Royal Enfield Crusader engine rebuild

by Jack Gray

ROYAL ENFIELD'S POST‑WAR RANGE of motorcycles did not include a 250cc model and it was only in 1951 that an engine of this capacity was reintroduced. The Model S was for export only, but in 1954 the 250cc Clipper was launched and both models were then offered for sale on the home market. Their engines were essentially pre‑war in design ‑ a long stroke, low compression ratio and soft valve timing ‑ with performance to match.

However, better things were to come and at the 1956 Earls Court show a completely new design, the Crusader, was announced. The engine was well over‑square with a stroke of 64.5mm and a bore of 70mm (or 2.751”) which it shared with the existing 350cc singles and 700cc twins. Sharper valve timing with wider angle valves and a compression ratio of 7.3:1 produced a brisker performance but, with heavy flywheels and an inlet port of only 7/8” it was not exactly blood‑tingling.

Agents and customers alike demanded something better and in 1959 the factory responded by introducing the Crusader Sports. Lighter flywheels, a compression ratio of 8.3:1, a larger inlet valve and hotter camshaft, with better valve springs and rocker gear ‑ all these factors transformed the engine's performance. To match the increase in speed and power, a 7” front brake was fitted and cosmetic improvements included a large chrome tank, chrome mudguards and rakish exhaust pipe; standard handlebars, inverted, gave the finishing touch to the bike's overall sporting appearance.

The Crusader Sports was an instant success and, over the next seven years, it formed the basis of Enfield's 250cc range. In 1962 the Super Five, probably the first production motorcycle with a five‑speed gearbox, was introduced. It featured a 9:1 compression ratio and 1$^{1}/_{16}$” inlet port, leading‑link forks and an old Enfield favourite, a deeply valanced front mudguard suspended from the sprung section of the forks. Despite the improvement in handling and weather protection, the latter was as unpopular as the wide rear mudguard, and by 1964 the Super Five had been removed from the range. For 1962 the Crusader Sports was fitted with the same rear mudguard, but in the following year this was replaced with the more attractive narrow chrome component.

Again, the factory was quick to respond to public opinion and in 1963 the Continental was added to the range. Fitted with the same power plant as the Super Five, the Continental sported telescopic forks (with speedo and tacho in an aluminium top panel), ace bars, a flyscreen, an Italian‑style humpbacked petrol tank and narrow rear mudguard. The new model found favour and continued, in 1964, with a standard tank in place of the humpback version.

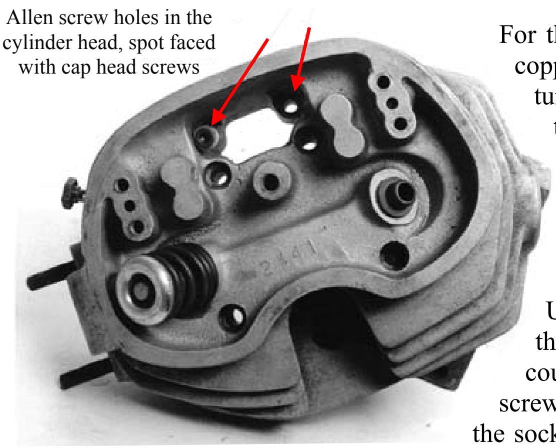
In the early Sixties, the fashion for customising standard models reached new heights and many a cafe racer was created by bolting assorted goodies, like fibreglass tanks, sports exhausts, racing seats and rear sets, onto new machines. Roger Boss, a newly appointed sales manager at Royal Enfield, decided it was high time the factory produced a customised machine of its own. In spite of a good deal of inertia amongst members of the establishment, the Continental GT (probably the first customised machine to be offered as a catalogue model) was launched in 1965.

In parallel with the Sports model, the standard Crusader continued in touring trim and, in 1958, a new 250cc Clipper was added to the range. This was a cheaper model, largely put together with old stock; it had a 6” front brake, a minimum of chrome and was without the quickly detachable rear wheel. The Airflow, a dolphin‑type fairing, was introduced in the same year and was usually fitted to Clipper and Crusader models; later on, Sportsflow and Speedflow versions were offered for use with the sports models.

Throughout the years, a variety of silencers were used. In 1957, a barrel silencer with a tail pipe; from 1958, a cigar‑shaped unit; and, in 1962. a long, three‑part silencer with an alloy fishtail and cap. Unfortunately, the cap had a tendency to fall off; this was because it was fixed by a long rod through the centre of the silencer which quickly corroded in the exhaust gas. In 1964 and 1965, following the link‑up with the group controlling Villiers all Enfield 250s but the GT were fitted with Villiers silencers. These knocked the performance right down and were hastily discarded by sporting riders.

The rocker cover is secured with a single stud and nut; note that the joint face is not machined but cast with a rib in it, presumably to assist location of the cover gasket. If there is constant leakage at the joint, place the cover on a flat surface ‑ if it rocks, lap the joint face on a piece of plate glass with valve grinding paste. On early covers, over tightening of the securing nut could cause cracking; on the later covers, this problem was cured by putting a substantial boss around the hole.

Allen screw holes in the cylinder head, spot faced with cap head screws

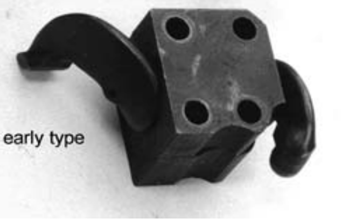


For the first two years of production the cylinder heed was in cast iron with a copper/asbestos gasket to the barrel; oil leaks at the joint around the pushrod tunnel were common. In 1959, an aluminium head was used, with a boss in the pushrod tunnel and a single Allen screw helping to secure the joint. From 1960 to 1961, the aluminium head was redesigned and two Allen screws in the pushrod tunnel and a solid copper gasket effectively cured the oil leak. The Allen screws are ¼”BSF with a countersunk head, and it is best to loosen them before loosening the cylinder‑head nuts.

Using a countersunk head screw was not a good idea; apart from the fact that the edges of the holes suffered frequent damage, the size of the socket in a countersunk screw is only $^{5}/_{32}$” diameter, compared with ⅜” for a cap‑headed screw. The $^{5}/_{32}$” Allen key springs under pressure and often rounds the edges of the socket, so the best approach is to take a ⅜" diameter flat punch and give each screw a hard blow. This has the effect of jarring the threads loose and slightly closing the socket, making the Allen key a tighter fit. If, in spite of this, the key slips in the socket, the screw head will have to be drilled off‑ not as difficult as it sounds ‑using a new $^{17}/_{64}$” bit at a very low speed and preferably in a large hand-drill. To save future trouble, spot face the screw hole and replace with cap-headed screws.

After the screws, there are five head nuts to remove: four under the rocker cover and one by the spark plug hole. You should now be able to lift the head off. The 250 heads do not stick as badly as the Bullets and twins, but a little knock with a piece of wood under the exhaust port and inlet port bosses may be necessary. There are washers in the recesses for the cylinder head nuts, and it is best to remove them now or they may fall out when the head is being worked on.

Rockers - late type



Rockers - early type

The rockers can be dismantled either before or after the head is removed. Engines built before the middle of 1960 have one‑piece rockers working in split bearing blocks, like the Bullets, each block secured with four studs and the rocker cover stud screwed into the cylinder head between them. They wear fairy quickly and the only satisfactory cure is to replace them.

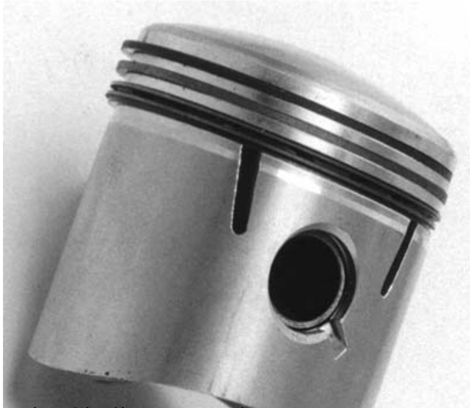
From mid‑1960, the rocker housing was a one‑piece alloy casting fitted with composite rockers and secured by two studs at either end, plus the centre stud for the rocker cover which screws through and helps secure it. The composite rockers, quieter in operation and much longer wearing than the earlier type, have an $^{11}/_{16}$” diameter spindle with the arm at each end located by a flat and secured with a nut and washer.

Composite rocker assembly and housing

The hole in the rocker arm is “D” shaped and wear can occur at this point. Hold the outer rocker arms in contact with the valves and check the position of the inner arms; they should be level. If one is higher than the other, either the metal has worn off the end in contact with the valve or the D‑hole has moved round on the spindle, in which case one or both will have to be renewed. The rocker bearing and rocker cover stud are 26TPI and stripped threads in the alloy head are not uncommon ‑ best rectified with a helicoil The carburettor studs are $^{5}/_{16}$" 26TPI; the holes for the oil-pipe banjo bolts are already helicoiled.

On early engines the valves have tapered collet grooves and hardened steel stem caps; the springs have steel top collars. Instead of stem caps, the valves on the sports engines were given semi‑circular grooves and hardened ends, while the smaller and more efficient springs were equipped with dural top collars. On removal, these collars should be examined for cracks around the spring seat. Sometimes the collet housing wears, causing the collar to rise in relation to the valve end and the rocker arm to foul the collar before bearing on the valve stem.

Cast‑iron heads are fitted with cast iron valve guides, alloy heads with phosphor bronze ones, the exhaust being longer than the inlet, with a bore of $^{11}/_{32}$“ and outside diameter of .627" to .628". Oversize components are available, should the guides work loose in the head. On new valves there is sometimes a burr around the reference number just below the collet groove; this should be removed with fine emery paper, otherwise it may damage the valve guide bore.



Wire Circlips are used to secure pin; piston rings are deep and require careful removal.

Removal of the cylinder barrel is usually quite easy but there is a long spigot at the base and, if it sticks, the two studs securing the crankcase mouth can be slackened. In extreme cases, the 5 cylinder barrel studs can be removed, the crankcase warmed with a blowlamp, and the barrel rotated to break the seal.

Extracting the centre cylinder barrel stud on the generator side makes it easier to remove the gudgeon pin; the latter is secured in the piston by wire circlips with a groove in one side to aid circlip removal. The piston ring dimensions are: compression $^{1}/_{16}$" wide and scraper $^{5}/_{32}$" wide; both have a heavy radial depth of .123" and are difficult to remove. I prefer to peel them off with a knife blade. The ring gap should not be less than .008" The piston crown has valve recesses, the inlet being slightly larger than the exhaust, so check them carefully before fitting.

Unless the crankshaft needs attention, the engine, as well as the gearbox, can be dismantled without being removed from the frame. I will deal with the engine first. Remove the kickstart and footchange pedals, the gear indicator and the five screws fixing the generator cover (the centre screw is 2.1/2" long and doubles as a level screw for the gearbox oil). Remove the stator but not the rotor as it is useful for turning the engine, either by hand on the rotor or by means of a spanner on the securing nut.

Removal of the contact-breaker plate will expose the auto advance which needs a special bolt to extract it (as shown on the left). Check the condition of the black and white wire before removing it together with the three alternator leads from the mufti snap connector. Disconnect the clutch cable and remove the cover and clutch operating lever, held on by two ¼" Allen screws. This will reveal the gearbox mainshaft securing nut, a $^{7}/_{16}$" Whit spanner size and left-hand thread, which is easier to undo at this stage. Remove the oil thrower behind it.

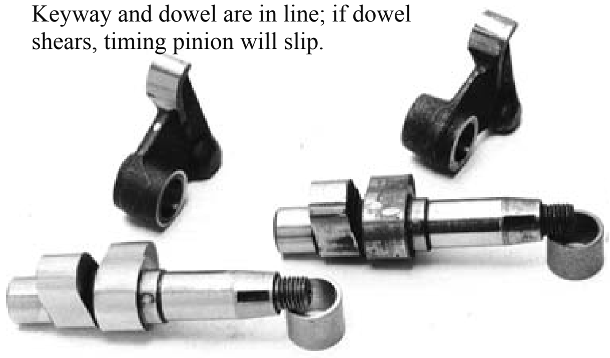
Attention can now be turned to the drive side. Have a drip tray ready when you remove the primary chaincases as it contains about ¼" pint of oil. The cover is held on by ten screws, six of which are 1⅝" long, two ¾" and two 1½"; the latter secure the cover at the rear and if a longer screw is used the end will protrude into the rear chain housing, get burred over by the chain and cause damage to the housing threads when it is removed.

Using the old method of a rod through the small end and block on either side to rest the rod on, the engine and camshaft sprocket nuts can be removed; they have a right-hand thread. The camshaft sprocket is on a taper and an extractor is required for its removal; a special tool is available for withdrawing both the clutch and camshaft. As the timing chain is endless, the two timing sprockets have to be drawn together. Watch out for the key on the camshaft and note that the washer between the timing and engine sprocket has a bevel on one edge to prevent fouling to the timing chain.

The small sprocket has a tongue which engages with a slot at the end of the crankshaft. The tongue is offset so it should only be possible to fit it in one position, but not everybody is aware of this and both the sprocket and the slot should be examined for damage. This is a good time to remove the stud which secures the sprocket and carries the oil into the big end; two $^{7}/_{16}$" BSF nuts locked together should do the trick. Inspect the end where it enters into the oil feed seal in the chaincase: minor scores can be polished off but in cases of more severe damage the stud should be replaced. Remove the oil pump cover, pump disc and plungers, followed by the five nuts which secure the timing cover. The two front nuts are extended to take the short screws securing the primary case. Early models with a two plate clutch were fitted with a narrow chaincase using ¾" long nuts; the chaincase for the later three-plate clutch is wider and secured with 1" long nuts. Using short nuts on the wide chaincase will cause the bosses carrying the front screw to crack. The timing cover should be full of oil, so be prepared when you remove it.

A thrust washer is fitted at each end of the cam followers and a spring washer in the centre, while the camshaft has just one thrust washer next to the crankcase. The three small gears have timing marks but these are best ignored as, with the hunting tooth set-up, one turn of the engine will put the marks out of line. The small gears on the camshaft and contact-breaker spindle have keyways which accommodate dowels on the shafts and, although the contact-breaker seldom gives trouble, the dowel on the camshaft is prone to shear. This is easily checked by seeing that the keyway in the gear is in line with the sprocket key-way on the camshaft; if not, you will know that the dowel is sheared. The engine may run satisfactory for a long while in this condition but the ignition timing may slip at an inconvenient moment (when is a convenient

Cam and followers before and after lapping. Keyway and dowel are in line; if dowel shears, timing pinion will slip.



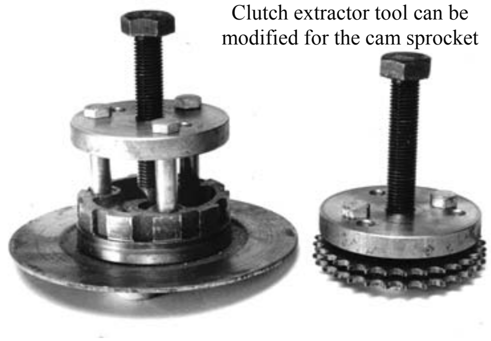
moment?), and it is therefore better to rectify the trouble straight away. Careful work with a drill is required to remove the sheared part, and a new dowel can be made from a piece of 10-gauge spoke.

Check the condition of the cam followers, both for excessive wear in the cups where the bottom of the pushrods fit, and the working faces in contact with the cams. The followers as well as the cams are usually scored and, although it would be nice to say renew them, the followers are becoming scarce and camshafts expensive. So, reclaiming is an option worth looking at. It is fairly simple to reface the followers and most camshafts can have the scores lapped from the cam faces. With the auto advance removed, the CB spindle can be withdrawn. Check the condition of the peg which drives the oil pump - a little wear does no harm but look carefully for signs of cracking.

Remove the three bolts holding the clutch spring retainer and take out all the plates. Up to 1963 the clutch sprockets had a ball-race in the centre and were retained by a circlip: from 1963 on they were fitted with a plain bearing in the centre and the circlip was dispensed with. If the primary chain tensioner is removed, the sprocket can usually be wangled over the centre and slipped out of mesh with the chain. Alternatively, both sprockets can be removed together. The engine. sprocket is on a straight spline and moves easily; there is a heavy distance tube behind it.

Further stripping of the crankcase can only be done with the engine removed from the frame and, in any case, the gearbox has to be dismantled. This can be done either before or after removal. If it has not already been done, this is a good stage at which to drain the oil by removing the two hexagonal plugs below the crankcase on the left-hand side.

Before removing the clutch centre and the back plate, engage a gear, revolve the centre by spinning the rear wheel and observe the back plate. If it wobbles, the clutch will not free completely and should be trued before being refitted. Beat it as true as possible with a hammer and then, when the gearbox mainshaft is removed, set it up in a lathe, fit the clutch centre to it and skim the working face. The clutch centre nut is ½” by 20TPI, a $^{7}/_{16}$" Whit spanner size and right-hand thread. There should be a locking washer behind it which can be freed with a 14mm plug socket spanner.



Clutch extractor tool can be modified for the cam sprocket

The clutch centre is a tapered fit on the shaft, and, if the tapers are in good condition, requires a special tool to remove it. The taper has a Woodruff key, but this is really only for locating the centre while the tapers are being tightened together, and if the tapers become damaged the key will shear. It the damage is slight, the centre can be lapped onto the shafts with fine valve grinding paste. There is, however, a limit to the amount of lapping that can be done, as there is very little clearance between the rear of the back plate and the plate holding the seal behind it.

Behind the clutch is a plate carrying the seal where the gearbox mainshaft enters the chaincase. The nut securing the final drive sprocket has a long spigot which protrudes through the seal, and oil leaks are not uncommon. After this plate is removed, inspect the final drive nut which is secured with a ¼” Whit grub screw. Check that the thread is tight and that there are no grooves on the surface which runs in the oil seal. Before removing the nut, you will probably find it necessary to remove the gearbox mainshaft; this entails working at the other end of the gearbox where we have already removed the cap over the small gearbox bearing and the left-hand nut.

Now remove the nut which anchors the end of the kickstart spring (it should be the top left-hand one) but do not undo the countersunk screw next to it as this secures the kickstart pawl stop-plate. Next comes the footchange mechanism. Later machines have a stop-plate over the pawls at the top with either a figure 4 or 5 stamped on it, depending on the number of gears in the box. It is not unusual for the number on the plate to differ from the number of gears, which should make gear selection difficult to say the least. Remove the coil spring from the squared shaft, then the stop-plate and the short tube on which it pivots.

The splined shaft at the bottom is secured by a nut. With this removed, and provided everything is in good condition, the top and bottom parts can be withdrawn together with the link-rod. If, as often happens, the pawl assembly sticks on the squared shaft, the circlip securing the bottom of the rod can be removed and the splined shaft taken off. If the pawl mechanism still proves difficult it can be left in position until the gearbox cover is removed, when, with the ⅜" bolt screwed into the end of the squared shaft, it can be tapped through the ratchet. Clean off any burrs on the square and make sure the ratchet slides on to aid re-assembly.

Before removing the cover, check the kickstart spindle for end play; this indicates the end float on the layshaft, and if excessive could mean that the flanges on the layshaft bushes are worn. This end float is less critical to gear selection on the four-speed model than on the five-speeders.

To remove the gearbox cover, undo the five nuts and two screws, followed by the spring-loaded locator assembly at the bottom right-hand comer. It should come off fairly easily. Push the mainshaft through the small bearing, as the cover moves. Take a peep behind it when it is about an inch from the case and, in order to prevent the internals from failing out in a heap, insert a lever to hold back the layshaft gears. Once the cover is removed, look for the thrust washer at the kickstart end of the layshaft - it may be on the shaft or inside the kickstart spindle. The mainshaft can now be withdrawn, then the layshaft together with the sliding gears on the mainshaft sleeve.

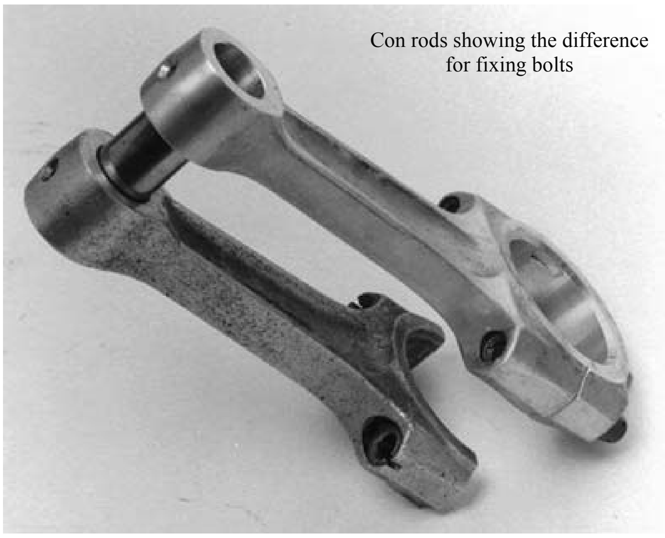
The next stage is to remove the final drive sprocket. After the lock screw has been taken out, the securing nut can be undone but this is a rather awkward spanner size $^{13}/_{16}$" Whit. Which can be extremely hard to locate. A $1^{5}/_{16}$" AF box spanner can usually be persuaded onto it, or better still a 34mm, though neither of these will prove all that easy to buy. Holding the sprocket can be effected either by selecting a gear and operating the rear brake or by blocking the rear wheel, if the engine is still in the frame. If the engine is out, you will need to wrap a length of chain around the sprocket and fasten the ends together at the rear of the tunnels where the chain enters the crankcase.
When the nut is off, check the sprocket for movement on the splines and if this is excessive, inspect the sleeve for wear. The sprocket should be a firm fit on its splines, otherwise every time you open up and shut down, the sprocket will move and gradually niggle the nut loose, possibly shearing the lock screw in the process. If the nut is loose, it will not run true in the clutch back seal and oil will leak from the primary chaincase. The nut has a felt seal inside it to prevent gearbox oil from creeping along the mainshaft.

With the sprocket off, inspect the boss at the rear which runs in the gearbox oil seal, if it is scored, gearbox oil may leak past the seal. The sleeve with bottom gear can now be pushed through the bearing, and the box dismantled ‑ all except for the bearing, oil seal, inside gear operator and pivot pin or pins which will be dealt with later.

In order to split the crankcase, the generator rotor will have to be removed: this is a parallel fit with a Woodruff key and comes off easily enough with two levers. Look for signs of oil running down the case as this will indicate that the seal, fitted behind the rotor, is leaking. Remove all the double‑ended studs, and the nuts from the fixed studs, and look inside the gearbox. Engines from 1962 on, have a screw towards the top, introduced to cure a troublesome oil leak along the top crankcase joint; this was caused by the long section between the rear crankcase mouth stud and the rear of the gearbox being without a through fastener.

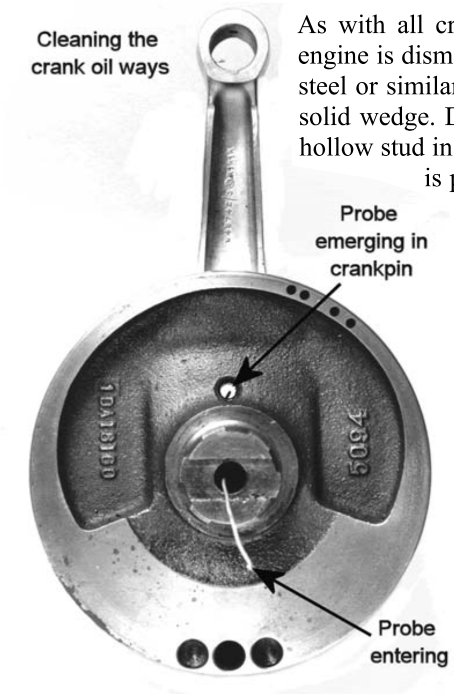
With all the fasteners removed, the crankcase can be split. Start with the generator side, which like all Enfields has an unlipped roller bearing, where the inner remains on the crankshaft while the outer remains in the case. A lever down the crankcase mouth between the case and the flywheel will do the trick, always remembering to use a soft material and gentle pressure. There are no shims or spacers to fall out. This will leave the drive case with the crankshaft in it; the case will need to be supported with two blocks of wood, or the ubiquitous wooden box with strong sides, when the crank can be driven through the main bearing. If it refuses, apply heat around the bearing housing to expand it slightly. The bearing will not leave the crankcase as it is secured by a circlip ‑ watch for the spacer.

The connecting rod can now be removed, and there are two types. Pre‑1961. the cap was secured by two round‑headed bolts with pins to stop them rotating, threaded at the other end 5/16" BSF, drilled for a split pin using castellated nuts. The above arrangement was discontinued because the counter-bore for the bolt head created a weak spot in a highly stressed area, with resultant breakage. High Duty Alloys just down the road from the Redditch factory, modified the design giving it more meat at the shoulders and Allen screw fixings, as on the twins, with the result that the rod now gives little trouble under fair treatment.


Con rods showing the difference for fixing bolts

The small end of the rod is unbushed but, in the event of wear, can be bored out and fitted with a bronze or alloy bush. The dural of the rod is a good bearing material and wears well, probably better than a bronze bush, but can occasionally give bother. If the small end runs short of oil, the subsequent seizure can cause the gudgeon pin to "fire up" with the rod and literally become a part of it. In my experience the best way to deal with this situation is to cut the piston to pieces, remove the rod, place it under a press and push the pin out. It will bring some of the dural with it, but the small end can be cleaned up and bushed and the rod saved. This can happen when a new rod with a new pin is assembled dry: the engine starts up and the piston and pin become hot while the conrod is still cold. The expansion is sufficient to cause this type of seizure ‑ the same is true of other marques, by the way, and is not peculiar to Royal Enfields.

We can now turn our attention to the crankshaft, often described as the heart of the engine. Models dating from 1957 to 1958 were fitted with a crankshaft which had heavy rims and a $^{5}/_{8}$" diameter hole through the centre of the crankpin. This hole was blocked by an alloy plug, relieved in the middle to permit the passage of oil. The weight restricted performance, and the size of the hole meant that the pin sometimes broke. For the 1959 Sports model, a different crank with lighter rims and a $^{1}/_{4}$" hole blocked at each end by Allen screws, was introduced.



As with all crankshaft oilways, centrifugal force causes a build‑up of sludge and any time the engine is dismantled it is advisable to clean out the oilway. The best thing to use is a piece of silver steel or similar material, nearly the same size as the hole, as this will push the sludge through in a solid wedge. Do not forget the radial oilways in the crankpin. The oil is fed to the crankpin via a hollow stud in the drive‑side axle and by a radial drilling up to the crankpin. The end of the drilling is plugged and covered by the main bearing but, with the feed stud removed, a piece of brazing rod can be fed into the hole and up the drill way as illustrated.

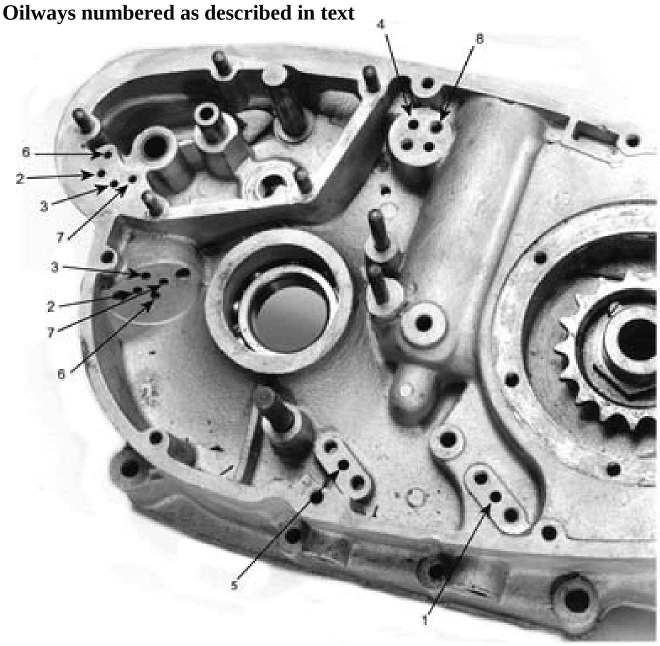
The crankshaft may need regrinding. Most grinders, if given a size, work to plus or minus half a thou, but I find that on plus half a thou the big end is usually too tight and so I always specify minus half to minus one thou. If a big end is tight, rectifying it involves scraping the shells‑a practice I avoid ‑ or rubbing a thou off the crankpin, which is hard work. Torque setting for the big end screws or bolts is 22lb/ft and although there are sometimes holes in the Allen screw heads, it is not customary to use locking wire through them. With the crankshaft ready for refitting, attention should be turned to the crankcase halves, drive‑side first.

Fit the camshaft only in the timing chest and fit the timing cover secured with three of the nuts. Check the cam for up‑and‑down play, especially on the inner bush, which is narrow. If you decide to replace the bushes, do it now, but if they only need reaming you can push the reamer through both bushes at once, something you cannot do when the case is assembled. Often, the inner end of the camshaft will be scored and a slack fit in a new bush, so the best remedy is to replace the camshaft or have the end of the shaft ground true and a bush made to suit. The outer bush, which is longer, seldom suffers from this problem. When the camshaft is turning freely, without up‑and‑down or excess end play, fit the cam followers with a thrust washer at each‑end and the spring washer in the middle, and make sure that they work freely. Check the depth of the cup into which the bottom end of the pushrod works and the surface of the end which makes contact with the cam. Slight scoring can be stoned down and if it is bad it may be possible to regrind it, but in extreme cases renewal is the only answer.

Push the crankcase halves together and secure with two or three bolts. Check the contact‑breaker spindle in its bushes, and the oil seal, and renew it necessary. Leave fitting the new main and/or gearbox bearing until last, otherwise pieces of swarf can enter during other operations, but if you are re‑using the old ones, pack them with high melting point grease or make a metal shield to protect them. Run a ¼" BSF plug tap in all the chaincase screw holes, as well as those on the oil pipe connections, as they are often packed with old jointing compound which will stop the screws going right home.

Virtually all of the much‑discussed oiling system is contained in the driveside crankcase and should be carefully checked at this stage. Although there is only one pump disc it has two plungers, each of which operates a separate circuit. the feed and the scavenge. The schematic diagrams in the workshop manual do not give a recognizable picture of what is happening in the mess of oil pipes situated in the primary chaincase, so I have tried, by the use of photographs, to give a clearer picture to follow.

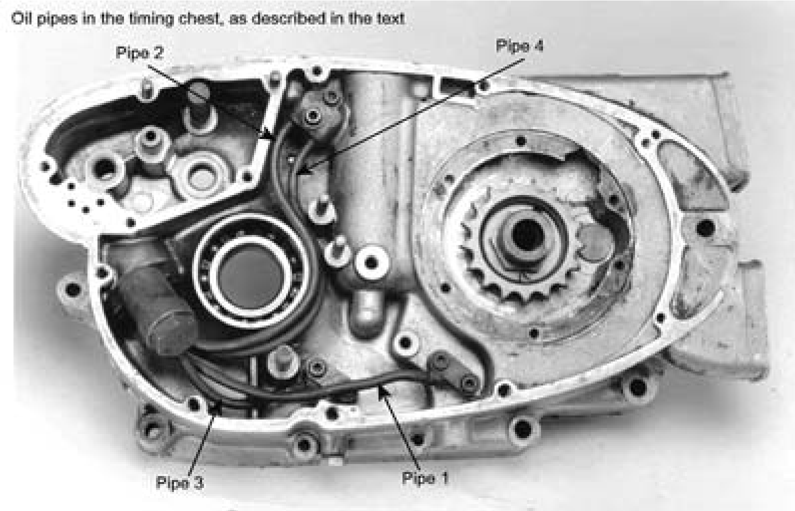
Oilways numbered as described in text



Oil is picked up from hole no.1 by pipe no.1, by the feed pump through hole no.2 and fed back through hole no.3, via pipe no.2, to hole no.4, from where a drilling takes it to the top of the oil filter housing. Here the filter cap has a radial groove with four holes which lead the oil to the inside of the filter element. The oil passes through the felt and fills the camber which has a hole in the bottom through which it flows, via a metal tube, to a boss in the primary chaincase. If the filter is not assembled correctly, with the brass cap at the bottom supported by the spring, the felt drops to the bottom and blocks the outlet hole, cutting off the oil supply to the engine.

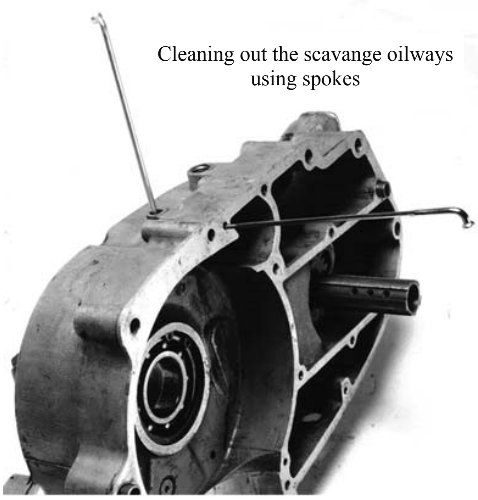
The oil runs forward in the chaincase boss to emerge through the feed seal into the hollow feed stud screwed in the end of the crankshaft. This comprises the entire feed circuit and should be checked as follows. Hole no.1 is not protected by a filter (as it is on other Enfields) but being in the side of the reservoir, about 1½" from the bottom, foreign bodies are seldom picked up in it. Make sure there is an unobstructed flow through pipe no.1 by forcing oil through it with a gun or using an airline. Holes no.2 and 3 rise at an angle of approximately 45 degrees and then turn at a sharp angle to the face of the pump. This is a favourite lodging place for small pieces of debris, usually hard jointing compound, and the only sure way of cleaning it out is to use a drill. If the hole is only half blocked, oil and air will still be able to pass through giving a false impression. Using a 4" long

$^{9}/_{64}$” drill and a hand brace, run the drill up each hole and then through those leading to the pump face. Test by inserting ⅛” metal rods in each pair of holes and feeling that the ends touch. Check that pipe no.2 and hole no.4 are clear and the feed side is finished.



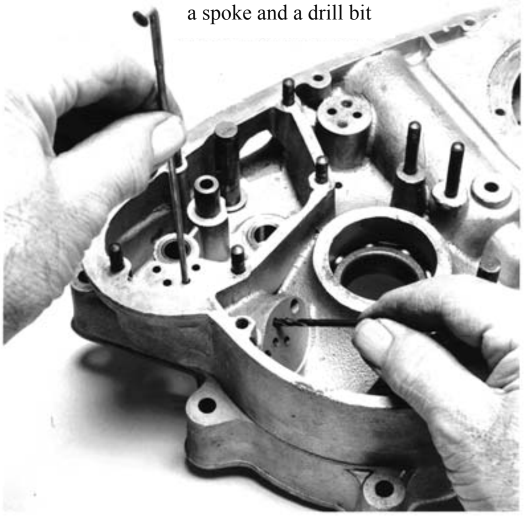
Oil pipes in the timing chest, as described in the text

Of the whole oiling system, the section which gives most trouble is hole no.5, the pick-up point in the crankcase for scavenged oil. This is also unprotected by a filter and is particularly prone to blockage by debris - white metal swarf from a failed big end, sections of broken piston rings, for example - which gets deposited in the trap at the bottom of the crankcase and drawn into the oilway. From inside the case the oilway runs parallel with the crankshaft and then turns in a vertical direction, for about 1”, to resume the horizontal line to connect with pipe no.3. Since a drill cannot go round corners, the vertical section is drilled from outside the case and the end of the drilling plugged with a short ¼ BSF screw or bolt.


Cleaning out the scavange oilways using spokes

Pre - 1962 engines were fitted with a hexagon-headed bolt, but if the thread became stripped owners would replace it with a longer bolt which effectively blocked the oilway. From 1963 on this was replaced with a countersunk Allen screw which, being inconspicuous, was seldom removed and therefore gave less bother. When you are satisfied that this section is completely clear, give holes no.6 and 7 the same treatment as 2 and 3; push a rod through hole no.8 (which seldom gives trouble), and check pipes 3 and 4 before bolting the pipe assembly in place.

Cleaning out the oilways in the pump block using a spoke and a drill bit



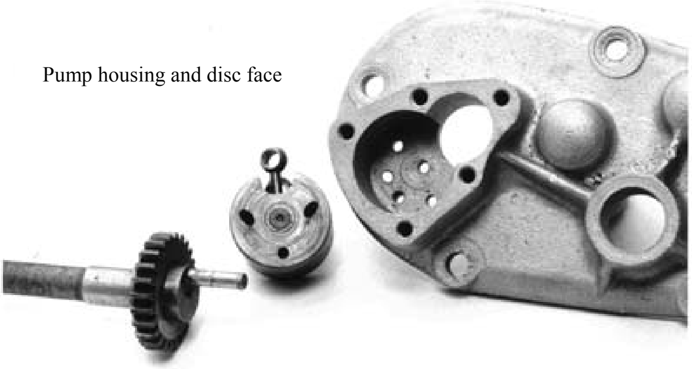
You may have problems, if the pipes have been distorted, but start with the four-pipe block below the pump and using a new gasket with a thin smear of compound to hold it in place, start both screws in the threaded holes, but do not tighten them. Repeat the procedure with the two-pipe junction at the top and then tighten all four screws home. The two single pipes are more flexible and can be manoeuvred into place and tightened too.

With all the pipes fitted, hold the half crankcase in your hand and, inserting a force-feed oilcan into each of the four holes leading to the pump face, observe the oil flowing from each of the four drillings into which the pipes lead. One, the pick-up point in the reservoir; two, the delivery hole in the top of the filter housing; three, the pick-up point for the scavenge pump; and four, the drilling leading to the crankcase joint to cross to the oil filler orifice, where the scavenged oil is returned to the reservoir.

If you have oil coming out of the breather and lots of blue smoke from the exhaust, it is usually down to a blockage in the scavenge side. There is, however, another cause that I have met several times over the years - the oil from the rocker gear drains down the pushrod tunnel into the timing chest. On early engines, the timing cover had a hole in it and when the oil reached its correct level it drained through the hole into the primary chaincase. Later engines had a hole in the rear of the timing chest through which the oil drained directly into the reservoir, and no hole in the timing cover. If you have an early engine with no drain hole in the timing chest, and a late timing cover with no level hole in it, the pushrod tunnel and rocker box will fill with oil. This oil has to go somewhere and that somewhere is usually down the inlet valve guide.

The next task is to ensure the pump is in a fit condition to pump oil through the oilways. Although section B16 of the workshop manual covers the theory admirably, I want to add a few notes on the practice. The fit of the plungers in the disc is easily checked: if play is excessive, renewal is indicated, as both new plungers and discs are readily available.

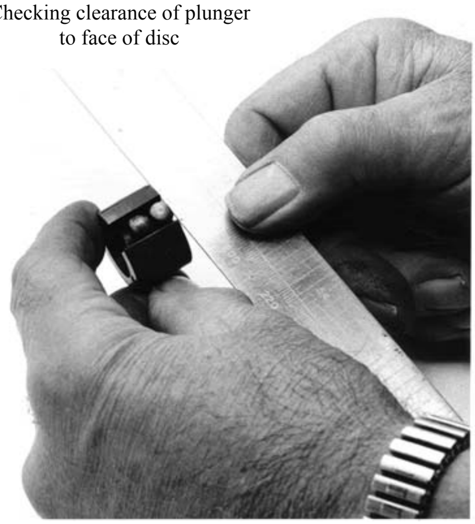
The feed plunger is a spindly looking ⅛ diameter and although this has never caused me any trouble, some owners have bored out the feed hole in the disc to $^{3}/_{16}$”, with an oversize plunger to suit, and declared the increased circulation beneficial. This is only hearsay and I have no personal experience to draw on. Incidentally, the easiest way to do this is by fitting the pump from



Pump housing and disc face

the 1957/8 models as these used the bigger feed plunger as standard. Inspect the peg closely for cracks as very occasionally they can break off, with disastrous results.

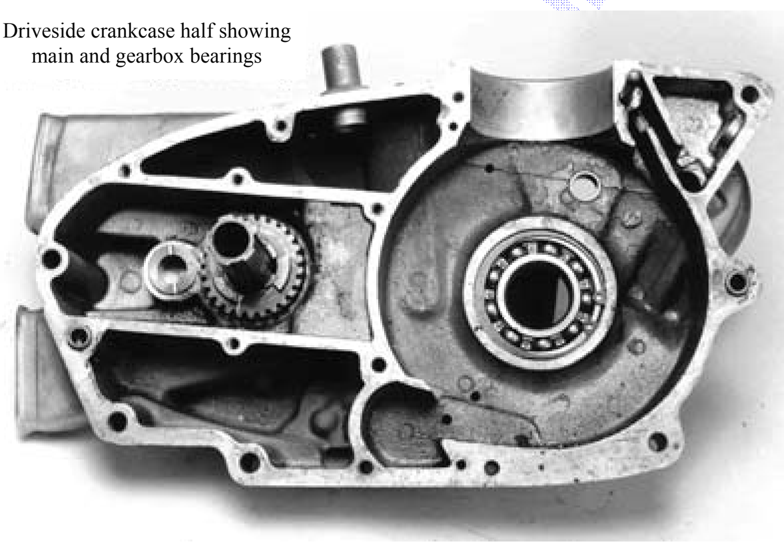
Another aspect of the pump to consider is the condition of the face of the disc and the housing against which it is kept in close contact by the pressure of the disc spring. A scored disc is easily refaced on a lathe, but remove the very minimum of metal. If it has been refaced before, you may find that the eye of the feed plunger is proud of the face, but this can be ground back. A damaged housing is more difficult to rectify, depending on the equipment available, but if it is badly damaged try to buy a new one if available. If you have access to machinery, it is possible to mill the housing to remove scoring on the face; if not, an old disc with fine abrasive paste can be used to clean it up before finally lapping in with the disc you are going to use.



Checking clearance of plunger to face of disc

Finally, check that the oil pump cover face is true; Do it on a flat surface and if it rocks, lap or machine it true. Inspect the threads in the cover screw holes. $^{3}/_{16}$" BSF. If you do not have a tap, file a flat on a screw and use it to remove old jointing compound from the bottom of the holes. On the right-hand crankcase half, check the oil hole running across to the filler and remove the non-return valve assembly (much easier now than when the engine is assembled). Examine the seating for the ball-bearing and condition of the spring, if suspect, renew it - they are cheap enough.

Items still requiring attention on the drive-side case are, engine main bearing and gearbox bearing and if the case is going to be heated for main bearing removal, any renewals to the gearbox may as well be done at the same time. The engine main is secured by a circlip. Once the clip is removed, it is the usual routine of heating the case to the "spit bounce" condition and banging it on a flat wooden surface when the bearing will drop out and the new one can be popped in. It can be secured with its circlip and will remain in position while the gearbox section is further heated. if necessary.



Driveside crankcase half showing main and gearbox bearings

The bush should have been inspected for wear both in the bore and on the face of the flange. Excessive end-play on the kickstart is usually caused by spindle wear on the face. The bush has a blind end and is easily knocked out; in the absence of a special drift, use the layshaft and a wooden mallet to fit the new one. If the ball bearing is removed by the same method as the engine bearing, the oil seal will also fall out. Look out for the two steel washers on either side of the seal. The reassembly order is as follows: small washer or shim, oil seal open end towards the gears, large flat washer (not dished as some publications state), and then the bearing. Again, in the absence of a special drift, use the gear sleeve to insert the bearing.

On the generator side, the only parts which may require renewal are the main bearing outer ring, generator oil seal, and contact-breaker spindle bush and seal. Being light in weight, the bearing outer ring will not normally fall out of the case if banged on a flat surface, so the crankcase has two holes through which the race can be removed by inserting two pieces of 1/8" rod and tapping with a hammer. While the case is still hot, fit the generator seal open side towards the bearing, and the CB spindle parts, as required.

If the generator side main roller is not going to be renewed, and the inner has to be removed from the crank, great care is needed to prevent damage to the roller cage. To start it on its way, I use a screwdriver ground to a fine taper which I drive between the bearing inner and the thrust washer. This causes some damage to the thrust washer, but it is easily cleaned up or renewed. There is one thrust washer each side and they have a radius on the inside which fits next to the crankshaft.

In the gearbox section of the right-hand case, removal of tine gear oil filler will reveal the slotted head of the gear operator anchor pin. The pre-1962 component is a long one-piece affair, while the post-'62 has two short pins; inspect them for signs of excessive wear which can affect gear operation. While you have the gear operator out that's the piece with the notched quadrant - look at the end which engages with the operator shaft. Together they form an elementary ball and socket which should fit reasonably closely; the gear operation is too short to afford any lost motion. Inspect the welded joint where the flat lever is fixed to the shaft as the weld has been known to crack, resulting again in lost movement.

The gearbox end cover holds the small ball-bearing for the mainshaft; it takes the end thrust of the clutch withdrawal and should be renewed it there are any signs of slackness. Often the bearing will be loose in its housing: If only just loose, apply Loctite, but if it is realty slack, buy a new or good used end cover. The same applies to the bronze bush for the kickstart spindle which seldom wears internally but can become loose in the cover and give rise to an oil leak. The kickstart spindle has an O ring carried in a groove to prevent oil seeping along the inside of the bush. Within the spindle is the other layshaft bearing which can present problems if it needs renewing: try the hydraulic effect, where you ½ fill the bush with grease and then with a close fitting drift inserted into the bush, tap with a hammer and sometimes the grease will force the bush out of its housing. Alternatively, tap and draw it out with a bolt or mount it in a lathe and bore it out. Don't forget to drill the oil hole when fitting a new bush.

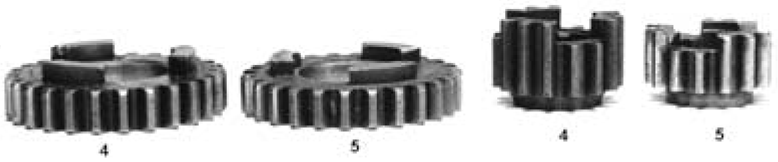
Examine the operator fork which joins the two gear clusters. This has two side plates riveted to the central body and the rivets can come loose or the side plates crack, or both. Check that the kickstart pawl and the teeth in the kickstart gear are in serviceable condition, and that the stop-plate pushes the pawl fully down and out of engagement

You can either fit the final drive sprocket at this stage or after the gearbox is assembled. I prefer to do it now as it is easier to fit the lock screw for the nut. The nut contains a felt washer which prevents oil seeping along the mainshaft. If a new felt is being fitted, smear it with grease and push it as far home as possible with your fingers, then slide the nut onto the end of the gearbox mainshaft and rotate it, pushing it up and down. If you don't do this, the mainshaft can pick the felt up and damage it when it enters the nut during assembly.

The crankcase halves can now be put together. Lay the generator side face uppermost and drop the crankshaft, with inner roller attached, into the case. Using a non-setting compound like Wellseal (hard-setting compounds are a hazard on engines with drilled oilways), coat both crankcase joint faces sparingly but comprehensively.

Making sure the distance piece is on, drop the drive-side case over the crank; the first splined section is relieved, and it will drop easily until it reaches the larger diameter. Tap the inner race with a tube and if there is undue resistance, gently heat the casting round the bearing housing when the case should drop right home. Fit enough fixing studs to ensure that the joint is firmly sealed all the way round and check that the crankshaft revolves freely.

Compare the width of 4 and 5 speed pinions



Now is the time to inspect the gears and shafts. First the long splined sleeve which has a series of holes, three for a four-speed and four for a five-speed. These sleeves are not interchangeable although they look similar. Look for cracks at the kickstart end and try the splined gear, or gears, to see that they slide freely. At the other end. check for wear on the splines which drive the sprocket and see that the sprocket is a firm fit. The effects of radial play here were dealt with earlier on, as was the condition of the taper on the clutch end of the mainshaft. Inspect the hole through which the clutch rod runs and clean out any swarf or rust; it is virtually unlubricated during use. Smear the rod with grease when assembling as a seized-in rod is extremely difficult to remove and it makes the operation that much easier anyway.

The following applies to four-speed boxes; five-speeders need separate instructions. The large gear held captive by the sleeve next to the main bearing is first, or bottom. while the small one splined to the end of the mainshaft is top. Both have dogs on their faces which engage with corresponding dogs on the faces of the splined sliding gear, so that the gears on the mainshaft engage bottom and top only. The dogs should be dovetailed or undercut so that the greater the pressure applied to them, the closer they slide into engagement. If the undercut is worn, pressure will make them fly apart causing the gear to jump out, so if you are experiencing this problem with top or bottom gear, these dogs are the most likely cause. Another not unknown cause of the same effect is that the corresponding top and bottom non-sliding gears on the mainshaft are very similar in the five speed version, the main difference being that the dogs are shorter, and even though they may look OK, the gears will not stay in engagement.

Second and third gears are engaged by the two sliding gears on the layshaft, the smaller being second and the larger third. They have radial concave internal grooves which engage with radiused pegs on the layshaft, one row of four pegs to each gear. The grooves are deep and once properly engaged the gears seldom jump out; however, if this trouble does develop, this is the area to examine. Look at the surface of the teeth too. Some pitting is usual, but excessive wear will be indicated by a burr on the edge of the teeth and this will cause noisy transmission in the lower gears. If you have what you suspect is a ,'moan" coming from the gearbox when the engine is idling, withdraw the clutch. This will stop the gears rotating, and if the noise ceases you will know the cause.

For lubricating the gears 20/50 or EP90 works well, although some owners think that EP oils attack the bronze bushes in the gearbox. This question was put directly to Castrol a number of years ago for their opinion and quote the following from their very friendly reply. 'Firstly, the question of EP oils attacking Phosphor Bronze. This, like many myths is founded on a modicum of fact, but certainly doesn't apply today. Early EP oils relied on the excellent, but highly active. load-carrying ability of sulphur and sulphur chlorides. Although these were effective with steel they did attack 'yellow' alloys and so could not be used where bronze was present. However, the advance of technology saw the introduction of more stable EP products (based on sulpho-phosphorized terpenes) which become active only when required - i.e. when the gears are under extreme pressure. When the bike is sitting in the shed they will be completely inactive!"

The small gear on the layshaft is splined on but is seldom removed. The large kickstart wheel is fitted in the same manner, but the boss round the splines is rather thin and should be inspected for cracks. Spares are readily available. Make sure the thrust washer is fitted between the gear and the kickstart spindle and if, after assembly, the spindle has excessive end play, a new thrust washer or further shims should be fitted.

Before fitting the end cover, try the spring-loaded locator assembly through the plain hole and if it is tight, now is the most convenient time to ream it out. The screwdriver slot in the end of the locator lines up with the chisel point on the plunger and should be in a vertical position. I like to leave the pressure on the light side, it makes gear changing easier and, contrary to popular belief, tightening the pressure will not stop gears from jumping out. There is a gasket for the cover and jointing compound applied to the gearbox casing only is usually sufficient, and helps if the cover has to be removed again. When the cover fixings have been tightened, fit the oil thrower and left-hand threaded nut (sitting in the dish of the thrower) onto the mainshaft. Tighten the nut and check the shaft at the other end to make sure there is no end float. Rotate the gearbox by turning the final drive sprocket and, using a ¼" Whit spanner on the squared operating shaft, gently "feel" the gear selection. If a gear is felt at each click of the locator in the quadrant, little can be wrong with the internal operation. Any subsequent difficulty in finding the gears will probably be due to the external mechanism, which can now be fitted.

This mechanism looks complicated but is fairly simple in operation. The central ratchet, sandwiched between two plates riveted together, is squared to fit the operator shaft while the plates rotate on tubes, and. each time the gear lever is released, return to a central position to pick up the next tooth on the ratchet. At the rear is another plate, the adjuster plate, with a slot at the end allowing a limited amount of movement. This is locked by a ¼" BSF bolt which should be kept tight once the adjustment has been set.

Each pawl has a hardened peg at its end. When the change pedal is pressed, a pawl will move into engagement with a tooth on the central ratchet; the peg on the idle pawl will contact the adjuster plate, which will lift it clear of the ratchet and allow it to move in the direction it is being pushed. If there is a lot of wear on the pegs at the point of contact with the plate, they can be turned 180 degrees and given a new lease of life.

The pawl has a slot into which the return spring fits; if you attempt to fit a new peg be sure to put a support, such as a thin washer, in the slot, or the pawl will crack. Check the condition of the wire pawl return spring by lifting a pawl with your finger; when released it should return with a sharp click. An adjustable rod at the rear of the ratchet assembly links it with the bottom lever which is splined to take the footchange pedal. This lever has two pegs: the rear fits into the small end of the pedal return spring and the front accepts the bottom end of the linkrod which is secured by a circlip. Both pegs are riveted in and can come loose. Secure them by re-riveting or brazing but, when riveting, be sure to rest the other end on a soft metal surface or it may chip. The linkrod is adjusted by a turnbuckle in the middle with a left and right-hand thread make sure the threads on rod and nuts are free in case adjustment is needed later.

Upto 1962. the movement of the footchange lever was governed by a screwed-in stop on each side. Wear on the pegs could result in too long a movement of the ratchet with faulty gear selection. If the pegs are changed over, they usually present an unworn face to the lever. When the first five speeder was introduced in 1962, this type of stop caused problems with gear selection and a new stop mechanism was brought out which transferred the function to the ratchet mechanism where it could be controlled more closely. The later control plate can be fitted to earlier machines if the appropriate parts are obtained, but do not forget to remove the original stops at the bottom.

The gearbox bearing cap, which can now be fitted, will probably have the clutch operating lever still attached. Remove it and examine both the condition of the ball-bearing in the adjuster screw and the lugs at the bottom of the lever which bear on the flange of the adjuster body. Smear the lot with grease as it does not get any other lubrication.

Engine assembly can now begin. With the usual rod through the small end supported by blocks at the crankcase mouth to stop the crank turning, fit the rotor and stator, checking there is an air gap all round. At the other end, fit the sleeve then the engine sprocket, followed by the thick washer with the bevelled outer edge outwards (the other way round, it will foul the timing chain), and the small timing sprocket. Pay special attention to this.

As mentioned earlier, the tongue on the centre boss and the groove in the crank end in which it fits are off-centre. When the washer and nut are fitted to the feed stud and everything is tight, the crank will be located rigidly to the driveside ball bearing, and there will be no end play. Check that the crank still revolves freely and, if it does not, take a look at the position of the rod in relation to the crankcase joint, which should be central; if not, you could have missed out the inside spacer. Fit the clutch centre and holding it with an appropriate tool, tighten up the nut. If the primary chain adjuster slipper is left out, it should be possible to fit the chain over the engine sprocket and the clutch sprocket and wangle it over the clutch centre. Clutch sprockets with ball-bearings use a retaining circlip, later plain bearing centres do not.

The clutches, particularly the early ones with only two corked plates, tend to slip when the kick-starter pedal is used; there is a six-spring conversion which increases the pressure without breaking your wrist. From now on things are going to be rotated, so it is best to fit the piston and barrel to avoid any damage to the conrod. Fit the primary tensioner and check the tightest spot. Ensure that there is approximately ½" up and down play on the top run. Slightly slack is better than slightly tight which is hard on the gearbox bearing.

If you have not already done so, fit the cam followers and contact-breaker spindle. The cam cover joint does not have a gasket and on these metal-to-metal joints I like to apply jointing compound to each face and let it get tacky before bringing them together. When the nuts are tightened give the camshaft a twirl with your fingers to make sure everything turns freely and then fit the oil pump, the cover to which does have a gasket. Finally, half fill the timing chest with oil to run on until the return starts to drain down the pushrod tunnel.

To fit the timing chain you will have to remove the small timing sprocket again, but this is not too difficult. Fit both sprockets into the timing chain and slide them into position. The camshaft key is in line with the mark on the sprocket which will be at five o'clock. If the keyway on the camshaft is slack and the key keeps falling out, turn the shaft 180 degrees and fit the sprocket in that position. The marks will line up again next time round, but remember to turn the crank a full turn or you may time the ignition on the wrong stroke.

Check the oil feed by half filling the oil reservoir and kicking the engine over until you see oil emerge from the hole in the filter housing. Fit the filter element; the order of assembly is spring, steel washer, felt washer, brass cup then the element. Half fill the filter chamber, then fit and tighten the top cap. It is often easier to fit the filter into the top cap before inserting it in the chamber. Another couple of dozen strokes of the kick-start pedal should see the big end primed with oil ready for the big bang - a wet start is crucial if you want the big end shells to enjoy a long life.

Adjust the timing chain sipper, making sure there is some slack in its tightest position, and you should be ready to fit the primary chaincase. Before fitting the cylinder head, time the ignition while it is still easy to measure piston movement in the barrel. Fit the auto advance on the spindle with just enough slack so that it can still be turned, and fit the CB plate with the screws in the centre of the slots to give scope for final adjustment either way. Turn the cam and check that the points are near the correct gap. Making sure that the piston is on the correct stroke (both valves closed), turn the engine backwards until it moves ¼" down the bore. Turn the CB cam until the points are just opening, then push it home on its taper and tighten the centre bolt. Turn the engine until the points are wide open and adjust the gap to between 0.012" and 0.015". Return the piston to '¼" BTDC and turn the cam clockwise against the auto advance spring; It should be possible to just discern movement at the points at the extreme of its travel. If it opens too early, turn the base plate clockwise; if too late, anti-clockwise.

Fit the pushrods and the cylinder head. If there are Allen screws in the joint, tighten them last but make sure they are started in their threads before tightening the head nuts. These are not diametrically opposed and the tightening sequence I use is as follows: the one near the plug hole first, followed by the two next to the pushrod tunnel and then the outer two, torque setting is 22lb/ft. Finally, tighten the Allen screws until the Allen key springs. Fit the rocker assembly and oil the pushrod cups and rocker ends before installing the cover. You can, if you wish, leave the top open and watch for the oil to seep out of the rocker ends when the engine is running. As a preliminary to this, always check that the rocker feed pipe is clear as they sometimes get blocked with solder or plating during manufacture.

With the engine installed, I adjust the gearchange mechanism last of all, in fact, I leave the generator cover off for the first test ride in order to make any necessary adjustments. The adjustment procedure is as follows: put the bike on the centre-stand, select second or third gear and study the position of the top and bottom pawls in relation to their adjacent ratchet teeth. The distance should be equal, it not, adjust by lengthening or shortening the linkrod. This is the only function of this adjuster when used with the late type stop-plate. Slacken the stop-plate, and select top gear. Holding the pedal at the end of its travel, move the stop-plate so that the end of the slot abuts the peg on the pawl. Tighten the locknut and test.

Remove the plug so that the engine will turn and; rotating the rear wheel, change down through the gears. If one is missed you have to find out it the mechanism has moved past it or not reached it, and adjust the stop-plate accordingly. When you finally get it right, remember that the gearchange is more responsive to a gentle nudge from an educated foot than a bash from a hefty Doc Marten!