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Kawasaki 650 Four Owners Workshop Manual

by Pete Shoemark

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About this manual

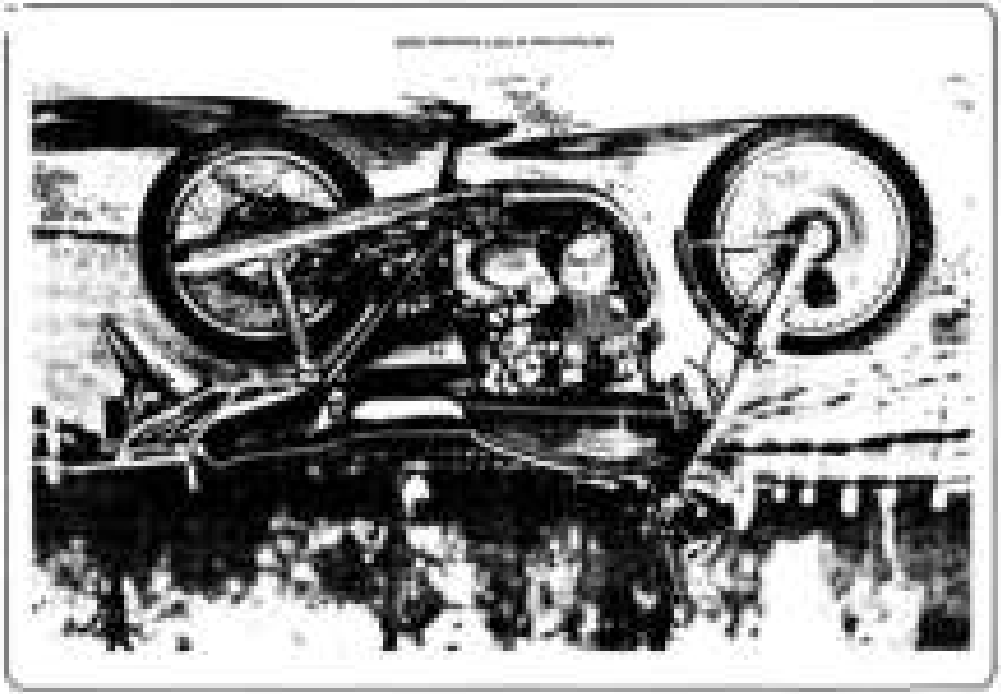
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Introduction to the Kawasaki 650 Four

[illegible]

Dimensions and weight

[illegible]		European models	GB models
Overall length		[illegible]	[illegible]
Overall width		[illegible]	
Overall height		[illegible]	
Wheelbase		[illegible]	
Ground clearance		[illegible]	[illegible]
Weight (dry)		[illegible]	

Ordering spare parts





Routine maintenance



Lubricating the suspension ball joints (front axle, left side)

Engine

Engine oil

Engine oil level

Check the oil level approximately every 2,500 miles (4,000 km) or at the specified intervals shown in the Maintenance Record Card. Check when cold. It is also essential that the oil level is correct. If the level is too low, serious damage to the engine may result due to lack of lubrication. Always maintain the oil level between the upper and lower dipstick markings.

Engine oil and filter change

Change the oil and filter at the specified intervals shown in the Maintenance Record Card. Ideally, this should be done when the engine is warm, as the oil will then flow more freely and any impurities will be held in suspension, so that they are drained off with the oil.

Place a container of at least 10 pints (6 litres) capacity under the drain plug. Unscrew the plug and allow the oil to drain. Unscrew the oil filter and discard it. Clean the sealing surface on the engine. Smear the rubber sealing ring on the new filter with clean engine oil and screw it into position. Refit the drain plug and refill the engine with the correct quantity and grade of oil. Run the engine for a few minutes and check for leaks around the filter and drain plug. Check the oil level and top up if necessary.

	Litres	Imp. pints
Engine	4.5 (4.75 US qts)	8
Engine and filter	5.0 (5.25 US qts)	9

Note: Always observe the recommended oil change intervals and use oil of the specified viscosity.

Cooling system

Coolant level

Check the coolant level in the expansion tank at the intervals specified in the Maintenance Record Card. The level should be between the MIN and MAX marks on the tank when the engine is cold. Top up with a 50% mixture of anti-freeze and water.

Coolant change

Drain the coolant by removing the plug from the bottom of the radiator and the cylinder block. Refit the plugs and refill the system with a 50% mixture of anti-freeze and water.

	Litres	Imp. pints
Cooling system	8.5 (9 US qts)	15

Note: Always observe the recommended coolant change intervals and use coolant of the specified concentration.

Fuel system

Fuel filter

Change the fuel filter at the intervals specified in the Maintenance Record Card. Unscrew the filter and discard it. Smear the rubber sealing ring on the new filter with clean engine oil and screw it into position.

Note: Always observe the recommended fuel filter change intervals.

Ignition system

Distributor lubrication

Lubricate the distributor at the intervals specified in the Maintenance Record Card. Apply a few drops of engine oil to the felt pad in the top of the distributor.

Spark plugs

Remove the spark plugs at the intervals specified in the Maintenance Record Card. Clean the plugs and adjust the gap to the specified setting. Refit the plugs and tighten to the specified torque.

	Gap	Torque
Petrol	0.7 mm (0.028 in)	27 lbf ft (3.7 kgf m)
Diesel	0.8 mm (0.032 in)	27 lbf ft (3.7 kgf m)

Note: Always observe the recommended spark plug change intervals and use plugs of the specified type.

Distributor points

Check the points gap at the intervals specified in the Maintenance Record Card. Adjust the gap to the specified setting.

	Gap
Petrol	0.4 mm (0.016 in)
Diesel	0.5 mm (0.020 in)

Note: Always observe the recommended distributor points change intervals and use points of the specified type.

Ignition timing

Check the ignition timing at the intervals specified in the Maintenance Record Card. Adjust the timing to the specified setting.

	Timing
Petrol	10° BTDC
Diesel	5° BTDC







3 Controlled cable advancement

Figure 3 shows the basic principle of the mechanism. It is similar to earlier models. Here, an unusual feature is in the cable clamping mechanism. Each clamp consists of two elements which can pivot on a common axle. Each element has a cable groove and a cable clamping surface. The two elements are spring loaded relative to each other.

4 Cable retract

When the machine is idle, cable retraction, clamping of cable in clamp, and fixing clamp relative to the frame are carried out by spring. Operation of solenoid 5 releases the clamp. This can be done by hand. Operation of solenoid 6 releases the cable. Both solenoids may be operated simultaneously. The clamp, thus released, is moved by the cable back to the initial position. Both solenoids are then released.

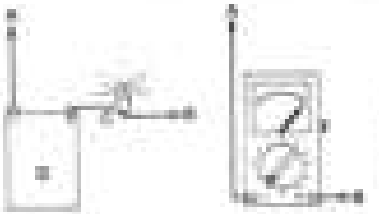
5 Load check

A load check has the same aim as the previously described load check and the same principle.

Cable machine with load check

Cable machine with load check and cable clamp

Cable machine with load check and cable clamp



Methodology methods of recording the agricultural crop

1. The computer recorder monitoring
2. Sensor
3. Sensor
4. Transmitter
5. Transmission line for transmission



Testing a control system

4 Changing the engine oil

Turn off the engine and engage with the engine oil in the internal combustion engine and to install them after a long. The engine must also not to overheated, then open the oil drain plug and drain the oil completely. After the oil has drained, replace the oil drain plug, tighten it completely. Fill the engine oil through the oil filler cap on the valve cover. Fill the engine oil to the level indicated on the dipstick. Start the engine and let it run for a few minutes to circulate the oil. Check the oil level again and add more oil if necessary.

Safety: Be careful not to overfill the engine oil, as this can cause damage to the engine. Dispose of the used oil properly at a designated recycling center. Always use the recommended type and grade of engine oil specified in the vehicle's owner's manual. Wear gloves and safety glasses to protect your skin and eyes from hot oil and chemicals.

5 Environmental conditions and maintenance

Environmental conditions can significantly affect the performance and lifespan of a vehicle's engine. Extreme temperatures, both hot and cold, can cause the engine to overheat or have difficulty starting. Dusty or sandy environments can lead to increased wear on engine components. Humidity can also affect the engine's performance, as it can cause corrosion and other issues.

To maintain the engine in these conditions, it is important to follow the manufacturer's recommended maintenance schedule. This may include more frequent oil changes, air filter replacements, and cooling system flushes. It is also important to use the correct type of engine oil and coolant for the specific environment in which the vehicle is operated.

Safety: Always follow the manufacturer's recommended maintenance schedule and use the correct type of engine oil and coolant. Be aware of the potential hazards of working in extreme environments, such as heat exhaustion or frostbite. Take appropriate precautions to protect yourself and others.

6 Engine oil and filter replacement

Engine oil and filter replacement is a crucial maintenance task that helps to keep the engine running smoothly and efficiently. Over time, the oil can become dirty and contaminated with debris, which can cause damage to the engine. Regularly changing the oil and filter helps to prevent this damage and extend the life of the engine.

To perform an oil and filter replacement, you will need a few basic tools, including a wrench, a drain pan, and a new oil filter. You will also need to purchase the correct type and amount of engine oil for your vehicle. Consult your owner's manual for the recommended oil type and capacity.

Safety: Always wear gloves and eye protection when working with engine oil. Be careful not to spill oil on the ground, as it can be harmful to the environment. Dispose of used oil properly at a designated recycling center.



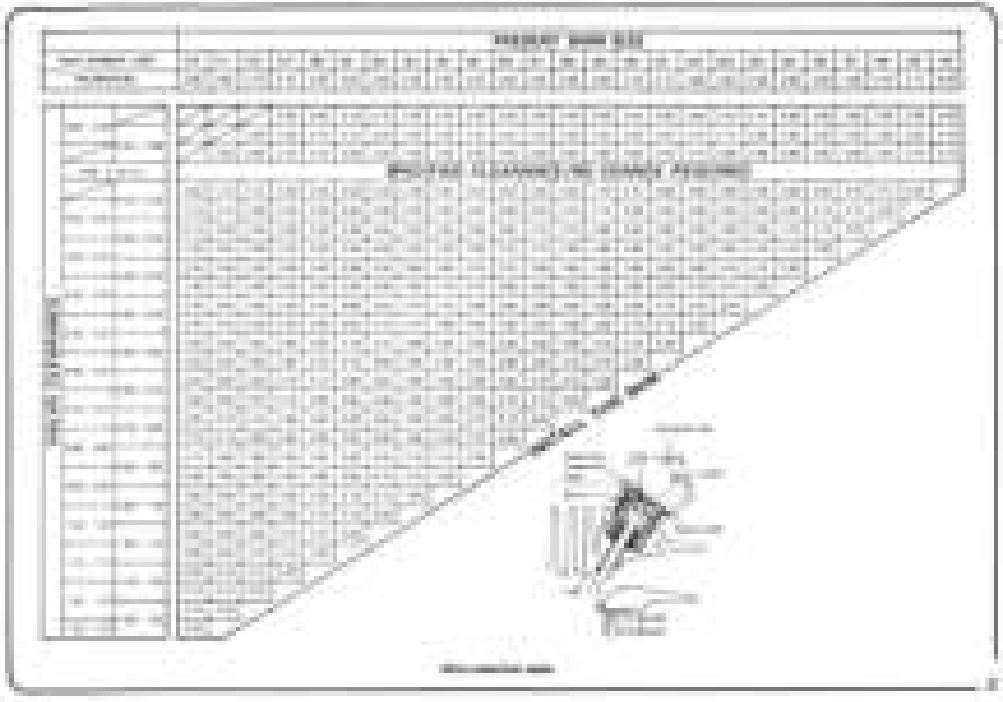
Basic tools for maintenance: Screwdriver, wrench and hammer



Figure 1 Caption for the first figure.



Figure 2 Caption for the second figure.



2 Changing the oil filter element

Change the engine oil as described under the 12 month/ 20000 mile heading. In addition, remove and renew the oil filter element which is located in a cartridge on the underside of the crankcase.



2.2 Oil filter cartridge (A) and element (B) – Turbo models

3 Changing the front hub damping oil

Check the handling on the road for signs of any loss of damping. Also check for signs of oil leakage from the front hub. Place a suitable stand under the engine/transmission unit to support the machine then raise the front wheel clear of the ground. Remove the front wheel. Unscrew the damping unit cover bolts and withdraw the cover, damping unit and spring. Clean away all traces of old oil and dirt. Refill the damping unit with the specified quantity of new damping oil. Refit the spring, damping unit and cover. Refit the front wheel and lower the machine to the ground. Check the operation of the front suspension.

4 Checking the steering head bearing adjustment

Place the machine on its centre stand so that the front wheel is clear of the ground. Push a suitable stand under the crankcase to support the machine then raise the front wheel clear of the ground. Grasp the bottom of the front forks and push and pull the assembly. Any movement between the steering head bearings and the frame indicates that adjustment is necessary. Refer to Chapter 5 for the adjustment procedure. Turn the handlebars from lock to lock. Any stiffness or notchiness indicates that the bearings are damaged and require renewal. Refer to Chapter 5 for the renewal procedure.

5 Steering play

Check for play in the steering by placing the machine on its centre stand and grasping the handlebar grips. Attempt to move the handlebars forwards and backwards. If any play is felt, the steering head bearings are in need of adjustment. Refer to Chapter 5 for the adjustment procedure.

6 Checking the swingarm bearings

Place the machine on its centre stand. Grasp the rear wheel and attempt to move it from side to side. Any movement indicates wear in the swingarm bearings. Refer to Chapter 5 for the swingarm bearing renewal procedure.

Quick glance
maintenance adjustments and capacities

Engine gasoline unit	[illegible]
Transmission	[illegible]
Front axle	[illegible]
Rear axle	[illegible]
Tire pressures	Front: [illegible] Rear: [illegible]
	[illegible] [illegible]

Recommended lubricants

Engine gasoline unit	[illegible]
Transmission	[illegible]
Front axle	[illegible]
Rear axle	[illegible]
Wheel bearings	[illegible]

Working conditions and tools

Chapter 1 Engine, clutch and gearbox

Engine

Type	Four-stroke, liquid-cooled, DOHC
Number of cylinders and bore	1 cyl: 2.0 in. (50 mm) [Sport, Trail, Adventure] 1 cyl: 2.2 in. (56 mm) [Sport, Trail, Adventure] 2 cyl: 2.0 in. (50 mm) [Sport, Trail, Adventure] 2 cyl: 2.2 in. (56 mm) [Sport, Trail, Adventure]
Cylinder arrangement	Horizontal, 1 cyl Horizontal, 2 cyl

Engine image

Base engine image	Base engine [Sport, Trail, Adventure]
Cylinder head image	Cylinder head [Sport, Trail, Adventure]
Cylinder head cover image	Cylinder head cover [Sport, Trail, Adventure]
Crankcase image	1 cyl: 1.5 in. (38 mm) [Sport, Trail, Adventure] 2 cyl: 1.5 in. (38 mm) [Sport, Trail, Adventure] 2 cyl: 1.8 in. (46 mm) [Sport, Trail, Adventure]
Engine mount hardware image	Engine mount hardware [Sport, Trail, Adventure]

Cylinder block

Cylinder block material	Aluminum [Sport, Trail, Adventure]
Sleeve type	Integral [Sport, Trail, Adventure]
Plating finish	Nikasil [Sport, Trail, Adventure]

Piston and connecting

Piston pin bore	0.5906 in. (15.000 mm) [Sport, Trail, Adventure]
Piston pin diameter	0.5905 in. (14.998 mm) [Sport, Trail, Adventure]
Piston pin length	1.3780 in. (35.000 mm) [Sport, Trail, Adventure]
Piston pin to piston clearance	0.0001 in. (0.002 mm) [Sport, Trail, Adventure]
Connecting rod to piston pin clearance	0.0004 in. (0.010 mm) [Sport, Trail, Adventure]

Ring and ring grooving

Ring end gap, top	0.0059 in. (0.150 mm) [Sport, Trail, Adventure]
Ring end gap, 2nd	0.0118 in. (0.300 mm) [Sport, Trail, Adventure]
Ring end gap, oil	0.0118 in. (0.300 mm) [Sport, Trail, Adventure]
Ring side clearance, top	0.0020 in. (0.050 mm) [Sport, Trail, Adventure]
Ring side clearance, 2nd	0.0020 in. (0.050 mm) [Sport, Trail, Adventure]
Ring groove width, top	0.0492 in. (1.250 mm) [Sport, Trail, Adventure]
Ring groove width, 2nd	0.0492 in. (1.250 mm) [Sport, Trail, Adventure]
Ring groove width, oil	0.0787 in. (2.000 mm) [Sport, Trail, Adventure]
Ring thickness, top	0.0469 in. (1.190 mm) [Sport, Trail, Adventure]
Ring thickness, 2nd	0.0469 in. (1.190 mm) [Sport, Trail, Adventure]
Ring thickness, oil	0.0768 in. (1.950 mm) [Sport, Trail, Adventure]
Ring type	Barrel [Sport, Trail, Adventure]
Ring material, top/2nd/oil	Steel [Sport, Trail, Adventure]
Ring coating	Nitrided [Sport, Trail, Adventure]

Valvetrain

Valve seat diameter, intake	1.1811 in. (30.000 mm) [Sport, Trail, Adventure]
Valve seat diameter, exhaust	1.0236 in. (26.000 mm) [Sport, Trail, Adventure]
Valve seat angle	45.00° [Sport, Trail, Adventure]
Valve seat width, intake	0.0394 in. (1.000 mm) [Sport, Trail, Adventure]
Valve seat width, exhaust	0.0394 in. (1.000 mm) [Sport, Trail, Adventure]
Valve seat material/configuration	Steel [Sport, Trail, Adventure]

Valve timing

Cam type	Dual [Sport, Trail, Adventure]
Cam drive	Chain [Sport, Trail, Adventure]
Tensioner	Auto [Sport, Trail, Adventure]
Camshaft, intake lift	0.2717 in. (6.902 mm) [Sport, Trail, Adventure]
Camshaft, exhaust lift	0.2717 in. (6.902 mm) [Sport, Trail, Adventure]
Duration	Open [Sport, Trail, Adventure]

Engine

Number of valves per cylinder	4 [Sport, Trail, Adventure]
Number of intake valves	2 [Sport, Trail, Adventure]
Throttle body, throttle bore	1 cyl: 1.1811 in. (30.000 mm) [Sport, Trail, Adventure] 2 cyl: 1.1811 in. (30.000 mm) [Sport, Trail, Adventure]
Valve train	Chain [Sport, Trail, Adventure]
Valve material, intake/exhaust	Steel [Sport, Trail, Adventure]

Engine
Type
Capacity
Power output
Torque output
Compression ratio
Bore and stroke
Firing order
Valve clearances (cold)
Inlet
Exhaust
Camshaft drive
Camshaft bearing journal diameter
Camshaft endfloat
Camshaft lobe height
Lubrication system
Oil pump type
Oil pressure
Oil capacity
Oil filter type
Oil pressure switch
Torque wrench settings
Component
Nm
Clutch
Gearbox
Gearbox mounting
Engine mounting
Engine mount bracket
Engine mount bolt
Driveshaft nut
Roadwheel nut
Exhaust manifold
Exhaust downpipe
Catalytic converter
Exhaust mounting
Steering
Steering column
Steering rack
Steering column universal joint
Steering rack mounting
Steering track rod end
Steering track rod end locknut
Suspension
Front suspension strut
Front suspension strut upper mounting
Front suspension strut lower mounting
Front suspension strut piston rod nut
Front suspension strut clamp bolt
Front suspension strut brake caliper bracket
Front suspension strut driveshaft nut
Front suspension strut wheel bearing housing
Front suspension lower balljoint
Front suspension lower balljoint clamp bolt
Front suspension lower balljoint nut
Front suspension lower arm
Front suspension lower arm pivot bolt
Front suspension lower arm balljoint
Front suspension lower arm balljoint nut
Front suspension lower arm balljoint clamp bolt
Front suspension lower arm mounting
Front suspension lower arm mounting bolt
Front suspension anti-roll bar
Front suspension anti-roll bar mounting
Front suspension anti-roll bar link
Front suspension anti-roll bar link nut
Front suspension anti-roll bar link bolt
Front suspension anti-roll bar clamp
Front suspension anti-roll bar clamp bolt
Front suspension subframe
Front suspension subframe mounting bolt
Front suspension subframe rear mounting bolt
Front suspension subframe front mounting bolt
Rear suspension
Rear suspension strut
Rear suspension strut upper mounting
Rear suspension strut lower mounting
Rear suspension strut piston rod nut
Rear suspension strut clamp bolt
Rear suspension strut driveshaft nut
Rear suspension strut wheel bearing housing
Rear suspension lower balljoint
Rear suspension lower balljoint clamp bolt
Rear suspension lower balljoint nut
Rear suspension lower arm
Rear suspension lower arm pivot bolt
Rear suspension lower arm balljoint
Rear suspension lower arm balljoint nut
Rear suspension lower arm balljoint clamp bolt
Rear suspension lower arm mounting
Rear suspension lower arm mounting bolt
Rear suspension anti-roll bar
Rear suspension anti-roll bar mounting
Rear suspension anti-roll bar link
Rear suspension anti-roll bar link nut
Rear suspension anti-roll bar link bolt
Rear suspension anti-roll bar clamp
Rear suspension anti-roll bar clamp bolt
Rear suspension subframe
Rear suspension subframe mounting bolt
Rear suspension subframe rear mounting bolt
Rear suspension subframe front mounting bolt
Brakes
Brake pedal
Brake servo
Brake master cylinder
Brake pipe unions
Brake hose
Brake caliper
Brake caliper mounting bracket
Brake caliper bleed screw
Brake disc
Brake disc shield
Brake drum
Brake drum shoe
Brake drum wheel cylinder
Brake drum backplate
Handbrake lever
Handbrake cable
Handbrake cable adjuster
Wheels
Roadwheel nut
Roadwheel bolt
Tyre pressures
Tyre size
Front
Rear
Spare
Tyre pressure valve
Wheel balance weight
Body fittings
Seat belt mounting bolt
Seat belt inertia reel
Seat belt buckle
Seat belt tongue
Seat belt upper anchorage
Seat belt lower anchorage
Seat belt stalk
Seat belt stalk bolt
Seat belt guide
Seat belt guide bolt
Seat belt pretensioner
Seat belt pretensioner bolt
Seat belt pretensioner anchorage
Seat belt pretensioner anchorage bolt
Seat belt pretensioner guide
Seat belt pretensioner guide bolt
Seat belt pretensioner buckle
Seat belt pretensioner buckle bolt
Seat belt pretensioner tongue
Seat belt pretensioner tongue bolt
Seat belt pretensioner stalk
Seat belt pretensioner stalk

1 Assessment of the project/application and its risk factors

In the assessment of the project/application and its risk factors, the following questions are to be considered. Depending on the project, some may not be relevant and others may be added.

- a) Financial and organizational risk factors?
- b) Technical and implementation risk factors?
- c) Technical and implementation risk factors of the hardware components?
- d) Technical and implementation risk factors of the software components?
- e) Technical and implementation risk factors of the communication?
- f) Technical and implementation risk factors of the operation?
- g) Technical and implementation risk factors of the maintenance (repair, upgrade, extension)?

2 What measures could be taken by the contractor and the client to minimize the risks and to safeguard or improve the economic success of the project? Are there any risks that cannot be influenced by the contractor?

2 Assessment of the organizational and technical interfaces

- a) Interfaces and organizational risk factors with the client?
- b) Interfaces and organizational risk factors with third parties?
- c) Interfaces and organizational risk factors with subcontractors?
- d) Interfaces and organizational risk factors with suppliers?
- e) Technical interfaces and risk factors with the hardware components?
- f) Technical interfaces and risk factors with the software components?
- g) Technical interfaces and risk factors with the communication?
- h) Technical interfaces and risk factors with the operation (e.g. network management, backup and data management)?

3 Assessment of project-specific contracts

The contractual provisions – the general and supplementary terms and conditions of contract and the conditions of the agreement – are to be assessed for their compliance with the legal framework and their usability.

The project must be assessed to see whether such risk assessments, which may have been made, for example, with the assistance of computer-aided risk management systems, have been carried out. The assessment must be made by the contractor. Participation of the client and representatives of the subcontractors and suppliers is necessary in order to ensure that all risks are identified and that the risk assessment is carried out in a realistic manner. Checklists can be used for this purpose.

4 Determining risk analysis guidelines

1 Every risk analysis follows on the various steps as shown in Illustration 1 (Control loop). The determination and grading of risks is always the challenge for a risk analysis which aims to minimize risks. Grading is of utmost importance.

2 Each risk can only be graded correctly if there is a clear understanding of the risk. This is why there are many risk analyses and risk assessments that have failed.

3 Risk analysis is a control loop. It is necessary to check whether the risk assessment has been carried out correctly and whether the risk has been graded correctly. This is why risk analysis is a control loop.

4 Risk analysis is a control loop in three steps (see Illustration 1). First, the risk is identified, then it is assessed and finally it is graded. Only then can the risk be controlled. Each activity in the control loop is carried out by a different person. The first person identifies the risk, the second person assesses the risk and the third person grades the risk. The control loop is carried out by a different person. The first person identifies the risk, the second person assesses the risk and the third person grades the risk. The control loop is carried out by a different person. The first person identifies the risk, the second person assesses the risk and the third person grades the risk.

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1.11 Typical gear lever arrangements



1.12 Typical cable-operated gear selector mechanism (arrowed) and rigid/flexible joint (inset)

4 Manual transmission overhaul - general information

1 Before commencing work on the gearbox unit, the operation should be considered very carefully. It is obviously helpful if the person has had experience of this type of work and access to the necessary workshop facilities is available. Alternatively, consider taking the unit to your local garage and asking them to carry out the work. Remember that most garages will charge a realistic rate for their time and skill, and that this can be considerable if the gearbox is in poor condition.

2 Many gearbox components are extremely heavy and may require the use of a hoist or jack and blocks during removal and refitting. Always ensure that adequate support is provided and that components are not damaged during the course of removal and refitting. Do not allow the weight of the gearbox unit to rest on the input shaft for any length of time.

3 When dismantling a gearbox, it is important that the internal components are kept in the correct order and position so that they can be easily reassembled and refitted in the same way. Mark the relative positions of components where necessary with paint or scribe marks.

4 Before dismantling begins, thoroughly clean the exterior of the gearbox unit. Any dirt which remains will find its way into the internal mechanism when the gearbox is opened up, and will cause rapid wear of the bearings and other components.

5 Gearbox oil seals are prone to leakage when worn. Renew the seals as a matter of course if the gearbox is being overhauled, or if there is evidence of oil leakage. Use a seal extractor to remove the seals, and drive the new seals into their housings with a block of wood or a tubular drift. Ensure that the lips of the seals are facing the correct way when they are fitted.

6 Gearbox bearings should be renewed if they are worn or damaged, or if they have covered a high mileage. Use a universal bearing puller to draw the bearings off their shafts, and a hammer and tubular drift to install the new bearings. Ensure that the bearing is driven squarely on to the shaft or into the housing, and that it enters the housing bore or shaft square to the bore or shaft axis.

7 Gearbox overhaul is a complex task which requires a high degree of skill and experience if it is to be carried out successfully. Before starting work, read the relevant sections of this Chapter and study the illustrations carefully. Make sure that you have the necessary tools and workshop facilities available before you begin.

5 Gearbox (manual transmission) - removing from and refitting to engine

1 Remove the air cleaner assembly, where necessary, for access.

2 Disconnect the battery negative lead, then remove the battery and its tray (see Chapter 5A).

3 Remove the clutch release arm and withdraw the release bearing from the gearbox input shaft bearing retainer. Refer to Chapter 5A for further information.

4 Disconnect the speedometer cable from the gearbox. Where applicable, disconnect the wiring from the reversing light switch.

5 Disconnect the gear lever from the selector rods. Refer to the relevant Chapter for further information.

6 Disconnect the clutch cable from the clutch release arm and the bracket on the gearbox bellhousing. Refer to Chapter 5A for further information.

7 Disconnect the wiring from the starter motor solenoid, then remove the starter motor (see Chapter 5A).

8 Disconnect the wiring from the oil pressure switch, then remove the switch.

9 Disconnect the wiring from the engine earth point on the gearbox.

10 Support the engine from above, using a hoist attached to the engine lifting eyes, or from below using a jack and block of wood placed under the sump. Take the weight of the engine, but do not lift it.

11 Remove the bolts securing the gearbox mounting bracket to the body, then remove the bracket.

12 Remove the bolts securing the gearbox to the engine, and withdraw the gearbox from the engine. Be prepared to support the gearbox as the last bolt is removed.

13 Refitting is a reversal of removal, but apply a little grease to the splines of the input shaft before offering the gearbox to the engine. Do not allow the weight of the gearbox to rest on the input shaft as it is inserted. Rotate the gearbox slightly as necessary to engage the splines of the input shaft with those of the clutch friction plate. Do not use excessive force to install the gearbox, as this may damage the clutch. If the gearbox will not fit, check that the input shaft splines are correctly aligned with those of the clutch friction plate.

14 Refer to the relevant Chapters for information on refitting the clutch release arm, the speedometer cable, the gear lever and the clutch cable.

15 Refit the gearbox mounting bracket and tighten the bolts to the specified torque.

16 Refit the starter motor (see Chapter 5A).

17 Reconnect the wiring to the oil pressure switch and reversing light switch.

18 Refit the battery and tray, and reconnect the battery negative lead.

19 Refit the air cleaner assembly.

20 Refill the gearbox with the correct grade and quantity of oil (see Chapter 1A).



1.13 Exploded view of a typical manual transmission



1.1a Remove the crankcase filler cap/breather hose (arrowed) from the rocker cover



1.1b Disconnect the hose from the rocker cover



1.1c Unscrewing the rocker cover bolts and lift off the cover



1.1d Fit new rocker cover gasket ensuring it is correctly located

2 Dismantling the engine and gearbox: removing the ancillaries and engine mountings

1 Position the engine on the workbench or other suitable working surface at a comfortable working height. If a workbench is not available, it is preferable to work on the engine with it on the floor rather than on the vehicle.

2 Remove the engine oil dipstick and the crankcase breather hose from the rocker cover.

3 Unscrew and remove the rocker cover bolts and lift off the cover, supporting each corner and unscrewing just 1 turn at a time. Lift off the cover and remove the gasket. If the gasket is in good condition it can be refitted, but if it is damaged or worn it must be renewed. Note the location of the 2 rubber grommets and the 2 spacers (see illustrations). Also remove the rubber seal from the cover (see illustration). Clean the cover and the cylinder head mating surfaces (see illustration).

3 Dismantling the engine and gearbox: removing the cylinder/piston assembly

1 Remove the cylinder head as described in Chapter 2, then remove the oil pump drive chain and sprocket as described in Chapter 2.

2 Remove the cylinder barrel by pulling it straight upwards off the crankcase studs. Recover the gasket and the 2 locating dowels. Stuff a clean rag around the connecting rod to prevent anything falling into the crankcase.

3 Remove the piston circlip (see illustration) and push out the gudgeon pin (see illustration). Mark the piston crown with a felt pen to ensure that it is refitted the correct way round. Remove the piston.

4 Dismantling the engine and gearbox: removing the clutch and primary gear

1 Remove the clutch assembly as described in Chapter 5.

2 Remove the primary gear nut (see illustration). Prevent the gear from turning by locking the teeth with a block of wood. Alternatively, lock the gear by engaging 2 gears at once. Remove the nut and its washer.

3 Withdraw the primary gear (see illustration). Recover the Woodruff key (see illustration).

5 Dismantling the engine and gearbox: removing the alternator/starter motor

1 Remove the alternator rotor as described in Chapter 12.

2 Remove the alternator stator assembly (see illustration). Note the wiring grommet in the crankcase.

3 Remove the starter motor as described in Chapter 12.

6 Dismantling the engine and gearbox: removing the gearchange mechanism

1 Remove the gearchange shaft pinch bolt (see illustration) and withdraw the shaft and lever (see illustration). Note the return spring and the washer.

2 Remove the gearchange drum stopper arm (see illustration).

3 Remove the gearchange drum bearing plate screws (see illustration). Withdraw the plate and the gearchange drum (see illustration).

4 Withdraw the gearchange shift forks and shafts (see illustration). Note which way round they are fitted and which fork engages with which gear.

7 Dismantling the engine and gearbox: removing the crankcase halves and gearbox components

1 Remove the screws securing the crankcase halves together (see illustration). Note the location of the various screws.

2 Turn the engine over and place it on the workbench with the crankcase mating surface uppermost. Remove the screws and lift off the upper crankcase half (see illustration). Tap around the joint with a soft-faced hammer to break the seal between the crankcase halves.

3 Lift out the gearbox components (see illustration). Note the location of the various components.

4 Withdraw the crankshaft assembly (see illustration).

[illegible]

1.3 Removing the engine and gearbox unit - removing the transmission

1 Remove the engine/gearbox unit from the vehicle as described in Section 1.2.

2 Unscrew the bolts securing the clutch cover plate to the flywheel, and withdraw the cover plate and clutch assembly from the flywheel dowels. Recover the clutch driven plate.



3 Mark the relative positions of the gearbox mounting flange and the engine rear plate, to ensure correct alignment on refitting, then unscrew the gearbox mounting flange bolts.

4 Withdraw the gearbox from the engine, keeping it parallel to the crankshaft centre line. Do not allow the weight of the gearbox to hang on the input shaft.



5 Withdraw the clutch release bearing and guide sleeve from the gearbox input shaft.



1.4 Separating the engine and gearbox unit - removing the clutch release bearing and guide sleeve

1 Remove the clutch release bearing and guide sleeve from the gearbox input shaft. The bearing is retained by spring clips on the operating fork. Use a screwdriver to release these clips, then withdraw the bearing and guide sleeve from the input shaft. Clean the bearing and guide sleeve, but do not immerse them in solvent as they are packed with grease.

1.5 Separating the engine and gearbox unit - removing the clutch release fork and bracket

1 Unscrew the bolt securing the clutch release fork to the pivot bracket, then withdraw the fork from the ball pin. Remove the dust cover from the gearbox bellhousing.

2 Unscrew the bolts securing the pivot bracket to the gearbox bellhousing, then withdraw the bracket.

1.6 Separating the engine and gearbox unit - removing the starter motor

1 Unscrew the bolts securing the starter motor to the gearbox bellhousing, then withdraw the starter motor.

1.7 Separating the engine and gearbox unit - removing the clutch

1 Unscrew the bolts securing the clutch cover plate to the flywheel, a little at a time, to release the spring pressure evenly. Remove the cover plate and clutch driven plate.

1.8 Removing the engine and gearbox unit - removing the ancillary components

1 Unscrew the bolts securing the alternator mounting bracket to the engine, then withdraw the alternator and mounting bracket.

2 Unscrew the bolts securing the engine mounting brackets to the gearbox bellhousing, then withdraw the brackets.

1.9 Removing the engine and gearbox unit - removing the ancillary components

1 On carburettor models, unscrew the bolts securing the inlet manifold to the cylinder head, and withdraw the manifold and carburettor as an assembly. Recover the gasket.

2 On fuel injection models, unscrew the bolts securing the inlet manifold to the cylinder head, and withdraw the manifold. Recover the gasket.

1.10 Separating the engine and gearbox unit - removing the starter motor

1 On carburettor models, unscrew the bolts securing the exhaust manifold to the cylinder head, and withdraw the manifold. Recover the gasket.

2 On fuel injection models, unscrew the bolts securing the exhaust manifold to the cylinder head, and withdraw the manifold. Recover the gasket.

3 Unscrew the bolts securing the inlet manifold to the cylinder head, and withdraw the manifold. Recover the gasket.

4 Unscrew the bolts securing the engine mounting brackets to the gearbox bellhousing, then withdraw the brackets.

















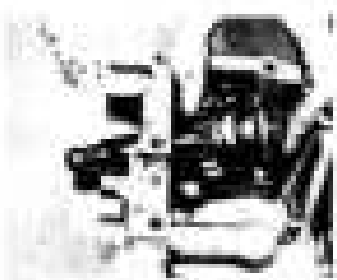










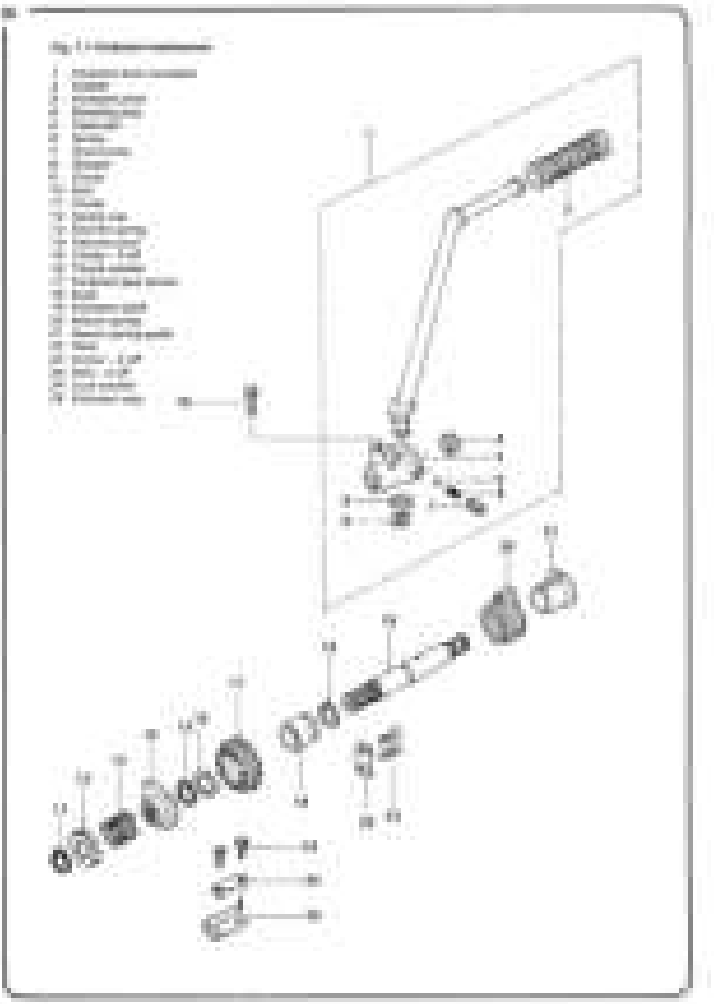


Engine cover and panels - general

Engine compartment panels are held in place by screws and clips. Refer to the illustrations for the location of the various panels.

Removal and installation of the engine cover is a straightforward procedure. Simply mark the position of the hinges on the cover to aid installation, then unscrew the hinge bolts and lift the cover off.

Removal and installation of the various panels is also straightforward. Simply unscrew the retaining screws and withdraw the panel. Some panels are also retained by clips which can be released by pulling the panel away from the bodywork. Take care not to damage the clips when removing the panels.













27 Transmission and driveshafts - removal and refitting

1 Jack up the front of the car and support it on axle stands. Remove the front roadwheels.

2 Drain the oil from the transmission (see Chapter 1).

3 Remove the front exhaust pipe (see Chapter 4).

4 Remove the bolt securing the gearchange rod to the gearchange lever on the transmission.

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27.1 Transmission mounting bracket and driveshaft (R.H. shown)

28 Transmission - overhaul (manual transmission only)

1 Remove the transmission from the car (see Chapter 1).

2 Remove the clutch release bearing and fork (see Chapter 1).

3 Remove the gearchange rod from the transmission.

4 Remove the bolt securing the gearchange rod to the gearchange lever on the transmission.

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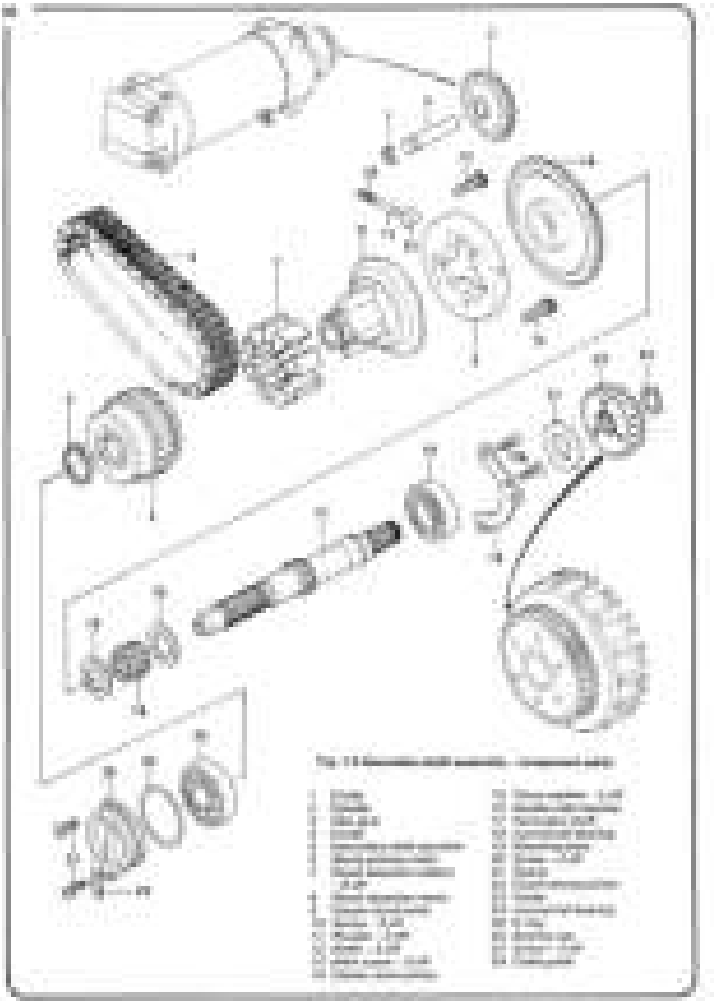
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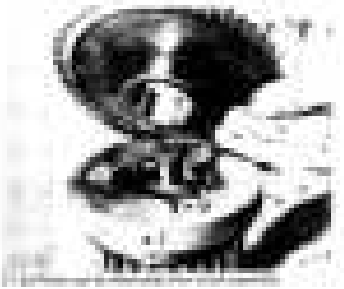
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1.2 Oil pump, sump/strainer and pipes/drilling

1 Oil pump failure is usually the result of oil starvation caused by a blocked strainer or pick-up pipe, or by a seal which has failed and is allowing air to be drawn into the pump. Occasionally, the pump drive gear may shear, or the pump may be damaged by debris which has been picked up from the sump. Whatever the cause, the first indication of trouble is usually a low oil pressure warning light or gauge reading. If this occurs, stop the engine immediately, or serious damage will quickly result.

2 To remove the pump, first remove the sump/strainer as described in Section 3.

3 Unscrew the two bolts securing the pump to the main bearing ladder, and withdraw the pump from the engine. Recover the drive gear.

4 Prime the pump with oil, then refit it to the engine, ensuring that the drive gear is correctly engaged with the crankshaft. Refit the sump/strainer as described in Section 3.

5 The sump/strainer unit should be cleaned at the specified intervals, or whenever the oil is changed. Unscrew the bolts and remove the sump/strainer from the engine. Clean the strainer gauze in paraffin, and wipe out the sump. Refit the sump/strainer using a new gasket, and tighten the bolts to the specified torque.

6 If the oil pressure relief valve is thought to be faulty, it may be removed for inspection after unscrewing the cap nut. Examine the valve and its seat for signs of damage or wear, and renew if necessary. Refit the valve, spring and cap nut, and tighten the cap nut to the specified torque.

7 Oil pipe failure is usually the result of physical damage to the pipes, or to the unions. Renew the pipes and unions as necessary.

1.3 Timing chain, sprockets and tensioner

1 The timing chain is driven by the crankshaft sprocket, and tensioned by a hydraulic tensioner. The camshaft sprocket is bolted to the camshaft flange.

2 Remove the timing cover as described in Section 4.

3 Remove the bolt securing the camshaft sprocket to the camshaft flange, and withdraw the sprocket from the front of the camshaft. Recover the Woodruff key.

4 Remove the bolt securing the tensioner to the cylinder block, and withdraw the tensioner from the engine.

5 Withdraw the timing chain from the crankshaft sprocket, and remove it from the engine.

6 Examine the teeth of the sprockets for signs of wear or damage. Renew the sprockets if necessary.

7 Examine the chain for signs of wear or damage, and renew it if necessary.

8 Examine the tensioner for signs of wear or damage, and renew it if necessary.

9 Refit the timing chain to the crankshaft sprocket, and refit the sprocket to the engine.

10 Refit the tensioner to the cylinder block, and tighten the bolt to the specified torque.

11 Refit the camshaft sprocket to the camshaft flange, and tighten the bolt to the specified torque.

12 Refit the timing cover as described in Section 4.

1.4 Flywheel, crankshaft rear oil seal and housing

1 The flywheel is bolted to the rear of the crankshaft, and carries the starter ring gear. It has a counterbalance weight. The rear crankshaft oil seal is contained in a housing bolted to the rear of the cylinder block.

2 Remove the engine/transmission as described in Chapter 2.

3 Remove the clutch as described in Chapter 5.

4 Mark the flywheel in relation to the crankshaft, then unscrew the bolts and withdraw the flywheel from the crankshaft flange. Recover the locating dowel.

5 Unscrew the bolts securing the oil seal housing to the cylinder block, and withdraw the housing from the engine. Recover the gasket.

6 Remove the oil seal from the housing, and discard it.

7 Clean the mating faces of the housing and the cylinder block.

8 Fit a new oil seal to the housing, using a suitable tubular drift.

9 Refit the housing to the cylinder block, using a new gasket.

10 Refit the flywheel to the crankshaft flange, aligning the marks made on removal, and tighten the bolts to the specified torque.

11 Refit the clutch as described in Chapter 5.

12 Refit the engine/transmission as described in Chapter 2.

1.5 Pistons, connecting rods, assembly and examination

1 If it is desired to remove the pistons and connecting rods, this can be done with the engine in the car, but it is necessary to remove the cylinder head and the sump/strainer.

2 Remove the cylinder head as described in Section 6.

3 Remove the sump/strainer as described in Section 3.

4 Before removing the pistons/connecting rods, ensure that there is no ridge at the top of the cylinder bores. If there is, remove it with a scraper. Ridges indicate that the bore is worn, and new cylinder liners will be required.

5 Mark the pistons and connecting rods with their cylinder numbers, using a centre punch or paint.

6 Unscrew the nuts from the first connecting rod bolts, and withdraw the connecting rod cap. Recover the bearing shell.

7 Push the piston/connecting rod assembly out of the top of the cylinder bore, and recover the bearing shell.

8 Repeat the operations on the remaining pistons/connecting rods.

9 Examine the pistons for signs of wear or damage. Renew if necessary.

10 Examine the connecting rods for signs of wear or damage. Renew if necessary.

11 Examine the bearing shells for signs of wear or damage. Renew if necessary.

12 Refit the bearing shell to the connecting rod, and refit the bearing shell to the cap.

13 Refit the piston/connecting rod assembly to the cylinder bore, and refit the cap to the connecting rod. Tighten the nuts to the specified torque.

14 Repeat the operations on the remaining pistons/connecting rods.

15 Refit the sump/strainer as described in Section 3.

16 Refit the cylinder head as described in Section 6.

1.6 Crankshaft main bearings, examination and renovation

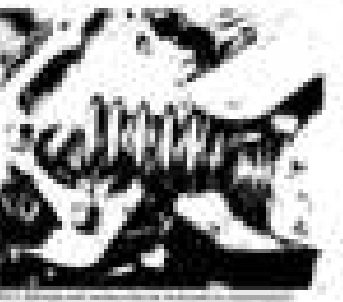
1 Removal of the crankshaft main bearings is not a task to be undertaken lightly, as it is necessary to remove the engine/transmission from the car, and to remove the engine/transmission from the car, and to remove the engine/transmission from the car, and

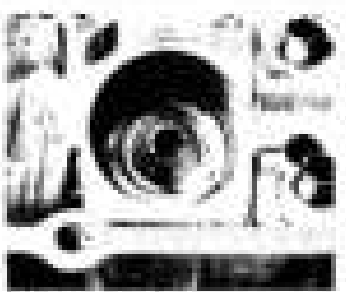
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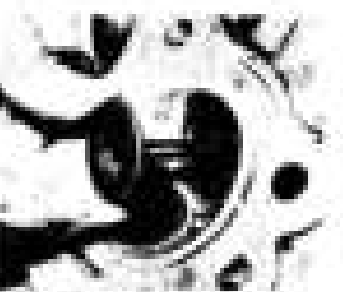


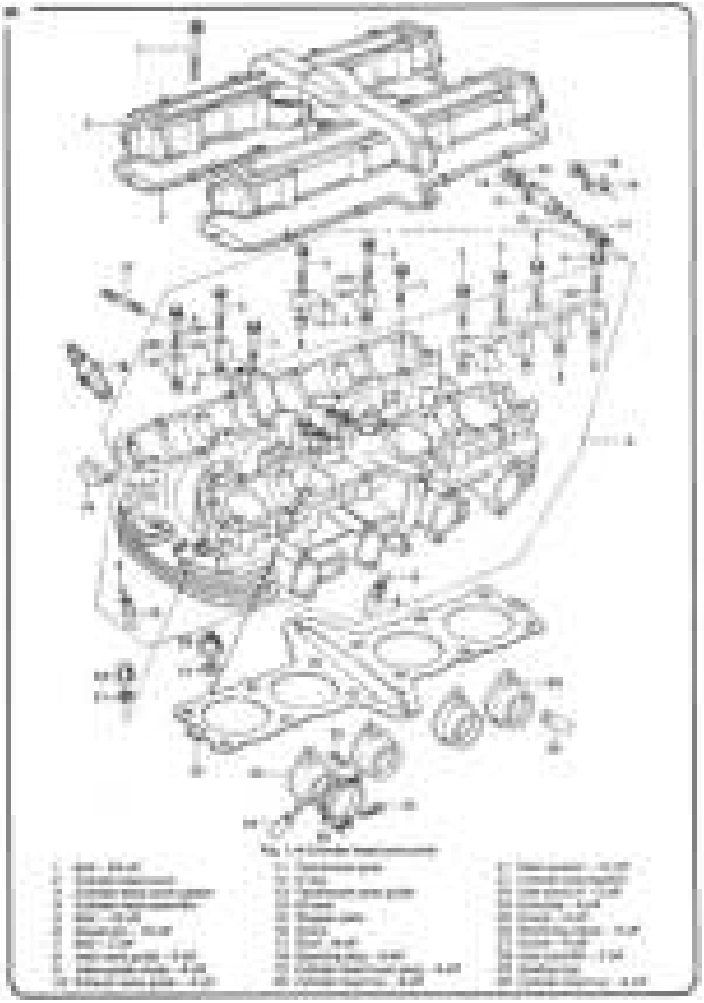


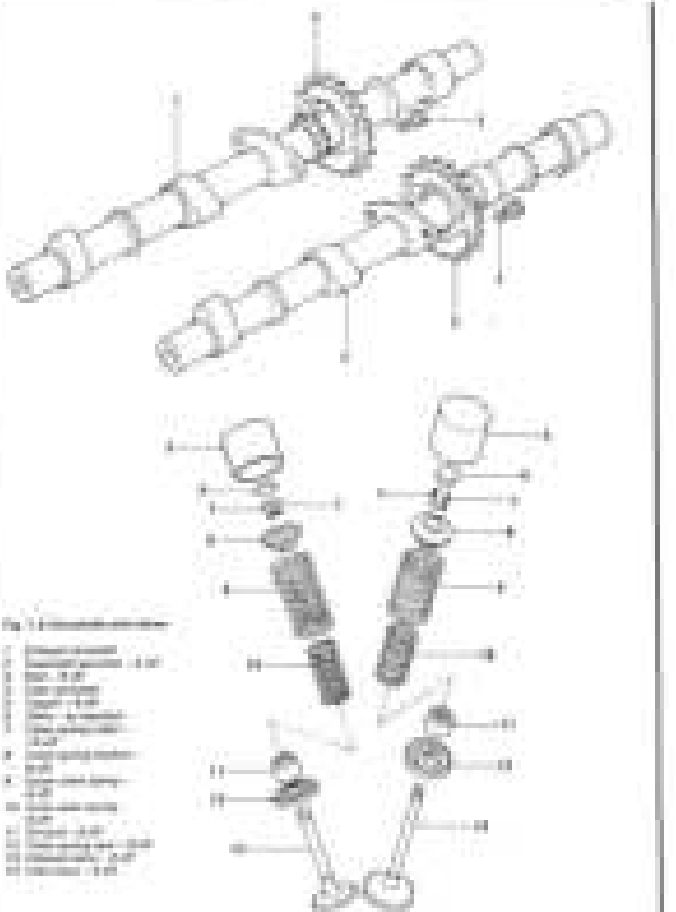












21 Crankshaft, bearings and connecting rods - examination and renovation

1 Remove the crankshaft bearings and thrust washers from the crankcase and the bearing caps. Clean the backs of the bearing shells and the bearing locations in the crankcase and caps, then lay the bearings in their respective locations. Fit the thrust washers in their original positions. Clean the crankshaft, taking particular care to clean the oil holes with a pipe cleaner. Remove all traces of oil from the bearing surfaces.

2 Examine the bearing shells for signs of scoring, pitting or flaking of the surface material. Bearing failure is usually caused by oil starvation, dirt or water in the oil, or by corrosion (see Section 22). Lack of oil is normally indicated by discoloration of the bearing shells, but this may also be caused by corrosion. Scratches in the bearing surfaces are usually caused by dirt in the oil. Bearing shells which have picked up dirt should be renewed as a matter of course. Bearing shells which have seized to the crankshaft journals will have obviously run hot and will be in a very bad condition.

3 Big-end bearing wear usually occurs first in the form of fatigue. Fatigue will show as pitting or flaking of the bearing surface material. Pitting and flaking are caused by abrasive particles in the oil, by corrosion, by lack of oil or by overloading the engine. Bearing shells which have worn to the point where the copper is showing through the bearing surface must be renewed.

4 Main bearing wear normally occurs evenly in all the bearings. Check for wear by comparing the bearing shells with the corresponding crankshaft journals. Measure the diameter of the journals with a micrometer and compare the results with the specified dimensions. Any journal which is worn to the point where it is no longer within the specified dimensions must be reground by a specialist engineering firm. Undersize bearing shells will be required to match the reground journals.

5 Check the crankshaft for cracks around the webs, big-end and main bearing journals. Any crankshaft which is cracked must be renewed. Check the oil seal contact surfaces at each end of the crankshaft for wear and damage. If the seal has worn a deep groove in the surface of the crankshaft, it will be necessary to renew the crankshaft or have it reground to suit a new seal.

6 Check the crankshaft gear for wear or damage. Renew the gear if necessary.

7 Check the connecting rods for signs of damage or distortion. Check the connecting rod bolts for stretching or damage to the threads. Renew the connecting rod if necessary.

8 Check the connecting rod bearing shells in the same way as the main bearing shells. Check the connecting rod and cap for cracks and for nicks made by careless use of a hammer during previous dismantling operations. Check the fit of the gudgeon pin in the connecting rod eye. Wear will usually be indicated by a knocking noise when the engine is running, particularly when pulling hard at low engine speeds. Renew the connecting rod if the gudgeon pin is a loose fit.

9 Measure the diameter of the gudgeon pin and the corresponding bore in the connecting rod eye. Calculate the clearance and compare it with the specified dimensions. If the clearance is excessive, renew the gudgeon pin and/or the connecting rod as necessary.

10 Check the crankshaft thrust washers for signs of scoring, wear or damage. Renew them if necessary.

11 Check the crankshaft sprocket for wear or damage. Renew the sprocket if necessary.

12 Check the crankshaft vibration damper for signs of damage. Renew the damper if necessary.

13 Check the oil pump drive gear for wear or damage. Renew the gear if necessary.

14 Check the oil pump pick-up and strainer for damage. Renew the pick-up and strainer if necessary.

15 Check the oil pump relief valve for signs of damage. Renew the valve if necessary.

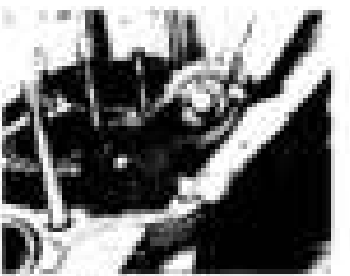
16 Check the oil pump cover for signs of damage. Renew the cover if necessary.

17 Check the oil pump body for signs of damage. Renew the body if necessary.

18 Check the oil pump rotors for signs of damage. Renew the rotors if necessary.

19 Check the oil pump relief valve spring for signs of damage. Renew the spring if necessary.

20 Check the oil pump relief valve plunger for signs of damage. Renew the plunger if necessary.



21.20 Oil pump components



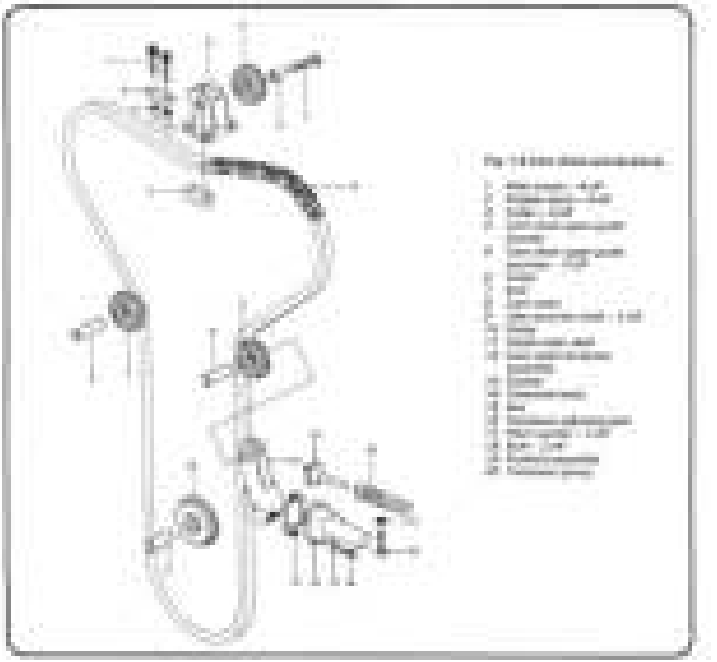
21.21 Crankshaft and bearings



21.22 Crankshaft and bearings







40 Clutch: removal, inspection and reassembly

1 After an extended period of service, the clutch friction disc will wear, and may need renewal. The only way to assess the condition of the clutch friction disc is to remove the gearbox/transmission and engine/transmission mounting bracket, and then remove the clutch cover assembly from the flywheel.

Standard	Service limit
Clutch plate thickness 8.1 – 8.4 mm	7.6 mm
Flywheel runout 0.05 mm	0.1 mm

Before the clutch cover assembly is removed, the clutch plate alignment tool must be obtained (see illustration 40.2).

2 The clutch friction disc and cover may be removed from the flywheel after the gearbox/transmission and engine/transmission mounting bracket have been removed. Mark the relationship of the clutch cover to the flywheel, then unscrew the bolts evenly and progressively, a turn at a time, to release the clutch spring tension. Support the clutch cover assembly as the bolts are removed, and then withdraw the clutch cover assembly and friction disc from the flywheel.

3 Examine the clutch assembly for signs of uneven or excessive wear, scoring, cracking or overheating. Check the diaphragm spring fingers for signs of wear where they contact the release bearing. Check the rivets that secure the friction lining material to the clutch plate for signs of loosening. Measure the depth of the friction lining material above the rivets and renew the clutch plate if the lining material is worn down to the specified service limit or less. Check the clutch plate for buckling, distortion and cracked or broken springs. Check the machined surfaces of the flywheel and pressure plate for signs of scoring or overheating. Minor scoring may be removed with emery paper, but if excessive, the flywheel must be renewed. Check the flywheel ring gear for excessive wear or damage. If the ring gear is worn or damaged, it must be renewed. Refer to Chapter 5 for the procedure.

4 Check the operation of the release bearing as described in Section 41. If the bearing is noisy, rough or has excessive play, it must be renewed.

5 Before reassembling the clutch, wipe clean the faces of the flywheel and pressure plate with a dry cloth. Take care not to touch the friction surfaces with your hands, as skin oils will cause slippage when the clutch is engaged. Lightly grease the splines of the clutch plate hub with a thin layer of high-melting-point grease.

6 Locate the clutch plate on the flywheel, then refit the clutch cover assembly. Use the clutch plate alignment tool to centralise the clutch plate (see illustration 40.2). Refit the clutch cover bolts and tighten them evenly and progressively, a turn at a time, to the specified torque setting.

7 Refit the gearbox/transmission and engine/transmission mounting bracket as described in the relevant Sections of this Chapter.

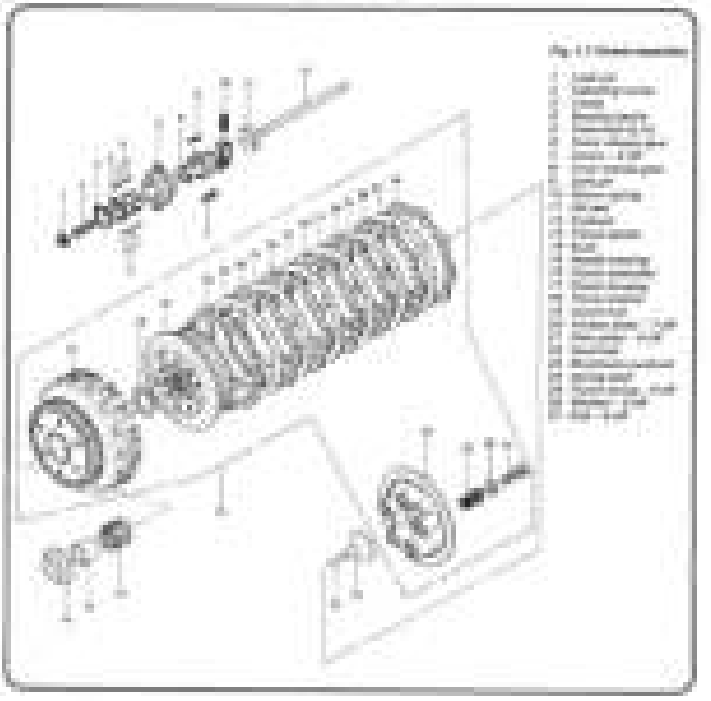
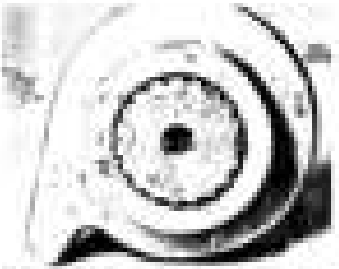


Fig. 1.7 Clutch components

1 Crankshaft
2 Flywheel ring gear
3 Dowel
4 Flywheel
5 Clutch plate
6 Clutch cover assembly
7 Bolt
8 Release bearing
9 Clutch release arm
10 Release arm pivot
11 Clutch release plate
12 Bolt
13 Release bearing
14 Bolt
15 Clutch cover
16 Bolt
17 Clutch plate alignment tool
18 Clutch plate
19 Clutch cover assembly
20 Bolt
21 Flywheel
22 Bolt
23 Flywheel ring gear
24 Dowel
25 Crankshaft

















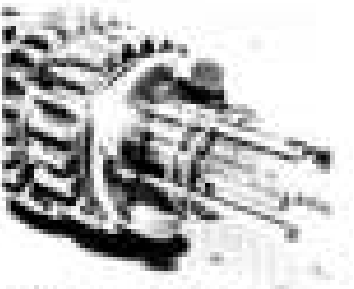






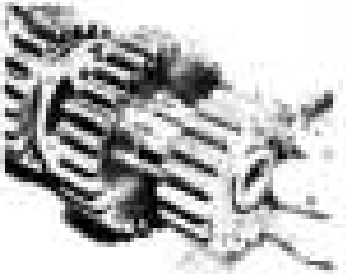


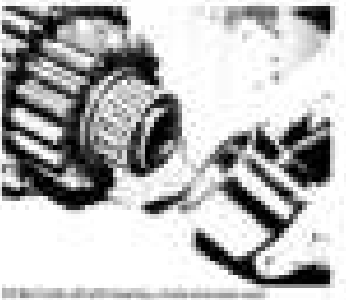


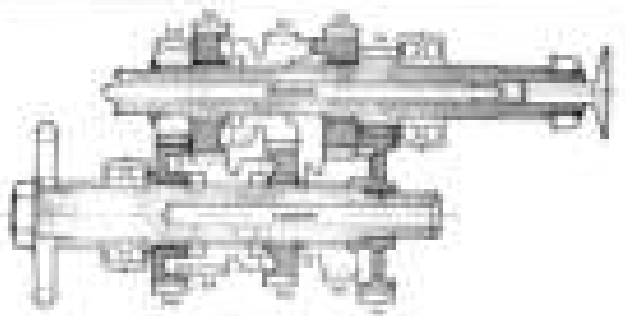


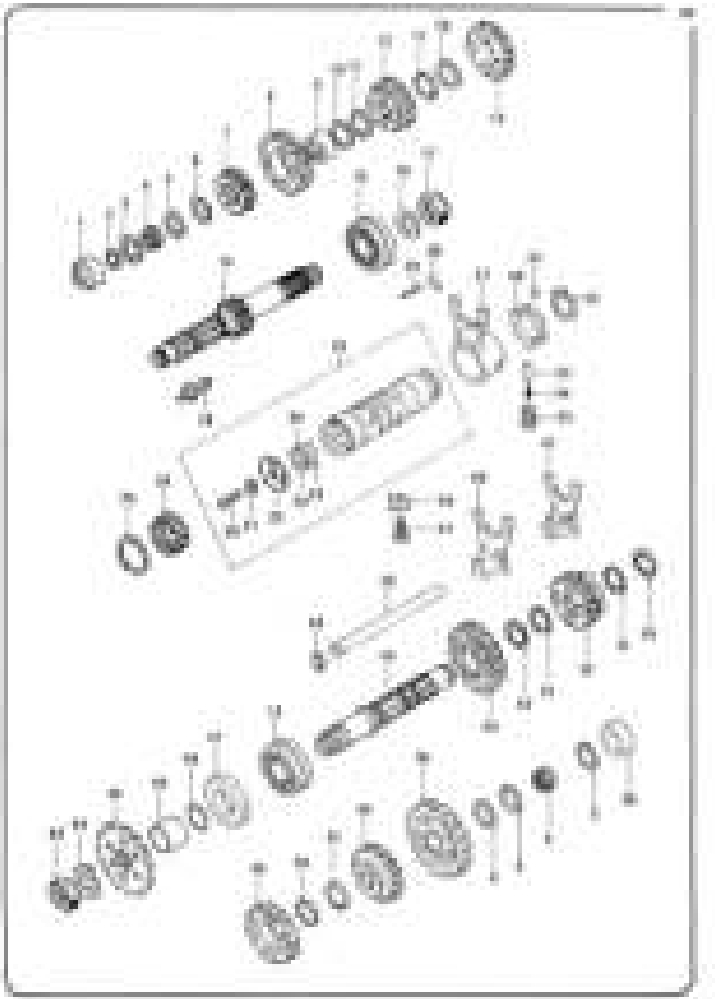












7.6 Engine overheating – symptoms

Engine overheating is the condition where the engine runs considerably hotter than it should. Normally, the engine will operate at a constant temperature, which is usually around the middle of the gauge range. Overheating will be indicated by the temperature gauge rising above the normal level, or by the warning light coming on.

Severe overheating can cause serious damage to the engine, such as warping of the cylinder head, leading to loss of compression and blown head gasket. Other damage can include seizure of the engine components, resulting in the need for extensive overhaul or replacement. Do not continue driving the vehicle if it is suspected of overheating.

Overheating is usually caused by a lack of coolant in the engine, or poor circulation of the coolant around the system. Other causes are a defective radiator cap, thermostat or electrical fault, or a badly tuned engine. Remember that if the vehicle is used for towing a caravan or trailer, or for driving in hilly areas, the cooling system will be subjected to additional loads, and may overheat even though it is in perfect condition.

Where overheating is caused by a lack of coolant, it is important to check the system thoroughly for the source of the leak, and to rectify it before refilling the system. Refer to Chapter 2 for more information on the cooling system.

7.7 Engine cold starting problems – checking the cooling system

Before any of the checks below are carried out, the coolant level must be correct. With the engine cold, remove the expansion tank filler cap and check that the coolant is visible in the filler neck. If the level is low, refer to Chapter 2 for the procedure for topping up the cooling system. If the coolant level in the expansion tank is low, but the filler neck is full, check the radiator filler neck as well. If the radiator is low, but the expansion tank is full, the system may have an airlock. Refer to Chapter 2 for the procedure for bleeding the system.

Check the coolant hoses for signs of deterioration, leaks and loose clips. Pay particular attention to the hoses which run from the radiator to the expansion tank. Squeeze the hoses at various points to check that they are not perished or blocked internally. Check the heater hoses in the same way. Refer to Chapter 2 for more information on the cooling system hoses.

Check the radiator for signs of damage to the fins, leaks and corrosion. Refer to Chapter 2 for more information on the radiator.

Check the operation of the cooling fan as the engine reaches its normal operating temperature. The fan should operate when the engine is hot, and stop when the engine is cold. Refer to Chapter 3 for more information on the cooling fan.

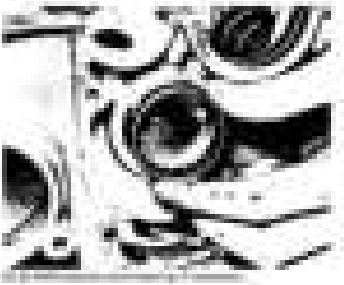






























1.6 Engine and gearbox assembly: refitting the gearbox (cont'd)

1 The gearbox mainshaft and clutch assembly becomes heavy as a unit, so it is best to have someone help with lifting this unit. Apart from that, the refitting is the reverse of removal. Make sure that the gearbox mainshaft splines are clean and lightly greased before you start to refit the gearbox. Don't forget to refit the two dowels which align the gearbox with the engine.

2 Refit the gearbox mounting bracket and tighten the bolts to the specified torque. Refit the gearbox mounting rubber and tighten the nuts to the specified torque. Refit the gearbox mounting rubber to the bracket on the gearbox and tighten the bolts to the specified torque. Refit the gearbox mounting rubber to the crossmember and tighten the nuts to the specified torque. Refit the crossmember and tighten the bolts to the specified torque. Refit the exhaust mounting rubber and tighten the nuts to the specified torque. Refit the exhaust mounting rubber to the crossmember and tighten the nuts to the specified torque.

3 Refit the starter motor and tighten the bolts to the specified torque. Refit the starter motor electrical connections.

4 Refit the clutch slave cylinder and tighten the bolts to the specified torque. Refit the clutch hydraulic pipe and tighten the union nut to the specified torque. Refit the clutch hydraulic pipe to the clip on the gearbox.

5 Refit the gearbox oil filler plug and tighten it to the specified torque. Refit the gearbox oil level plug and tighten it to the specified torque. Refill the gearbox with the specified amount and grade of oil.

6 Refit the speedometer drive and tighten the bolt to the specified torque. Refit the speedometer cable and tighten the nut to the specified torque.

7 Refit the gearchange linkage and tighten the bolts to the specified torque. Refit the gearchange linkage rod and tighten the nut to the specified torque. Refit the gearchange linkage rod to the gearchange lever and tighten the nut to the specified torque. Refit the gearchange linkage rod to the gearchange lever and tighten the nut to the specified torque.

8 Refit the driveshafts and tighten the bolts to the specified torque. Refit the driveshaft hubs and tighten the nuts to the specified torque. Refit the driveshaft hubs to the wheel bearings and tighten the nuts to the specified torque. Refit the driveshaft hubs to the wheel bearings and tighten the nuts to the specified torque.

9 Refit the wheels and tighten the wheel nuts to the specified torque. Refit the wheel trims. Refit the roadwheels and tighten the wheel nuts to the specified torque. Refit the wheel trims.

10 Refit the battery and tighten the terminal clamps. Refit the battery cover. Refit the battery tray and tighten the bolts to the specified torque. Refit the battery to the tray and tighten the bolts to the specified torque. Refit the battery to the tray and tighten the bolts to the specified torque.

11 Refit the air cleaner assembly and tighten the bolts to the specified torque. Refit the air cleaner hose and tighten the clip. Refit the air cleaner hose and tighten the clip. Refit the air cleaner hose and tighten the clip.

12 Refit the engine oil filler cap. Refit the engine oil dipstick. Refit the engine oil dipstick and tighten the bolt to the specified torque. Refit the engine oil dipstick and tighten the bolt to the specified torque.

13 Refit the engine coolant expansion tank and tighten the bolts to the specified torque. Refit the engine coolant expansion tank and tighten the bolts to the specified torque. Refit the engine coolant expansion tank and tighten the bolts to the specified torque.

14 Refit the engine coolant hoses and tighten the clips. Refit the engine coolant hoses and tighten the clips. Refit the engine coolant hoses and tighten the clips.

15 Refit the engine coolant temperature sensor and tighten the bolt to the specified torque. Refit the engine coolant temperature sensor and tighten the bolt to the specified torque. Refit the engine coolant temperature sensor and tighten the bolt to the specified torque.

16 Refit the engine coolant pump and tighten the bolts to the specified torque. Refit the engine coolant pump and tighten the bolts to the specified torque. Refit the engine coolant pump and tighten the bolts to the specified torque.

17 Refit the engine coolant pump pulley and tighten the bolts to the specified torque. Refit the engine coolant pump pulley and tighten the bolts to the specified torque. Refit the engine coolant pump pulley and tighten the bolts to the specified torque.

18 Refit the engine coolant pump belt and tighten the belt to the specified tension. Refit the engine coolant pump belt and tighten the belt to the specified tension. Refit the engine coolant pump belt and tighten the belt to the specified tension.

19 Refit the engine coolant pump belt tensioner and tighten the bolts to the specified torque. Refit the engine coolant pump belt tensioner and tighten the bolts to the specified torque. Refit the engine coolant pump belt tensioner and tighten the bolts to the specified torque.

20 Refit the engine coolant pump belt tensioner and tighten the bolts to the specified torque. Refit the engine coolant pump belt tensioner and tighten the bolts to the specified torque. Refit the engine coolant pump belt tensioner and tighten the bolts to the specified torque.

1.6 Engine and gearbox assembly: refitting the gearbox (cont'd)

1 Refit the gearbox mainshaft and clutch assembly. Make sure that the splines are clean and lightly greased before you start to refit the gearbox. Don't forget to refit the two dowels which align the gearbox with the engine. Refit the gearbox mainshaft and clutch assembly. Make sure that the splines are clean and lightly greased before you start to refit the gearbox. Don't forget to refit the two dowels which align the gearbox with the engine. Refit the gearbox mainshaft and clutch assembly. Make sure that the splines are clean and lightly greased before you start to refit the gearbox. Don't forget to refit the two dowels which align the gearbox with the engine.

2 Refit the gearbox mounting bracket and tighten the bolts to the specified torque. Refit the gearbox mounting rubber and tighten the nuts to the specified torque. Refit the gearbox mounting rubber to the bracket on the gearbox and tighten the bolts to the specified torque. Refit the gearbox mounting rubber to the crossmember and tighten the nuts to the specified torque. Refit the crossmember and tighten the bolts to the specified torque. Refit the exhaust mounting rubber and tighten the nuts to the specified torque. Refit the exhaust mounting rubber to the crossmember and tighten the nuts to the specified torque. Refit the gearbox mounting bracket and tighten the bolts to the specified torque. Refit the gearbox mounting rubber and tighten the nuts to the specified torque. Refit the gearbox mounting rubber to the bracket on the gearbox and tighten the bolts to the specified torque. Refit the gearbox mounting rubber to the crossmember and tighten the nuts to the specified torque. Refit the crossmember and tighten the bolts to the specified torque. Refit the exhaust mounting rubber and tighten the nuts to the specified torque. Refit the exhaust mounting rubber to the crossmember and tighten the nuts to the specified torque.

3 Refit the starter motor and tighten the bolts to the specified torque. Refit the starter motor electrical connections. Refit the starter motor and tighten the bolts to the specified torque. Refit the starter motor electrical connections. Refit the starter motor and tighten the bolts to the specified torque. Refit the starter motor electrical connections.

4 Refit the clutch slave cylinder and tighten the bolts to the specified torque. Refit the clutch hydraulic pipe and tighten the union nut to the specified torque. Refit the clutch hydraulic pipe to the clip on the gearbox. Refit the clutch slave cylinder and tighten the bolts to the specified torque. Refit the clutch hydraulic pipe and tighten the union nut to the specified torque. Refit the clutch hydraulic pipe to the clip on the gearbox. Refit the clutch slave cylinder and tighten the bolts to the specified torque. Refit the clutch hydraulic pipe and tighten the union nut to the specified torque. Refit the clutch hydraulic pipe to the clip on the gearbox.

5 Refit the gearbox oil filler plug and tighten it to the specified torque. Refit the gearbox oil level plug and tighten it to the specified torque. Refill the gearbox with the specified amount and grade of oil. Refit the gearbox oil filler plug and tighten it to the specified torque. Refit the gearbox oil level plug and tighten it to the specified torque. Refill the gearbox with the specified amount and grade of oil. Refit the gearbox oil filler plug and tighten it to the specified torque. Refit the gearbox oil level plug and tighten it to the specified torque. Refill the gearbox with the specified amount and grade of oil.

6 Refit the speedometer drive and tighten the bolt to the specified torque. Refit the speedometer cable and tighten the nut to the specified torque. Refit the speedometer drive and tighten the bolt to the specified torque. Refit the speedometer cable and tighten the nut to the specified torque. Refit the speedometer drive and tighten the bolt to the specified torque. Refit the speedometer cable and tighten the nut to the specified torque.

7 Refit the gearchange linkage and tighten the bolts to the specified torque. Refit the gearchange linkage rod and tighten the nut to the specified torque. Refit the gearchange linkage rod to the gearchange lever and tighten the nut to the specified torque. Refit the gearchange linkage rod to the gearchange lever and tighten the nut to the specified torque. Refit the gearchange linkage and tighten the bolts to the specified torque. Refit the gearchange linkage rod and tighten the nut to the specified torque. Refit the gearchange linkage rod to the gearchange lever and tighten the nut to the specified torque. Refit the gearchange linkage rod to the gearchange lever and tighten the nut to the specified torque.

8 Refit the driveshafts and tighten the bolts to the specified torque. Refit the driveshaft hubs and tighten the nuts to the specified torque. Refit the driveshaft hubs to the wheel bearings and tighten the nuts to the specified torque. Refit the driveshaft hubs to the wheel bearings and tighten the nuts to the specified torque. Refit the driveshafts and tighten the bolts to the specified torque. Refit the driveshaft hubs and tighten the nuts to the specified torque. Refit the driveshaft hubs to the wheel bearings and tighten the nuts to the specified torque. Refit the driveshaft hubs to the wheel bearings and tighten the nuts to the specified torque.

9 Refit the wheels and tighten the wheel nuts to the specified torque. Refit the wheel trims. Refit the roadwheels and tighten the wheel nuts to the specified torque. Refit the wheel trims. Refit the wheels and tighten the wheel nuts to the specified torque. Refit the wheel trims. Refit the roadwheels and tighten the wheel nuts to the specified torque. Refit the wheel trims.



Fig. 1.6 Refitting the gearbox mounting bracket

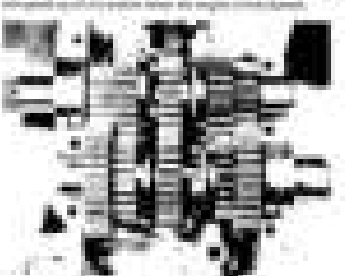
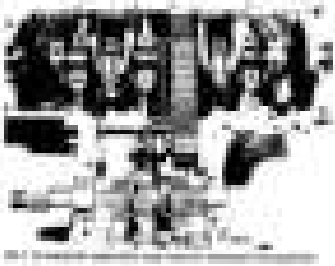


Fig. 1.6 Refitting gearbox mounting and exhaust mounting









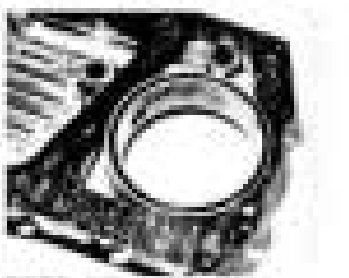


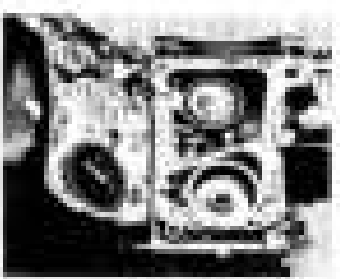












8 Engine and gearbox combination - removing and installing

Removing and installing engine

Special tools required

- For the gearbox version with code letters DKV, DKW, DKX or DKY, a locking pin is required to secure the crankshaft in the correct position. The pin is inserted in the hole in the flywheel and engages in the corresponding hole in the cylinder block. The pin is part of the special tool assembly VW 558 or can be made from a 6 mm drill bit.

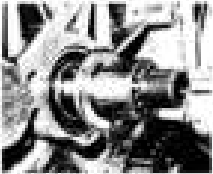
Removing

- Open the bonnet, cover the wings with protective sheeting and remove the engine cover panel.
- Disconnect the battery earth lead.
- Remove the air cleaner housing and the intake hose.
- Remove the radiator fan cowl.
- Drain the coolant from the radiator and the engine block.
- Remove the radiator.
- Remove the coolant expansion tank.
- Remove the heater hoses from the engine.
- Remove the accelerator cable from the throttle valve housing.
- Remove the clutch cable from the clutch release lever.
- Remove the starter motor.
- Remove the engine mounting bolts.
- Remove the gearbox mounting bolts.
- Support the gearbox with a jack and a piece of wood.
- Lift the engine out of the engine compartment.

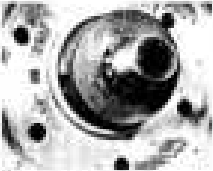
Installing

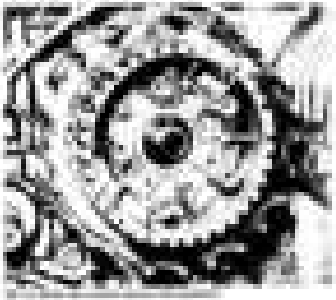
- Installation is carried out in the reverse order of removal.
- Fill the engine with coolant.
- Adjust the clutch cable.
- Adjust the accelerator cable.
- Check the ignition timing.
- Check the idle speed and CO content.

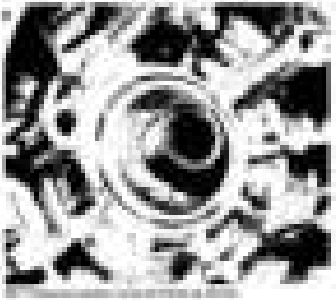


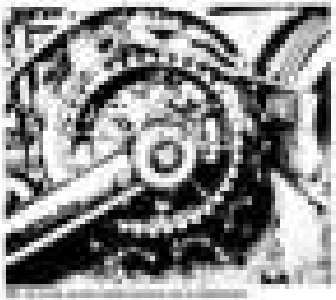




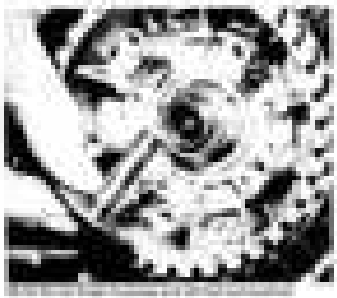


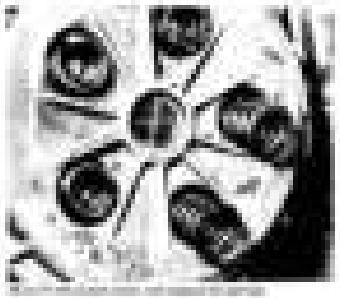


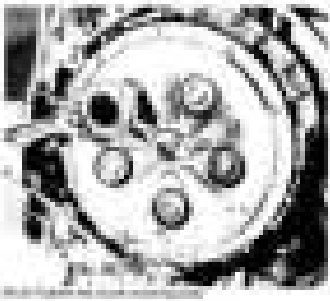






















Ex. 7.1 Given the general parametric representation of the circle in space

$$\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$$

1. Explain the meaning of the vectors $\mathbf{x}_0$, $\mathbf{u}$, $\mathbf{v}$ and the scalar r.
2. Find the parametric representation of the circle in space with centre $(1, 2, 3)$, radius $r = 2$, and lying in the plane $x + y + z = 6$.
3. Find the parametric representation of the circle in space with centre $(1, 2, 3)$, radius $r = 2$, and lying in the plane $x + y + z = 6$ and such that the point $(3, 2, 1)$ corresponds to the value $t = 0$.

Ex. 7.2 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the length of the chord $\mathbf{x}_1\mathbf{x}_2$ is $2r\sin\frac{t_2 - t_1}{2}$.

Ex. 7.3 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the length of the arc $\mathbf{x}_1\mathbf{x}_2$ is $r(t_2 - t_1)$.

Ex. 7.4 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.5 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.6 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.7 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.8 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.9 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.10 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.11 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.12 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.13 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.14 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.15 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.16 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.17 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.18 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.19 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.20 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.21 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.22 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.23 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.

Ex. 7.24 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular segment bounded by the chord $\mathbf{x}_1\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1 - \sin(t_2 - t_1))$.

Ex. 7.25 Let $\mathbf{x}(t) = \mathbf{x}_0 + r\cos t\,\mathbf{u} + r\sin t\,\mathbf{v}$ be the general parametric representation of a circle. Let $\mathbf{x}_1 = \mathbf{x}(t_1)$ and $\mathbf{x}_2 = \mathbf{x}(t_2)$ be two points on the circle. Prove that the area of the circular sector bounded by the chords $\mathbf{x}_0\mathbf{x}_1$, $\mathbf{x}_0\mathbf{x}_2$ and the arc $\mathbf{x}_1\mathbf{x}_2$ is $\frac{r^2}{2}(t_2 - t_1)$.



Fig. 7.1 Circular segment and circular sector bounded by a chord











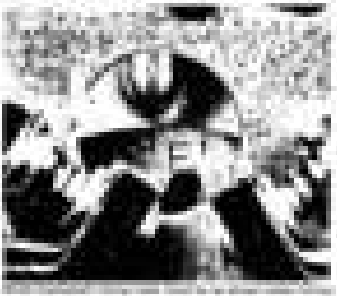


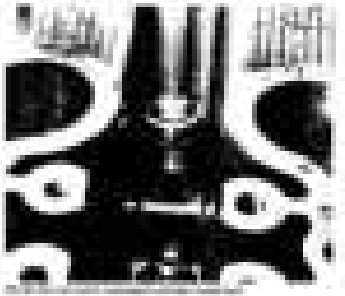


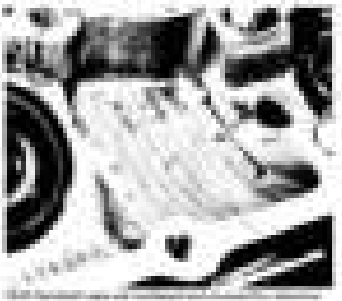


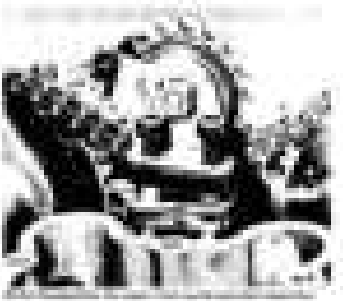








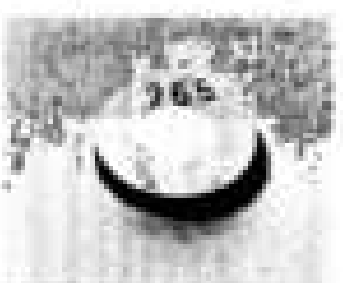











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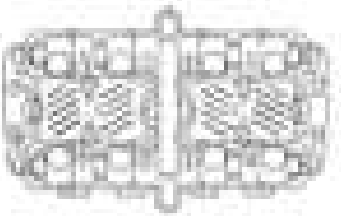


Fig. 1.10 Cylinder head nut tightening sequence

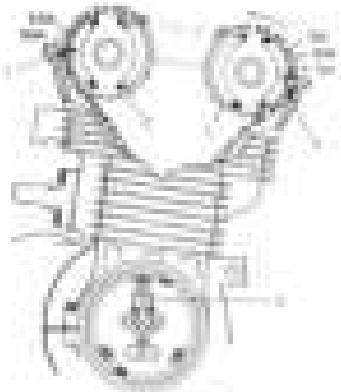


Fig. 1.11 Valve timing

1 Inlet camshaft timing mark
2 Inlet camshaft sprocket
3 Exhaust camshaft sprocket
4 Exhaust camshaft timing mark
5 Timing chain
A = Inlet valve timing mark
B = Exhaust valve timing mark

4 Valves/valve seats/valve guides – inspection and renovation

1 After removing the cylinder head, clean the valves thoroughly and scrape away all traces of carbon from the valve heads and stems. Also clean away the carbon deposits from the combustion chambers, taking care not to damage the gasket surfaces.

2 Examine the valve heads for pitting and burning, especially the exhaust valves. Check the valve stems for scoring and wear ridges. Rotate each valve and check for any obvious indication that it is bent. Look for cracks between the valve head and stem. Check the condition of the valve stem end where it contacts the rocker arm adjuster screw.

3 Remove any carbon deposits from the valve guides using a piece of scrap valve stem. Push the valve a little way into the guide and clean the valve stem and guide bore with a rag soaked in paraffin. Withdraw the valve and clean the valve guide bore with a rag soaked in paraffin. Withdraw the valve and clean the valve guide bore with a rag soaked in paraffin.

4 Measure the valve stem diameter at several points along its length using a micrometer. Measure the valve guide bore diameter at the inlet and exhaust valve guide bore diameter at the inlet and exhaust valve guide bore diameter at the inlet and exhaust









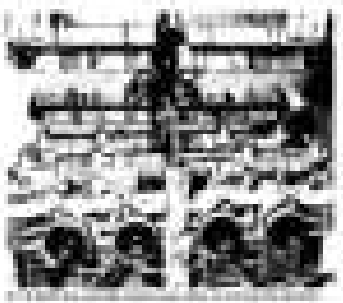




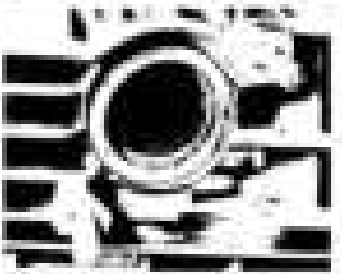


















20 Engine overhaul – removing the clutch and gearbox unit

1 Refer to the relevant Sections and remove the engine/gearbox unit from the vehicle as described in Chapter 2, Part A. Place the unit on the workbench and remove the starter motor.

2 Unscrew the bolts and withdraw the clutch cover plate. Note the location of the dowels.

3 Unscrew the bolts and withdraw the clutch pressure plate assembly. Collect the driven plate.

4 Unscrew the bolts and withdraw the flywheel. Note the location of the dowel.

5 Unscrew the bolts and withdraw the engine rear mounting plate.

6 Unscrew the bolts and withdraw the gearbox end cover.

7 Unscrew the bolts and withdraw the gearbox casing. Note the location of the dowels.

8 Unscrew the bolts and withdraw the gearbox internal cover plate.

9 Unscrew the bolts and withdraw the gearbox mounting bracket.

10 Unscrew the bolts and withdraw the gearbox mounting bracket.

11 Unscrew the bolts and withdraw the gearbox mounting bracket.

12 Unscrew the bolts and withdraw the gearbox mounting bracket.

Mr Kent response: angles

Behaviour	Cause	Remedy
Copies out the rules	Defensive coping strategy	Remove the page but be kind to the struggling pupil Check whether pupil found other angles in an investigation earlier
	Does not understand terminology	Check HA vocabulary in the lesson and consider pre-teaching key words
	Cannot remember procedures	Check whether HA pupils can work independently Remind the pupil that D here is perpendicular to AC
Doesn't see connections	Ignores previous learning	Check which pupils independently for the pupil Ask pupil to explain how it is different from the previous question
	Working outside their grasp	Ask pupil to explain how it is different from the previous question
	Incorrect recall/learning	Check the connections pupil is making
Lack of focus	Pupil is distracted or overtired (pupil is trying)	Check that there is no distraction Make sure pupil is trying
Poor concentration	Certain times of week/day/lesson	Check what time of day/lesson you're teaching it

Mr Flint Response: Jacob

Behaviour	Cause	Remedy
Pupil says he knows something but he can't explain how or what he knows	Procedural	Ask pupil to explain how he knows Ask pupil to show how he knows
Difficulty in changing a point, path, triangle and/or shape in relation to other things in space, and/or in relation to difficulty in working around	Spatial	Check pupil's ability to see shapes in relation to other things Check pupil's ability to see shapes in relation to other things
Pupil's explanation after	Conceptual: struggles to explain connections after	Check pupil's ability to see shapes in relation to other things Check pupil's ability to see shapes in relation to other things

Mr Lord (Progression: Upstairs)

Behaviour	Cause	Remedy
Difficulty in navigating space	Spatial: visualisation Short-term/working memory/retrieval issues	Reduce cognitive load Check pupil needs for accommodation - ask parents/SENCo/colleagues
Reaching a plan for an idea	Does not see the point of spatial activity	Provide more practice
Can't identify and make the steps in an argument/proof	Doesn't see the point	Do this with me
Struggling to keep all the information in mind	Working memory overload/short-term memory	Provide aid/help in recording
Inattentive state	Boredom, underchallenged	Consider/ask pupil to do harder or more work

Chapter 2 Fuel system and lubrication

Contents

Specifications

Engine lubrication system

Type	Wet sump, full flow filtration
Pressure	2.5 bar (250 kPa) at 2000 rpm

Oil pump

Type	Gear driven
Drive	Crankshaft
Clearances	
Gear end float	0.04 mm
Gear radial clearance	0.08 mm
Relief valve opening pressure	4.1 bar (410 kPa)
Pump body bolts	8 Nm (5.9 lbf ft)

Oil capacities

Sump	4.5 litres (7.9 pints) (5.4 US quarts)
Filter change	0.5 litres (0.9 pints) (0.6 US quarts)

Oil pump

Type	Gear driven from crankshaft
Drive	Duplex chain from crankshaft
Clearances	
Gear end float	0.04 mm
Gear radial clearance	0.08 mm
Relief valve opening pressure	4.1 bar (410 kPa)
Pump body bolts	8 Nm (5.9 lbf ft)

Network diagrams

The first method is called that of a project activity chart. Don't worry if you've never heard of it. The term describes a flowchart or diagram. You can find many examples of this on the internet. Search for 'project activity chart' and you'll find a number of examples. Some are very simple, others are more complex. Some are free, others are not. Some are very good, others are not so good. Some are easy to understand, others are not so easy to understand. Some are very detailed, others are not so detailed. Some are very long, others are not so long. Some are very short, others are not so short. Some are very complex, others are not so complex. Some are very simple, others are not so simple. Some are very good, others are not so good. Some are very bad, others are not so bad. Some are very ugly, others are not so ugly. Some are very beautiful, others are not so beautiful









3.3 Examples of machines operating on compressible and incompressible fluids

3.3.1 Introduction: classification and principles

The machines for converting work into pressure energy or vice versa, commonly called turbomachines, are of many kinds and have many names. Some of the commoner names are fan, blower, compressor, pump, propeller, windmill, turbine, waterwheel, etc. The modern ones are the most powerful and efficient machines ever developed by man. The best examples are shown in figure 3.3.1. Some of the machines are designed to work with compressible fluids (gases), others with incompressible fluids (liquids). The first example (see figure 3.3.1a) is a large axial-flow compressor for a gas turbine engine. The second example (see figure 3.3.1b) is a Pelton wheel, a tangential-flow impulse water turbine. The third example (see figure 3.3.1c) is a mixed-flow pump impeller. The last example (see figure 3.3.1d) is a Francis turbine runner, a radial-flow reaction water turbine.

The machines are operated by any agency from the environment, and in return they transmit that energy either to or from another system. The agency is represented in the simplest cases by a rotating shaft, and the energy transmitted is the product of the shaft torque and the angular velocity. Other agencies are also possible, for example, electromagnetic induction, and the energy transmitted is then the product of the electromotive force and the current. Sometimes the energy is transmitted by a fluid stream, in which case the machine forms a link in a fluid system.

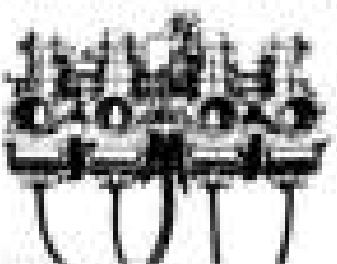
In all the machines energy is transferred to or from a rotating member, usually called a rotor or impeller, and changes in the fluid energy are associated with changes in the velocity and pressure of the fluid as it flows through the rotor. The rotor is surrounded by a stationary casing which guides the fluid to or from the rotor. Usually, but not always, the casing is designed to convert kinetic energy into pressure energy, or vice versa, as efficiently as possible. Sometimes, however, the casing is designed to perform the opposite function, in order to produce a jet of high velocity, as in the nozzle of a steam turbine, or to collect the kinetic energy from a jet of high velocity, as in the Pelton wheel (see figure 3.3.1b). Sometimes the casing is designed to perform both functions, as in the diffuser and collector of a wind tunnel.

In a machine which does work on the fluid, the work is done on the rotor, and the fluid passes from the entrance duct, through the rotor, to the delivery duct. In a machine which extracts energy from the fluid, the fluid passes from the entrance duct, through the rotor, to the exit duct. The entrance duct leads the fluid to the rotor in the correct manner, and the exit duct leads away the fluid which has passed through the rotor. Sometimes the entrance duct is omitted, and sometimes the exit duct is omitted, but usually both ducts are present.

The rotor is usually surrounded by a stationary casing, which may be designed to form a diffuser or a nozzle, as mentioned above. The casing may also be designed to form a collector for the fluid which has passed through the rotor, and to lead it to the exit duct. Sometimes the casing is designed to perform the opposite function, in order to distribute the fluid from the entrance duct to the rotor. Usually, but not always, the casing is designed to convert kinetic energy into pressure energy, or vice versa, as efficiently as possible. Sometimes, however, the casing is designed to perform the opposite function, in order to produce a jet of high velocity, as in the nozzle of a steam turbine, or to collect the kinetic energy from a jet of high velocity, as in the Pelton wheel (see figure 3.3.1b). Sometimes the casing is designed to perform both functions, as in the diffuser and collector of a wind tunnel.

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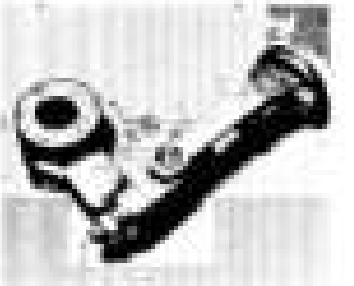








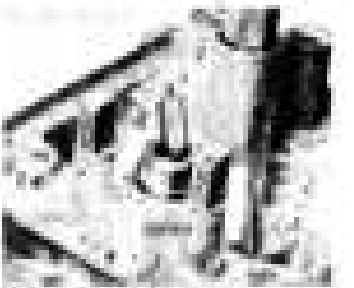






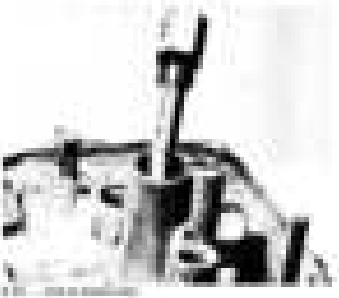


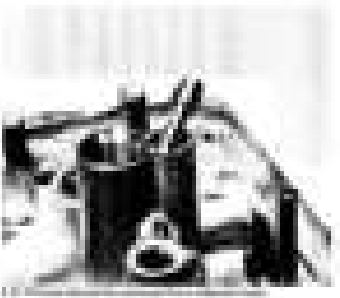




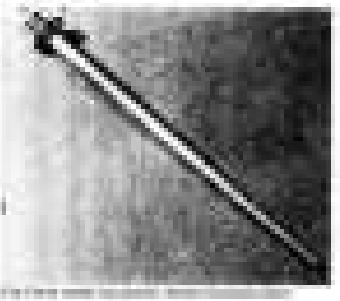


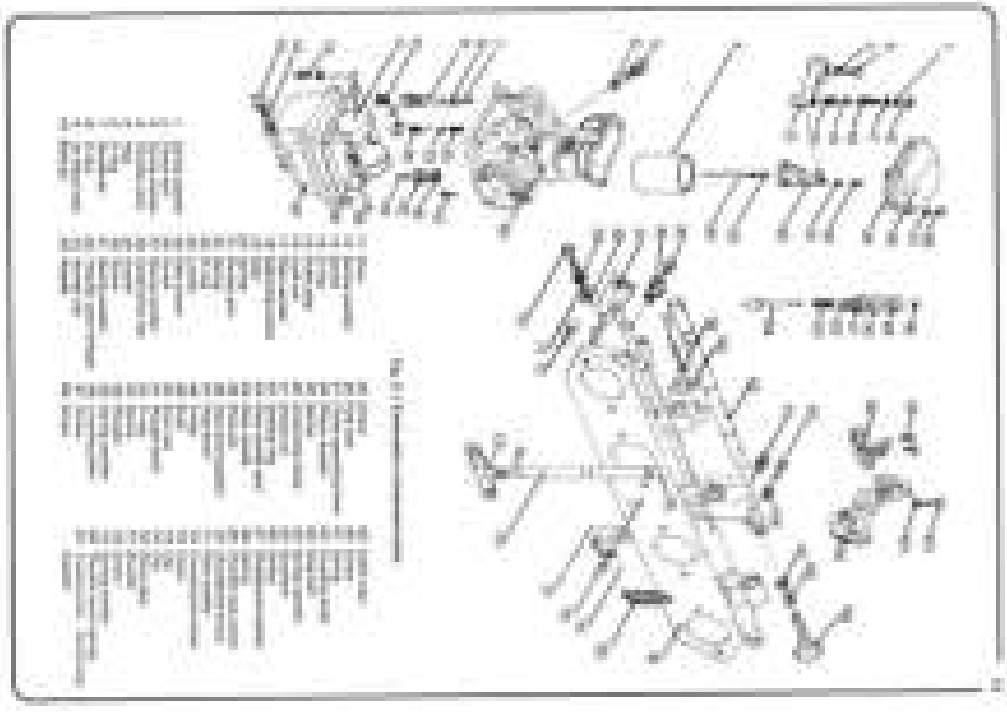




















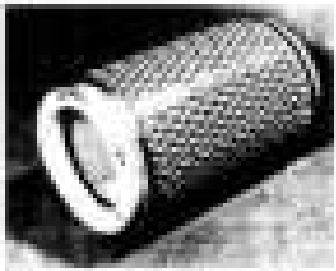


Fig. 2. Fuel injection nozzle with multiple spray holes

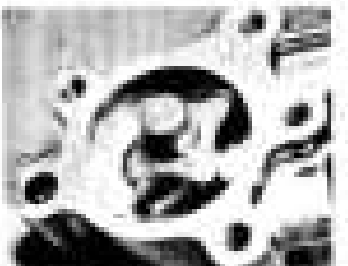


Fig. 3. Swirl chamber (upper left) and combustion chamber (lower right) of a diesel engine with indirect injection

Fig. 3. Swirl chamber (upper left) and combustion chamber (lower right) of a diesel engine with indirect injection





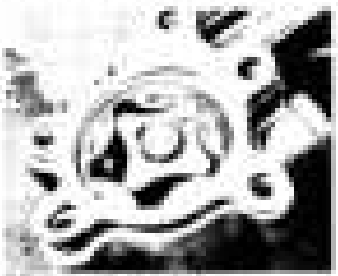
















Mr. Jonathan, reading the instructions

1. Turn on Video, a commercial station, or any available entertainment channel. Position the screen so that you can watch it while you read the instructions. Make sure that the sound is turned down and that you can hear your own voice clearly. Practice reading aloud. Once you've mastered this, you are ready to proceed with the Video Reading Improvement Exercise. Be sure to watch the screen, not the book, as you read the instructions.

2. When reading the Video Reading Improvement Exercise, read the text in one voice and the commercials in another voice. Be sure to read the commercials with enthusiasm.

3. Now, as soon as the commercials come on, begin to read the instructions for the Video Reading Improvement Exercise. Your voice should change instantly. Do not pause. Do not stammer. Do not hesitate. Your voice should sound clear and strong. The instructions are given in a conversational style, and you should read them as if you were talking to a friend. Be enthusiastic about the Video Reading Improvement Exercise.

4. Watch as the Video Reading Improvement Exercise changes. You can tell when the commercials are coming on and off the screen.

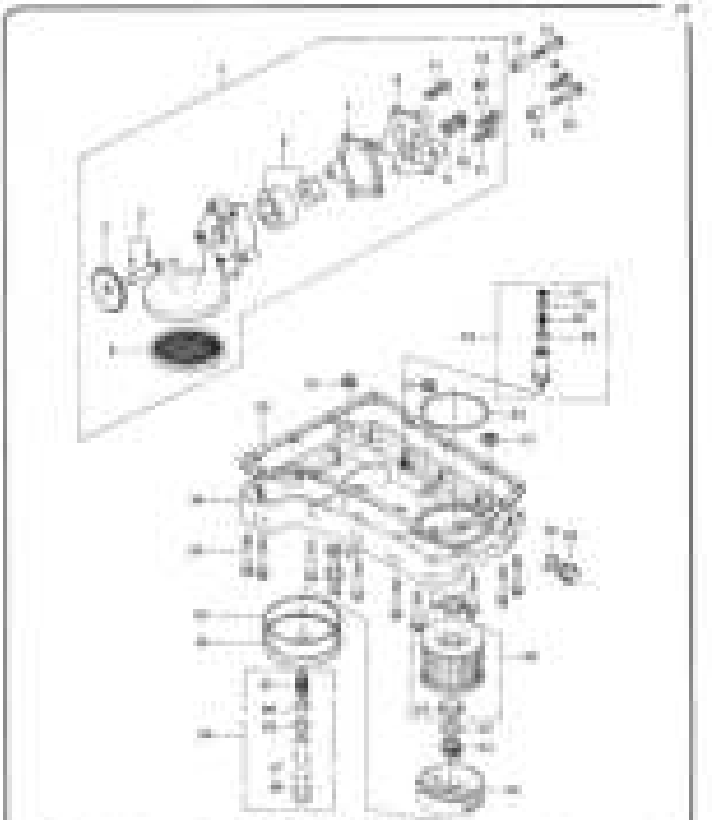




Fig. 1 Title Needs to be Descriptive, Concise and Self-Explanatory



2.1 Introductory Learning Activities

1. Do not introduce learning activities in a mechanical way. Use your imagination to make them interesting. Remember that the success of learning depends on the activities you provide for the learners. Activities should be varied and should provide for learning by doing. Learning by doing is the best way to learn. Learners learn more by doing than by listening. Learners learn more by doing than by reading. Learners learn more by doing than by watching. Learners learn more by doing than by anything else.

2. Activities should be appropriate to the level of the learners. They should be neither too difficult nor too easy. They should be challenging but not frustrating. They should be relevant to the learners' needs and interests. They should be meaningful to the learners. They should be enjoyable for the learners.

3. Activities should be sequenced in a logical order. They should build on each other. They should progress from simple to complex. They should progress from concrete to abstract. They should progress from known to unknown. They should progress from familiar to unfamiliar.

4. Activities should be flexible. They should be adaptable to different learning styles. They should be adaptable to different learning needs. They should be adaptable to different learning abilities. They should be adaptable to different learning interests. They should be adaptable to different learning goals.

5. Activities should be varied. They should include a variety of different types of activities. They should include a variety of different learning strategies. They should include a variety of different learning tools. They should include a variety of different learning resources. They should include a variety of different learning environments.

6. Activities should be integrated. They should be integrated with each other. They should be integrated with the learning objectives. They should be integrated with the learning outcomes. They should be integrated with the assessment. They should be integrated with the learning environment.

7. Activities should be evaluated. They should be evaluated for their effectiveness. They should be evaluated for their appropriateness. They should be evaluated for their relevance. They should be evaluated for their enjoyment. They should be evaluated for their flexibility. They should be evaluated for their variety. They should be evaluated for their integration. They should be evaluated for their sequencing. They should be evaluated for their level of challenge. They should be evaluated for their level of support. They should be evaluated for their level of feedback. They should be evaluated for their level of reflection. They should be evaluated for their level of collaboration. They should be evaluated for their level of autonomy. They should be evaluated for their level of creativity. They should be evaluated for their level of problem solving. They should be evaluated for their level of critical thinking. They should be evaluated for their level of decision making. They should be evaluated for their level of communication. They should be evaluated for their level of interaction. They should be evaluated for their level of engagement. They should be evaluated for their level of motivation. They should be evaluated for their level of satisfaction. They should be evaluated for their level of learning outcomes.

8. Now, after reading the guidelines, identify what is wrong with the activities mentioned in the introductory section. Then, using the above guidelines, try to improve them. Also, mention what the learning objectives are.

Fig. 2 The Activities Section in Introductory Textbooks Usually Includes Boilerplate

Table 1 Footer Alignment, Font Variation and Abbreviations

Alignment	Usage	Example
Flushing and Hyphenation Options and Issues	Text Alignment	Options and Issues in Text Alignment, Flushing and Hyphenation
Flushing and Hyphenation Options and Issues	Typesetting Terminology	Typesetting Terms Related to Alignment, Flushing and Hyphenation
Flushing and Hyphenation Options and Issues	Flushing Options Text Alignment Options and Issues with Flushing and Hyphenation Flushing and Hyphenation Options and Issues	Flushing Text Alignment Options and Issues Flushing and Hyphenation Flushing and Hyphenation Options
Text Alignment and Flushing Options and Issues	Text Alignment and Flushing Options Flushing and Hyphenation Options and Issues	Text Alignment and Flushing Options and Issues Flushing and Hyphenation Options and Issues
Flushing and Hyphenation Options and Issues	Flushing and Hyphenation Options and Issues	Flushing and Hyphenation Options and Issues

Chapter 3 Ignition system

Contents

Ignition system - description	1	Ignition timing - checking and adjusting	6
Ignition coils - checking	2	Ignition switch/steering lock - removal and refitting	7
Ignition module - checking	3	Ignition system components - removal and refitting	8
Ignition module - removal and refitting	4	Spark plug HT leads - checking and renewal	9
Ignition timing - checking and adjusting (basic check)	5	Spark plugs - renewal	10
Ignition timing - checking and adjusting (advanced check)	5	Crankshaft sensor - removal and refitting	11
Crankshaft sensor - removal and refitting	6	Electronic ignition - general information	12

Specifications

Switching circuit

Type	Hall sensor
Module	Mounted on engine
Trigger wheel/sensor gap	0.8 mm ± 0.1 mm
Coil	Ignition coil with integral HT lead
Primary resistance (at 20°C/68°F)	0.5 to 0.6 ohms
Secondary resistance (at 20°C/68°F)	6000 to 8000 ohms
Spark plugs	Champion RC9YC or equivalent (see text)
Electrode gap	0.7 mm (0.028 inch) (see text)
Recommended torque wrench setting	27 Nm (20 lbf ft)

Crankshaft

Sensor air gap	0.25 to 0.65 mm (adjust to 0.4 mm)

Ignition coil(s)

Number	1
Type	Mounted on cylinder head
Colour	Black
Primary resistance	0.5 to 0.6 ohms
Secondary resistance	6000 to 8000 ohms

Ignition timing

Basic	10° BTDC
Static check (vacuum pipe disconnected)	10° ± 1° BTDC
Static check (vacuum pipe plugged)	17° ± 1° BTDC
Dynamic check (at idle)	10° ± 1° BTDC
Advanced	10° BTDC at 1,000 rpm (no vacuum) and 32° BTDC at 3,000 rpm (vacuum connected)
Mechanical advance	Weights and flyweight governor

1 General description

The ignition components on petrol engines are all mounted on the distributor, which is driven by the camshaft. The distributor contains the ignition module, which is a sealed unit and cannot be repaired. The distributor also contains the crankshaft sensor, which is a non-adjustable type. The ignition coil is mounted on the front of the engine.

The ignition system is controlled by the engine management system, which is described in Chapter 4. The system is fully integrated and has no provision for manual adjustment of the ignition timing. The only ignition system component which requires regular attention is the spark plugs, which should be renewed at the intervals specified in Chapter 1.

Warning: The ignition system operates at very high voltage. Take care to avoid electric shock when working on any part of the system with the ignition switched on. People with pacemakers should be especially careful. The ignition system also produces voltages which could damage semiconductor components, so switch off the ignition before disconnecting or connecting any wiring.





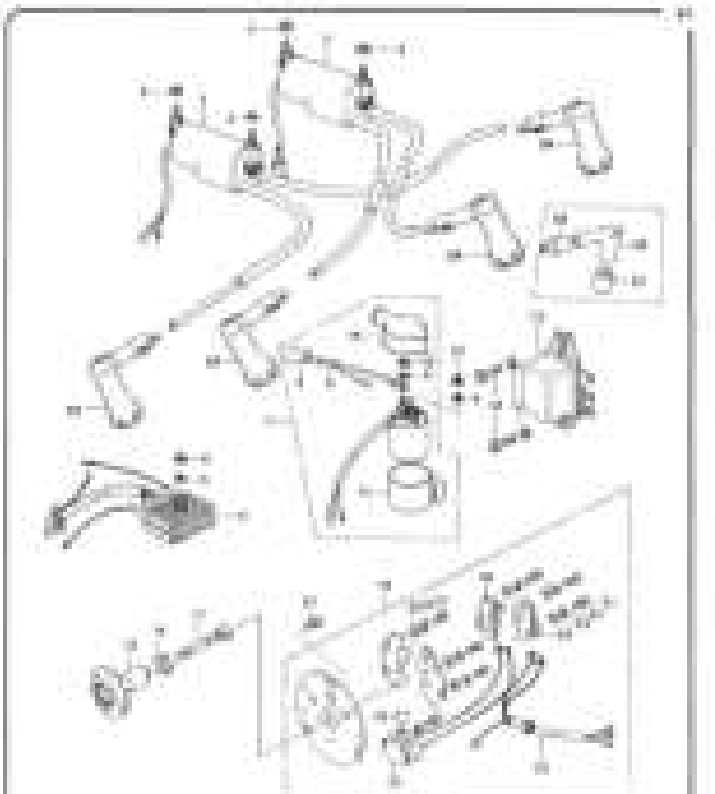


Fig. 3.3 Ignition system - component parts



1 Ground wire from ignition coil (HT) lead to distributor cap



Fig. 3.2 Contact breaker assembly

1 Contact breaker base
2 Cam lubrication wick
3 Contact breaker – fixed
4 Mounting screw – 2 off
5 Nut – 2 off
6 Spring washer – 2 off
7 Plain washer – 2 off
8 Adjusting screw
9 Contact breaker – moving
10 Contact breaker spring
11 Condenser – 2 off
12 Condenser lead
13 Contact breaker assembly – 2 off
14 Contact breaker – fixed
15 Mounting screw – 2 off
16 Adjusting screw
17 Contact breaker – moving
18 Contact breaker spring
19 Condenser – 2 off
20 Condenser lead
21 Contact breaker assembly

2 Contact breaker assembly – removal and refitment

1 The contact breaker gear may be left in situ when undertaking these operations, although it is first necessary to remove the distributor cap and rotor. If ignition timing is to be checked, it is advisable to mark the relative positions of the rotor and the distributor body before removal.

2 Unscrew the two screws which secure the contact breaker assembly to the base plate and withdraw the assembly from the distributor. Disconnect the condenser lead from the terminal on the contact breaker assembly.

3 Refitment is a reversal of the removal procedure. Ensure that the contact breaker gap is correctly adjusted (see Section 3) before finally tightening the securing screws.

3 Contact breaker assembly – cleaning and adjustment

1 The contact breaker points may be cleaned with a fine carborundum stone or emery cloth. Remove the contact breaker assembly from the distributor as described in Section 2. Rub the faces of the points together to clean them. Alternatively, prise the points apart and clean them with a fine carborundum stone or emery cloth. Do not use oil on the faces of the points.

2 Adjustment of the contact breaker gap is necessary after the points have been in use for some time, or if they have been disturbed for any reason. Ideally, the gap should be checked with a feeler gauge, but this is a fiddly operation and it is more convenient to use a dwell meter. Turn the engine over until the heel of the moving contact is on the peak of one of the cam lobes. Insert the feeler gauge between the points and check that the gap is correct. If adjustment is necessary, slacken the screw which secures the fixed contact plate and move the plate until the gap is correct. Tighten the screw and recheck the gap. Adjustment is correct when the feeler gauge is a sliding fit between the points. Alternatively, connect a dwell meter according to the manufacturer's instructions and turn the engine over until the heel of the moving contact is on the peak of one of the cam lobes. Adjust the gap as described above until the dwell meter reads 60°.

3 Refitment is a reversal of the removal procedure.

4 Condenser – removal and refitment

1 The condenser is mounted externally on the contact breaker assembly and is secured by a single screw. To remove the condenser, disconnect the lead from the terminal on the contact breaker assembly and withdraw the condenser from the distributor.

2 Refitment is a reversal of the removal procedure.

5 Distributor – removal and refitment

1 Disconnect the battery earth lead.

2 Disconnect the HT leads from the spark plugs and the coil. Mark the leads to ensure correct refitment.

3 Disconnect the vacuum pipe from the distributor.

4 Disconnect the LT lead from the coil.

5 Unscrew the distributor clamp plate nut and withdraw the clamp plate.

6 Withdraw the distributor from the cylinder block.

7 Refitment is a reversal of the removal procedure. Ensure that the rotor arm is pointing to the HT lead segment for No 1 cylinder when the distributor is fitted. Check the ignition timing as described in Section 6.

6 Ignition timing

1 The ignition timing should be checked every 6000 miles (10 000 km) or every six months, whichever is the sooner, and also whenever the distributor has been disturbed.

2 Run the engine at idle speed until it reaches its normal operating temperature. Stop the engine and connect a timing light according to the manufacturer's instructions. Typically, the timing light is connected between the No 1 spark plug HT lead and the spark plug.

3 Start the engine and point the timing light at the timing marks. The timing mark on the crankshaft pulley should appear stationary and aligned with the correct timing mark on the timing cover. If adjustment is necessary, slacken the distributor clamp plate nut and turn the distributor body until the timing marks are aligned. Tighten the clamp plate nut and recheck the timing.

4 Switch off the engine and disconnect the timing light.



Spark plug maintenance: Checking plug gap with feeler gauge.



Adjusting the plug gap. Note use of correct tool.



Spark plug conditions: A brown, tan or gray firing end is indicative of correct engine running conditions and the selection of the recommended heat rating plug.



White deposits have accumulated from excessive amounts of oil in the combustion chamber or through the use of low quality oil. Remove deposits or a hot spot may form.



Black sooty deposits indicate an over-rich fuel/air mixture, or a malfunctioning ignition system. If no improvement is obtained, try one grade hotter plug.



Wet, oily carbon deposits form an electrical leakage path across the insulator nose, resulting in a misfire. The cause may be a badly worn engine or a malfunctioning ignition system.



A blistered white insulator or melted electrode indicates over-advanced ignition timing or a malfunctioning cooling system. If correction does not prove effective, try a cooler grade plug.



A worn spark plug not only wastes fuel but also overloads the whole ignition system because the increased gap requires higher voltage to initiate the spark. This condition can also affect acceleration.



4.3 Semi-automatic two-head flame cutting machine (ESAB)



4.4 Portable semi-automatic flame cutting machine for cutting bevels on plate edges (ESAB)

4 Semi-automatic cutting and beveling

1 In order to obtain the highest cutting speeds it is necessary to use a machine which can move the torch at a constant speed. Semi-automatic machines are designed to do this.

2 Semi-automatic machines are those in which the torch is moved by a motor-driven carriage which runs on a track. The operator has to set the machine up and start it off, but he does not have to control the movement of the torch.

3 Semi-automatic machines are used for straight cutting and for cutting bevels on the edges of plates. They are also used for cutting circles and other curved shapes.

4 Straight cutting Fig. 4.3 shows a typical semi-automatic machine for straight cutting. The carriage runs on a track which is clamped to the plate. The torch is mounted on a vertical slide which is fixed to the carriage. The slide can be moved up and down to adjust the distance between the torch and the plate. The carriage is driven by an electric motor. The speed of the motor can be varied so that the speed of the torch can be adjusted to suit the thickness of the plate being cut.

5 Cutting bevels Fig. 4.4 shows a portable machine for cutting bevels on the edges of plates. The machine is clamped to the plate and the torch is mounted on a carriage which runs on a circular track. The track is clamped to the plate in such a position that the torch is at the correct distance from the edge of the plate. The carriage is driven by an electric motor. The speed of the motor can be varied so that the speed of the torch can be adjusted to suit the thickness of the plate being cut.

6 Cutting circles and other curved shapes Fig. 4.5 shows a machine for cutting circles and other curved shapes. The machine is clamped to the plate and the torch is mounted on a carriage which runs on a circular track. The track is clamped to the plate in such a position that the torch is at the correct distance from the edge of the plate. The carriage is driven by an electric motor. The speed of the motor can be varied so that the speed of the torch can be adjusted to suit the thickness of the plate being cut.

5 Automatic cutting and beveling

1 The automatic cutting machine (Fig. 4.6) is designed to cut a number of identical shapes. It is controlled by a template which is made from a piece of thin sheet metal. The shape of the template is the same as the shape of the plate to be cut. The machine has a tracer which follows the edge of the template. The movement of the tracer is transmitted to the torch so that the torch follows the same path as the tracer.

2 The machine consists of a rectangular framework supported on four wheels which run on rails. The framework carries a vertical beam which can be moved backwards and forwards along the framework. The beam carries a horizontal arm which can be moved up and down the beam. The arm carries the tracer and the torch. The tracer is mounted on a vertical slide which is fixed to the arm. The torch is mounted on a vertical slide which is fixed to the arm. The tracer and the torch are connected by a linkage which transmits the movement of the tracer to the torch.

3 The machine is set up by placing the template on the plate to be cut. The tracer is then moved to the edge of the template and the torch is moved to the edge of the plate. The machine is then started and the tracer follows the edge of the template. The movement of the tracer is transmitted to the torch so that the torch follows the same path as the tracer. The machine is stopped when the tracer has completed one circuit of the template.

4 The machine is used for cutting out a number of identical shapes. It is not suitable for cutting out a single shape or for cutting out shapes which are not identical.

6 Machining edges, drilling and marking out plates

1 Plate edge planing machines are used for planing the edges of plates. They are also used for planing the edges of bars and sections.

2 The machine consists of a bed on which the plate is clamped. The bed is mounted on a carriage which runs on rails. The carriage is driven by an electric motor. The speed of the motor can be varied so that the speed of the carriage can be adjusted to suit the thickness of the plate being planed.

3 The machine has a cutting tool which is mounted on a vertical slide. The slide is mounted on a horizontal arm which can be moved backwards and forwards along the bed. The arm is driven by an electric motor. The speed of the motor can be varied so that the speed of the cutting tool can be adjusted to suit the thickness of the plate being planed.

4 The machine is set up by clamping the plate to be planed on the bed. The arm is then moved backwards and forwards along the bed so that the cutting tool removes a small amount of material from the edge of the plate. The arm is then moved sideways so that the cutting tool removes a small amount of material from the next edge of the plate. This process is repeated until all the edges of the plate have been planed.

5 The machine is used for planing the edges of plates which are to be welded together. It is also used for planing the edges of plates which are to be bolted together.

7 Machining edges, drilling and marking out plates

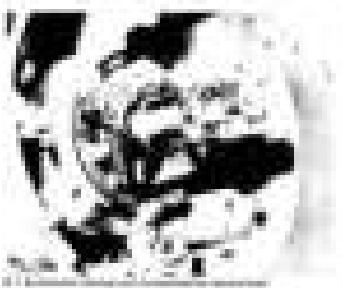
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5 The machine is used for planing the edges of plates which are to be welded together. It is also used for planing the edges of plates which are to be bolted together.



3.1 Ignition coil mounting bolt (1) and HT lead (2)



3.2 Distributor cap screws (arrowed) and HT leads

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Chapter 4 Frame and forks

Contents

Specifications

Frame 1
Front brake 1
Rear suspension unit 1
Swingarm 1
Wheel and tire 2
Front fork 2
Steering 3
Rear suspension 3
Rear brake 4
Torque specifications 4
Special tools 5

Specifications

Frame	
Type	Tubular, double cradle
Front brake	
Type	Hydraulically actuated dual disc
Operation	Right hand lever
Disc outside diameter	298 mm (11.73 in)
Disc thickness	4.5 mm (0.18 in)
Brake disc runout limit	0.30 mm (0.012 in)
Brake pad lining thickness	Inner pad: 4.0 mm (0.16 in) Outer pad: 4.0 mm (0.16 in)
Rear suspension unit	
Type	Swingarm, link-mechanism damper
Swingarm	
Type	Aluminum alloy, box section
Swingarm bushing	Oil-impregnated sintered metal bushing
Swingarm bushing inner diameter	22.000 – 22.021 mm (0.8661 – 0.8669 in)
Swingarm shaft	21.959 – 21.980 mm (0.8645 – 0.8654 in)
Swingarm bushing wear limit	22.080 mm (0.8693 in)
Swingarm shaft runout limit	0.30 mm (0.012 in)
Thrust play limit	1.0 mm (0.04 in)

1. Consult applicable regulations
2. The frame is the foundation casting on which all major components are positioned and aligned. Proper alignment is necessary to ensure stable handling characteristics.
3. A long, thin, wire is used to check the straightness of the cast, oil tight passages within the frame. Sandblasting is the only acceptable method for cleaning passages. Use of any type of wire or drill bit may damage passages, resulting in restricted oil flow to the engine and transmission. Do not attempt to repair damaged passages; replacement of the frame is necessary.

4. The front brakes are hydraulically actuated, single piston floating caliper, disc brakes. Leaking hydraulic fluid will severely reduce braking performance. Keep all brake components and hydraulic fluid clean. Inspect the master cylinder reservoir cover gasket, diaphragm and brake hoses frequently for cracks or signs of leakage. Any hydraulic brake system component requiring disassembly should be serviced by a Kawasaki dealer.
5. The rear suspension is a single shock, link type system. The single shock absorber is mounted to the frame at the top and to the swingarm through the linkage at the bottom. The linkage is mounted to the frame and swingarm. Refer to the Rear Suspension section for more information.

















Fig. 6.1 Fluorescence from the Earth and the moon



Fig. 6.2 Spectrophotometer for measuring fluorescence



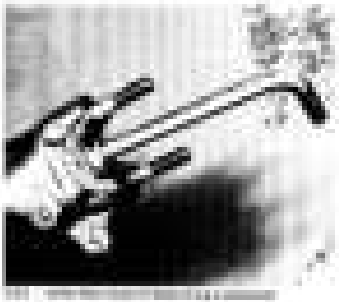


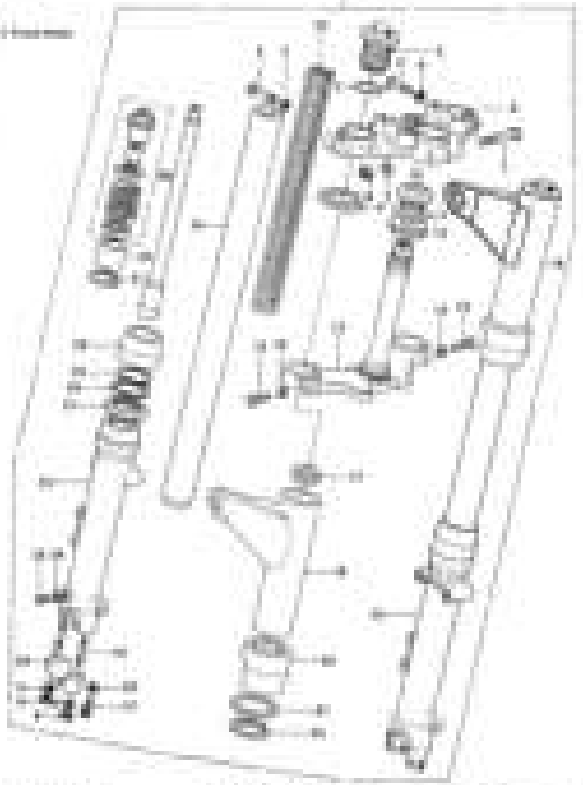








Fig. 82 Front fork



1 Fork tube assembly
2 Fork tube upper bush
3 Ring - 1 off
4 Seal - 1 off
5 Spring retainer - 1 off
6 Spring - 1 off
7 Nut
8 Nut - 2 off
9 Fork tube damper - 1 off
10 Damper rod assembly
11 Sleeve
12 Drain plug - 1 off
13 Allen screw - 2 off
14 Fork tube lower bush - 1 off
15 Fork tube - 1 off
16 Fork tube bush - 1 off
17 Fork tube seal - 1 off
18 Dust excluder - 1 off
19 Fork tube spring - 1 off
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21 Fork tube bush - 1 off
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4 Managing with Parts: Controls and Indicators

4.1 Introduction

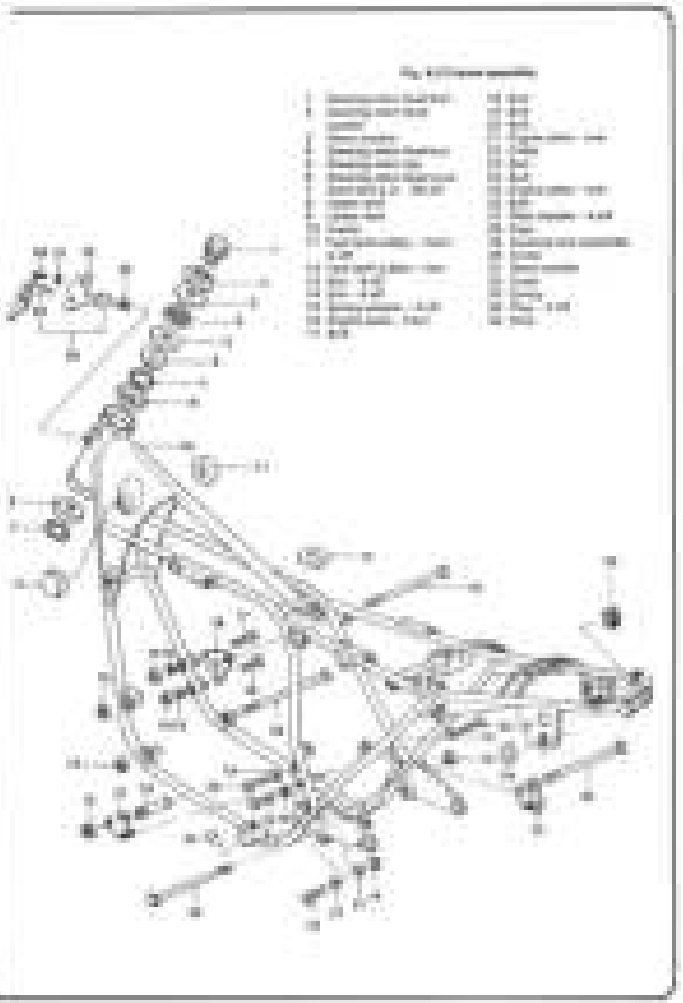
Most machines are designed to be used by people. Therefore, they must have parts that people can manage. Such parts are called controls or indicators. Controls are parts that people use to change the machine's operation. Indicators are parts that tell people how the machine is operating. Some parts are both controls and indicators.

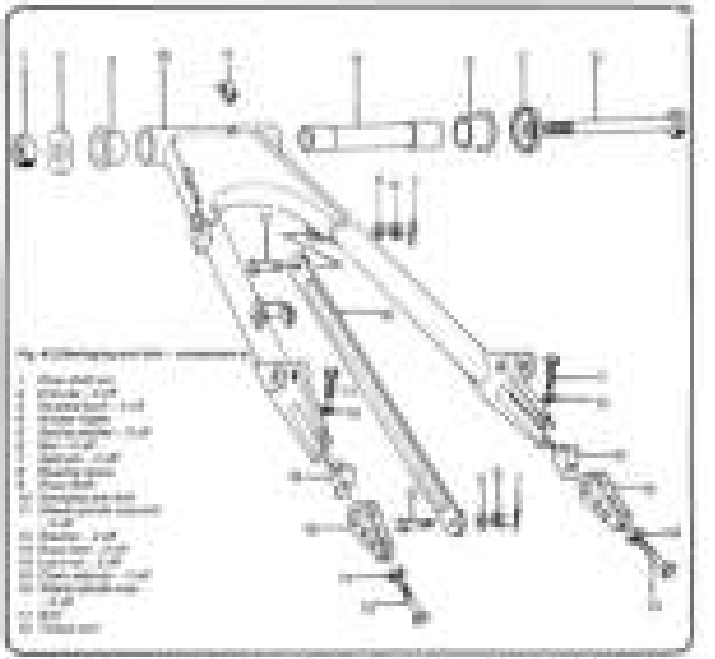
Many of the machines you design will be intended for use by people who have little or no training in how to use them. Such machines must be designed so that people can easily learn how to use them. Their controls and indicators must be designed so that people can easily learn what they are for and how to use them.

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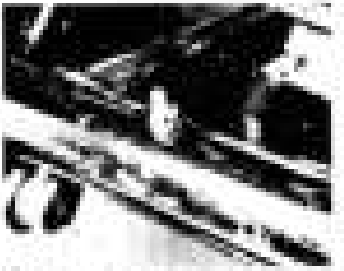




8.3 A Kongsberg computer-controlled active ride height system



8.4 The Lotus Esprit's active suspension system is controlled by



8.5a Modern aircraft are rigid 'cars' compared with their ground rivals

8.1 Wing loads and suspension

The main reason a racecar is a racecar is the massive load it can corner with, and it is because of the downforce generated by the wings and other aerodynamic devices. Without downforce, a racecar would be little more than a fast road car.

8.2 Suspension and body/aero geometry interactions

The interaction of the suspension and body/aero geometry is complex and is dealt with in detail in Chapter 9. The principles of suspension design are, however, the same whether the car has downforce or not and are covered in Chapter 6.

The suspension must be designed to work in conjunction with the aerodynamic devices, the ground clearance varying under the influence of suspension movement and aerodynamic loads.

8.3 Dampers, springs and anti-roll bars

The dampers (or shock absorbers as they are commonly called) control the speed at which the suspension springs move. The springs support the weight of the car and the anti-roll bars control the amount of roll the car experiences when cornering.



8.5b Modern aircraft are rigid 'cars' compared with their ground rivals

8.4 Tyres, suspension and aerodynamics

The tyres, suspension and aerodynamics are all interdependent. The tyres must be capable of providing the grip required by the suspension and aerodynamics, and the suspension must be designed to work with the tyres and aerodynamics.

8.5 Suspension and body/aero geometry interactions

The suspension must be designed to work in conjunction with the aerodynamic devices, the ground clearance varying under the influence of suspension movement and aerodynamic loads.

8.6 Suspension and body/aero geometry interactions

The suspension must be designed to work in conjunction with the aerodynamic devices, the ground clearance varying under the influence of suspension movement and aerodynamic loads.

Now add more chalk and press the sand up until the valley resembles Wimbledon Hill once more, using fingers and thumbs to press down into the valleys and push up ridges. Use these techniques to create a gentle valley and a steep one between Wimbledon Hill and Putney Heath.

Finally, smooth out the sand with your hands and then lightly dust the whole model with chalk powder. Use a sieve to do this, or a powder puff. Dusting with chalk powder will help to reduce the amount of moisture in the sand, which will help to prevent the sand from sticking to the model when you remove it from the mould.



Fig. 6.2. Wimbledon Common and Putney Heath, a height model. Note the mounds added to chalk

6.3. Reproducing real environments: Ordnance Survey maps and aerial photographs

Ordnance Survey maps are particularly useful for creating height models of real environments. They contain information about the height of the land and the position of roads, rivers and buildings. Aerial photographs are also very useful, as they show the position of roads, rivers and buildings, and can be used to help you to estimate the height of the land.

Ordnance Survey maps are available from most bookshops and from specialist map shops. They are published by the Ordnance Survey, the government department responsible for mapping Great Britain. Maps are available at a number of different scales, ranging from 1:1,250 (1 inch on the map represents 1,250 inches on the ground) to 1:1,000,000 (1 inch on the map represents 1,000,000 inches on the ground). The most useful scales for height models are 1:50,000 (1 inch on the map represents 50,000 inches on the ground) and 1:25,000 (1 inch on the map represents 25,000 inches on the ground).

Aerial photographs are also available from the Ordnance Survey. They are usually taken from aeroplanes and show the land in great detail. Aerial photographs are available in a number of different scales, ranging from 1:10,000 (1 inch on the photograph represents 10,000 inches on the ground) to 1:50,000 (1 inch on the photograph represents 50,000 inches on the ground).

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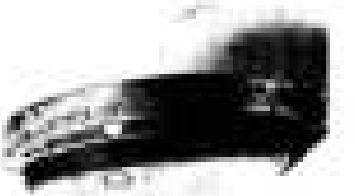
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14 Form fragment: team summary

Element	Purpose	Notes
Wrapping form with id="team-summary" and method="post"	Groups the summary fields	Required for the fragment to submit
Text input with name="team_name"	Lets the user type the team name	Pre-filled with "Rocket Otters"
Checkbox with id="is_active" and name="is_active"	Marks whether the team is active	Checked by default
Label for="is_active"	Explains what the checkbox means	Clicking the label also toggles the checkbox
Number input with name="founded_year"	Lets the user enter the year the team was founded	Min 1900, max 2026, step 1
Select with name="league"	Lets the user choose a league	Options: Harbour League, Valley Cup, Open Division
Textarea with name="notes"	Lets the user write free-form notes	Two rows tall
Submit button	Sends the form to the server	Label: "Save team"

Chapter 5 Wheels, brakes and tyres



5.18 Wheel bearings: (a) tapered roller, (b) ball



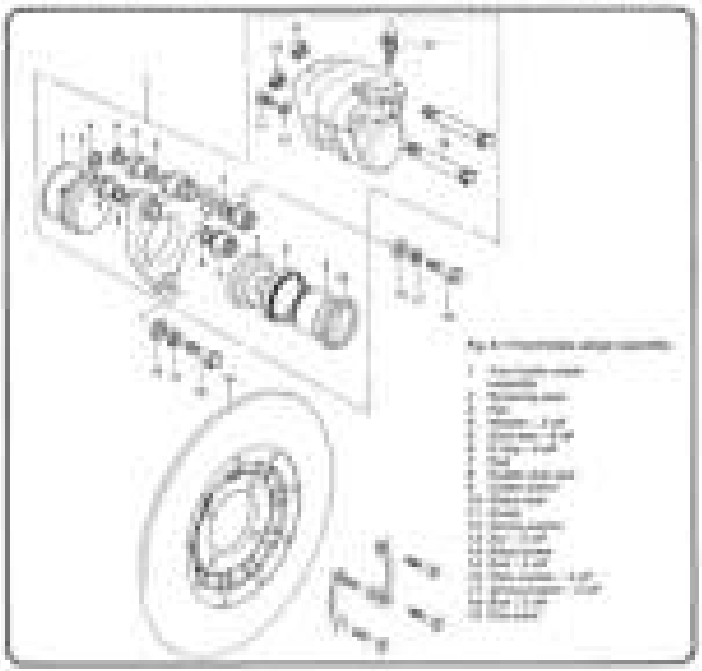
5.19 Removing the caliper from the brake disc



5.20 Removing the caliper mounting bracket







5.1 Electromagnetic spectrum for modern links

A 5.1.1 Many links now ride on the radio-frequency spectrum, and a modem engineer must know the basic numbers: carrier frequency, wavelength, and the rule that higher carrier frequency usually means more available bandwidth but shorter range. Wavelength is the speed of light divided by frequency, so a 2.4 GHz signal has a wavelength of about 12.5 cm. That small size is why antennas for Wi-Fi can be compact, and why a metal wall can block the signal so easily.

A 5.1.2 The usable band around a carrier is called the channel bandwidth. A wider channel can carry more bits per second, but it also collects more noise and may overlap with neighboring users. Regulators divide the spectrum into licensed bands, where one operator has exclusive use, and unlicensed bands, where many devices share the same space under simple rules. Cellular networks mostly use licensed bands, while Wi-Fi and Bluetooth live in unlicensed ones.

A 5.1.3 The Shannon limit sets the best-case data rate for a channel with a given bandwidth and signal-to-noise ratio: $C = B \log_2(1 + \mathrm{SNR})$. Real modems never reach it, but it tells us that doubling bandwidth helps more than doubling power, and that improving SNR by a few decibels can matter more than adding a little spectrum. Every modem design is a trade between these two resources.

5.2 Wireless channels: reflections and interference

A 5.2.1 The channel between a transmitter and a receiver rarely delivers a single clean copy of the signal. Instead, the receiver hears many copies that have bounced off walls, floors, furniture, and people, each arriving with a different delay, strength, and phase. This effect is called multipath propagation, and it is the main reason wireless links are harder than wired ones.

A 5.2.2 When the delayed copies add up in step, they reinforce each other and the signal gets stronger. When they arrive out of step, they cancel or smear the symbols together, causing errors. Because the receiver moves relative to the reflectors, the pattern changes from moment to moment, so a link can be fine one second and poor the next. Designers must plan for this constant variation rather than for a single fixed condition.

A 5.2.3 Interference is any unwanted energy that lands in the receiver's band, whether it comes from another transmitter, a microwave oven, or a neighboring network. Unlike multipath, interference is not a copy of the signal, so it cannot be undone by clever processing alone. The best defense is to avoid crowded channels, limit transmit power, and use antennas that point mostly toward the intended partner.

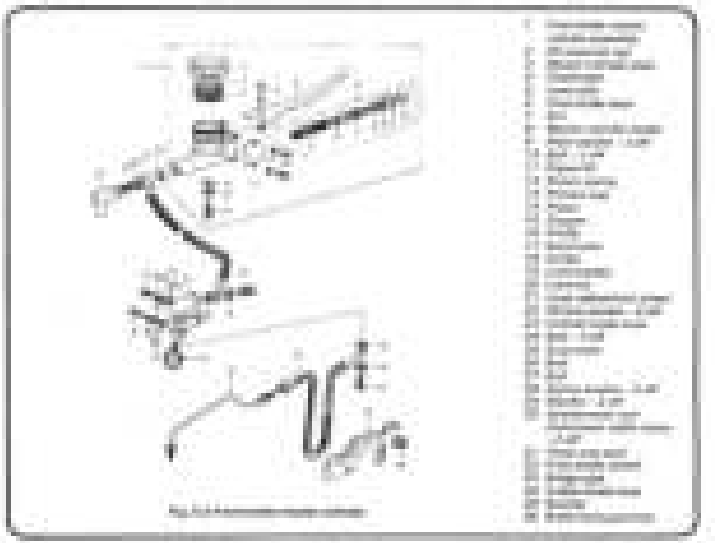
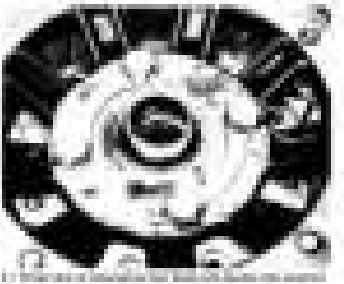


Fig. 5.2.4 Illustrative wireless-channel diagram.



4.1 Wheel disc in composite form showing the various main elements



4.2 Exploded view of a typical wheel and tyre assembly

4 — Road wheel fastenings: requirements and specifications

4.1 Introduction

Studded or studless? Is the front wheel drive/rear wheel drive question still relevant? Are the days of the steel wheel disc and rim numbered? Tyre manufacturers and their customers are constantly seeking improvements in the performance and life of their products. Wheel and tyre technology has also been subject to change and development as a consequence of the ever increasing demands placed on the vehicle.

The purpose of this chapter is to examine the various factors that have contributed to these changes and to consider the current trends in wheel and tyre design and development.

Before the fitting of pneumatic tyres, wheels were not the object of much attention. Wooden wheels were made by the local wheelwright and were usually fitted with iron tyres. Apart from the fact that they were heavy and uncomfortable, they were also unreliable. Iron tyres were prone to shrinkage and would frequently work loose, causing the wheel to collapse. Periodic tightening was necessary to prevent this from happening.

Wooden disc wheels were developed from the iron tyred wooden type, which had the advantage of being lighter and more comfortable. Initially the wheel discs were made from a single piece of timber, but this was soon found to be unsatisfactory because of shrinkage and distortion. Subsequently, wheels were made from a number of pieces of timber glued together and then turned to the required shape. Wooden wheels were used extensively on horse drawn vehicles and were also fitted to the first motor cars.

Wooden wheels are still used on some vintage cars and for display purposes on commercial vehicles, but they have largely been superseded by pressed steel wheels. These are lighter, stronger and more reliable than wooden wheels and are also cheaper to produce in quantity.

Pressed steel wheels are made in two pieces, the rim and the disc, which are welded together. Wheels of this type are used on the majority of passenger cars and commercial vehicles.

Cast aluminium alloy wheels are used on some passenger cars and commercial vehicles. They are lighter than pressed steel wheels and have a number of advantages in terms of appearance, heat dissipation and unsprung weight. They are, however, more expensive to produce than pressed steel wheels.

Wheels are fitted to the vehicle hub by a number of different methods. The most common method is by means of wheel nuts which screw onto studs projecting from the hub flange. Other methods include the use of bolts which pass through holes in the wheel disc and screw into the hub flange, and the use of a single large nut which screws onto a threaded hub spindle.



4.3 Wheel and tyre assembly for a heavy commercial vehicle



4.4 Wheel and tyre assembly for a heavy commercial vehicle

4 — Road wheel fastenings: requirements and specifications

4.1 Introduction

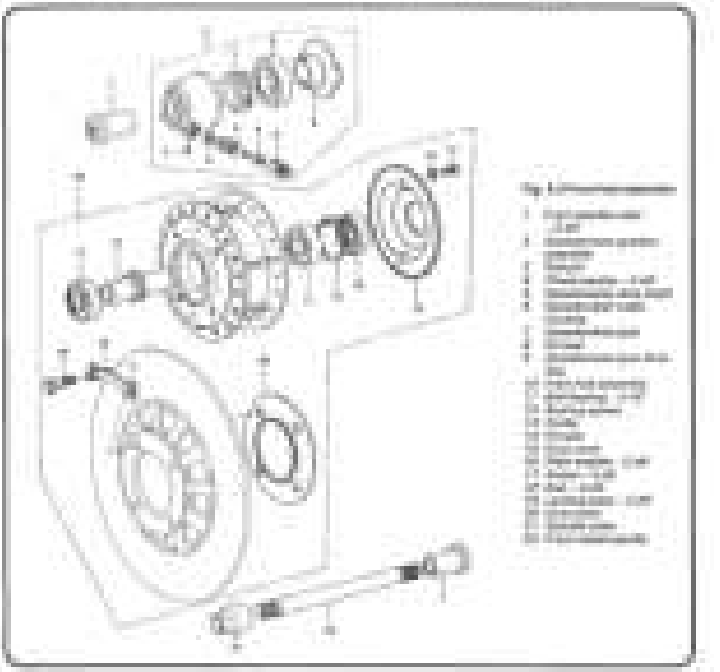
Many new investors in the casino sector do what they have always done and look for the prime location in the busiest city. Others prefer to find a city or market segment by themselves and then develop it. Both approaches have their pros and cons, which we will explore in this chapter. Whichever approach you choose, you will find many of the principles in Section 1.1 of this chapter helpful.

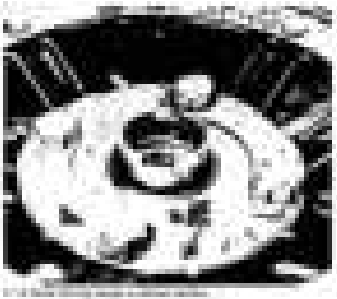
The following story will follow, after an Overview of Section 4.2, as we share the lessons learned from a casino that was developed in the 1990s in a market segment that was not yet fully developed, and then grew to be a very successful casino. Later, we will look at the changing requirements for this market segment, and how the casino has had to change to meet these requirements. Finally, we will look at the lessons learned from this story and how they can be applied to other casino development projects.

4.5 Wheel and tyre assembly for a heavy commercial vehicle

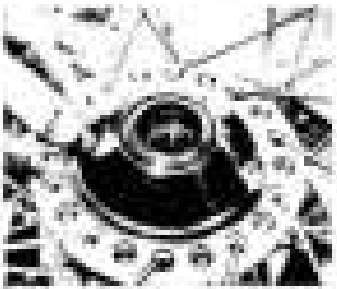


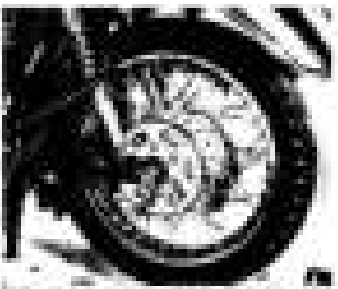
















10 Rear wheel bearings: examination and replacement

1 The rear wheel bearings are of the sealed for life taper roller type and require no maintenance. Examine the bearings for signs of roughness or excessive play by spinning the wheel and rocking it from side to side. Renew the bearings if they are worn or damaged.

2 Remove the brake drum and the hub (see Chapter 9). Using a screwdriver, lever out the oil seal from the outer end of the hub. Extract the bearing inner race and spacer from the hub.

3 Support the hub assembly on blocks of wood and drive out the bearing outer races using a suitable drift. Alternatively, the outer races may be withdrawn using a slide hammer with internal jaws.

4 Before the new bearings are fitted, the hub must be packed with high melting point grease. Work the grease well into the bearings and apply a thin coat to the bearing outer races.

5 Position one of the bearing outer races in the hub and drive it home using a suitable tubular drift. Turn the hub over and repeat the operation on the other bearing outer race.

6 Position the inner bearing and spacer in the hub, then drive a new oil seal into the hub using a suitable tubular drift. Ensure that the seal is fitted with its sealing lip facing inwards.

7 Refit the brake drum and the hub (see Chapter 9).

11 Rear wheel: removal and refitting

1 Slacken the rear wheel nuts, then jack up the rear of the vehicle and support it on axle stands placed under the rear suspension arms. Remove the wheel nuts and withdraw the wheel.

2 Refitting is the reverse of removal. Tighten the wheel nuts to the specified torque.

12 Tyres: general information and fault finding

1 Regular inspection of the tyres may help to prevent punctures and deflation occurring as a result of neglect. Periodically remove the wheels and clean away any embedded flints or stones which may be present in the tread. Check the tyres carefully for signs of cracking or damage, especially in the sidewalls. Check the tread depth regularly to ensure adequate depth is maintained (see *Specifications*).

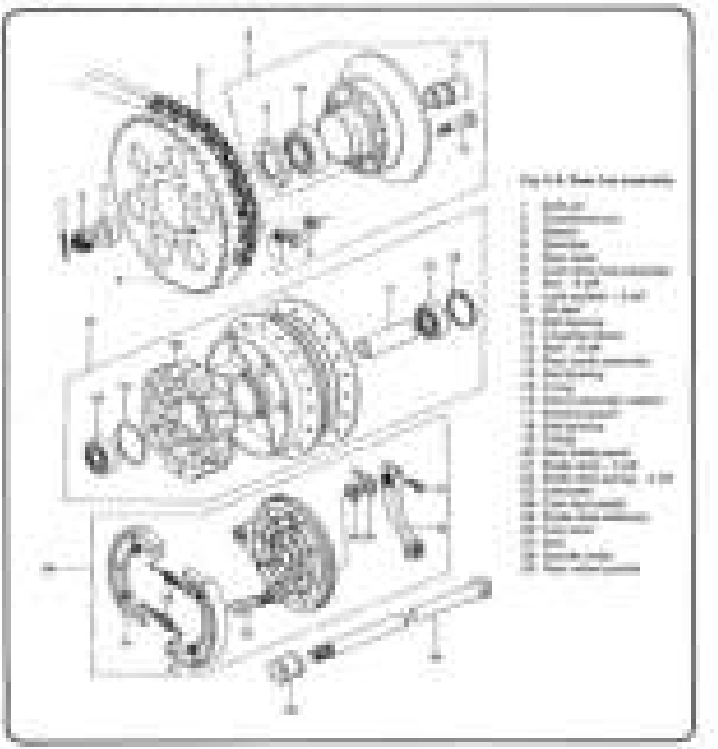
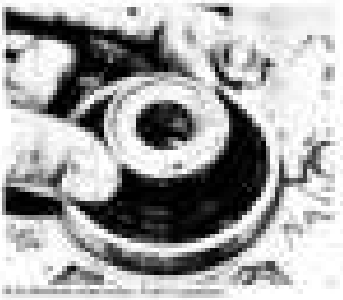
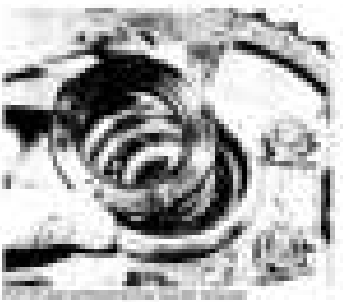


Fig. 8.11 Rear hub assembly

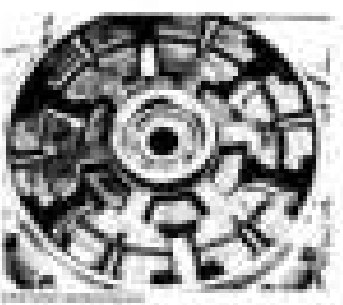
1 Hub nut
2 Washer
3 Bearing
4 Spacer
5 Brake drum
6 Hub bearing outer race (inner)
7 Hub – 5 stud
8 Hub – 4 stud
9 Hub bearing outer race (outer)
10 Oil seal
11 Wheel stud – 5 stud
12 Wheel stud – 4 stud
13 Wheel nut
14 Spring washer
15 Plain washer
16 Cover
17 Wheel cylinder – 180 mm
18 Wheel cylinder – 203 mm
19 Anti-rattle spring
20 Shoe
21 Handbrake lever
22 Brake shoe – 5 stud
23 Brake shoe – 4 stud
24 Adjuster
25 Handbrake cable
26 Cable retaining clip
27 Cable clevis
28 Pin
29 Split pin
30 Anti-rattle spring















Tyre removal: Deflate inner tube and insert lever in place
previously by tyre valve



Use tyre levers to work bead over the edge of rim



When first bead is clear, remove tyre as shown



Tyre fitting: Inflate inner tube and insert in tyre



Lay tyre on rim and feed valve through hole in rim



Work first bead over rim, using tools on final section



Use similar technique for second bead, finish at tyre valve
position



Push valve and tube up into tyre when fitting final section, to
avoid trapping

6.2 Rim types, designations, nominations, nomenclature and marking

1 The rim types listed in 6.2.2 and 6.2.3 are commonly available in the tyre sizes shown in standardization lists, catalogues and year books. Rims of other types and sizes may be used for special purposes.

2 Each rim type is identified by a code consisting of a letter or letters followed by a number. The letter(s) indicate the rim type and the number indicates the nominal rim diameter. Rims of the same type and nominal diameter but with some minor differences in detail are distinguished by a suffix letter.

3 Rims are designated by the manufacturer's name or trademark, the rim type code, the nominal rim width and the symbol for the material of the rim body.

4 Rims are nominated by the rim type code, the nominal rim width and the rim offset.

5 Rim nomenclature is the precise system of designating rims that enables a rim to be described in such a way that anyone reading the description will know exactly what rim is meant and be able to identify it from a set of drawings.

6 Rim marking is the system whereby certain essential information is permanently marked on the rim so that it can be identified after it has been removed from the vehicle.

6.2.1 Rim materials, manufacturing, nominations, nomenclature and designations

1 Rims are made from steel sheet, cast aluminium alloy or forged aluminium alloy. The material is selected to withstand the stresses imposed by the vehicle and its operating conditions and to provide adequate resistance to corrosion. Steel rims are usually painted or plated for corrosion protection. Aluminium alloy rims are usually polished and lacquered or painted.

2 Steel rims are made from flat sheet by pressing, rolling and welding. Cast aluminium alloy rims are made by pouring molten metal into moulds. Forged aluminium alloy rims are made by forging billets of aluminium alloy in dies.

3 Rims are designated by the manufacturer's name or trademark, the rim type code, the nominal rim width and the symbol for the material of the rim body.

4 Rims are nominated by the rim type code, the nominal rim width and the rim offset.

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Fig. 6.1 Illustrative text relating to wheels and tyres







[illegible] the sand of the core or beach surface, which indicates the net [illegible] direction along the coastal reach at that location. If the core is collected located on the map, the [illegible] direction [illegible] may [illegible] to the measurement procedure. It is important [illegible] and [illegible] [illegible] [illegible] [illegible].

13. Analyze each [illegible] sample for [illegible] [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

14. Prepare a [illegible] [illegible] [illegible] [illegible] [illegible]

Chapter 6 Electrical system

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Specifications

Battery	
Type	Lead acid
Voltage	12 volts
Capacity	36 amp hour
Earth	Negative
Alternator	
Output	Approximately 45 amps
Regulator	Solid state
Drive	V-belt
Starter motor	
Type	Pre-engaged
Output	0.6 kW
Fuses/relays	
Number of fuses	12 (additional fuse in rear wiring harness)
Type	12 (additional relay in fuse box)
Bulbs	
Headlight	60/55 watt halogen (H4)
Front sidelight and indicator	21/5 watt
Foglight	55 watt halogen (H3)
Front indicator repeater	5 watt
Rear light cluster	21/5 watt
Number plate light	5 watt
Interior light	10 watt
Horn	10 A fuse

1 Vehicle electrics

The electrical system is powered by a 12 volt battery which is kept charged by the alternator. The battery supplies current to all the electrical circuits in the car, including the starter motor, ignition system, lights and accessories. The alternator is driven by the auxiliary drive belt and incorporates a solid state regulator unit which ensures that the output voltage remains constant, irrespective of variations in engine speed and load. Refer to Chapter 2 for information on the auxiliary drive belt.

2 Battery and alternator: removal and refitting

1. The battery and alternator are located on the left-hand side of the engine compartment.
2. To remove the battery, first disconnect the negative lead from the battery terminal. Then disconnect the positive lead. Release the battery clamp bolt and lift out the battery. Take care not to spill any electrolyte on your skin or clothing, as it is highly corrosive.
3. To remove the alternator, first disconnect the battery negative lead. Then disconnect the wiring plug from the rear of the alternator. Release the adjuster and pivot bolts and slacken the auxiliary drive belt. Remove the belt from the alternator pulley and withdraw the bolts. Lift the alternator out of the engine compartment.
4. Refitting is a reversal of removal. Tension the auxiliary drive belt as described in Chapter 2.







8.1 The Mercedes-Benz A-Class was designed to be environmentally friendly

8.1 Ecological legislation – becoming more and more demanding

The increasing awareness of the need to protect the environment has led to the introduction of numerous laws and regulations. Many of these have a direct impact on the development and production of motor vehicles and their components. The most important of these are briefly described below.

The European Union (EU) has issued a number of directives which have a significant impact on the development of motor vehicles. Directives are binding instructions issued by the EU Commission to the governments of the member states. They must be implemented in the form of national laws within a specified period of time. Directives are issued in the form of framework directives and individual directives. Framework directives specify the basic principles and objectives, while individual directives contain the detailed regulations.

Directives of the EU Commission are issued by the Council of Ministers of the European Union (EU) and the European Parliament. The Council of Ministers is the legislative body of the EU. It consists of the ministers of the governments of the member states. The European Parliament is the parliamentary body of the EU. Its members are elected by the citizens of the member states.

The EU Commission is the executive body of the EU. It is responsible for the implementation of the decisions of the Council of Ministers and the European Parliament. It also has the right to initiate legislation. It is the only body which can propose new directives. The Commission is also responsible for monitoring the implementation of directives in the member states.

The EU Commission has established a number of committees to assist it in the preparation of directives. These committees consist of representatives of the governments of the member states. The committees are divided into working groups which deal with specific subjects. The working groups are responsible for the detailed preparation of directives.

8.2 European legislation

Each country has its own laws and regulations. In the EU, it is the responsibility of the EU Commission to harmonize the various laws and regulations of the member states. This is necessary to ensure the free movement of goods within the EU. Harmonization is the process of bringing the laws and regulations of the member states into line with each other. This is done by issuing directives which must be implemented in the form of national laws by the member states.

8.2.1 Framework directives

The framework directives are the basis for the individual directives. They specify the basic principles and objectives. The framework directives are issued by the EU Commission. They must be implemented in the form of national laws by the member states.

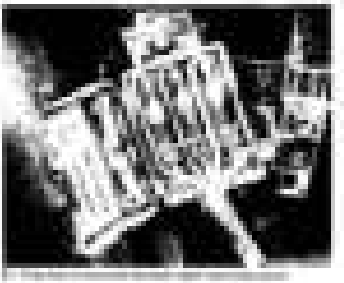
The framework directives are divided into a number of chapters. Each chapter deals with a specific subject. The chapters are divided into articles. The articles contain the detailed regulations.

The framework directives are binding instructions issued by the EU Commission to the governments of the member states. They must be implemented in the form of national laws within a specified period of time.

The framework directives are issued in the form of framework directives and individual directives. Framework directives specify the basic principles and objectives, while individual directives







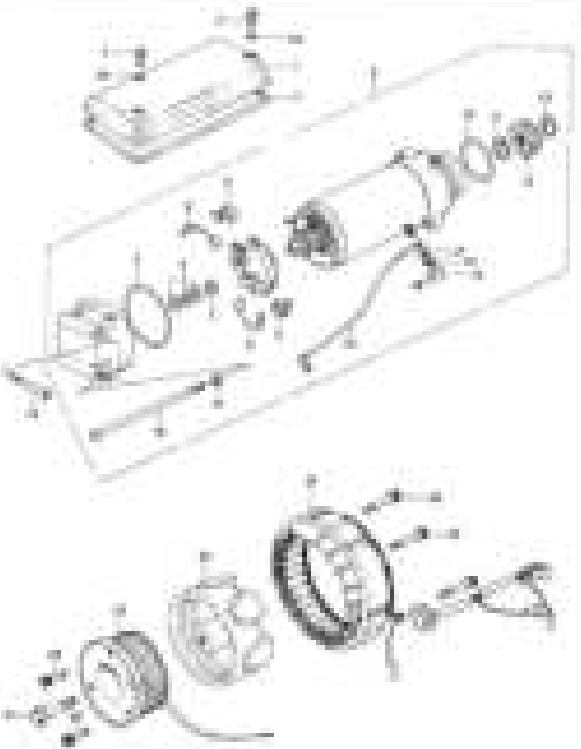


Fig. 6.2 Starter motor — components (early)

1 Bracket (drive end)
2 Bracket (slip ring end)
3 Bolt (2 off)
4 Washer (drive end bracket)
5 Screw
6 Bolt (2 off)
7 Yoke assembly
8 Field coil assembly
9 Brush holder
10 Brush spring (4 off)
11 Brush
12 Armature
13 Circlip
14 Thrust washer
15 Drive pinion
16 Sleeve
17 Operating lever
18 Pivot pin
19 Solenoid
20 Bolt (2 off)
21 Washer (2 off)
22 Nut
23 Solenoid
24 Screw
25 Plunger
26 Return spring
27 Washer (2 off)
28 Bolt (2 off)
29 Washer (2 off)
30 Nut
31 Solenoid
32 Screw
33 Plunger
34 Return spring
35 Washer (2 off)



















8.5 Knowledge-based systems in business and industry

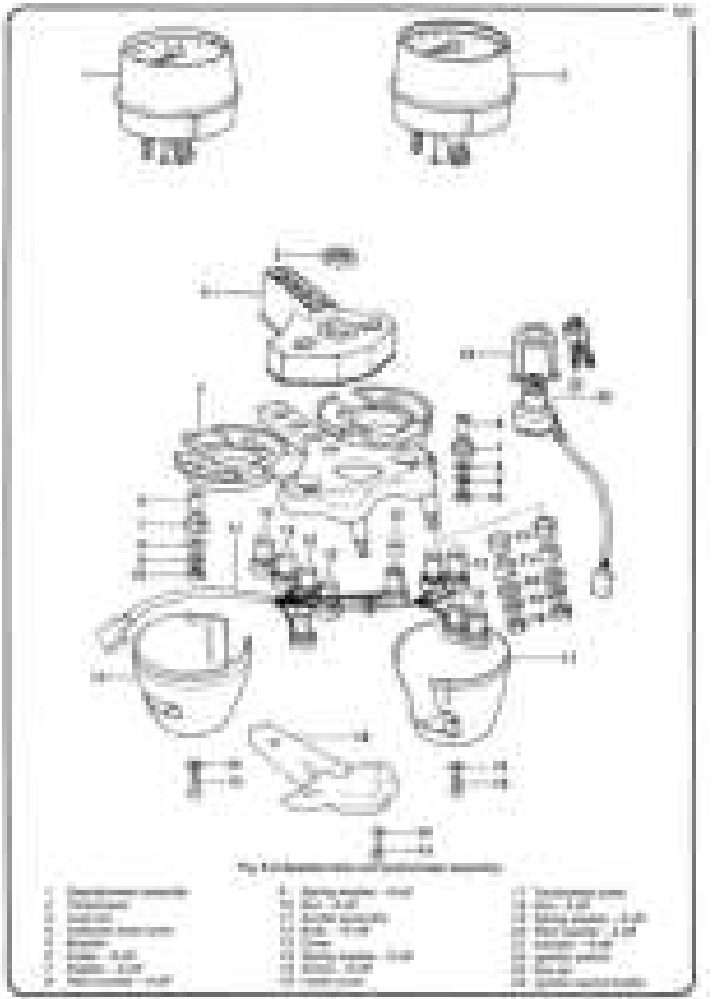
The most widely known of the artificial intelligence tools is knowledge-based systems technology, sometimes referred to as expert systems technology. Knowledge-based systems are computer programs that contain some of the knowledge of human experts, both facts about a subject area and rules of thumb about how to make decisions in that subject area. The knowledge is used to solve problems in the area that normally would require human expertise. A knowledge-based system has two essential components: the knowledge base and the inference engine. The knowledge base is the representation of facts about the world. The inference engine is the portion of the system that can reason or draw conclusions using the knowledge base. Knowledge-based systems technology is the subject of the next two chapters.

Knowledge-based systems technology has had considerable success in business and industry. Applications have been developed in such diverse areas as finance, medicine, manufacturing, and space exploration. Knowledge-based systems are being used to help diagnose problems, design manufacturing facilities, schedule production, and configure complex equipment. Many companies have developed knowledge-based systems to help them maintain their competitive edge. Some companies have developed systems that have become critical to their success. Knowledge-based systems technology is having a significant impact on the way business is conducted.

Knowledge-based systems technology is not the only area in which artificial intelligence has had success. Other areas include robotics, vision systems, speech recognition, and natural language understanding. Robotics has had success in the manufacturing area, particularly in the automobile industry. Robots are used to perform jobs that are repetitive or dangerous for humans. Vision systems are used in conjunction with robots in manufacturing to provide the robot with the ability to "see" its environment. Speech recognition and natural language understanding have had success in applications that require human-computer communication.


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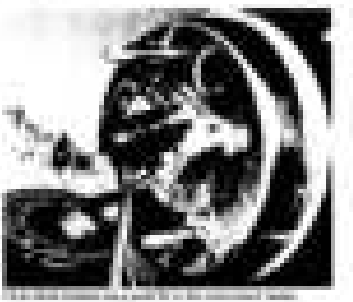




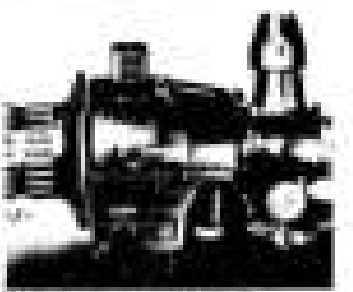


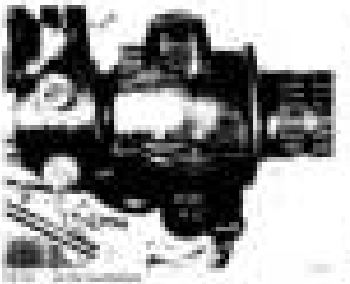












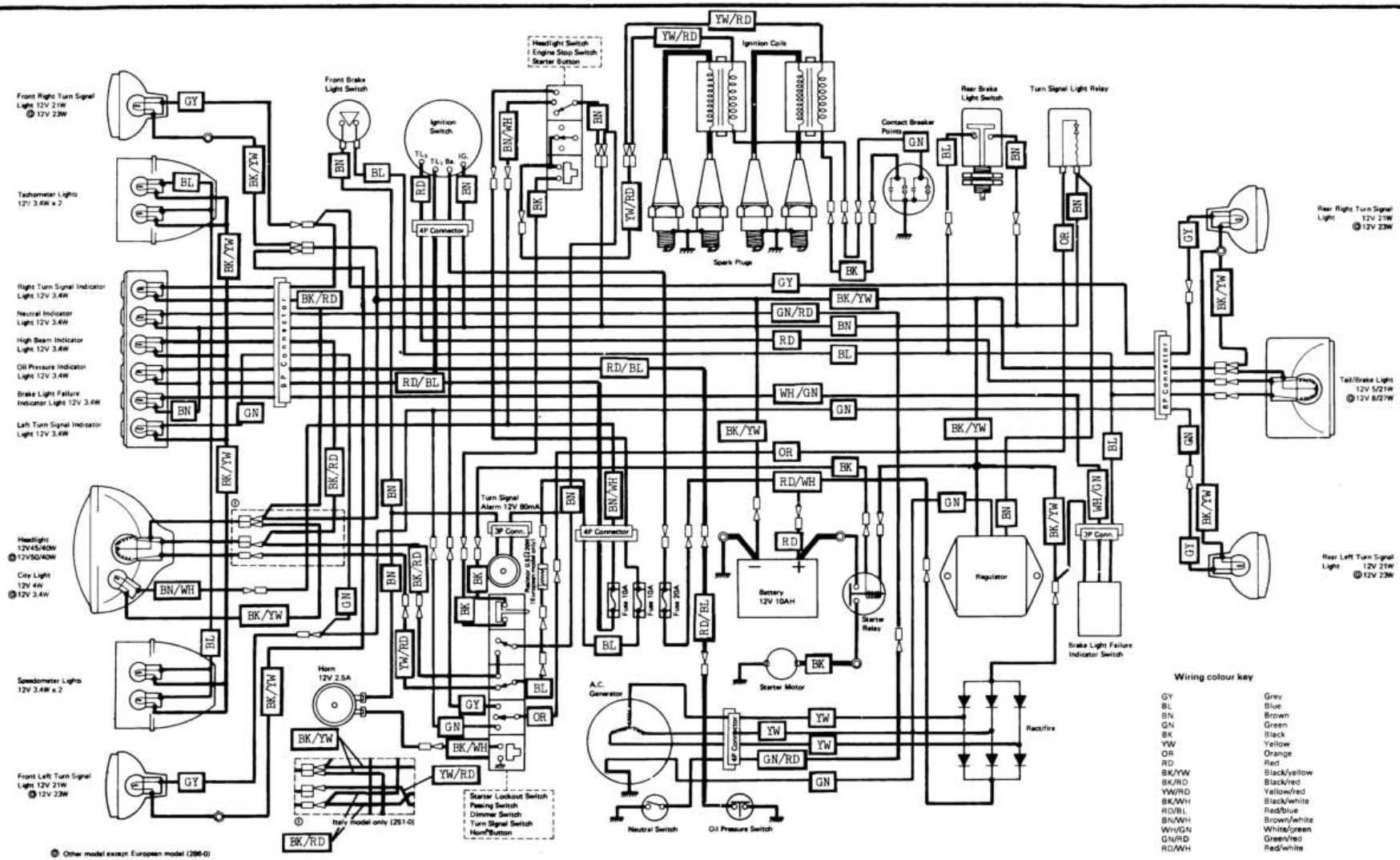




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Table 9.2 Some drugs that affect thyroid hormone synthesis, release, or action

Mechanism	Drugs	Remarks
Competitive inhibition of peroxidase	Methimazole	Methimazole is the drug of choice for hyperthyroidism except in pregnancy.
	Propylthiouracil (PTU)	PTU is the drug of choice in pregnancy.
Competitive blocking of iodide transport	Perchlorate, pertechnetate	Perchlorate is rarely used clinically.
Blocks release of thyroid hormone from the gland	Radioactive iodine (^{131}I)	Radioactive iodine is the treatment of choice for hyperthyroidism in the elderly.
Inhibition of thyroid hormone release	Iodide in high concentrations (Wolff-Chaikoff effect)	Iodide is rapidly effective in hyperthyroidism.
Decreases peripheral conversion of T_4 to T_3	Propranolol, glucocorticoids, amiodarone, PTU	Propranolol is rapidly effective in hyperthyroidism.
Binds to thyroid receptor	Thyroid hormones (T_4, T_3)	Thyroid hormones are used in hypothyroidism.
	Thyroid receptor antagonists (tetrac, NDGA)	Tetrac and NDGA are experimental drugs.



Left Handlebar Switch Connections

Passing Switch			Starter Lockout Switch			Dimmer Switch				Turn Signal Switch				Horn Button		
Color	Brown	Bk/R	Color	Bk	Bk	Color	Bk/R	Blue	R/Y	Color	Green	Orange	Slate	Color	Bk/W	yellow
ON	●	●	ON	●	●	HI	●	●		Left	●	●		ON	●	●
						LO		●	●	Right		●	●			

Ignition Switch Connections

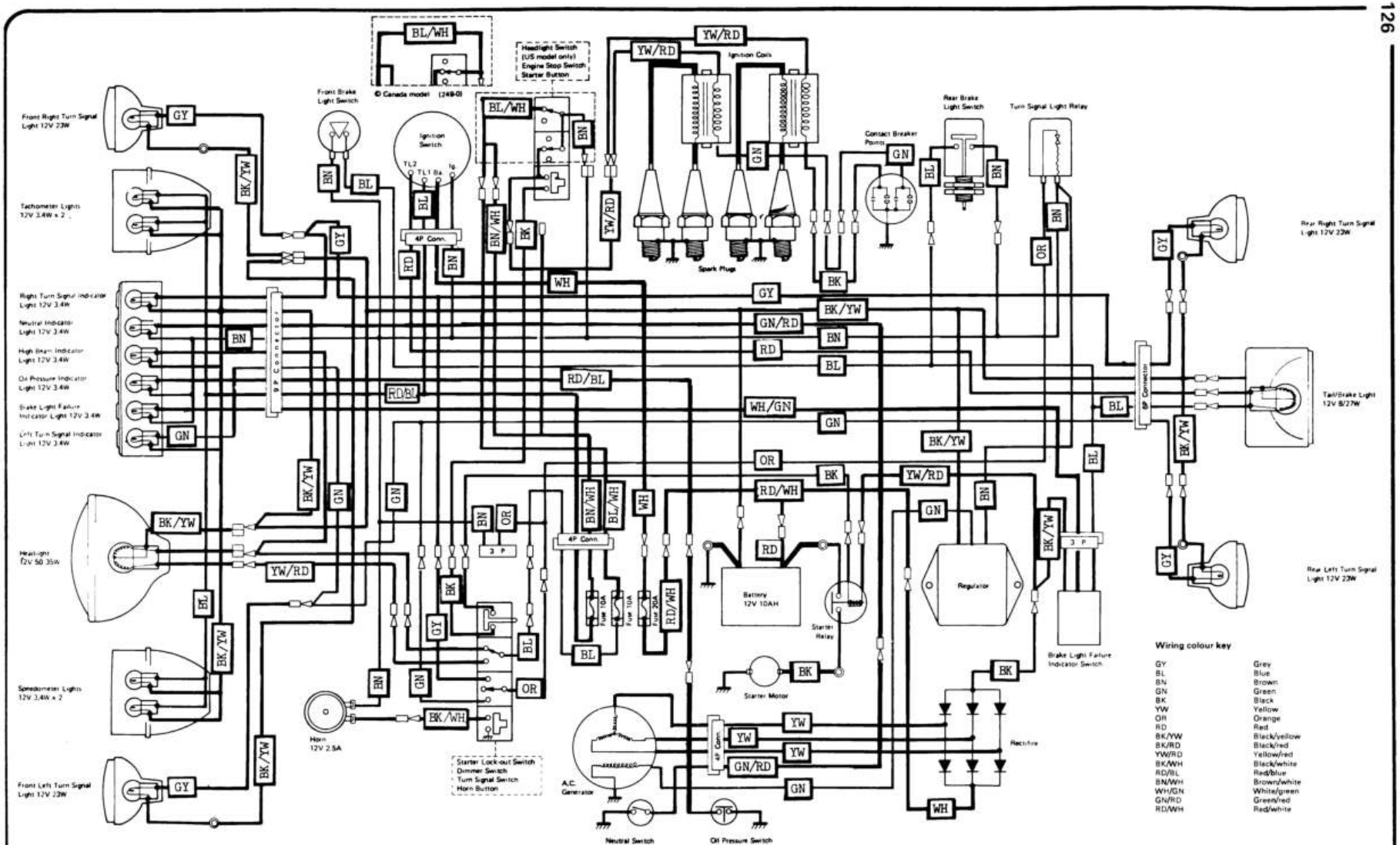
	Battery	Ignition	Tail 1	Tail 2
Color	White	Brown	Blue	Red
OFF				
ON	●	●	●	●
PARK	●		●	●

(250-0)

Right Handlebar Switch Connection

Headlight Switch				Starter Button			Engine Stop Switch		
Color	Brown	Bl/W	Br/W	Color	Black	R/Y	Color	Brown	R/Y
OFF							OFF		
PO	●	●	●	ON	●	●	RUN	●	●
ON	●	●	●				OFF		

Wiring diagram Z650 model (UK)



Left Handlebar Switch Connections

Starter Lock-out Switch			Dimmer Switch				Turn Signal Switch				Horn Button		
Color	Bk	Bk	Color	Bk/R	Blue	R/Y	Color	Green	Orange	Slate	Color	Bk/W	
ON	●	●	HI				Left				ON		
			LO		●	●	Right						

Ignition Switch Connections

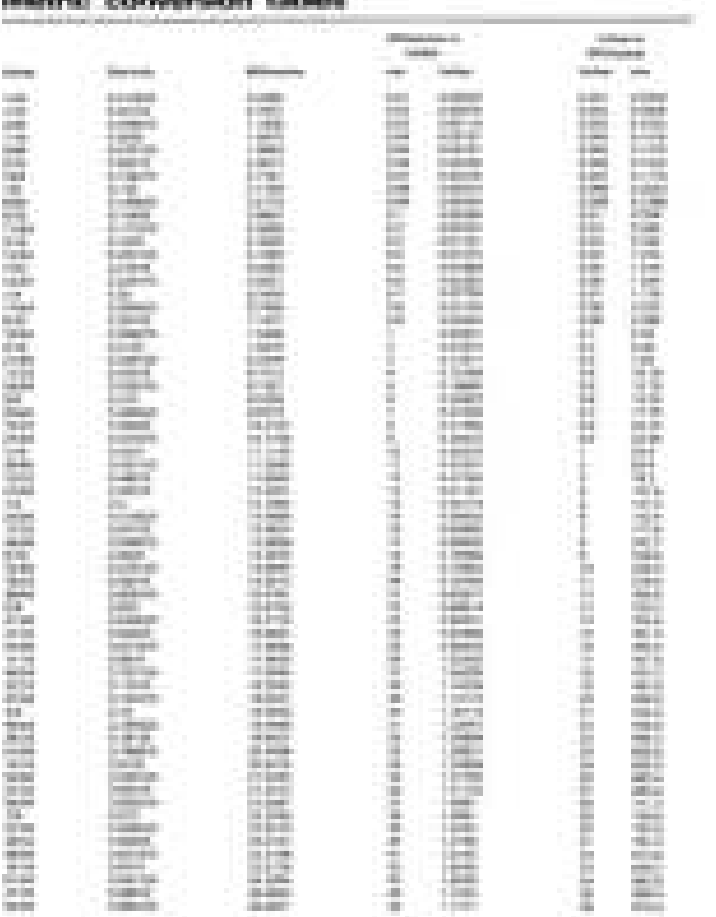
	Battery	Ignition	Tail 1	Tail 2
Color	White	Brown	Blue	Red
OFF				
ON	●		●	
PARK	●			●

Right Handlebar Switch Connections

Headlight Switch				Starter Button			Engine Stop Switch			
Color	Brown	Bl/W	Bl/W	Color	Black	R/Y	Color	Brown	R/Y	
OFF							UFF			
ON	●	●	●	ON	●	●	RUN	●	●	
							OFF			

Wiring diagram KZ650 model (USA)

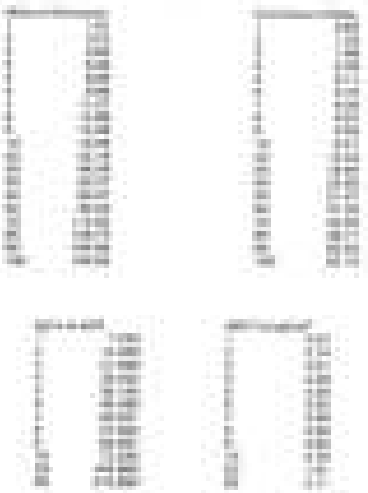
Metric conversion tables



1 Industrial goods: +38 (up cycle) +1 (Rs/US$ effect) −20 (US $ cycle) +4 (Rs/ton)

2 Oil gains: +4 (US income) +3 (Rs/ton) −2 (US $ cycle) +2 (Rs/ton)

3 Other: +5 (1 Rs/ton) −4 (US $ cycle) −3 (Rs/ton)



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