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Note: General description and specifications are given in each Chapter immediately after list of contents.
Fault diagnosis is given when applicable at the end of the Chapter.

Routine maintenance

Periodic routine maintenance is a continuous process that commences immediately the machine is used and continues until the machine is no longer fit for service. It must be carried out at specified mileage recordings or on a calendar basis if the machine is not used regularly, whichever is the soonest. Maintenance should be regarded as an insurance policy, to help keep the machine in the peak of condition and to ensure long, trouble-free service. It has the additional benefit of giving early warning of any faults that may develop and will act as a safety check, to the obvious advantage of both rider and machine alike.

The various maintenance tasks are described under their respective mileage and calendar headings. Accompanying photos or diagrams are provided, where necessary. It should be remembered that the interval between the various maintenance tasks serves only as a guide. As the machine gets older, is driven hard, or is used under particularly adverse conditions, it is advisable to reduce the period between each check.

For ease of reference each service operation is described in detail under the relevant heading. However, if further general information is required it can be found within the manual in the relevant Chapter.

Although no special tools are required for routine maintenance, a good selection of general workshop tools are essential. Included in the tools must be a range of metric ring or combination spanners, a selection of cross-head screwdrivers, and two pairs of circlip pliers, one external opening and the other internal opening. Additionally, owing to the extreme tight-

ness of most casing screws on Japanese machines, an impact screwdriver together with a choice of large or small cross-head screw bits, is absolutely indispensable. This is particularly so if the engine has not been dismantled since leaving the factory.

Weekly or every 200 miles (300 km)

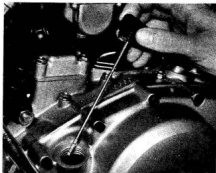
1 Tyre pressures

Check the tyre pressures with a pressure-gauge that is known to be accurate. Always check the pressures when the tyres are cold. If the tyres are checked after the machine has travelled a number of miles, the tyres will have become hot and consequently the pressure will have increased, possibly as much as 8 psi. A false reading will therefore always result.

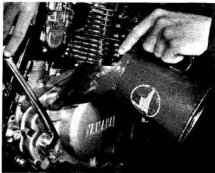
Tyre pressures:	Solo	Pillion or continuous high speed
Front tyre	26 psi (1.8 kg/cm ²)	28 psi (2.0 kg/cm ²)
Rear tyre	28 psi (2.0 kg/cm ²)	33 psi (2.3 kg/cm ²)

2 Engine/transmission oil level check

Check the engine/transmission oil level by means of the dipstick integral with the filler cap in the primary drive casing. To ascertain the level, unscrew the cap, wipe the dipstick clean, and then insert the dipstick so that the cap rests on the top edge



Check engine oil level by means of dipstick



Replenish with SAE 20W/50 engine oil

of the casing. Do not screw the cap in to determine the level. If necessary, replenish with SAE 20W/50 engine oil.

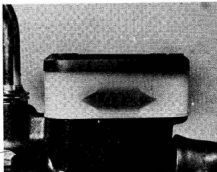
3 Hydraulic fluid level (disc brake models only)

Check the level of the hydraulic fluid in the front brake master cylinder reservoir, on the handlebars, and also the rear brake reservoir, behind the right-hand frame side cover. The level in both reservoirs should lie between the upper and lower level marks. During normal service, it is unlikely that the hydraulic fluid level will fall dramatically, unless a leak has developed in the system. If this occurs, the fault should be remedied AT ONCE. The level will fall slowly as the brake linings wear and the fluid deficiency should be corrected, when required. Always use an hydraulic fluid of DOT 3 or SAE J1703 specification, and if possible do not mix different types of fluid, even if the specifications appear the same. This will preclude the possibility of two incompatible fluids being mixed and the resultant chemical reactions damaging the seals.

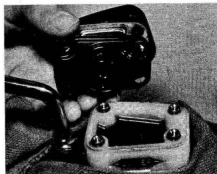
If the level in either reservoir has been allowed to fall below the specified limit, and air has entered the system, the brake in question must be bled, as described in Chapter 5, Section 17.

4 Control cable lubrication

Apply a few drops of motor oil to the exposed inner portion



Check fluid level of front and ...



Remove cap and diaphragm to replenish

of each control cable. This will prevent drying-up of the cables between the more thorough lubrication that should be carried out during the 2000 mile/3 monthly service.

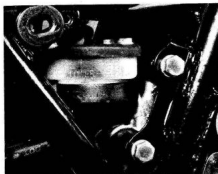
5 Rear chain lubrication and adjustment

In order that the life of the rear chain be extended as much as possible, regular lubrication and adjustment is essential.

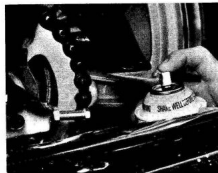
Intermediate lubrication should take place at the weekly or 200 mile service interval with the chain in situ. Application of one of the proprietary chain greases contained in an aerosol can is ideal. Ordinary engine oil can be used, though owing to the speed with which it is flung off the rotating chain, its effectiveness is limited.

Adjust the chain after lubrication, so that there is approximately 20 mm ($\frac{3}{4}$ in) slack in the middle of the lower run. Always check with the chain at the tightest point as a chain rarely wears evenly during service.

Adjustment is accomplished after placing the machine on the centre stand and slackening the wheel nut, so that the wheel can be drawn backwards by means of the drawbolt adjusters in the fork ends. On drum brake models the torque arm nut must also be slackened during this operation. Adjust the drawbolts an equal amount to preserve wheel alignment. The fork ends are clearly marked with a series of parallel lines above the adjusters, to provide a simple visual check.



... rear brake fluid reservoirs



Use aerosol chain lubricant to lubricate chain, on machine

6 Safety check

Give the machine a close visual inspection, checking for loose nuts and fittings, frayed control cables etc. Check the tyres for damage, especially splitting on the sidewalls. Remove any stones or other objects caught between the treads. This is particularly important on the front tyre, where rapid deflation due to penetration of the inner tube will almost certainly cause total loss of control.

7 Legal check

Ensure that the lights, horn and trafficators function correctly, also the speedometer.

Monthly or every 1000 miles (1600 km)

Carry out the checks listed under the weekly/200 mile heading and then complete the following:

1 Final drive chain lubrication

The final drive chain should be removed from the machine for thorough cleaning and lubrication if long service life is to be expected. This is in addition to the intermediate lubrication carried out with the chain on the machine, as described under the weekly/200 mile service heading.

Separate the chain by removing the master link and run it off the sprockets. If an old chain is available, interconnect the old and new chain, before the new chain is run off the sprockets. In this way the old chain can be pulled into place on the sprockets and then used to pull the regreased chain into place with ease.

Clean the chain thoroughly in a paraffin bath and then finally with petrol. The petrol will wash the paraffin out of the links and rollers which will then dry more quickly.

Allow the chain to dry and then immerse it in a molten lubricant such as Linklyte or Chainguard. These lubricants must be used hot and will achieve better penetration of the links and rollers, and are less likely to be thrown off by centrifugal force when the chain is in motion.

Refit the newly greased chain onto the sprocket, replacing the master link. This is accomplished most easily when the free ends of the chain are pushed into mesh on the rear wheel sprocket. The spring link must be fitted so that the closed end faces the normal direction of chain travel.

2 Battery electrolyte level

A conventional lead-acid battery is fitted to all models.



Electrolyte levels are clearly marked on battery

The transparent plastic case of the battery permits the upper and lower levels of the electrolyte to be observed when the battery is lifted from its housing below the dual seat. Maintenance is normally limited to keeping the electrolyte level between the prescribed upper and lower limits and by making sure that the vent pipe is not blocked. The lead plates and their separators can be seen through the transparent case, a further guide to the general condition of the battery.

Unless acid is split, as may occur if the machine falls over, the electrolyte should always be topped up with distilled water, to restore the correct level. If acid is split on any part of the machine, it should be neutralised with an alkali such as washing soda and washed away with plenty of water, otherwise serious corrosion will occur. Top up with sulphuric acid of the correct specific gravity (1.260 – 1.280) only when spillage has occurred. Check that the vent pipe is well clear of the frame tubes or any of the other cycle parts, for obvious reasons.

3 Adjusting the front and rear brakes (drum brake models only)

The front brake should be adjusted so that there is 5.8 mm (0.2 – 0.3 in) movement, measured between the handlebar lever and the lever stock, before the brake starts to bite. Adjustment may be made either at the cable adjuster on the handlebar lever or the cable adjuster on the brake back plate.

If uneven brake shoe wear reduces the efficiency of the brake, the brake arm link rod should be adjusted as described in Chapter 5, Section 10.

Adjust the rear brake by means of the adjuster nut on the brake rod so that there is approximately 30 mm (1.2 in) vertical movement at the brake pedal foot pad before the brake commences operation.

Three monthly or every 2000 miles (3200 km)

Complete the tasks enumerated in the weekly/200 mile and monthly/1000 mile maintenance schedules, and then carry out the following:

1 Changing the engine/transmission oil

Place a container of more than 3.0 litres (6.4/5.3 US/imp pints) below the crankcase. Remove the filler cap from the primary drive case and unscrew the oil drain plug from the base of the crankcase. A second plug fitted to the left-hand wall of the crankcase below the alternator cover may also be removed. Drain the oil after the engine has been allowed to reach normal working temperature, preferably after a run; the oil will be thinner when hot and so drain more rapidly and completely.

Replace the drain plugs and refill the engine with 2.0 litres (4.2/3.5 US/imp pints) of SAE 20W/50 engine oil. Allow the oil to settle for a few moments and then check the level by means of the dipstick in the filler cap. Add more oil, if required.

2 Cleaning the air filter elements

Two identical air filter boxes are fitted, each of which contains a woven fabric air filter element. One box is fitted behind each frame side cover which must be detached to gain access. Remove and clean each filter separately, in the same manner, as follows:

Slacken the air hose/air filter box screw clip and remove the single bolt securing the lower end of the air filter box retaining strap. Hinge the strap up and pull the air filter box from place. The air filter box is a two-piece moulding held together by two screws. After removal of the screws, separate the two box halves and withdraw the element.

The air filter is best cleaned using a compressed air line directed from the inside. If this is not available, the dust should be loosened, using a soft brush, and then blown out, using a tyre pump.

A badly soiled or oily element will restrict the flow of air to the engine and so reduce performance. In addition, the mixture

will be richened, increasing the fuel consumption proportionately.

Do not on any account run the machine with the air filter removed or with the air cleaner hoses disconnected. If this precaution is not observed, the engine will run with a permanently weak mixture, which will cause overheating and possible seizure.

3 Control cable lubrication

Lubricate the control cables thoroughly with motor oil or an all-purpose oil. A good method of lubricating the cables is shown in the accompanying illustration, using a plasticine funnel. This method has the disadvantage that the cables usually need removing from the machine. An hydraulic cable oiler which pressurises the lubricant overcomes this problem. Do not lubricate nylon lined cables (which may have been fitted as replacements), as the oil may cause the nylon to swell, thereby causing total cable seizure.



Oiling control cables

4 General lubrication

Apply grease or oil to the handlebar lever pivots and to the centre stand and prop stand pivots.

5 Wheel condition (spoke type)

Check the spoke tension by gently tapping each one with a metal object. A loose spoke is identifiable by the low pitch noise generated. If any one spoke needs considerable tightening, it will be necessary to remove the tyre and inner tube in order to file down the protruding spoke end. This will prevent the spoke from chafing through the rim band and piercing the inner tube. Rotate the wheel and test for rim runout. Excessive runout will cause handling problems and should be corrected by tightening or loosening the relevant spokes. Care must be taken, since altering the tension in the wrong spokes may create more problems.

6 Cleaning and checking spark plugs

Remove the spark plugs and clean them, using a wire brush. Clean the electrodes using fine emery paper or cloth and then reset the gaps to 0.7 – 0.8 mm (0.028 – 0.030 in) with the correct feeler gauge. Before replacing the plugs, smear the threads with a small amount of graphite grease to aid future removal.

7 Cleaning and adjusting the contact breaker points

To gain access to the contact breaker assembly, it is necessary to remove the cover plate which is held by two cross head screws to the cylinder head. Note that the cover has a paper gasket to prevent the ingress of water.

Remove the alternator inspection cover and rotate the engine until the left-hand points are fully open. Removal of the spark plugs will aid rotation.

Inspect the faces of each of the two sets of contact breaker points. Slight burning or pitting can be removed while the contact breaker unit is in situ on the machine, using a very fine swiss file or emery paper (No. 400) backed by a thin strip of tin. If pitting or burning is excessive the contact breaker unit should be removed for points dressing or renewal. (See Chapter 3, Section 4). After the points have been cleaned, they should be adjusted to restore the correct gap as follows:

Adjustment is effected by slackening the two screws through the plate of the fixed contact breaker point and moving the point either closer to, or further away from, the moving contact until the gap is correct as measured by a feeler gauge. The correct gap with the points FULLY OPEN is 0.3 – 0.4 mm (0.012 – 0.016 in).

Two small projections on the contact breaker base plate permit the insertion of a screwdriver to lever the adjustable point into its correct location. Repeat this operation if there is any doubt about the accuracy of the measurement. Although this adjustment is relatively easy, it is of prime importance.

Carry out the procedure on the right-hand set of contact breakers after turning the engine again so that the points are fully open.

After making contact breaker adjustments, the ignition timing should be checked, and if necessary adjusted, as described under the following heading.

8 Ignition timing

To enable ignition timing to be carried out accurately, either manually or using a stroboscope, two sets of marks are made on the alternator rotor periphery, which may be aligned with an index pointer cast into the alternator cover. Each set of marks relates to a different cylinder.

Commence by checking, and if necessary adjusting the left-hand contact breaker points which control ignition timing of the left-hand cylinder.

With the contact breakers having been gapped previously (see previous Section), turn the engine in an anti-clockwise direction so that the LF mark aligns and the left-hand cylinder is on its compression stroke. Note that the timing is accomplished in the fully retarded position, i.e. with the balance weight of the auto-advance unit unextended.

If the timing is correct, the points should be just on the verge of opening as the LF mark comes into alignment.

To check when the opening occurs a 12 volt lamp bulb can be connected between the moving contact breaker point or the condenser connection and earth on the engine. The lamp will light up when the contact breaker points open, if the ignition circuit is switched on.

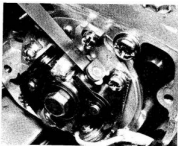
If the timing is incorrect, slacken the two screws which pass into the cylinder head, clamping the contact breaker assembly base plate in position. Rotate the complete assembly until the light flickers, and then tighten the screws. Recheck the timing by rotating the engine backwards about 45° and then forwards again until the LF mark aligns precisely with the index mark. The engine must be rotated one way and then the other to take up any backlash in the timing chain (camshaft chain).

Repeat the timing check procedure on the right-hand contact-breaker, using the RF mark on the alternator rotor. If the timing is incorrect **DO NOT** slacken the two screws previously used for timing. The right-hand contact breaker is mounted on a separate smaller base plate retained by two screws passing through elongated holes in the plate. The elongated holes allow a limited amount of plate movement for ignition timing.

Timing the engine manually as described above should be acceptably accurate provided that the contact breakers are in good condition and great care is taken. The use of a stroboscopic lamp, however, which enables ignition timing to take place with the engine running, is recommended. The LF or RF marks on the alternator rotor represent the fully retarded ignition point. The single unmarked scribed line just to the left of each fully retarded firing mark is the full advance mark for the cylinder.

Use the stroboscope in accordance with the manufacturer's instructions. Adjustment of the timing is the same as that given for manual adjustment.

Before replacing the contact breaker cover apply a small amount of thin oil to the cam lubricating wicks. One or two drops will suffice. Too much oil will contaminate the points faces, causing ignition failure.



Check points gap when in fully open position

9 Adjusting the tick-over speed

The engine tick-over speed may be adjusted by means of the throttle pulley stop screw, which is located between the two carburetors. The screw can be identified by the serrated plastic knob. The correct tick-over speed is 1,200 rpm.

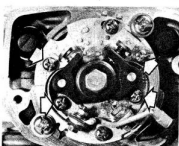
If the two carburetors are not synchronised accurately, refer to Chapter 2 Section 7 for the correct adjustment procedure.

Six monthly or every 4000 miles (6400 km)

Carry out the tasks described in the weekly, monthly and three monthly sections and then carry out the following:

1 Checking and adjusting the valve clearances

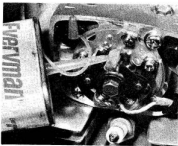
To gain access to the camshaft cover and to give adequate working room, the petrol tank should be removed from the machine. Remove all four tappet inspection caps from the camshaft cover. Rotate the crankshaft anti-clockwise until the LT mark aligns with the timing mark. In this position the left-hand cylinder is at TDC with both valves closed and can



Loosen two screws to adjust each set of points



A = LH cylinder timing adjustment screws; B = RH cylinder screws



Lubricate cam wick springy

therefore be checked for rocker clearance. The correct clearance with the engine cold is as follows:

Inlet valve	0.08 – 0.12 mm (0.003 – 0.005 in)
Exhaust valve	0.15 – 0.20 mm (0.006 – 0.008 in)

Insert a feeler gauge of the correct denomination through the rocker adjustment office and between the head of the valve stem and the rocker adjustment screw. If the clearance is correct the blade of the gauge will be a tight slip fit. To adjust the clearance, loosen the adjuster screw locknut and rotate the screw the required amount until the adjustment is correct. Hold the screw in the set position and tighten the locknut. Recheck the clearance, as it is all too easy to alter the position of the screw when tightening the locknut.

When rocker adjustment on the left-hand cylinder has been carried out, rotate the crankshaft 180° anti-clockwise until the right-hand cylinder is at TDC, the RT timing mark on the alternator rotor will now be aligned with the stator timing mark. Repeat rocker adjustment as for the left-hand cylinder.

Replace and tighten the four rocker adjustment caps.

2 Changing the oil filter

During the 4000 mile service, ie at every second oil change, the old oil filter should be removed and discarded, and a replacement element fitted.

The oil filter is contained within a semi-isolated chamber at the front of the crankcase. Access to the element is made by unscrewing the filter cover centre bolt which will bring with it the cover and also the element. Before removing the cover, place a receptacle beneath the engine to catch the engine oil contained in the filter chamber.

When renewing the filter element it is wise to renew the filter cover 'O' ring at the same time. This will obviate the possibility of any oil leaks. Do not overtighten the centre bolt on replacement; the correct torque setting is 1.3 – 1.7 kg m (9.5 – 12.0 lb ft).

The filter by-pass valve, comprising a plunger and spring, is situated in the bore of the filter cover centre bolt. It is recommended that the by-pass valve be checked for free movement during every filter change. The spring and plunger are retained by a pin across the centre bolt. Knocking the pin out will allow the spring and plunger to be removed for cleaning.

Never run the engine without the filter element or increase the period between the recommended oil changes or oil filter changes.

Yearly or every 8000 miles (12 875 km)

Again complete the checks listed under the previous routine maintenance interval headings. The following additional tasks are now necessary.

1 Front fork oil change

Drain and replenish the damping fluid in the front forks. Refer to the relevant section in Chapter 4 for the relevant information.

2 Removal, inspection and relubrication of wheel bearings

Carry out the operations listed in the heading by following the procedure given in Chapter 5, Section 11 for the front wheel and Section 12 for the rear wheel.

3 Front and rear brake shoe inspection

On drum brake models both wheels should be removed and the brake shoes inspected for wear. Refer to Chapter 5 Sections 9, 10 and 14 for the relevant details.

4 Steering head bearings

During the yearly service, the steering head bearings should be inspected and repacked with grease as described in Chapter

4 Section 6. To gain access to the bearings, the front forks must be removed as described in Section 2 and 3 of that Chapter.

5 Swinging arm bearings

The swinging arm should be removed from the machine, and the bearings re-packed with grease. See Chapter 4, Sections 9 and 10.

General maintenance adjustments

1 Clutch adjustment

The intervals at which the clutch should be adjusted will depend on the style of riding and the conditions under which the machine is used.

Adjust the clutch in two stages as follows:

Remove the clutch adjustment cover, which is retained by two screws. Loosen the cable adjuster screw locknut and turn the adjuster inwards fully, to give plenty of slack in the inner cable. Loosen the adjuster screw locknut in the casing and turn the screw clockwise until slight resistance is felt. Back off the screw about $\frac{1}{2}$ turn and tighten the locknut. The cover may be replaced.

Undo the cable adjuster screw at the handlebar lever, until there is approximately 2 – 3 mm (0.08 – 0.12 in) play measured between the inner face of the lever and the stock face. Finally, tighten the cable adjuster locknut.

2 Checking brake pad wear

Brake wear depends largely on the conditions in which the machine is ridden and at what speed. It is difficult therefore, to give precise inspection intervals, but it follows that pad wear should be checked more frequently on a hard ridden machine.

The condition of the brake pads can be determined with the pads in place in the caliper by viewing them through the inspection aperture in the caliper cover. The aperture is closed by a small plastic cap which may be hinged back to give access. Each pad has a red marked groove around the periphery. If it can be seen that one or both pads have worn down to or past the groove, the pads must be renewed as a set.

Pad removal can be accomplished without removing the front wheel, as follows:

Remove the single bolt which passes through the piston/cylinder casting into the caliper support bracket. It is upon this bolt that the casting slides. From the rear of the unit remove the single crosshead screw by passing the shank of a screwdriver through the wheel spokes. Grasp the piston/cylinder casting and lift it away, leaving the two pads in place on the support bracket either side of the disc.

To prevent the piston being expelled from the cylinder, in the event of the brake lever being applied inadvertently, place a wooden wedge between the piston and outer wall of the casting.

Lift each pad away from the disc and out of the support bracket. Note that the outer pad on the XS 380C model is fitted with an anti-chatter shim. This should be detached from the pad.

As stated above the pads must be renewed as a pair if either pad has worn down to the groove. The minimum pad thickness is 1.5 mm (0.06 in).

Replace the new pads by reversing the dismantling procedure. On XS 380C models, the anti-chatter spring must be fitted to the outer pad so that the stamped arrow mark is facing the direction of normal wheel travel. The outer faces of both pads should be smeared with a thin coating of silicon grease of the type supplied especially for disc brakes. Do not allow any grease to find its way onto the friction surfaces of the pad. It goes without saying that a pad contaminated with grease will not function efficiently.

Make sure that the brake pads are correctly located in the caliper and that the front wheel revolves quite freely when reassembly is complete. Always check the brake action before taking the machine on the road.

Summary of routine maintenance, adjustments and capacities

Spark plugs	***	***	***	***	***	***	***	***	NGK BP-7ES (XS250 and 400), BP-6ES (XS360)
Spark plug gap	***	***	***	***	***	***	***	***	0.7 to 0.8 mm (0.028 to 0.032 in)
Contact breaker gap	***	***	***	***	***	***	***	***	0.3 to 0.4 mm (0.012 to 0.016 in)
Valve tappet clearance (cold engine)									
Inlet	***	***	***	***	***	***	***	***	0.08 to 0.12 mm (0.003 to 0.005 in)
Exhaust	***	***	***	***	***	***	***	***	0.16 to 0.20 mm (0.006 to 0.008 in)
Tyre pressures									
Front	***	***	***	***	***	***	***	***	solo 26 psi (1.8 kg/cm ²)
Rear	***	***	***	***	***	***	***	***	28 psi (2.0 kg/cm ²)
Fuel tank capacity	***	***	***	***	***	***	***	***	11.0 litres (2.9/2.4 US/imp gallons)
Engine oil capacity									
With filter change	***	***	***	***	***	***	***	***	2.3 litres (5.0/4.0 US/imp pints)
Without filter change	***	***	***	***	***	***	***	***	2.0 litres (4.2/3.5 US/imp pints)
Front fork leg capacity	***	***	***	***	***	***	***	***	130 cc (4.4/3.7 US/imp fl ozs)

Recommended lubricants

Component	Lubricant								
Engine/gearbox unit	***	***	***	***	***	***	***	***	SAE 20W/50 engine oil
Telescopic forks	***	***	***	***	***	***	***	***	SAE 10W/30 engine oil, SAE 20 fork oil or ATF
Hydraulic front brake master cylinder	***	***	***	***	***	***	***	***	DOT 3 or SAE J1703 clutch and brake fluid
Control cables	***	***	***	***	***	***	***	***	Light engine oil
Grease nipples and wheel bearings	***	***	***	***	***	***	***	***	High melting point general purpose grease
Chain	***	***	***	***	***	***	***	***	Chain lubricant or graphited grease

Working conditions and tools

When a major overhaul is contemplated, it is important that a clean, well-lit working space is available, equipped with a workbench and vice, and with space for laying out or storing the dismantled assemblies in an orderly manner where they are unlikely to be disturbed. The use of a good workshop will give the satisfaction of work done in comfort and without haste, where there is little chance of the machine being dismantled and reassembled in anything other than clean surroundings. Unfortunately, these ideal working conditions are not always practicable and under these latter circumstances when improvisation is called for, extra care and time will be needed.

The other essential requirement is a comprehensive set of good quality tools. Quality is of prime importance since cheap tools will prove expensive in the long run if they slip or break and damage the components to which they are applied. A good quality tool will last a long time, and more than justify the cost. The basis of any tool kit is a set of open-ended spanners which can be used on almost any part of the machine to which there is reasonable access. A set of ring spanners makes a useful addition, since they can be used on nuts that are very tight or where access is restricted. Where the cost has to be kept within reasonable bounds, a compromise can be effected with a set of combination spanners — open-ended at one end and having a ring of the same size on the other end. Socket spanners may also be considered a good investment; a basic 3/8 in or 1/2 in drive kit comprising a ratchet handle and a small number of socket heads, is ideal if money is limited. Additional sockets can be purchased, as and when they are required. Provided they are slim in profile, sockets will reach nuts or bolts that are deeply recessed. When purchasing spanners of any kind, make sure the correct size standard is purchased. Almost all machines manufactured outside the UK and the USA have metric nuts and bolts, whilst those produced in Britain have BSP or BSF sizes. The standard used in the USA is AF, which is also found on some of the later British machines. Other tools that should be included in the kit are a range of crosshead screwdrivers, a pair of pliers and a hammer.

When considering the purchase of tools, it should be remembered that by carrying out the work oneself, a large proportion of the normal repair cost, made up by labour charges, will be saved. The economy made on even a minor overhaul will go a long way towards the improvement of a tool kit.

In addition to the basic tool kit, certain additional tools can prove invaluable when they are close to hand, to help speed up a multitude of repetitive jobs. For example, an impact screwdriver will ease the removal of screws that have been

tightened by a similar tool, during assembly, without a risk of damaging the screw heads. And, of course, it can be used again to retighten the screws, to ensure an oil or airtight seal results. Circlip pliers have their uses too, since gear pinions, shafts and similar components are frequently retained by circlips that are not too easily displaced by a screwdriver. There are two types of circlip pliers, one for internal and one for external circlips. They may also have straight or right-angled jaws.

One of the most useful of all tools is the torque wrench, a form of spanner that can be adjusted to slip when a measured amount of force is applied to any bolt or nut. Torque wrench settings are given in almost every modern workshop or service manual, where the extent is given to which a complex component, such as a cylinder head, can be tightened without fear of distortion or leakage. The tightening of bearing caps is yet another example. Overtightening will stretch or even break bolts, necessitating extra work to extract the broken portions.

As may be expected, the more sophisticated the machine, the greater is the number of tools likely to be required if it is to be kept in first class condition by the home mechanic. Unfortunately there are certain jobs which cannot be accomplished successfully without the correct equipment and although there is invariably a specialist who will undertake the work for a fee, the home mechanic will have to dig more deeply in his pocket for the purchase of similar equipment if he does not wish to employ the services of others. Here a word of caution is necessary, since some of these jobs are best left to the expert. Although an electrical multimeter of the AVO type will prove helpful in tracing electrical faults, in inexperienced hands it may irrevocably damage some of the electrical components if a test current is passed through them in the wrong direction. This can apply to the synchronisation of twin or multiple carburettors too, where a certain amount of expertise is needed when setting them up with vacuum gauges. These are, however, exceptions. Some instruments, such as a strobe lamp, are virtually essential when checking the timing of a machine powered by CDI ignition system. In short, do not purchase any of these special items unless you have the experience to use them correctly.

Although this manual shows how components can be removed and replaced without the use of special service tools (unless absolutely essential), it is worthwhile giving consideration to the purchase of the more commonly used tools if the machine is regarded as a long term purchase. Whilst the alternative methods suggested will remove and replace parts without risk of damage, the use of the special tools recommended and sold by the manufacturer will invariably save time.

Chapter 1 Engine, clutch and gearbox

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Specifications

Engine

	XS 250	XS 360	XS 400
Type	Vertical parallel twin cylinder, overhead camshaft, four-stroke		
Bore	55 mm (2.1653 in)	66 mm (2.528 in)	69 mm (2.717 in)
Stroke		52.4 mm (2.063 in)	
Capacity	248 cc (15.13 cu in)	358 cc (21.85 cu in)	392 cc (23.92 cu in)
Compression ratio	9.6:1	9.6:1	9.2:1
bhp	27 × 5,500 rpm	34 × 8,500 rpm	—

Pistons and rings

Piston/cylinder clearance	0.030–0.050 mm (0.0012–0.0020 in)
Piston oversizes available	+0.25 mm, +0.50 mm, +0.75 mm and +1.0 mm
Piston ring end gap	0.15–0.35 mm (0.006–0.014 in) 0.2–0.4 mm (0.008–0.016 in)
Top and 2nd ring	0.2–0.9 mm (0.008–0.035 in)
Oil control ring	0.04–0.08 mm (0.0016–0.0032 in)
Ring side clearance	0.03–0.07 mm (0.0012–0.0028 in)
Top ring	
Second ring	

Cylinder barrel

Cylinder bore diameter	55.0 + 0.02 mm (2.17 + 0.0008 in)	66.0 + 0.02 mm (2.59 + 0.0008 in)	69.0 + 0.02 mm (2.72 + 0.0008 in)
Bore taper limit	0.05 mm (0.002 in)		
Quality limit	0.01 mm (0.0004 in)		

Valves and springs

Valve clearance (look)			
Inlet	0.08–0.12 mm (0.003–0.005 in)		
Exhaust	0.16–0.20 mm (0.006–0.008 in)		
Valve stem diameter			
Inlet	7.0 –0.025 mm	(0.275 –0.0009 in)	–0.0004 –0.0009 in
Exhaust	7.0 –0.030 –0.045 mm	(0.275 –0.0012 –0.0018 in)	–0.0012 –0.0018 in
Stem/guide clearance			
Inlet	0.010–0.037 mm (0.0004–0.0014 in)		
Exhaust	0.030–0.057 mm (0.0012–0.0022 in)		
Valve spring free length			
Inner	39.3 mm (1.547 in)		
Outer	42.8 mm (1.685 in)		

Camshaft

Bearing inside diameter	23 + 0.021 mm (0.906 + 0.0082 in)	
Journal outside diameter	23 –0.033 mm	(0.906 –0.0013 in)
Bearing journal	0.020–0.054 mm (0.0008–0.0020 in)	
Cam height wear limit		
XS250 and 400; inlet	39.38 mm (1.550 in)	
exhaust	39.42 mm (1.552 in)	
XS360; inlet	38.70 mm (1.527 in)	
exhaust	38.74 mm (1.525 in)	

Valve timing

Inlet opens	24° BTDC	30° BTDC
Inlet closes	60° ABDC	70° ABDC
Exhaust opens	58° BBDC	70° BBDC
Exhaust closes	26° ATDC	30° ATDC

Crankshaft

Big end clearance	0.021–0.045 mm (0.0008–0.0018 in)
Main bearing clearance	0.020–0.044 mm (0.0008–0.0018 in)
Connecting rod axial clearance	0.160–0.0264 mm (0.0063–0.0104 in)
Connecting rod deflection	0.30–0.50 mm (0.012–0.019 in)
Small end bore diameter	16 + 0.028 + 0.015 mm (1.614 + 0.0011 in + 0.0028 in)

Clutch

Type	Wet, multi-plate
Number of plates	7
Friction	6
Plain	4
Number of springs	3 mm (0.12 in)
Friction plate thickness	2.7 mm (0.11 in)
Wear limit	34.6 mm (1.362 in)
Spring free length	33.6 mm (1.323 in)
Wear limit	

Gearbox

Type				6-speed, constant mesh		
Ratios						
1st gear	---	---	---	2.500:1	2.500:1	2.500:1
2nd gear	---	---	---	1.777:1	1.777:1	1.777:1
3rd gear	---	---	---	1.380:1	1.380:1	1.380:1
4th gear	---	---	---	1.125:1	1.125:1	1.125:1
5th gear	---	---	---	0.961:1	0.961:1	0.961:1
6th gear	---	---	---	0.866:1	0.866:1	0.866:1
Secondary ratio	---	---	---	2.867:1	2.500:1	2.312:1

Torque wrench settings

Cylinder head			
6 mm bolts	---	---	0.8–1.2 kg/m (5.8–8.7 lbf/ft)
8 mm nuts (XS360 and 260)	---	---	2.0–2.4 kg/m (14.5–17.4 lbf/ft)
10 mm nuts (XS400)	---	---	3.3 kg/m (23.9 lbf/ft)
Primary drive pinion bolt	---	---	4.3 kg/m (31 lbf/ft)
Crankcase bolts			
6 mm	---	---	1.0 kg/m (7.2 lbf/ft)
8 mm	---	---	2.2 kg/m (16 lbf/ft)
Connecting rod cap bolts	---	---	3.3–3.8 kg/m (23.9–27.5 lbf/ft)

1 General description

The Yamaha XS250, 360 and 400 models use an engine unit which is identical in all major respects, there being differences only in the size of pistons and allied components relating to the engine capacity.

The engine is a vertical parallel twin with a 180° crankshaft, supported by three shell type main bearings. The 180° crankshaft has better inherent balance characteristics than the 360° crank more normally utilized in parallel twin engines, and dispenses with the necessity of a counter-balance assembly which is often fitted to modern vertical twins. The valve gear consists of an overhead camshaft driven by a chain from the crankshaft, passing through a tunnel between the two cylinders. The chain is automatically tensioned and rocker clearance is adjusted by means of adjuster screws on the rocker arms. All major engine casings are in light aluminium alloy, the cylinder block having dry steel liners. The engine/gearbox housings (crankcases) are split in a horizontal plane to facilitate dismantling and reassembly.

Engine lubrication is provided by a wet sump system i.e. the oil reservoir is contained in the crankcase, not as is more usual, a separate oil tank mounted on the frame. Oil is picked up from the sump through a gauze oil trap and is fed under pressure by a trochoid oil pump through a corrugated paper filter to the working parts of the engine.

Primary drive is by double spur gears to a multi-plate wet clutch. A six-speed constant mesh gearbox then transmits drive via a roller chain to the rear wheel.

Two Mikuni constant vacuum carburetors and two independent exhaust systems are fitted.

An ac generator (alternator) mounted on the left-hand end of the crankshaft provides power to the electrical system. An electric starter motor is fitted to all but the XS 360-2D models, supplemented by a kickstart lever on the right-hand side of the machine.

2 Operations with engine/gearbox in the frame

It is not necessary to remove the engine unit from the frame for dismantling the following items:

- 1 Cylinder head cover
- 2 Cylinder head, block and pistons
- 3 Right-hand and left-hand crankcase covers
- 4 Clutch assembly and oil pump
- 5 Alternator and starter motor
- 6 Replacement of the kickstart return spring

If work on the crankshaft or the gearbox components is to be carried out it will be necessary to remove the engine from the frame in order that the crankcases may be separated. If a great deal of work is anticipated, it would be advantageous to remove the complete unit, thereby affording greater access.

3 Method of engine/gearbox removal

As mentioned previously the engine/gearbox is built in unit and it is necessary to remove the complete crankcase in order to gain access to the components. Separation is accomplished after the engine unit has been removed from the frame, and refitting cannot take place until the crankcase has been reassembled.

4 Removing the engine/gearbox unit

- 1 Place the machine on its centre stand, making sure that it is standing securely on firm ground.

2 Place a receptacle of more than 2.3 litres (5-0/4-0 US/imp pints) below the engine and remove the filler cap from the primary crankcase and the drain plug from the base of the crankcase. A secondary drain plug is fitted in the crankcase left-hand wall, below the alternator casing. Oil drainage will be facilitated if the engine has been allowed to reach normal working temperature: the oil will be thinner and so flow more easily. Detach the oil filter chamber and oil filter element from the front of the crankcase by unscrewing the central bolt. Move the drain bath forwards to catch the small quantity of oil contained within the filter housing.

3 Raise the dashboard and disconnect the negative lead (-) from the battery, followed by the positive lead. This will isolate the electrical system and so prevent accidental shorting during subsequent dismantling. If it is anticipated that the machine is to be unused for an extended length of time, the battery should be removed for storage and given a refresher charge from an external source at approximately monthly intervals.

4 Turn the petrol tap to the On or Reserve position and disconnect the petrol feed pipe and the smaller gauge vacuum tube. Both tubes are secured on the unions by spring clips, the ears of which should be pinched together to release the tension. Drainage of the petrol tank for removal is not strictly necessary, although the reduction in weight will facilitate this operation. The petrol tank is supported at the front by two rubber buffers, which engage with a cup each side of the frame top tube, and is secured at the rear by a single bolt passing through a projecting lug. Remove the bolt and ease the petrol tank rearwards so that the buffers leave the cups. The tank may then be lifted upwards

away from the machine. Remove the two side covers from either side of the machine. The covers are a three point push fit in rubber grommets attached to the frame. Unscrew the screw clips which secure the carburetors to the inlet stubs, and the air hose unit to the carburetor mouths and the twin air filter boxes. Each air filter box may be pulled from position after removing the retaining strap, which is secured at the lower end by a single bolt and at the top by a hook arrangement. Disconnect the air hose breather tube from the breather cover on the crankcase, after displacing the spring securing clip. The air hose unit can now be pulled off the carburetor mouths and tilted backwards and downwards so that it clears the carburetors. Careful manipulation may be required as the clearance is limited. Pull the carburetors back out of the inlet stubs and lift them towards the right-hand side of the machine, as a unit.

5 Disconnect the throttle cable at the carburetor end. Lift the outer cable from the splayed adjustment and displace the nipple and inner cable end from the throttle pulley between the two instruments.

6 Remove the tachometer drive cable from the front right of the camshaft cover. The cable is retained by a countersunk crosshead screw.

7 Disconnect the starter motor lead from the upper terminal on the starter solenoid switch. Pull the wire through, towards the engine, so that it will not get entangled when the engine is removed. The lead is secured to the machine at a number of points along its length by small lugs projecting from the rear mudguard (starter motor not fitted to X5380-20 model).

8 Disconnect the main electrical connections to the engine. The main alternator leads are connected at two block type multi-pin sockets behind the frame left-hand cover. The low tension leads should be disconnected from the ignition coil snap connectors above the cylinder head. The main earth lead from the battery to the engine is retained by a crankcase bolt to the rear of the gearbox. The lead may be disconnected by removing the bolt, or may be pulled through towards the engine and removed after lifting out the engine.

9 Undo the two nuts holding each exhaust clamp to the cylinder head and slide the clamps back. Note the split collets, and remove them. Slacken the bolt securing the two exhaust pipes/silencer joint clamps. The exhaust pipes may be pulled from position individually, leaving the silencers in place. Silencer removal is not necessary when removing the engine: each unit may be tipped forwards on the single mounting stud to clear the front of the engine. Prise out the exhaust port gaskets with a small screwdriver.

10 Remove the kickstart lever and the gear lever from their respective splined shafts. Both levers are retained by a pinch bolt which must be removed completely before the lever can be pulled off the shaft.

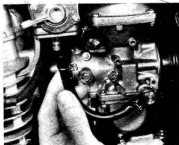
11 Remove the five screws which hold the final drive sprocket casing to the left-hand side of the engine. Pull the casing out until it is clear of the gearchange shaft. The clutch cable must be disconnected from the operating arm inside the case before the casing is completely free. Take care not to lose the - 'all steel ball which lies between the inner face of the clutch lifting mechanism and the clutch pushrod, in the centre of the mainshaft.

12 Before removing the master link from the chain and running it off the sprockets, the gearbox sprocket nut should be loosened. Loosening this large nut after the engine has been removed can be accomplished but preventing the sprocket from rotating is more difficult. Bend down the tab washer before fitting the spanner and then apply the rear brake pedal to hold the sprocket. The sprocket may be pulled off the shaft with the chain in mesh, or after separation of the chain.

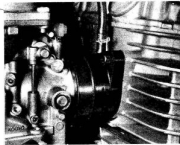
13 Remove the rear brake pedal from the splined pivot shaft after unscrewing completely the pinch bolt. Then detach both front footrests, each of which is held on two projecting stubs and retained by two bolts. Disconnect the stop lamp switch spring from the brake pivot arm and then lift the switch out of the holding bracket. Tuck the switch out of harm's way, to the right of the battery carrier.

14 The engine is held in position by two short bolts at the front and two long through bolts at the rear, the upper of which passes through two detachable mounting brackets. In addition, a head steady is fitted to a lug projecting from the camshaft cover. Commence engine removal by detaching the head steady plates. The plates are held by two bolts passing through frame lugs and a single bolt passing through the camshaft cover lug. Remove the upper rear engine bolt and the two mounting plates, together with the stop lamp switch bracket. The lower bolt may now be removed, lifting the engine if necessary and then allowing it to rest on the frame lugs. During engine removal the two left-hand exhaust port studs may foul the frame down tube. To prevent unnecessary damage to the paintwork, apply a thick covering of tape to the threads.

15 The engine can now be lifted out of the frame to the right-hand side. It is recommended that an assistant is present during engine removal to avoid the danger of dropping the heavy assembly.



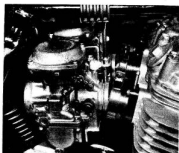
4.4a Detach the fuel pipe at the tap union and ...



4.4b ... the tap vacuum pipe at the inlet stub



4.5a Pull air hose unit from carburetors and ...



4.5b ... pull carburetors out of the inlet stubs



4.5c Disconnect the throttle cable at the pulley



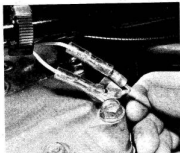
4.6 Tachometer cable is held by a single screw



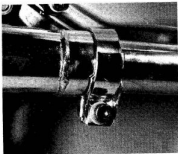
4.7 Detach starter lead at solenoid upper terminal



4.8a Main alternator leads connected by block connectors



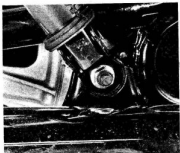
4.8b Disconnect the two separate contact breaker wires



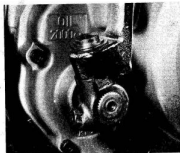
4.9a Loosen silencer/exhaust pipe clamps and ...



4.9b ... free the exhaust pipe flanges



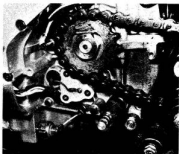
4.9c Slacken silencer mounting nut and tip silencer forwards



4.10 Kickstart and gear levers held by a pinch bolt



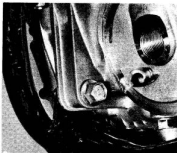
4.11 Detach clutch cable at operating mechanism



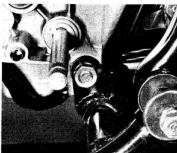
4.12 Bend down washer and loosen nut before chain removal



4.14a Detach the head steady, held by three bolts



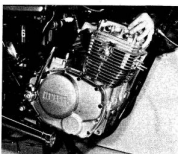
14.4b Engine is secured at front by two short bolts and



14.4c ... held at lower rear by a single long bolt



4.14d Detach upper bolt and also mounting plates



4.15 Lift out engine towards right-hand side

5 Dismantling the engine/gearbox: general

1 Before undertaking any work on the engine unit it should be thoroughly cleaned with a proprietary de-greaser to remove the grease and grime which accumulates. If this precaution is not followed then there is a very likely possibility of foreign particles entering the dismantled engine and components. **Note:** Make sure to block up the inlet and exhaust ports when washing down, to stop water entering the engine.

2 If the engine has not been stripped before, it is strongly advisable to have an impact screwdriver complete with a set of crosshead bits available. If an impact screwdriver is unavailable, it is sometimes possible to use a crosshead screwdriver fitted with a T handle. Whenever an attempt is made to slacken a screw, assume initially that it is very tight and proceed accordingly. Avoid a half-hearted attempt at loosening as the screwdriver may slip, causing damage to the head and so prevent subsequent successful removal.

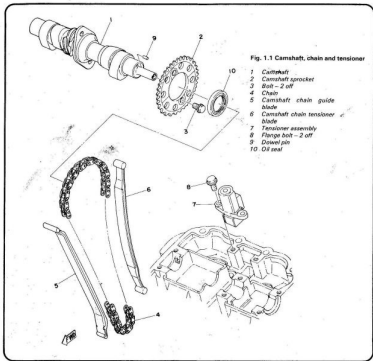
3 Do not use force to remove any parts unless specific mention is made in the manual. If any component is difficult to

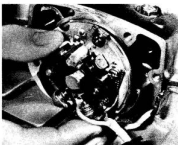
remove, first check that everything has been dismantled and/or loosened in the correct sequence.

6 Dismantling the engine/gearbox: removing the contact breaker assembly and automatic timing unit

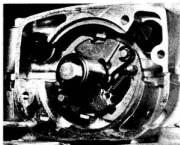
1 Remove the two screws which hold the contact breaker cover plate to the left-hand side of the cylinder head cover. The twin contact breaker assembly plate is retained in position by two clamping screws and large plain washers; the screws do not pass through the base plate but clamp it in place. Before loosening the screws, scribe a line across the plate and onto the edge of the casing. This will aid correct positioning on reassembly.

2 The automatic timing unit (ATU) is positioned behind the contact breaker base plate. Remove the centre bolt and pull the ATU off the end of the camshaft. Note that a dowel pin fitted in the end of the camshaft locates with the ATU and ensures that the ATU/camshaft relationship is always correct.





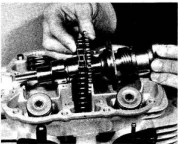
6.1 Remove the contact breaker assembly complete



6.2 The ATU is retained by a single bolt

7 Dismantling the engine/gearbox: removing the camshaft cover, and cylinder head

- 1 Position the engine on the workbench, resting it securely on the crankcase base with a wood block placed between the front mounting lugs and the bench.
- 2 The camshaft cover is retained by fourteen bolts which should be slackened in an even and diagonal sequence. The camshaft cover is under uneven stress from those valves and springs on partial or complete lift and therefore the holding down bolts must be unscrewed evenly to avoid distortion of the cover.
- 3 With all the bolts removed, lift the camshaft cover away. Note that no gasket or sealing 'O' ring is fitted between the mating surfaces of the camshaft cover and cylinder head.
- 4 Remove the two bolts which retain the cam chain guide holder. Lift off the holder and pull out the chain tensioner blade and also the chain guide blade, from the forward edge of the cam chain tunnel.
- 5 In order to gain access to the two cam chain sprocket bolts, it will be necessary to rotate the crankshaft through about 90°. This is best accomplished after the alternator cover has been removed, when a spanner can be fitted on the alternator rotor



7.6 Do not allow chain to fall into crankcase

bolt. The alternator cover and gasket are retained by three countersunk screws. Remove the two sprocket bolts and pull the sprocket towards the left-hand end of the camshaft. This will bring the sprocket off the locating boss and allow the cam chain to be lifted off the sprocket.

6 The camshaft and sprocket can now be eased out of position in the cylinder head. To prevent the cam chain falling down into the crankcase, place a screwdriver or short rod through the chain so that it rests across the camshaft half-bearings. Although this is not so important if the engine is being dismantled completely, it may prove difficult to retrieve the cam chain if only the top end of the engine is being overhauled.

7 The cylinder head is retained by eight acorn nuts and two bolts. First loosen the two bolts which are fitted one each side of the head, adjacent to the spark plug holes. Loosen the eight acorn nuts in the reverse order given in Fig. 1.14 which accompanies Section 42. This procedure will prevent distortion of the complex aluminium structure.

8 The cylinder head can now be eased up, off the holding down studs. It may be necessary to use a soft-nosed mallet to aid removal. Do not strike the cylinder head fins except where they are well supported by the porting. Do not use levers to lift the head or broken or bent fins will result. When the head is clear of the cylinder block, slide another screwdriver between the cam chain and remove the screwdriver from the top of the cylinder head.

9 Pull the three hollow dowel pins from the top of the cylinder block, noting the rubber seal on the rear right-hand dowel. Remove and discard the cylinder head gasket.

8 Dismantling the engine/gearbox: removing the cylinder block and pistons

- 1 After removing the cylinder head, the block is free to be lifted off. If it is stuck by the gasket, careful use of a hide hammer may be required. When lifting the block off the connecting rods, the pistons should be supported to stop them falling against the edge of the crankcase mouth, which will damage them. After raising the cylinder block from the base gasket, but before the piston rings leave the cylinder bore spigots, pad the crankcase mouths with clean rag. This will prevent pieces of broken piston ring, or gudgeon pin circlips from falling into the crankcase. This is particularly important when a top-end overhaul only is being carried out. After removing the cylinder block, pull out the three hollow dowels and the O ring.

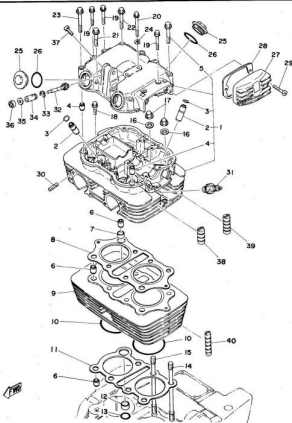


Fig. 1.2 Cylinder head and cover

- | | | |
|--------------------------|---------------------------|--------------------------|
| 1 Cylinder head assembly | 15 Bolt - 4 off | 28 Gasket |
| 2 Valve guide - 4 off | 16 Washer 8 off | 29 Panhead screw - 2 off |
| 3 Circlip - 4 off | 17 Nut - 8 off | 30 Stud - 4 off |
| 4 Dowel pin - 2 off | 18 Bolt - 2 off | 31 Spark plug - 2 off |
| 5 Bolt | 19 Bolt - 4 off | 32 Gear piston (15T) |
| 6 Dowel pin - 5 off | 20 Bolt - 2 off | 33 Circlip |
| 7 Seal | 21 Bolt | 34 Housing |
| 8 Gasket | 22 Bolt - 4 off | 35 Washer |
| 9 Cylinder block | 23 Bolt - 2 off | 36 Oil seal |
| 10 'O' ring - 2 off | 24 Washer - 2 off | 37 Screw |
| 11 Gasket | 25 Camshaft cover - 4 off | 38 Damper rubber |
| 12 Hollow dowel | 26 'O' ring - 4 off | 39 Damper rubber |
| 13 'O' ring | 27 Contact breaker cover | 40 Damper rubber |
| 14 Bolt - 4 off | | |

- 2 Remove both the circlips from each piston and drift out the gudgeon pin using a correct diameter drift. Support both the piston and the connecting rod during this operation to prevent any undue sideways strain. Do not completely remove the gudgeon pin but leave it in its respective piston boss. After removing each piston, mark it on the inside of the skirt so it can be replaced in its correct bore on subsequent reassembly. If the gudgeon pin is a tight fit in the piston, the piston should be gently heated by placing a rag soaked in boiling water on the crown. Do not use excessive force to remove a gudgeon pin because of the possibility of bending a connecting rod.
- 3 There are no separate small end bearings, the gudgeon pin bears directly onto the bearing surface of the connecting rod.
- 4 The piston rings can be removed by gently opening the gap and lifting them one at a time off the piston. Great care must be exercised since the rings are very brittle and thus easy to break. If it is intended to use the rings again note the order in which they were removed and also which was the top and bottom surface. If difficulty is encountered in removing the piston rings, three thin strips of tin, cut from an oil can, may be used to aid removal (see illustration).

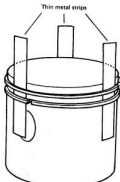


Fig. 1.3 Freeing gummed piston rings

9 Dismantling the engine/gearbox: removing the alternator rotor and the starter motor

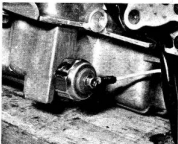
- 1 Remove the alternator outer cover (if this has not already been done) to aid crankshaft rotation, as described in Section 7.5.
- 2 The inner cover, which houses the alternator field coils and encloses the starter motor drive chain, is retained by socket bolts. Remove the inner cover and gasket after disconnecting the neutral warning switch lead and oil pressure warning switch lead from their respective switches. Each lead terminal is retained by a small screw. Displace the two alternator cables from the securing clips to free the case completely.
- 3 Remove the chromed cover which encloses the starter motor chamber and which is retained by two bolts.
- 4 Unscrew the two crosshead screws at the rear of the starter motor. Withdraw the starter motor whilst holding the starter motor sprocket. The starter motor sprocket is not retained on

the motor shaft splines by any fixing system; it is a sliding fit, it may be necessary to lightly tap the starter motor out of the crankcase with a hide mallet, since it is often a tight fit in the housing. **Warning:** Do not hit the starter motor on the splined shaft as this will damage the planetary reduction gear. Lift the starter motor out of the chamber together with the main lead which is retained on the terminal on the underside of the motor by a nut.

- 5 The starter motor chain and sprocket are now free and can be lifted away from the large driven sprocket.
- 6 Remove the driven sprocket guide plate which is retained by a single bolt.
- 7 To remove the alternator rotor retaining bolt it is necessary to stop the engine turning. This is best achieved by placing a metal bar through one of the little end bosses. Rest this bar on pieces of wood placed on top of the crankcase mouth. On no account must the metal bar be allowed to bear directly down onto the gasket face; if it does it will most certainly damage the jointing surface and cause oil leaks.
- 8 After jamming the engine to stop movement, remove the retaining bolt and washer from the alternator rotor. This will uncover an internal thread in the centre boss of the rotor. This thread facilitates the use of the Yamaha extractor tool.
- 9 Remove the rotor from its tapered shaft. If the special tool is unavailable a two or three jaw puller can be used instead. Note there are cutways in the rotor which can be utilised by the puller's legs. Do not forget to remove the Woodruff key. Replace the centre bolt loosely during extraction with a puller, to prevent damage to the internal thread.
- 10 The large sprocket is a push fit over the crankshaft and can be lifted clear after removal of the small retention tongue held by a single bolt.
- 11 The starter motor free running clutch is contained at the rear of the rotor. For further details refer to Chapter 6, Section 16.

10 Dismantling the engine/gearbox: removing the neutral indicator switch

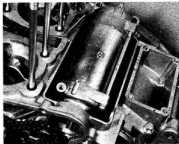
- 1 The neutral indicator switch is retained on the gearbox left-hand wall by three countersunk screws. Slacken the screws evenly and remove them, followed by the switch body. Make a scribe mark on the body to aid correct repositioning on subsequent reassembly.
- 2 Removal of the tiny contact brush and spring from the hole in the gearchange drum end is not necessary unless the contact is worn or the spring weakened.



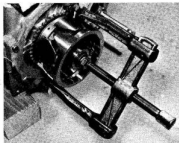
9.2a Detach oil pressure switch lead and ...



9.2b ... neutral indicator switch lead



9.4 Lift starter motor out of the chamber



9.9 Sprocket puller makes good substitute for Yamaha extractor

2. Unscrew the four bolts in the clutch pressure plate, and lift off the plate complete with bolts, springs and washers. Remove the clutch operating thrust piece and the clutch operating push rod. Note that a small steel ball is fitted between these components. Displace the ball, using a length of stiff wire, and store it in a safe place. Lift out the clutch plates either one at a time or as a sandwich, and note their sequence to aid reassembly.

3. Remove the circlip from position on the mainshaft end and pull off the clutch centre boss followed by the clutch outer drum.

4. The primary drive pinion is a tight push fit on the crankshaft end, where it is retained by a single bolt and located by a Woodruff key. Lock the crankshaft with a close fitting bar through one small end eye. Using the previously described method, remove the centre bolt and then draw the pinion off the shaft. If necessary, place two levers between the casing wall and the rear face of the pinion, to facilitate removal. Care must be taken not to damage the casing. Pry the Woodruff key from the recess in the shaft.

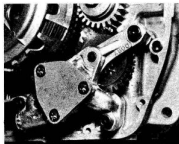
11 Dismantling the engine/gearbox: removing the primary drive cover and the oil pump

1. Loosen evenly and remove the screws which hold the primary drive cover in place. The cover is located on two dowel pins and may require tapping from position with a rawhide mallet.

2. The oil pump is secured by three large socket bolts and is located by a single dowel. Remove the bolts and lift the unit away from the casing, complete with the idler gear. The idler gear is a free sliding fit on the stub shaft.

12 Dismantling the engine/gearbox: removing the kickstart assembly, the clutch and primary drive pinion

1. Grasp the outer turned end of the kickstart return spring with a pair of pliers and ease it off the anchor lug projecting from the crankcase. Allow the tension on the spring to be released in a controlled manner. The kickstart assembly may be withdrawn from the casing as a complete unit and placed to one side, for examination at a later stage.



11.2 Remove the three socket bolts holding the oil pump

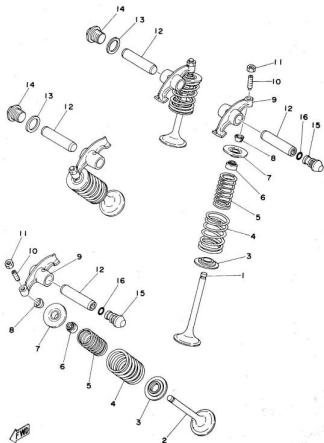


Fig. 1.4 Valves and rocker arms

- 1 Inlet valve - 2 off
 2 Exhaust valve - 2 off
 3 Valve spring seat - 4 off
 4 Outer spring - 4 off
 5 Inner spring - 4 off
 6 Valve stem oil seal - 4 off

- 7 Valve collar - 4 off
 8 Split collet - 8 off
 9 Valve rocker arm - 4 off
 10 Valve clearance adjusting screw - 4 off
 11 Nut - 4 off

- 12 Rocker arm spindle - 4 off
 13 Washer - 2 off
 14 Plug - 2 off
 15 Plug - 2 off
 16 O-ring - 2 off

13 Dismantling the engine/gearbox: removing the gearchange mechanism

- 1 Pull the rubber boot from the left-hand end of the gearchange shaft and prise off the 'E' clip, removing it together with the washer. Withdraw the shaft from the right-hand side of the engine and lift the small shouldered pivot bush from the stub shaft projecting from the gear selector arm. The arm is retained on the extended front gear selector fork rod by an 'E' clip. Remove the 'E' clip and hold the two pivot arms out, away from the change drum pins, to allow removal of the arm.
- 2 Loosen and remove the four screws which hold the two small plates either side of the change drum end. These screws are very tight and will require a concerted attempt to remove them. Special care should be taken when loosening the dome headed screws as the heads are easily damaged.

14 Dismantling the engine/gearbox: separating the crankcase halves

- 1 Invert the engine so that the lower crankcase faces upwards and the upper crankcase rests securely on the cylinder holding down studs and the rear portion of the upper gearbox casing.
- 2 Loosen the crankcase holding bolts evenly by reversing the sequence given in Fig. 1.11 accompanying Section 35 of this Chapter. Each holding bolt should be loosened initially about $\frac{1}{4}$ turn and then the sequence repeated.

Invert the crankcase once more and remove the upper bolts following the correct sequence. Double check that all the bolts have been removed before attempting to separate the cases. A rawhide mallet may be used to separate the crankcase halves; the use of levers should be avoided as the mating surfaces are easily damaged, leading to oil loss once the engine is in service again.

- 3 The upper crankcase half should be lifted away, leaving the crankshaft and gearbox components in place in the casing lower half.

The three main bearing shells in the upper casing should be left in place at this stage. If they fall out when lifting the casing, restore them to their original positions to avoid confusion.

15 Dismantling the engine/gearbox: removing the crankshaft and gearshaft assemblies

- 1 The crankshaft assembly can be lifted out of position, and the cam chain removed as soon as the crankcases have been separated.
- 2 Lift out the layshaft as a complete unit and then remove the mainshaft. Displace the half clips which locate the bearings axially and remove from the mainshaft the clutch pushed oil seal.
- 3 The three main assemblies should be placed to one side for later examination and dismantling.

16 Dismantling the engine/gearbox: removing the gear selector mechanism

- 1 Invert the crankcase lower half and using a large screwdriver remove the change drum detent housing bolt, spring and scroled plunger. Flip the casing to gain access to the selector fork rods.
- 2 Prise the 'E' clip from the rear selector fork rod, where it locates in the annular groove adjacent to the gearbox left-hand wall. Using a suitable drift, drive out partly the selector fork rod towards the left-hand side. This will displace the blind grommet in the gearbox wall. Pull the rod out completely to free the two selector forks. It is suggested that each of the four forks be marked clearly, to aid replacement. The guide pins are a light

push fit in the forks and should be removed to avoid loss. Drive out the remaining selector fork rod in a similar manner.

- 3 Pull the gearchange drum out of its bearing as far to the primary drive side as possible. Prise off the circlip on the drum end and remove the drum stopper cam plate. Remove the small peg from the drum end. The change drum is now free to be withdrawn completely.

17 Dismantling the engine/gearbox: removing the oil baffle plate and the oil strainer screen and cover

- 1 A detachable baffle plate is fitted within the crankcase lower half, which may be removed to facilitate casing cleaning. The baffle plate is retained under its own tension by a transverse rod, which passes over the top of the plate and locates in apertures in the casing walls. Removal of the plate may be effected by pressing downwards firmly on the plate and withdrawing the rod.
- 2 A filter screen is fitted in the underside of the crankcase, enclosed by a plate held by six bolts. Remove the bolts and break the seal between the cover and gasket, using a rawhide mallet. Lift the screen from position.

18 Examination and renovation: general

- 1 Before examining the parts of the dismantled engine unit for wear, it is essential that they should be cleaned thoroughly. Use a paraffin/petrol mix to remove all traces of old oil and sludge which may have accumulated within the engine. Neat paraffin, although an admirable solvent, has a low evaporation rate. As a consequence of this, difficulty is often encountered in drying cleaned components.

- 2 Examine the crankcase castings for cracks or other signs of damage. If a crack is discovered, it will require professional repair.

- 3 Examine carefully each part to determine the extent of wear, checking with the tolerance figures listed in the Specifications section of this Chapter or accompanying text. A vernier gauge or external micrometer will be required for determining external dimensions. The running clearance between two working surfaces such as the piston and cylinder bore can often be checked using ordinary feeler gauges. Checking internal dimensions such as the diameter of a shell bearing or cylinder bore requires the use of an internal micrometer, the size of which may vary depending on the component concerned. After some experience has been gained, it is often possible to determine by eye the extent of wear, and hence the need for renewal, without resorting to the direct measurement. If there is any question of doubt, play safe and renew.

- 4 Use a clean, lint-free rag for cleaning and drying the various components. This will obviate the risk of small particles obstructing the internal oilways, causing the lubrication system to fail.

19 Examination and renovation: main bearings and big-end bearings

- 1 The XS series twins are fitted with shell type bearings on the crankshaft and the big-end assemblies.
- 2 Bearing shells are relatively inexpensive and it is prudent to renew the entire set of main bearing shells when the engine is dismantled completely, especially in view of the amount of work which will be necessary at a later date if any of the bearings fail. Always renew the three sets of main bearings together. Replacement bearing shells are supplied on a selective fit basis (i.e. bearings are selected for correct tolerance to fit the original journal diameter and the diameter of the bearing housing). Each bearing is selected by subtracting the crankshaft journal number from the crankcase housing number, and referring to the following selection table.

Housing No.	Journal No.	Shell No.
3	1	1 (Blue)
4	2	2 (Black)
5	—	3 (Brown)
—	—	4 (Green)

The identification numbers for the crankcase and journals are found on the crankcase upper half and the crankshaft webs respectively as shown in the accompanying illustrations. In practice, provided that the correct numbers are quoted, the supplier of the replacement bearings will be in a position to make the correct selection.

3. Wear is usually evident in the form of scuffing or score marks in the bearing surface. It is not possible to polish these marks out in view of the very soft nature of the bearing surface and the increased clearance that will result. If wear of this nature is detected, the crankshaft must be checked for ovality as described in the following Section.

4. Failure of the big-end bearings is invariably accompanied by a pronounced knock within the crankcase. The knock will become progressively worse and vibration will also be experienced. It is essential that bearing failure is attended to without delay because if the engine is used in this condition there is a risk of breaking a connecting rod or even the crankshaft, causing more extensive damage.

5. Some indication of big-end wear may be deduced by

measuring the side-to-side movement of the connecting rod at the small-end eye. The connecting rod should be moved in line with the crankshaft. A deflection of 0.50 mm (0.019 in) or more indicates the need for bearing renewal. Check the axial float of the connecting rod between the big-end eye and the crankshaft checks, using a feeler gauge. A clearance of more than 0.254 mm (0.0104 in) indicates a worn crankshaft or connecting rod.

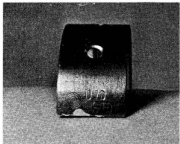
Before the big-end bearings can be examined, the bearing caps must be removed from each connecting rod. Each cap is retained by two high tensile bolts. Before removal, mark each cap in relation to its connecting rod so that it may be replaced correctly. As with the main bearings, wear will be evident as scuffing or scoring and the bearing shells must be replaced as two (2) complete sets.

Replacement big-end bearings are selected in a similar manner to that adopted for main bearing renewal, by referring to the same table. The housing numbers and journal size numbers will be found on the connecting rods and the extreme right-hand web on the crankshaft. Of the two numbers stamped side by side on the web, the first corresponds to the left-hand journal, and the second to the right-hand journal.

6. Both main bearing and big-end bearing shells are colour coded, as stated in the table. Check the colour marks to be doubly sure of the correct selection.



19.3a Check bearing shells for scoring or wear



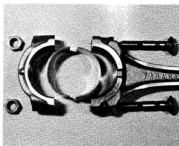
19.3b Main bearing shells are colour marked to aid identification



19.3c Main bearing journal numbers



19.5a Separate the big-end bearing caps from connecting rods



19.5b Big-end/connecting rod assembly: general view

20 Examination and renovation: crankshaft assembly

1 If wear has necessitated the renewal of the big-end and/or main bearing shells, the crankshaft should be checked with a micrometer to verify whether ovality has occurred. If the reading on any one journal varies by more than 0.002 in (0.06 mm) the crankshaft should be renewed.

2 Mount the crankshaft by supporting both ends on V blocks or between centres on a lathe and check the run-out at the centre main bearing surfaces by means of a dial gauge. The run-out will be half that of the gauge reading indicated. The correct run-out as standard is under 0.02 mm (0.0008 in) and if it exceeds this the crankshaft should be renewed.

3 If scoring or flaking of the crankshaft is evident, renewal is the only remedy. Regrinding of the journals is not possible and no oversize bearing shells are available.

4 When refitting the connecting rods and shell bearings, note that under no circumstances should the shells be adjusted with a shim, 'scraped in' or the fit 'corrected' by filing the connecting rod and bearing cap or by applying emery cloth to the bearing surface. Treatment such as this will end in disaster; if the bearing fit is not good, the parts concerned have not been assembled correctly. This advice also applies to the main bearing shells. Use new big-end bolts too – the originals may have stretched and weakened.

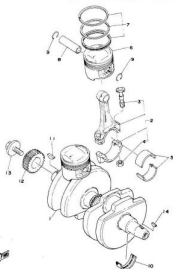
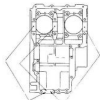
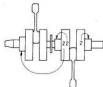


Fig. 1.5 Crankshaft and piston assembly

- | | |
|---------------------------|-------------------------------|
| 1 Crankshaft | 7 Piston ring set – 2 off |
| 2 Connecting rod assembly | 8 Gudgeon pin – 2 off |
| – 2 off | 9 Circlip – 4 off |
| 3 Connecting rod bolt | 10 Main bearing – 6 off |
| – 4 off | 11 Woodruff key |
| 4 Nut – 4 off | 12 Primary drive pinion (24T) |
| 5 Big end bearing shell | 13 Bolt |
| – 4 off | 14 Woodruff key |
| 6 Piston – 2 of | |



Main bearing housing numbers



Main bearing journal numbers



Big-end bearing journal numbers

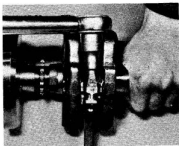
Fig. 1.6 Shell bearing selection number locations

5 Oil the bearing surfaces before reassembly takes place and make sure the tags of the bearing shells are located correctly. Fit each connecting rod and cap so that the two tangs are to the rear of the engine and the mark Yamaha on each rod is facing towards the left-hand side of the engine. After the initial tightening of the connecting rod nuts, check that each connecting rod revolves freely, then tighten to a torque setting of 3.3 – 3.7 kg/m (24 – 27 ft/lb). Check again that the bearing is quite free.

21 Examination and renovation: connecting rods

1 It is unlikely that either of the connecting rods will bend during normal usage, unless an unusual occurrence such as a dropped valve has caused the engine to lock. Carelessness when removing a tight gudgeon pin can also give rise to a similar problem. It is not advisable to straighten a bent connecting rod; renewal is the only satisfactory solution.

2 The small end eye of the connecting rod is unbrashed and it will be necessary to renew the connecting rod if the gudgeon pin becomes a slack fit. Always check that the oil hole in the small end eye is not blocked since if the oil supply is cut off, the bearing surfaces will wear very rapidly.



20.6 Tighten big-end bolts to correct torque

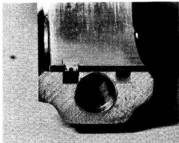
22 Examination and renovation: cylinder block

1 Cylinder bore wear is usually accompanied by excessive oil consumption and blue smoke from the exhaust. On examination of the top of the bores there will be a pronounced ridge at the limit of the travel of the top piston ring if wear has occurred. Do not mistake a ridge for a carbon deposit which can be scraped off.

2 Measure the bore, with an internal micrometer, just below the ridge (or at the limit of travel of the top piston ring) between the front and the rear of the barrel, where most wear occurs. Also measure the bore at the bottom of the cylinder. A comparison of the two results will give the cylinder bore wear.

If no internal micrometer is available, place a piston ring squarely in the top of the bore, below the ridge, and measure the end gap with a feeler gauge. Repeat at the bottom of the bore. Subtract this latter figure from the first and divide by three (more accurately 22/7). This will give the approximate wear. The bottom of the skirt of the piston can be used to position the ring squarely in the bore. Compare the results obtained with the service limits.

3 Check the bores for score marks; any deep damage will necessitate a rebore.



20.4 Ensure that bearing shell tags locate correctly

4 Check that the cooling fins are not clogged with oil and dirt otherwise overheating will occur. The fins can be cleaned by judicious use of a small screwdriver and/or a wire brush.

23 Examination and renovation: pistons and piston rings

1 If a rebore is required, due to the condition of the bores, new oversize pistons and rings will have to be obtained.

2 Remove the carbon from the piston crowns using a soft scraper (an old piece of aluminium bar which has been sharpened for the purpose makes an ideal scraper) and finally finish with metal polish. Emery cloth is not recommended but wire wool and oil can be successfully employed.

3 Wear is usually evident on the thrust side of the pistons and is noticeable as vertical streaks and/or score marks. If the score marks are not severe they may be smoothed out by light filing with a needle or Swiss file.

4 The piston ring grooves may have become enlarged. Check them with a feeler gauge and compare the reading with the service limits.

5 Piston ring wear is difficult to estimate due to the variability in the end gap setting when the engine was last assembled. However, there is a service limit and the rings can be checked by placing them squarely in the bore and measuring the end gap with a feeler gauge. If the gap is greater than the maximum allowed, then renew the rings. However, if the gap is within the prescribed limits it does not positively show that excessive wear has not taken place. Therefore if in doubt or if a high mileage has been covered, renew the piston rings as a precaution.

24 Examination and renovation: cylinder head

1 The cylinder head, which was removed at an earlier stage, now contains only the valves, valve springs and associated components.

2 Remove the carbon from the head with the valves still in position, using the same technique as in the previous Section. It is advisable to put two old spark plugs in the sparking plug holes so that the threads do not become either damaged or blocked.

3 A valve spring compressor is required to remove the valves. On compressing the spring the valve collets can be lifted out and then the pressure released. This will free both the valve, valve spring collar and valve springs. Note where the valves come from so that they can be replaced in their respective seats. The inlet valve has the larger diameter head. Remove and

discard the valve oil seals which are a push fit on the valve guides. The seals should be renewed as a matter of course. The spring lower seat can now be lifted off.

4 Finish cleaning the head and valves and remove any dirt from between the head face, to stop overheating.

5 Check that the valve guides are free from carbon, particularly the exhaust.

6 Visually inspect the valves for wear on the stem and/or the collet area. If excessive wear is evident or in doubt, replace the valves. Measure the valve stem in several places with a micrometer and compare readings with the service limit. If the valve is in good condition except for some deep pits in the seat, the valve can probably be refaced at a garage. Also check that the valve stem is straight by rolling the valve on a flat plate whereby any irregularities will be noticed.

7 Measure the internal diameter of the valve guides and compare readings with the service limits. Renew if necessary. If replacement is required the head should be uniformly heated to 100°C (212°F) in an oven (a kitchen oven) and the old guide drilled out with a correct sized drill. The new guide should then be immediately drilled in whilst the head is still hot. Do not omit the small circlip which is fitted to the guide. On cooling, the guide should be reamed out to the correct size using a copious amount of oil. If the guides have had to be replaced, the valve seats will also need recutting.

8 Inspect the valve seats and if they are deeply pitted, or new guides have been fitted, they will have to be reset at a garage. Both inlet and exhaust valve seats are out to the same angle, see Specifications.

9 If the pitting of either the valves or valve seats is only slight, or if new valves have been fitted, the valves will require grinding in.

10 Valve grinding is basically a simple task – smear a little medium or fine grinding compound (carburettor paste), depending on the amount of pitting, onto the valve seat. Oil the valve guide and place the valve into position. Rotate it backwards and forwards using a suction valve grinding tool. Occasionally the valve should be lifted and replaced in a different position on the valve seat so as to grind in the whole seat evenly. Repeat this operation, using fine grinding paste, if this has not been used previously. Be careful not to get any grinding paste on the valve stem or in the valve guide. The valve is ground in when there is a complete and unbroken ring of light grey matt finish on both the valve and seat. Afterwards, thoroughly wash off the grinding paste to prevent damage that will be caused by its abrasive action. Do not resort to excessive grinding as this will pocket the valve in the seat.

11 Check the valve collets for wear or chipping and renew them if necessary.

12 The valve springs should be checked by measuring their free length and comparing the measurements with the service limits. Also check that the springs are not starting to crack or have worn badly by rubbing against each other. Replace them all if in any doubt.

13 Check that the cylinder head to block gasket face is in good condition and that the head is not warped. To check for warping use engineers blue on a surface plate, or a piece of plate glass. Failing this, check in several places, using a straight edge. Small high spots or slight warpage can be corrected by hand, with a flat oil stone.

26 Examination and renovation: camshaft, camshaft sprockets, chain and tensioner

1 The cam lobes should have a smooth surface, with no indentations. It is unusual to find wear unless a lubrication fault has occurred. If scuffing is apparent but is not serious, it should be stoned out with a carborundum stone and oil. If scuffing on the cam lobes is sufficient to alter the cam shape after stoning has been carried out, then the camshaft will need renewing. Measure the overall height of each cam from the base circle to the tip of the lobe. If the measurement is less than the service

limit on any one cam, the camshaft should be renewed.

2 The camshaft does not have any bearings as such but rotates on the camshaft journals on bearing ways machined into the cylinder head and the camshaft cover. Check the condition of the bearing surfaces. It is unlikely that wear will have taken place on the cylinder head or camshaft cover, unless lubrication failure has occurred.

3 If wear has developed in the bearing surfaces as a whole the cylinder head, camshaft cover and camshaft must be renewed.

4 Check the camshaft sprocket for missing and/or chipped teeth. If side wear is apparent, it is probably due to worn camshaft bearings or incorrect endfloat. The lower sprocket on the crankshaft should also be checked. This component is an integral part of the crankshaft, and as such if wear occurs the crankshaft must be renewed. Fortunately this state of affairs rarely occurs because the crankshaft sprocket operates in ideal conditions.

5 Inspect the camshaft chain for wear, cracked links or missing rollers. An indication of wear is given by bending the chain sideways, across the line of the rollers; if a pronounced curve is formed, the chain is worn and should be renewed. Camshaft chains do not generally wear until considerable service has been seen, as they function in an ideal environment, always correctly lubricated.

6 The chain tensioner blade and the chain guide blade are made of plastic and will wear eventually. Light grooves in the blades can be overlooked, but if heavier wear has taken place, the blade should be renewed. The chain tensioner unit is unlikely to suffer wear or damage. Check that the plunger moves in or out smoothly after depressing the spring load pawl.

28 Examination and renovation: rocker arms and pins and tachometer driveshaft

1 Visually inspect the rocker arms for cracks and check the tips for excessive wear.

2 Check the rocker arm pins for wear and see that there is not an excessive clearance between the pin and arm. If there is too much clearance there will be a general rattle or clatter from inside the cambox. Inspect the tappet adjuster screw heads for hammering or flaking, renewing where necessary. The left-hand rocker pins are retained by rubber plugs which in turn are secured by the contact breaker plate. The right-hand pins are secured by screw plugs. Each pin has an internal thread in the outer end into which may be screwed a suitable bolt, to aid extraction.

3 The tachometer driveshaft is fitted to the camshaft cover where it is driven by a scroll gear integral with the camshaft. The shaft is unlikely to wear unless lubrication failure occurs. To remove the shaft and housing displace the 'E' clip from inside the cover. The housing may then be drilled out, driving out the housing oil seal and spacing washer at the same time. Withdraw the shaft from inside the camshaft cover.

27 Examination and renovation: primary drive gears

1 Check the two primary drive gears for worn or broken teeth. If damage of this type is evident, both items should be renewed as a set, since the wear characteristics of one gear will soon damage a new component with which it is mated. The primary driven gear is supplied only complete with the clutch outer drum to which it is riveted. If the rivets work loose they may be tightened using a ball-poin hammer.

2 On original assembly the gears are fitted selectively to ensure that the back lash in the teeth is correct. When renewing gears, ensure that the correctly sized component is fitted. Each gear is marked with a letter A – F, the replacement components should bear the same identification mark as the original part. Failure to match the parts correctly will lead to increased gear noise and accelerated wear.

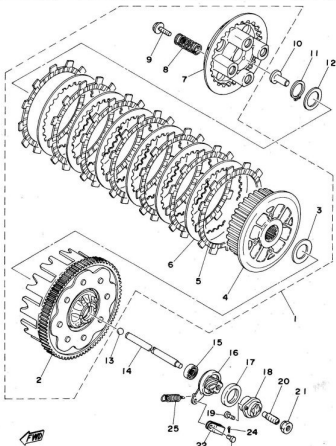


Fig. 1.7 Clutch assembly

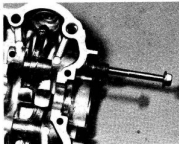
- 1 Clutch assembly
- 2 Primary driven gear and clutch outer drum
- 3 Thrust washer
- 4 Clutch centre boss
- 5 Friction plate - 7 off
- 6 Clutch plate - 6 off
- 7 Pressure plate
- 8 Compression spring - 4 off

- 9 Clutch spring screw - 4 off
- 10 Clutch pushrod 'mushroom'
- 11 Circlip
- 12 Shim
- 13 Ball bearing $1\frac{1}{8}$ inch
- 14 Pushrod
- 15 Pushrod seal
- 16 Clutch actuating quick-screw
- 17 Dust seal

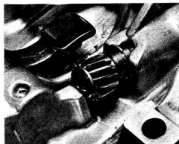
- 18 Actuating mechanism housing
- 19 Screw - 2 off
- 20 Adjusting screw
- 21 Nut
- 22 Cable anchor
- 23 Clevis pin
- 24 Split pin
- 25 Return spring



26.2a Left-hand rocker pins are held by rubber plugs



26.2b Use casing bolt to withdraw each pin



26.3 Displace 'E' clip to allow removal of shaft

28 Examination and renovation: clutch assembly

1 After an extended period of service the clutch linings will wear and promote clutch slip. The limit of wear measured across each inserted plate and the standard measurement is as follows:

Clutch plate thickness

Standard	Service limit
3 mm (0.12 in)	2.7 mm (0.11 in)

When the overall width reaches the limit, the inserted plates must be renewed, preferably as a complete set.

2 The plain plates should not show any excess heating (bluing). Check the warpage of each plate using plate glass or surface plate and a feeler gauge. The maximum allowable warpage is 0.05 mm (0.002 in).

3 Check the condition of the steel spring rings which lie between the clutch plates. Replace any that are bent or broken.

4 Check the free length of each clutch spring with a vernier gauge. After considerable use the springs will take a permanent set thereby reducing the pressure applied to the clutch plates. The correct measurements are as follows:

Clutch springs

Standard	Service limit
34.6 mm (1.362 in)	33.6 mm (1.323 in)

5 Examine the clutch assembly for burns or indentation on the edges of the protruding tongues of the inserted plates and/or slots worn in the edges of the outer drum with which they engage. Similar wear can occur between the inner tongues of the plain clutch plates and the slots in the clutch inner drum. Wear of this nature will cause clutch drag and slow disengagement during gear changes, since the plates will become trapped and will not free fully when the clutch is withdrawn. A small amount of wear can be corrected by dressing with a fine file; more extensive wear will necessitate renewal of the worn parts.

6 The clutch release mechanism attached to the final drive sprocket cover does not normally require attention provided it is greased at regular intervals. It is held to the cover by two crosshead screws and operates on the worm and quick start thread principle.

29 Examination and renovation: gearbox components

1 Examine each of the gear pinions to ensure that there are no chipped or broken teeth and that the dogs on the end of the pinions are not rounded. Gear pinions with any of these defects must be renewed; there is no satisfactory method of reclaiming them. Dismantling the two gearshaft assemblies is quite straightforward, requiring the removal of the thrust washers and locating washers to free each pinion in sequence. If necessary, make sketches to facilitate correct reassembly.

2 The gearbox bearings must be free from play and show no signs of roughness when they are rotated. After thorough washing in petrol the bearings should be examined for roughness and play. Also check for pitting on the roller tracks.

3 It is advisable to renew the gearbox oil seals irrespective of their condition. Should a re-used oil seal fail at a late date, a considerable amount of work is involved to gain access to renew it.

4 Check the gear selector rods for straightness by rolling them on a sheet of plate glass. A bent rod will cause difficulty in

selecting gears and will make the gear change particularly heavy.

5 The selector forks should be examined closely, to ensure that they are not bent or badly worn. The case hardened pins which engage with the cam channels are easily renewable if they are worn. Under normal conditions, the gear selector mechanism is unlikely to wear quickly, unless the gearbox oil level has been allowed to become low.

6 The tracks in the selector drum, with which the selector forks engage, should not show any undue signs of wear unless neglect has led to under-lubrication of the gearbox. Check the tension of the gearchange pawl, gearchange arm and drum stopper arm springs. Weakness in the springs will lead to imprecise gear selection. Check the condition of the gear stopper arm roller and the pins in the change drum and with which it engages. It is unlikely that wear will take place here except after considerable mileage.

30 Examination and replacement: kickstart shaft assembly

1 Check the condition of the kickstart components. If slipping has been encountered, a worn ratchet and pawl may be traced as the cause.

2 The same symptom may be a result of the clip being either too tight or too loose on the pinion boss. The condition of the clip may be checked by attaching a spring balance to the clip projection and reading off the force needed to promote slip. A reading of 0.8 – 1.3 kg (1.8 – 2.9 lbs) indicates that the clip is in good condition.

3 Any other damage or wear to the components will be self-evident. If either the ratchet or pawl is found to be faulty, both components must be renewed as a pair. Examine the kickstart return spring, which should be renewed if there is any doubt about its condition.

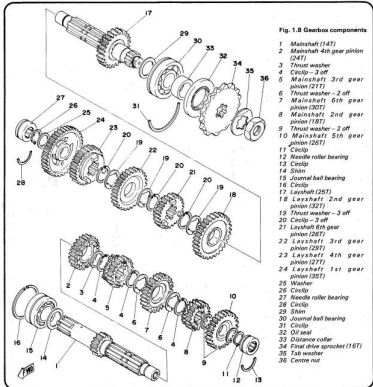
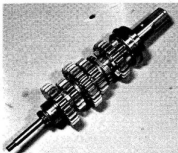
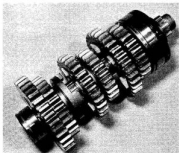


Fig. 1.8 Gearbox components

- 1 Mainshaft (14T)
- 2 Mainshaft 4th gear pinion (24T)
- 3 Thrust washer
- 4 Circlip – 3 off
- 5 Mainshaft 3rd gear pinion (21T)
- 6 Thrust washer – 2 off
- 7 Mainshaft 6th gear pinion (30T)
- 8 Mainshaft 2nd gear pinion (18T)
- 9 Thrust washer – 2 off
- 10 Mainshaft 5th gear pinion (26T)
- 11 Circlip
- 12 Needle roller bearing
- 13 Circlip
- 14 Shim
- 15 Journal ball bearing
- 16 Circlip
- 17 Layshaft (25T)
- 18 Layshaft 2nd gear pinion (32T)
- 19 Thrust washer – 3 off
- 20 Circlip – 3 off
- 21 Layshaft 6th gear pinion (26T)
- 22 Layshaft 3rd gear pinion (29T)
- 23 Layshaft 4th gear pinion (27T)
- 24 Layshaft 1st gear pinion (27T)
- 25 Washer
- 26 Circlip
- 27 Needle roller bearing
- 28 Circlip
- 29 Shim
- 30 Journal ball bearing
- 31 Circlip
- 32 OX seal
- 33 Distance collar
- 34 Final drive sprocket (16T)
- 35 Tab washer
- 36 Centre nut



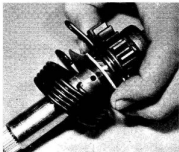
29.1a Assembled mainshaft - general view



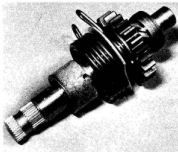
29.1b Assembled layshaft - general view



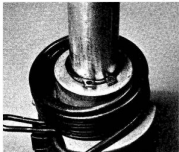
30.1a Check the condition of the kickstart clip



30.1b Insert spring inner turned end into shaft hole and ...



30.1c ... slide in guide to engage turned end



30.1d Secure by means of the circlip

31 Engine/gearbox reassembly: general

1 Before reassembly of the engine/gear unit is commenced, the various component parts should be cleaned thoroughly and placed on a sheet of clean paper, close to the working area.

2 Make sure all traces of old gaskets have been removed and that the mating surfaces are clean and undamaged. One of the best ways to remove old gasket cement is to apply a rag soaked in methylated spirit. This acts as a solvent and will ensure that the cement is removed without resort to scraping and the consequent risk of damage.

3 Gather together all the necessary tools and have available an oil can filled with clean engine oil. Make sure all new gaskets and oil seals are to hand, also all the replacement parts required. Nothing is more frustrating than having to stop in the middle of a reassembly sequence because a vital gasket or replacement has been overlooked.

4 Make sure that the reassembly area is clean and that there is adequate working space. Refer to the torque and clearance settings wherever they are given. Many of the smaller bolts are easily sheared if over-tightened. Always use the correct size screwdriver bit for the crosshead screws and never an ordinary screwdriver or punch. If the existing screws show evidence of maltreatment in the past, it is advisable to renew them as a complete set.

32 Engine/gearbox reassembly: replacing the gear selector mechanism

1 Insert the gearchange drum through the aperture in the gearbox wall so that the drum projects into the gearbox. Replace the drive peg in the end of the change drum and then fit the drum stopper plate so that it locates with the peg. Secure the plate by means of the circlip. The circlip must be fitted so that the two eye ends are positioned as shown in the accompanying photograph. In any other position the circlip will foul the detent plunger. Lubricate the drum bearing surfaces and

then slide the unit into place in the gearbox left-hand wall.

2 Insert the crankcase lower half and refit the detent plunger, spring and housing bolt so that the plunger locates with the change drum. Check the bolt sealing washer before refitting. Rotate the change drum so that it is in the neutral position. This can be found by turning the change drum fully anti-clockwise and then one position back.

3 Place the crankcase lower half upright on the workbench. Insert the longer of the two selector fork rods into the gearbox wall forward of the change drum. Position the two selector forks and push the rod fully home. The forks should be placed as shown in the accompanying photograph, with the left-hand one locating with the left-hand cam track and the right-hand one locating with the extreme right-hand cam track. Fit the rear selector forks in a similar manner, noting that the left-hand fork should locate with centre cam track. Fit the retaining 'E' clip to the rear selector fork rod grooves adjacent to the gearbox left-hand wall and then fit the blind grommets to the rod ends.

33 Engine/gearbox reassembly: replacing the gearshaft assemblies

1 Before being fitted into the crankcase, the two gearshafts must be reassembled complete with the various pinions, washers, circlips and bearings. Assemble each shaft by referring to the relevant illustrations, ensuring that all components are fitted in the correct sequence. Even one misplaced washer or circlip may lead to incorrect gear selection and the need for considerable dismantling at a later stage.

2 Fit the two small and one large bearing locating half clips into the bearing recesses in the casing. Lower the mainshaft into position, followed by the layshaft, which should have the left-hand oil seal and collar in place on the shaft. Ensure that the bearings enter the locating clips and that the selector forks engage with the channels in the gear pinions.

3 Place the pushrod oil seal in the recess to the left of the mainshaft end.

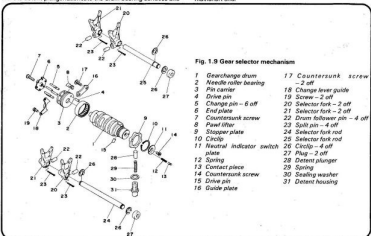
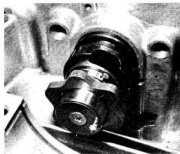
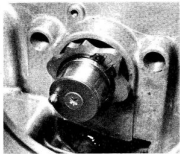


Fig. 1.9 Gear selector mechanism

- | | |
|-----------------------------|------------------------------|
| 1 Gearchange drum | 17 Countersunk screw |
| 2 Needle roller bearing | 18 Change lever guide |
| 3 Pin carrier | 19 Screw - 2 off |
| 4 Drive pin | 20 Selector fork - 2 off |
| 5 Change pin - 6 off | 21 Selector fork - 2 off |
| 6 End plate | 22 Drum follower pin - 4 off |
| 7 Countersunk screw | 23 Split pin - 4 off |
| 8 Pawl lifter | 24 Selector fork rod |
| 9 Stopper plate | 25 Selector fork rod |
| 10 Circlip | 26 Circlip - 4 off |
| 11 Neutral indicator switch | 27 Plug - 2 off |
| 12 Spring | 28 Detent plunger |
| 13 Contact piece | 29 Spring |
| 14 Countersunk screw | 30 Sealing washer |
| 15 Drive pin | 31 Detent housing |
| 16 Guide plate | |



32.1a Insert change drum and locate stopper plate with peg



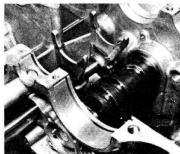
32.1b Circlip must be positioned, as shown



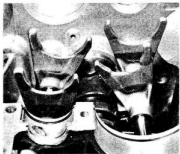
32.2 Replace the desert housing bolt, plunger and spring



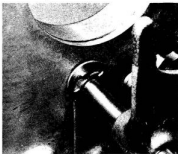
32.3a Fit the guide pins to the selector forks



32.3b Locate the forward selector forks and insert the rod



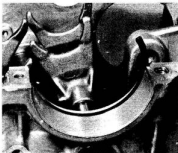
32.3c Fit the near selector forks and ...



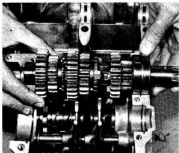
32.3d ... secure the rod by means of the 'E' clip



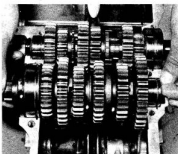
32.3e Drift both rod blind grommets into place



33.2a Slide the gearbox bearing half clips into position



33.2b Fit completed mainshaft and then replace ...



33.2c ... the completed layshaft with left-hand seal in position



33.3 Install the clutch pushrod seal in end of the mainshaft

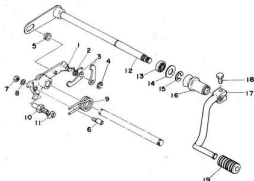


Fig. 1.10 Gearchange mechanism

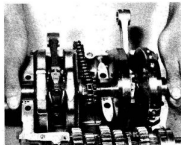
- 1 Gear selector arm
- 2 Pawl spring
- 3 Gearchange pawl - 2 off
- 4 Circlip
- 5 Gear selector arm roller
- 6 Centraliser screw
- 7 Nut
- 8 Spring washer
- 9 Return spring
- 10 Stop
- 11 Lock washer
- 12 Gearchange shaft
- 13 Oil seal
- 14 Washer
- 15 Circlip
- 16 Sealing rubber
- 17 Gearchange lever
- 18 Pinch bolt
- 19 Rubber

34 Engine/gearbox reassembly: replacing the crankshaft

- 1 Replace the oil baffle plates in the crankcase, depressing them firmly to enable the transverse retaining rod to be fitted.
- 2 Clean the main bearing housings thoroughly and then refit the new main bearing shells into the two crankcase halves. The locating tags must engage with the relieved portion of each housing and the ends of each shell should be flush with the crankcase mating surface.
- 3 Fit the cam chain onto the crankshaft central sprocket and then lubricate the main bearing journals. Lift the crankshaft up into position in the casing. Check that the main bearing shells have not been displaced.

35 Engine/gearbox reassembly: joining the crankcase halves

- 1 Ensure that both mating surfaces of the crankcase halves are clean and smear them with a light coating of gasket cement. Check again that the bearing shells are located correctly.

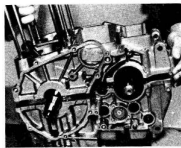


34.3 Lift crankshaft and camchain into position in crankcase

- 2 Fit the upper crankcase half into position on the lower half so that it locates with the dowel pins and gently tap it down with the flat of the hand. Check that the mating surfaces have contacted all round the cases. If any difficulty is encountered in fitting the two cases together, do not use force. Remove the lower half, check the components for correct positioning and then repeat the fitting operation.
- 3 Refit the bolts into the crankcase upper half, bearing in mind that the rear bolt behind and to the right of the breather chamber also retains the main earth lead. Do not omit the clips which secure the alternator leads. Tighten the bolts only by hand at this stage. Invert the crankcase and fit the lower bolts. Tighten all the bolts evenly, a little at a time, in the sequence given in the accompanying illustration. The final torque settings are as follows:

8 mm bolts	2.0 - 2.4 kg m (15 ft lb)
6 mm bolts	0.8 - 1.2 kg m (6 ft lb)

- During tightening, check that the crankshaft and engine shafts revolve freely.



35.2 Lower upper casing into place over gears and crankshaft

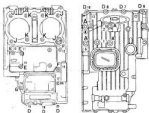


Fig. 1.11 Crankcase bolt tightening sequence

36 Engine/gearbox reassembly: replacing the gearchange mechanism

- 1 Fit the change drum guide plate and selector arm guide plate into the primary chaincase, tightening the screws fully. Fit the centraliser spring onto the selector arm boss as shown in the accompanying photograph. Fit the selector arm into the casing, simultaneously holding apart the two change pawls so that they clear the end of the change drum. When released, the pawls should locate with the change pins. Secure the selector arm by means of the 'E' clip.
- 2 Place the shouldered pivot bush onto the stub projecting from the selector arm so that the smaller diameter is outwards. Lubricate the splined end of the gearchange shaft and then insert it into position in the casing, pushing it fully home so that the elongated hole in the shaft arm engages with the shouldered pivot bolt. From the opposite side of the engine, fit the thrust washer and 'E' clip which secure the gearchange shaft.
- 3 Before continuing with assembly, temporarily replace the gear change lever and attempt to select each gear in turn. Rotating the two gearshafts will aid selection. If difficulty is encountered in selection and no obvious cause is evident, the crankcase halves must be separated and the fault traced. Incorrect assembly of gear clusters or selector forks should be looked for. Sluggish gear selection may be caused by incorrect centralisation of the gear selector arm, which should be checked in any case as a matter of course.
- 4 Place the engine in first gear and check that the distance between each of the two selector pawls and its adjacent change pin is equal. See the accompanying illustration. If the distances are unequal, slacken the locknut on the adjuster screw in the selector arm and rotate the screw as necessary, to equalise the pawls. Tighten the locknut without allowing the screw to turn. Carry out this check in each gear, if necessary making further adjustment. It may be necessary to make a compromise in adjustment if any components are worn.

37 Engine/gearbox reassembly: replacing the primary drive gear, clutch and kickstart shaft

- 1 Fit the Woodruff key into the right-hand end of the crankshaft so that the top face is parallel with the shaft. Slide the primary drive pinion onto the shaft so that the internal keyway engages with the key. The pinion must be fitted with the raised boss facing outwards. Replace the centre bolt and washer with the convex face of the washer away from the pinion. Use a close fitting bar through one small-end eye to lock the crankshaft and tighten the bolt to 4.0–4.5 kg m (29–33 lb ft).

- 2 Place the clutch outer drum over the clutch shaft (mainshaft) after lubricating the bearing surface. Grease the clutch pushrod and insert it into the hollow shaft with the shouldered end towards the left-hand side. Similarly fit the steel ball and the clutch operating thrust piece.
- 3 Install the clutch centre backing washer over the clutch shaft and then fit the centre boss, securing it by means of the large washer and circlip. Check that the circlip is located securely in the groove. Replace the clutch plates, commencing with a friction plate followed by a plain plate. Continue fitting the plates alternately and then replace the clutch pressure plate, springs and bolts. Note that the pressure plate is marked with a single arrow at the periphery. This arrow should be aligned with a similar mark on the outer raised face of the centre boss. Tighten the clutch bolts fully.
- 4 If the kickstart shaft assembly was dismantled for inspection or attention it should now be reassembled, prior to installation in the casing. Refer to the appropriate line drawing for the correct assembly sequence. Insert the completed unit into the casing, ensuring that the clip projection enters the guideway in the lower edge of the casing. Grip the outer turned end of the kickstart return spring with a stout pair of pliers and tension the spring in a clockwise direction through approximately one full turn, until the hook end can be anchored on the pillar projecting from the casing wall.
- 5 Temporarily refit the kickstart lever and check that the starting mechanism functions correctly.

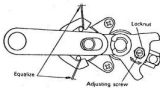
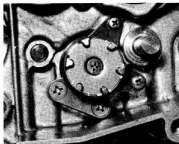
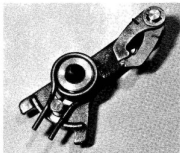


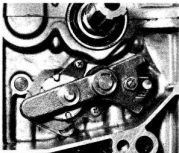
Fig. 1.12 Centralising the gearchange pawls



36.1a Install the drum, guide plate and selector arm guide



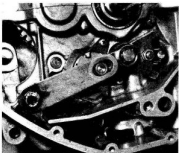
36.1b Main centraliser spring must be fitted as shown



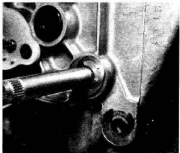
36.1c Replace the 'E' clip to retain the change arm



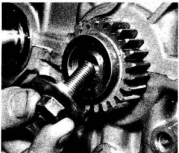
36.2a Place the pivot bush on the change arm stub and



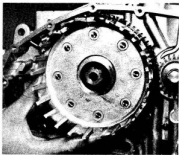
36.2b slide the gearchange shaft into place locating with the bush



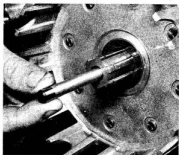
36.2c Secure the gearchange shaft with the washer and 'E' clip



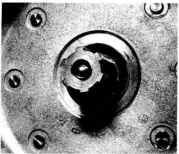
37.1 Install the primary drive pinion with the boss outermost



37.2a Fit the clutch drum and thrust washer onto the shaft



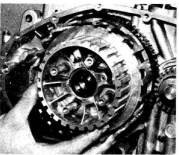
37.2b Insert the clutch pushrod and ...



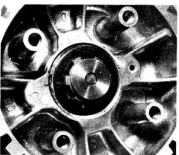
37.2c ... the single steel ball, followed by ...



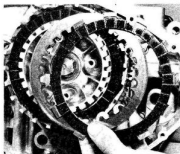
37.2d ... the clutch thrust piece



37.3a Replace the clutch centre boss and ...



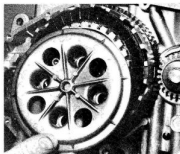
37.3b ... the heavy plate washer



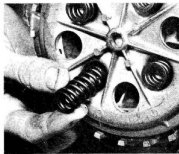
37.3c Ensure that the circlip is correctly seated in the groove



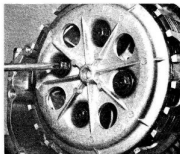
37.3d Install the clutch plates alternately and ...



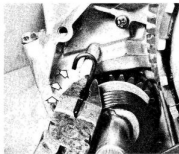
37.3e ... fit the clutch pressure plate



37.3f Replace the clutch springs and ...



37.3g ... the bolts which should be tightened fully



37.4 Tension kickstart spring in clockwise direction

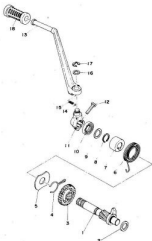


Fig. 1.13 Kickstart mechanism

- | | |
|--------------------------|-------------------------------|
| 1 Kickstart shaft | 10 Oil seal |
| 2 Shim | 11 Splined boss |
| 3 Kickstart pinion (23T) | 12 Pinch bolt |
| 4 Pinion clip | 13 Kickstart crank |
| 5 Spring cover | 14 Ball ($\frac{1}{8}$ inch) |
| 6 Return spring | 15 Compression spring |
| 7 Spring guide | 16 Washer |
| 8 Circlip | 17 E-clip |
| 9 Washer | 18 Pedal rubber |

38 Engine/gearbox reassembly: replacing the oil pump, primary drive cover and the oil strainer screen

1 The oil pump should be refitted as a completed unit, together with the oil pump idler gear. Check that the single dowel is in position in the rear part of the casing and place the oil pump in position. Insert the three socket bolts, tightening them until it is just possible to move the pump up and down slightly in a vertical direction. The oil pump is fitted with a single dowel only, so that its position may be altered and the backlash between the pump idler pinion and the primary drive pinion can be adjusted. To make the adjustment, select a 0.4 mm (0.015 in) feeler gauge and slide it between the driven sides of the central meshed teeth of the two pinions. The position of the feeler gauge will be just to the right of an imaginary line drawn between the centres of the two pinions. Push the oil pump forward bracket arm upwards so that the feeler gauge is gripped lightly and then tighten the forward socket bolt. Tighten the remaining two bolts and recheck the backlash.

2 Lubricate liberally with engine oil the components within the primary drive chamber and fit a new gasket over the locating dowels. Grease the lip of the kickstart shaft oil seal and check that the kickstart shaft thrust washer is in place. Fit the primary drive cover and tighten the screws evenly, in a diagonal sequence.

3 Tilt the engine forwards so that access can be made to the

crankcase base. Install the oil strainer screen and fit the cover, together with a new gasket. The cover should be fitted with the arrow mark pointing forwards.

39 Engine/gearbox reassembly: replacing the alternator and stator motor

1 Lubricate the starter clutch driven sprocket bush and slide the sprocket onto the left-hand end of the crankshaft. Fit the sprocket and replace the retention torque which is held by a single bolt. The torque should be fitted with the turned upper end abutting against the flat milled on the casing boss.

2 Replace the small Woodruff key in the tapered shaft and install the alternator rotor so that the internal keyway engages with the key. In order to allow the starter driven sprocket boss to enter the starter clutch rollers, rotate the sprocket clockwise as the rotor is being pushed home. Fit the alternator bolt, tightening it to 3.0–3.5 kg m (22–25 lb ft).

3 Loop the starter chain around the sprocket and mesh the starter motor sprocket towards the rear of the casing. The sprocket should be fitted with the tapered boss outwards. If the starter motor lead was disconnected from the motor, it must be refitted now, before installation of the starter motor itself. Lightly grease the starter motor boss 'O' ring and insert the unit into the casing. Locate the sprocket on the splined motor shaft and push the motor fully home. Insert and tighten the two retaining bolts. Push the wiring lead and grommet into the rebate in the side of the casing and fit the starter motor cover.

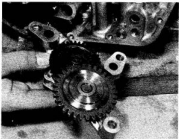
4 Place a new gasket on the alternator cover locating dowels and fit the cover, complete with the alternator stator. Fit and tighten the retaining screws.

40 Engine/gearbox reassembly: replacing the neutral indicator switch and oil pressure warning switch

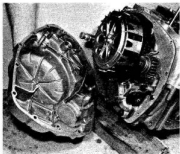
1 Check the condition of the 'O' ring on the neutral indicator switch and then fit the switch into the casing. The switch should be positioned with the terminal screw towards the rear of the engine.

2 Apply a small quantity of sealing compound to the tapered threads of the oil pressure switch. Insert and tighten the switch. Do not overtighten or the switch may shear off. Reconnect the wires to the two switches, by means of the small screws.

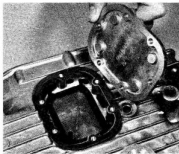
3 Track the two alternator leads down behind the neutral indicator switch and through the recess in the bottom edge of the casing. Secure the cables by means of the two cable clamps.



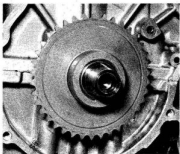
38.1 Install the oil pump complete with idler gear and dowel



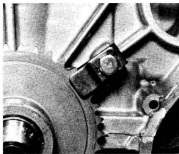
38.2 Use a new gasket at the primary drive cover



38.3 Reft the oil strainer, gasket and cover



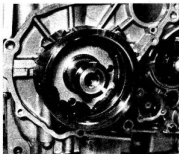
39.1a Install the sprocket after lubricating the bush



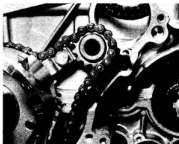
39.1b Secure the sprocket by means of the guide



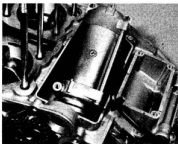
39.2a Fit the Woodruff key in the crankshaft and ...



39.2b ... slide the alternator rotor into position



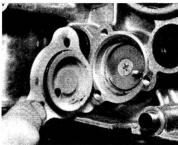
39.3a Fit the starter sprocket with the tapered boss outwards



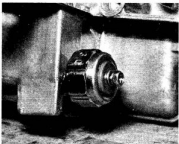
39.3b Install the starter motor together with the cable



39.3c Fit the alternator cover, using a new gasket



40.1 Do not omit the 'O' ring on the neutral switch



40.2 DO NOT overtighten the oil pressure switch

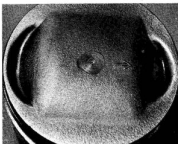
41 Engine/gearbox reassembly: refitting the pistons and cylinder block

1. Place the engine in the normal upright position so that it rests securely on the workbench.
2. Place clean rags in the crankcase mouths, around the connecting rods to prevent any small components, such as circlips, from falling down into the crankcase.
3. Carefully fit the rings on to each piston. The oil ring should be fitted from the skirt of the piston and the second compression ring fitted over the crown. Make certain that the compression rings are fitted the correct way up with the stamped side facing upwards.
4. Fit each piston on to its respective small end after thoroughly lubricating the gudgeon pin with clean engine oil. Make certain that the correct piston is fitted to the respective connecting rod and that it is the proper way round, i.e. with the arrow on the crown pointing forwards. If the gudgeon pin is a tight fit in the piston bosses, pre-heat the piston in boiling water; do not force the gudgeon pin into place. Ensure that the piston is absolutely dry before fitting. Replace the circlips making sure that they seat correctly in their retaining grooves.

Warning: Never re-use old circlips since they are likely to be stretched or weakened. A loose circlip will cause extensive damage to the cylinder bore and piston. Arrange the ring gaps so that they are at about 120° to each other.

5 Turn the crankshaft until both pistons are at equal height. Place a new cylinder base gasket over the holding down studs. Gasket cement should not be necessary. Fit the two forward locating dowels and the large dowel on the rear right-hand cylinder holding stud around which is fitted an 'O' ring. Check that the large 'O' rings are correctly positioned on the cylinder sleeves, where they leave the cylinder block, and liberally lubricate the cylinder bores with engine oil. Hook the camshaft chain up and secure it with a screwdriver or wire. Check it is still engaged with the crankshaft sprocket.

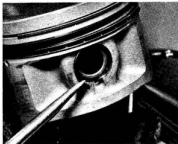
6 Position the cylinder block over the holding down studs and slide it down until the pistons begin to enter the cylinder bores. Piston ring clamps should not be required as the cylinder sleeves have a generous lead in, but care should be taken that the ring ends do not become dislodged from the ring grooves. Hook the camshaft chain up through the tunnel between the cylinder bores and place a screwdriver through the chain, at the top. Remove the rag padding from the crankcase mouths and slide the cylinder block fully home.



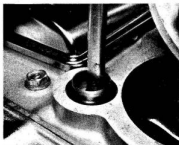
41.4a Piston must be fitted with arrow pointing forwards



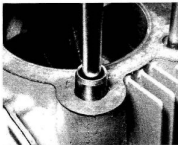
41.4b Insert gudgeon pin and fit ...



41.4c ... the circlips, ensuring that they seat correctly



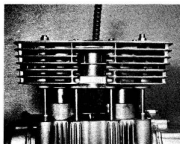
41.5a Fit the large dowel and the seal and ...



41.5b ... install a new base gasket and the two dowels



41.5c Check that cylinder 'O' rings are correctly positioned



41.6 Draw chain up through cylinder block

42 Engine/gearbox reassembly: replacing the cylinder head

1 Before the cylinder head is refitted, the valves and associated components must be replaced. Reassemble the valve and valve springs by reversing the dismantling procedure. Fit new oil seals to each valve guide and oil both the valve stem and the valve guide, prior to reassembly. Take special care to ensure the valve guide oil seal is not damaged when the valve is inserted. As final check after assembly, give the end of each valve stem a light tap with a hammer, to make sure the split collars have located correctly. The valve springs are more closely wound at one end than the other. The springs must be fitted with the close wound pitch towards the cylinder head.

2 Fit a new cylinder head gasket to the top of the cylinder block; no gasket cement is required. Replace the two front dowels and the right-hand rear dowel and rubber seal.

3 Loosely fit a length of wire around the camshaft chain and remove the screwdriver or rod. Position the cylinder head so that the wire can be run through the chain tunnel and slide the head down over the holding down studs. Place a screwdriver through the chain.

4 Replace the thick washers over the holding down studs and fit the dome nuts and also the two flange bolts either side of the plug holes. The cylinder head holding down nuts and bolts must be tightened down very evenly, otherwise there is considerable danger of distorting the large aluminium casting. Tighten the head bolts and the two bolts in the sequence given in the accompanying illustration. The torque figures are as follows:

10 mm bolts	3.0 – 3.5 kg m (21.7 – 24.6 lb ft)
6 mm bolts	0.8 – 1.2 kg m (5.2 – 8.0 lb ft)

43 Engine/gearbox reassembly: replacing the camshaft and tensioner and timing the valves

1 Apply a spanner to the alternator rotor centre bolt and turn the engine in a forward direction until the LT mark on the rotor aligns with the index mark on the alternator cover. The cam chain must be hand fed to prevent it bunching or jamming on the lower sprocket. The left-hand piston is now at TDC, the datum position from which valve timing is made.

2 Position the camshaft sprocket to the right of the cam chain so that the two marked lines on the sprocket face are to the left-hand side. Insert the camshaft from the left, through the sprocket and chain. The sprocket has a slightly raised face around both bolt holes, of which one has a small raised pin on the outer edge. Mesh the sprocket with the chain so that the

bolt hole pin points vertically from the engine and so that the two lines marked on the sprocket face are parallel with the mating surface of the central bearing housing. Push the camshaft fully into position and then rotate it so that the ATU drive pin in the camshaft is at the top. Insert the first sprocket retaining bolt and tighten it slightly. Before proceeding further, check that the LT mark on the alternator rotor is still in line with the mark and that the camshaft and sprocket are still in the prescribed positions. If all is well, rotate the crankshaft to gain access to the second sprocket bolt hole and insert the bolt. Both sprocket retaining bolts should be secured by applying a small amount of locking fluid to the threads. Tighten the bolts evenly, turning the engine to gain access as required.

3 Insert the cam chain guide blade into the front of the chain tunnel, ensuring that it locates at the lower end with the recess in the crankcase. Fit the cam chain tensioner blade in a similar manner. The chain tensioner unit is spring loaded, with a ratchet and pawl arrangement to prevent the plunger from being pushed back up into the body after it has moved down to tension the chain automatically. Before fitting the tensioner, depress the pawl and push the plunger in as far as possible. The plunger should be temporarily secured in this position by screwing a suitable small bolt or screw into the tiny threaded hole provided in the upper end of the tensioner body. Fit the tensioner so that the blade locates with the recessed plunger end and tighten the two bolts. The screw or bolt can now be removed to allow the plunger to move downwards and so tension the chain.

4 Fit and tighten the two spark plugs.

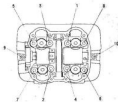


Fig. 1.14 Cylinder head nut & bolt tightening sequence



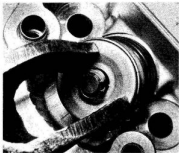
42.1a Fit the spring seat before fitting the new oil seal



42.1b Lubricate the valve stem and guide thoroughly



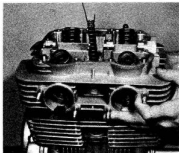
42.1c Install the spring with close wound pitch downward



42.1d Compress the springs to allow cotter replacement



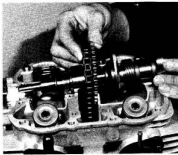
42.2 Fit a new head gasket, the dowels and dowel seal



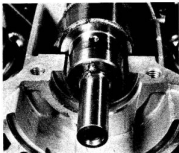
42.3 Hook the cam chain up whilst lowering the cylinder head



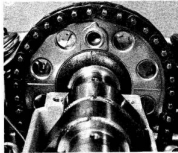
42.4 Do not omit to tighten the two outer head bolts



43.2a Insert the camshaft to locate the chain and sprocket



43.2b Position camshaft with drive pin at 12 o'clock



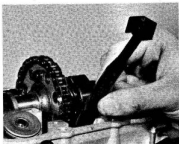
43.2c Mesh sprocket with chain so that bolt hole 'pip' is pointing upwards



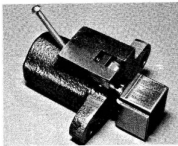
43.2 Insert and tighten sprocket retaining bolts



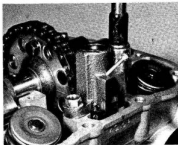
43.3a Refit the chain guide and ...



43.3b ... the tensioner blade



43.3c Compress the tension plunger, securing it with a screw



43.3d Replace the chain tensioner before removing the screw

and does not distort the cover. The correct torque setting is as follows:

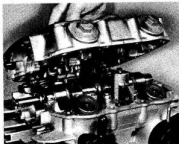
8mm bolts	2.0 – 2.4 kg m (14.5 – 17.0 lb ft)
6 mm bolts	0.8 – 1.2 kg m (6.0 – 8.5 lb ft)

45 Engine/gearbox reassembly: replacing the automatic timing unit and contact breaker assembly

- 1 Fit the automatic timing unit on to the end of the camshaft, locating it with the dowel pin. Insert and tighten the ATU retaining bolt.
- 2 Position the contact breaker base plate, complete with the two contact breaker assemblies, into position over the ATU. Fit the wiring lead grommet into the recess in the edge of the casing and replace the base plate clamping screws finger tight. It, as suggested during dismantling, a line was scribed on the base plate to align with a mark on the casing, the ignition timing will only require checking as described in Chapter 3, Section 5, paragraphs 1 – 2. If the timing is to be carried out from scratch, refer to Chapter 3, Section 5, paragraphs 3 – 5.
- 3 For the purpose of ignition timing the contact breaker cover and the alternator end cover should be left off until after the engine has been installed in the frame.

44 Engine/gearbox reassembly: replacing the camshaft cover and tachometer driveshaft

- 1 If the rocker arms and pins have been removed they must now be replaced, together with the tachometer driveshaft, if this too has been displaced. Lubricate the pins before inserting them, with the threaded ends outwards to enable easy removal at any subsequent overhaul. Check the condition of the sealing washers on the plugs holding the right-hand pins.
- 2 Insert the tachometer driveshaft and housing followed by the plain washers. Carefully drive in the shaft oil seal and then fit the 'E' clip to the housing inside the camshaft cover.
- 3 Apply a non-hardening sealing compound to the mating surfaces of the camshaft cover. Check that the two locating dowels are in position in the cylinder head. Lubricate the camshaft and valve thoroughly and partially fill the cam feed troughs with engine oil. Place the camshaft cover in position and insert the bolt. Note that the two bolts fitted on the extreme left-hand side of the camshaft cover each have a single aluminium washer.
- 4 Tighten the bolts very evenly, in a diagonal sequence, so that the uneven upward pressure from the camshaft is spread



44.3a Use gasket cement at camshaft cover joint



44.3b Note aluminium washers on two left-hand bolts

46 Engine/gearbox reassembly: adjusting the tappet clearance

1 Remove all four tappet inspection caps from the camshaft cover. Rotate the crankshaft anti-clockwise until the LT mark aligns with the timing mark. In this position the left-hand cylinder is at TDC with both valves closed and can therefore be checked for rocker clearance. The correct clearance with the engine cold is as follows:

Inlet valve	0.08 – 0.12 mm (0.003 – 0.005 in)
Exhaust valve	0.16 – 0.20 mm (0.006 – 0.008 in)

Insert a feeler gauge of the correct denomination through the rocker adjustment orifice and between the head of the valve stem and the rocker adjustment screw. If the clearance is correct, the blade of the gauge will be a tight slip fit. To adjust the clearance, loosen the adjuster screw locknut and rotate the screw the required amount until the adjustment is correct. Hold the screw in the set position and tighten the locknut. Recheck the clearance, as it is all too easy to alter the position of the screw when tightening the locknut.

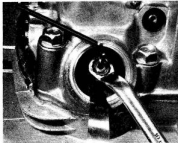
2 When rocker adjustment on the left-hand cylinder has been carried out, rotate the crankshaft 180° anti-clockwise until the right-hand cylinder is at TDC. The RT timing mark on the alternator rotor will now be aligned with the stator timing mark. Repeat rocker adjustment as for the left-hand cylinder.

3 Replace and tighten the four rocker adjustment caps

47 Replacing the engine/gearbox unit in the frame

1 As is the case with removal, engine replacement requires considerable care and patience. Replacing the engine necessitates the use of two people and it is important that the machine is standing firmly on level ground. Lift the engine in from the right-hand side of the machine, with the front of the engine going in first. Tip the engine over to the left and then lift the rear of the engine up and into place.

2 Lift the engine when necessary to stop the bolt threads fouling the brackets and insert the bottom rear engine bolt from the left. Fit the two front bolts, again lifting the engine, if required. Replace the two engine mounting brackets to the rear of the engine, remembering that the stop lamp switch bracket is held by the right-hand bracket lower bolt. Before replacing the nuts on the engine mounting bolts, refit the head steady bracket



46.1 Check tappet clearances using a feeler gauge

which is held to the camshaft cover. The head steady is held to the cover by a single through bolt and to the frame top tube by two bolts. Fit and tighten all the mounting bolt nuts, commencing with the lowest and finishing at the head steady.

3 Track the starter motor lead across behind the engine, from left-to-right, and secure it to the mudguard before reconnection to the starter solenoid upper terminal. Route the two cables from the alternator up forward of the battery box, securing them by means of the clips provided, and reconnecting them at the two block connectors. Reconnect the two contact breaker leads.

4 Rest the air hose unit on the rear of the crankcase, close to the frame down tubes. Position the carburetors to the right-hand side of the machine and reconnect the throttle cable to the pulley wheel between the carburetors. Slide the carburetors into place and then forwards, so they enter the inlet stubs. Ensure that the carburetors are correctly positioned before tightening the screw clips. Manoeuvre the air hose unit upwards so that it may be pushed into place on the carburetor mouths. Replace the air filter boxes and retaining straps and then tighten the four screw clips holding the hose unit. Reconnect the breather pipe at the breather cover.

5 Replace the exhaust system after fitting a new gasket ring into each exhaust port. Tighten the flange nuts evenly and then tighten the silencer/pipe joint clamps.

6 Fit the final drive sprocket to the gearbox splined shaft. Replace the tab washer and the nut, which should be placed with the relieved face towards the sprocket. Loop the final drive chain over the engine sprocket and mesh the two ends onto the rear wheel sprocket. Replace the master link making certain that the spring link is replaced the correct way round. That is with the closed end facing the direction of travel. Apply the rear brake to prevent rotation of the sprocket and then tighten the centre nut fully. Bend up the tab washer to secure the nut.

7 Reconnect the clutch cable with the lifting mechanism in the final drive sprocket cover. Do not omit the cable abutment piece which fits into the top of the case. Check that the lifting mechanism is well lubricated with grease and that the small central steel ball is in place. Fit the gearchange shaft protecting boot and then replace the cover and screws. Refit the gearchange pedal, checking the operating angle before tightening the bolt.

8 Replace both front footrests. A small amount of household detergent applied to the rubber mounting dampers will aid replacement.

9 Reconnect the tachometer drive cable at the cylinder head, securing it with the single cross-head screw.

10 Replace the battery and reconnect it to the electrical system. Ensure that the red lead is connected to the positive (+) terminal and the black lead is connected to the negative(-) terminal. Check also that the breather tube is reconnected and routed so that the tube end is clear of any cycle parts. Vented electrolyte will quickly corrode components with which it comes in contact.

11 Refit the petrol tank and connect the fuel lines. Do not omit the small spring clips.

12 Reconnect the spark plug caps to their respective spark plugs. Give a final visual check to all electrical connections and replace the two side covers. Both are a push fit.

13 Fit a new oil filter element into the filter chamber, after first inserting the oil filter spring and spacer washer. Check the condition of the sealing 'O' ring and then position the chamber against the front of the crankcase. Tighten the oil filter bolt to 1.3 - 1.7 kg m (9.5 - 12.0 lb ft). Replenish the engine with SAE 20W/50 engine oil. It will require 2.6 litres (5.5/4.6 US/imp ptsl). Allow the oil level to settle for a few moments and then check the level by means of the dipstick integral with the filler cap. Do not screw the cap in when checking the level; allow the cap to rest on the casing edge. Kick the engine over smartly with the ignition off, to help prime the oilways.



47.3 Alternator connectors cannot be incorrectly reconnected



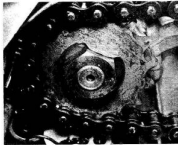
47.5a Fit a new ring gasket to each exhaust port



47.5b Split collars should be fitted as shown



47.6a Replace the sprocket nut with relieved face inwards



47.6b Bend up tab washer to secure the nut



47.7a Check that the steel ball is fitted to the clutch



47.7b ... reconnect the clutch cable

48 Starting and running the rebuilt engine

- 1 Open the petrol tap, close the carburettor chokes and start the engine, using either the kickstart or the electric starter. Raise the chokes as soon as the engine will run evenly and keep it running at a low speed for a few minutes to allow oil pressure to build up and the oil to circulate. If the red oil pressure indicator lamp is not extinguished, stop the engine immediately and investigate the lack of oil pressure.
- 2 The engine may tend to smoke through the exhausts initially, due to the amount of oil used when assembling the various components. The excess of oil should gradually burn away as the engine settles down.
- 3 Check the exterior of the machine for oil leaks or blowing gaskets. Make sure that each gear engages correctly and that all the controls function effectively, particularly the brakes. This is an essential last check before taking the machine on the road.

49 Taking the rebuilt machine on the road

- 1 Any rebuilt machine will need time to settle down, even if

parts have been replaced in their original order. For this reason it is highly advisable to treat the machine gently for the first few miles to ensure oil has circulated throughout the lubrication system and that any new parts fitted have begun to bed down.

- 2 Even greater care is necessary if the engine has been rebored or if a new crankshaft has been fitted. In the case of a rebore, the engine will have to be run-in again, as if the machine were new. This means greater use of the gearbox and a restraining hand on the throttle until at least 500 miles have been covered. There is no point in keeping to any set speed limit; the main requirement is to keep a light loading on the engine and to gradually work up performance until the 500 mile mark is reached. These recommendations can be lessened to an extent when only a new crankshaft is fitted. Experience is the best guide since it is easy to tell when an engine is running freely.
- 3 If at any time a lubrication failure is suspected, stop the engine immediately, and investigate the cause. If an engine is run without oil, even for a short period, irreparable engine damage is inevitable.

- 4 When the engine has cooled down completely after the initial run, recheck the various settings, especially the valve clearances. During the run most of the engine components will have settled into their normal working locations.

50 Fault diagnosis: engine

Symptom	Cause	Remedy
Engine will not start	Defective spark plugs	Remove the plugs and lay on cylinder head. Check whether a good spark occurs when ignition is switched on and engine rotated.
	Dirty or closed contact breaker points	Check condition of points and whether gap is correct.
	Faulty or disconnected condenser	Check whether points arc when separated. Renew condenser if evidence of arcing, or if a weak spark is obtained and the plugs are in good condition.
Engine runs unevenly	Ignition and/or fuel system fault	Check each system independently, as though engine will not start.
	Blowing cylinder head gasket	Leak should be evident from oil leakage where gas escapes.
	Incorrect ignition timing	Check accuracy and if necessary reset.

Lack of power	Fault in fuel system or incorrect ignition timing	See above.
Heavy oil consumption	Cylinder block in need of rebore Damaged oil seals Worn valve guides and/or stems	Check for bore wear, rebore and fit oversize pistons if required. Check engine for oil leaks. Check for wear and renew if necessary.
Excessive mechanical noise	Worn cylinder block (piston slap) Worn camshaft drive chain (rattle) Worn big end bearings (knock) Worn main bearings (rumble)	Rebore and fit oversize pistons. Renew chain. Fit replacement big-end shells. Fit replacement main-bearing shells.
Engine overheats and fades	Lubrication failure	Stop engine and check whether internal parts are receiving oil. Check oil level in crankcase.

51 Fault diagnosis: clutch

Symptom	Cause	Remedy
Engine speed increased as shown by tachometer but machine does not respond	Clutch slip	Check clutch adjustment for free play at handlebar lever. Check thickness of inserted plates.
Difficulty in engaging gears. Gear changes jerky and machine creeps forward when clutch is withdrawn. Difficulty in selecting neutral	Clutch drag	Check clutch adjustment for too much free play. Check clutch drums for indentations in slots and clutch plates for burns on tongues. Dress with file if damage not too great.
Clutch operation stiff	Damaged, trapped or frayed control cable Bent operating pushrod	Check cable and renew if necessary. Make sure cable is lubricated and has no sharp bends. Check the pushrod for trueness.

52 Fault diagnosis: gearbox

Symptom	Cause	Remedy
Difficulty in engaging gears	Selector forks bent Gear clusters not assembled correctly	Renew. Check gear cluster arrangement and position of thrust washers.
Machine jumps out of gear	Worn dogs on ends of gear pinions Stopper arms not seating correctly	Renew worn pinions. Remove right hand crankcase cover and check stopper arm action.
Gearchange lever does not return to original position	Broken return spring	Renew spring.
Kickstart does not return when engine is turned over or started	Broken or poorly tensioned return spring	Renew spring or re-tension
Kickstart slips	Ratchet assembly or kickstart clip worn	Renew worn components.