traces of the old grease from the bearings, hub and spindle. A small brush may prove helpful; however make sure no bristles from the brush embed themselves inside the bearing rollers. Allow the parts to air dry.

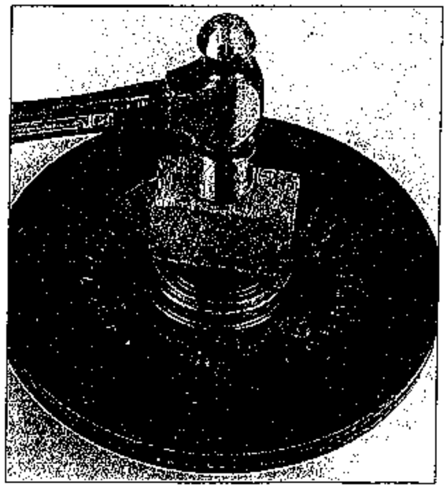
21 Carefully inspect the bearings for cracks, heat discolouration, worn rollers, etc. Check the bearing races inside the hub for wear and damage. If the bearing races are defective, drive the bearing race out of the hub using a brass drift **(see illustration)**. Drive the new race into the hub using the appropriate size bearing driver (inexpensive bearing driver sets are available at most automotive parts stores) **(see illustration)**. Note that the bearings and races are renewed as matched sets; used bearings should never be refitted on new races.

22 Use only high-temperature front wheel bearing grease to pack the bearings. Inexpensive bearing packing tools are available at automotive parts stores, but not entirely necessary. If one is not available, pack the grease by hand completely into the bearings, forcing it between the rollers, cone and cage from the back side.

23 Apply a thin coat of grease to the spindle at the outer bearing seat, inner bearing seat, shoulder and seal seat.

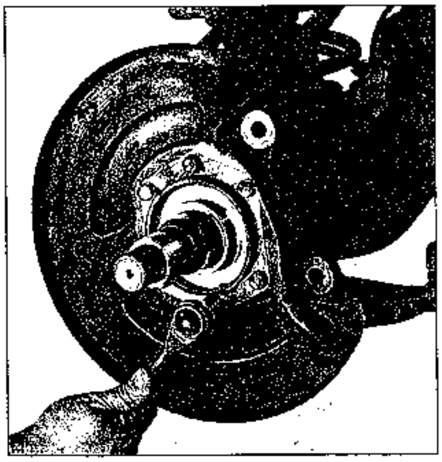
24 Place a small quantity of grease inboard of each bearing race inside the hub. Using your finger, form a dam at these points to provide extra grease availability and to keep thinned grease from flowing out of the bearing.

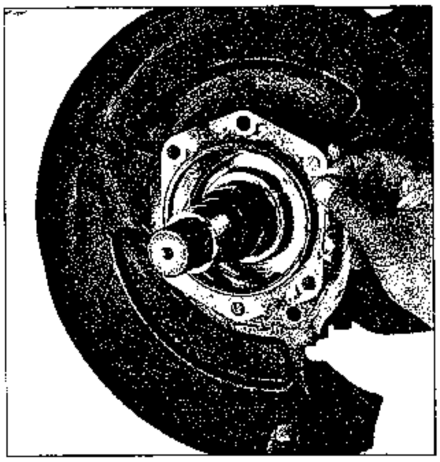
25 Place the grease-packed inner bearing into the rear of the hub and put a little more grease outboard of the bearing.



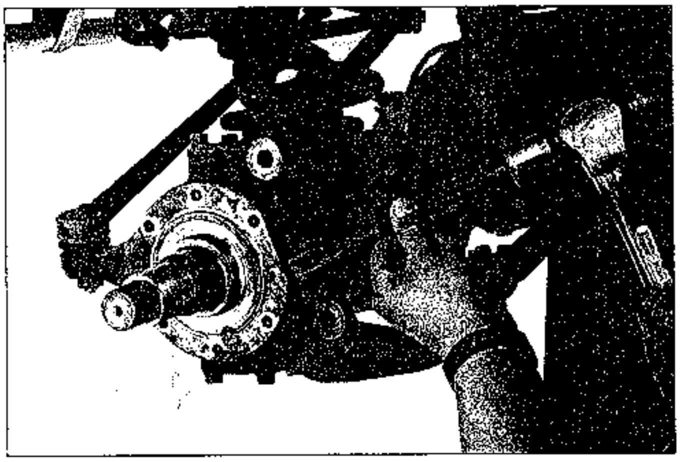
15.26b A hammer and a block of wood will drive the new seals in squarely

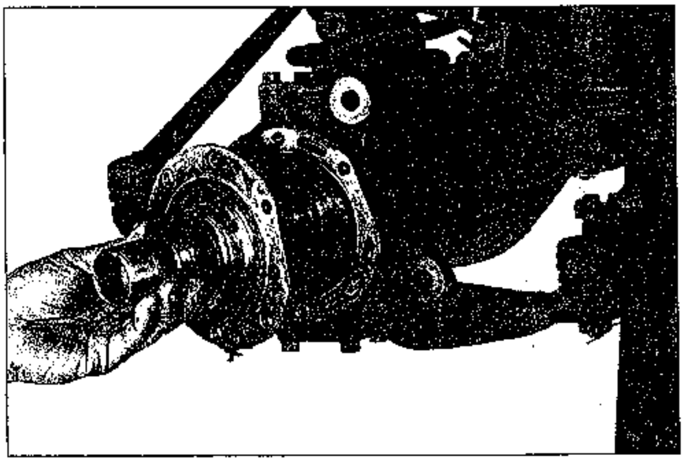
26 Place a new seal over the inner bearing and tap the seal evenly into place with a hammer and block of wood until it's flush with the hub **(see illustrations)**.


15.28a Remove these bolts . . .


15.28b . . . to remove the dust seal . . .


15.28c . . . and the large baffle plate


15.28d The seal on the spindle can be broken with a hammer and chisel . . .


15.28e . . . and then the spindle can be lifted off

Axleshaft lubrication and renewal

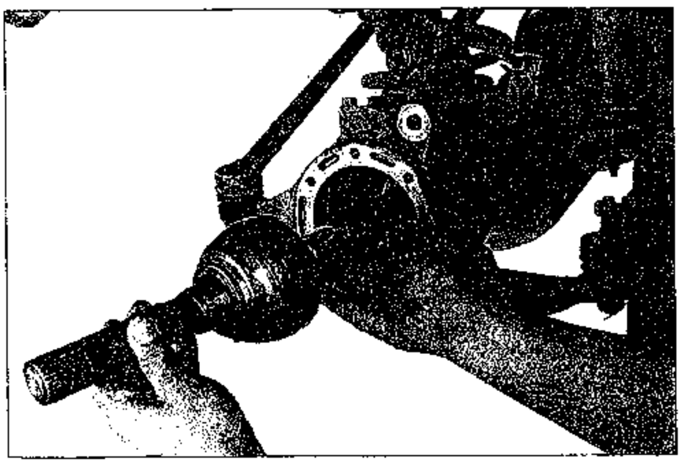
Refer to illustrations 15.28a, 15.28b, 15.28c, 15.28d, 15.28e, 15.29, 15.30, 15.31, 15.33a, 15.33b, 15.42, 15.45 and 15.46

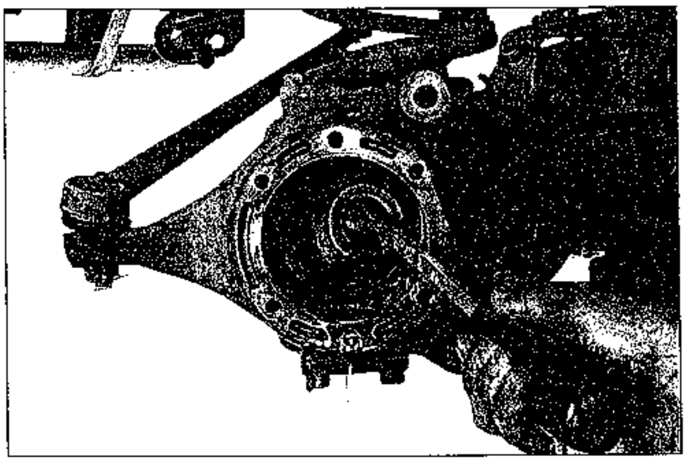
27 Drain two litres of lubricant from the front differential.

28 Remove the dust seal, the large baffle plate and the knuckle spindle from the end of the axle assembly **(see illustrations)**.

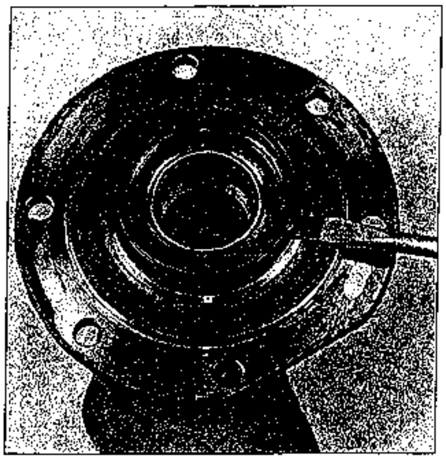
29 Carefully slide the axle out of the housing until the axle joint is accessible. Take care to not damage the grease seals **(see illustration)**. Pack the joint with the recommended grease.

30 To renew the inner seal, remove the axle completely and prise the seal from the axle housing **(see illustration)**.

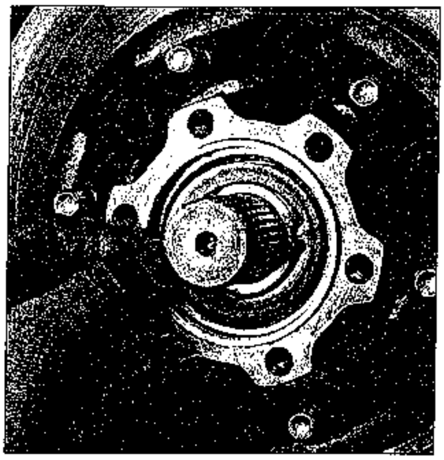

15.29 Do not drag the axle over the inner seal as you slide it out - the seal will be ruined


15.30 If the inner seal has shown signs of leakage, it can be renewed after the axle has been completely removed from the housing

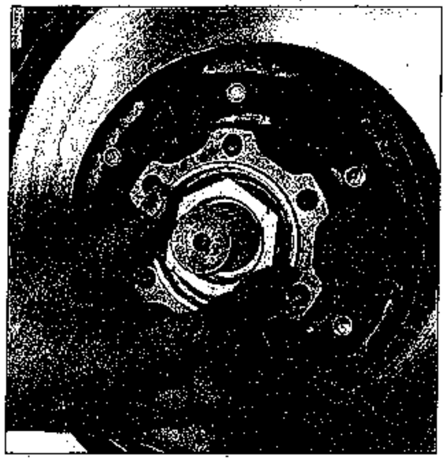
8



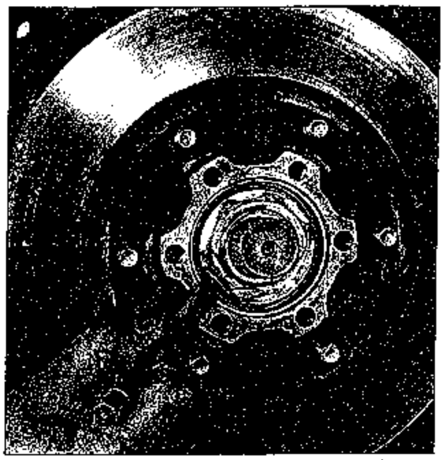
15.31 The spindle seal should be checked and renewed at this time



15.33a Refit the thrust washer . . .

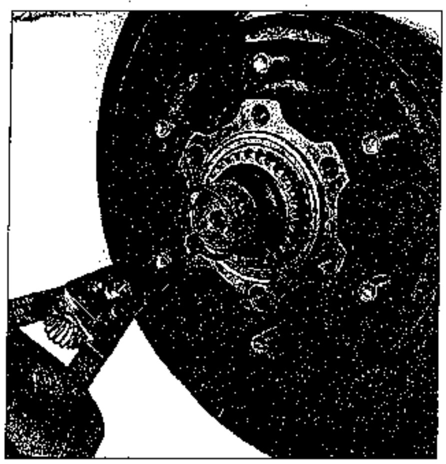


15.33b . . . and the nut



15.42 Secure the nut by bending up a corner of the lock washer

15.45 Refit the drive clutch



15.46 Use a new snap-ring to complete the assembly

31 Refitting is the reverse of removal. If necessary, renew the seal on the spindle **(see illustration)**.

Adjustment

32 Carefully place the brake rotor assembly onto the spindle and push the grease-packed outer bearing into position.
33 Refit the thrust washer and the locknut onto the spindle **(see illustrations)**.
34 Tighten the nut to 167 to 196 Nm.
35 Spin the hub in both directions.
36 Loosen the nut fully.
37 Torque the nut again, but this time to only 4 Nm.
38 Again spin the hub in both directions.
39 Again torque the nut to 4 Nm.
40 Again spin the hub in both directions. The hub should turn smoothly with only a very slight amount of drag.
41 Mount a dial indicator with the tip on the end of the hub and pointing parallel with the axle shaft.
42 Grasp the hub and push it in and out. The total movement must be less than 0.08 mm. Bend the lock washer over to secure the nut **(see illustration)**.

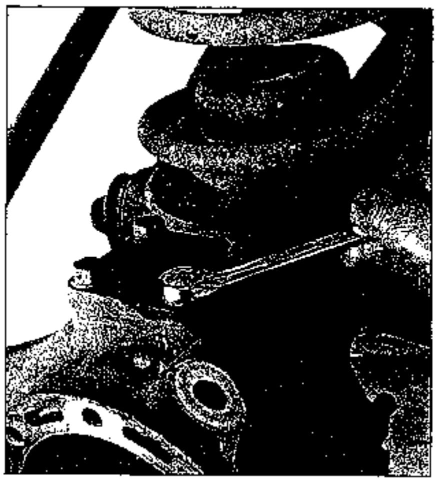
Reassembly

Models with manual locking hubs

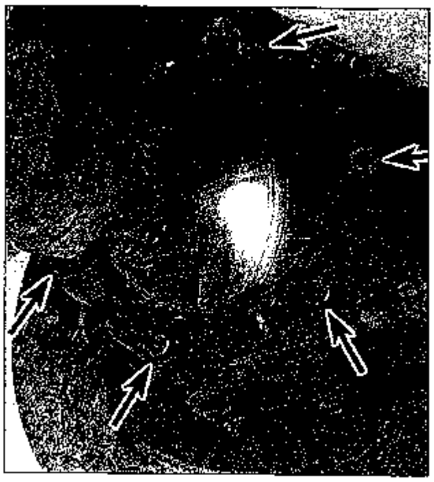
43 Place a new lock washer over the adjusting nut. Apply lubricant to the side of the outer locking nut and refit it to the listed torque in the Specifications of this Chapter. Bend the lock washer to secure both nuts.
44 Liberally grease the bush, then tap it and the spacer into place.
45 Refit the complete drive clutch assembly **(see illustration)**. Make sure that you grease it thoroughly before refitting.
46 Refit a new snap-ring **(see illustration)**.
47 Use feeler gauges to verify that the total free play of the hub (as measured between the snap-ring and the hub) is less than 0.02 mm. Snap-rings of various thicknesses are available to set the correct freeplay if it is not within the 0.0 to 0.02 mm range.
48 The remainder of refitting is the reverse of removal. **Note:** *Grease the internal components of the manual locking hub assembly with the recommended chassis grease. DO NOT pack the hubs full of grease or poor operation may occur. If the locking hub is disassembled, be sure to mark the relationship of the clutch to the housing with a dab of paint before unscrewing it. The clutch must be refitted with the marks aligned and to the same depth as when removed.*

Models with automatic locking hubs

49 Refit the inner brake and the two washers. The washer with the two internal tangs goes on first, with the tangs directed inwards.
50 Refit a new snap-ring. Use feeler gauges to verify that the total free play of the hub (as measured between the snap-ring and the hub) is less than 0.02 mm. Snap-rings of various thicknesses are available to set the correct freeplay if it is not within the 0.0 to 0.02 mm range.
51 Refit the locking hub assembly, complete with a new O-ring, the large spring and the outer brake. Make sure the hub is still set to the LOCK position. Tighten the bolts to the torque listed in this Chapter's Specifications. **Note:** *The automatic locking hub assembly must be renewed as a unit if it is damaged. Do not disassemble it.*
52 Set the hubs to the AUTO position.
53 The remainder of refitting is the reverse of removal.



16.3 Both the upper and lower bearing caps are secured by four bolts. Do not let the shims beneath these caps get out of order as you remove them



16.4 These bolts secure the seal guard plate. One of them acts as the steering travel stopper

16 Swivel hub assembly - removal and refitting

Refer to illustrations 16.3 and 16.4

1 Remove the axle shaft (refer to Section 15).

2 Disconnect the tie-rod ends from the swivel hub (refer to Chapter 10).

3 Remove the bearing caps with their shim stacks **(see illustration)**. Keep all of the components in order so the shims and caps can be returned to their original positions.

4 Remove the bolts from the seal guard **(see illustration)**. **Note:** *One of the bolts is used as a steering stop. Mark the threads on this bolt so that it can be refitted to the same depth later. Remember the location where it was refitted.*

5 Pull the swivel hub off and remove the seal guard, scraper, seal and support ring.

6 Use a brass drift to drive out the upper and lower bearing races and kingpin plugs.

7 Carefully check all components for wear and damage. Renew any that require it. Always renew the scraper and the seal, as they are prone to rapid wear.

8 Always renew the plugs. Renew the races if the bearings were renewed.

9 Pack the bearings with grease prior to refitting. All other moving components should also receive a light application of grease as they are refitted. The swivel area itself should receive 50 g of grease. Refit the scraper and support ring with the openings facing downwards.

10 After refitting the bearing caps, check the turning effort by attaching a spring scale (fish scale) to the tie-rod connection hole of the knuckle.

11 It should require from 6 to 17 N of force to rotate the swivel hub assembly. The force required can be adjusted by adding or subtracting shims from the bearing caps. Always add or subtract shims equally from the top and bottom caps.

12 Refitting is the reverse of removal. Tighten the fasteners to the torques listed in this Chapter's Specifications. The steering stop bolt and lock-nut must be refitted on the stopper side of the axle housing.

17 Axle assembly (front or rear) - removal and refitting

Removal

Refer to illustrations 17.3 and 17.8

1 Loosen the wheel lug nuts, raise the vehicle and support it securely on jackstands positioned under the frame rails. Remove the wheels.

2 Remove the brake components, if desired (see Chapter 9). If you decide to leave the brake assemblies refitted on the axle housing, disconnect the brake lines from the axle and plug all of the openings.

3 On front axles, disconnect the tie-rod ends and centre link **(see illustration)** from the steering knuckles (see Chapter 10).

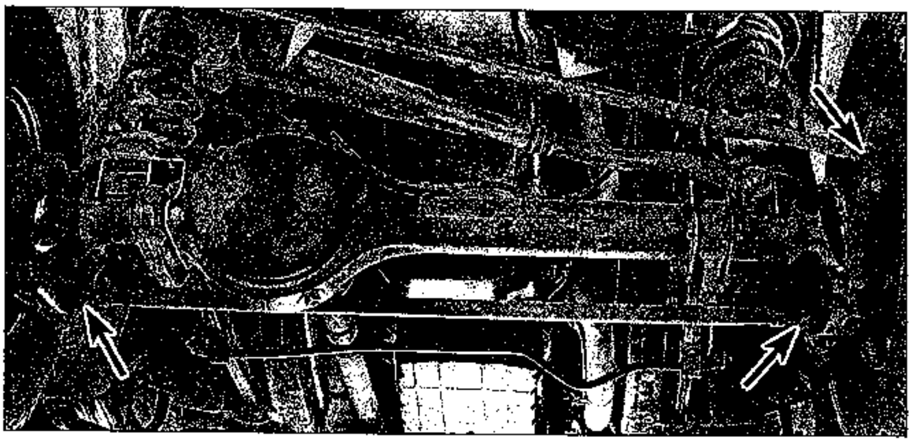
4 Disconnect the driveshaft from the pinion flange (see Section 13).

5 Remove the stabiliser bar if equipped (see Chapter 10).

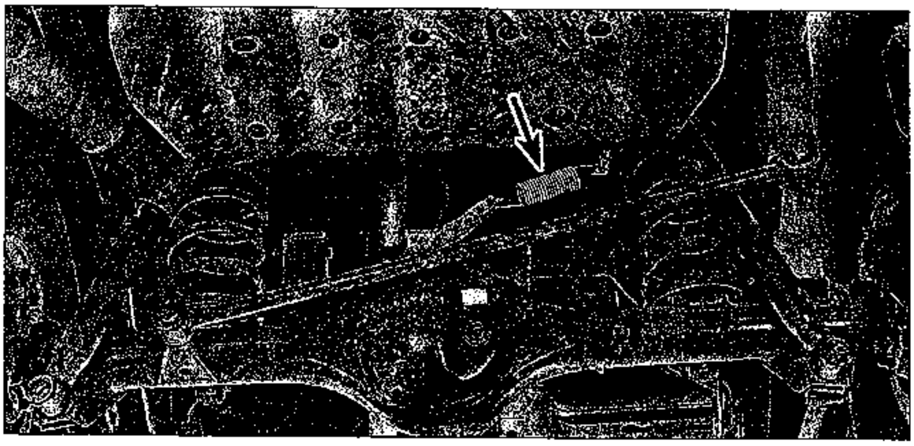
6 If the axle is equipped with a Panhard bar, disconnect it from the axle (see Chapter 10).

7 Drain the lubricant from the axle housing. Disconnect the vent hose.

8 If equipped, disconnect the load level

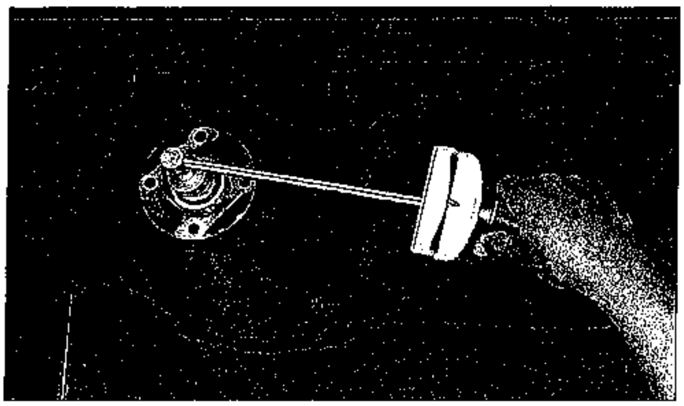


17.3 You will probably have to use a tie-rod puller or a "pickle-fork" to disconnect the tie-rod ends and the steering link (arrows)

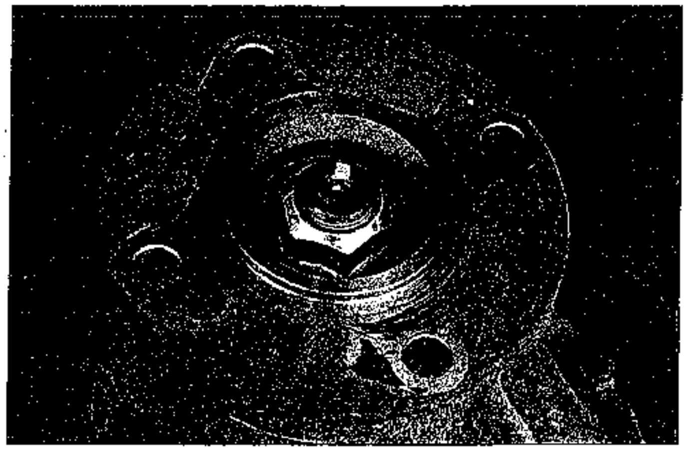


17.8 The load level sensor spring has to be disconnected. Check that all vent hoses, etc., are also free before lowering the axle assembly

8

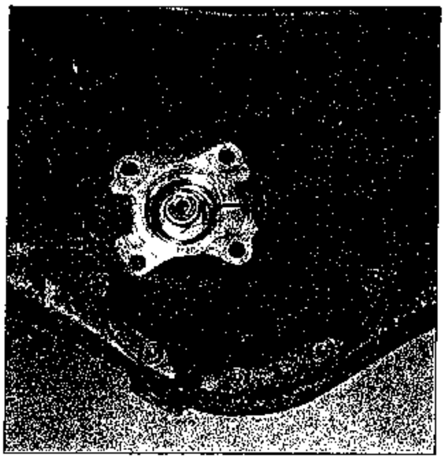


18.5 Using a kg-cm torque wrench, measure and record the break away torque required to turn the pinion nut before renewing the pinion oil seal



18.6 Mark the position of the nut on the pinion shaft

18.7a A large screwdriver, positioned as shown, can be used to hold the companion flange stationary while the nut is loosened



18.7b Mark the relationship of the flange to the pinion shaft

18.8 Remove the companion flange from the pinion shaft with a two-jaw puller

sensor spring from the rear axle **(see illustration)**.

9 Place a floor jack under the differential and raise the rear axle assembly slightly.

10 Disconnect the lower ends of the shock absorbers from the axle assembly (see Chapter 10).

11 If equipped with coil springs Carefully lower the axle assembly until the coil springs are fully extended, then remove the springs (see Chapter 10).

12 If equipped with leaf springs, unbolt the U-bolts and tie plates from the axle (see Chapter 10). Remove the bolts attaching the front spring shackles to the springs and lower the springs to the ground. **Caution:** *Once the leaf springs are disconnected from the axle assembly, it's no longer stable. Have an assistant help balance the axle on the floor jack pad.*

13 On coil spring equipped vehicles, Disconnect the upper and or lower suspension arms from the axle assembly (see Chapter 10). **Caution:** *Once the suspension arms are disconnected from the axle assembly, it's no longer stable. Have an assistant help balance the axle on the floor jack pad.*

14 Slowly lower the axle assembly and wheel it out from under the vehicle.

Refitting

15 Refitting is the reverse of the removal procedure. When refitting the axle, make sure it's positioned properly. For fasteners with specified torque values, be sure they are tightened to the torque listed in the Chapter 8, 9 and 10 Specifications.

18 Pinion oil seal - renewal

Refer to illustrations 18.5, 18.6, 18.7a, 18.7b, 18.8, 18.9 and 18.10

1 A pinion shaft oil seal failure results in the leakage of differential gear lubricant past the seal and onto the driveshaft yoke or flange. The seal can be renewed without removing or disassembling the differential.

2 Raise the vehicle and support it securely on jackstands.

3 Drain the differential lubricant (see Chapter 1). After draining is complete, refit the drain plug and tighten it securely.

4 Disconnect the driveshaft from the pinion shaft yoke (see Section 13). Support the driveshaft out of the way with a piece of wire.

5 Using a kg-cm torque wrench, measure the torque required to move the pinion shaft within its backlash (break-loose torque This is the area of movement in which no movement of the ring gear or axles takes place). Record this figure, as it will be used to set the pinion shaft preload during refitting **(see illustration)**.

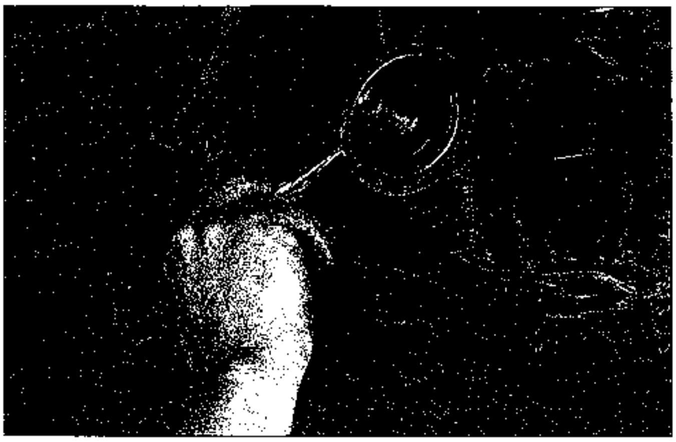
6 Mark the position of the companion flange nut to the pinion shaft **(see illustration)**.

7 Using a large screwdriver or lever acting on two bolts in the flange, hold the companion flange stationary, then remove the companion flange nut **(see illustration)**. Mark the relationship of the pinion shaft to the companion flange **(see illustration)**.

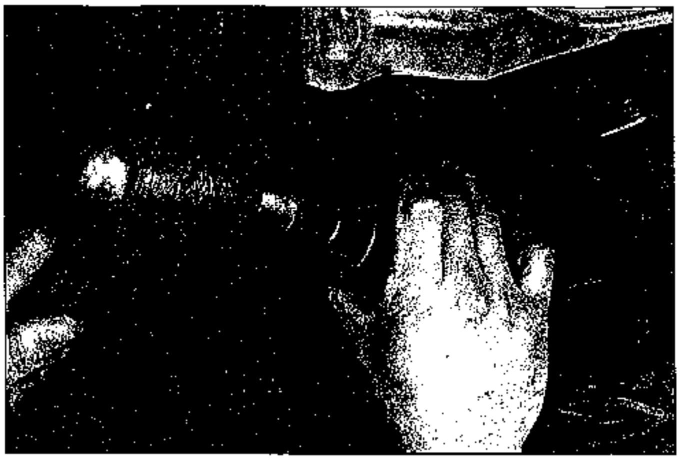
8 Remove the companion flange from the pinion shaft with a two-jaw puller **(see illustration)**.

9 Carefully prise the seal out of the differential with a screwdriver or seal puller. Be careful not to damage the splines on the pinion shaft **(see illustration)**.

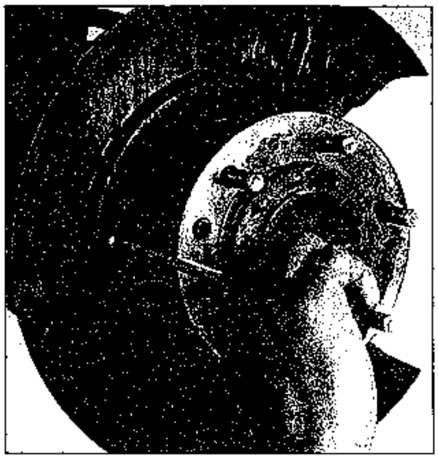
10 Lubricate the new seal lip with multi-purpose grease or differential lubricant and



18.9 It'll probably be necessary to drive the seal out with a hammer and punch - be careful not to damage the splines or threads on the pinion shaft



18.10 A hammer and a socket of the proper diameter can be used to drive the seal into place



19.3 There are outer screws securing the dust shield to the rear axle housing

19.5 Remove the bolts from the axle bearing housing . . .

19.6a . . . then carefully slide the axle out of the housing. Take care to not drag the axle over the seal as you do so

carefully refit it in position in the differential. Using a hammer and a seal driver, large socket or a short section of pipe of the proper diameter, carefully drive the seal into place **(see illustration)**.

11 Clean the sealing lip contact surface of the companion flange. Apply a thin coat of multi-purpose grease to the seal contact surface and the shaft splines. Slide the companion flange onto the shaft, making sure the match marks line up.

12 Coat the threads of the pinion shaft with multi-purpose grease. Refit a new nut and, holding the flange stationary, tighten the nut to the initial torque listed in this Chapter's Specifications. Turn the companion flange several times to seat the bearing.

13 Using a torque wrench, see how much torque is required to turn the pinion shaft within its backlash (break-loose torque). The desired preload is the previously recorded torque value plus 6 kg-cm. If the preload is less than desired, retighten the nut in small increments until the desired preload is reached. If the maximum torque on the pinion shaft nut (see this Chapter's Specifications) is reached before the desired preload is obtained, the bearing spacer must be renewed by a repair shop. **Note:** *Do not back-off the pinion nut to reduce the preload. After the preload is properly adjusted, proceed to the next Step.*

14 Connect the driveshaft to the companion flange (see Section 13).

15 Fill the differential with the recommended lubricant (see Chapter 1).

16 Lower the vehicle to the ground and test drive the vehicle. Check around the companion flange for evidence of leakage.

19 Rear axle bearing and seal (semi-floating) - removal and refitting

Refer to illustrations 19.3, 19.5, 19.6a, 19.6b, 19.7, 19.8, 19.9, 19.10a, 19.10b, 19.11 and 19.12

Axle assembly removal

1 The axleshafts can be removed without disturbing the differential assembly. They must be removed in order to renew the bearings and oil seals and when removing the differential carrier from the rear axle housing. **Note:** *Read the entire Section before starting work.*

2 Raise the rear of the vehicle and support it securely on jackstands. Block the front wheels to keep the vehicle from rolling.

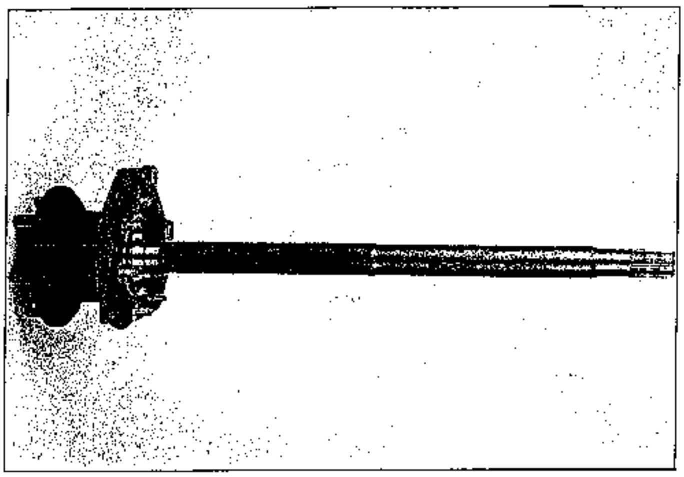
3 Remove the rear wheels, then remove the brake drum or disc brake caliper and rotor as well as the dust shield **(see illustration)** (see Chapter 9 for details). On drum brake models, disconnect the brake line from the wheel cylinder and plug the openings.

4 Remove the drain plug and drain the differential oil into a suitable container. When the draining is complete, tighten the drain plug in place.

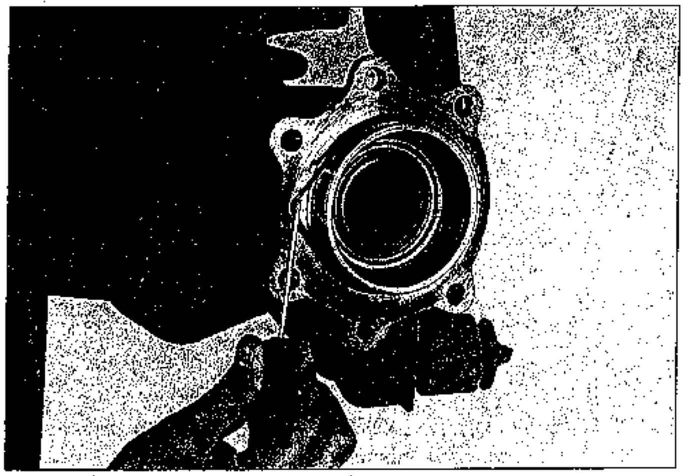
5 Remove the nuts from the axle retainer **(see illustration)**.

6 Use a slide hammer to pull the axle from the housing **(see illustrations)**. **Note:** *If a slide hammer is not available, it may be possible to temporarily refit a brake drum or rotor onto the end of the axle with the nuts loose. Grasp the drum or rotor and attempt to free the axle in this manner.*

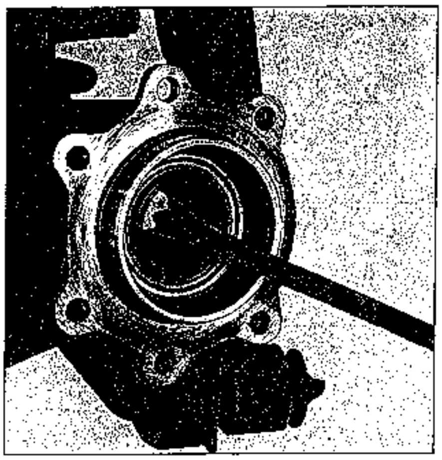
8



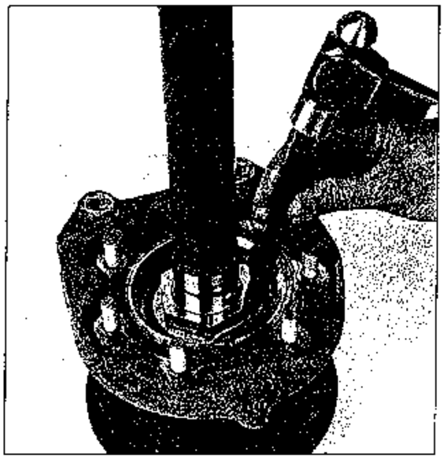
19.6b The axle bearing and seal can now be worked on



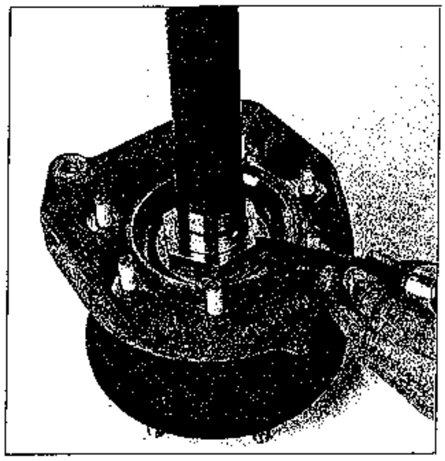
19.7 Disc brake models use an O-ring which should be renewed



19.8 the axle seal must be renewed if there are signs of leakage onto the brakes or on the backing plate



19.9 Flatten the lock washer with a hammer and drift



19.10a This nut is extremely tight. A special factory tool (ST38080001) is available to remove it, but a hammer and drift may work if it is not available

7 On disc brake models, remove the O-ring **(see illustration)**. On drum brake models, remove the shims and dust seal.

8 Use a screwdriver or lever to remove the housing oil seal **(see illustration)**.

Axle bearing

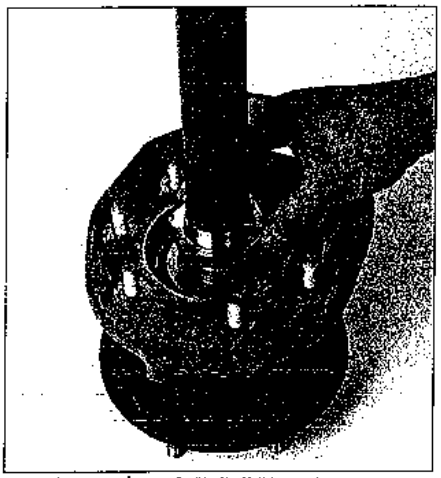
Renewal

9 Flatten the nut washer with a screwdriver and hammer **(see illustration)**.

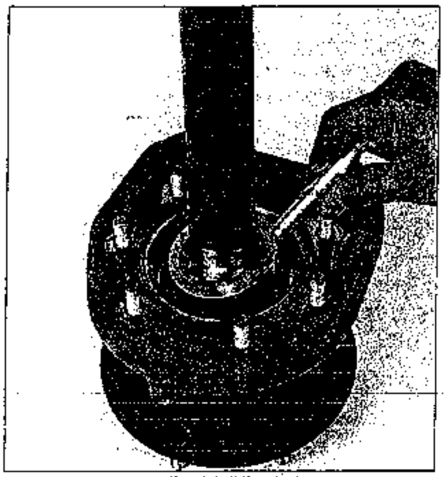
10 Use a hammer and drift to loosen and then remove the bearing nut **(see illustrations)**. It is extremely tight.

11 Remove the lock washer **(see illustration)**.

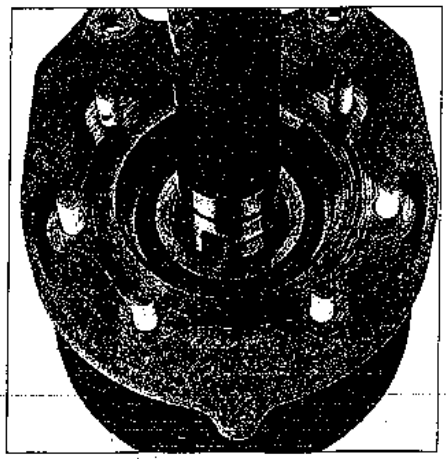
12 Take the axle to a shop equipped with a



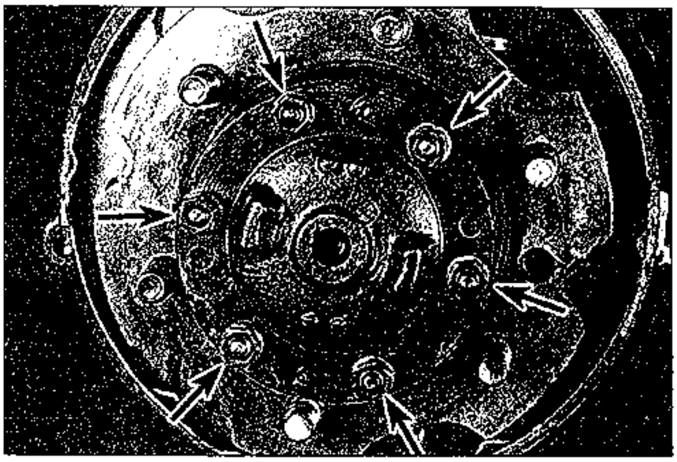
19.10b Remove the nut from the axle . . .



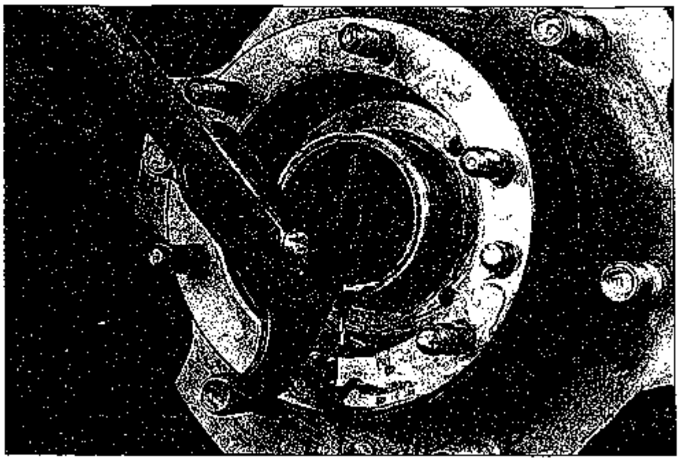
19.11 . . . then remove the lock washer



19.12 The bearing will have to be removed with a hydraulic press



20.3 Remove the axle flange retaining nuts (arrows)



20.4 Use a hook shaped seal puller to prise out the oil seal

hydraulic press and the proper press plates to have the bearing housing pressed off of the axle **(see illustration)**.

13 Drive the bearing(s) and the outer race from the housing and renew the components as necessary. A new race can be driven into place with a hammer and a brass drift.

14 Apply grease to the bearing and race. On all models, renew the seal and refit it after the spacer.

15 Refitting is the reverse of removal. Tighten the fasteners to the torques listed in this Chapter's specifications. Unless special equipment is available, simply tighten the axle bearing nut with a hammer and drift as much as possible, then secure it with a new locking washer. Check the bearing for smooth operation - it must turn easily by hand.

Refitting

Disc brake models

16 Refer to the beginning of this Chapter for the torque specifications, then refit the components in the reverse order of removal. Renew the O-rings.

17 Be very careful to not allow the axle to contact the seal when sliding it into place. Fill the rear axle with the lubricant specified in Chapter 1.

Drum brake models

18 Refit the backing plate for the brake assembly. Connect the brake line.

19 Put a new dust seal onto the bearing housing and refit the axle. Be very careful to not allow the axle to contact the seal when sliding it into place. **Note:** *This is only a temporary refitting to check endplay.*

20 Tighten the axle retaining nuts to the torque listed in this Chapter's Specifications.

21 Remove the opposite axle if it was not already removed. Renew the dust seal and place a stack of shims on it equal to 1.6 mm. (The shims fit between the dust seal and the main axle housing - not outboard of the dust seal). Refit that axle as well and tighten the axle retaining nuts until contact is made or the axle binds. Do not overtighten the nuts.

22 Attach a dial indicator to the axle housing and measure axle endplay.

23 Refit the necessary shim stack on the axle with no shims in order to achieve endplay of 0.02 to 0.15 mm. **Note:** *There must be a relatively equal amount of shims on each axle. There should not be a shim stack difference of more than 1 mm.*

24 After all the shims are refitted, check the axle endplay again to verify all measurements.

25 Refitting of the remaining components is the reverse of removal. On drum brake models, bleed the brakes (refer to Chapter 9).

20 Rear axle and wheel bearing (full-floating) - removal and refitting

Refer to illustrations 20.3 and 20.4

1 Raise the vehicle and support it securely with jackstands.

2 Remove the wheel. Drain the lubricant from the rear axle housing.

3 Remove the outer bolts and remove the axle shaft **(see illustration)**.

4 Remove the oil seal, O-ring and lock washer (with its screw) from the end of the bearing housing **(see illustration)**.

5 Use a special factory tool KV40104600 or its equivalent to loosen and remove the round lock-nut.

6 Remove the wheel bearing and hub assembly. Do not allow the outer bearing to fall.

7 Remove the inner bearing outer race, the grease seal and the outer wheel bearing race.

8 Use a hammer and a brass drift to drive out the other races. New races can be refitted with a large socket or a brass drift and a hammer. Make sure to pack the inside of the bearing housing and the bearings with grease prior to assembly.

9 Renew the grease seal, carefully driving it into the housing with a hammer. It should be marked as to the bearing side.

10 Position the bearing and hub assembly on the axle housing. Screw the round lock-nut into place.

11 Tighten the lock-nut to the torque listed in this Chapter's Specifications using the correct tool or its equivalent. Rotate the hub several times.

12 Loosen the nut completely and then tighten it to 4 Nm.

21 Rear locking differential - general information

1 Some vehicles are equipped with a locking differential. This type of mechanism is different from a conventional differential and a limited slip differential in that both rear wheels are solidly locked when the unit is energised.

2 A switch in the vehicle operates two vacuum solenoids which direct engine vacuum to the operator on the rear axle housing. This device moves a shift fork inside the differential to lock the rear wheels. **Note:** *Operate the differential lock switch only when the vehicle is stopped.*

3 Internal repair of the differential should be left to a well-equipped shop. However, if the unit is not functioning, check the external components of the system as follows.

4 Inspect all vacuum lines from the engine compartment to the rear axle for damage. Check the vacuum solenoids for obvious leaks. Starting at the engine compartment and with the engine idling, disconnect vacuum connections until a point of zero vacuum is located. The leak will be on the upstream side of this point.

5 Check the operating unit on the rear axle housing for signs of vacuum leaks or other damage. The unit can be removed from the axle housing and renewed or rebuilt if necessary.

Notes

Chapter 9 Brakes

Contents

Specifications

General

Brake fluid type	See Chapter 1
Power brake booster pushrod from firewall surface protrusion	10.275 to 10.525 mm

Disc brakes

Brake pad thickness	
Front	
Standard	11.5 mm
Minimum	3.0 mm
Rear	
Standard	11.0 mm
Minimum	2.0 mm
Disc runout (front and rear)	0.15 mm
Front disc thickness*	
Petrol	
Standard	20 mm
Minimum	18 mm
Diesel	
Standard	26 mm
Minimum	24 mm
Disc runout, maximum	0.07 mm
Rear disc thickness (all models with rear disc brakes)*	
Standard	18 mm
Minimum	16 mm
Caliper bore	
Front	68.1 mm
Rear	51.1 mm

Drum brakes

Shoe thickness	
Standard	6.1 mm
Minimum	1.5 mm
Drum inside diameter*	
Standard	295 mm
Maximum	296.5 mm
Drum out-of-round, maximum	0.03 mm
Drum runout, maximum	0.05 mm
Wheel cylinder bore	25.4 mm

***Note:** *If different specifications are cast into the disc or drum, they supersede information printed here.*

Parking brake

Drum diameter	
Standard	203.2 mm
Maximum	204.5 mm
Drum out-of-round, maximum	0.03 mm
Drum runout, maximum	0.05 mm
Shoe lining thickness	
Standard	5.1 mm
Minimum	1.5 mm
Lever travel with normal force	7 to 9 notches
Pedal height and freeplay	See Chapter 1

***Note:** *If different specifications are cast into the disc or drum, they supersede information printed here.*

Torque specifications

	Nm
Caliper anchor bolts	
Front	72 to 97
Rear	38 to 52
Caliper fitting banjo bolt	17 to 20
Disc brake caliper guide pin bolts	
Front caliper	22 to 31
Rear caliper	31 to 41
Load sensing valve bolts	8 to 11
Master cylinder-to-brake booster nuts	
Models prior to 8/95	8 to 11
Models from 8/95	12 to 15
Parking brake backing plate bolts	42 to 52
Pedal pivot nut	8 to 11
Power brake booster mounting nuts	
Models prior to 8/95	8 to 11
Models from 8/95	13 to 16
Rear backing plate bolts	50 to 68
Rotor (front) bolts	50 to 68
Tubing nuts	15 to 18
Wheel cylinder mounting bolts	6 to 7

1 General information

The vehicles covered by this manual are equipped with hydraulically operated front and rear brake systems. The front brakes are all disc type. Rears may be drum or disc. Both the front and rear brakes are self adjusting. The disc brakes automatically compensate for pad wear, while the rear drum brakes (if equipped) incorporate an adjustment mechanism which is activated as the brakes are operated.

Hydraulic system

The hydraulic system consists of two separate circuits. The master cylinder is designed for the split system and incorporates a primary piston for one circuit and a secondary piston for the other, and, in the event of a leak or failure in one hydraulic circuit, the other circuit will remain operative. A load sensing valve adjusts brake fluid pressure to the rear brakes according to how much weight is in the rear of the vehicle.

Power brake booster

The power brake booster, utilising engine manifold vacuum and atmospheric pressure to provide assistance to the hydraulically operated brakes, is mounted on the firewall in the engine compartment.

Parking brake

The parking brake operates on the rear of the transmission. It is activated by the parking brake lever which is mounted on the console.

Service

After completing any operation involving disassembly of any part of the brake system, always test drive the vehicle to check for proper braking performance before resuming normal driving. When testing the brakes, perform the tests on a clean, dry, flat surface. Conditions other than these can lead to inaccurate test results.

Test the brakes at various speeds with both light and heavy pedal force. The vehicle should stop evenly without pulling to one side or the other. Avoid locking the brakes, because this slides the tyres and diminishes braking efficiency and control of the vehicle.

Tyres, vehicle load and wheel alignment are factors which also affect braking performance.

2 Disc brake pads - renewal

Refer to illustrations 2.5 a through 2.5n

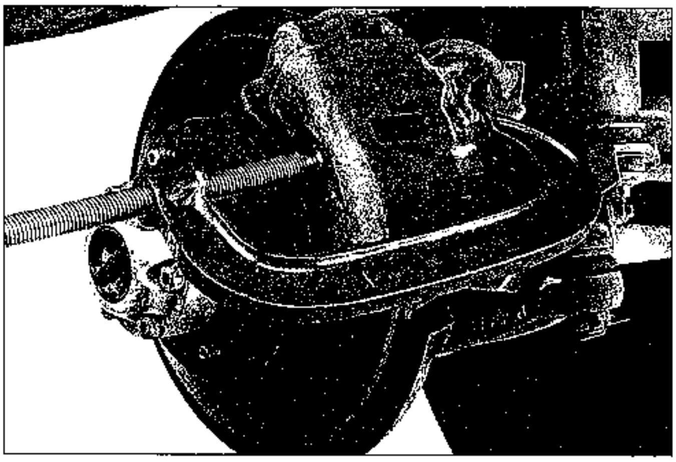
Warning: *Disc brake pads must be renewed on both front or rear wheels at the same time - never renew the pads on only one wheel. Also, the dust created by the brake system may contain asbestos, which is harmful to your health. Never blow it out with compressed air and don't inhale any of it. An approved filtering mask should be worn when working on the brakes. Do not, under any circumstances, use petroleum-based solvents to clean brake parts. Use brake cleaner or denatured alcohol only! When servicing the disc brakes, use only high-quality, brand-name pads.*

Note: *This procedure applies to both the front and rear disc brakes.*

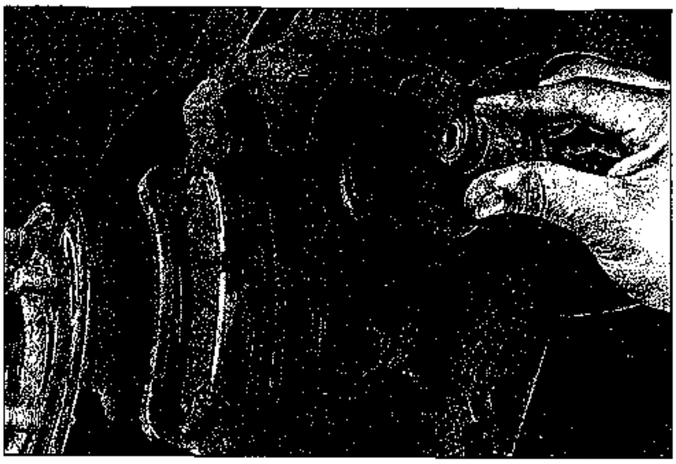
1 Remove the cap from the brake fluid reservoir.

2 Loosen the wheel lug nuts, raise the front or rear of the vehicle and support it securely on jackstands. Block the wheels at the opposite end and set the parking brake.

3 Remove the wheels. Work on one brake assembly at a time, using the assembled



2.5a Use a large C-clamp to compress the piston back into its bore



2.5b Remove the lower guide pin bolt to swing the caliper up out of the way . . .

2.5c . . . or remove both bolts to remove the caliper completely

2.5d If you decide to remove the caliper completely, hang it from a wire like this to avoid having its weight stretch the hose

brake for reference if necessary.

4 Inspect the brake disc carefully as outlined in Section 4. If machining is necessary, follow the information in that Section to remove the disc, at which time the pads can be removed as well.

5 Follow the accompanying photos **(see illustrations)** for the actual pad renewal procedure. Most of the illustrations are of a front brake job, but the rear procedure is identical. Be sure to stay in order and read the caption under each illustration.

Note 1: *As the caliper piston is depressed to the bottom of the caliper bore, the fluid in the master cylinder will rise. Make sure that it doesn't overflow. Check it and, if necessary, siphon off some of the fluid.*

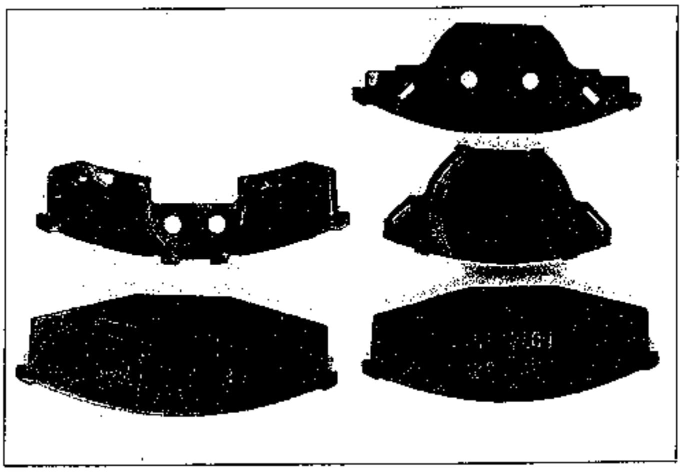
Note 2: *Be sure to transfer the wear indica-*

2.5e Lift out the outer pad . . .

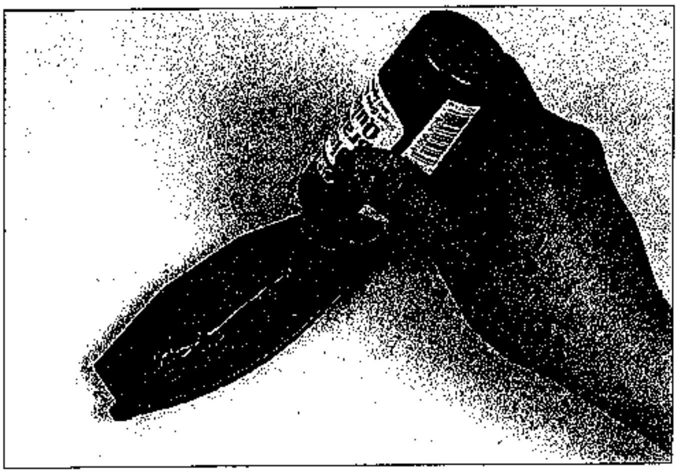
2.5f . . . and then the inner pad

2.5g Take out the lower pad retainer clip . . .

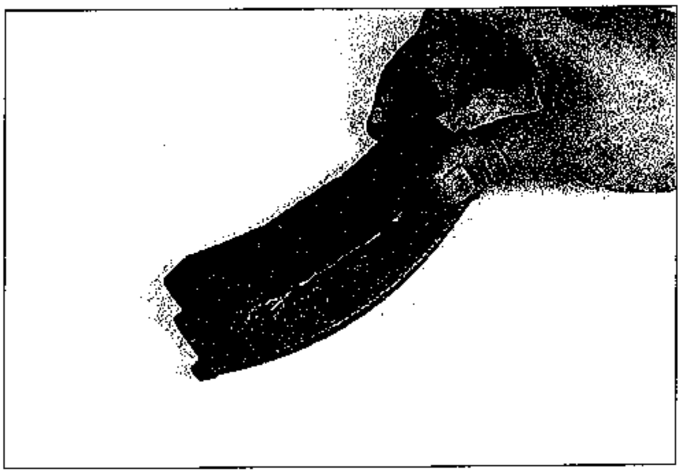
2.5h ... and the upper retainer



2.5I Note that the outer pad uses one shim and the inner pad uses a shim and a shim cover



2.5j Apply anti-squeal to the outside of the outer pad ...



2.5k ... and then refit the outer shim to it

tors from the old brake pads onto the new pads. If they are worn or bent, renew them.

6 When refitting the caliper, be sure to tighten the mounting bolts to the torque listed in this Chapter's Specifications. **Warning:** *After the job has been completed, firmly depress the brake pedal a few times to bring the pads into contact with the disc. The brakes will not operate until this is done.* Check the level of the brake fluid, adding some if necessary. Check the operation of the brakes carefully before placing the vehicle into normal service.

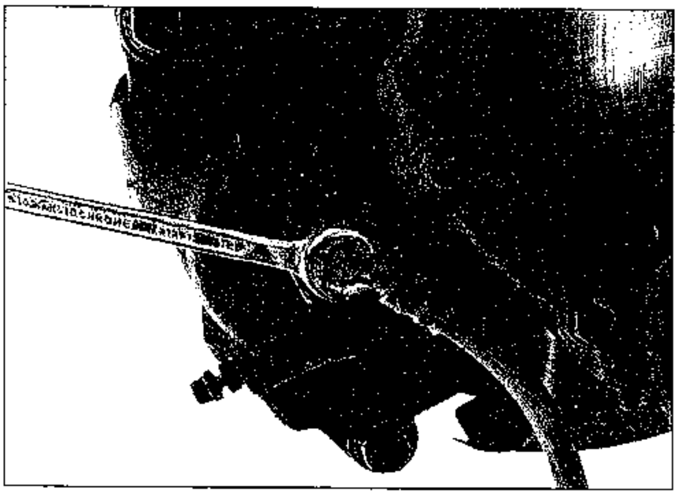
3 Disc brake caliper - removal, overhaul and refitting

Warning: *Dust created by the brake system may contain asbestos, which is harmful to your health. Never blow it out with com-*

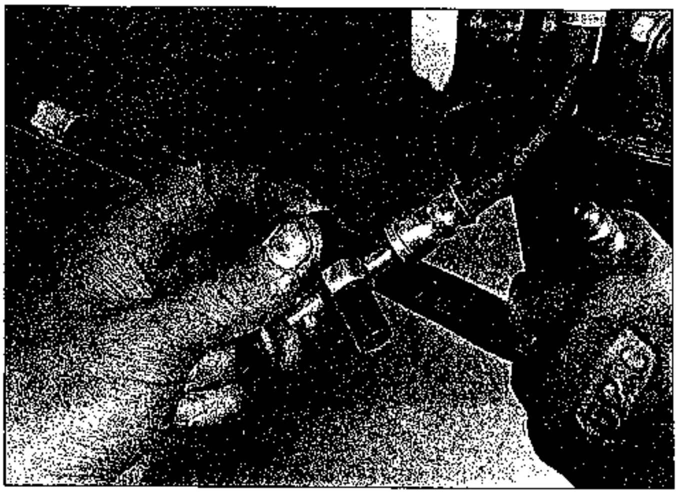
2.5I Apply anti-squeal to the outside of the inner pad ...

2.5m ... followed by the inner pad shim ...

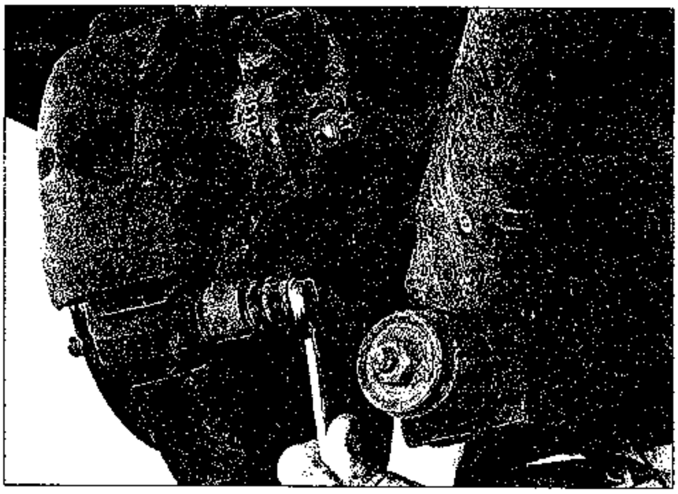
2.5n ... and the small shim cover. Reverse the removal procedure to refit the brake components



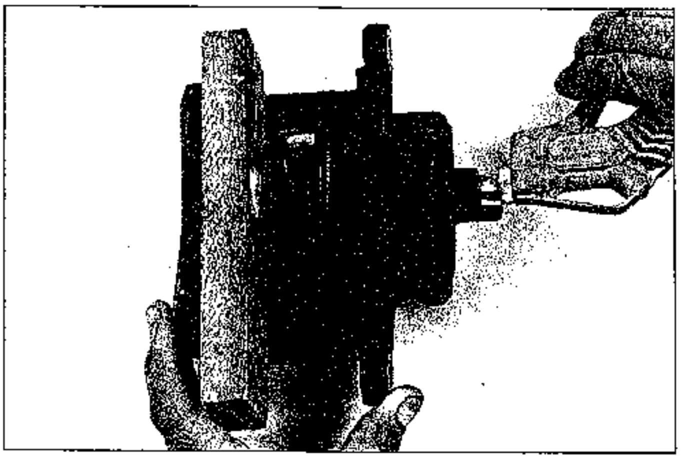
3.1 Remove the banjo fitting bolt from the brake line



3.2 Using a piece of rubber hose of the appropriate size, plug the brake line



3.3 Remove the caliper mounting bolts



3.5a With the caliper padded to catch the piston, use compressed air to force the piston out of its bore - make sure your hands or fingers are not between the piston and caliper

pressed air and don't inhale any of it. An approved filtering mask should be worn when working on the brakes. Do not, under any circumstances, use petroleum-based solvents to clean brake parts. Use brake cleaner or denatured alcohol only!

Note 1: *If an overhaul is indicated (usually because of fluid leakage), explore all options before beginning the job. New and factory rebuilt calipers are available on an exchange basis, which makes this job quite easy. If it's decided to rebuild the calipers, make sure a rebuild kit is available before proceeding. Always rebuild the calipers in pairs - never rebuild just one of them.*

Note 2: *This procedure is illustrated with a single piston type caliper. The procedures are the same for the dual piston type. This procedure applies to both the front and rear disc brakes.*

Removal

Refer to illustrations 3.1, 3.2 and 3.3

1 Remove the bolt and disconnect the brake hose from the caliper **(see illustration)**.

2 Plug the brake hose to keep contaminants out of the brake system and to prevent losing any more brake fluid than is necessary **(see illustration)**.

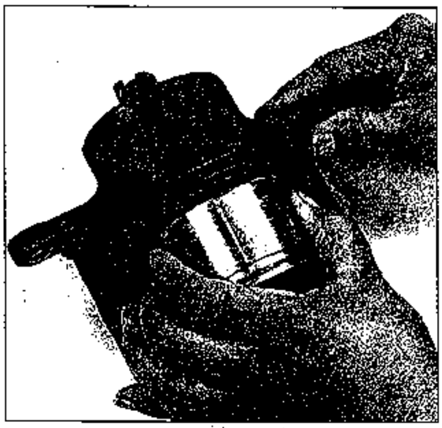
3 Slightly depress the piston (refer to Section 2), remove the upper and lower guide pin bolts and remove the caliper **(see illustration)**.

Overhaul

Refer to illustrations 3.5a, 3.5b, 3.7a, 3.7b, 3.11 and 3.12

4 Before you remove the piston, place a wood block between the piston and caliper to prevent damage as it is removed.

5 To remove the piston from the caliper, apply compressed air to the brake fluid hose connection on the caliper body **(see illustrations)**. Use only enough pressure to ease the piston out of its bore. **Warning:** *Be careful not to place your fingers between the piston and the caliper as the piston will come out with some force.*

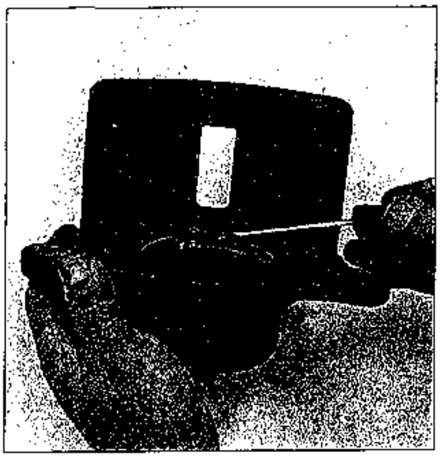


3.5b Slip the piston completely out and then inspect the bore and the piston

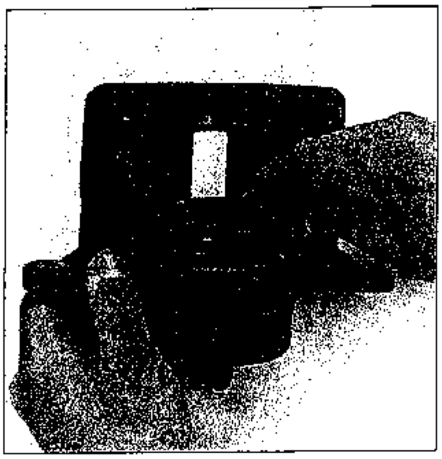
6 Inspect the mating surfaces of the piston and caliper bore wall. If there is any scoring, rust, pitting or bright areas, renew the complete caliper unit.

7 If these components are in good condi-

3.7a The dust boot can now be removed. Some calipers use a clip to retain the boot - remove it first



3.7b The piston seal should be removed with a plastic or wooden tool to avoid damage to the bore and seal groove - a pencil will do the job



3.11 Refit the seal into the bore and then press the dust boot into its groove

tion, remove the dust boot along with its retainer (if used), and the piston seal from the caliper bore using a wooden or plastic tool **(see illustrations)**. Metal tools may damage the cylinder bore.

8 On single piston type calipers, push the sliding bushes out of the torque plate and remove the dust boots from both ends.

9 Wash all the components in clean brake fluid or brake cleaner.

10 Submerge the new piston seal and the piston in brake fluid and refit the seal into the caliper bore.

11 Refit the new piston dust boot **(see illustration)**. Refit the dust boot retaining ring (rear brakes only).

12 Refit the piston. Do not force the piston into the bore, but make sure that it is squarely in place, then apply firm (but not excessive) force to refit it **(see illustration)**.

13 On single piston type calipers, apply silicone-based grease (supplied with the rebuild kit) to the sliding pins and the bushes. Refit the dust boots.

Refitting

14 Refit the caliper by reversing the removal procedure. Remember to renew the copper sealing washers (gaskets) at the brake hose-to-caliper connection (new washers normally come with the rebuild kit).

15 Bleed the brake circuit according to the procedure in Section 9. Make sure there are no leaks from the hose connections. Test the brakes carefully before returning the vehicle to normal service. **Note:** *The manufacturer recommends that the amount of torque required to rotate the disc be checked after final assembly to ensure that there is not a binding condition in the guide pins which could be preventing the caliper assembly from releasing completely. It is good practice to simply disassemble the sliding hardware (pins, bolts and boots), clean all the components and renew any parts that require it. Lubricate all the sliding components with high temperature brake grease before reassembly. Make sure that the sliding mechanism operates freely before refitting the caliper. This will eliminate binding calipers and dragging brakes.*

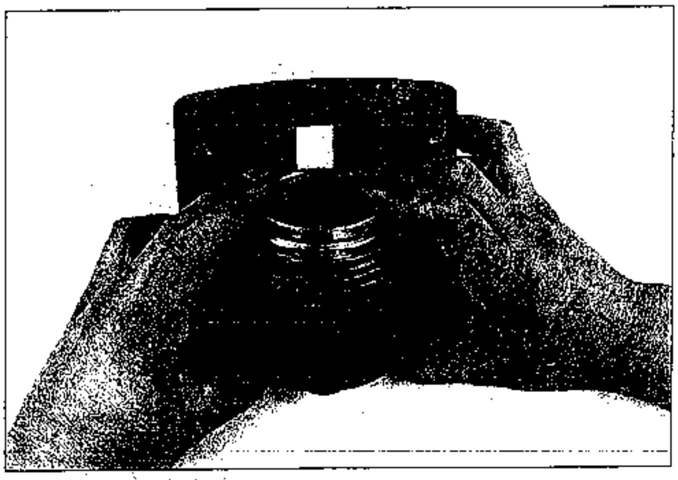
4 Brake disc - inspection, removal and refitting

Inspection

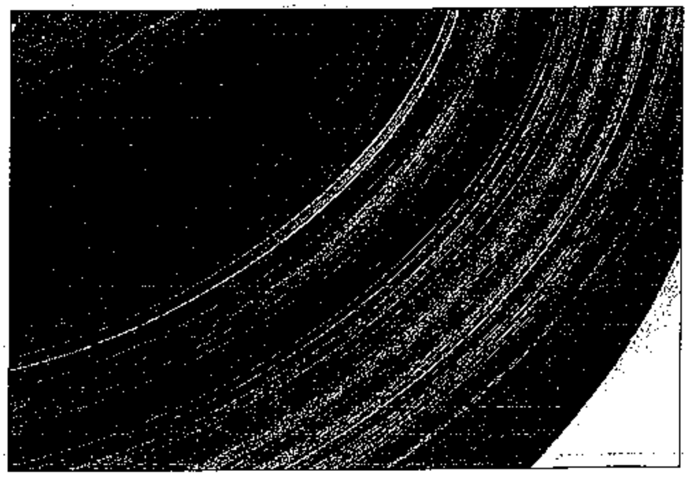
Refer to illustrations 4.3, 4.4a, 4.4b, 4.5a and 4.5b

1 Loosen the wheel lug nuts, raise the vehicle and support it securely on jackstands. Remove the wheel and refit two or three lug nuts to hold the disc in place (on rear brakes only). If the rear brake disc is being worked on, release the parking brake.

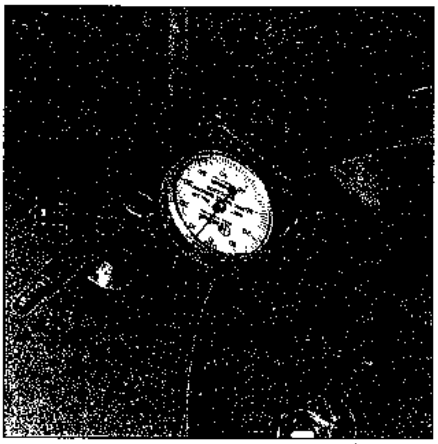
2 Slightly depress the caliper piston with a C-clamp (refer to Section 2), remove the caliper mounting bolts and remove the caliper **(refer to Section 3)**. It isn't necessary to disconnect the brake hose. After removing the caliper bolts, suspend the caliper out of



3.12 Lubricate all of the components with special brake system lubricant or brake fluid and then refit the piston through the dust boot and into the seal and bore



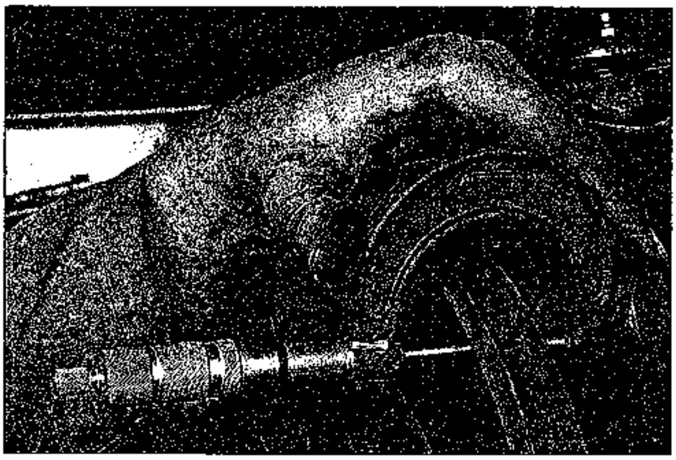
4.3 The brake pads on this vehicle were obviously neglected, as they wore down to the rivets and cut deep grooves into the disc - wear this severe will require renewal of the disc



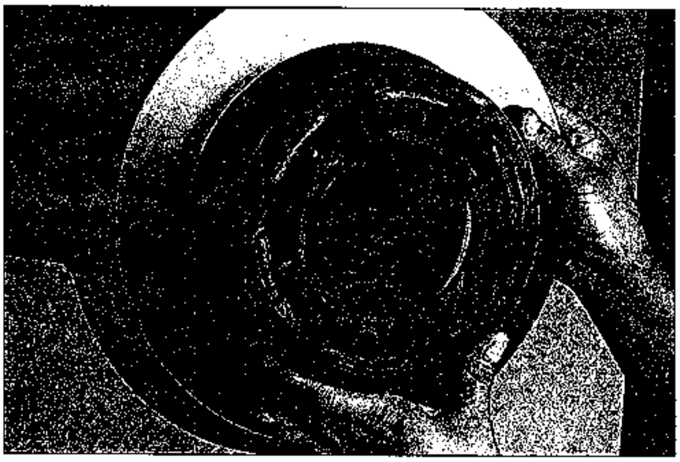
4.4a Use a dial indicator to check disc runout - if the reading exceeds the maximum allowable runout limit, the disc will have to be machined or renewed

4.4b Using a swirling motion, remove the glaze from the disc surface with sandpaper or emery cloth

4.5a The minimum wear dimension is cast into the disc. It is not permissible to machine the disc smaller than this figure



4.5b Use a micrometer to measure disc thickness



4.11 After the rear caliper has been removed, the disc can be slipped off

the way with a piece of wire.

3 Visually inspect the disc surface for score marks and other damage. Light scratches and shallow grooves are normal after use and may not always be detrimental to brake operation, but deep scoring - over 1.0 mm - requires disc removal and refinishing by an automotive machine shop. Be sure to check both sides of the disc **(see illustration)**. If pulsating has been noticed during application of the brakes, suspect excessive disc runout.

4 To check disc runout, place a dial indicator at a point about 12 mm from the outer edge of the disc **(see illustration)**. Set the indicator to zero and turn the disc. The indicator reading should not exceed the specified allowable runout limit. If it does, the disc should be refinished by an automotive machine shop. **Note:** *It is a good practice to have the discs resurfaced regardless of the dial indicator reading, as this will impart a smooth finish and ensure a perfectly flat surface, eliminating any brake pedal pulsation or other undesirable symptoms related to questionable discs. At the very least, if you elect not to have the discs resurfaced, remove the glaze from the surface with emery cloth using a swirling motion* **(see illustration)**.

5 It's absolutely critical that the disc not be machined to a thickness under the specified minimum allowable disc refinish thickness. The minimum wear (or discard) thickness is cast into the disc **(see illustration)**. The disc thickness can be checked with a micrometer **(see illustration)**.

Renewal

Front brakes

6 Refer to Chapter 8 and remove the hub assembly.

7 Remove the bolts which secure the disc to the hub.

8 Refitting is the reverse of removal. Tighten the fasteners to the torque listed in this Chapter's specifications.

9 Adjust the pre-load of the front wheel bearings (refer to Chapter 8).

Rear brakes

Refer to illustration 4.11

10 Remove the caliper anchor plate (refer to Section 3).

11 Lift the disc from the axle **(see illustration)**.

12 Refitting is the reverse of removal. Refit the caliper and tighten the mounting bolts to the specified torque.

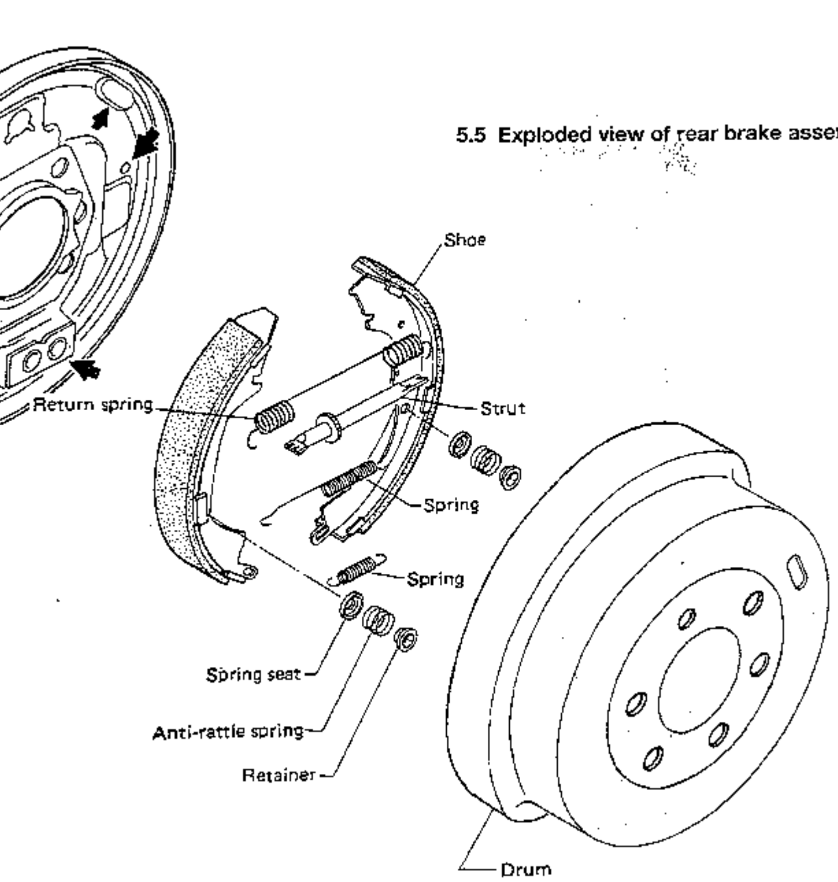
Front and rear brakes

13 Refit the wheel, then lower the vehicle to the ground. Tighten the lug nuts to the torque listed in the Chapter 1 Specifications. Depress the brake pedal a few times to bring the brake pads into contact with the disc. Bleeding won't be necessary unless the brake hose was disconnected from the caliper. Check the operation of the brakes carefully before driving the vehicle.

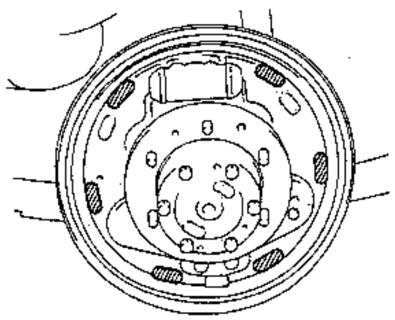
5 Drum brake shoes - renewal

Refer to illustrations 5.5, 5.13 and 5.14

Warning: *Drum brake shoes must be renewed on both wheels at the same time - never renew the shoes on only one wheel. Also, the dust created by the brake system*

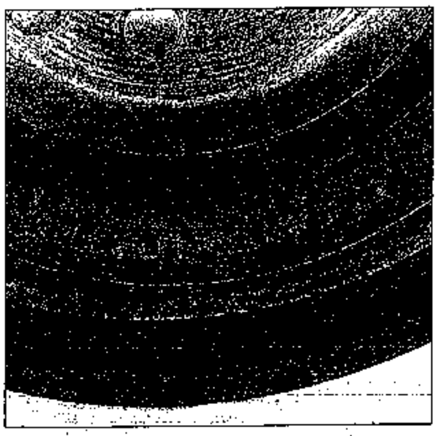


5.5 Exploded view of rear brake assembly



5.13 Lubricate the brake shoe contact points on the backing plate

may contain asbestos, which is harmful to your health. Never blow it out with compressed air and don't inhale any of it. An approved filtering mask should be worn when working on the brakes. Do not, under any circumstances, use petroleum-based solvents



5.14 The maximum brake drum diameter is cast directly into it

to clean brake parts. Use brake cleaner or denatured alcohol only!

Caution: *Whenever the brake shoes are renewed, the return and hold-down springs should also be renewed. Due to the continuous heating/cooling cycle the springs are subjected to, they lose tension over a period of time and may allow the shoes to drag on the drum and wear at a much faster rate than normal. When renewing the brake shoes, use only high-quality, brand-name parts.*

1 Loosen the wheel lug nuts, raise the front or rear of the vehicle and support it securely on jackstands. Block the wheels at the opposite end to keep the vehicle from rolling.

2 Release the parking brake.

3 Remove the wheels and brake drums. If the brake drums cannot be easily pulled off the axle and shoe assembly, apply some penetrating oil at the hub-to-drum joint. Allow the oil to soak in and try to pull the drum off. Insert two M8 x 1.25 bolts into the threaded holes in the brake drum and tighten them gradually. **Note:** *Before removing anything, clean the brake assembly with brake cleaner and allow it to dry - position a drain pan under the brake to catch the fluid and residue -* **Do not use compressed air to blow the dust from the parts!**

4 Always leave one brake assembly intact so that you can refer to it if necessary. Never disassemble both rear brakes at the same time.

5 Remove the shoe hold-down retainers, springs, seats and pins **(see illustration)**.

6 Remove the spring from the bottom of the shoes.

7 Pull the shoes apart at the top and remove them from the backing plate.

8 Disassemble the adjuster and spring from the shoes.

9 Remove the adjuster bracket from the top of the shoe.

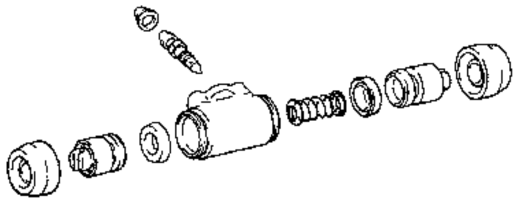
10 Clean all components including the backing plate thoroughly. Examine all components including the springs and adjuster for wear. Renew any worn parts.

11 Inspect the wheel cylinder for signs of leakage by carefully pulling back the dust boots.

12 Refitting is the reverse of removal.

13 Apply a small amount of brake grease to the wear surfaces of the backing plate and to the adjuster mechanism **(see illustration)**.

14 Before refitting the drum, it should be checked for cracks, score marks, deep scratches and hard spots, which will appear as small discoloured areas. If the hard spots cannot be removed with fine emery cloth or if any of the other conditions listed above exist, the drum must be taken to an automotive machine shop to be turned. **Note:** *Professionals recommend resurfacing the drums*



6.7 An exploded view of the wheel cylinder

each time a brake job is done. Resurfacing will eliminate the possibility of out-of-round drums. If the drums are worn so much that they can't be resurfaced without exceeding the maximum allowable diameter (cast into the drum), then new ones will be required **(see illustration)**. *At the very least, if you elect not to have the drums resurfaced, remove the glaze from the surface with emery cloth using a swirling motion.*

15 Refit the brake drum on the axle flange and check the preliminary brake adjustment. If the brake drum fits loosely over the shoes, remove the drum again and rotate the adjuster until the brake drum just barely slides over the brake shoes.

16 Mount the wheel, refit the lug nuts, then lower the vehicle.

17 Make a number of forward and reverse stops to adjust the brakes until satisfactory pedal action is obtained.

18 Check the operation of the brakes carefully before driving the vehicle.

6 Wheel cylinder - removal, overhaul and refitting

Note: *If an overhaul is indicated (usually because of fluid leaks or sticky operation), explore all options before beginning the job. New wheel cylinders are available, which makes this job quite easy. If it is decided to rebuild the wheel cylinder, make sure a rebuild kit is available before proceeding. Never overhaul only one wheel cylinder - always rebuild both of them at the same time.*

Removal

1 Raise the rear of the vehicle and support it securely on jackstands. Block the wheels at the front to keep the vehicle from rolling.

2 Remove the brake shoe assembly (see Section 5).

3 Remove all dirt and foreign material from around the wheel cylinder.

4 Disconnect the brake line with a flare-nut spanner, if available. Don't pull the brake line away from the wheel cylinder.

5 Remove the wheel cylinder mounting bolts.

6 Detach the wheel cylinder from the brake backing plate and place it on a clean workbench. Immediately plug the vehicle brake line to prevent fluid loss and contamination.

Overhaul

Refer to illustration 6.7

7 Remove the bleeder screw, cups, pistons, boots and spring assembly from the wheel cylinder body **(see illustration)**.

8 Clean the wheel cylinder with brake fluid, denatured alcohol or brake system cleaner. **Warning:** *Do not, under any circumstances, use petroleum-based solvents to clean brake parts!*

9 Use compressed air to dry the wheel cylinder and blow out the passages.

10 Check the bore for corrosion and score marks. Crocus cloth or a brake cylinder hone can be used to remove light corrosion and stains, but the cylinder must be renewed if the defects cannot be removed easily, or if the bore is scored.

11 Lubricate the new cups with brake fluid.

12 Assemble the brake cylinder components. Make sure the cup lips face in.

Refitting

13 Place the wheel cylinder(s) in position and refit the bolts finger tight. Connect the brake line to the cylinder, being careful not to cross-thread the fitting. Tighten the wheel cylinder bolts to the torque listed in this Chapter's Specifications.

14 Tighten the brake line and refit the brake shoe assembly.

15 Bleed the brakes (see Section 9).

16 Check the operation of the brakes carefully before driving the vehicle.

7 Master cylinder - removal, overhaul and refitting

Note: *Before deciding to overhaul the master cylinder, check on the availability and cost of a new or factory rebuilt unit and also the availability of a rebuild kit.*

Removal

Refer to illustrations 7.4 and 7.6

1 The master cylinder is located in the engine compartment, mounted on the power brake booster.

2 Remove as much fluid as possible from the reservoir with a syringe.

3 Place rags under the fittings and prepare caps or plastic bags to cover the ends of the lines once they're disconnected. **Caution:** *Brake fluid will damage paint. Cover all body parts and be careful not to spill fluid during this procedure.*

7.4 Completely loosen the brake line fittings at the master cylinder, but don't bend the lines out of the way

4 Loosen the fittings at the ends of the brake lines where they enter the master cylinder **(see illustration)**. To prevent rounding off the flats, use a flare-nut spanner, which wraps around the fitting hex.

5 Pull the brake lines away from the master cylinder and plug the ends to prevent contamination.

6 Disconnect the electrical connector at the master cylinder **(see illustration)**, then remove the nuts attaching the master cylinder to the power booster. Pull the master cylinder off the studs to remove it. Again, be careful not to spill the fluid as this is done.

Overhaul

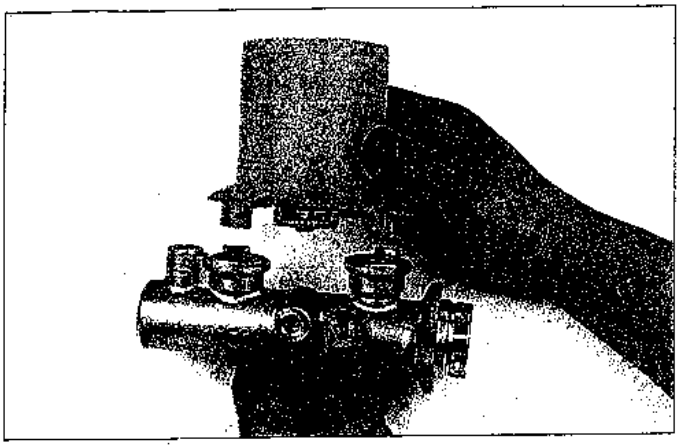
Refer to illustrations 7.8a, 7.8b, 7.9, 7.10a, 7.10b, 7.10c, 7.12a and 7.12b

7 **Note:** *Before attempting the overhaul of the master cylinder, obtain the proper rebuild kit, which will contain the necessary replacement parts and also any instructions which may be specific to your model.*

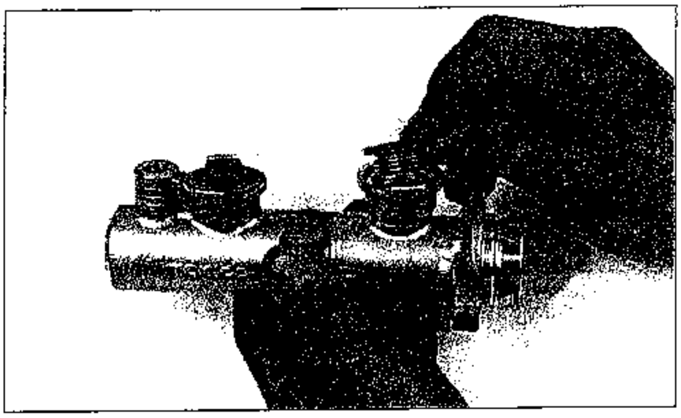
8 Remove the reservoir by carefully but

7.6 Disconnect the wiring from the unit

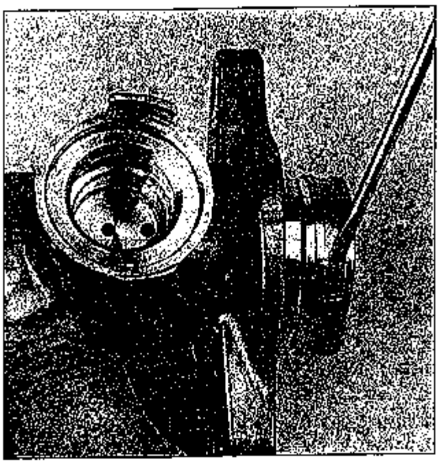
9



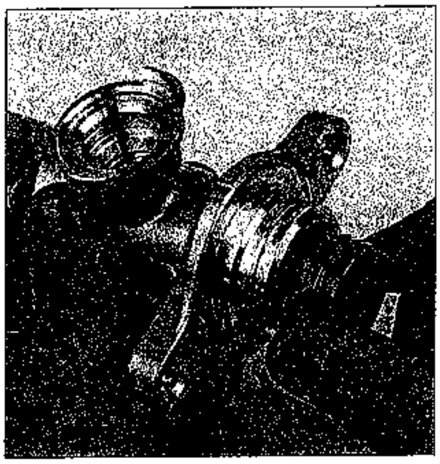
7.8a The master cylinder should be mounted carefully in a vise before attempting to remove the reservoir



7.8b After the reservoir has been removed, pull the grommets from the master cylinder body. If they are hardened, damaged or appear to have been leaking, renew them



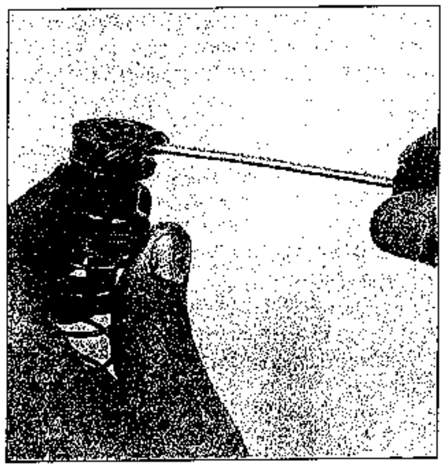
7.9 Straighten the lock tabs - if they are not in good condition, renew the end cap



7.10a Draw out the primary piston assembly

7.10b If necessary, tap the master cylinder on a block of wood to release the secondary piston assembly

7.10c Pull out the secondary piston assembly. Lay out the parts in order as you remove them



7.12a Renew all of the rubber components with the new items in the overhaul kit. Make certain that they are refitted facing the proper direction

forcefully levering it upwards. Inspect the reservoir grommets for indications of leakage near the base of the reservoir **(see illustrations)**.

9 Use a small screwdriver to straighten the locking tabs on the end cap **(see illustration)**. Pull the end cap off.

10 The internal components can now be removed from the bore **(see illustrations)**. Make a note of the proper order of the components so they can be returned to their original locations.

11 Carefully inspect the bore of the master cylinder. Any deep score marks or other damage will mean a new master cylinder is required. DO NOT attempt to hone the bore.

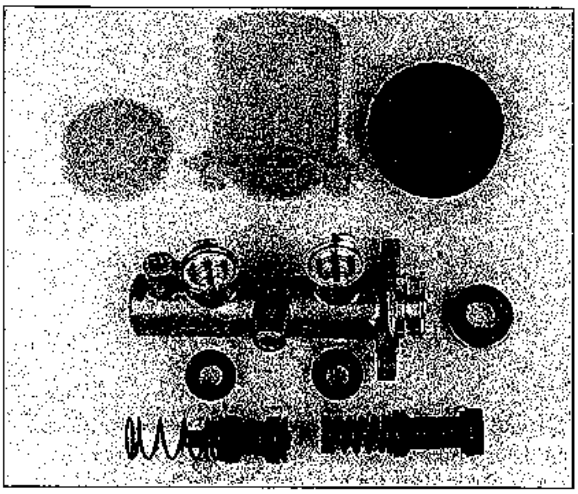
12 Renew all parts included in the rebuild kit, following any instructions in the kit **(see illustrations)**. Clean all reused parts with new brake fluid, brake system cleaner or denatured alcohol. **Warning:** *Do not use any petroleum-based solvents. During reassembly, lubricate all parts liberally with clean brake fluid.*

13 Push the assembled components into the bore, bottoming them against the end of the master cylinder, then refit the end cap.

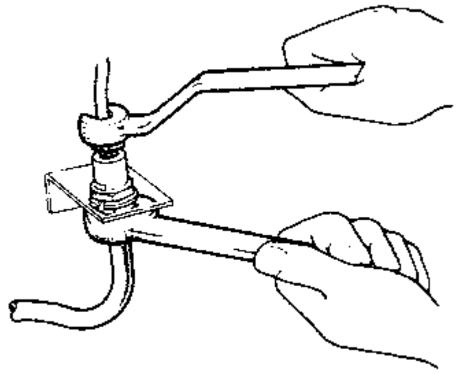
14 Bend the locking tabs to securely fasten the cap in place.

15 Refit new reservoir grommets and the reservoir in the reverse order of removal.

16 Before refitting the master cylinder, it should be bench bled. Since you'll have to apply force to the master cylinder piston and, at the same time, control flow from the brake line outlets, the master cylinder should be mounted in a vice, with the jaws of the vice clamping on the mounting flange.



7.12b Exploded view of the master cylinder



8.3 Hold the hose fitting with a spanner to prevent twisting the line, then loosen the tube nut with a flare-nut spanner to prevent rounding off the corners of the nut

17 Insert threaded plugs into the brake line outlet holes and snug them down so no air will leak past them, but not so tight that they can't be easily loosened. If plugs are not available, hold your fingers tightly over the outlet ports.
18 Fill the reservoir with brake fluid of the recommended type (see Chapter 1).
19 Remove one plug (or finger) and push the piston assembly into the bore to expel the air from the master cylinder. A large Phillips screwdriver can be used to push on the piston assembly.
20 To prevent air from being drawn back into the master cylinder, the plug (or finger) must be renewed before releasing the force on the piston.
21 Repeat the procedure until only brake fluid is expelled from the brake line outlet hole. When only brake fluid is expelled, repeat the procedure at the other outlet hole and plug. Be sure to keep the master cylinder reservoir filled with brake fluid to prevent the introduction of air into the system.

Refitting

22 Refit the master cylinder over the studs on the power brake booster and tighten the nuts only finger-tight at this time.
23 Thread the brake line fittings into the master cylinder. Since the master cylinder is still a bit loose, it can be moved slightly so the fittings thread in easily. Don't strip the threads as the fittings are tightened.
24 Tighten the mounting nuts and the brake line fittings.
25 Fill the master cylinder reservoir with fluid, then bleed the master cylinder (only if hasn't been bench bled) and the brake system (see Section 9). To bleed the master cylinder on the vehicle, have an assistant depress the brake pedal and hold it down. Loosen the fitting to allow air and fluid to escape. Tighten the fitting, then allow your assistant to return the pedal to its rest position. Repeat this procedure on both fittings until the fluid is free of air bubbles. Check the operation of the brake system carefully before driving the vehicle.

8 Brake hoses and lines - inspection and renewal

Inspection

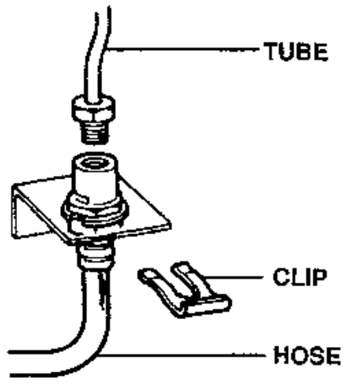
1 About every six months, with the vehicle raised and supported securely on jackstands, the rubber hoses which connect the steel brake lines with the front and rear brake assemblies should be inspected for cracks, chafing of the outer cover, leaks, blisters and other damage. These are important and vulnerable parts of the brake system and inspection should be complete. A light and mirror will be helpful for a thorough check. If a hose exhibits any of the above conditions, renew it.

Renewal

Front brake hose

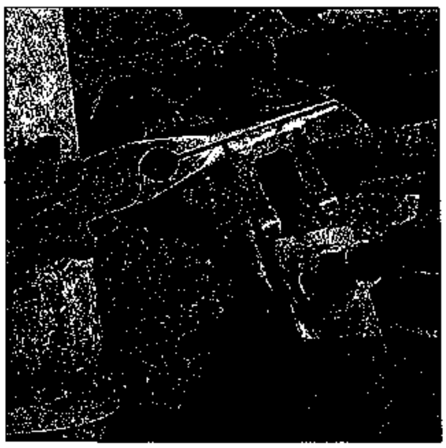
Refer to illustrations 8.3, 8.4a and 8.4b

2 Loosen the wheel lug nuts, raise the vehicle and support it securely on jackstands. Remove the wheel.



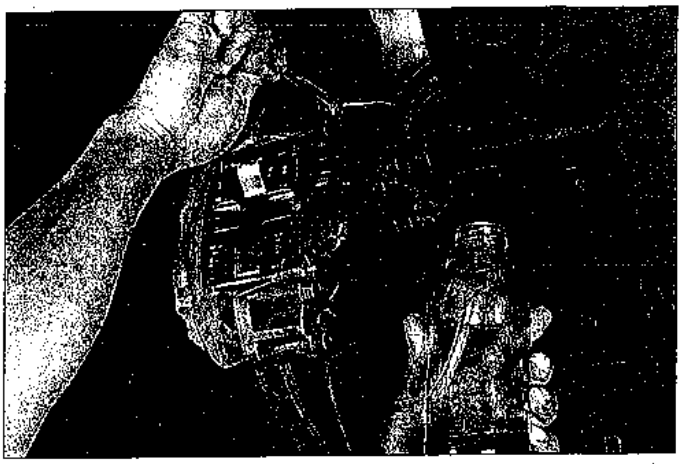
8.4a Once the tube nut has been completely loosened, remove the clip with a pair of pliers - some models may be equipped with an E-ring, as shown here, which can be removed with a screwdriver

3 At the frame bracket, hold the hose fitting with an open-end spanner and unscrew the brake line fitting from the hose **(see illustration)**. Use a flare-nut spanner to prevent rounding off the corners.
4 Remove the U-clip and E-ring, if equipped, from the female fitting at the bracket with a pair of pliers, then pass the hose through the bracket **(see illustrations)**.
5 At the caliper end of the hose, remove the banjo fitting bolt, then separate the hose from the caliper. Note that there is a copper sealing washer on each side of the fitting - they should be renewed during refitting.
6 Remove the U-clip from the strut bracket, then feed the hose through the bracket.
7 To refit the hose, pass the caliper fitting end through the strut bracket, then connect the fitting to the caliper with the banjo bolt and copper washers. Make sure the locating lug on the fitting is engaged with the hole in the caliper, then tighten the bolt to the torque listed in this Chapter's Specifications.
8 Push the metal support into the strut bracket and refit the U-clip. Make sure the hose isn't twisted between the caliper and the strut bracket.

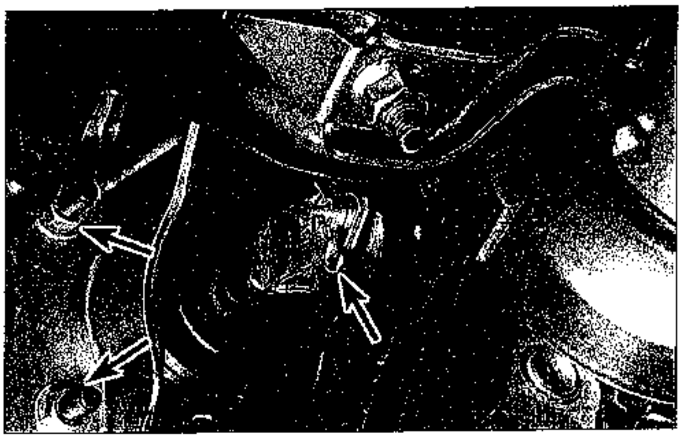


8.4b Long-nose pliers work best for removing the clip

9



9.8 When bleeding the brakes, a hose is connected to the bleeder valve at the caliper or wheel cylinder and then submerged in brake fluid. Air will be seen as bubbles in the tube and container. All air must be expelled before moving to the next wheel



10.7 Remove this retaining clip (arrow), pull out the clevis pin and detach the pushrod from the brake pedal; the two left power brake booster mounting nuts (arrows) are visible in this photo (the two right nuts, not visible in this photo, are to the right of the booster mounting bracket)

9 Route the hose into the frame bracket, again making sure it isn't twisted, then connect the brake line fitting, starting the threads by hand. Refit the clip and E-ring, if equipped, then tighten the fitting securely.
10 Bleed the caliper (see Section 9).
11 Refit the wheel and lug nuts, lower the vehicle and tighten the lug nuts to the torque specified in Chapter 1.

Rear brake hose

12 Perform Steps 2, 3 and 4 above, then repeat Steps 3 and 4 at the other end of the hose. Be sure to bleed the wheel cylinder (or caliper) (see Section 9).

Metal brake lines

13 When renewing brake lines, be sure to use the correct parts. Don't use copper tubing for any brake system components. Purchase steel brake lines from a dealer or auto parts store.
14 Prefabricated brake line, with the tube ends already flared and fittings refitted, is available at auto parts stores and dealer parts departments. These lines are also bent to the proper shapes.
15 When refitting the new line, make sure it's securely supported in the brackets and has plenty of clearance between moving or hot components.
16 After refitting, check the master cylinder fluid level and add fluid as necessary. Bleed the brake system (see Section 9) and test the brakes carefully before driving the vehicle in traffic.

9 Brake hydraulic system - bleeding

Refer to illustration 9.8

Warning: *Wear eye protection when bleeding the brake system. If the fluid comes in contact with your eyes, immediately rinse them with water and seek medical attention.*

Note: *Bleeding the hydraulic system is necessary to remove any air that manages to find its way into the system when it's been opened during removal and refitting of a hose, line, caliper or master cylinder.*

1 You'll probably have to bleed the system at all four brakes if air has entered it due to low fluid level, or if the brake lines have been disconnected at the master cylinder. If you must bleed the entire system, start with the load sensing valve, then proceed to the left rear wheel, the right rear, the left front and the right front, in that order.
2 If a brake line was disconnected only at a wheel, then only that caliper or wheel cylinder must be bled.
3 If a brake line is disconnected at a fitting located between the master cylinder and any of the brakes, that part of the system served by the disconnected line must be bled.
4 Remove any residual vacuum from the brake power booster by applying the brake several times with the engine off.
5 Remove the master cylinder reservoir cover and fill the reservoir with brake fluid. Refit the cover. **Note:** *Check the fluid level often during the bleeding operation and add fluid as necessary to prevent the fluid level from falling low enough to allow air bubbles into the master cylinder.*
6 Have an assistant on hand, as well as a supply of new brake fluid, a clear plastic container partially filled with clean brake fluid, a length of plastic, rubber or vinyl tubing to fit over the bleeder valve and a spanner to open and close the bleeder valve.
7 Loosen the bleeder valve slightly, then tighten it to a point where it's snug but can still be loosened quickly and easily.
8 Place one end of the tubing over the bleeder valve and submerge the other end in brake fluid in the container **(see illustration)**.
9 Have the assistant pump the brakes slowly a few times to get pressure in the system, then hold the pedal down firmly.
10 While the pedal is held down, open the bleeder valve just enough to allow a flow of fluid to leave the valve. Watch for air bubbles to exit the submerged end of the tube. When the fluid flow slows after a couple of seconds, close the valve and have your assistant release the pedal.
11 Repeat Steps 9 and 10 until no more air is seen leaving the tube, then tighten the bleeder valve and proceed to the next bleeding position in the proper order (refer to Step 1). Perform the same procedure. Be sure to check the fluid in the master cylinder reservoir frequently.
12 Never use old brake fluid. It contains moisture which will deteriorate the brake system components.
13 Refill the master cylinder with fluid at the end of the operation.
14 Check the operation of the brakes. The pedal should feel solid when depressed, with no sponginess. If necessary, repeat the entire process. **Warning:** *Do not operate the vehicle if you're in doubt about the effectiveness of the brake system.*

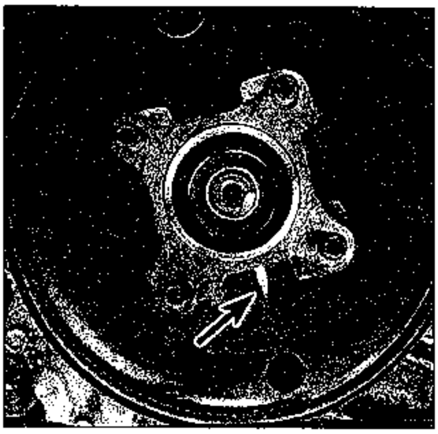
10 Power brake booster - check, removal and refitting

Operating check

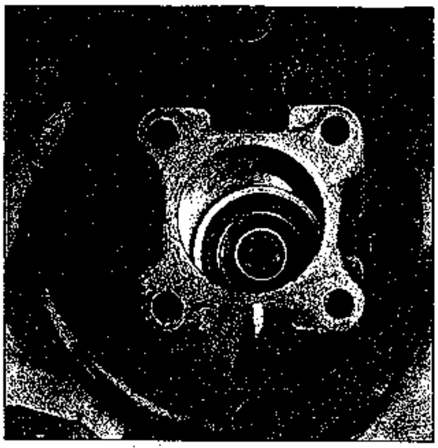
1 Depress the brake pedal several times with the engine off and make sure there's no change in the pedal reserve distance.
2 Depress the pedal and start the engine. If the pedal goes down slightly, operation is normal.

Airtightness check

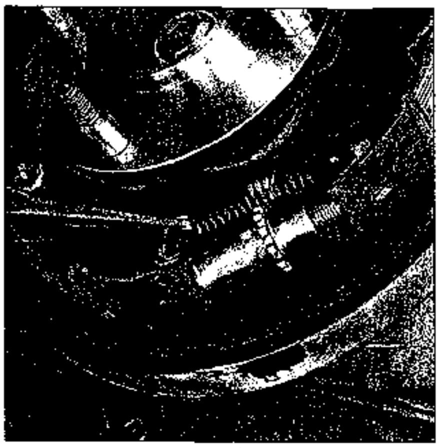
3 Start the engine and turn it off after one or two minutes. Depress the brake pedal slowly several times. If the pedal depresses less each time, the booster is airtight.
4 Depress the brake pedal while the engine is running, then stop the engine with the pedal depressed. If there's no change in the pedal reserve travel after holding the pedal for 30 seconds, the booster is airtight.



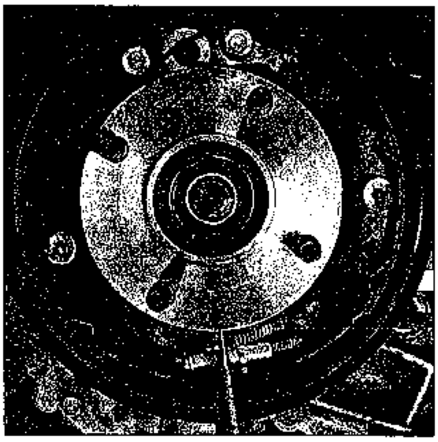
11.4a A dab of paint (arrow) can be used to mark the position of the parking brake drum relative to the lock tab on the nut



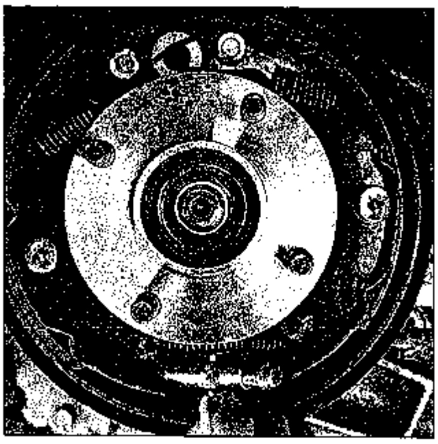
11.4b Lift the drum from the parking brake unit



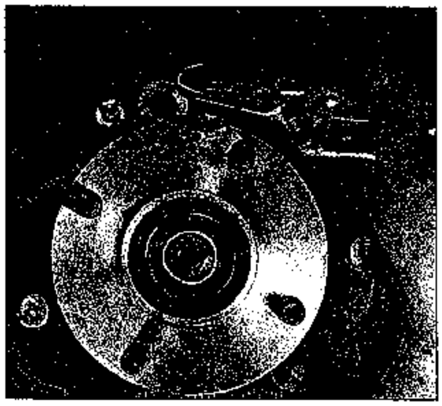
11.5a Lift the lower return spring from the shoes . . .



11.5b . . . and then remove it from the assembly



11.5c Remove the adjuster



11.6a Disconnect the upper return springs . . .

Removal

Refer to illustration 10.7

5 Power brake booster units shouldn't be disassembled. They require special tools not normally found in most automotive repair shops. They're fairly complex and, because of their critical relationship to brake performance, should be renewed with a new or rebuilt one.

6 To remove the booster, first remove the brake master cylinder (see Section 7).

7 Locate the pushrod clevis connecting the booster input rod to the brake pedal **(see illustration)**. It's accessible from inside the vehicle, under the dash board.

8 Remove the clevis pin retaining clip with pliers.

9 Holding the clevis with pliers, loosen the locknut with a spanner. Remove the clevis pin.

10 Disconnect the hose from the brake booster. Be careful not to damage the hose when removing it from the booster fitting.

11 Remove the four nuts and washers holding the brake booster to the firewall from under the dash (you may need a light to see them).

12 Slide the booster straight out from the firewall until the studs clear the holes.

Refitting

13 Refitting procedures are basically the reverse of removal. Tighten the clevis locknut securely and the booster mounting nuts to the torque listed in this Chapter's Specifications.

14 If the power booster unit is being renewed, the clearance between the firewall surface of the booster and the end of the output rod must be measured and, if necessary, adjusted to the value listed in the Specifications in this Chapter. Using calipers or a machinist's scale, measure the distance from the end of the booster output rod to the firewall surface of the booster (the distance which the rod protrudes). If it is not within specifications, hold the rod with long-nose pliers and turn the adjusting screw on the end of the power booster pushrod until the clearance is within the specified values.

15 After the final refitting of the master cylinder and brake hoses and lines, the brake pedal height and freeplay must be adjusted and the system must be bled (see Chapter 1 and also Section 9 of this Chapter).

11 Parking brake shoes - inspection and renewal

Refer to illustrations 11.4a, 11.4b, 11.5a, 11.5b, 11.5c, 11.6a, 11.6b, 11.6c, 11.7a, 11.7b, 11.7c, 11.8a, 11.8b, 11.9a, 11.9b, 11.9c, and 11.10

Warning: *Dust created by the brake system may contain asbestos, which is hazardous to your health. Never blow it out with compressed air and don't inhale any of it. An approved filtering mask should be worn when working on the brakes. Do not, under any circumstances, use petroleum-based solvents to clean brake parts. Use brake cleaner or denatured alcohol only!*

1 Raise the vehicle and support it securely with jackstands.

2 Remove the rear driveshaft (refer to Chapter 8).

3 Release the parking brake.

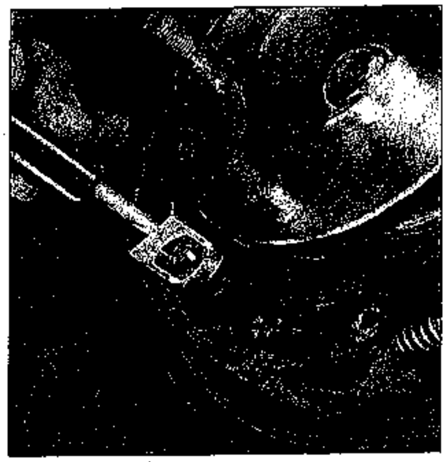
4 Use paint to mark the position of the drum on the drive flange so it can be refitted in the same position **(see illustration)**. Pull the parking brake drum from the rear of the transmission **(see illustration)**.

5 Remove the lower return spring and the adjuster mechanism **(see illustrations)**.

6 Remove the upper return springs **(see**

11.6b . . . then remove them

11.6c Remove the pivot washer



11.7a Use a hold-down spring tool to push in on the shoe retainers and turn them a quarter turn in either direction

11.7b Lift the spring and retainer from the shoe

11.7c Remove the retainer spring seat also, then push the pin through the backing plate and remove it

11.8a Disconnect the cable from the operating assembly by collapsing the spring

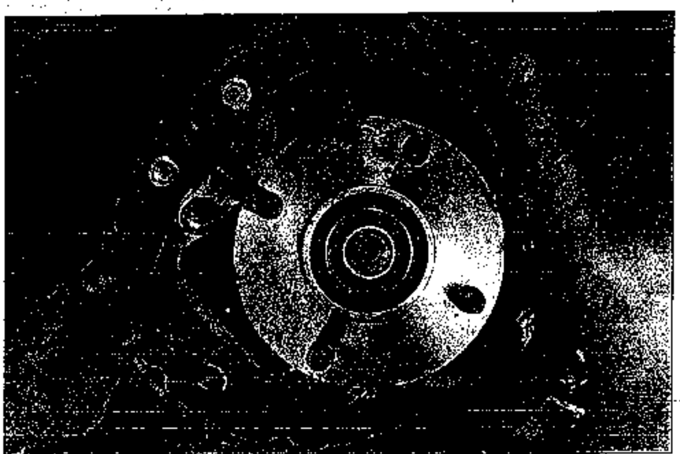
illustrations).

7 Release the shoe hold-down springs by pushing them in and turning them a quarter turn. Then remove the springs along with the retainers and spring seats **(see illustrations)**. It is easiest to use a special brake spring tool to do this.

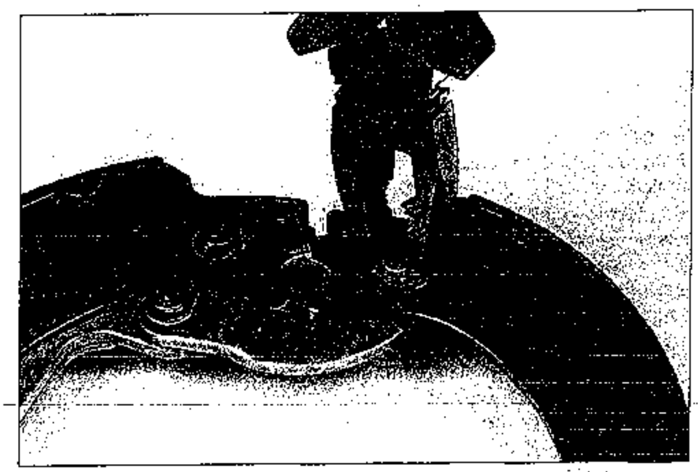
8 Disconnect the cable from the operating mechanism **(see illustration)**. Remove the shoes from the vehicle **(see illustration)**.

9 Remove the clips which retain the shoes to the operating mechanism **(see illustrations)**.

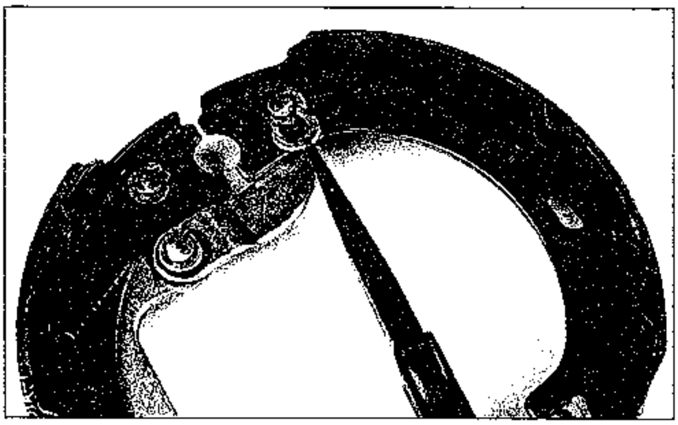
10 Inspect all components for wear and damage **(see illustration)**. Pay special attention to the cable and the backing plate. Check the shoes for lining thickness and compare your findings with the Specifications in this Chapter. Check the drum carefully (refer to Section 5 and the Specification in this Chapter).



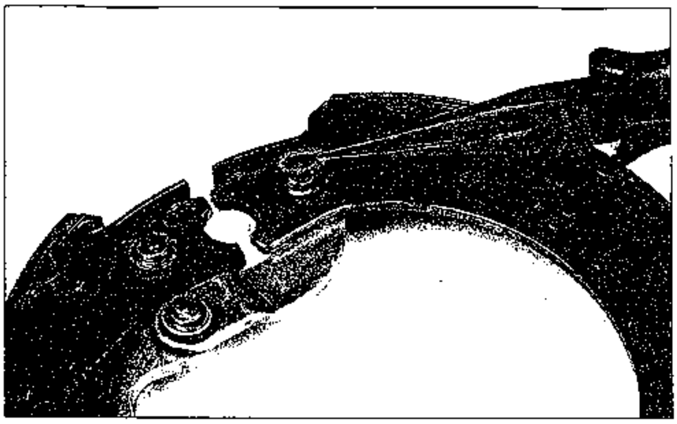
11.8b The entire assembly can now be lifted from the vehicle. Place it on a clean work bench to finish disassembly



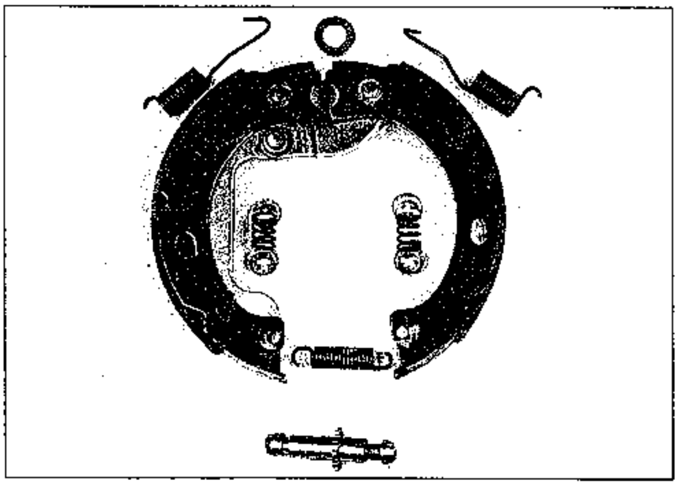
11.9a Remove the retaining clip from the pin . . .



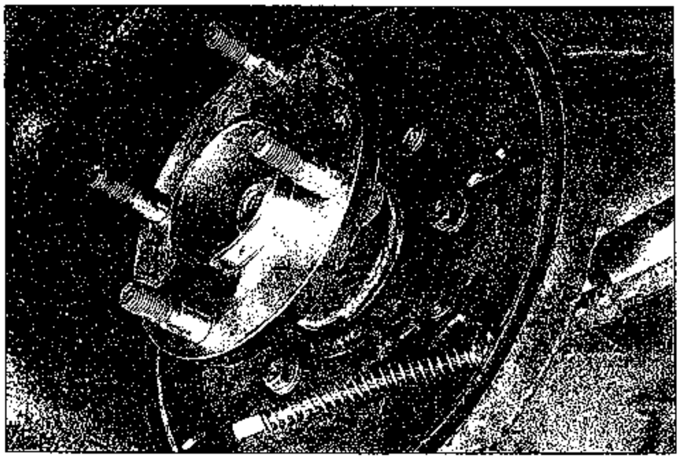
11.9b . . . then pull it off and repeat the procedure on the other pin



11.9c Remove the washers



11.10 The complete parking brake assembly



13.3 The complete parking brake shoe assembly must be removed in order to access the cable

11 Renew the shoes and machine the drum as required.
12 Lubricate the backing plate rubbing surfaces with a small amount of brake grease. Clean the adjuster mechanism and lightly lubricate its threads.
13 Refitting is the reverse of removal.
14 Rotate the drum until the adjustment hole is in line with the adjuster. Remove the rubber plug from the adjuster hole.
15 Insert a small screwdriver through the adjusting hole and rotate the star wheel until the shoes rub on the drum.
16 Back off the adjustment until there is a maximum of 0.2 mm clearance between the drum and the shoes.

12 Parking brake - adjustment

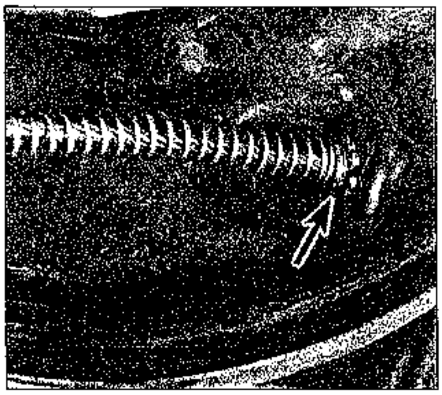
1 The parking brake lever, when properly adjusted, should travel seven to nine clicks when a moderate pulling force is applied. If it travels less than five clicks, there's a chance the parking brake might not be releasing completely and might be dragging on the drum or disc. If the lever can be pulled up more than ten clicks, the parking brake may not hold adequately on an incline, allowing the car to roll.
2 To gain access to the parking brake cable adjuster, remove the lever cover (refer to Chapter 11).
3 Loosen the locknut (the upper nut) while holding the adjusting nut (lower nut) with a spanner. Tighten the adjusting nut until the desired travel is attained. Tighten the locknut.
4 Recheck the parking brake travel.
5 Check the operation of the parking brake warning light. It should illuminate when the lever has been pulled two notches. It must go out when the lever is released.
6 Bend the switch mounting plate on the lever assembly to make an adjustment.

13 Parking brake cable - renewal

Refer to illustrations 13.3 and 13.4

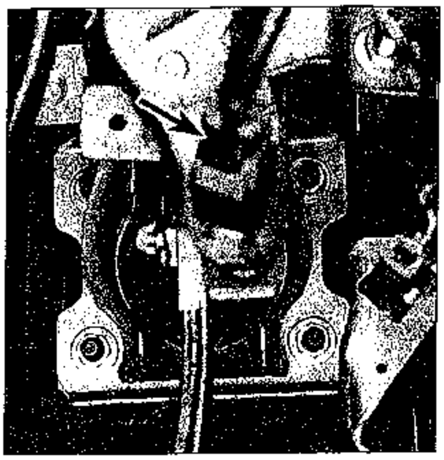
Renewal

1 Remove the cover to gain access to the parking brake cable adjuster (refer to Chapter 11).
2 With the lever in the down (off) position, remove the locknut and the adjusting nut and from the lever. Pull the clevis pin and remove the clevis from the cable end.



13.4 Collapse the spring and then remove the clip (arrow) to disconnect the cable from the backing plate

3 Remove the parking brake shoes **(see illustration)**(refer to Section 11).
4 Disconnect the cable from the parking brake backing plate **(see illustration)**.
5 Pull the cable through the floor grommet and out of the vehicle.
6 Refitting is the reverse of removal. Apply a light coat of grease to all wearing surfaces.
7 Adjust the cable (refer to Section 12).



14.3 The brake light switch is located on the chassis above the brake pedal (arrow)

14 Brake light switch - removal, refitting and adjustment

Refer to illustrations 14.3 and 14.4

Removal and refitting

1 The brake light switch is located on a bracket at the top of the brake pedal. The switch activates the brake lights at the rear of the vehicle when the pedal is depressed.
2 Disconnect the negative battery cable from the battery.
3 Disconnect the wiring harness at the brake light switch **(see illustration)**.
4 Loosen the lock-nut **(see illustration)** and unscrew the switch from the pedal bracket.
5 Refitting is the reverse of removal.

Adjustment

6 Loosen the locknut, adjust the switch until the clearance is as specified, then tighten the locknut. The adjustment of the brake pedal switch is also the adjustment for the brake pedal freeplay. Refer to the brake pedal height and freeplay adjustment procedure in Chapter 1.
7 Connect the wires at the switch and the battery. Make sure the brake lights are functioning properly.

14.4 Loosen the lock-nut (arrow) to unscrew the switch from its bracket

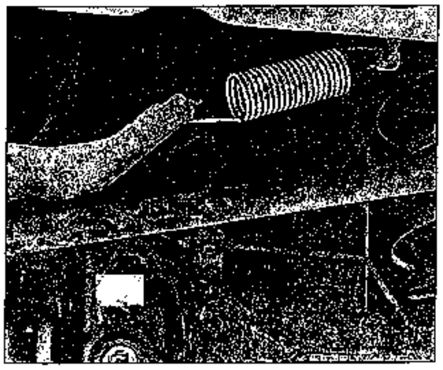
15 Load sensing valve - general information and renewal

Refer to illustrations 15.1a and 15.1b
Note: *The load sensing valve should not be disassembled for service.*

General information

1 The load sensing valve is a device incorporated into the brake system that senses the amount of weight (passengers, equipment, etc.) on the rear of the vehicle and increases the rear wheel brake fluid pressure to compensate for an additional load. This system is located above the rear axle assembly and it consists of a valve, spring and bracket **(see illustrations)**.
2 When bleeding the brake system, it is necessary to bleed the load sensing proportioning and by-pass valve first, before all the wheel cylinders and calipers are bled (see Section 9).
3 In the event of poor braking performance, have the system adjusted by a dealer service department. Poor braking performance could mean that the rear wheels lock when braking with little weight in the rear or that they do not provide enough braking when the rear is carrying a load.
4 If it becomes necessary to remove the assembly for renewal of another component, be sure to mark the position of the adjusting

15.1a The load sensing valve is mounted to a bracket on the right frame rail



15.1b A spring connects the valve to the rear axle housing to detect how much the rear springs are collapsed. This informs the system of how much weight is on the rear of the vehicle

nut. It must be refitted in exactly the same position as before removal.

Renewal

5 Raise the vehicle and support it securely with jackstands.
6 Disconnect the brake lines from the valve. Plug the ends to prevent contamination and fluid loss.
7 Disconnect the spring and remove the bolts. Remove the valve.
8 Refitting is the reverse of removal. Bleed the valve and then the rest of the system in the proper order (refer to Section 9).