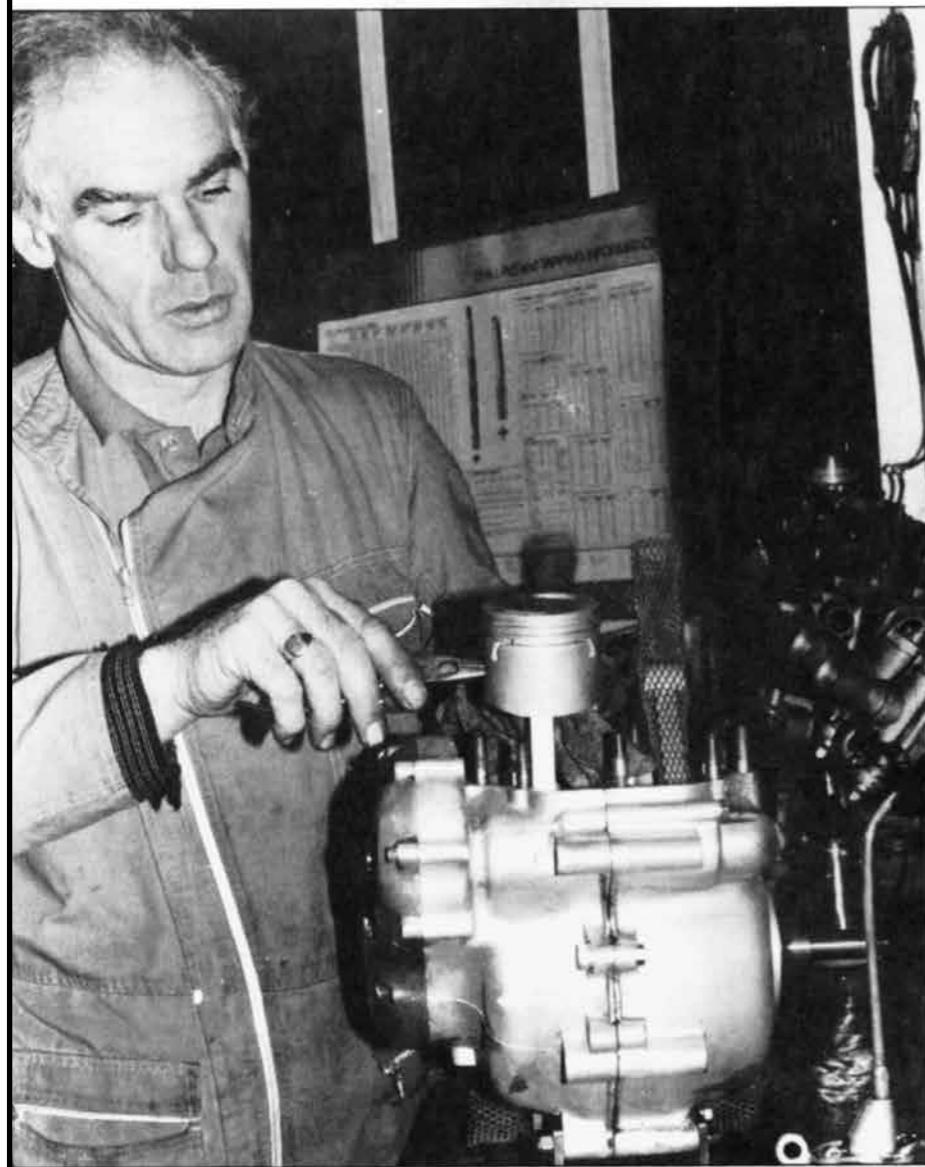


Norton twin rebuild

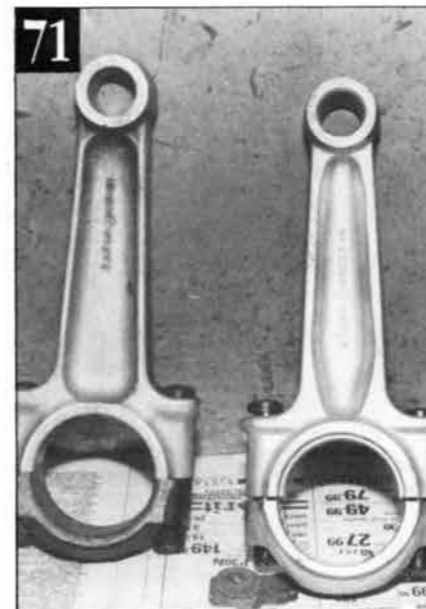
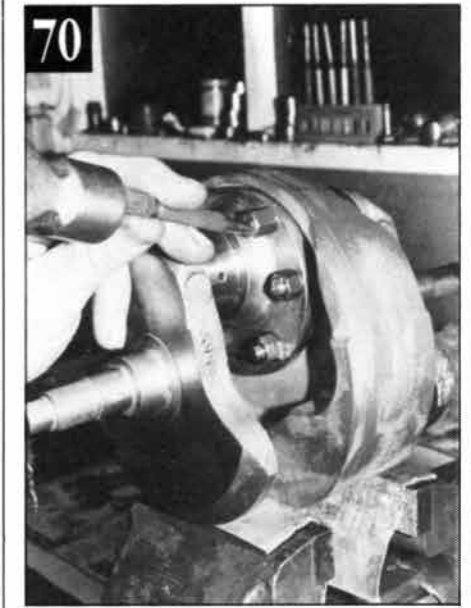
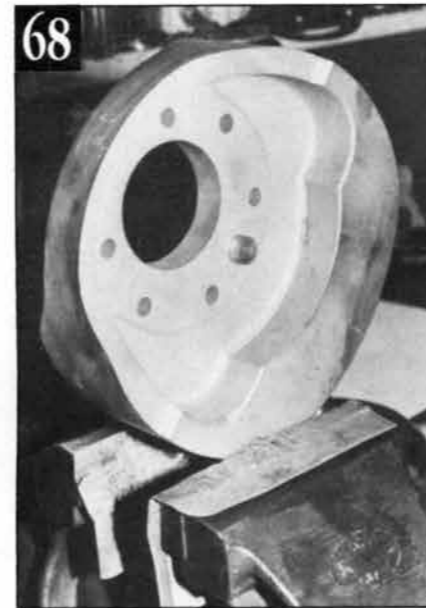
Norton twin rebuild

Part two: Mick Hemmings stripped this Norton Atlas engine in the last issue. Now, with words by Brian Crichton, he completes the rebuild, carrying on the picture sequence from last time

FOLLOWING the stripdown (with pics 1-67) in the (Dec/Jan) of *Classic Mechanics*, our featured 750cc Norton Atlas engine was thoroughly cleaned and the head, crankcases and barrels bead blasted. The barrels were honed and the fins painted black. Crankshaft and con rods were also bead blasted, all part of the engine rebuild service from Mick Hemmings. Do not attempt to rebuild without reading part one of this feature.



- The first step is to rebuild the crank.
- Put the flywheel in a vice, oil the inside of the crankshaft with engine oil – Mick recommends a straight SAE 40 grade of oil for this engine – and insert crankshaft locating dowel into flywheel.
- Tap crankshaft 'cheek' on to dowel shown in pic 68 using soft hammer.
- Early engines use nuts and bolts to hold the crankshaft together and these are now replaced with studs and nuts as used on the Commando. They are all interchangeable.
- Insert lower two studs with lockplate (pic 69) then fit the other cheek.
- Make sure that cheeks are the same way round as on stripdown. They should have been centre punched on stripdown, or scored, as reference for rebuild. This is necessary because in practice the balance factor can be adversely affected if the cheeks are fitted the wrong way round.
- Studs with long nuts go to the 'top'. All threads should be Loctited and studs and nuts should be new. Should a fatigued stud break it can snap a con rod in half. This has happened to Mick, hence his advice to use new.
- Mick uses ring spanners and experience to do up nuts. Torque setting is 35ft-lb, but you will need an adaptor when using torque wrench to get to the nuts which are shrouded by the flywheel cheeks.
- Spanner sizes are 1/2in AF. On older engines with nuts and bolts sizes are 1/4 Whitworth.
- Push over the lock tabs on the bottom nuts and centre punch the other nuts (pic 70). This locks the nut to the stud.
- Always fit new con rod bolts. Ensure that the head is fully seated in the con rod because they are offset, ie the head of the bolt is offset so that it doesn't turn when it is 'home'.
- Smear the rod with oil before fitting shell big end. Pic 71 shows an older rod (left) compared with the later type which features an oil hole (pic 72) which allows lubrication to the bores. This rod was fitted from engine no: 116372. Later rods can be fitted to older engines and this is recommended anyway.
- Put a smear of oil in the big end cap.

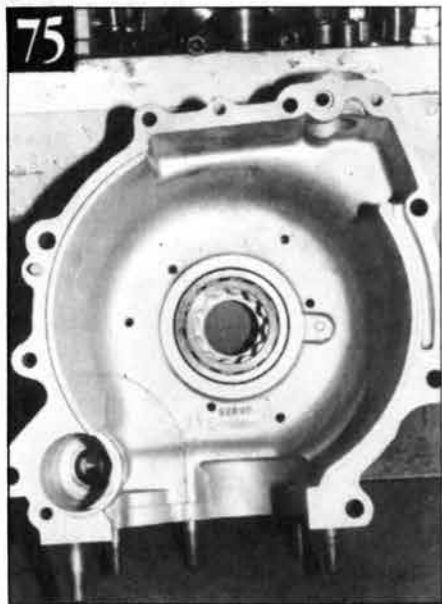


- Fit the shell ensuring the tags are in line, and oil the shell bearings (pic 73) making sure your fingers are clean so as not to score the surface of the shell which is soft lead indium copper backed and easily damaged.
- Oil big end journals on the crankshaft and squirt some oil inside the crank.
- Fit con rod to crankshaft ensuring that scribe marks on con rod cap match up and that oil hole in con rod (pic 74) is towards 'outside'.
- Note there are no washers on con rod nuts (1/4 Whit). Torque setting 25ft-lb. You are advised to use Loctite.
- If you have an engine which has been burning excessive oil it's in order to swap the shells and block the hole in the rod. This is what the factory did on some of the early Commandos which had over-oiling problems. Later engines with Apex rings to control oil on the bores cured this at the factory.
- Oil either side of con rod and ensure that rod spins freely on big end. If it's tight there's something wrong!
- Big end shells in this instance were still standard, and big end journals had been

- polished only rather than reground by Mick's local crankshaft specialist.
- If in doubt over big end shell sizes you must consult a crank expert. Also if in doubt with regard to the condition of the big end have them measured by a specialist dealer.
- If there is excessive scoring or ovality and it exceeds 0.0015in on the big end journals, then regrinding is necessary.
- Shells are available in the following sizes only: standard, 0.010, 0.020 and 0.030in which is maximum.
- If the crank is seriously damaged it can be reclaimed by specialist welding, but this is very costly. Mick can get this work done if required. Cranks for these engines are just not available, though you could get lucky at an autojumble.
- If the crankshaft needs to be reground make sure that this is done by a reputable company who will know the correct radius to grind on the journals.
- The crank is now ready. Fitting main bearings follows.
- Warm the crankcases in an oven (when the wife's out) or with careful use of a blow torch. The cases need to be heated and therefore expanded so that the main bearings can be inserted into their bosses.
- A simple way to tell when the crankcase is warm enough is to spit on it. If this immediately sizzles the main bearing should then just drop in without any force being required.
- Mick will only fit Superblend main

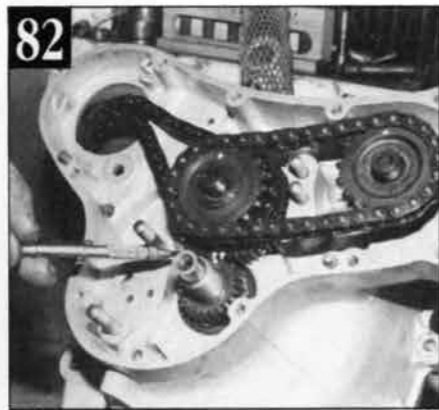


- bearings which have barrel shaped rollers that stop the ends of the rollers digging into the track when the crankshaft flexes. Thus the life of the bearing is extended.
- Superblend mains have been in Mick's racing engines for over five years without needing replacement, hence his faith in this type in place of the standard roller on the drive side and ball on the timing side.
- The outer race of the bearing should be fitted with the lettering towards the 'outside'.
- Pic 75 shows a Superblend bearing fitted to the drive side. No lettering can be seen because its on the 'outside'.
- Drift inner race to drive side crankshaft with lettering towards you (pic 76). Never heat inner race. You have to drift on with a fair degree of force. If undue



force is required 'ease' the crank mainshaft using emery cloth and try again.

- Fit crankshaft to drive side crankcase (pic 77). Lubricate the the main bearing first.
- Lubricate timed breather valve and spring (shown in pic 44) and fit into drive side camshaft bronze bush.
- Lubricate camshaft and also fit to bush ensuring that the two tags engage with end of camshaft.
- Picture 78 shows how ears on camshaft peg onto the valve.
- Carefully smear jointing compound – Mick prefers Wellseal – to both halves of crankcase. Allow the compound to get tacky before assembling crankcase halves.
- Now the crankcase halves can be bolted together.
- Ensure that camshaft spins and will push in and out freely. If not, the two tags for the rotary breather are not fitted correctly.
- Fit the two screws to lower half of crankcase, nut and bolt to the front of crankcase and two nuts on left-hand side top.
- Fit drive side crankshaft oil seal. Drift it on having lightly seated it with light 'toffee' hammer (pic 79).
- Fit main bearing chip plate to timing side mainshaft (pic 80) followed by triangular shaped washer, then Woodruff key.
- Next fit Woodruff key to camshaft.
- Fit crankshaft 'half time' pinion to crankshaft again using hollow drift to seat



it.

- Fit timing chain to cam sprockets as shown in pic 81. Correct timing is six chain links inclusive, ie ten rollers between dots. The dots have been highlighted for the sake of the pictures.
- Loosely fit magneto chain to inner sprocket of intermediate gear. Fit camshaft chain and camshaft sprocket to gear. Then slide on intermediate and camshaft sprockets ensuring cam sprocket is fitted to keyway correctly (pic 82) and that marks on crankshaft and intermediate gear match up.
- NB: Do not forget the hardened steel washer fitted behind the intermediate gear. This applies only to engines that do not have the contact breakers mounted on the timing cover before engine no: 131257. Pic 82 shows gear arrangement for timing.
- Now we can move on to the oil pump.
- Dismantling of the pump was covered in the previous article (Dec/Jan issue). Examine pump gears for signs of damage. These parts are no longer available separately.
- If damage has occurred a new oil pump should be fitted.
- Score marks to pump end plates should be removed by grinding with fine grinding paste on a face plate or sheet of glass. Grind in a figure of eight motion. The plate after facing up using grinding paste is shown in pic 83.
- Liberally oil pump gears and assemble pump. Centre punch the four oil pump securing screws (pic 84). Prime pump with oil (pic 85).
- Oil pump gasket is not normally fitted to pre-Commando engines but because here we are using a Commando timing cover gasket that is thicker than the standard Atlas type we shall also use an oil

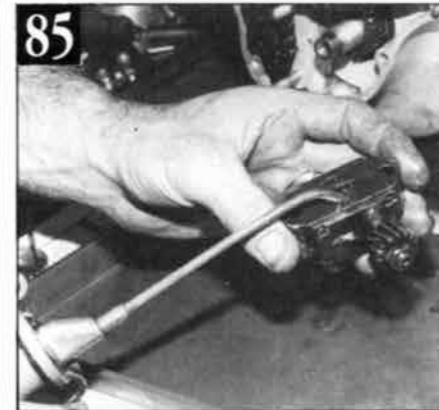
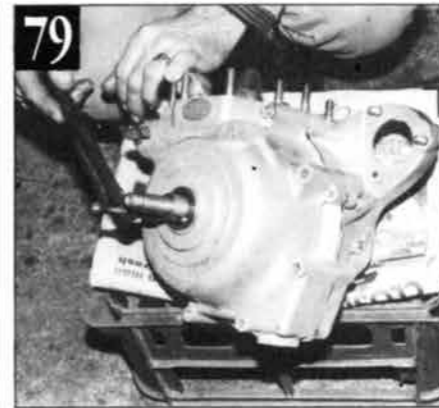


pump gasket (pic 86) on this motor. This is because of the rubber seal between the timing cover and oil pump (this will be shown later) being compressed more.

- Fit oil pump and use Loctite on the threads of the studs. Note there are no washers.
- Protect the top of the crankcases and use steel bar to lock crankshaft via connecting rod eyes (see in pic 22).
- Fit oil pump drive nut/gear. Note that it is left-hand thread and this is of the six start variety. This aspect of the oil pump was covered in the last issue.
- No torque is available from Norton for the left-hand thread oil pump drive nut/gear. Do it up tight using common sense.
- When tightening camshaft nut fit dummy timing cover (pic 22) as explained in the stripdown sequence in the previous issue.
- A spot of Loctite on the camshaft nut should be used. Then tighten using 1/2in Whit socket, and shock socket bar with hammer (pic 22).
- Fit slipper tensioner and side plates in the order shown in stripdown. Lift tensioner to adjust chain to manual recommended 1/8in up and down movement at the tightest part of the chain. Crankshaft should be turned and chain tried in two or three positions to check tension. Mick usually runs his engines with 1/16in up and down play (pic 87).
- Now we turn our attention to the pistons and barrels.

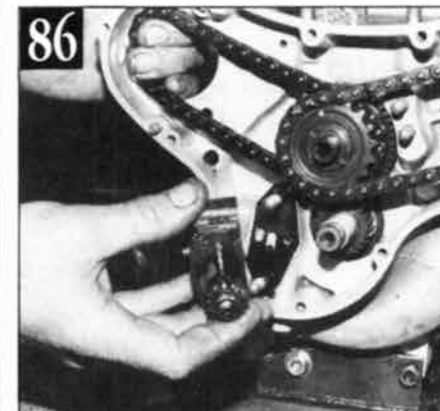


- Pistons have been vaqua blasted (fine bead blasting).
- Clean out any carbon deposits left in the ring grooves using an old piston ring (pic 20).
- Fit one circlip to the piston ensuring that it is correctly seated in the groove.
- Gently heat piston until gudgeon pin slides home freely.
- Lubricate small end eye. Fit piston to con rod and slide gudgeon pin through small end eye.
- Ensure that pistons are fitted the right way round. Norton pistons are 'handed' because the valve pockets are splayed and not diametrically opposite to each other (pic 13).
- Place rag round mouth of crankcase before fitting circlip to opposite side of gudgeon pin.
- To ensure that circlip is correctly seated spin the circlip in its groove as a method of checking this.
- Mick prefers Apex (Hepolite) oil control rings. But none were available for this engine so genuine Norton oil control rings were used. All Hepolite pistons and rings for Norton twins are becoming very rare now.
- Note that the Norton oil control ring is in three pieces – one expander and two rails (pic 88).
- The top ring is chrome and the second compression ring is cast iron.
- Fitting of the three-piece oil ring: first fit a rail below the bottom ring groove. Fit the expander then thread in the top rail (pic 89). Turn rings to ensure that rail gaps are not in line. Both rails are identical, therefore you cannot get them the wrong way round, or upside down for that matter.
- Next fit the cast iron ring which is marked 'top' to the second ring groove.

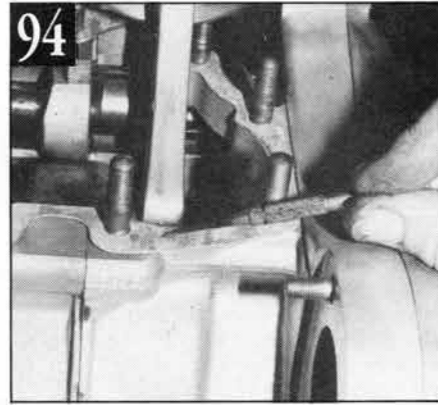
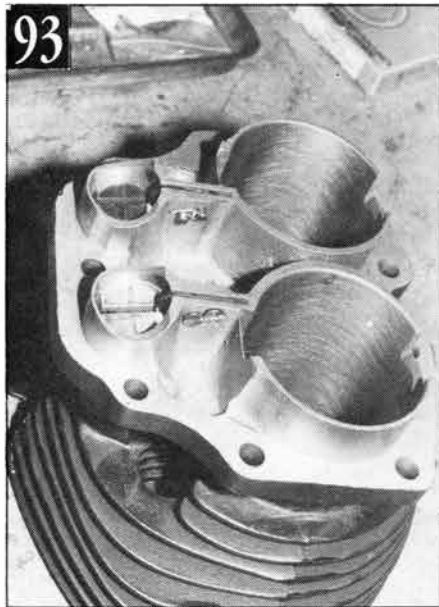
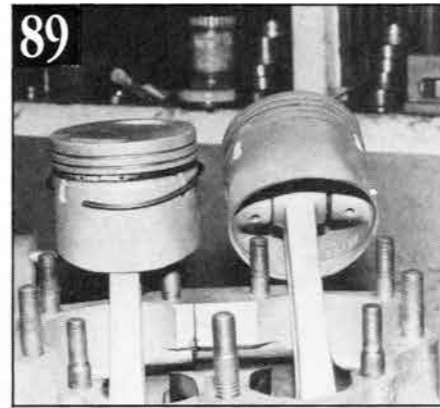
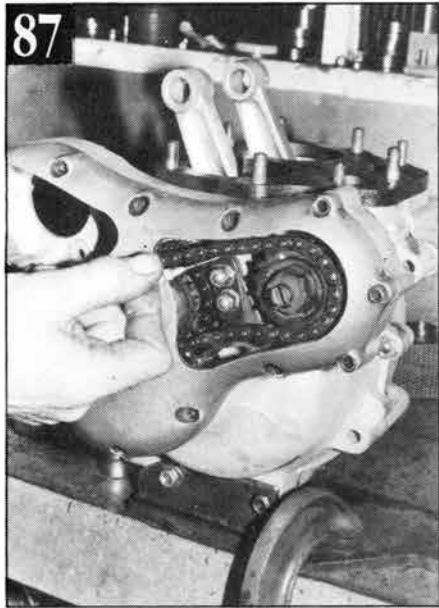


The wording must be uppermost.

- Top ring (chrome) is mared 'AE'. Again this must be uppermost. Usually this ring is coated in a pink substance. This is bedding in compound and it's best not to wipe this off.
- Stagger all ring gaps so that they do not line up.
- Be careful when fitting the cast iron ring. This is brittle and easily broken. The oil ring rails are steel and unlikely to break unless you really force them, but beware of bending them. The chrome ring is also fragile and could snap if mishandled.
- Oil all ring grooves and ensure that rings move freely in the groove.
- The ring gaps should be 0.003in per inch of bore.
- Chrome plated top rings should have a gap of 0.004in per inch of bore.
- If with new rings you have excessive ring gaps, as shown being measured in pic 90, then the bore is worn and rebore is required with next size up pistons.
- Oversize pistons are available, but supply varies.
- Almost all pistons for Norton twins are now manufactured in Italy and cost about £95 per pair complete with rings, gudgeon pins and circlips. But be very careful about breaking rings because rings are no longer available separately.
- Lubricate cam follower tunnels in the cylinder block.
- Oil cam followers. Note that the chamfer on the followers goes to the front of the barrel (pic 91).
- Cam followers are machined in pairs and when removed should always be kept together.
- Fit the follower locating plate between the followers and secure with the two locating plate screws (pic 92).
- Repeat procedure for other cylinder.

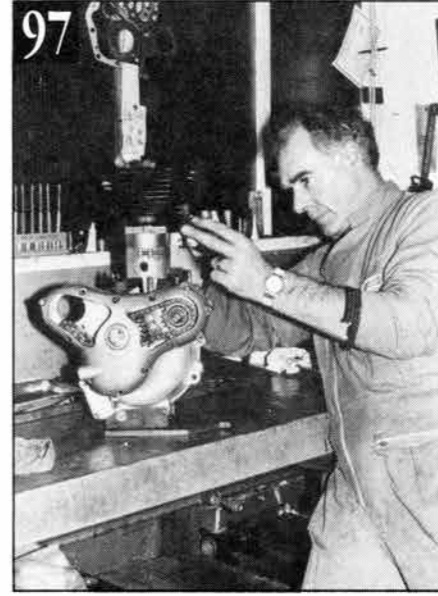


- Important: do not forget to lockwire the locating plate screws which have holes drilled in their ends for this purpose (pic 93).
- Fit new base gasket. Here Mick is using a Commando base gasket which is of thicker material and is a better quality gasket than an Atlas type. With regard to Dominator gaskets which are of the 'brown paper' type you will need to use Wellseal.
- Note oil drain hole from cylinder head and ensure that the gasket is not covering this hole (pic 94).
- On some gasket sets the gasket only has one hole and it's easy to fit it the wrong way up and cover drain hole thereby flooding the rocker boxes with oil.
- Note that gasket used had two holes so that it could be fitted either way up.
- Fit ring clamps and use blocks of wood to support pistons while fitting cylinder block (pic 95).
- Liberally oil bores and cam followers and cam lobes.
- To ensure proper lubrication for when the engine is first started Mick also smears Graphogen paste (pic 96) on all components just mentioned.
- Slide cylinders down over pistons and remove wood blocks and clamps (pic 97).
- Do not fully seat cylinders yet. Leave approximately a 1/16in gap so that base nuts can be finger fitted.

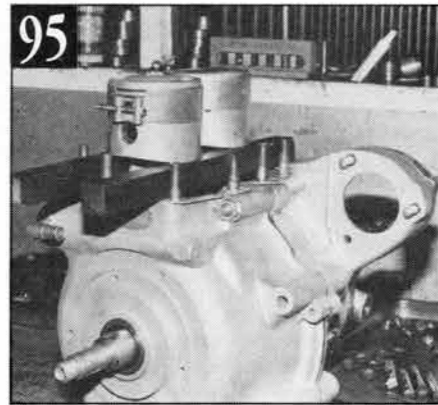


have three stud mountings instead of the bottom nut and bolt fixing.

- Fit timing disc to crankshaft and establish top dead centre by the following method: fit pointer to one of the base studs. A piece of welding wire can be used as a pointer. Get pistons at TDC and align pointer with zero degrees on the timing wheel (pic 98). Turn crankshaft backwards until pistons are approximately 2ins down the bores. Take reading off disc, in this example 87 degrees then turn crankshaft forward until pistons are down the bore to the same measurement, again take reading from disc. If readings are identical you have established exact top dead centre. If the readings are 2-3 degrees different, move the pointer to split the difference and repeat procedure to check. Keep moving the pointer until readings are the same. Then exact TDC is established.



- Note thick plain washers are needed. Tighten systematically using 1/4 Whit open ended spanner. Note that thread on the Atlas is 26TPI, but on the Commando it is 24TPI (threads per inch) which is UNF.
- We now move on to rebuilding the magneto.
- The slip ring had been faced off in a lathe. This is quite in order so long as the grooving is not too deep. If in doubt fit a new slip ring.
- Use high melting point grease on the bearings (pic 97a).
- Reassemble magneto and check end float of armature.
- This magneto did not have any shims behind the cap end plate. Usually there are two or three shims and it's in order to remove shims as necessary to ensure that armature spins freely.
- If the magneto is obviously unserviceable it would have to be sent to a specialist. Overhaul cost is pricey, between £100 and £150 being the usual charge. Ouch!
- To adjust the magneto points gap to the required 12 thou clearance, an easy method is to place the shaft in the jaws of



- a vice and rotate the body of the magneto having loosened the points lockscrew.
- On early models there is a simple nut and bolt arrangement rather than lockscrew and adjuster screw.
- Fit magneto gasket using Wellseal and fit magneto loosely to engine because the bottom fitting is a shouldered bolt and nut. This magneto is not adjustable. Some magnetos have stepped fitted studs which allow the magneto to move backwards or forwards to adjust tension of the magneto chain.
- Fit auto advance unit to chain and lightly tighten bolt using 5/16 Whit socket.
- A good tip is to use a sleeve bolt as fitted to BSA A10 engines, and this assists removal of the magneto when the engine is in the frame. This applies to models that

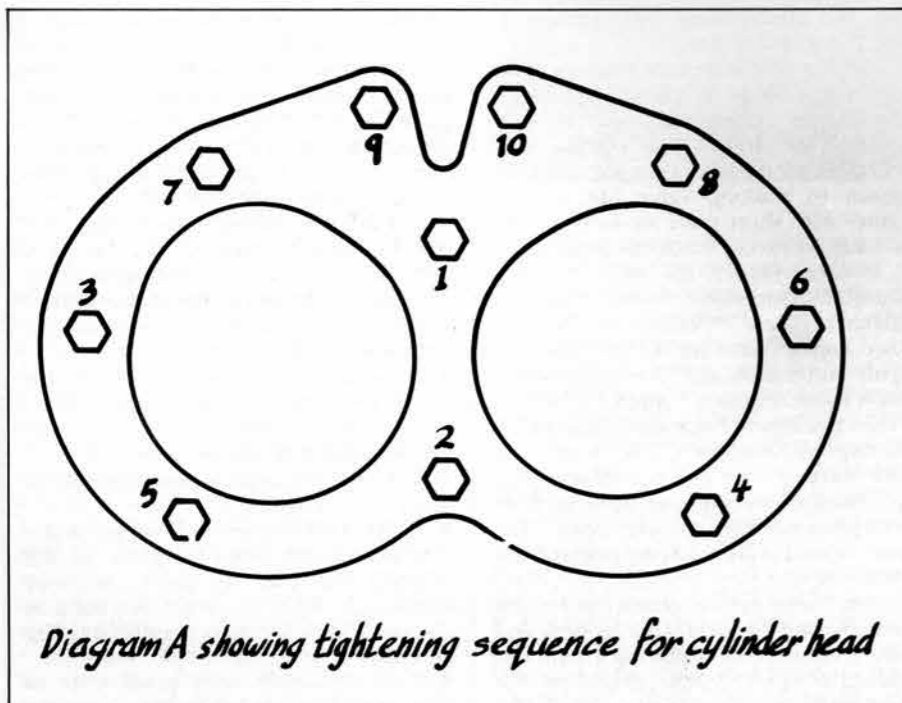
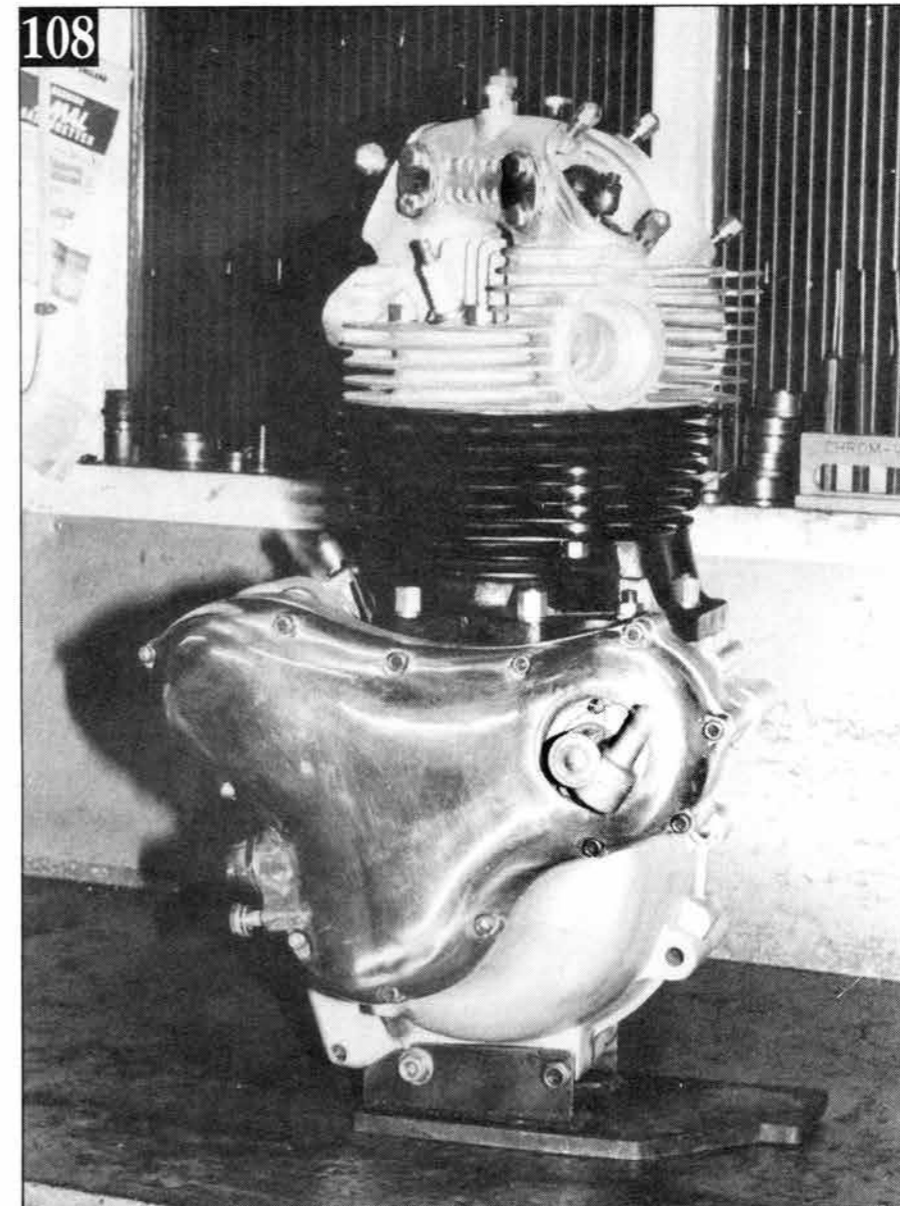
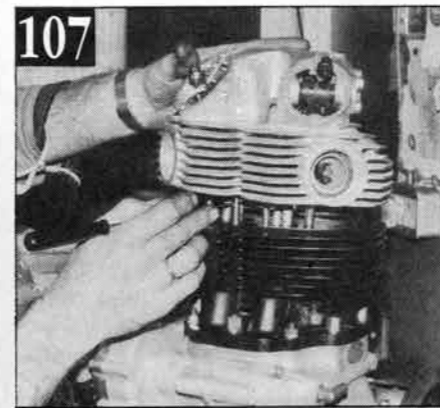
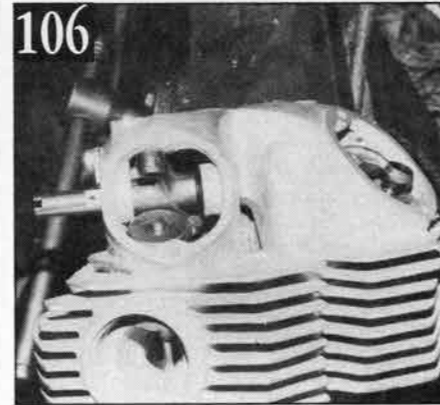
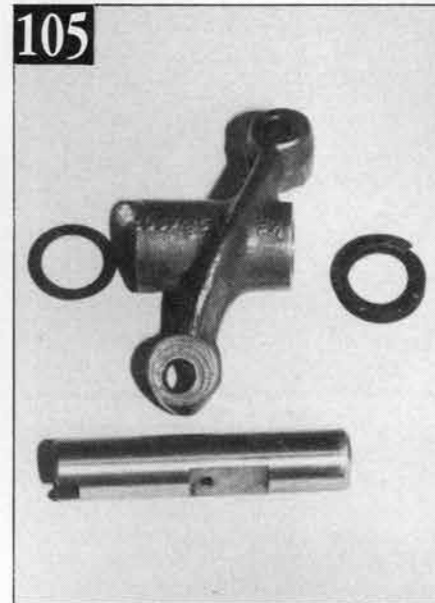
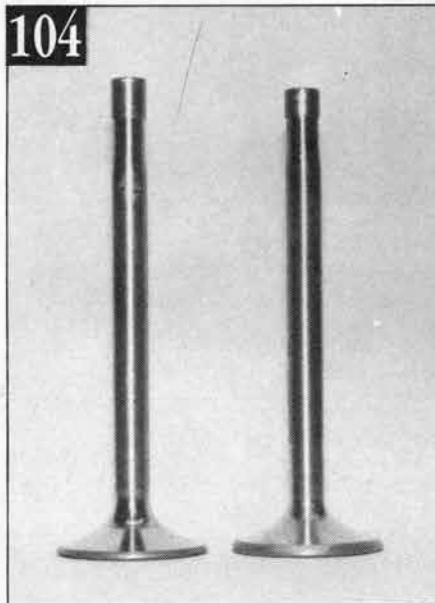
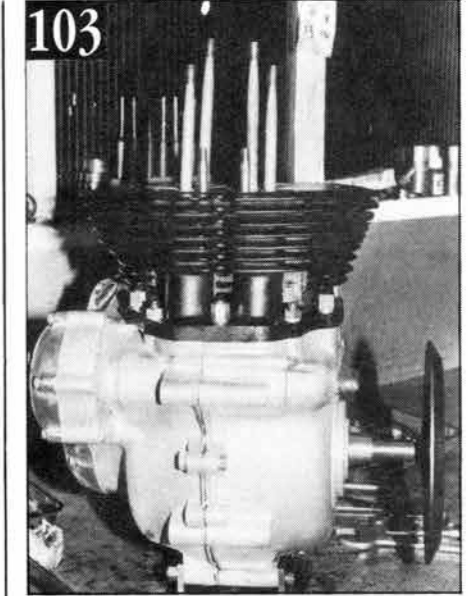
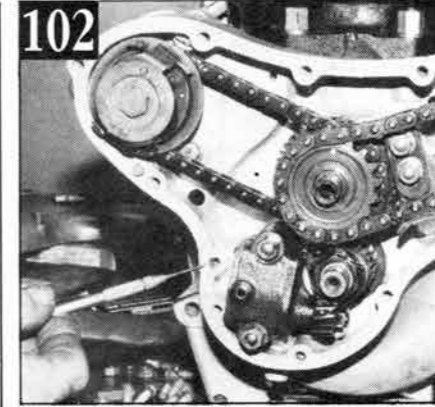
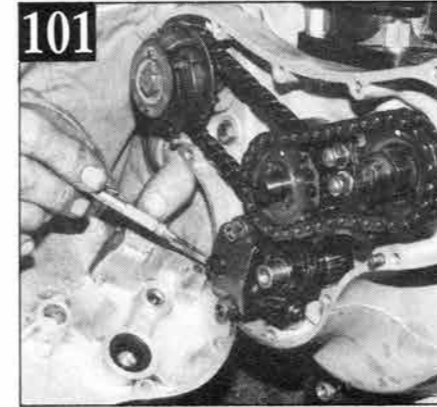
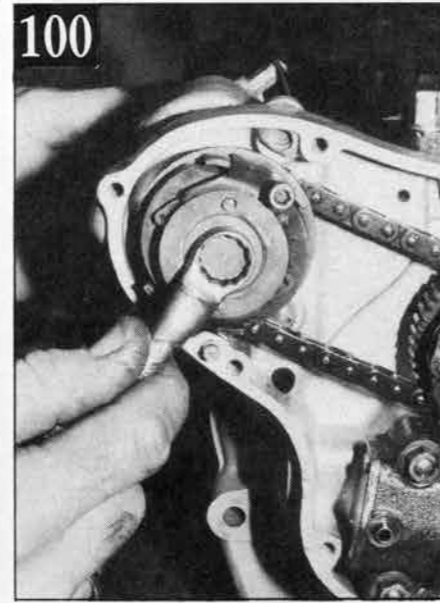
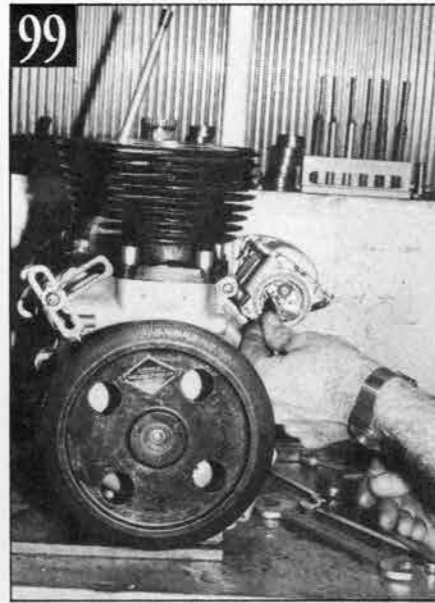
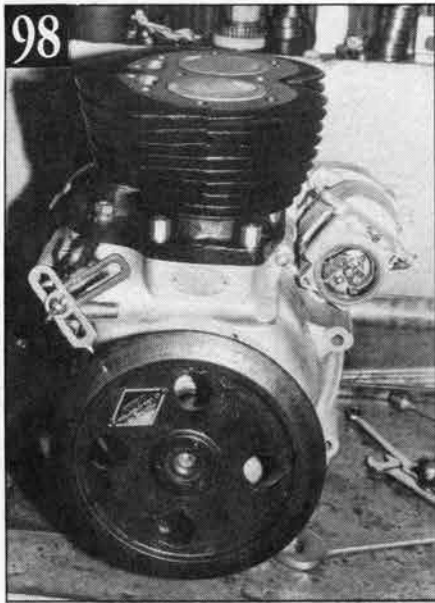
- Using a pushrod on the inner left-hand follower, turn crankshaft until the pushrod rises and falls. When pushrod falls keep turning engine forward until pistons reach TDC. This is now the firing stroke on the left hand cylinder, ie TDC with both valves shut.
- Ignition timing is as follows: Model 88 500cc 30 deg/1/4in/6.35mm BTDC (before top dead centre); Model 99 600cc 32 deg/0.307in/7.8mm; 650cc 32 deg/0.343in/8.69mm; 750cc Atlas 32 deg/0.343in/8.69mm; 750 and 850 Commando 28 deg BTDC. Note: Norton do not specify piston position for Commando.
- Rotate Atlas engine backwards until pistons are halfway down bore, then rotate forward until disc reads 32 deg (or pistons are 0.343in BTDC). Now turn magneto until contact breaker points are at approximately 8 o'clock and brass segment is just showing in rear aperture of magneto.
- Using a 0.0015in feeler, or piece of cigarette paper if you must, insert feeler in contact breaker which are shut at this stage and turn magneto clockwise until feeler is just free ie points beginning to open (pic 99).
- Now comes the tricky part! Fully open bobweights of auto advance unit and wedge open with a pencil or 1/4in bolt. Ensuring magneto armature does not rotate fully tighten auto advance unit (pic 100).
- Fit oil pump conical rubber washer to oil pump nipple (pic 101). This was missing from the engine when it was stripped. This seals the oil pump to the timing

cover.

- Fit new oil seal to timing cover with spring of oil seal facing inwards (pic 101) and fit retaining circlip.
- Timing cover can now be fitted. Mick used the later gasket for Commando, but do not use an Atlas timing cover gasket on a Commando.
- If the Atlas timing cover gasket were used on a Commando it does not fully cover the extra oilway (pic 102) in the timing cover and it would allow oil to escape from the big end feeds into the timing cover. This could result in a big end seizure.
- The Commando gasket again is thicker and of better quality. This is why we fitted an oil pump gasket (mentioned earlier). The oil pump gasket in effect spaces the oil pump body and ensures correct compression of oil pump nipple (cone) rubber thereby giving an oil pressure tight seal.
- When fitting timing cover use a small screwdriver in the tach drive to align tach drive gearbox with slot in camshaft nut. Do not force the cover on. Mick recommends an Allen screw kit to retain the timing cover rather than original cheesehead screws.
- We now move on to fitting the cylinder head.
- Mick drilled and retapped the four outer cylinder head holding bolts from 1/4in to 3/8in 26TPI bolts as fitted to later Atlas and Commando engines. This obvi-

- ously gives better sealing of the cylinder head gasket.
- Place pushrods into cylinder. The two long ones are inlet fitted to the inner followers (pic 103).
- One new seat was fitted to cylinder head because the original was damaged and new guides were fitted. New valves were also fitted. These were ground in using fine grinding paste.
- All 500, 600 and Atlas engines have short valve stems 0.100in (100 thou) shorter than Commandos and late 650 engines (pic 104). This was because rocker geometry was changed on later engines to prolong valve life. So, on engines with short valve stems you must use long pushrods. Pushrod lengths are as follows: Model 88 inlet 7.928in, exhaust 7.085in; Model 99 650 Atlas inlet 8.210in, exhaust 7.366in; all 650 750 828cc engines after no: 125871 (including all Commando and Mercury models) inlet 8.110in, exhaust 7.266in.
- Oil valve stems. Place into guide and fit heat washer, bottom collar, inner and outer valve springs and top valve spring cap. (Racing valve springs such as W&S have progressively wound coils. The closer wound coils are fitted towards the cylinder head.)
- Using valve spring compressor compress assembly and fit split collets and remove valve spring compressor tool. Tap valve tip using soft drift to seat collets. Pic 60 shows valve components.

- Fit rockers to cylinder head in the following order: shim washer, rocker, Thackeray washer (pic 105).
- When fitting liberally oiled spindle ensure that the flat on the spindle points away from the centre of the head, ie towards the valve (pic 106). If fitted incorrectly this can cause over oiling to cylinder head, a common problem due to improper assembly.
- Always use a new cylinder head gasket and Mick prefers to anneal even a new gasket (by heating to cherry red and quenching in cold water). Annealing applies only to solid copper gaskets, not copper-asbestos types.
- The order for fitting rocker spindle end plates is: gasket with hole in centre, plate with two tags - ensure that these locate correctly in the slot of the rocker spindle - followed by the plain gasket and the plain outer spindle plate.
- Mick also fitted copper washers to the end plate securing bolts, as on a Commando engine. The copper washers prevent oil leakage from the bolts.
- The cylinder head is now ready to be fitted to the engine.
- Hollow Allen screw type tappet adjusters have been fitted in place of the originals for ease of valve clearance adjustment. Mick does not recommend the use of alloy locknuts because they are unreliable.
- Turn crankshaft until pistons are at TDC and pushrods are as close to being



aligned as possible, then loop two rubber bands from rocker to rocker over the head (pic 107).

- Put one of the front cylinder head sleeve nuts between head and barrel to prevent head seating fully and using a long screwdriver hook in the pushrods ensuring the ball of the rocker is fully seated into the pushrod.
- Rock crank backwards and forwards gently to check location of pushrods.
- Loosely fit four outer head bolts. Coat the threads with Copaslip to aid future removal.
- Screw down outer head bolts until light resistance is felt. Note that at this stage there will still be a gap between head and cylinders caused by valve overlap.

- Fit centre head bolt and tighten down. Resistance will be felt as the head is fully seated and begins to compress the valve springs.
- Turn engine over GENTLY. Make sure the pushrods do not jump out. If all is well further tighten the four outside bolts and centre bolt.
- Make sure the outer head bolts tighten against the head and are not bottoming out. This can be checked by using a thin screwdriver to check the depth of the

- holes against the length of each bolt before inserting bolt. An extra washer on an offending head bolt could be fitted to act as a spacer.
- Next fit the two front sleeve nuts securing the head (pic 4) and nip up.
- Next fit rear, hard to get at, nut (pic 1).
- Fit the two 5/16in nuts and washer shown in pic 5. Nip up before final head tightening.
- Tightening of the head should be done in the order shown in diagram A. This

sequence is recommended by Norton expert and former service manager John Hudson.

- Torque settings: 3/8in nuts and bolts 30ft-lb, the two 5/16in nuts (nos: nine and ten in diagram) 20ft-lb.
- Remove elastic bands holding rockers and adjust valve clearances.
- There is a specific procedure as follows: rotate engine until left-hand inlet valve is fully open. Loosen adjuster locknut on right-hand inlet valve, and using the correct feeler gauge set clearance.
- Rotate engine until right-hand inlet valve is fully open and carry out the same procedure on left-hand valve.
- Turn the engine over until the right-hand exhaust valve is fully open, set clearance on left-hand exhaust.
- Turn engine over again until left-hand exhaust is fully open and set right-hand exhaust valve clearance.
- Valve clearances are as follows: Model 88 inlet 0.003in, exhaust 0.005in; 650SS, Atlas, Commando 750, 850 inlet 0.006in, exhaust 0.008in. Clearances set cold.
- Liberally oil valves, rockers and pushrods then fit rocker box gaskets and inspection caps ... and here we are in Mick's race workshop at 1am finishing off the usual past midnight rebuild to make the deadline for this issue (pic 108)!
- Before we go: when fitting HT leads to the magneto note that the rear lead of the magneto goes to the left-hand cylinder.
- Recommended spark plugs are N3 Champions with 0.025in gap (0.023-0.028in tolerance).

• FOR all Norton and Norvil requirements contact Mick Hemmings Motorcycles, 36-42 Wellington Street, Northampton. Tel: 0604-38505.