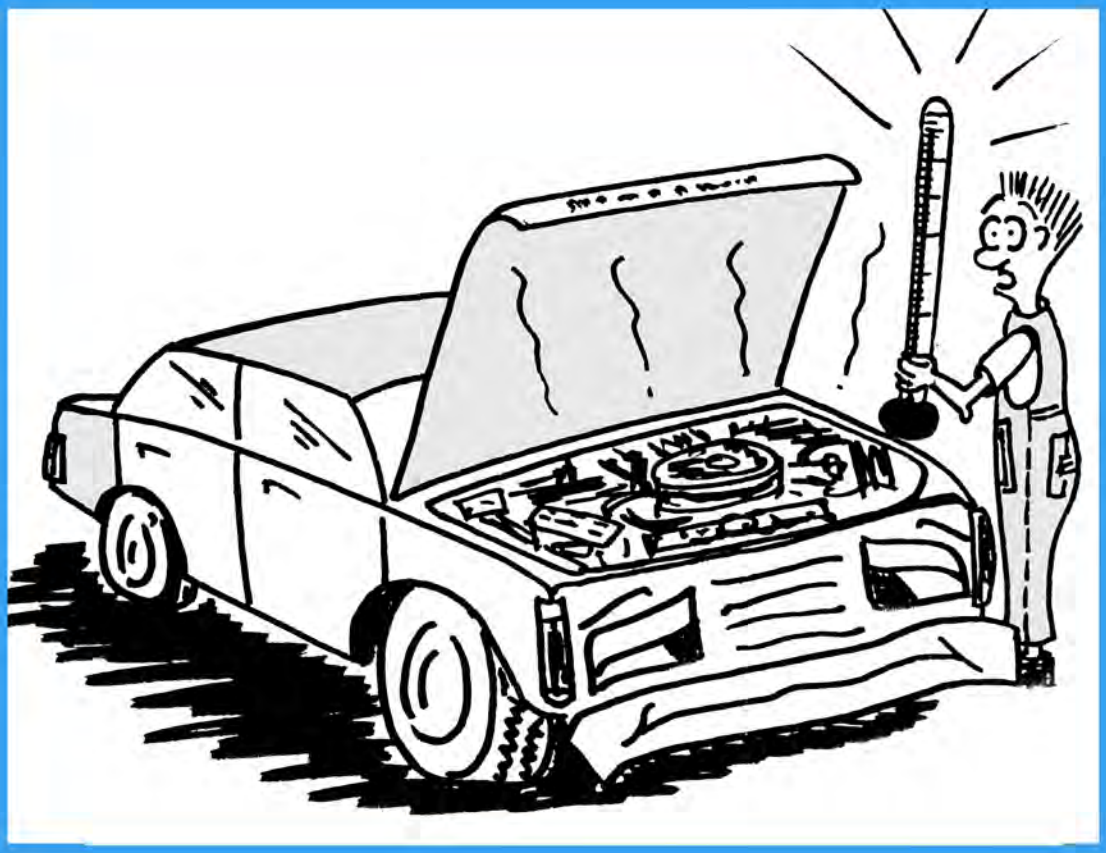
CARING FOR YOUR MOTOR CAR

STUDENT NOTES

for introductory motor courses



by

Jim Sheffield

Reprinted 1991, 1992 (twice), 1993, 1994

Reprinted - 2005

Illustrations:

Brady Moffatt

Typesetting:

Mark Moffatt, Bob Moffatt

ISBN 2025 E Pub
978-1-86283-234-3

ISBN hard copy
1 86283 030 4

Published by
Wet Paper
PO Box 540
Coolangatta 4225

www.wetpaper.com.au

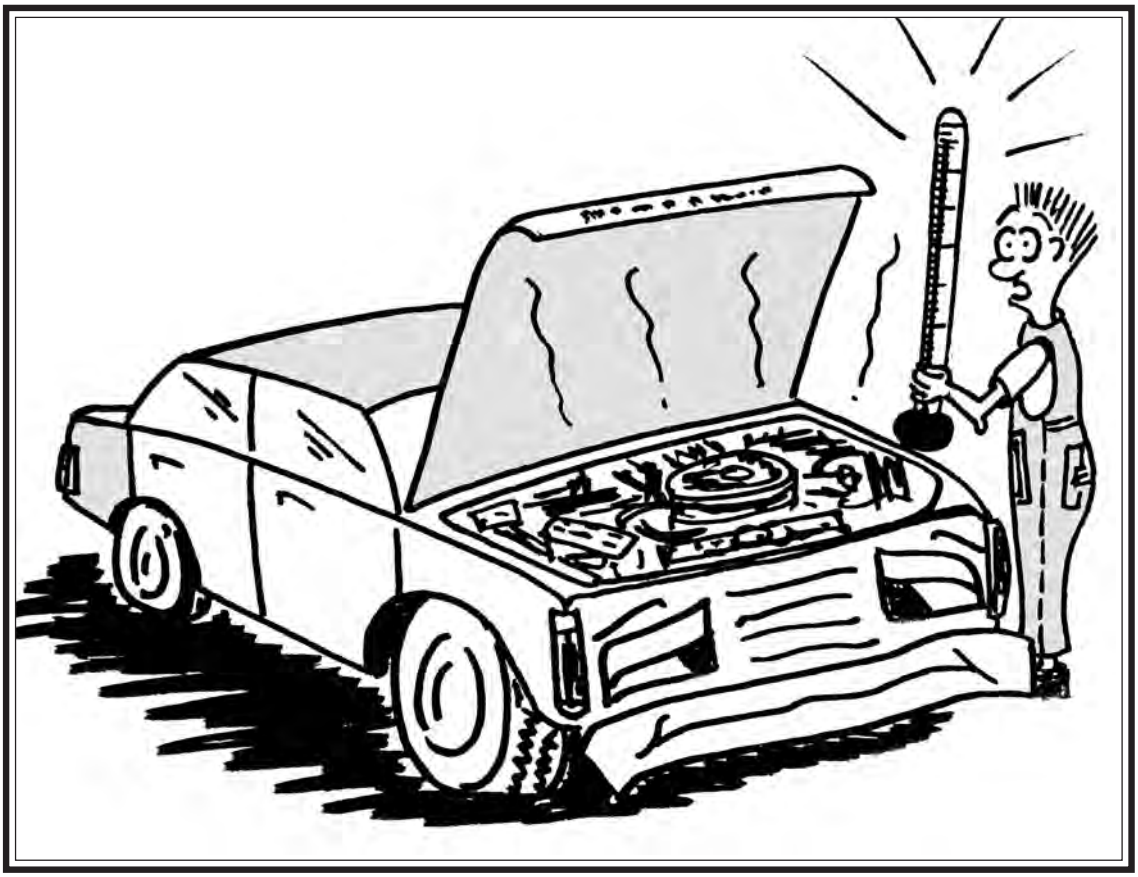
CARING FOR YOUR CAR

Student Notes

for

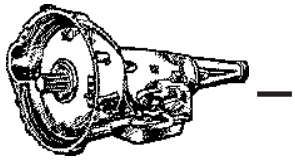
TAFE and High School Students

by Jim Sheffield



Wet Paper

CONTENTS



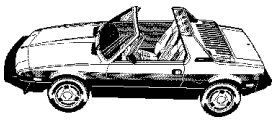
VEHICLE CAR CARE

About the Author

Jim Sheffield teaches automotive engineering at the Gold Coast Institute of TAFE where he conducts classes in motor mechanics to adult, prevocational, trade, advanced trade and secondary school students.

In 1979 the course, *Basic Car Care,* was introduced to adults.

This set of notes has been written to make the job of studying for examinations easier for the student.



CHAPTER 1

SAFETY IN A WORKSHOP

Workshop accidents happen mainly because the person does not THINK before he / she acts or does something, because they do not ASK or QUESTION what they are about to do. EXAMINE the situation carefully before starting to do the task and finally CHECK for yourself that everything is safe before you act.

Never guess or take something for granted!

Fig 1 Safety rules are important in any practical subject

An accident is normally an unplanned and unexpected occurrence which can result in injury and can be caused by:-

- Failure to take adequate precautions.
- Ignorance of the dangers involved through lack of skill or inadequate training.
- Tiredness causing lack of concentration and thought.
- Fooling around or skylarking.

Good housekeeping is also an important factor with regard to safety in a workshop or on the job. This means that tools and materials are not left strewn around while you are working on the job and that when completed, the work area is left clean and tidy.

PERSONAL PROTECTION

A large number of accidents that occur can be caused by the individuals lack of personal protection with regard to accident prevention.

Personal protection includes such things as:-

- Skin Care
- Gloves
- Goggles
- Foot Protection
- Clothing
- Head Protection
- Jewellery

SKIN CARE

Dermatitis is an inflammation of the skin, and many cases of trade dermatitis are caused by substances used on the job such as cleaning fluids, kerosene, petrol, white spirit, turpentine and some oils.

In all cases of suspected dermatitis a visit to the local doctor should be made. To avoid dermatitis use a suitable protective skin cream.

GLOVES

Industrial gloves are available and are designed to protect hands and fingers against damage from rough surfaces, acids and corrosives however may NOT give protection against electric shock.

GOGGLES

Two types of goggles are available to protect the eyes.

(1) To protect the eyes against flying objects, dust or splashing fluids and should be used when using a grinding wheel or handling acids etc.
(2) To protect the eyes from dangerous light rays given of when welding, and, if electric welding a special filter glass must be used to protect against the ultra violet rays.

A flash from a welding arc can cause burning of the eyes which will result in medical attention.

FOOT PROTECTION

Safety boots or shoes are normally made with steel toe caps to give protection from falling objects. Foot wear with anti-skid soles should be worn on slippery or greasy floor conditions.

- Shoes or boots with thin or worn soles give little protection against sharp objects.
- Sandshoes or thongs are not suitable in a workshop situation.

CLOTHING

It is dangerous to have loose fitting clothing, unbuttoned shirt sleeves or to wear a tie when working near moving machinery. A tie should either be taken off or tucked into the shirt and the sleeves rolled up to avoid accidents.

Some clothing material (ie nylon) is dangerous to wear in the workshop when sparks could spatter. e.g. welding.

HEAD PROTECTION

A good fitting cap or beret should be worn to protect the hair against dirt, oil and grease. Long hair should be contained in either a beret or hair net when near revolving machinery.

JEWELLERY

Jewellery such as watches, rings and neck chains should not be worn in a workshop.

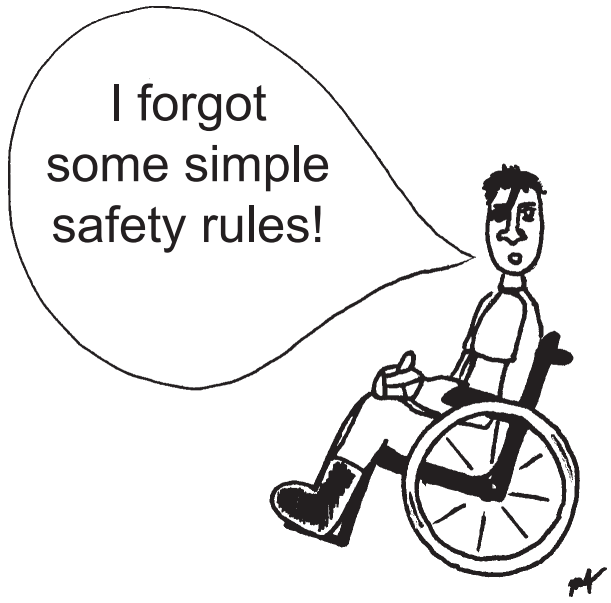


Fig 2 Just a simple reminder

FIRES AND EXTINGUISHERS

Three components are necessary to create a fire:-

- FUEL
- AIR
- HEAT

Take away any one of these components and the fire will extinguish.

There are three classes of fires:-

- Class A
- Class B
- Class C

"CLASS A" - ORDINARY COMBUSTIBLES

These are materials such as paper, wood, clothing and packing materials. To extinguish this type of fire the heat must be reduced and either a Soda and Acid Extinguisher, a Water Extinguisher or a Water/CO2 Extinguisher can be used.

"CLASS B" - FLAMMABLE LIQUIDS

This is liquids such as petrol, spirits, paint, thinners, waxes, oils and greases. To extinguish a class B fire the air must be removed and this is done with the use of a Foam Extinguisher, Carbon Dioxide (CO_2) type, Dry Chemical or B.C.F. Extinguisher. B.C.F.= Bromochlorodifluromethane.

"CLASS C" - ELECTRICAL FIRES

These types of fires should only be extinguished with NON-CONDUCTORS of electricity, types of extinguishers. Therefore Carbon Dioxide CO_2, Dry Chemical or B.C.F. types of extinguishers should be used.

TYPES OF EXTINGUISHERS

SODA ACID

Always painted RED. These extinguishers are used inverted (upside down) and can produce a stream which can travel for up to 9 meters. Shown in *fig 3*.

FOAM

Always painted BLUE. Also used inverted which produces a foam from the acid solution and the alkaline solution. The foam flows over the burning liquid suffocating the fire. Foam type shown here.

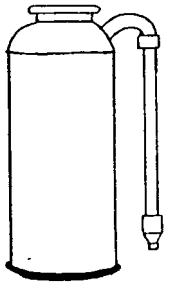


Fig 3 Soda Acid Fire extinguisher

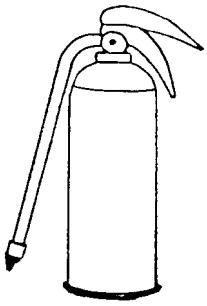


Fig 4 Foam Extringuisher

CARBON DIOXIDE (CO_2)

Painted RED with BLACK stripe, CO_2 is the cleanest means of extinguishing a fire and is non-toxic. This type of extinguisher is used in the upright position where a safety pin is removed before the handle can be squeezed. *fig 5*.

DRY CHEMICAL

Painted RED with WHITE band. Used in the upright position, strike plunger and direct discharge at base of fire. A very fine powder is discharged from this type of extinguisher — see *fig 7* below.

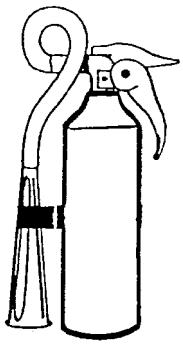


Fig 5 Carbon dioxide (CO_2)

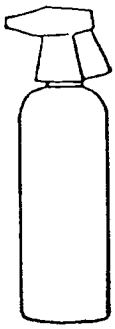


Fig 6 BCF

Fig 7 Dry Chemical

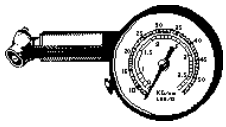
B.C.F.

Are painted YELLOW. To operate use in the upright position, release safety catch, squeeze lever and aim at base of fire. The rapid action of B.C.F. when discharged in a fine mist blankets the fire eliminating the air — see *fig 6* above. New legislation on the 18th February 1994, called the Clean Air (ozone depleting substances) Regulation 1994, has placed restrictions on the use of this type of extinguisher due to it containing a halon which damages the ozone layer.

OTHER SAFETY TIPS

- Always use safety stands to support a vehicle NEVER rely on jacks or chain hoists.
- Never play practical jokes with compressed air, pressure grease guns or high tension spark leads.
- Place truck wheels in a safety cage when inflating them, the safety ring can fly off causing injury.
- Avoid using damaged tools ie; worn spanners can slip, chipped hammer heads and burred chisel and punch heads are dangerous.
- Avoid lifting objects too heavy for you - get help or use a portable crane.
- Be careful when releasing over heated radiators pressure cap - serious scalding can result.
- Always use safety glasses when grinding, cutting, drilling or chipping.

CAR CARE WORKSHEET 1



SAFETY - WORKSHEET

(1) List 4 reasons that could cause an accident to happen.

_____

_____

_____

_____

(2) Make a list of 5 items that could improve personal safety.

_____

_____

_____

_____

_____

(3) What is Dermatitis?

_____

_____

(4) What type of footwear should be worn in a workshop?

_____

_____

(5) What are the three items required to create a fire?

_____

_____

(6) List the types of fires the following classes are referred to as:-

*"CLASS A"*_____

*"CLASS B"*_____

*"CLASS C"*_____

(7) List the extinguisher type suitable for each class of fire and how it is identified.

CLASS	EXTINGUISHER TYPE	IDENTIFICATION
(A)		
(B)		
(C)		

(8) List some other safety tips that you should be aware of when working on a motor vehicle.

(a)_____

_____

(b)_____

_____

(c)_____

_____

(d)_____

_____

(e)_____

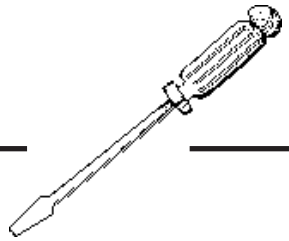
_____

(f) _____

_____

CHAPTER 2

SERVICING A MOTOR VEHICLE



ENGINE OIL

Your engine needs a good oil to protect it against wear between the moving components, protect it against harmful effects of the by-products of combustion, to act as a coolant and to provide a seal between the piston assembly and cylinder bores.

The oil needs to carry out these functions whether the engine is cold or hot and under varying climatic conditions.

When the engine is cold you need a thin free flowing oil, a thick oil would not flow freely enough to lubricate the components and so the term Viscosity.

Viscosity refers to the internal resistance to flow. (The "thickness" or "body" of a fluid).

Oils are classified by their "flowability" by numbers, a 10 may be recommended for winter and a 30 for summer operation. A multi-grade oil that reduces change in viscosity over a wide range of operating conditions overcomes these problems.

A multi-grade oil is one which covers more than three classifications. ie. 10 W 30 ; 20 - 40 ; 10 - 40.

The mineral oil refined from the crude oil has to have a number of chemical additives added to overcome various by products of combustion whereby its lubricating qualities are extended.

Some of the additives used are:- Dispersant, Inhibitors, Anti-Scuff Additives, Extreme Pressure Additives, Anti-Foam Agents and Pour Point Depressants.

DISPERSANT:- This additive is to prevent products of combustion, carbon and sludge from forming within the engine.

INHIBITORS:- This is added to reduce the oils tendency to produce varnishes or resins. A corrosion inhibitor reduces the acidic products of combustion.

ANTI-SCUFF ADDITIVES:- These additives reduce scuffing of cams and tappets.

EXTREME PRESSURE ADDITIVES:- To prevent the oil film on components from being ruptured.

ANTI-FOAM AGENTS:- Are used to prevent frothing and to reduce the rate of oxidation.

POUR-POINT DEPRESSANTS:- Reduce the formation of waxes and maintain fluidity in the lubricant at low temperatures.

OIL CHANGE PERIODS

Most engine oils lose their ability to protect and lubricate the components not because the oil has worn out, but because it has become loaded with contaminants such as water, acids, unburnt and burnt fuel, dirt and abrasives.

These types of contaminants cannot be removed by the oil filter, and the only way of removing them is to change the engine oil.

Most manufacturers are recommending oil be changed at 10000 Kilometers or every 60 days. A number of people forget about the 60 days unfortunately, whereby, a vehicle that is only used for short stop-start trips (ie a city car), is operating under the hardest type of operation, where the engine does not reach maximum operating temperatures and therefore increases oil deterioration and consequently engine wear results.

When changing engine oil it is important that the oil filter be changed at the same time, and before you change the oil it is vital that the engine is at normal operating temperature, and that the vehicle is positioned so that on removing the sump plug ALL the old oil can be drained from the sump pan.

To remove a sump plug always use a ring spanner or socket, never an open ended spanner or crescent shifter as these can cause damage to the hexagon shape of the plug.

When replacing the sump plug on completion of the oil draining always check the condition of the gasket/ seal.

Never dispose of old engine oil down a drain

OIL FILTERS

The purpose of the oil filter is to remove particles of engine wear, and other contaminants which have accumulated in the lubricating oil as it circulates through the system.

The filter used by most manufacturers today is the throw-away canister type, and, to remove this type from an engine a special removal tool is required to obtain the necessary leverage to unscrew it.

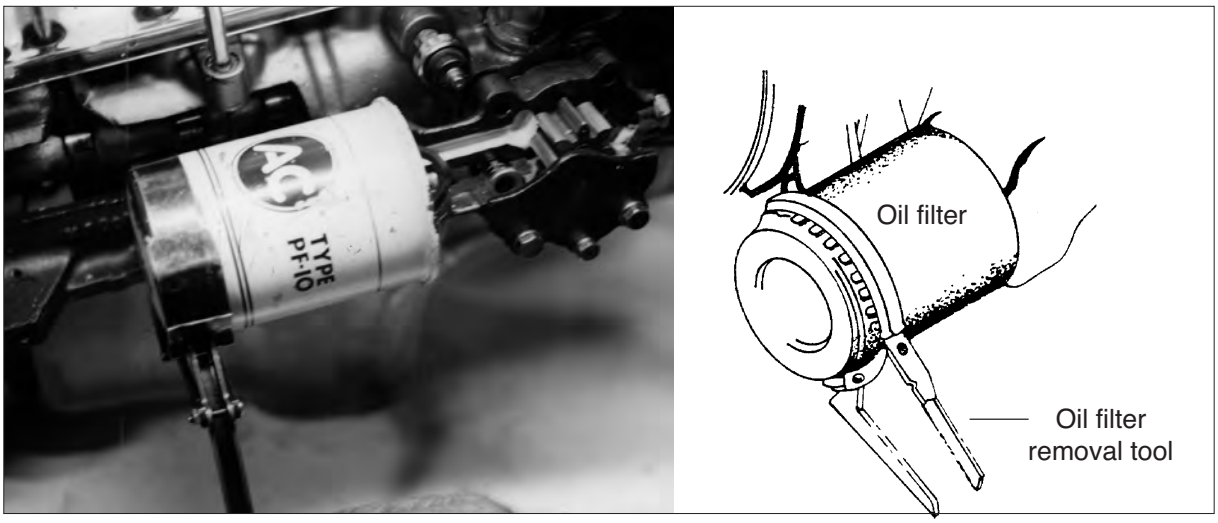


Fig 8 Throw-away type filter and special tool

This type of filter once removed is completely thrown away, and, prior to fitting the new one it is necessary to ensure the mating surface on the engine is clean, and the sealing ring on the new filter to be fitted is smeared with clean engine oil.

Damage can result if overtightened

To fit this type of filter screw on until the seal comes in contact with the engine surface, then tighten 2/ 3 turn by hand only. On fitting a new filter always check that there are no leaks once the engine is refilled with oil and started.

HYDRAULIC BRAKE FLUID

This fluid is basically a vegetable oil and therefore it is critical that no contact is made between it and a mineral oil based product (e.g. kerosene, petrol, engine oil etc.) otherwise contamination of the fluid will result in swelling of the rubber components within the system.

Brake fluid also has chemical additives to provide the properties required such as Boiling Point, Viscosity, Corrosion Attack and Rubber Swell.

BOILING POINT

Because of the considerable heat generated in a braking system the fluid must be capable of withstanding this heat without boiling otherwise, braking efficiency is lost.

VISCOSITY

The fluid must be capable of withstanding all climatic conditions, whereby its flow rate is not effected by excessively cold conditions nor will it thin out at high temperatures.

CORROSION ATTACK

Brake fluid has to act as a lubricant for the components within the system, yet have the properties to prevent corrosion between the dis-similar metals used and the rubber components of the brake system.

RUBBER SWELL

A chemical additive is used to prevent the rubber seals from swelling. Apart from checking the level of the brake fluid in the master cylinder, and inspecting the system for possible leaks, during a service brake fluid loses its efficiency as it is very HYGROSCOPIC. (This is its ability to absorb moisture from the atmosphere.) As a result of this it is recommended that brake fluid be changed in a system annually and this procedure should only be carried out by a qualified motor mechanic.

AUTOMATIC TRANSMISSION FLUIDS

Are manufactured from a combination of high quality base oils with special additives to provide:- Anti-Foam Properties, Detergent Compounds, Anti-Wear Additives and Oxidation Inhibitors.

Automatic transmission fluids have to perform the variety of functions ranging from:- transmitting the torque from the engine to the transmission, lubricating the gears and bearings, influence the friction between the clutches and bands and prevent drying out of the various seals within the gearbox.

There are various types of automatic transmission fluids available on the market for use in different gearboxes, depending on the frictional quality of the oil, and therefore referral to the owners manual for its recommendation to the type to be used is a must.

Use of the wrong oil can result in a major overhaul of the unit being necessary which is quite expensive. This fluid is also used in some power steering units. Various manufacturers of automatic transmission units have different methods of checking the level within the gearbox so once again referral to the owners handbook is essential.

GEAR OILS

Gear oils have been manufactured to meet different gear lubricating conditions and have been classified as:- Straight, Extreme Pressure and Multi-Purpose E.P oils.

STRAIGHT GEAR OILS

This is a refined oil blended from mineral oil and containing an Anti-Foaming Agent. This type of oil is used where gear designs, tooth loads and temperatures are moderate. It is produced in viscosity ratings of 90, 140 and 250.

EXTREME PRESSURE OILS

A refined oil from mineral oil containing Anti-Foaming Agents and chemical compounds such as Sulphur and Chlorine Lead have been added. With the lower driveshaft position on most modern

vehicles the driving pinion is below the centre line of the crown wheel resulting in the teeth having to be cut on a curve. This creates very high temperatures and pressures with the rolling, wiping action between the mating teeth whereby ordinary straight gear oils would either be burnt or wiped off during operation.

E.P. Oils are manufactured in the viscosity ratings of E.P. 80, E.P.90 and E.P.140.

MULTI-PURPOSE E.P. OILS

This type of gear oil has the characteristics of Straight and Extreme Pressure Oils and are capable of meeting the requirements of most cars. They are inexpensive, stable and non-corrosive.

It is most important that when selecting gear oils that the correct type and grade of gear oil is made before either "topping up" or "changing" is carried out and therefore reference to either a workshop manual or service chart is essential.

GREASE

Lubricating grease is mainly a mineral oil base thickened with metallic soap, the actual lubricating process is carried out by the mineral oil in the grease. In the automotive industry, lubrication is either carried out by chassis or wheel bearing grease.

CHASSIS GREASE

Has four basic requirements

- Should not oxerdize or dry out.
- Relatively soft for handling.
- Ability to carry lubricant film without being squeezed out.
- Insoluble in water.

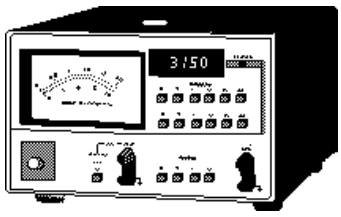
WHEEL BEARING GREASE

Wheel bearing grease in the main are Sodium- Soap based greases which gives this grease a higher melting point characteristic. Clay based grease with a higher melting point again should be used on disc brake equipped vehicles.

MULTI-PURPOSE GREASE

This is a lithium based or clay based grease suitable for lubrication of chassis, wheel bearings, universal joints etc., due to its water resistance, medium body, heavy duty characteristics and most suitable for very high temperature conditions.

CARCARE WORKSHEET 2



SERVICING - WORKSHEET

(1) What is the name given to a fluids resistance to flow?

_____

_____

(2) State two functions of an engine oil.

_____

(3) Name the type of fluid commonly used in a power steering unit.

_____

(4) Name two additives used in engine oils and state their function.

(a) _____

(b) _____

(5) “Soaps” are added to mineral oil to form what lubricant

_____

(6) Why is it necessary to change the engine oil in a motor vehicle?

_____

_____

(7) Explain how you would replace a throw-away canister type oil filter.

_____

_____

_____

_____

(8) Brake fluid has the ability to absorb moisture from the atmosphere.
What is the name given to this?

_____

(9) Name the different types of gear oils.

_____

_____

_____

(10) A multi-purpose grease has what type of base?

_____

CHAPTER 3

TUNE UP

The term tune up means checking all phases of engine operation, and making any needed light repairs and adjustments. Checking before and after adjustments are made is the basic part of a tune up.

Engines in poor condition cannot be tuned satisfactorily, and so diagnosis of the engine and its auxiliary systems, is an important element of a tune up. Without knowing what is needed, makes it difficult to know what should be done.

A good tune up therefore consists of 2 parts:-

- Diagnosis, Analysis or Trouble Shooting
- Correction which may be adjustment, replacement, or repair.

In carrying out a tune up a definite procedure should be followed to check and adjust all components that may effect power and performance which has been gradually lost through wear or deterioration.

The sequence for a tune up is as follows:-

- Battery
- Starter system
- Compression test
- Ignition system (spark plugs, distributor and timing)
- Charging system
- Fuel system
- Road test

BATTERY

The battery should be checked with a voltmeter to ascertain the state of charge, check the electrolyte level to ensure the plates are covered, this should be approximately 6 mm above the plates, or to the level indicator if fitted.

Avoid over-filling as this can cause electrolyte to be forced from the vent hole once the battery is charging, having a detrimental effect on the battery carrier, terminals and surrounding areas. The battery case should be inspected for cracks, sealing and distortion. Cracked cases can result from hold-down clamps being over tightened, or to loose.

The condition of terminals and cables should be examined to ensure they are secure and not corroded. If corroded, they can be cleaned with a mixture of baking soda and water. (Don't allow this mixture to enter the cells of the battery).

If the terminals have been removed for cleaning, they may be coated with petroleum jelly to assist in retarding the corrosions reappearance.

With the aid of a voltmeter check the battery cranking volts, this is carried out while the starter is cranking over the engine, and the voltage should not fall below 10.5 volts on a 12 volt system.

If this reading is satisfactory it proves the battery has sufficient capacity for good starting, and the performance of the starter indicates the condition of the starter motor, starter switch, cables and connections.

COMPRESSION TEST

To carry out a compression test a special tool called a compression gauge is required. (Refer *fig 9*).

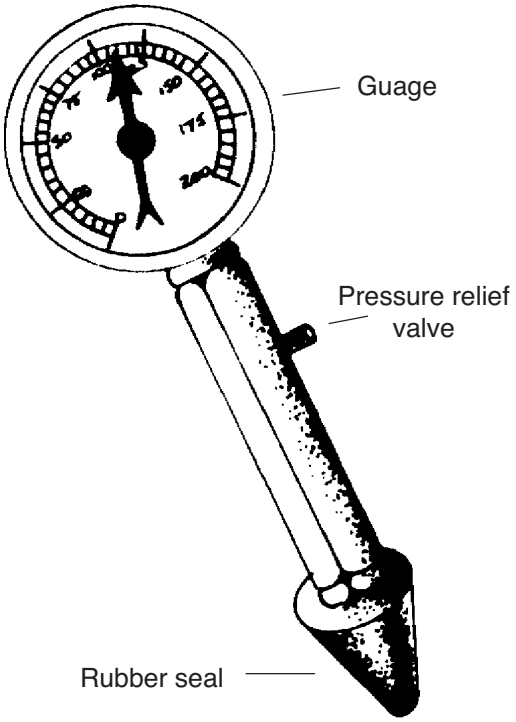


Fig 9 Compression guage

Before carrying out a compression test ensure the engine is at normal operating temperature, remove all spark plugs, and make sure the H.T. (high tension) leads are out of the way.

Set the throttle fully open and make sure the choke butterfly is open. (Do not pump the throttle as this will flood the engine).

Place the compression gauge into number 1 spark plug hole, and crank the engine over counting the number of revolutions for the gauge to reach its maximum reading.

Record this reading, release the pressure reading from the gauge, and continue with this procedure throughout the remaining cylinders, writing down each reading in the order it was obtained.

Compare the readings obtained a variation of 10% is allowable. If there is a difference in excess of 10%, further investigation is required as a satisfactory tune up will not be achieved. The pressure losses could be from worn rings, valves or cylinder head gasket.

To find out which of these it may be, insert a tea spoon full of engine oil down the spark plug hole, and repeat the compression test, once again recording the readings obtained.

While carrying out this second test the radiator should be full of water, and with the cap removed, the water level observed during the test watching for any rise in its level as the piston of the cylinder being tested is rising on the compression stroke.

A rise in the water level indicates a blown (or leaking) cylinder head gasket or a cracked cylinder head.

If the gauge readings on this (wet test) are the same as before, it indicates the valves are at fault. However should an increase in pressures be obtained, it indicates worn rings whereby a satisfactory tune up will not be achieved without the problem first being attended to.

Should the compression test reveal the pressures to be satisfactory the next step of the tune up can be commenced.

IGNITION SYSTEM

SPARK PLUGS

Before removing spark plugs from an engine always blow any dirt away from the area surrounding the spark plug to ensure no foreign matter enters the combustion chamber.

Upon removal a close examination should be made to the condition of the insulator and electrodes. *(REFER fig 10)*.

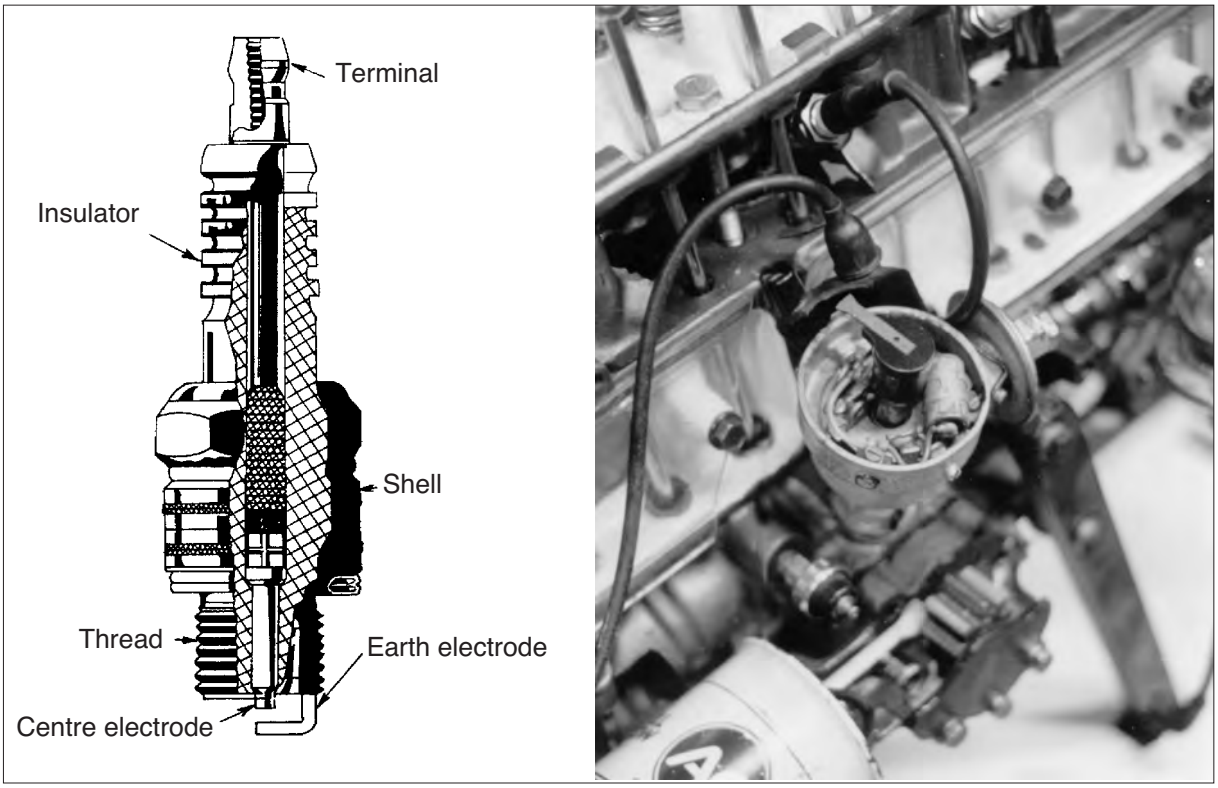


Fig 10 The spark plug location on motor block

Check the condition of the insulator for cracks, and for the build up of dirt which could cause tracking of the high voltage during operation.

The electrodes burn during operation, giving a round nose appearance to the centre electrode which increases the voltage required to jump the gap.

If the electrodes are not excessively burnt, they should be filed before re-gapping, so as to keep the firing voltage as low as possible. Should the electrodes be excessively burnt the plugs should be replaced making sure the correct Heat Range, Reach and Thread Diameter have been selected.

Check all new spark plugs before fitting

When adjusting the gap on a spark plug always bend the earth electrode, and when a minimum and maximum gap is given by a manufacturer (ie 0.7 mm - 0.8 mm) always select the minimum. This is to allow for the widening of the electrode gap once put into use.

Too close a gap can cause engine surge when running at part throttle and poor idling. While too large a gap causes missing under load, high speed miss and hard starting.

When replacing spark plugs into the engine always use a tension wrench to obtain the correct torque.

There are many different types and sizes of spark plugs which are designed for a number of different requirements. These design features include THREAD SIZE, REACH AND HEAT RANGE.

THREAD SIZE

The threaded shell portion of the spark plug and the attaching holes in the cylinder are manufactured to meet certain industry standards. The diameter is referred to as thread size. Those commonly used are 10 mm, 14 mm, and 18 mm. The 14 mm plug being most common in automotive applications.

REACH

The length of thread, and the thread depth in the cylinder wall or cylinder head are also standardized throughout the industry.

This dimension is measured from gasket seat of cylinder head to the end of the cylinder head thread. Four different reach plugs are commonly used :- 3/8 inch, 7/16 inch, 1/2 inch and 3/4 inch.

HEAT RANGE

During engine operation, some of the heat generated during combustion is transferred to the spark plug, and from the plug to the cylinder head through the shell threads and gasket.

The operating temperature of the spark plug plays an important role in engine operation. If the plug retains to much heat the air/fuel mixture may be ignited by contact with the heated surface prior to the ignition spark occurring. This condition is referred to as PRE-IGNITION.

The operating temperature of the plug tip can be controlled, within limits, by altering the length of the path the heat must follow to reach the threads and gasket of the plug.

Thus a plug with a short stubby insulator around the centre electrode will run cooler than one with a long, slim insulator. *(See fig 11)*.

COLD HEAT RANGE **HOT HEAT RANGE**

Fig 11 Heat range

No one spark plug, can be ideally suited for long periods of slow speed operation and still be the best possible type for high speed operation. Then there is that middle path for plugs that lie somewhere in between the two extremes.

TORQUE CHART FOR SPARK PLUGS

PLUG SIZE	CAST IRON HEAD	ALUMINIUM HEAD
10 mm	18-20 N.M.	12-15 N.M.
14 mm	35-41 N.M.	31-37 N.M.
18 mm	43-52 N.M.	38-46 N.M.

Never replace a spark plug using any lubricating type of compound on the thread, as it will reduce the heat transfer from the plug.

DISTRIBUTOR

Remove the distributor cap and visually inspect it for cracks both internally and externally, any evidence of a crack will normally give the appearance of a lead pencil mark on the bakelite. The external area should be thoroughly cleaned to ensure no H.T. voltage can track to ground, or cause cross firing between the plug lead towers. (Fig 12).

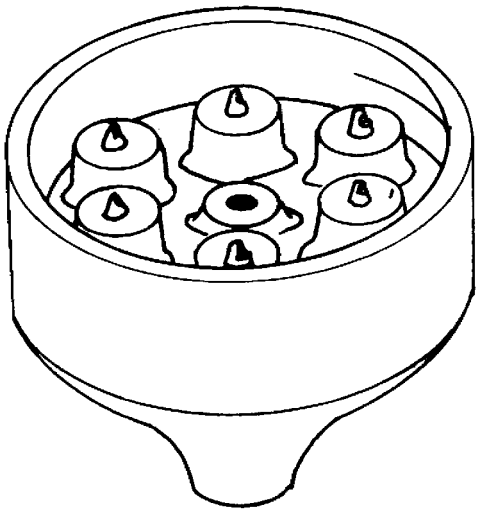


Fig 12 Inspect cap for defects

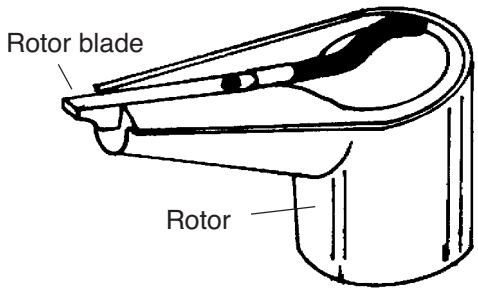


Fig 13 Rotor

The rotor should be removed from the distributor shaft and also inspected for cracks. (Once again giving the appearance of a lead pencil mark).

The end of the rotor blade should be inspected for burning, if attempting to clean this area **DO NOT FILE IT** as you will increase the air gap between it and the distributor cap terminals. If any excessive burning of the rotor blade or distributor cap terminals is evident the component should be replaced. *(fig 13*).

Remove the breaker points from the distributor base plate, and inspect their point faces for burning and pitting, should their be any evidence of this the points should be discarded and replaced with a new set. It is always advisable to purchase new points from the vehicles agents.

While inspecting the point faces pay attention to the colour of them as this often gives an indication as to the condensers condition. If the points appear to have been heated (a dark blueish appearance) it would be advisable to replace them.

When replacing contact points (especially new ones) always remove any traces of oil from their faces before installing them.

Turn the engine over until the heel of the breaker arm is on the highest part of the cam lobe, and with a clean feeler gauge of the correct specification in place, tighten the securing screws.

Always re-check the setting after tightening the screws to ensure that the points have not moved. When adjusting point clearance always use the maximum reading if the manufacturer has given a range in the specifications (ie 0.4 - 0.5 mm.), this will allow for settling in of the new rubbing block.

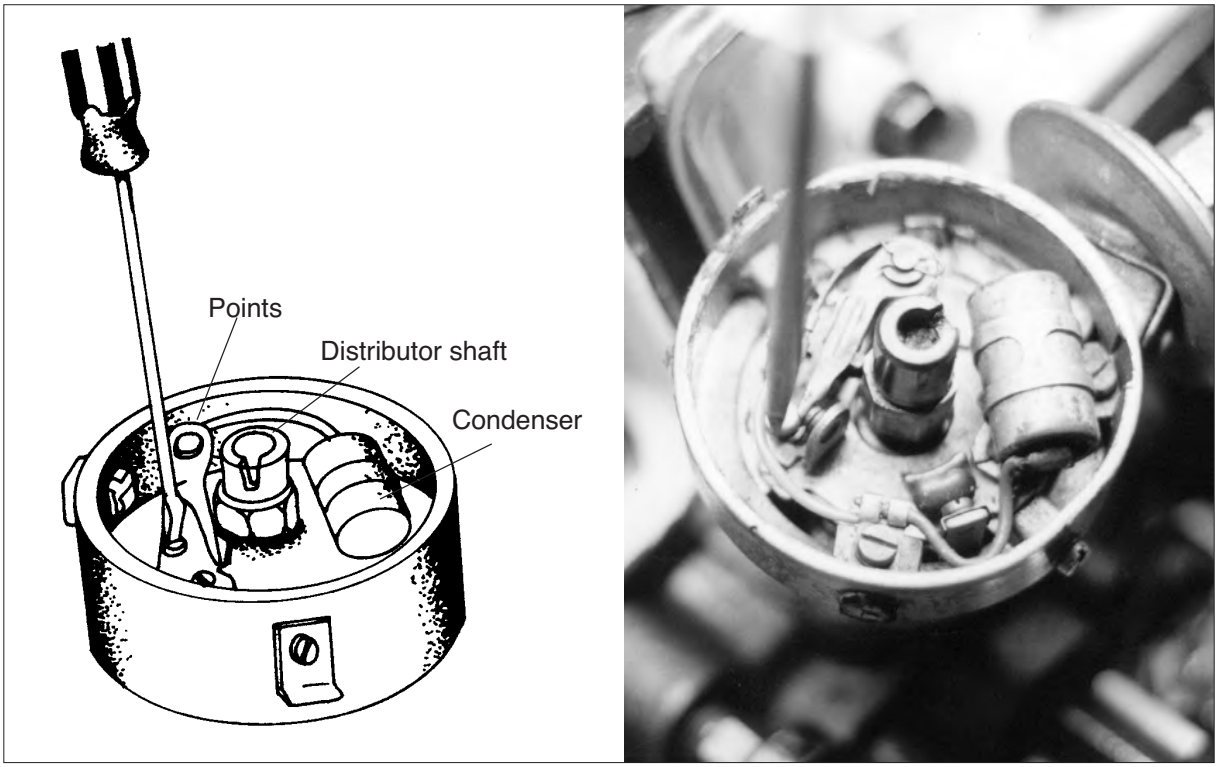


Fig 14 Points adjustment

Place a smear of high melting point grease on the cam lobes and replace the rotor arm. A check can be made on the centrifugal advance mechanism by twisting the rotor arm and ensuring that it springs back. Replace the distributor cap and H.T. leads.

If a dwell angle meter is available the cam angle should be checked, it is essential that the reading obtained fall within the manufacturers specifications, normally a range is given (e.g.. 50 - 54 degrees).

Although correct point opening is necessary for good starting and low speed operation, and correct cam angle is necessary for good high speed performance, both of the settings should fall within the specifications of the manufacturer.

While the dwell angle meter is connected, the reading should be taken at idle speed, and then at approximately 2000 R.P.M. if the reading obtained on the second test is greater than 3 degrees of the first, it indicates the distributor shaft has excessive wear and the distributor should be overhauled.

Once the points gap and cam angle have been adjusted the ignition timing can be checked.

Before commencing the ignition timing check the manufacturers specifications to see if there is any special notes. (Some manufacturers advise that vacuum hoses to the distributor be disconnected, others don't. Also note the R.P.M. recommended at idle as the idle speed and timing must be adjusted together).

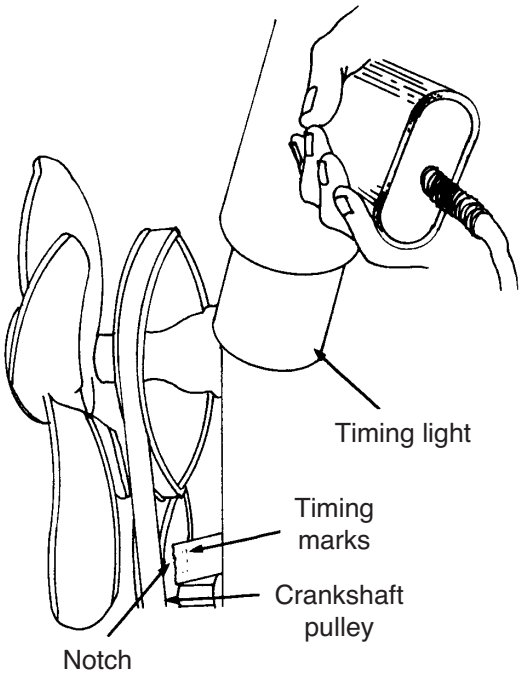


Fig 15 Use of a timing light

When using a timing light, always aim it straight and look down the beam of light to the timing mark. Should you be sighting at an angle to the beam, you are likely to be out several degrees. (Fig 15).

CHARGING SYSTEM

The fan belt should be inspected for damage. A fan belt that is beginning to deteriorate normally starts to develop the cracks on the inside of the V section, therefore it is necessary to twist the belt to allow the visual inspection to be carried out.

To check the charging system, connect a volt meter across the battery terminals and start the engine. With the engine running at approximately 1500 R.P.M. the battery voltage will rise to between 13.8 to 14.2 volts on a 12 volt system if the alternator is operating satisfactorily.

FUEL SYSTEM

Remove the air cleaner and inspect the condition of the element cartridge. Most air cleaners currently in production are of the throw away paper element type.

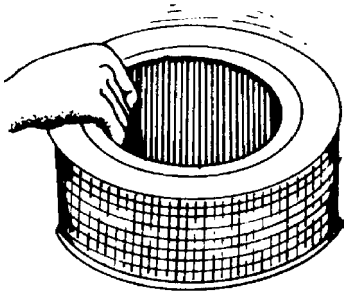


Fig 16 Air cleaner

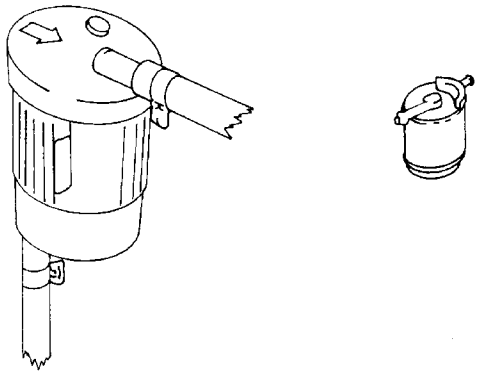


Fig 17 Throw away type filter

Inspect the element for the extent of dust that has accumulated on the outer surface of the paper, this can often be cleaned by gently tapping it on a flat surface paying particular attention that the sealing rubber edges are not distorted. *(Fig 16)*. Should the element be heavily loaded with dust, or have damage evident to the filter material (such as holes, or distortion to the sealing flanges) it should be replaced with a new one. This also applies if the filter has been damaged with oil.

The fuel filter should be inspected, this component can be of two types depending on the particular vehicles manufacturer.

On some models the fuel filter is incorporated in the fuel pump as shown in *(fig 18)*. On this type remove the filter bowl and clean out the sediment. Inspect the condition of the neoprene rubber seal before reinstalling the filter bowl. Other more frequently found filters today are the throw away type shown in *(fig 17)*. On this type it is impossible to clean them in any way and therefore they are replaced with a new one. It is advisable to replace this type of filter annually.

Other checks on the fuel system should include fuel lines and hoses for loose connections, evidence of fuel leakage (normally indicated by a reddish stain), worn or missing linkages and the mounting of the fuel pump to ensure it is tight on the engine block.

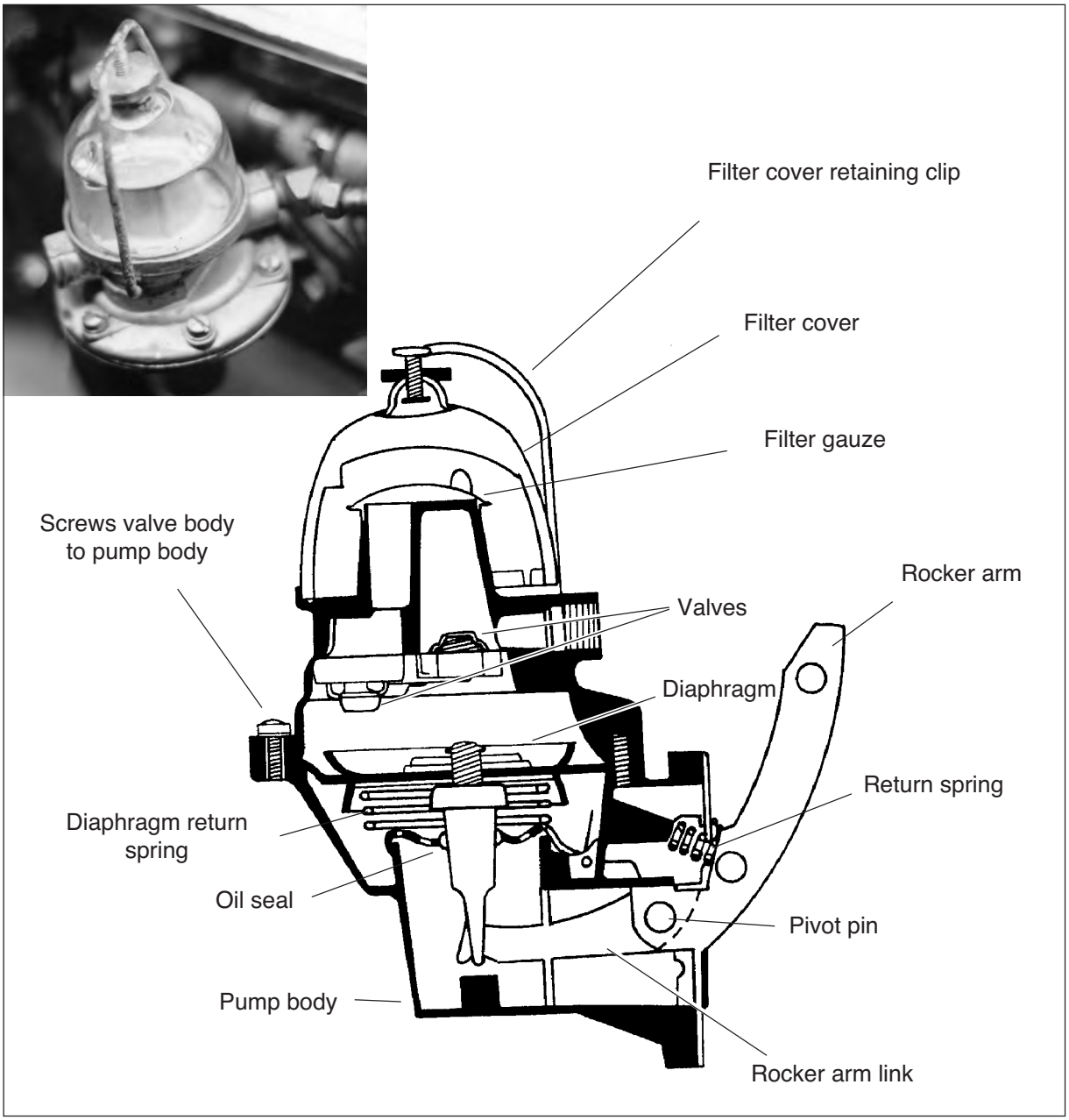


Fig 18 Fuel pump

ROAD TEST

When the road test is carried out it should be conducted over a variety of road surfaces and gradients, and be made in both directions over the same stretch of road, to cancel out favourable and adverse factors of wind and gradient, with particular attention to the performance of the engine.

CARCARE WORKSHEET 3

TUNE UP - WORKSHEET

Complete the following questions in your note book

(1) What does the term tune up mean?

_____

(2) Why should the battery be the first item to check when carrying out a tune up?

_____

(3) How would you carry out a compression test on an engine?

_____

(4) What should you look for when inspecting a set of spark plugs?

_____

(5) Explain the procedure for replacing a set of distributor points.

_____

(6) When checking the charging system on a vehicle, what do you look for?

_____

(7) Should any lubricating oil be used on the thread of a spark plug, and if not why?

_____

(8) Why should the end of a rotor arm NOT be filed?

_____

(9) With regard to spark plugs, what do the following design feature terms mean?

Heat range, reach, thread size.

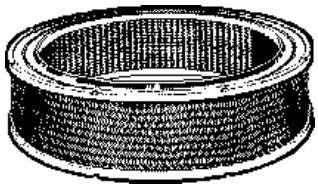
_____

_____

_____

CHAPTER 4

COOLING SYSTEMS



The cooling system for an internal combustion engine has two separate functions to carry out:-

(1) To remove excess heat as quickly as possible to avoid damage to engine parts such as engine valves, pistons starting to melt, and lubricating oil being burnt from the cylinder bore, and
(2) To avoid over-cooling so that an efficient operating temperature can be maintained over a wide range of conditions.

Heat is developed in an engine from the burning of the air/fuel mixture within the combustion chamber where temperatures can reach in excess of 2000 degrees Centigrade, and from the heat created by friction of the moving components.

There are two types of cooling systems found on motor vehicles, these being AIR COOLING and LIQUID COOLING. Although, the majority of automotive engines are liquid cooled while air cooling is favoured for small engines and motor cycles.

AIR COOLING

There are two important requirements for an air cooled engine to be efficient in its operation, these are large surface areas on the cylinder walls and cylinder head, and a constant supply of cool air. To assist in the cooling of a multi-cylinder engine the cylinders are often separated from each other, this allows for additional surface area and also more air to circulate between the cylinders.

The heat developed in an engine is transferred to the cooling fins of the cylinders by means of conduction and is then radiated to the surrounding air. The constant supply of cool air is provided by a forced air fan, which can be either the fins of the flywheel on a small engine, or by a separate fan driven by a "V" belt from the engine.

Shrouds of sheet metal are formed around the engine so that the air which is drawn into the centre of the fan and forced outwards by the blades is directed to flow over the cylinder head and block cooling fins, and remove the heat.

For good economy and performance an engine must reach operating temperature quickly but then maintain that temperature at a constant level, to achieve this a thermostat is installed within the air stream, which is connected to a control shutter. A thermostat / control shutter type air cooled engine is shown in *(fig 19)*.

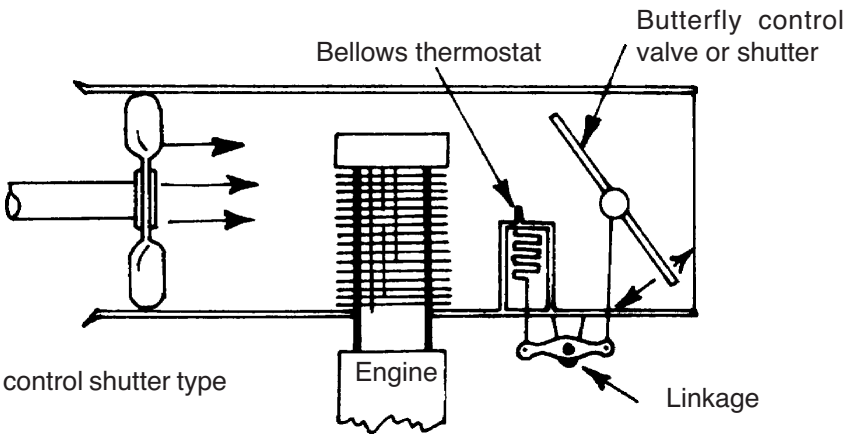


Fig 19 A thermostat / control shutter type air cooled engine

When the engine is cold the bellows are contracted and the control shutter is closed. The bellows being filled with alcohol, are extremely sensitive to heat so when the engine is started and the temperature rises on the bellows, the alcohol generates pressure proportional to the temperature and expands allowing the control shutter to open.

This bellows and control shutter provide a regulated flow of air to pass over the engine and maintain the operating temperature.

AIR COOLING ADVANTAGES:-

- No leaks can develop
- Corrosion cannot develop in the engine components
- The engine cannot boil
- Reaches operating temperature quickly

DISADVANTAGES OF AIR COOLING:-

- Power is absorbed by the fan required to cool the engine
- Manufacturing costs higher due to large fin area requirements
- Noisier than liquid cooled engines
- More prone to overheating under extreme operating conditions

LIQUID COOLING

With this type of system the coolant is contained in the engine block in casings called water jackets. These water jackets are cast into the engine block and cylinder head, and allow the water to circulate through them and the radiator by means of a water pump, which is driven by the engine.

In a liquid cooled system the pump draws water from the bottom tank of the radiator, and circulates it around the water jackets of the engine block and cylinder head, and on into the top tank of the radiator. As it flows down the radiator tubes it is cooled by the air flow passing over the radiator fins and re-enters the bottom tank of the radiator.

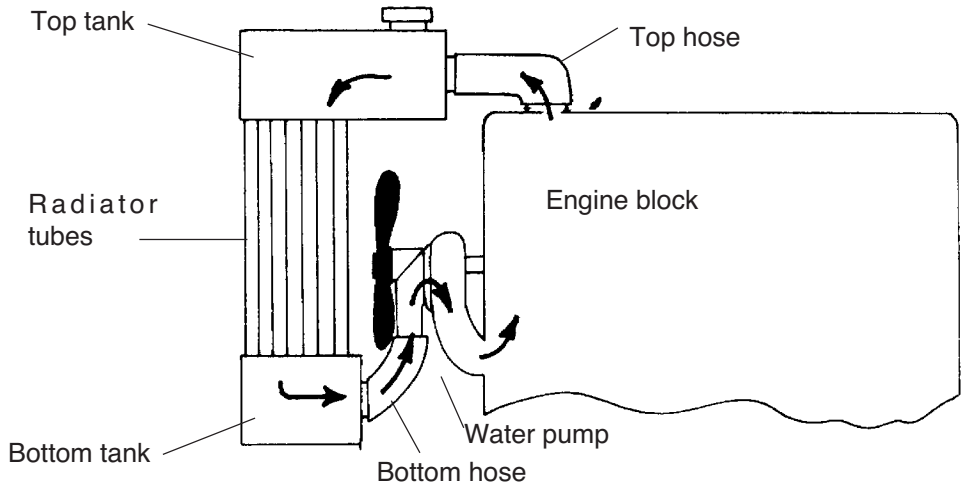


Fig 20 Circulation of water in a liquid cooled system

The water pump is a centrifugal type pump which does not develop much pressure but circulates the water very efficiently.

The pump housing is manufactured from either cast iron or more commonly today aluminium, and contains the impeller shaft and impeller, which runs on a double row bearing. The unit has a special seal which prevents water leaking from the pump.

Engine fans are usually mounted on the water pump shaft, and are used to draw air through the radiator.

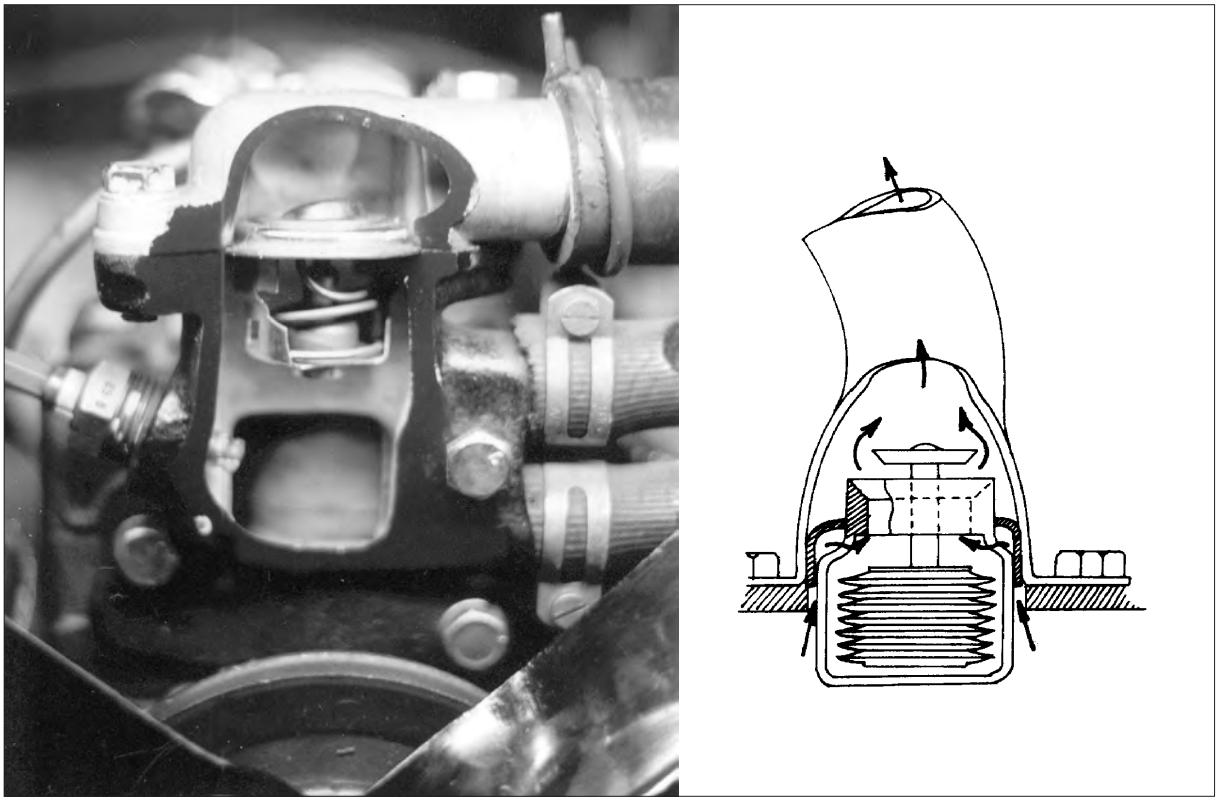


Fig 21 A bellows type thermostat

Some fans have a shroud which improves the fans efficiency by ensuring that the air is drawn through the radiator. Although most fans draw air through the radiator, some engines (especially east-west) push the air out through the radiator.

Variable speed fans are used by some engine manufacturers and these are driven by a fluid coupling which allows the fan speed to be reduced during high speed operation where sufficient ram air flow is being past over the radiator to obtain satisfactory cooling.

The radiator is usually made of brass or copper to avoid rusting, and allows for a large volume of water to be contained in contact with a large volume of air, so that the heat can be transferred away from the water.

It is important that the condition of the fins of a radiator are in good condition as it is their function to absorb the heat from the tubes of the radiator, this allows for a very large area to be in contact with the surrounding air, to ensure good dissipation of the heat.

A thermostat is placed in the cooling systems water passage, normally between the cylinder head and the top radiator hose, to regulate the flow of water.

When the engine is cold the thermostat is closed so that water circulation is restricted, this allows the engine to reach operating temperature quickly.

As the engine temperature increases the thermostat opens allowing the water to circulate. It is important that when replacing a thermostat that the correct operating temperature one is used.

Various manufacturers use different opening temperatures on thermostats to suit different vehicles, the opening temperature is stamped on a thermostat. (i.e. 80 degrees C).

It is important that if a thermostat is found to be defective that it is replaced with a new one.

Don't throw them away, thinking they are not needed

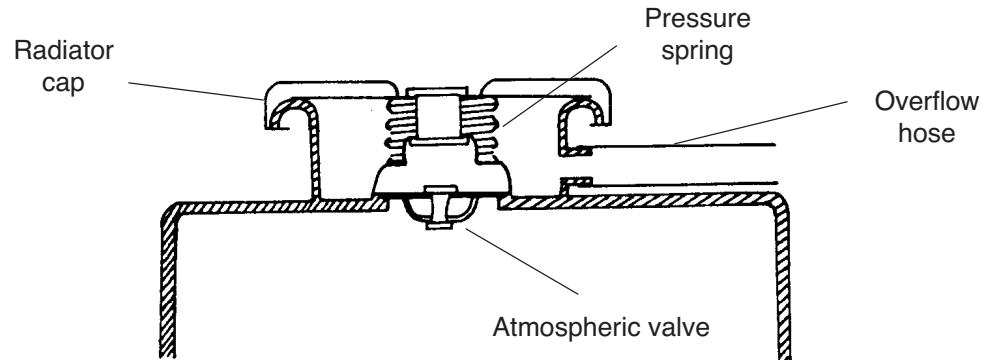


Fig 22 A radiator cap

PRESSURE CAPS:-

At atmospheric conditions and at sea level water boils at 100 degrees C.

To increase the boiling temperature of the coolant pressure caps are fitted to radiators. (For each 10 kPa the boiling point of water is raised by 2 degrees C.)

The pressure cap fitted to the radiator increases the pressure within the system allowing the water to reach higher temperatures without boiling.

Depending on the radiator caps pressure that is fitted it is possible that the water may reach 125 degrees C before boiling.

Radiator caps have two valves:-

- the pressure valve and
- the vacuum valve. (As shown above in *fig 22*.)

The pressure valve in a radiator cap consists of a rubber seal which is held on the seat of the filler spout by a calibrated spring.

Should the pressure in the cooling system develop above the springs pressure, the seal is forced off its seat allowing the excess pressure to escape to atmosphere.

The function of the vacuum valve is to prevent a vacuum forming within the system as the engine is cooling.

After an engine has been running, the water because it is hot has increased in volume, so as the engine cools the reduction in volume creates a vacuum which pulls open the vacuum valve and allows atmospheric pressure from the outside to enter and equalize.

Should a vacuum valve not function correctly, the radiator hoses collapse (draw together).

When removing radiator caps always turn them slowly, feeling for the safety ramp which has been designed in the filler neck. As the safety ramp stop is reached, allow the pressure to be relieved before removing the cap fully.

Never try to remove the radiator cap from an overheated engine as serious personal injury can result, allow the engine to cool first

PRESSURE COOLING SYSTEM ADVANTAGES:-

- Water pump efficiency is improved
- Engine efficiency is improved with the higher working temperatures
- Increased boiling temperatures
- Smaller radiators can dissipate the same heat as a large radiator operating at a lower temperature

To obtain satisfactory service from a cooling system it should be serviced annually. The service should include reverse flushing of the entire system (including the heater core) and on completion of the flushing new inhibitor added to the water to overcome the effects of corrosion and electrolysis.

Whenever adding new inhibitor to a cooling system always flush the system first as some inhibitors chemicals are not compatible with others and this can cause increased corrosion attack to the components of the cooling system.

The thermostat should always be removed when flushing a cooling system.

Ensure the radiator core is free from insects, dust and other matter that may restrict the normal flow of air over the cooling fins.

FAULT DIAGNOSIS

PROBLEM	*POSSIBLE CAUSE*
Engine overheats	Loss of coolant Insufficient coolant Inoperative thermostat Blocked radiator tubes Faulty pressure cap Cooling fins (obstructed air flow) Belt tension too loose
Loss of coolant	Leaking hose connections Leaking radiator Water pump leaking Welsh plugs leaking in engine block Defective radiator cap Cylinder head gasket blown Cracked cylinder head

WARNING:-

TEMPERATURE GAUGES DO NOT ALWAYS RECORD

AN OVERHEATING PROBLEM ESPECIALLY IF THERE IS A SUDDEN LOSS OF WATER

(A temperature gauge does not record unless it is in water.)

CARCARE WORKSHEET 4

COOLING SYSTEMS - WORKSHEET

(1) What are the two functions of a cooling system in an internal combustion engine?

(a) _____

(b) _____

(2) What are the two types of cooling systems found on motor vehicles?

(a) _____

(b) _____

(3) How is the heat of an engine transferred to the cooling fins?

_____

(4) Describe the operation of air cooling on a engine.

_____

(5) What is the name given to the component that maintains a constant operating temperature?

_____

(6) What are some advantages of an air cooled engine?

_____

(7) Describe the circulation path of the coolant in a liquid cooled system.

_____

(8) What is the material a radiator is usually made of?

_____

(9) What is a water jacket?

_____

(10) Describe the operation of a thermostat.

_____

(11) What is the purpose of fitting a pressure cap to a radiator?

_____

(12) What are the names given to the two valves of a radiator cap?

_____

(13) What are some of the advantages of a pressurised cooling system?

_____

(14) What would be some of the causes of an engine overheating?

_____

CHAPTER 5

TYRES AND WHEELS

TYRES

The tyres of a motor vehicle are a very important part and have a number of functions to perform these include:-

- carry the load
- cushion the vehicle
- provide a firm grip on the road for acceleration and
- steering and braking.

There are three main components in the construction of a tyre these are called the casing, tread and beads. (*fig 23* shows details of the construction of a tyre).

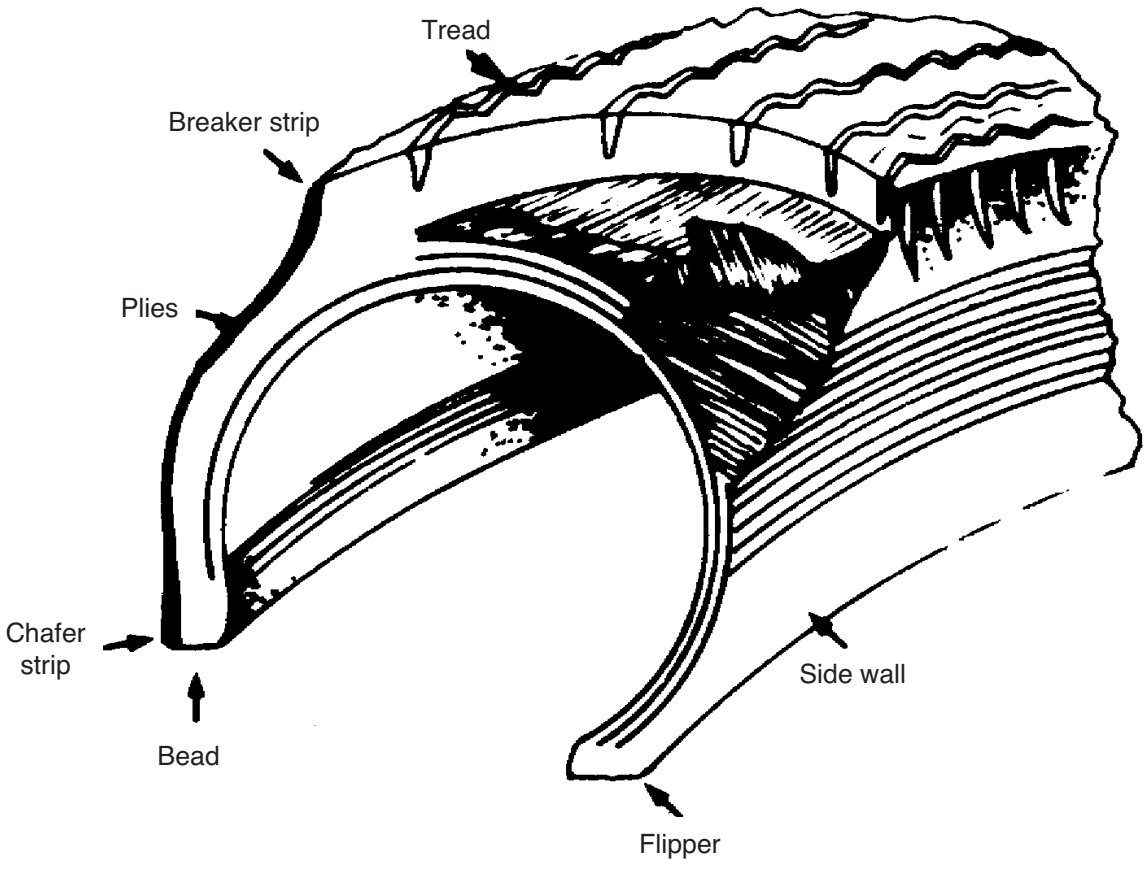


Fig 23 Construction of a tyre

The strength of a tyre is controlled by the casing which is made up of a number of layers called plies. A strong yet flexible casing is obtained by positioning each ply at an angle to the previous one as shown in *fig 23* above.

These plies on a modern tyre are made of either rayon, polyester or nylon which is far stronger, have greater heat resistance and are lighter than the cotton which was originally used in tyre construction.

The ply rating of a tyre does not necessarily mean that the tyre has that number of plies in its construction. A standard has been set that a tyre ply strength has 11,000 DENIERS.

Therefore a modern tyre with 2 ply construction but made from a strong synthetic fibre could have a strength of 44,000 deniers. Such a tyre would be referred to as a "four ply rating" as it has the same strength as a normal four ply tyre yet only has two plies.

Therefore the term ply rating is an indication of the tyres strength and not the number of fabric layers in the casing.

There are two types of tyre construction commonly found on the modern motor vehicle these are the radial ply tyre and the cross ply (or conventional) type.

The **RADIAL PLY** tyre has one or more plies of rayon, polyester or nylon going from bead to bead, (depending on the ply rating of the tyre), and between the plies and the tread has a belt which consists of two or more layers of either fibre-glass or steel cord, which stabilises the casing giving improved road handling characteristics.

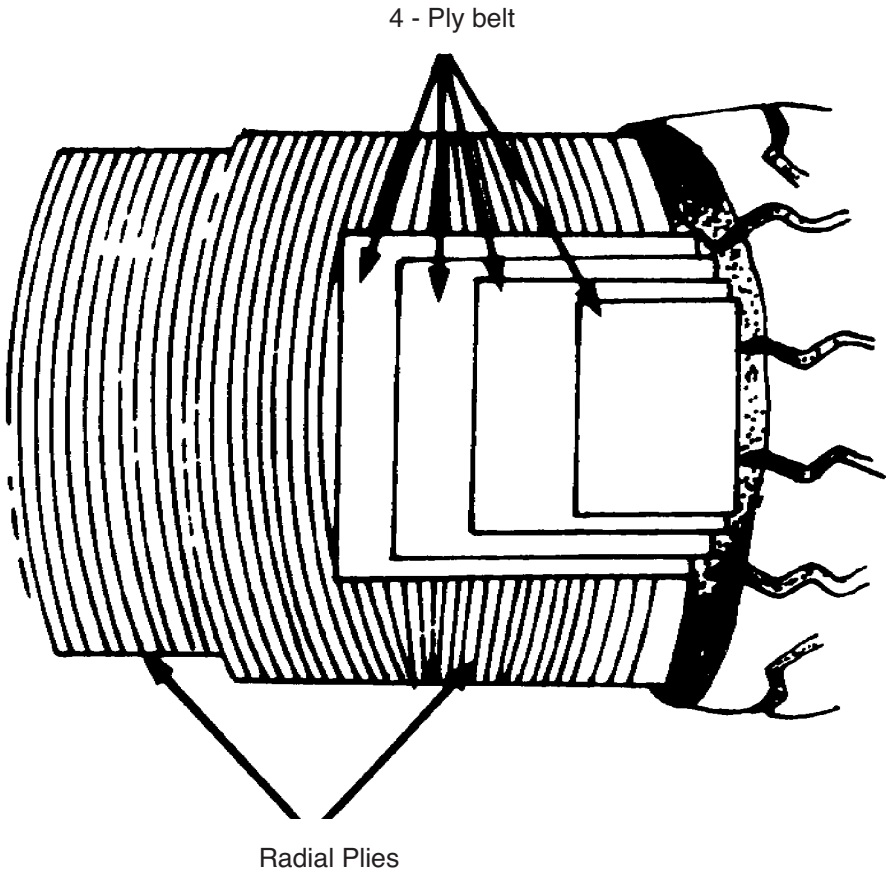


Fig 24 Radial ply tyre construction

RADIAL PLY TYRE CONSTRUCTION

The rigid belt, which is under tension when the tyre is inflated tends to produce a harsh ride at slow vehicle speed however gives radial ply tyres a number of good characteristics.

Road handling is improved, as the belt tends to hold the tread area flat on the road surface under most conditions, allowing for better traction and safer braking.

Radial ply tyres run cooler than conventional tyres as the plies do not cross each other, and the rigid belt distributes any shock distortion evenly around the perimeter of the tyre, because distortion is reduced so to is the heat generated within the tyre.

As the rolling resistance is reduced by the rigid steel belt, the fuel economy of the vehicle is normally improved. And so the advantages of radial ply tyres are improved road holding, run at reduced temperatures, last longer and improve fuel consumption.

The disadvantages are low speed harshness and slightly dearer to purchase than conventional tyres.

The CONVENTIONAL or CROSS PLY tyre is constructed with the plies arranged at an angle to each other. The angle of the cords varies with each manufacturer and application to which the tyre has been designed for. High speed road handling is improved with lower ply angles, however increases low speed ride harshness.

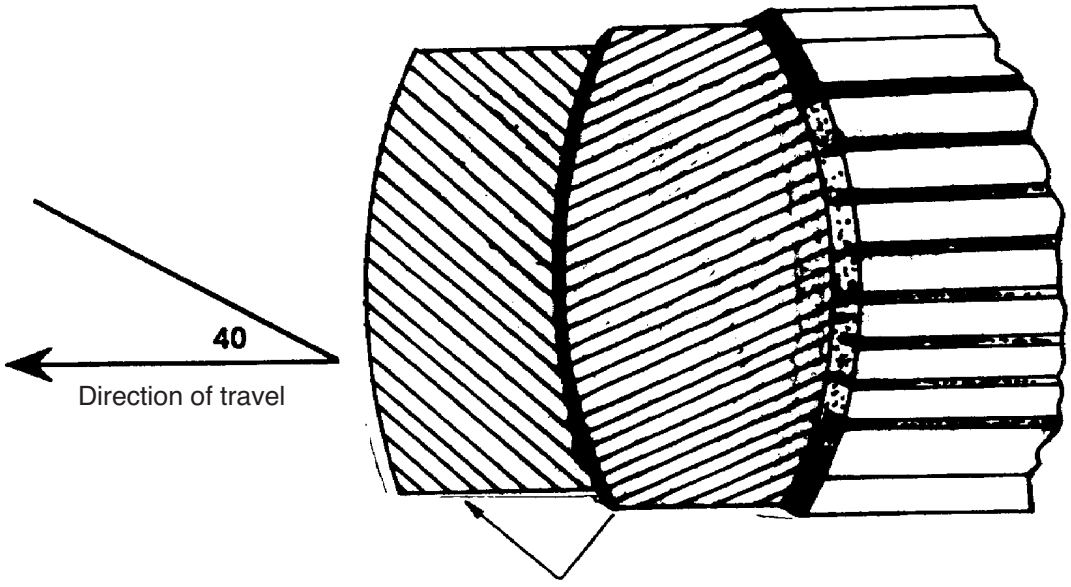


Fig 25 Tyre cross angles

CROSS PLY or CONVENTIONAL TYRE CONSTRUCTION

Cross ply tyres are safe and reliable however at sustained high speeds they tend to develop shock waves around the tyre which increases tyre wear and increases the tyres operating temperature which can result in tyre failure.

TYRE SIZE

The size of a tyre is indicated by a set of numbers

For example: 6,50 - 13

The first number indicates the width of the tyre and the second number is the diameter of the wheel rim that the tyre is designed to fit to.

Conventional or Cross ply tyre sizes are in the imperial measurement of inches while Radial tyre sizes are shown in millimetres. Therefore the size mentioned earlier is a conventional tyre of 6 1/2" width and fits a rim diameter of 13".

A Radial tyre would have the markings 185R14 which indicates the width of the tyre is 185 millimetres, the R indicating a Radial ply construction and the 14 indicating it is designed to be fitted to a rim diameter of 14 inches. (*fig 26* shows the dimensions of a tyre.)

Within the numerical markings on the side wall of a tyre are various letters indicating the performance rating of the tyre these include such symbols as:-

"L" indicates the tyre to be of low profile construction, and having a performance rating of 120 Km/h.
"S"indicates a performance rating of 180 Km/h.
"H" indicates a performance rating of 210 Km/h. which is a special high speed tyre.

Therefore a tyre marked 185HR15 indicates that the tyre is a special high speed radial.

Tyre profile is the shape of the tyres section width and in the years prior to 1938, tyres were made circular, meaning that the section width was the same measurement as the section height.

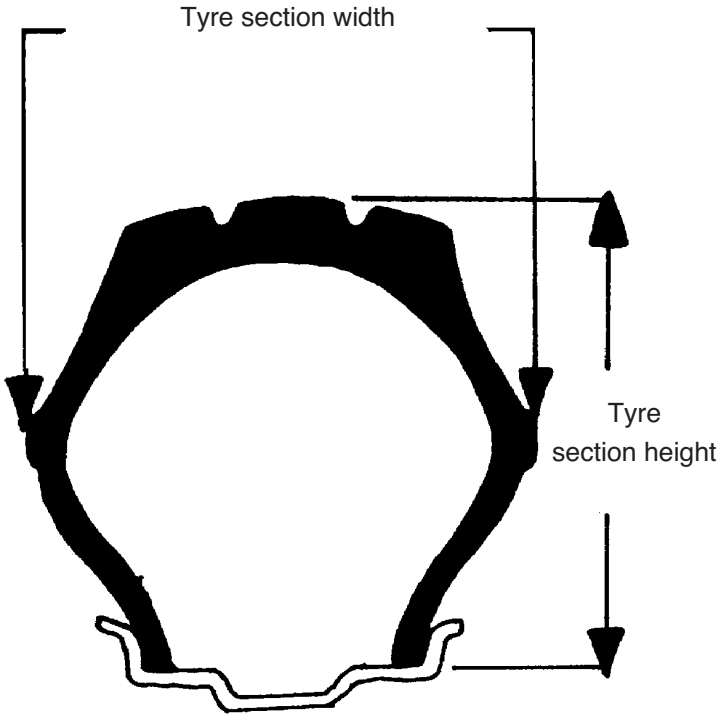


Fig 26 Tyre size, tyre profile

Advances in the production of motor vehicles have required the tyres to have a lower profile (meaning a more "flatter" appearance). This is the tyre has a lower section height than section width. The profile of a tyre is expressed as a percentage. The lower the profile of the tyre the more tread area that comes in contact with the road surface. As seen in *fig 27*.

Therefore a tyre with the markings 185/70HR15 indicates a 185 millimetre section width, 70 refers to the profile ratio, H refers to the speed category, R indicates a radial ply tyre, 15 refers to the wheel rim diameter in inches.

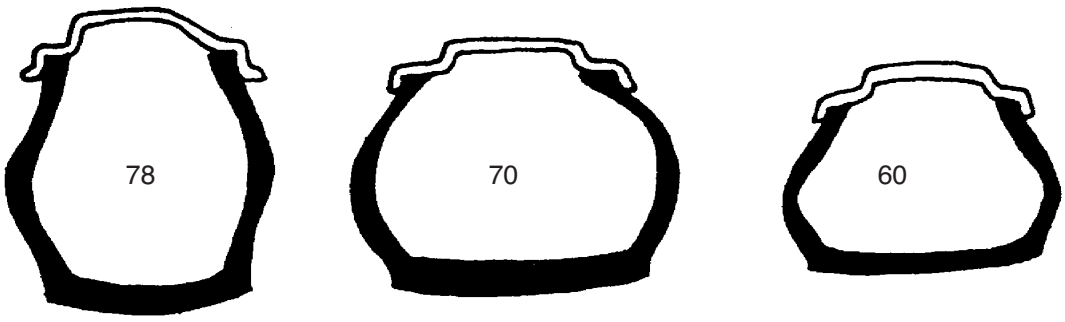


Fig 27 Tyre profiles

TYRE INFLATION

Tyres are often forgotten when it comes to checking the pressure of air within them, yet to obtain good traction, fuel economy, riding comfort and maximum tyre life it is essential that they are inflated to the vehicle manufacturers recommended pressure.

Under inflation leads to most tyre problems that are encountered, for when a tyre runs with insufficient air pressure the side walls flex excessively, this generates high temperatures which tend to soften the rubber and weakens the adhesion between the cords and tread.

Under inflation leads to the outer edges of the tyre tread area wearing excessively, and steering effort is increased.

Over inflation causes a hard ride, possible casing rupture and rapid wear in the centre of the tread pattern area.

Often a tyre is over inflated with the thought that it will improve the load carrying capacity of the tyre.

Tyre pressures should be checked regularly and only when the tyres are cold, NOT after the vehicle has travelled any considerable distance.

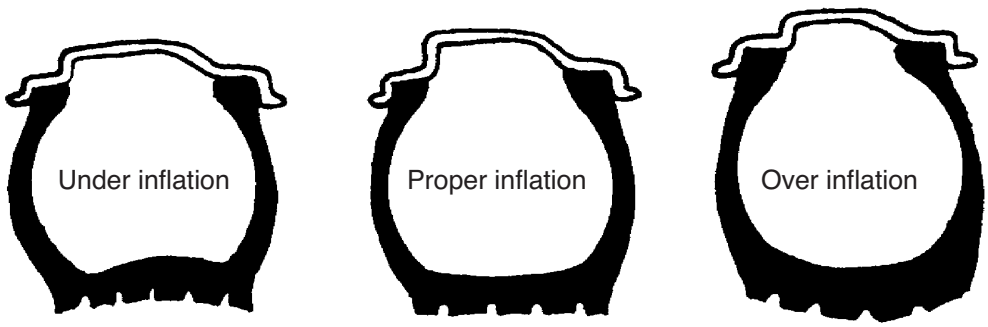


Fig 28 Tyre inflation effects on tread contact

TYRE INFLATION EFFECTS ON TREAD CONTACT

Although incorrect tyre pressure is the most common cause of excessive tyre wear, there are other mechanical reasons why tyres wear prematurely.

OVER LOADING

If a vehicle is over loaded, side wall flexing is increased which results in rapid and uneven tread wear due to the excessive heat that is built up in the tyre, in some instances over loading can result in the tyre "blowing out".

WHEEL ALIGNMENT

A vehicle is designed to have the front suspension set at manufacturers specifications for Toe-In, Camber, Caster, and King Pin Inclination. Should any of these adjustments be upset by hitting the kerb, or bad pot holes in the road then excessive tyre wear can result. This is mostly experienced in the first two settings of Toe-In and Camber. This type of wear patterns are illustrated in *fig 29*.

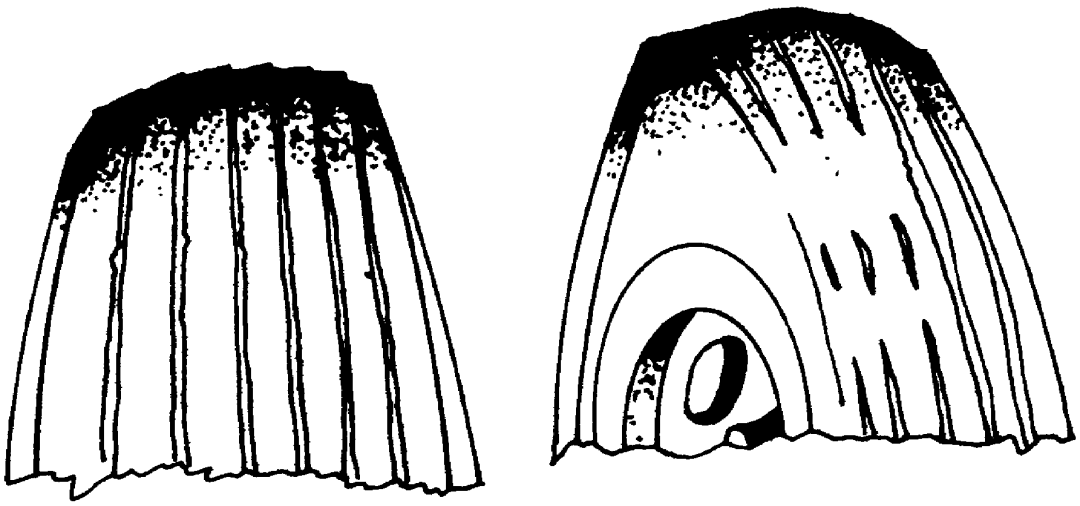


Fig 29 Excessive Toe in Wear Excessive Camber Wear

WHEEL BALANCE

An unbalanced wheel assembly will bounce along the road, causing flat spots to be worn around the tread area.

This condition is evident to the driver as the steering wheel will develop a "shimmy" or "vibration" to develop each time the vehicle reaches a certain speed, if when the speed is reduced or increased the "shimmy" in the steering wheel ceases it is an indication that the front wheels are out of balance.

Worn front suspension components and un-serviceable shock absorbers are also a contributing condition to tyre "flat-spotting".

This condition is shown in *fig 30*.

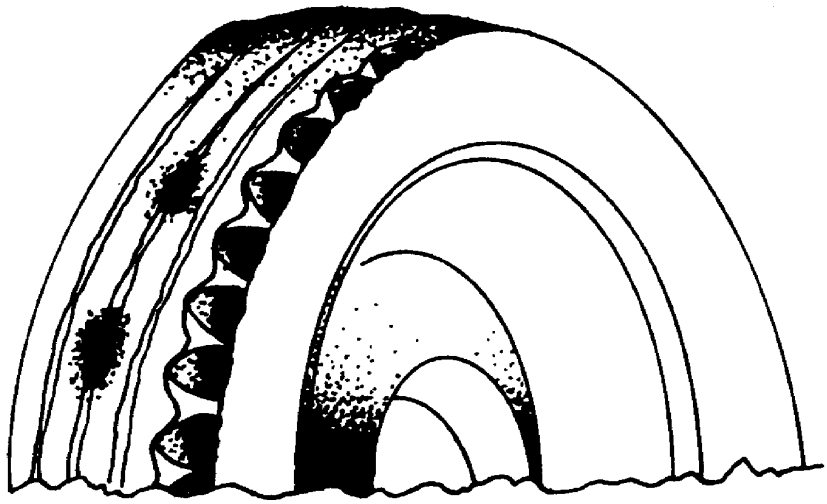


Fig 30 Tyre flat spotting

WHEEL ROTATION

No matter how particular you are with tyres wear patterns will develop especially on front tyres due to the changing conditions that they are subjected to. However, patchy and uneven wear can be reduced if the tyres are rotated regularly.

The rotation of wheels increases tyre life, and various rotation methods are used. Conventional type tyres can be rotated by a criss-cross method, however, many tyre manufacturers do not recommend this method for Radial type tyres, which should only be rotated front to back. Both methods are shown in *fig 31*.

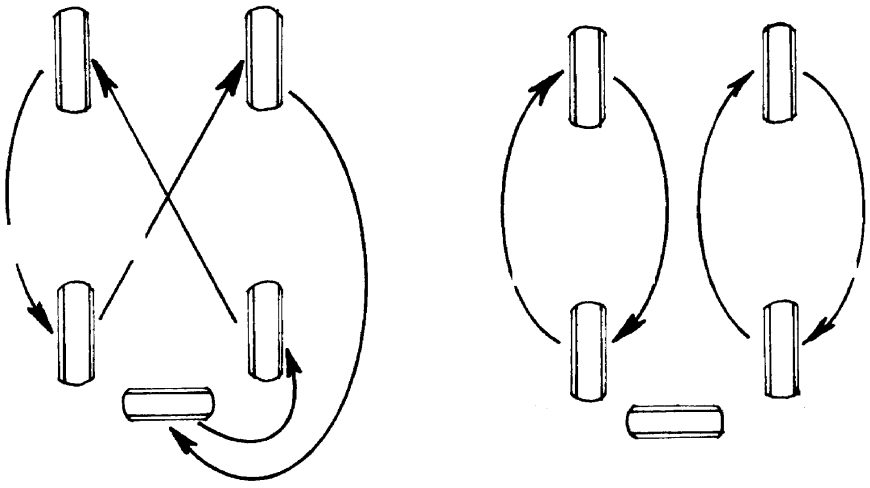


Fig 31 Criss Cross method Front to back method

A spare tyre should always be in as good a condition as the road wheels of the vehicle. A lot of drivers have patched up tyres for spare wheels thinking that it is only a spare.

---

it is no longer a spare once it has to be used, and this can often be dangerous.

WHEELS

There are three types of wheels in common use presently, these are the drop centre pressed steel, spoked type and the alloy type. The most common type of wheel on cars is the drop centre pressed steel.

The pressed steel wheel is light in weight and easy to clean, and consists of two pressed or stamped steel discs that are either riveted or welded to the circular rim.

The centre section of the rim is "dropped" to allow for ease of fitting and removing the tyre.

When one bead of the tyre is placed in the dropped area the other can be easily removed from the rim. Most wheels produced have safety humps (or ridges) to prevent the tyre from moving into the drop centre if the tyre should become under-inflated. As shown in *fig 32*.

The purpose for the slots or holes that are cut into the disc near the rim are to allow for air to circulate and cool the braking system.

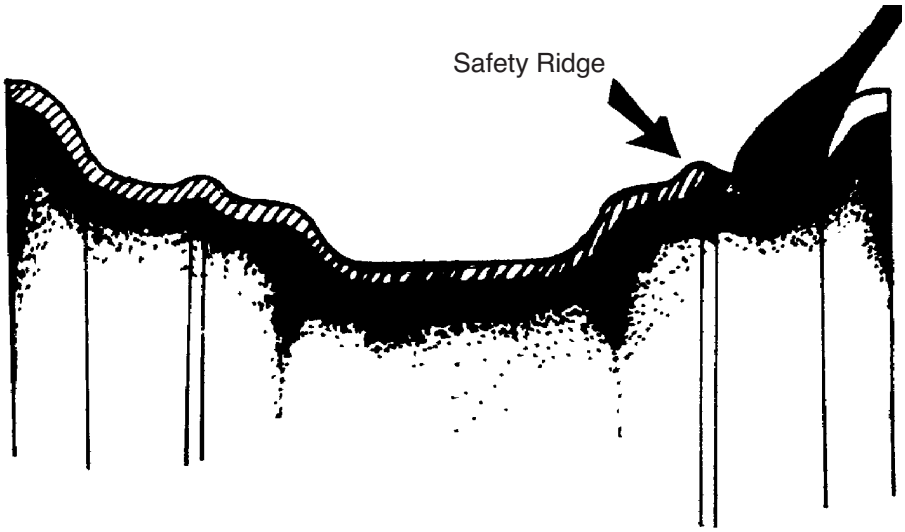


Fig 32 Safety Rim

Spoked type wheels are mainly used on sports cars and have the characteristics of being strong, light weight and have only one central nut to allow the wheel to be changed quickly.

Alloy wheels are manufactured from aluminium and magnesium and are in the main an "after market" option fitted by some car owners.

The light weight construction is strong, and as the alloys used are good conductors of heat, they allow the heat generated by the brakes and tyres to be dissipated more rapidly than steel type wheels.

Wheel size is identified by three measurements (all imperial) and are usually found stamped on the wheel rim. (i.e. 6Kx14)

6 = 6 inch wheel rim width

K = flange height .77 inches

14 = 14 inch wheel rim diameter

Flange heights are identified by letters such as J, K, JJ, etc. and all letters refer to specific heights.

Tyre manufacturers recommend that the width of a wheel rim (the measurement between the bead flanges) be 70% of the width of the tyre.

Regular inspection on the condition of the tyres is VERY IMPORTANT for all the power, efficiency and safety that is built into the modern motor vehicle is all reliant on four small areas of the tyres known as the "footprint".

Which is about the same size as the average males shoe.

CARCARE WORKSHEET 5

TYRES AND WHEELS - WORKSHEET

---

(1) What are the two of the functions of a car tyre?
(a) _____

(b) _____

(2) How is the strength of a tyre obtained and what is the name given to tyre ply strength?
_____
_____
_____

(3) What are the names of 2 types of tyre construction?
(a) _____

(b) _____

(4) The size of a tyre is 7.50 - 14. What does this mean?
_____
_____
_____

(5) A radial tyre is marked 185HR14 . What does the H indicate?
_____
_____

(6) What section of the tyres tread area would be showing wear if the tyre was used extensively in an under-inflated state, and what effect would this have on the tyre?
_____
_____
_____

(7) When should you check the pressures in the tyres?
_____
_____

(8) What are two other wear patterns that may develop on the tread area of a tyre?
(a) _____

(b) _____

(9) How would the driver of a vehicle be aware that a tyre and wheel assembly is out of balance?

_____
_____
_____

(10) Name the two methods of tyre rotation?

_____
_____

(11) What is the purpose of rotating tyre and wheel assemblies?

_____
_____
_____

(12) Name the three types of wheels used on motor vehicles?

_____
_____
_____

(13) What is the purpose of the safety humps or ridges on a wheel?

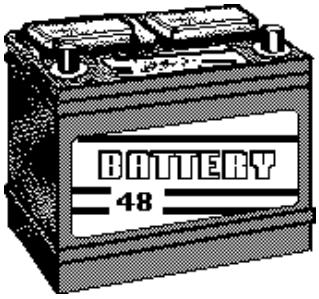
_____
_____

(14) A wheel is stamped 5JJx13. What does this indicate to you?

_____
_____
_____

CHAPTER 6

BATTERIES



One of the most important components of a motor vehicle is the battery, as it has to supply the necessary power to crank the engine when the ignition key is turned, and provide power for ignition and all other electrical components of the vehicle.

The battery should be clean and should be held secure in the carrier by the mounting hold down clamps.

If the exterior of the battery case is moist and much dirt has accumulated on it, current can leak from one battery post to the other, resulting in the battery getting into a discharged state.

BATTERY CARE

To clean a battery it should be removed from the vehicle however before doing this *PRECAUTIONS* should be taken as a battery contains *SULPHURIC ACID* and they generate an explosive mixture of *HYDROGEN AND OXYGEN GASES* in each cell.

batteries develop explosive gases so keep cigarettes, flames, sparks or other sources that may cause ignition of the gases well away

All electrical switches should be turned off, so that there is no chance of a spark occurring as the lead is removed from the battery post.

The earth (or ground) lead is always disconnected first, so that if the spanner should happen to touch the vehicles bodywork no sparks occur. The positive cable is then removed from its battery post.

The hold down clamp is then removed, which may be of two types, either across the top of the battery, or at the base of the battery case.

When lifting a battery from a vehicle, always keep the battery upright to avoid spilling the acid on clothing, skin or the vehicles bodywork.

If the electrolyte (acid) is spilt on your clothing it will cause holes, and will burn your skin. Should acid get spilt it should be washed immediately with a solution of baking soda and then flushed with lots of water, to minimize the damage it can cause.

Washing the outside of the battery with hot water, while brushing it with a soft brush will generally remove any accumulated dirt, acid or oil film, and as the hot water evaporates quickly the battery is left clean and dry.

The battery carrier and hold down clamps should be cleaned in the same manner as used for the battery and then painted with a special acid proof paint to give them added protection.

It is essential that prior to refitting the battery to the vehicle that the battery posts and terminals are cleaned thoroughly so that there will be no resistance to current flow.

Always visually inspect the case of the battery for cracks, and that there is no evidence of bulging, (which is an indication of internal damage). The case and cover should be smooth and flat.

On refitting the battery to the vehicle ensure that it is clamped securely (*BUT NOT OVER-TIGHTENED* which can cause case damage and cracks to form once the vehicle is put into use).

The positive cable is connected first, followed by the negative (or ground) cable. Once this is completed the terminals can be coated with grease to keep dampness away, which will minimize corrosion that leads to resistance.

Some special pressure pack products are sold at automotive accessory shops for this purpose.

ELECTROLYTE

The electrolyte level in the battery is most important. The electrolyte is Sulphuric Acid (H_2SO_4), however water only is lost in normal service and therefore it is necessary to top up the electrolyte level by simply adding water. It is recommended by most battery manufacturers that only distilled water be added to a battery.

If the electrolyte level is too low permanent damage to the plates internally can result, and the loss of capacity may result due to the plates becoming exposed to the air.

Where-by if too high, expansion due to the collection of gas bubbles on the plates and also temperature increases during charging may cause the battery to overflow.

The electrolyte level should be maintained at 10 mm. (3/8") above the plates, unless specified otherwise by the manufacturer.

Always ensure that the vent caps are replaced properly after checking the electrolyte level, to prevent the spillage of the electrolyte.

Should excessive topping up of electrolyte be necessary and there is no visible leaks from the case of the battery then it is possible that the electrical system is overcharging, and adjustment of the voltage regulator is required. This should only be carried out by an Automotive Electrician.

TERMINAL DESIGNS

Terminal designs used on batteries come in three types these are the Tapered Top Terminal, the Side Terminal and the "L" Terminal. The Tapered Top type being the most common in use on motor vehicles.

TAPERED TOP TYPE

This type of terminal uses tapered posts built to a standard by all manufacturers, so that all cable clamps will fit any battery.

The positive post is always slightly larger than the negative post, so as to avoid the possibility of incorrectly connecting the leads to the wrong post there-by causing reverse polarity.

The positive terminal 17.5 mm (or 11/16") diameter at the top of the taper while the negative post has a diameter of 15.88 mm or (5/8") at the top. The minimum length under the standard for a post is 15.88 mm (or 5/8").

SIDE TERMINAL

The Side Terminal type is moulded into the side of the case near the top edge of the battery.

The battery cables are attached to these terminals by a special bolt which screws into the terminal post.

The bolt for this type of terminal is of a special design and should it get misplaced then it is necessary to replace the entire cable which is sold complete with the bolt.

To prevent terminal damage on this type of battery it is recommended that a tension wrench be used and the bolt be tightened to the manufacturers specifications, or terminal damage will result.

"L" TERMINAL

The "L" Terminal is often used on European cars, light duty vehicles and marine applications. The battery cable is attached to the terminal by means of a bolt and nut (and some times by a wing nut).

TESTING AND CHARGING

Like any working equipment a battery has a life cycle, and with regular testing a warning of eminent battery failure will avoid a possible breakdown on the side of the road.

To obtain a complete assessment of a batteries condition two tests are required to be carried out:-

- To assess the state of charge
- To determine the battery condition.

STATE OF CHARGE

To determine the state of charge of a battery a HYDROMETER is required. This instrument measures the specific gravity (or density) of the electrolyte.

A Hydrometer is operated on a syringe method, whereby enough electrolyte is drawn into the barrel of the hydrometer to enable the float to move freely with no pressure exerted on the bulb.

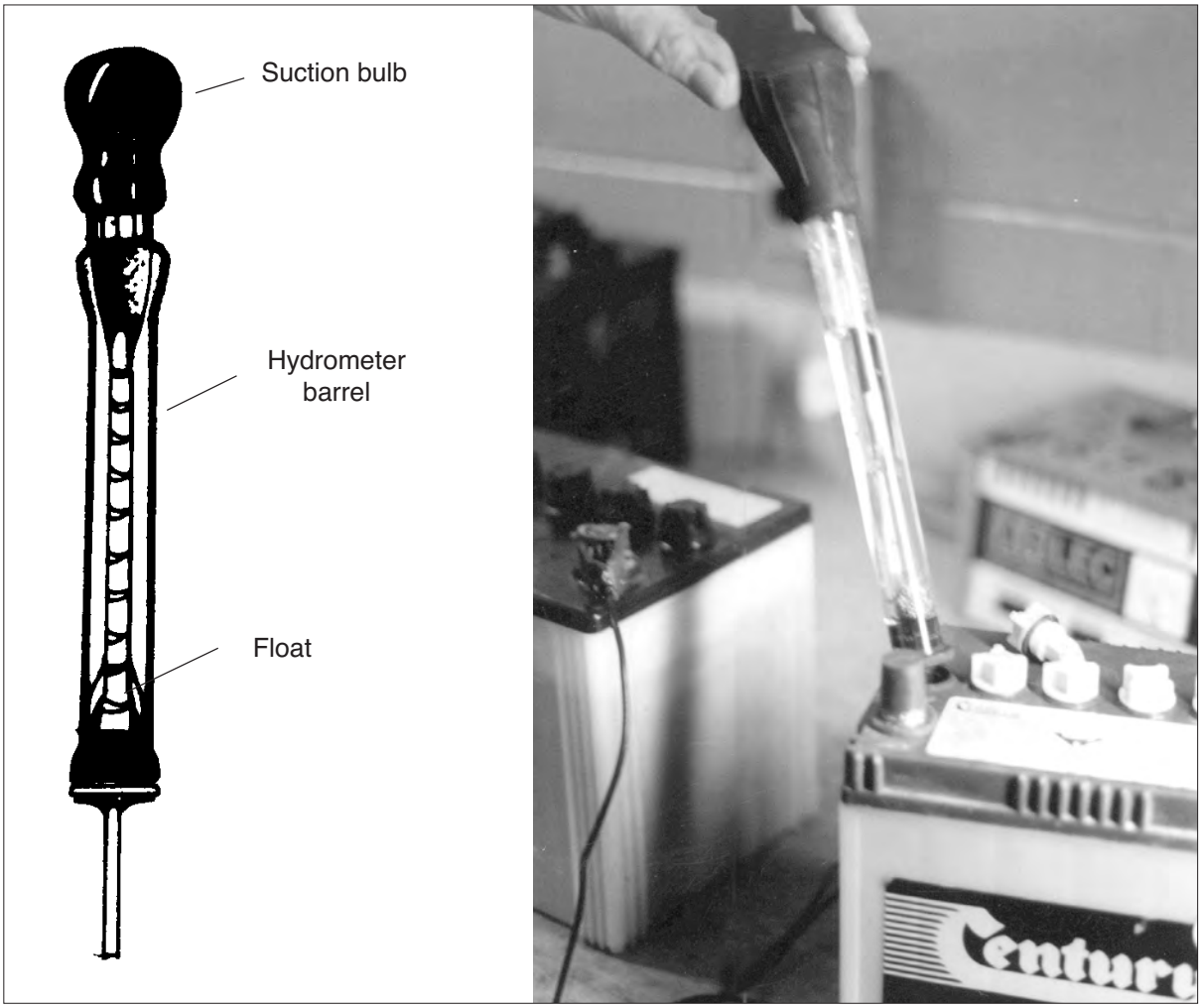


Fig 33 Hydrometer

When reading the specific gravity graduation on the hydrometer ensure that the barrel is held vertically, so that the float is not rubbing on the side of it.

The specific gravity of the electrolyte is taken and recorded in each cell of the battery.

A fully charged cell the specific gravity at 25°C is 1.250, a reading of 1.200 is considered half charged while a fully discharged or (flat) reading would be 1.150. Any reading below this the vehicles lights may operate but there would be insufficient charge to start the engine.

The specific gravity test should never be taken immediately after topping up a cell with water. The battery should be charged for at least 30 minutes to ensure that the water has mixed with the electrolyte to allow for accurate readings to be obtained.

Specific gravity readings vary with temperature and if the electrolyte is above 25°C, seven points (or 0.007) need to be added for every 10°C the temperature is above. Deduct seven points (or 0.007) for every 10°C the temperature is below 25°C.

BATTERY CONDITION

To carry out this test a High Rate Discharge Tester is required, which indicates the batteries ability to deliver a high current over a short period without output voltage falling too low for engine starting and ignition requirements.

This test can only be carried out to a battery that has a specific gravity of 1.200 or higher. A battery that has a lower state of charge than this will not give a true indication of its condition.

The test is conducted by applying a discharge load to the battery through a fixed resistance for approximately 10 seconds and recording the voltage drop of the battery.

A satisfactory reading for a 12 volt battery under this test is for it to maintain 8 volts or higher.

If the reading is below this figure, and the hydrometer test showed that the battery was charged then it indicates that the battery is faulty.

When carrying out these tests the battery should be removed from the vehicle so that any suspect fault showing up during the tests indicates that it is the battery that is at fault and not the vehicles electrical circuit.

Any doubtful battery should be left stand for several days between charging and testing whereby any very small "short" internally in a cell will be able to be noticed.

CHARGING

A battery can only be charged by Direct Current. On a vehicle this can be either by a (D.C.) Direct Current Generator or by a (A.C.) Alternating Current Alternator rectified to D.C.

There are various battery charger types available on the market from Constant Current Chargers (constant amperage), Constant Potential Chargers (constant voltage), Fast Chargers and Trickle Chargers.

CONSTANT CURRENT CHARGERS

In this type of charging, the charging current (amperage) is kept at a constant level throughout the duration of the charge no matter what the rise in cell voltage is.

CONSTANT POTENTIAL CHARGING

In this method, a fixed resistance is in series with the battery to limit the current flow.

The charging current is regulated by the chargers output voltage against the batteries voltage, where on commencement of the charge the amperage flow is quite high and gradually reduces to a low rate as the battery reaches a full charge state.

FAST CHARGERS

A fast charger is useful to boost charge a battery in a vehicle. However this type of charging is dependant on the condition of the battery.

Batteries that are in good condition will accept a high rate of charge more readily than a battery that is old and in a sulphated condition.

Fast charging will only be accepted by a battery to 80% of its capacity, the remaining 20% must be carried out by a slow charge.

It is essential that the temperature of the electrolyte is observed for heavy gassing can be detrimental to the life of a battery.

TRICKLE CHARGERS

The name "trickle charge" is really a low rate charge that can be applied to a battery to keep it in a fully charged condition. Excessive trickle charging of a battery can shorten the batteries life.

---

for safety always ensure that chargers are switched off before connecting or disconnecting the leads to avoid the possibilities of sparks

---

CONNECTING JUMPER LEADS

When a "flat" battery is experienced it is common practice to connect jumper leads from one vehicle to the other stalled vehicle so that the stalled vehicle can be cranked over by the good vehicles battery.

Jumper leads MUST be installed correctly or damage may be experienced.

First the positive (RED) lead is connected to the positive post of the stalled vehicle then to the positive post of the service vehicle.

The negative (BLACK) lead should then be connected to a good clean earth on both engines, this is to avoid the possibility of any sparks near the batteries.

The vehicle with the good battery is then started and the throttle held at a fast idle so that the alternator output is at maximum, the stalled car can then be started and if the battery was only flattened by leaving some electrical item switched on then the vehicles own charging system will recharge the battery.

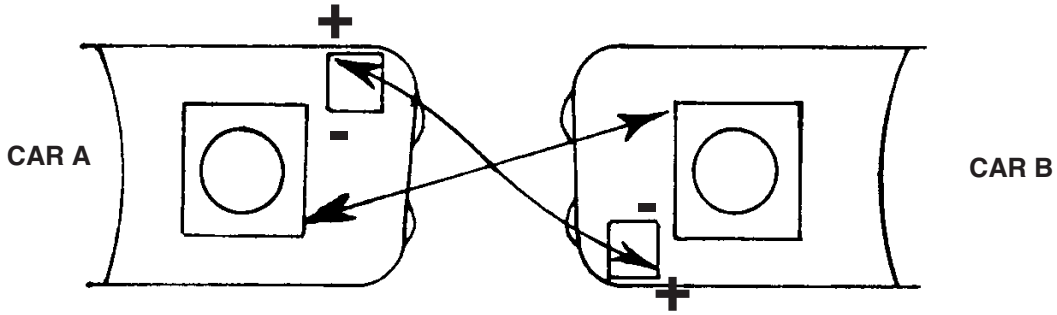
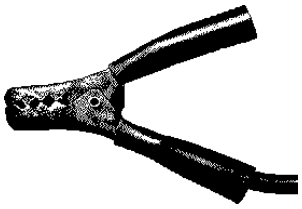


Fig 34 Lead connections for starting a car with a flat battery

CARCARE WORKSHEET 6

BATTERIES - WORKSHEET



(1) Why should a battery be kept clean?

_____

(2) Why should all switches be turned of prior to removing a battery cable?

_____

(3) Why should the ground (earth) cable be removed first?

_____

(4) How should the exterior of a battery be cleaned?

_____

(5) Why should sparks at a battery post be avoided?

_____

(6) What is the name of the chemical used as electrolyte in a battery?

_____

(7) At what level should the electrolyte level be kept at?

_____

(8) What would be the possible causes of the battery electrolyte level requiring regular topping up?

_____

(9) What are the names of the different types of terminal designs on batteries?

_____

(10) What are the two tests required to be carried out on a battery to ascertain its condition?

_____

(11) Name the instrument used to carry out a specific gravity test on a battery?

_____

(12) What would be the reading that would be obtained on a fully charged battery if the electrolyte temperature was 25°C?

_____

13) How is a high rate discharge test carried out?

_____

(14) With the aid of a sketch explain the correct proceedure to connect a set of jumper leads to a vehicle?

CHAPTER 7

GLOSSARY OF TERMS

ACCELERATION

The average rate of change of an increasing velocity or speed.

ADVANCE

A term used to indicate that ignition occurs before the piston reaches T.D.C.; To adjust the ignition to fire earlier.

AIR COOLED ENGINE

An internal combustion engine cooled by forced air.

AIR/FUEL RATIO

The ratio of the weight of air to the weight of fuel.

AIR GAP

The space between spark plug electrodes.

ALIGNMENT

The setting of the front or rear suspension of a vehicle.

ALPHA-NUMERIC

The use of letters and numbers for identifying tyres.

ALTERNATING CURRENT (A.C.)

A current of electrons that moves first in one direction then in the other.

ALTERNATOR

A component driven by the engine that produces electricity.

AMPERE

Unit or measurement of flow of electrical current.

ASPECT RATIO

A term used to express the ratio between the height and width of a tyre.

BATTERY RATING

A measurement used to rate a batteries ability to supply energy under specific conditions.

BLEEDING

A process used to remove air from a sealed system such as a hydraulic brake system.

BOTTOM DEAD CENTRE (B.D.C.)

The lower limit of piston movement.

CAM ANGLE

(Dwell angle) The number of degrees of rotation of the distributor shaft while the points are closed.

CAMBER

The number of degrees the front wheels of a vehicle are tilted outward or inward from a true vertical position.

CARBURETTOR

A component used to mix air and petrol in correct ratios.

CASTER

The backward tilt (or inclination) of the axle from the vertical plane.

CHOKE

A mixture enriching device in a carburettor. Used to restrict the flow of air.

CIRCUIT

A path through which fuel, oil or the electrical current flows.

COIL

Used in an ignition circuit to increase battery voltage to that required to jump a spark plug gap.

COMBUSTION

The burning of an air/fuel mixture within a chamber.

COMBUSTION CHAMBER

The space within the cylinder when the piston is at top dead centre. (T.D.C.)

COMPRESSION

To be reduced into a smaller space, to be condensed or reduced in volume.

COMPRESSION PRESSURE

The amount of pressure resulting from the piston moving from B.D.C. to T.D.C.

COOLANT

The liquid used in a cooling system.

COOLING SYSTEM

A unit that carries off and dissipates unused heat generated in an engine. (Can be air or liquid).

CORRODE

A chemical action that attacks a metal.

CURRENT

The flow of electricity (amps) through a conductor.

DEGREE

(Circle) 1/360th of a circle.

DEGREE

(Temperature) 1/100th part of a Celsius scale.

DETONATION

A knock in an engine resulting from the too rapid burning of the fuel in the combustion chamber.

DIFF

The abbreviation of the differential unit or final drive.

DIRECT CURRENT (D.C.)

The flow of electrons moving in one direction only.

DISCHARGE

(Battery) Amps (or current) flowing from a battery.

ELECTROLYTE

A mixture of sulphuric acid and water found in a battery.

FILTER

A component that removes foreign particles from oil, petrol, water and air.

FOUR STROKE CYCLE

A cycle of engine operation which requires four strokes in 720 degrees for completion.

GASSING

Boiling battery electrolyte that emits hydrogen gas during battery charging.

GROUND

(Electrical) Connection of an electrical unit to the engine frame etc. to return the current to its source (also known as "earth").

HIGH TENSION

Refers to the high voltage produced in an ignition coil and delivered to the spark plugs.

HOT PLUG

A spark plug that runs warmer than others in an engine.

HYDROMETER

An instrument used to determine the specific gravity of a liquid.

IDLING

Engine running without load at the lowest speed possible without stalling.

JUMPER LEADS

Heavy duty electrical cables with clips at each end, used for starting an engine.

MAG WHEELS

The term "MAG" is often used when referring to Alloy wheels.

OTTO CYCLE

A cycle of four events which occur in a gasoline engine in the following order:

(1) INTAKE

(2) COMPRESSION

(3) POWER

(4) EXHAUST

PISTON DISPLACEMENT

The cubical content of the cylindrical space created as the piston moves from B.D.C. to T.D.C. of its strokes.

PISTON STROKE

The length of piston travel within a cylinder.

PLY RATING

(Tyres) A guide to the tyres load carrying ability.

POWER

The capacity to do work, capacity to do mechanical work as measured at the rate it is being done.

RETARD

(Ignition Timing) To have the ignition timing adjusted later than specified.

SHOCK ABSORBER

A component fitted to the suspension at each corner of the vehicle to eliminate the vehicle bouncing after bumps.

SPARK

Current flow across a air-gap.

SPARK COIL

A device used to raise (or step up) the voltage by electromagnetic induction.

TIMING

The relationship of one moving component to another. eg. The relationship of the spark at the spark plug to the position of the piston in the bore.

TOP DEAD CENTRE (T.D.C.)

The upper limit of piston movement.

VACUUM

Result of reducing atmospheric pressure.

VISCOSITY

The tendency of a fluid to resist flowing.

VOLT

The unit for electrical force.

VOLTMETER

The instrument used to measure voltage.

WET PAPER PUBLICATIONS