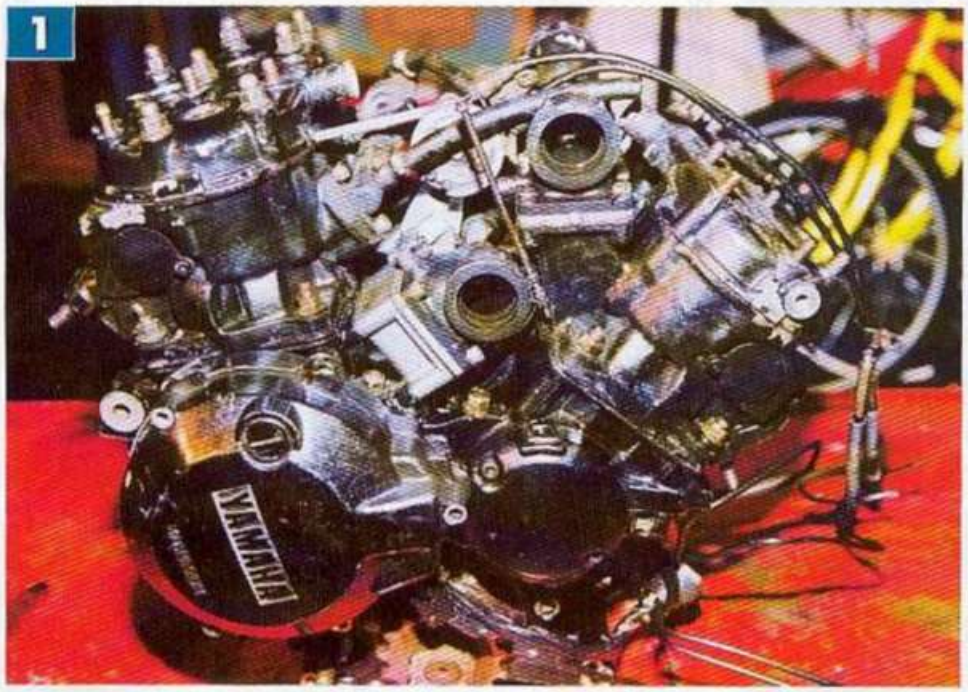


Tackling the gearing

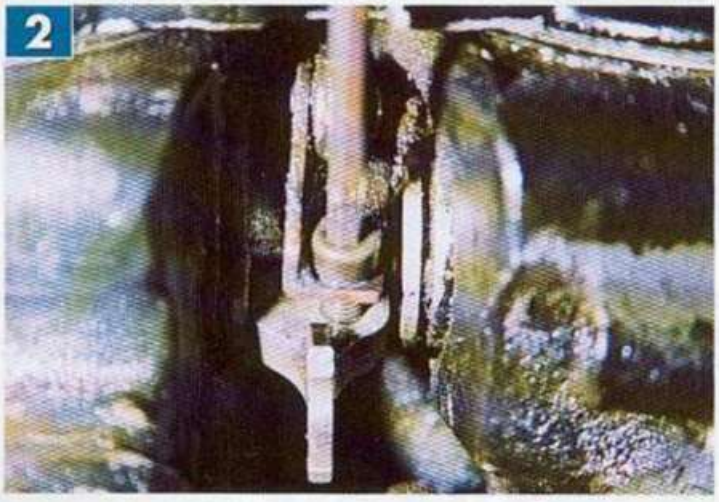
Chris Pearson gets to work on the complex cogs, bolts and rods that hold the gearbox and clutch together on his 'Staff Bikes' V4 two stroke.

WITH the bike coming along nicely in the Staff Bikes section we felt it only proper to cover the actual engine side in a separate series of articles.

This is due mainly to the unique complexity of the Yamaha V4 unit as it would need far more space than the staff bikes section could ever give it.

This strip is being done on the bench but the majority of it can be completed while the engine is still in the frame. The only part of this work that requires complete removal from the frame is when access is needed to the gearbox via the cover situated on the left hand side.

All of the oils and fluids have been drained whilst in situ to give us a cleaner environment as the internals are stripped.

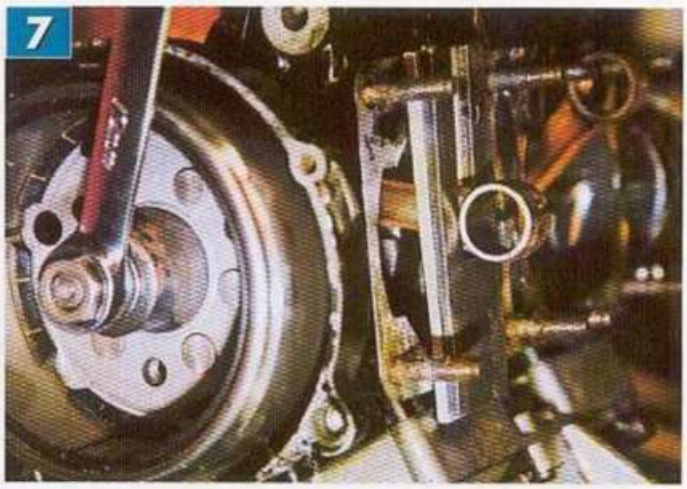
















And in the ideal world you will have removed the gearbox sprocket while the chain was still attached to the rear wheel.

FIRST of all, with the complete engine out of the chassis the top end can be removed. The whole unit can easily be removed even with the four carburettors still in place and makes quite an impressive sight sat on the workbench.

The carb clips feature extended bolts to facilitate their easy removal and when undone the bodies come away in their respective pairs.

Picture one: This reveals the sideways facing inlet rubbers and the power valve mechanism that sits in the middle of the V. Next step is to remove the cylinder heads to get at the end of the power valves situated between each pair of barrels.

Picture two: Between each pair of cylinders are the power valve actuating mechanisms. These are held together with a rather crude clamp assembly but luckily the screws holding it in place are hardened Allen headed items rather than the cheese head No. 2 Phillips that the Japs would normally use.

These will let go with a good healthy crack and the clamps then separate easily. With these undone the whole power valve actuator can be unbolted and the removed from between the barrels, greatly freeing up some space.

It is crucial at this point that you mark the crowns of the pistons for identification later on. The top left cylinder is no. one, bottom left is no. two, top right no. three and bottom right no. four.

You are going to have rather a lot of similar looking parts on the bench in the not-too-distant future so start as we mean to go on.

Picture three: Between the front pair of barrels is a waterway that must be removed before going any further.

Picture four: The barrels are held in place by four 8mm nuts in each corner of the base. It is crucial to use the correct size and fitting spanner on these, preferably a flank drive type as seen here.

If the spanner slips and damages the nut this can be a major problem due to the lack of space here.

With the nuts removed then all four barrels can be safely lifted off. However, if this is as far as you intend to go, put some clean rag around the conrod, completely blocking off the crankshaft to prevent anything dropping down there.

Picture five: With the barrels safely off the pistons can be removed, cleaned and measured. As can be seen here, the *Mechanics* V4 has been neglected in the piston ring department with excessive blow-back well down the piston almost to the bottom.

One or two rings were actually stuck in, once again indicative of high mileage and carbon build-up.

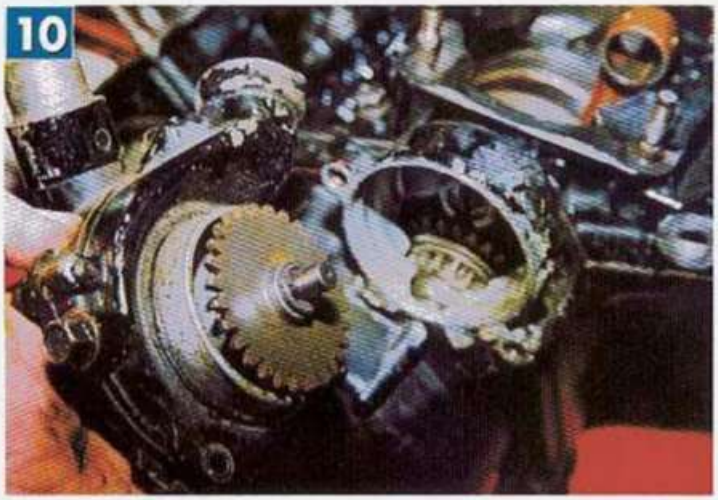
Picture six: With a multi engine like this, especially with such signs of carbon build up, it is a good idea to fabricate a gudgeon pin remover by cutting a piece of 8mm threaded bar and using two nuts and washers through a socket or tube.

This will remove the temptation to tap them out with a drift or worse. This nearly always results in damage to the rod or big end bearing. With each pin safely out the small ends can be slid out and we can move on to the next stage.

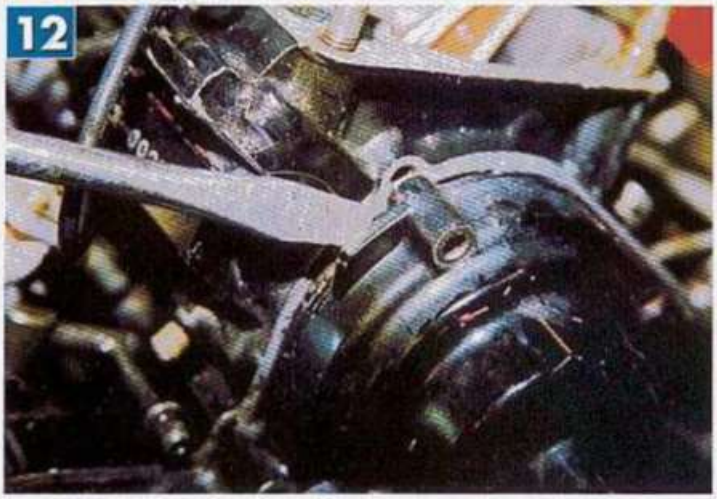
Picture seven: To get the rotor off we need to lock up the engine and this is best done with special tool, part no. 01067. These little steel forks slide under the small end eye and are the most solid way off undoing crank end nuts and the like.

It is a good idea to use a flat spanner for this job if possible, as any kind of socket and extension will transmit the turning force in the wrong direction and dissipate valuable undoing power.

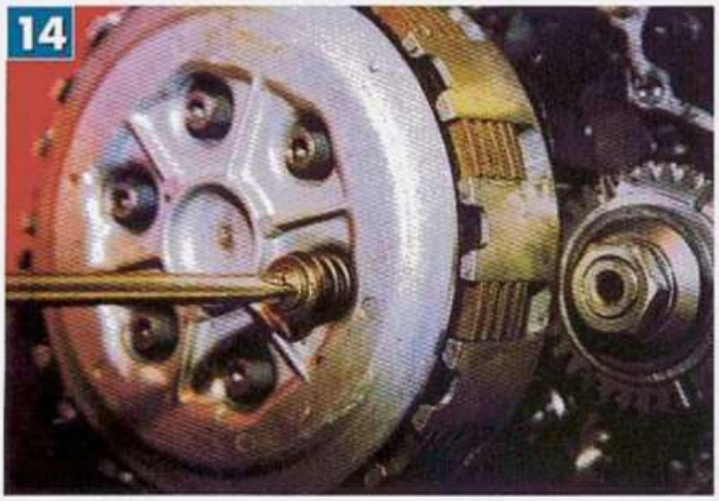
Picture eight: With the 19mm nut undone a three-legged puller is threaded in place to remove the rotor. Never go behind these with a claw-like puller, as this will damage the

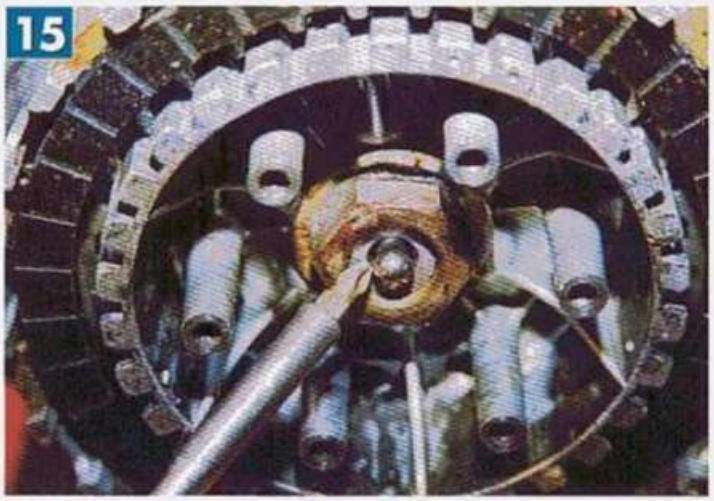












rotor. Always use the threaded holes provided. If this has been in place from new then it is likely to pop off with an almighty crack so beware.

With the rotor off then the Woodruff key can be removed and the large cover held in place with four screws.

Picture nine: The reed valve assemblies of the front two cylinders can now be undone and removed.

These are held in place by eight Allen screws which, when undone, should let the blocks lift out. If these are a little stubborn a slight sideways tap can be implemented to loosen the gasket surface.

THE engine can be turned around now to start the disassembly of the clutch side.

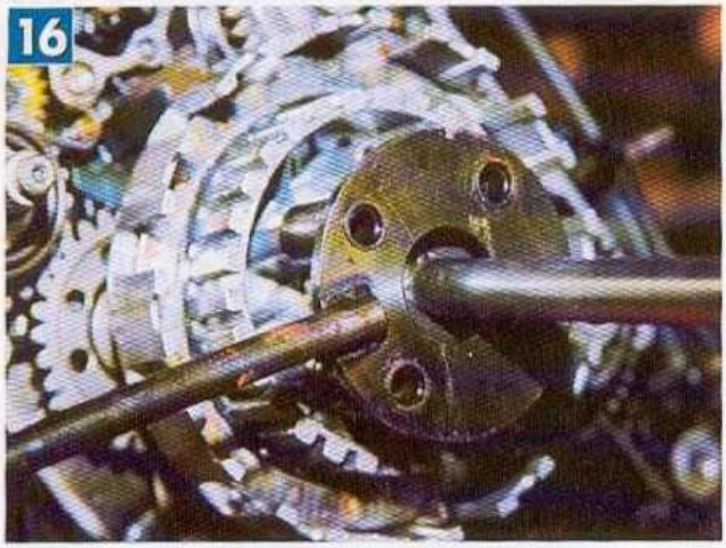
Picture ten: First of all undo the two bolts that hold the water pump in place. This simply slides out of the clutch casing.

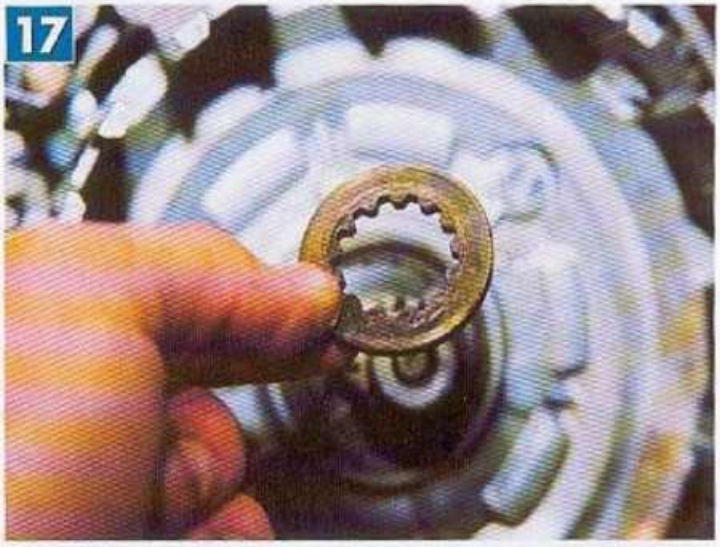
Picture 11: There is an oilway that runs around the rear of the engine to the right hand casing that must be removed before the casing is loosened. With this out of the way the cover can be slid off.

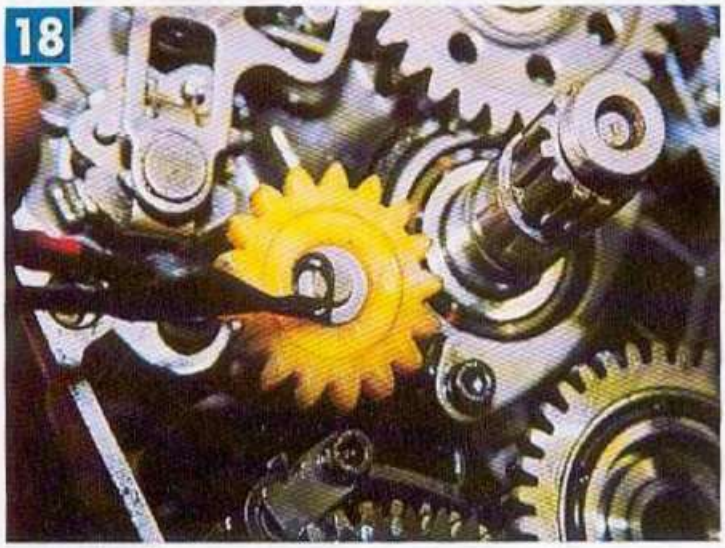
Picture 12: If it is reluctant, there are two lever points provided to allow the use of a large screwdriver or suchlike to crack the gasket surface.

Picture 13: Once in, the mass of primary drive and various other gears are clearly seen. This is the business end of the RD. Here the twisting and turning power of the V4 is collected, coupled and despatched on through the gearbox and off to the rear wheel.

Along with the bit that we are all interested in are all of the boring bits. Taking their drive









off the primary drive gears are the water pump, oil pump, balancer shaft, and kick start. Allied to that is the two stroke autolube pump driven off the kick-start idler gear! That equates to being an awful lot of gears to get working together.

To assist the smooth running of the Yamaha engine there are many dots placed on the faces of the gears so the timing can be set upon reassembly.

If all that is required to fix the engine is crank-related, we can stop at this point and just remove the top part of the crankcases to get to that particular bit. Likewise if it is just a gearbox problem then we can leave the cranks well alone.

Either way it is a good point at which to undo the nuts on the end of each crank (see picture). Once again the lock-up plate can be used on the conrod to facilitate this. With these loosened the clutch is the next thing to take apart.

Picture 14: The first thing to undo is the clutch pressure plate. This is unusually held together by six no. three Phillips screws. Great care must be taken to get a good bite on these at the first attempt - any slip by the tool will round off the screw head and cause endless trouble.

With the screws undone the outer plate can be removed along with the steel and fibre clutch plates. Take care to note the orientation of the wavy steel washers that assist low speed clutch behaviour and prevent snatch.

The last steel plate is held in situ by a large wire clip which has to be lifted clear of its hole before removal can take place. This is a good opportunity to witness one of nature's natural oil filters as the centrifugal forces present in the clutch outer basket actually trap the solid matter within the gearbox oil.

Picture 15: The mushroom-shaped pusher can be pulled out and a magnetic screwdriver or suchlike will grab the ball bearing just behind it. It is a good idea to push the clutch pushrod that runs the length of the gearbox out of the left side of the engine, as if this is bent or badly scored it will not get stuck in the shaft or damage anything on its way through.

Picture 16: Knock back the lock tab with a small drift and attach the clutch holding tool to the inner (genuine part no. 90890-04086) or similar. Make sure the socket is good fit on the clutch nut as, with a tightening torque of 65 ft lbs, this will require some effort to undo.

Hopefully the nut has come off reasonably easy and the clutch inner can be slid off the splines of the gearbox shaft.

Picture 17: Behind the inner is a thick spacer that can prove troublesome to slide off as sometimes the inner splines can burr over, so watch out for that one.

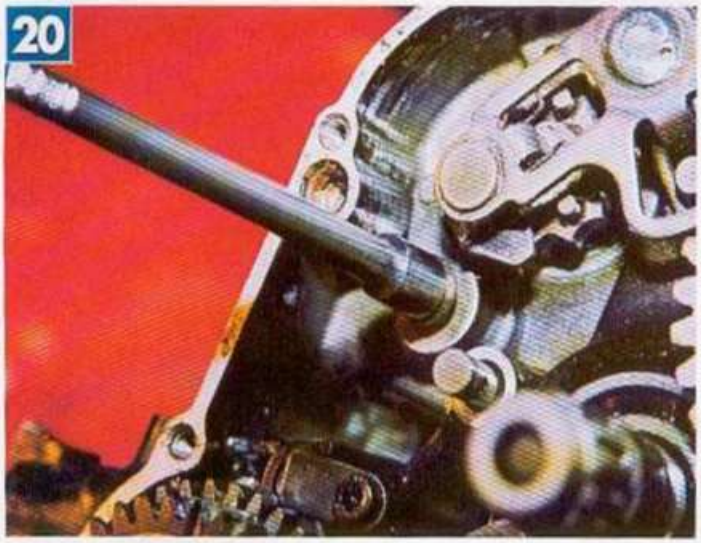
The clutch outer can now be removed. Pay attention to the order of the spacers and washers, particularly if you are not the first to venture into the engine.

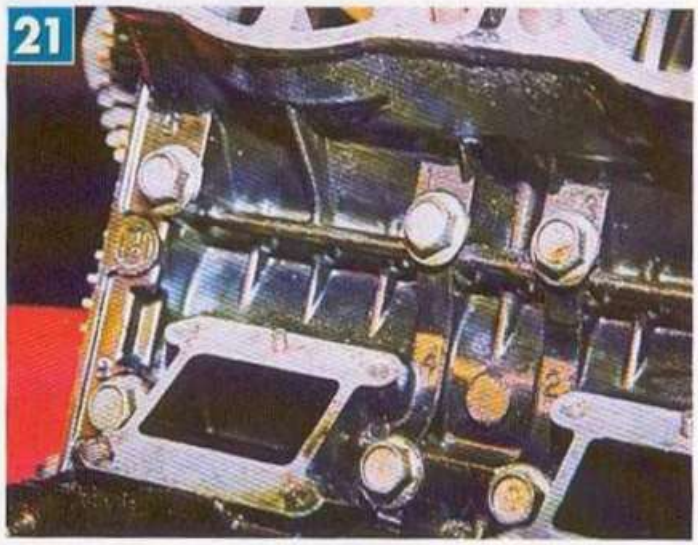
Picture 18: The tiny circlip that holds the main oil pump drive gear in place can be troublesome to get a purchase on without the correct size pliers. These are hard to find in your local toolshop and in the absence of the correct item a good mod is to grind a pair of normal pliers on the inside of the jaws so they close up more.

Picture 19: The kick-start mechanism can be taken out as can the idler gear that connects it to the rear of the clutch basket. This is held in place by a large circlip with a washer just behind it and a further identical washer actually to the rear of the gear.

Picture 20: The ten millimetre headed bolt just in front of the selector holds the shift cam in place, undo this and remove the cam and spring. Give the end of the gear change shaft a good clean before removal as this, like the clutch pushrod, can get damaged and very dirty - once again with the potential to get stuck and cause mayhem on its journey through the engine.

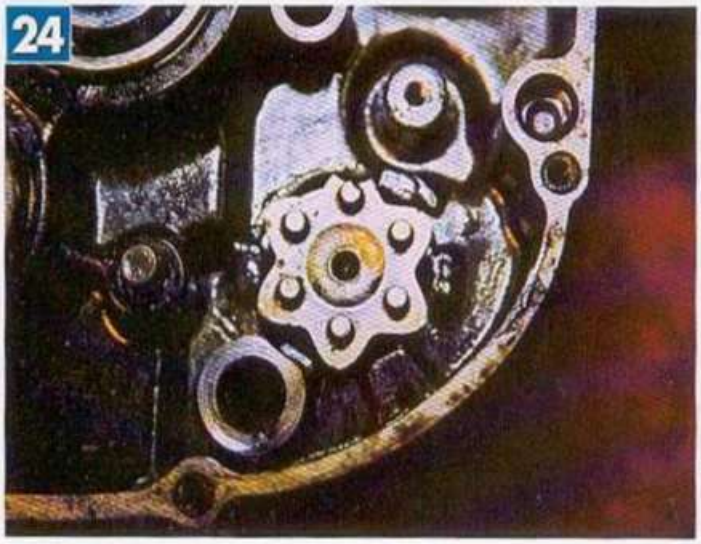
The autolube pump can now be removed from its home just behind the kickstart mechanism. It is held in place by two 5mm head Allen bolts and slides out once these are undone.

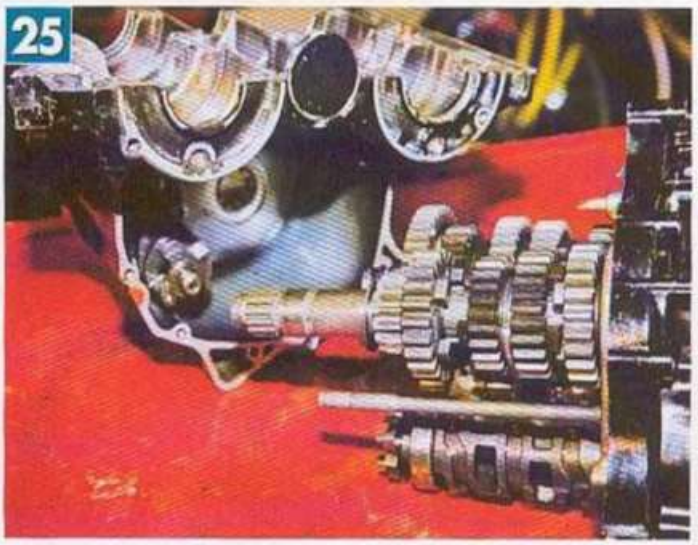












THE casings can now be split.

Picture 21: Undo the bolts - and the one nut at the very rear of the engine - a little at a time in the order of numbers clearly visible next to each bolt head, starting with the highest first.

Picture 22: In all there should be eighteen in total - the missing two are situated under the front base gaskets. Be careful undoing these first two as they can be a little soft if a good quality 6mm Allen key is not used.

With all of the bolts removed the top casing should lift off, revealing the two cranks and the balancer shaft.

Picture 23: Lift these out of the casing, paying attention to the half clips used to locate the bearings in the cases.

Moving on to the gearbox area, the main oil pump can be removed from the left hand casing as can the oil-feed pipe that attaches to the casing via a banjo bolt arrangement. Now undo the eight Allen screws that hold the transmission cover in place and you are almost ready to slide the complete transmission out of the main casings.

Picture 24: All that is required is to make sure the right hand side of selector is correctly aligned so it can slip through the casing and away you go.

Picture 25: A gentle tap with a soft-faced mallet can be used to get the shafts moving and before long you will have the complete gearbox in your hands.

Next month: By now you will have an awful lot of engine components on the bench that will need cleaning, checking and measuring before any thought can be made regarding reassembly. We will cover this in the next gripping instalment.

Checking and measuring

Chris Pearson breaks out the micrometer and feeler gauges to meticulously check the engine components of the V4.

WITH all of the parts removed from the casings it is now time to check everything for correct operation and function. This particular engine was originally stripped following its total failure of a big end bearing. We know the cause was probably its high mileage because the rest of the engine is well worn.

The 500LC does have a few common faults that can also cause such mechanical misdemeanours, amongst them being the leakage of float valves, which then flood the crankcases. This in turn washes away the two stroke oil and the result is badly worn main and big end bearings.

The gearbox has several damaged pieces and at some point the crank casing has suffered some damage, with a large lump of the casting actually missing. This was probably caused by the amateurish removal of the blind bearing situated on the end of the gearbox input shaft.

Luckily, enough metal remains in place to prevent the bearing coming out the wrong way so the casing is still serviceable. Had it not been, a repair could have been made by welding the aluminium - but that is always a risky operation due to possible distortion of the metal.

WE can start by measuring everything as specified in the genuine Yamaha workshop manual that came with the bike. That way we will hopefully also spot anything that is likely to fail later.

First off is the top end. We can measure ring wear along with the state of the pistons and the actual barrels themselves. First, place the rings squarely into each cylinder. Use a piston to push the ring 5mm or so into the barrel as there will be little wear due to nothing getting that far up.

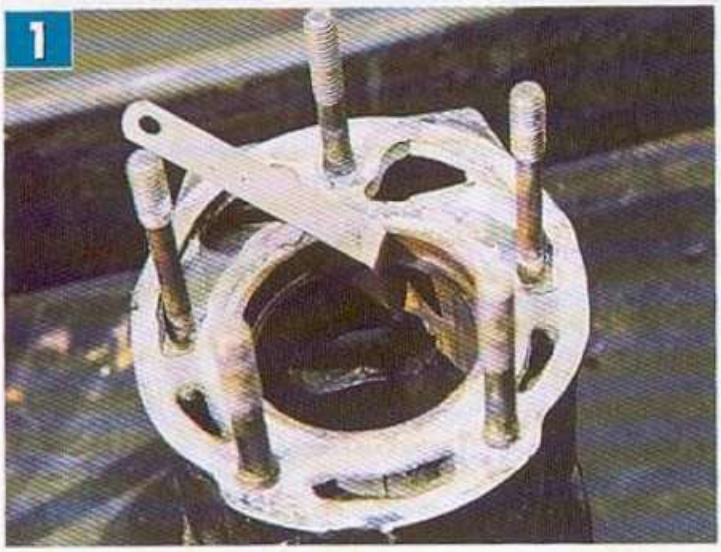
The 'end gap' can then be checked with a feeler gauge **(pic one).** It is a good idea to try a large gauge first, working down in size until one fits. The gap should be between 0.030 - 0.050mm for the top ring and 0.30 - 0.065mm for the lower one.

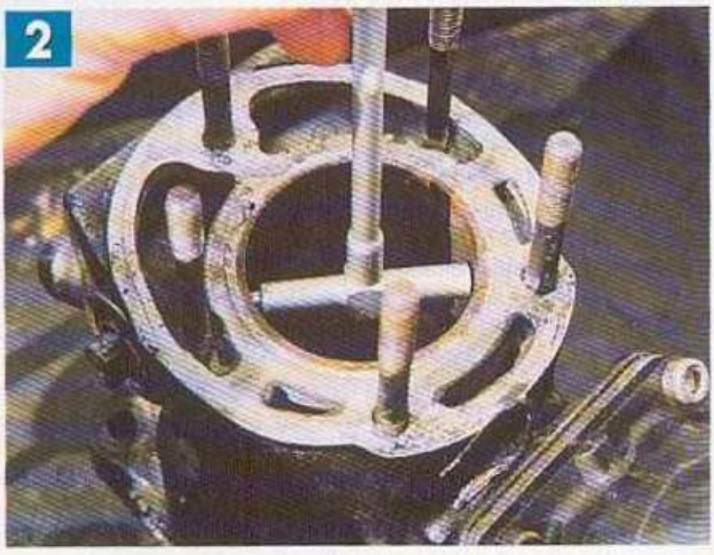
The power valves can be removed from their respective cylinders. Either keep them well apart or do one at a time to prevent the mixing up of parts. Visually check the surfaces for scratches and excessive wear. The seals will need replacing as these are notorious for leaking unburnt two stroke oil.

The barrels are a little bit more complicated to measure. If in doubt seek specialist help. Sliding the relevant piston into its cylinder is a good indicator of wear - slip a feeler gauge into the gap to establish the correct clearance - but not a perfect test.

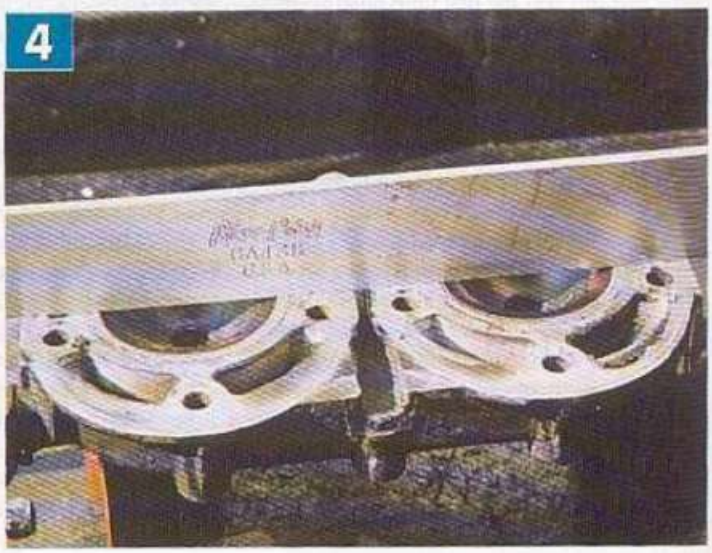
Ideally use a micrometer to establish the size of the piston then you will have a starting point to work from.

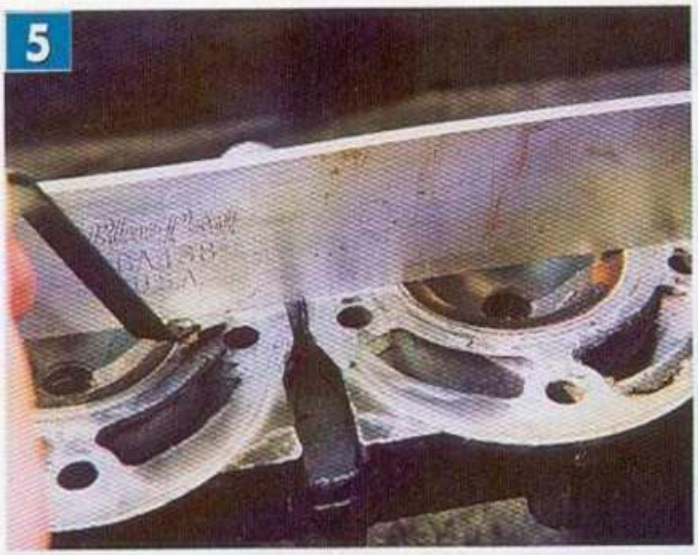
Using a bore gauge **(pic two),** the walls can be carefully and more accurately checked before measuring the gauges themselves with



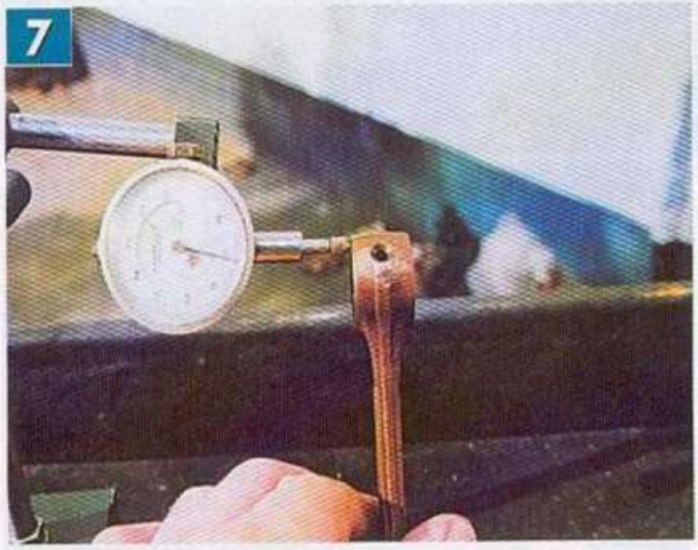














a micrometer. What you are looking for is wear at the mid point of the cylinder and excessive amounts are easily spotted when compared with the very top and bottom.

Anything more 0.10mm over and above the standard size will be excessive and a taper greater than 0.05mm over the whole length of the cylinder will be a sign of the barrel wearing oval.

It is clear that the top end of our V4 is in pretty bad shape and greatly in need of a rebore across all four of the cylinders. Be careful when ordering parts and reassembling as the front pistons are different to the rear.

There are four separate reed valve assemblies that will need to be checked. Firstly measure the height of the valve stopper **(pic three).** This should be set between 8.7mm and 9.3mm. With this correct, then make sure the valve petals themselves do not stand more than 0.5mm proud of the rubber surface of the holder. If any do, replacement valves are required.

The gasket surface of the cylinder heads can be visually ascertained by first cleaning the gasket off then applying a straight edge across the head **(pic four).** A feeler can be slotted under the straight edge **(pic five)** to establish any warpage. If there is some, it is a simple matter of rubbing the individual head, in a criss cross pattern, on a piece of 400/600 grit wet and dry paper until flat again.

THE cranks are easily checked. First the end clearance of each big end bearing is measured with a feeler gauge **(pic six),** then the radial movement is measured with a dial gauge **(pic seven)** - as well as the actual up and down movement when the rod is central.

Side float should not be greater than 0.1mm while radial movement is excessive beyond 0.2mm. If any of these measurements are out of tolerance, new rod kits will be required. Many local dealers these days will not have the facility to build a stroker crankshaft so specialist help will be needed.

The RD500LC is particularly difficult to pull apart and reassemble due to the centres not being splined. This requires an indexing jig to correctly align the two outer crank halves.

The small end bearing and rod eye is checked in a similar manner to the big end by assembling the bearing and gudgeon pin then measuring the axial play, which should be minimal. Another good indicator can be the surface of the rod eye and also the cage of the bearing. If there are rub marks on either, it could prove worthwhile changing all of the separate components.

The crank seals and the main bearings don't need checking - just change them whenever the engine is apart as the 500LC is renowned for wrecking its mains every 20,000 miles or so.

The complex array of drive gears has to be removed from the right hand side of each crank assembly **(pic eight).** Pay special attention to this process as the gears are different for each crank.

To remove the mains a bearing splitter is essential **(pic nine).** This attaches around the outer cage and then winds in to push the bearing away from the crank web. The cranks can be checked for straightness by placing each crank on a pair of V-blocks and measuring any movement with a dial gauge **(pic ten).** Should the movement on the very end of each crank exceed 0.03mm, once again specialist help could well be required.

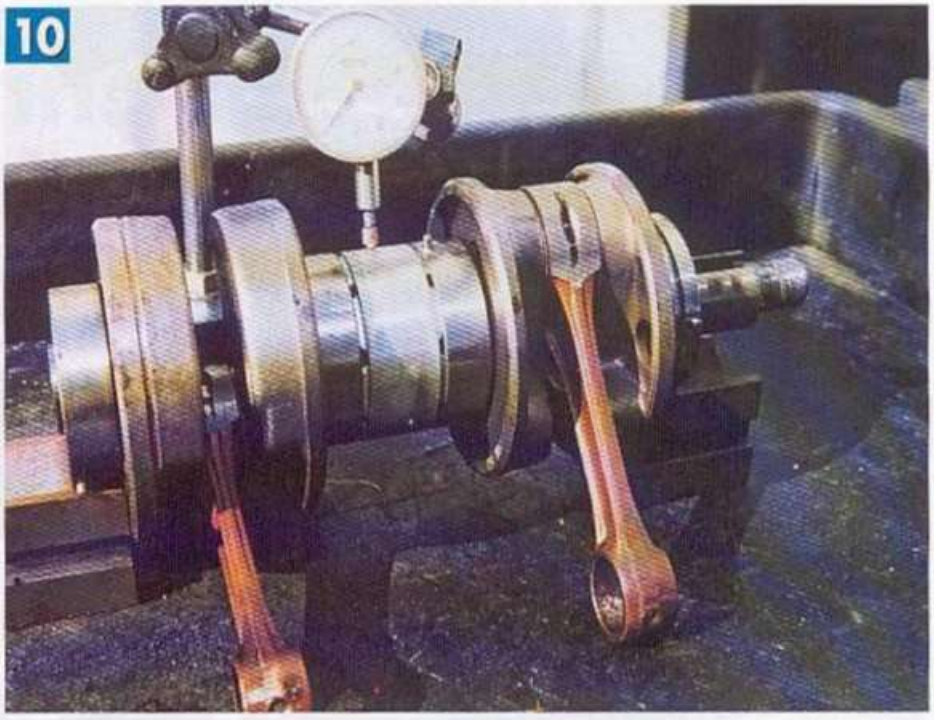
MOVING on to the bottom end and the clutch assembly. This can be checked both visually for slots developing in the inner and outer **(pic 11)** and also measured for plate wear. The friction plate should be no less than 2.8mm in thickness **(pic 12)** while the metal plate should not be warped more than 0.1mm across its entire width.

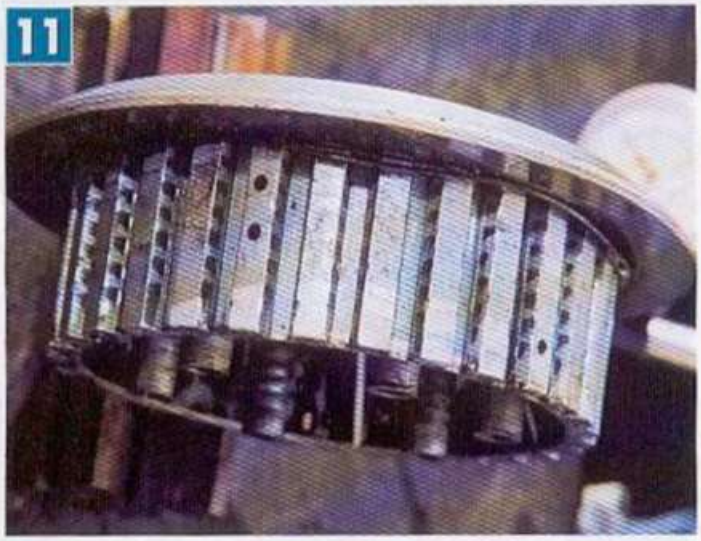
Anything other than these measurements will require replacement.

The clutch pushrod can be rolled on the V-blocks to check for straightness. Any movement in excess of 0.5mm will need either straightening or a new rod.

There are two different types of spring in the LC clutch - the actual springs that clamp the device together and the ring springs that assist clutch operation. The clutch spring

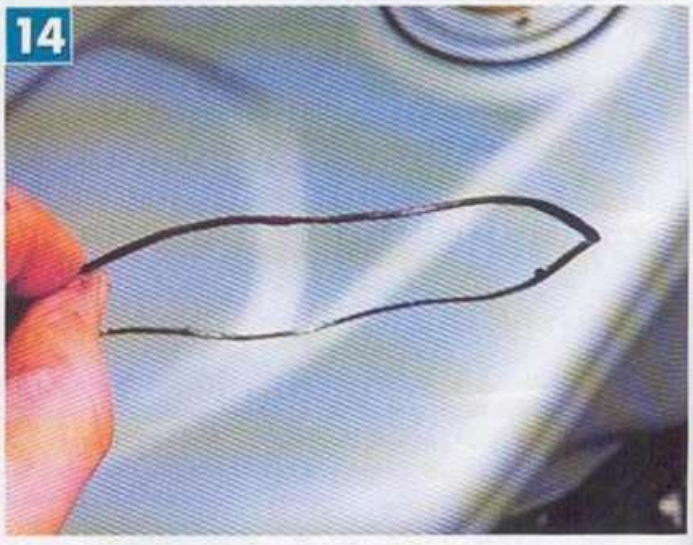












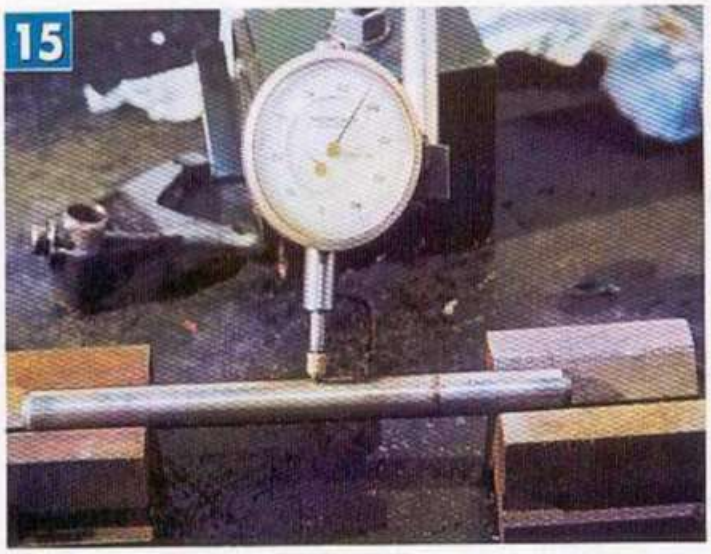
length **(pic 13)** should be 41.5mm. Anything less and it needs replacing.

The ring springs **(pic 14)** should be laid flat and their height measured, 3.25mm being the minimum. The gears that run on the clutch outer are less likely to be badly worn thanks to the ingenious lash-gear set up. These gears run slightly out of sync with the main primary gears and consequently prevent any sloppiness in the drive.

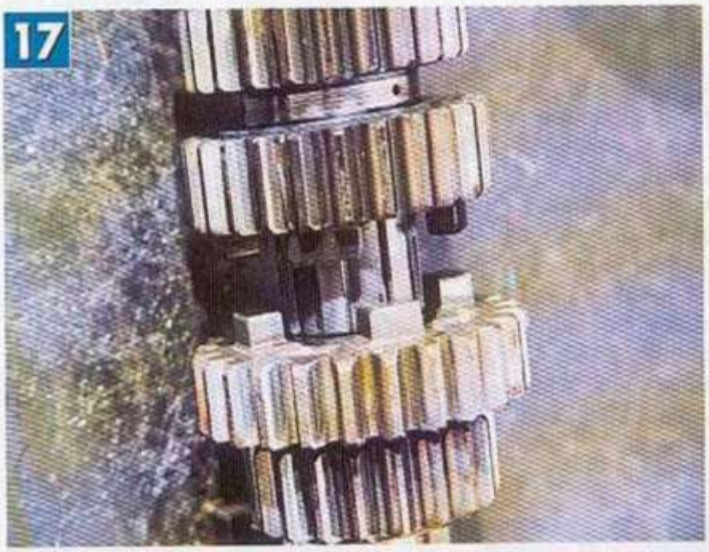
The shafts that the selector forks run on can be checked, once again on the V-blocks **(pic 15).** No run-out should be tolerated on these, as any bend will severely hamper the fork's movement.

The forks are measured with an accurate vernier caliper and micrometer. These should also be checked for visible wear, blueing and straightness across the faces **(pic 16).**

The same applies for the actual gears these run in. They can be measured for wear and checked for blueing in the slots **(pic 17).** The













locating dogs and holes on each gear can also be visually checked for signs of abuse in the form of rounding of the shoulders. Any such wear will mean replacement of the gear cog.

Every gear that is removable can be placed on each gear shaft and checked for sloppiness. Before dismantling the shafts, measure the overall width of the gears mounted on shaft that has the clutch on the end **(pic 18).** This should be 136.2mm in length.

When removing the gears it is a good idea to have a couple of dowels set upright into a block of wood. An old egg box in which to place each part as it comes off the shaft will also suffice to ensure the gears and washers stay in the correct order. This will prevent the mix up of the different, but similar looking parts, and save many a tear at the assembly stage.

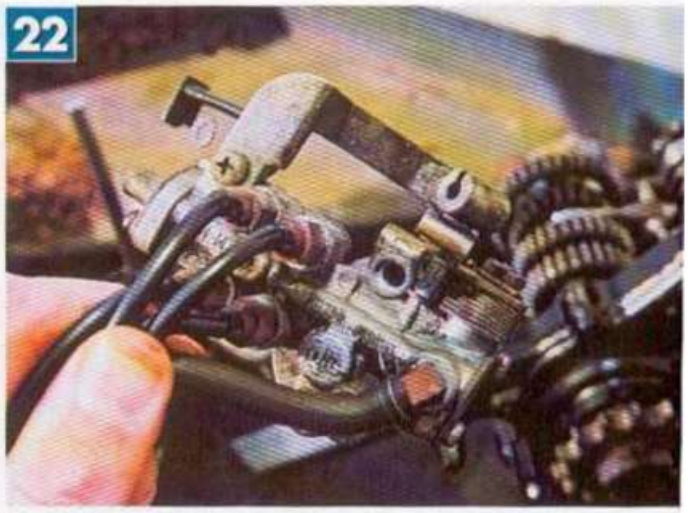
Make sure the circlips were on correctly to start with - the round face should be away from the gear in each case. If someone has been in the gearbox before you, as is the case here, it could well lead to the gearbox being assembled incorrectly.

EVERY shaft within the engine can be placed on the same V-blocks used for the crankshafts and checked in the same way for straightness. Also check where the various oil seals and suchlike have been in contact with the shafts.

In high mileage engines these will have invariably worn into the steel of the shaft and in most cases will need replacing. Hot spot for this is in the water pump, usually due to the large seals required to hold back the pressurised water to prevent it from contaminating the gear oil.

There are lots of bearings and seals within a





500LC engine, thanks to the excessive amounts of shafts and ancillary gears. These will all need visual inspection along with a good spin to check for free movement. If in doubt fit new parts.

The 500LC has two separate oil pumps. The first is the transmission oil pump and is driven off the clutch outer gear via a shaft that runs the width of the engine. This shaft can be checked for run-out and the pump can be dismantled and also checked. Because the pump works by building up pressure - due to the viscosity of the oil rather than using seals - it is important that the condition and clearance of the trochoid rotor is correct.

Use a 010-0.15 feeler to measure the clearance between the outer rotor and the housing **(pic 19).** If this is greater then a new pump will be required. Using a straight edge the whole width of the pump is measured with a 0.04-0.09mm feeler **(pic 20).** Once again, if this gap is greater than the limit of 0.12mm, get your cheque book out!

There is a long metal oil-delivery pipe that runs both along the inside **(pic 21)** and outside of the engine. This has a join mid way and is a good idea to replace the O-rings in these joins as well as the four copper washers used for sealing the banjo bolts at either end of the outer pipe.

There is very little that can be done with the actual two stroke oil pump **(pic 22)** ot than check the lever moves smoothly. Measure the output when the engine is ba together.

With the separate parts now exposed it good time to clean off the gasket surfaces. Use gasket remover with great care as the black of the casings can easily be damage

Any seals, plastic or rubber parts must b taken off the casings as these can be adversely affected.

If in doubt a stiff wire brush and a Stanl knife can be used just as effectively witho attacking the paintwork.

Putting it back together

It'll soon be playtime on the V4 500cc Yamaha in *Mechanics* now that Chris Pearson has the engine rebuilt and back in the frame. Once all the complicated plumbing has been completed it'll be time to hit the road! Stay tuned.

ALL of the gaskets and other parts like circlips have now arrived. With the surfaces squeaky clean, the components can be reassembled in their respective casings. New seals have been fitted into the casings.

In this case the clutch pushrod, gearbox sprocket and the gearchange shaft all have seals that have to be renewed. Smear a small amount of grease in the centre of all of these seals and around the large collar behind the sprocket.

Starting with the top half of the engine, the cranks can be installed, so once again new seals are fitted on to each end of the individual shafts. The half-moon circlips, used for locating the bearing, can be placed into the bottom half of the casing.

There are locating pegs on each crank bearing that must be installed into the relevant slot, so take great care that all of these items are in place **(pic one)**.

Likewise, the crank seals have ridges on them that must be located with slots in the casing. The main seals also have protrusions on one face and these must go against the bearing outer race **(pic two)**.

The rear crankshaft does not have a seal as such, just a plain blanking plug. It is a good idea to apply a little gasket sealer around the outside of this. The balancer shaft is not so hard to install, possessing only the one half-moon locating circlip on one end and a full clip built onto the bearing on the other.

With these in place **(pic three)** the top casing can be carefully put in place. Check for free rotation of all parts when the casing is fully down and if all is well put the bolts in place and start to tighten them down.

Remember to use the numbers as cast on to the casing surface **(pic four)**, starting with the lowest and not forgetting the two Allen bolts, numbered 17 and 18 **(pic five)**, that go under the gasket surface at the very front. Once these are wound down reasonably tightly they can be they can be properly torqued down - 17 ft/lbs (24nm) for the bolts and 16 ft/lbs (22nm) for the nut at the very rear of the engine.

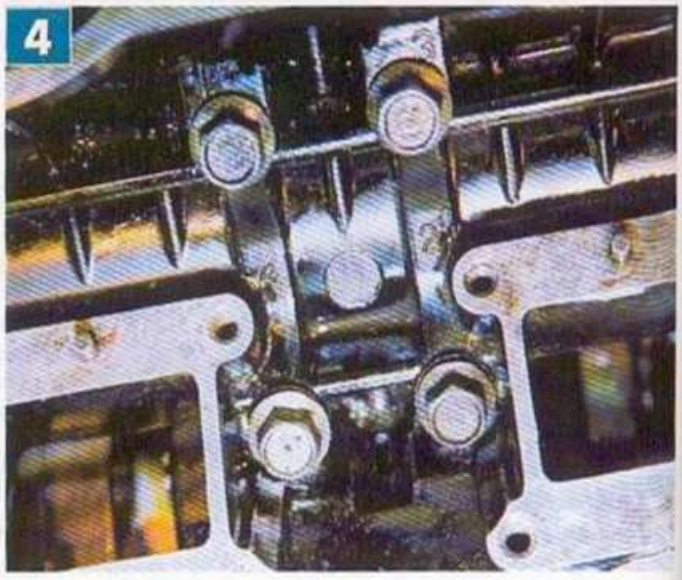
NOW the gears can be placed on to the end of the cranks enabling the first part of the complicated timing procedure.

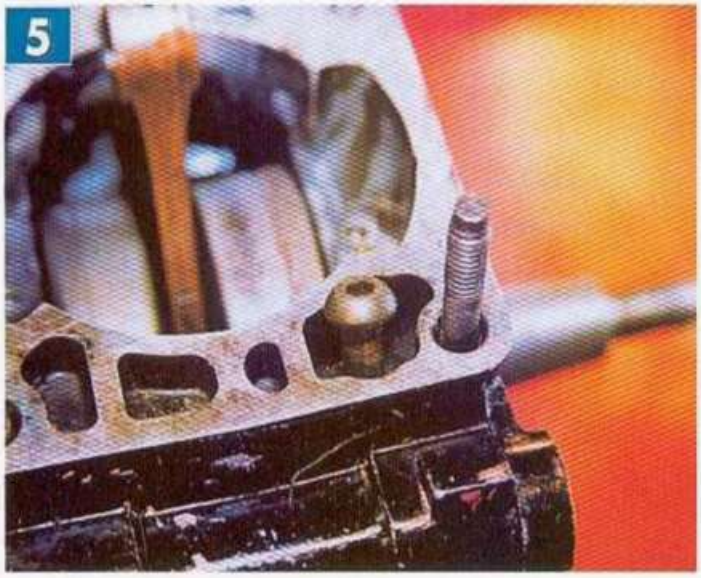
Starting at the front, lower crank, there are no less than nine individual components that make up the gears. These must be carefully placed in the correct order to ensure correct operation. The front gear has a notch ground



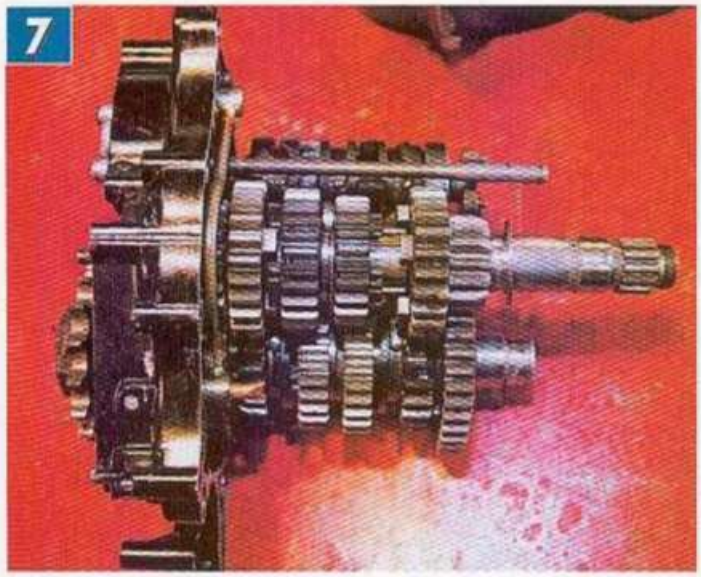


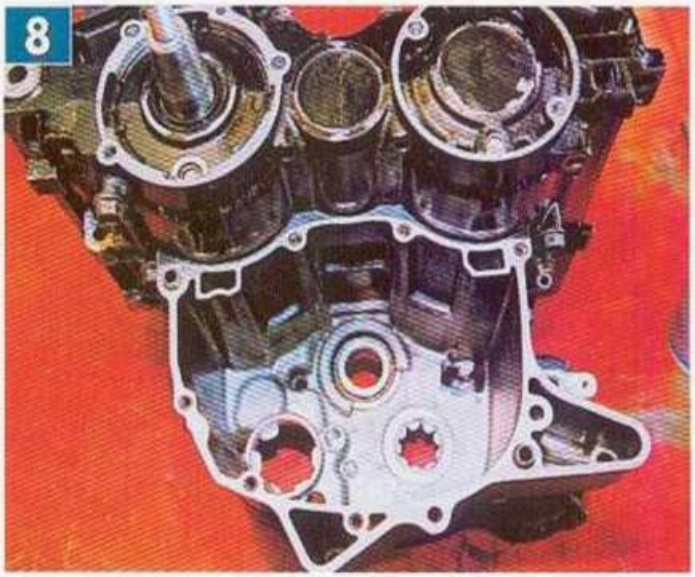












into the top part of each tooth denoting it as the front gear rather than the rear.

The balance shaft and this crank are timed together using the dot on the crank gear and a funny engraved squiggle on the balance gear **(pic six)**. Finally the new conical washer is placed with the concave side facing inwards and the nut is tightened down - but not to the full torque setting yet as some free movement is required in the lash gears for the installation of the clutch outer.

The same can now be done with the rear, upper crank, that luckily has much fewer parts. At the moment there is no need to time it up with anything as it transmits its drive via the clutch outer.

ON to the gearbox. Check the oil feed pipe that runs inside the transmission cover. There are two O-rings that really need replacing before reassembly.

The entire transmission **(pic seven)** can be put together in the left hand cover **(pic eight)**, complete with the gasket, and then slid into the crankcases as one whole unit. If this is done with the gearbox in neutral then the selector end will be in the correct position to slot into the right hand side casing.

Check that the gear shafts can rotate freely during the installation of the gearbox. Should they tighten or at any time stop turning, halt proceedings and investigate why.

Once in the casings the Allen screws can be installed and then tightened to seven ft/lbs (10nm) once again making sure the gear shafts turn freely while doing this. The oil pump drive shaft can be slid through the engine and the plastic gears installed at the left hand end **(pic nine)**.

The complete oil pump can now be fitted, followed by the cover and the oil drain plug. The screws of the cover are tightened to seven ft/lbs (10nm) and the drain plug at 16 ft/lbs (22nm).

Turning your attention to the other side of the engine, it is a good idea to install the gear change shaft and the stopper cam so the proper operation of the gearbox can be checked before moving on.

If all is okay, the various idler gears can be installed **(pic ten)** using new circlips at all times.

The kickstart idler and the oil pump gears are now fitted so the actual kickstart mechanism can also be installed. This is a little difficult, as the spring needs to be held in place at the same time as the mechanism is slid into place.

With the mechanism in place the idler gear, the autolube pump gear and its corresponding wheel on the rear of the kickstart shaft should spin quite freely.

On the primary gears of each crankshaft is a dot that must correspond with the pointer cast into the casing **(pics 11 and 12)**. These must be aligned before the next stage, hence the slackness of the crank nuts facilitating the easy assembly of the clutch basket onto the gears.

The clutch can now be assembled, starting with the large washer and inner bush that slide onto the gearbox input shaft. Then rest of the clutch can now be installed, making sure the dots on the cranks still align with the pointers before doing so.

Slide into place the splined thrust washer and then the clutch inner boss. Use a new tab washer and tighten the nut to 65 ft/lbs (90nm) then knock one of the tabs over to secure the clutch nut.

The two 24mm nuts on each crank can now be tightened fully to 61 ft/lbs (85nm). Spin the engine over a time or two to ensure the correct alignment of the two dots with the casing pointers.

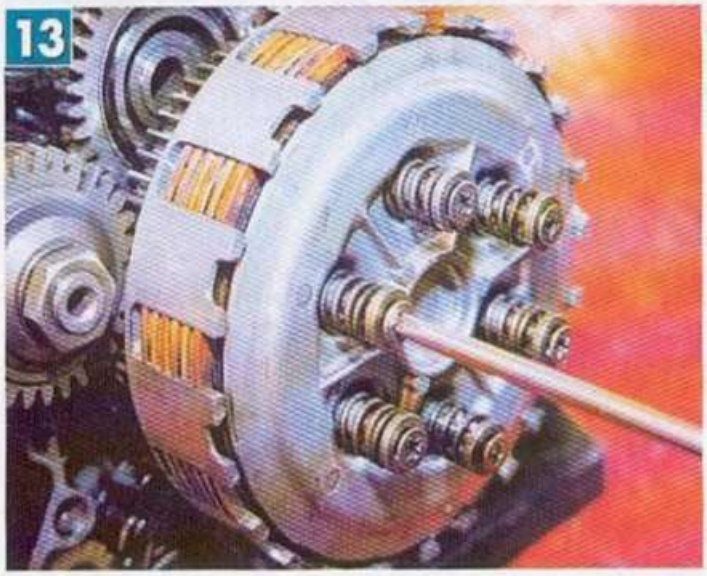
The plates can then be installed, making sure the ring springs are correctly positioned in the boss slots. The very last spring is between the two slots as shown on the clutch boss. With this done, the clutch pushrod can













be slid into place followed by the ball bearing and finally the mushroom-shaped pusher.

Now the pressure plate can be installed along with the six springs. Finally, wind the screws in a little at a time until each one is fully home **(pic 13)**. These need torqueing to six ft/lbs (eight nm) so you will need a number three Phillips adapter for your torque wrench.

THIS completed, the clutch cover can be put in place. Fit the gasket onto the two dowels in the crank cases, use some light grease on the gasket to hold it in place, and fit the cover.

Tighten its Allen screws to seven ft/lbs (10nm), not forgetting the solitary one that is located within the water pump housing.

The water pump can now be installed, using a new O-ring **(pic 14)**. The two Allen screws are tightened to the same torque as the clutch cover. The kickstart lever can be installed now and the correct operation checked. The nut is tightened to 47 ft/lbs (65nm).

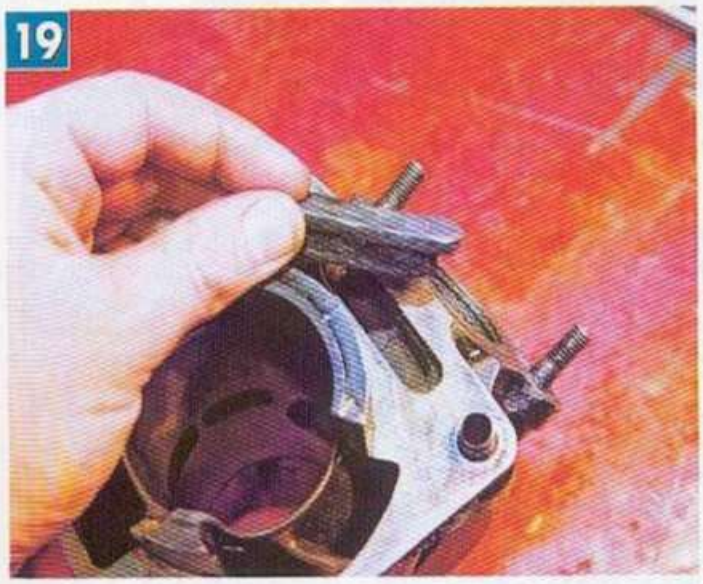
Now is a good time to install the rotor onto the front, lower crank end. First fit the outer casing, making sure it aligns correctly with the dowel pin **(pic 15)**, then the Woodruff key, before using the lock-up plates to secure

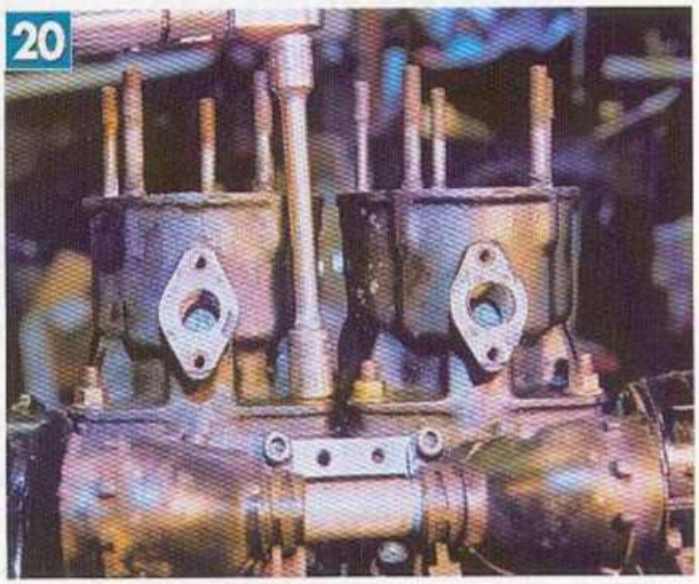












the conrod. Then make sure the taper of both the crank and the inner rotor is absolutely free from any oil or grease as this will interfere with the fit and the ability of the taper to hold the rotor.

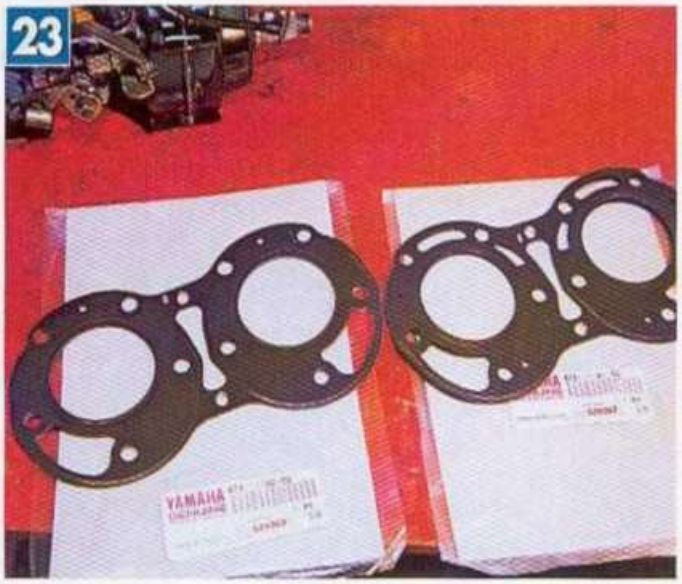
The rotor can then be slid into place, making sure the key is not disturbed, then the flat washer, locking spring washer and nut can be fitted. Apply a little locking compound to the nut and torque it to 58 ft/lbs (80nm).

The oil delivery pipe that runs from one side of the engine to the other can now be fitted. Four new copper washers should be used for this **(pic 16)**. The oil delivery pipe is in two halves, the first running from the gearbox cover and slotting into the rear of the crankcases, before joining the second part that bolts onto the clutch cover. The hollow bolt that holds it in place at either end is tightened to 12 ft/lbs (17nm).

The autolube pump can now be fitted, using a new O-ring, making sure the slotted drive is correctly aligned before pressing fully home and fitting the two screws. Tighten these to seven ft/lbs (10nm) and then thread the four feed pipes around the rear of the engine (under the clip) before they fit under the cover that goes on the end of the rear, upper crank shaft. The cover has a little arrow on it and this must face upwards.









The reed valve assemblies for the front, lower cylinders can now be fitted. First the new gasket, then the housing followed by more new gaskets.

Finally the valves and rubbers can be fitted. Although the valves themselves look to be symmetrical they do in fact have alignment slots that must face outwards when fitted **(pic 17)**.

Once complete the screws can be tightened to the usual six mm setting of seven ft/lbs (10nm).

WE are now ready to fit the top ends and it is prudent to keep all of the components completely separate to prevent confusion. The two assemblies that make up the barrels are very different so great care must be taken to prevent a mishap.

The pistons are visibly different due to the absence of inlet ports in the front, lower pair, and the arrows cast into the crowns must face the exhaust port of each cylinder.

With the pistons and rings fitted (using new circlips), the base gaskets can be fitted. These have a rubberised surface on one side that must face upwards **(pic 18)**. Have a good look at every barrel's base gasket surface as there is a rubber bung **(pic 19)** pressed into each one. These must be present and tight-fitting to prevent coolant leaking out through the gasket surface.

Now each barrel can be slid down onto its respective piston. Holding the rings in tightly as you do so, apply two stroke oil onto each cylinder wall to aid the pistons' journey up the barrel.

Once fully down, each barrel can be tightened down **(pic 20)** by fitting the four eight mm nuts to each corner of the base. These are tightened to 20 ft/lbs (28nm). This can prove difficult for half of them due to the lack of access.

There are certain types of spanner-type adapters, 'crows feet', that fit onto a torque wrench to give sideways access. Without them, tighten the four accessible nuts to the correct setting and try to assess the feel of their tightness with a spanner. This knowledge can then be used to tighten the other four nuts.

Use an oil can, or syringe, to prime the two stroke feed pipes before fitting them onto the inlets on each carburettor rubber. This will make sure the slow-moving auto lube pump gets a fighting chance of delivering some much needed lubrication when the engine first fires up.

The oil pump must also be purged of air by removing the pipe from the stopper **(pic 21)** found on the right hand side casing.

The power valve assembly is then fitted to the crankcases before the linkages are clamped on to the valve ends between each pair of barrels **(pic 22)**.

We are now ready to fit the head gaskets and finally the cylinder heads. Pay attention to the two different head gaskets **(pic 23)**. Part number 11182 goes to the front cylinder and 81 - with the larger hole to the rear - goes on the upper cylinder.

Each head nut has a copper washer under it and the very front two nuts (nos. five and eight) on the lower cylinders also have a mounting plate that must be fitted first.

Each cylinder nut needs to be carefully tightened a little at a time in the numerical order **(pic 24)** stamped on to each head casting before finally torqueing down to 16 ft/lbs (22nm).

The complete engine can now be slotted into the chassis and the plumbers nightmare that is the electrics, cooling and finally the fuel system, can begin. The plus side of all this work is that when properly put together the big LC is a reliable piece of kit. Run on good two stroke oil and maintained regularly, it will not need this sort of attention very often.

Let's go and play!