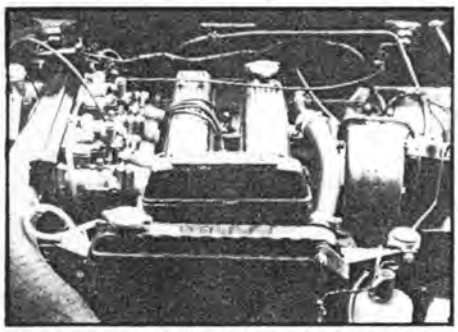
Lotus Elan +2 Engine Rebuild

Part 1: *Dismantling — the horror story, by Miles Wilkins.*

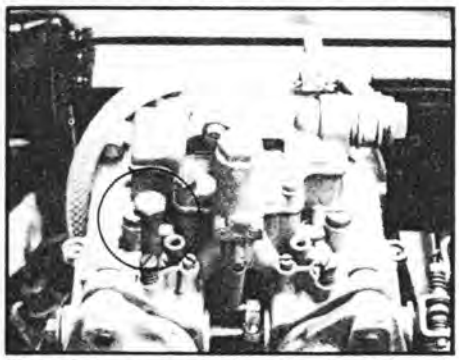
When I was asked by *Practical Classics* to rebuild the engine and gearbox for their October/ November 1984 competition prizewinner I had no idea what to expect. So it was with some trepidation that I opened the bonnet and found a very clean and completely standard engine bay, save only for a piece of braided fuel line and a bolt instead of the blanking screw on the front Dellorto. So often we find that the engine bay has been bastardised over the years and coupled to neglect and ignorance, the result is a mess accompanied by an engine not performing as well as it should, if at all.

All initial thoughts of a relatively easy task disappeared upon starting the engine to go for a test run. The engine clanked (literally) into life and after warming up would not idle at all, the carbs were way off and all the time this was accompanied by a light tapping

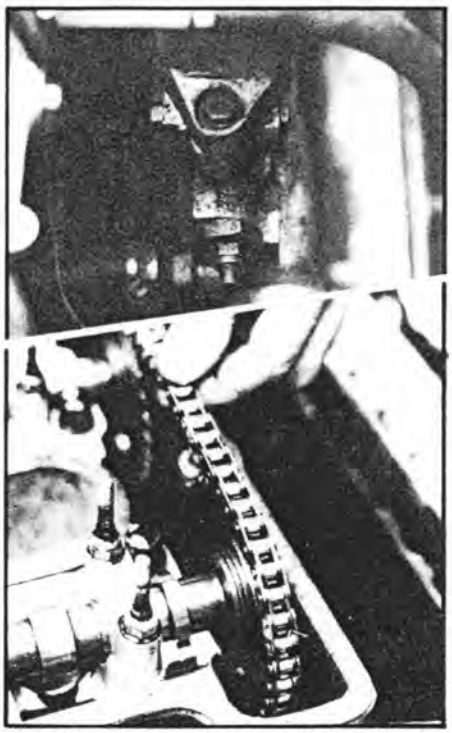


The very presentable and standard engine bay before any work commenced.

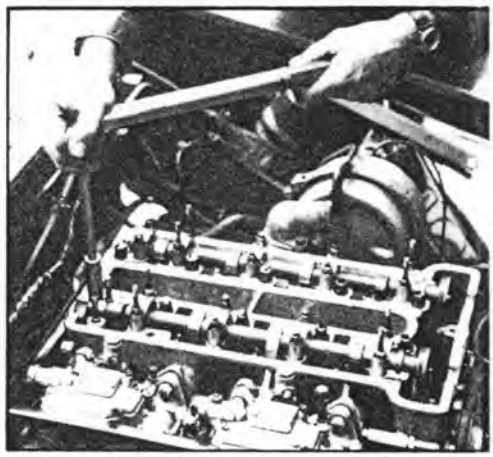
sound. A blue haze followed me too, both on acceleration and deceleration. There was no performance to speak of either, certainly not the 126 bhp of a big valve twin cam. However, one point that was uppermost in my mind was the distinct lack of brakes; in short the car was devoid of them and how the owner drove the car like this without having an accident I just don't know (the servo was full of fluid and will be rebuilt or replaced before the car goes back). This was going to be a "normal" rebuild we thought as the car was driven onto the lift. In the air, the oil was pouring out of every seam and the slick from



The bolt is not standard on No. 1 carb barrel! Braided fuel line should never be used as it hardens with age and becomes brittle and will eventually crack. This type of piping is the cause of many fires on cars.



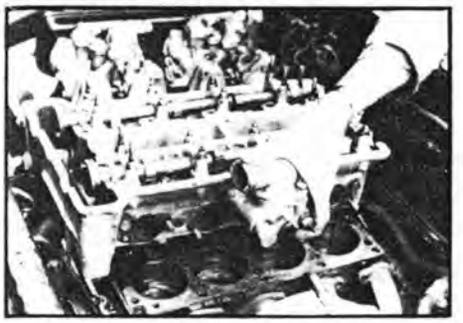
The timing chain tensioner is well in, indicating a worn chain. The ends of the threads are damaged as well. The chain is too loose, ½" total deflection at this point is the correct measurement.



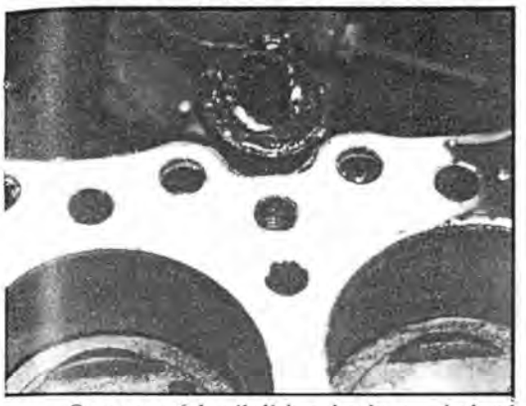
Undoing the head. The rear inlet cam bearing cap has to be removed to allow the socket to fit.

the rear oil seal had removed all the underseal from the underbody — at least the chassis won't rust for a very long time! We noticed that all four Rotoflex couplings were dangerously split, so these too will be changed before the car goes back.

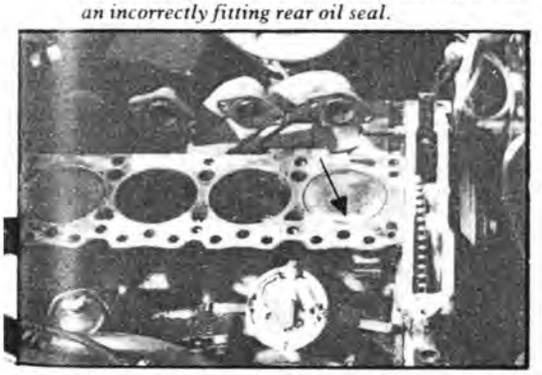
The dismantling procedure is straightforward. Remove the bonnet completely, drain the radiator and the sump, remove the airbox and trunking, undo the exhaust manifolds, all the hoses, oil line (if fitted), choke and throttle cables, all wires and the engine is



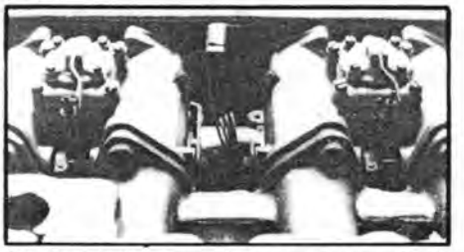
The head being lifted clear, carbs etc. stay on.



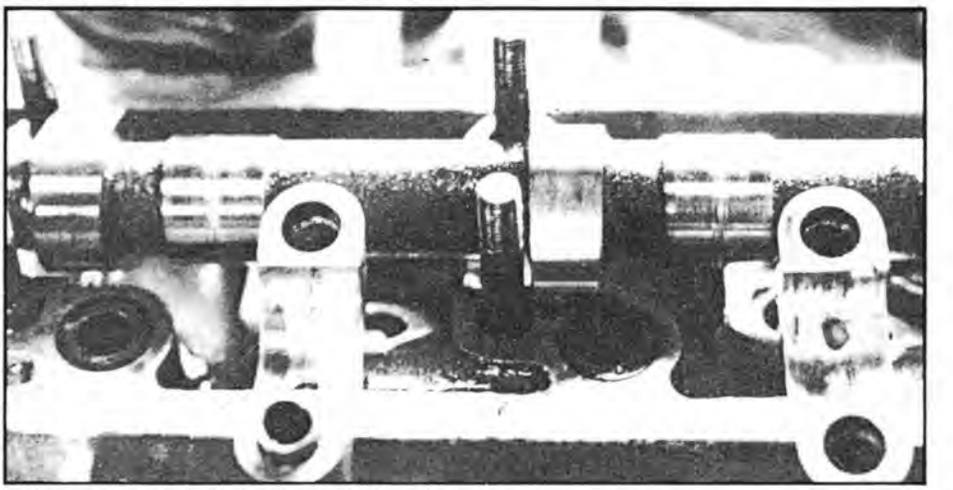
One cause of the oil slick under the car; the head to block rubber was not properly located in the head — a legacy from the last effort — allowing the draining oil to run out. The other cause was an incorrectly fitting rear oil seal.



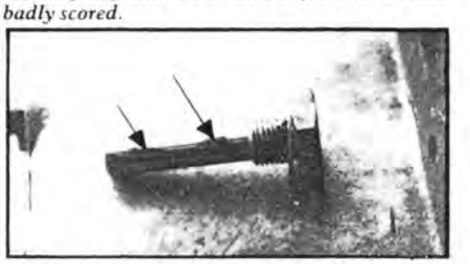
A general view showing the shiny mark (arrowed) on No. 1 piston where the valve had been hitting. There should be the correct cut-out rotor arm fitted, this standard one will be replaced. Note the high build up of oil coke in the manifolds.



The throttle diaphragm levers are set completely wrong. The rear carb was pumping in it's fuel way before the front one. There were two spring washers instead of Thackery washers holding the carbs on.



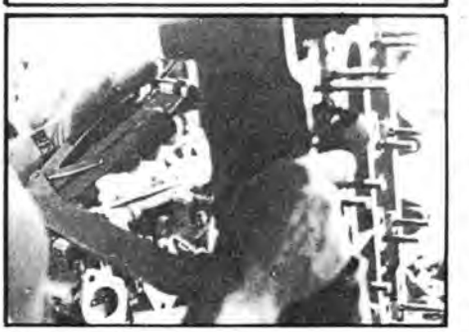
Both camshafts and all bearings ruined by the metal swarf and sand grit being pumped around. The oil pump will be thrown away as this was too badly scored.



The timing chain bracket pivot badly worn (arrowed).

Tools and equipment

Jack and axle stands • Engine hoist • ½" or ⅜" drive socket set (preferably ⅜") • A good set of A.F. spanners • Most important of all, a Torque Wrench.



Removing the valves using the correct headed compressor that allows you to get into the recess.

Note the oil trace in the port where the oil has been pouring out because of over reamed guides.

nearly ready to come out. I'm afraid we differ here from usual procedures by always taking the head off first, then removing the radiator and finally the block. We find it far easier to do this, as with the head out of the way all the bellhousing bolts and engine mounting bolts become so much more accessable, and can be undone from the top instead of grovelling from underneath.

So with the cam cover removed the sprockets were undone and the chain dropped down, front cover and head bolts were undone and the head lifted clear. We were appalled at what we saw; all inlet valves were hitting the pistons (this explained the knocking noise). The pistons (standard) were so slack in the bores that we initially thought that some idiot had rebored the block 20 thou and fitted std. pistons; upon subsequent measurement we weren't far wrong as there was an 18 thou gap (piston/bore clearance should be 3/3.5 thou). Two bellhousing bolts were missing and the starter motor was held on by one 5/16th nut and bolt through a 3/8ths hole. Needless to say this explained the awful clanking noise when starting; the ring gear was smashed to pieces. The starter motor was the wrong one anyway, being a three bolt fixing with a 10 tooth pinion instead of a two bolt fixing and a 9 tooth pinion. After all the bellhousing and engine mounting bolts were undone the block was lifted out of the engine bay revealing a heavily scored bellhousing — something had been bouncing about in there. The head was dismantled first and from here on it is a sad tale of woe, so I shall digress with another lecture coming up! Everything looked too clean inside the engine for 70,000 odd miles and many components looked as though they had just been changed; the valves etc. were all too new. The photographs show the mess.

I asked the owner if he had had any work carried out on the engine, — no — but the previous owner had, and had passed on all the invoices. It transpired that in October '82 the bottom end was rebuilt; the car still did not perform and in June '83 advice was sought elsewhere, and apparently the valve timing was wrong and a new split linked chain was fitted, no difference — surprise, surprise! The engine *still* not right, a third firm was sought in February '84 who diagnosed no compression and promptly did a head job. They sand-blasted everything in sight and fitted new guides and seats and finally skimmed the head. Unfortunately these half-wits over-reamed the guides, thus allowing the oil to pour out down them (see photograph). All the inlet seats had a 30 thou. gap between the head recess and the back of the seat and so the valve was sticking out too far, hence touching the pistons. Fortunately the seats had not moved, though they could have easily done so causing monumental damage. The head

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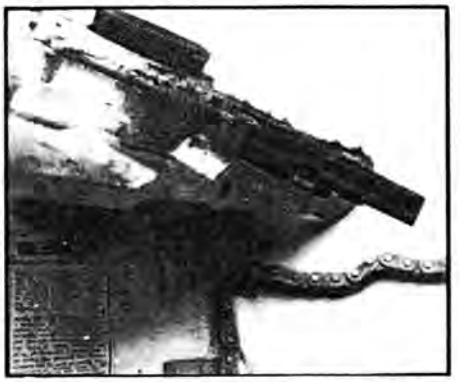
The inlet seat protruding way above the head face (arrowed). It had not been fitted correctly onto it's base in the head recess (all were like this).

The exhaust seat also on No. 1 was fitted badly as well. Note the gap (arrowed) between the seat and the head, presumably where someone had tried to force the old seat out.

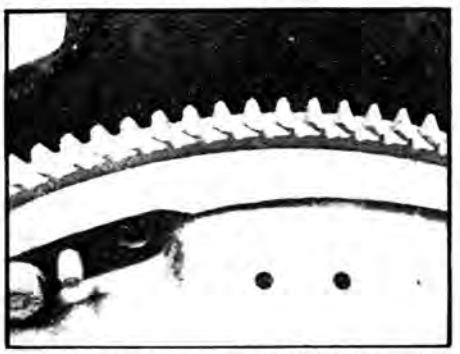
Removing the block is straight forward.

was not cleaned out and the remains of the sand and metal swarf were responsible for ruining both camshafts; the bearings and the main and big-end bearings were scored to the copper as well.

The bottom end was stripped down; the clutch was undone revealing an oil soaked plate, then the flywheel and front pulley. The sump next, (again lots of swarf in the bottom) followed by the front cover with the water pump, back plate and jackshaft. Finally, the



NEVER fit a split-linked chain. When the link severs, a hell of a lot of damage is done. The slipper is all chewed up. All that gunge around the water pump is not necessary either.

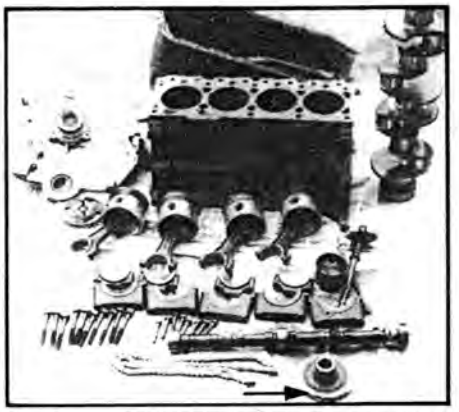


With the wrong starter motor held on by one bolt it is hardly surprising that the ring gear is smashed up.

Block core plugs are automatically changed by us on every rebuild. Only a build up of rust and Bars Leak prevented this rear plug from leaking.

pistons and crankshaft were removed. The latter will certainly have to have the main journals ground, the big ends may just survive with a polish. It took 8 hours to reach this stage.

What upsets me is that between these three idiots (libel prevents me from naming them!)



The bottom end laid bare. Note the front pulley flange (arrowed) all broken away. The crank suffered deep scoring on the main journals — these will have to be ground. The big end journals may survive with a polish.

Books

The workshop manuals tell all:
Elan at **£21** Elan +2 at **£31** Europa at **£35**, all + £2.50 p&p.
(Please note new prices from my last series of articles, I'm afraid Lotus have had two price increases since then).

the then owner paid virtually a thousand pounds for an engine that could never by any stretch of the imagination perform as it should. He sold it in April 1984 and the mileage has increased by only two thousand. Those of you who take *Practical Classics* regularly will understand when I say "Why, oh why do they do it?" It is certainly not cheaper since in 1985 we only charge the same amount for a completely balanced and blueprinted engine that WORKS. Surely the message must get through that there are some genuine Lotus dealers (of the old brigade) and a few specialists, who have lived with the twin cam engine for many many years; they do the best work, not the local garage mechanic.

Lotus have just announced a new Classic Lotus Scheme whereby just eight dealers have been appointed to undertake full restoration services on all aspects of the twin cam era cars. Their combined knowledge is unrivalled so please seek their advice first before spending your well earned money with these other jokers. □

NEXT MONTH
Reassembling the engine.

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Lotus Elan +2 Engine Rebuild

Part 2 Machining, reassembly, and more straight talking from Miles Wilkins.

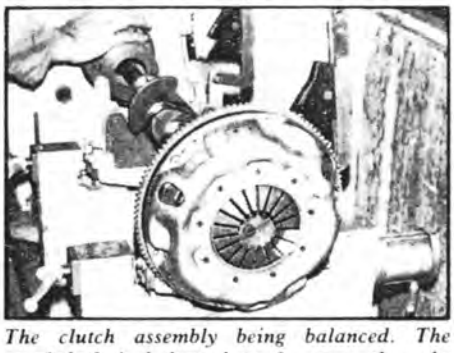
We left off last month with the engine stripped down in rather a sorry state – this article will deal with the assembly.

The first task entailed all the machining; the block was rebored to +20, new jackshaft bearings fitted (reamed to the jackshaft), and then the block face was checked for any distortion. The crankshaft and con-rods were crack tested (all passed), and the crankshaft was reground +10 on the mains, but fortunately the standard big-ends survived with a polish. New small-end bushes were fitted to the con-rods and reamed to the new gudgeon pins.

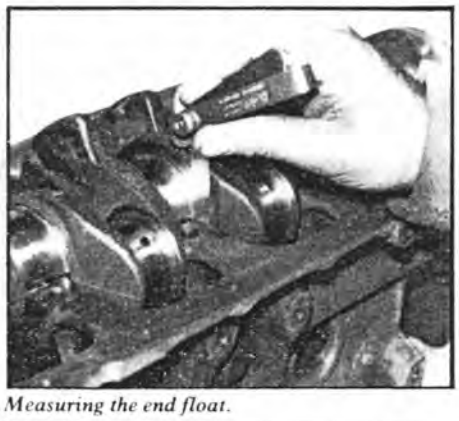
As we saw last time the head was in a terrible mess, and apart from the ill fitting seats, we found to our horror that the head had been skimmed a total of 100 thou; technically scrap as the maximum permissable amount allowed is 45 thou off a small valve head and 10 thou off a big valve. This was why the chain tensioner was so far in to compensate, and in turn had so drastically altered the valve timing that the opening and closing angles of the valves were completely wrong. I'm afraid the rebuild ground to a halt at this point as in my view the head was not salvageable. The alternatives were worse; new Weber Dellorto heads are at least a year away at a cost of over £1,000, new Stromberg heads are available, but Stromberg carbs are not, and in any case the owner did not want Strombergs and even if this was the only way out the bonnet would have to be changed and so on. The concerning factor for us was finance. *Practical Classics* were paying £1,500 and in the final tally this covered the engine, the gearbox being left (see later). The owner did not wish to put in any extra over and above his new brake servo and Rotoflex couplings.

I looked at over a dozen secondhand heads and I was appalled at the pure junk being offered for between £200-£300; our head was pristine in comparison! I can only hope that when the new heads are available all this secondhand junk dealing will cease. So with extreme reluctance the head was retained and new valve guides and seats were inserted. Mercifully the head was flat and true.

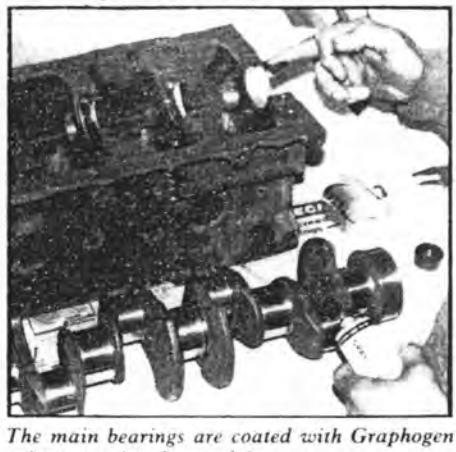
The piston assemblies being balanced. The other set of scales are used in conjunction with the first set for end to end balancing of the con rods.



The clutch assembly being balanced. The crankshaft is balanced on its own, then the flywheel added, then the clutch and finally the front pulley.

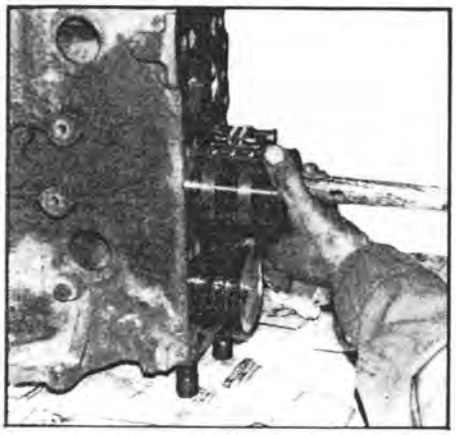


Measuring the end float.

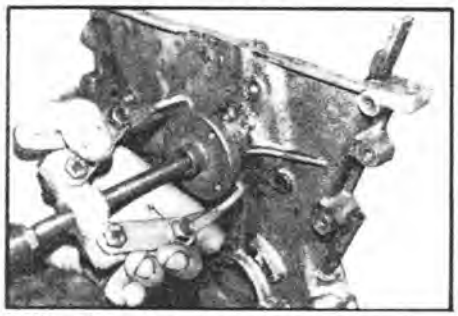


The main bearings are coated with Graphogen prior to putting the crank in.

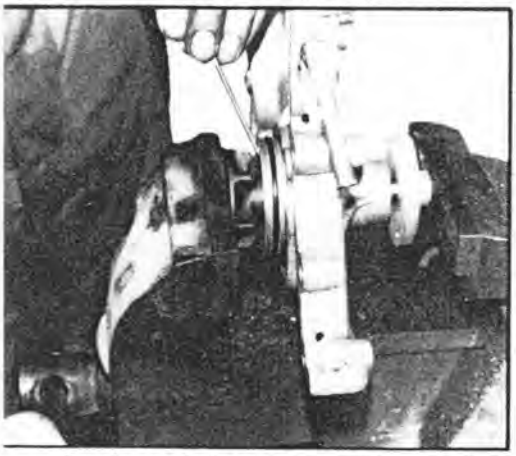
Torquing the main caps. They must be done in three stages, not pulled down in one go.



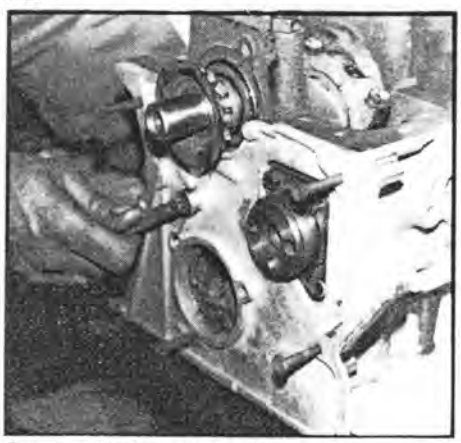
Fitting the pistons with the aid of a piston clamp, note the use of Graphogen again.



Pulling the water pump pulley off prior to cleaning, and re-fitting the pump, damper and oil seal.



Pressing on the impellor to give the correct clearance. The new bearing is pressed in with the front cover hot, i.e. leave it in boiling water for a few minutes. Make sure the seal seating area is scrupulously clean, and that the drain hole is clear.



Locating the back plate.

The piston crowns were machined at 30 thou. to reduce the compression and then these along with the con-rods, crank, flywheel, clutch and front pulley were balanced (Basset Down, Swindon does all ours; put simply, they are the best.)

The block was assembled first; all the components were thoroughly cleaned and dried, (it is essential that a great deal of time is spent cleaning all the oilways to remove traces of sludge and grit etc. So many good rebuilds are ruined by lack of cleanliness). The crankshaft goes in first, and the correct thrust washers fitted to take up the end float. In our case .025 were needed. The main caps were torqued down (make sure they go on in the right order please). The pistons were fitted next and then the jackshaft along with the new oil tubes. The rear oil seal housing went on next and then the back and front covers with the chain and water pump. Finally the sump was bolted down, the flywheel (with new ring gear) and clutch assembly were fitted; that completed the bottom end.

What you will need

Sealants: ***Graphogen*** on all bearing surfaces. ***Wellseal*** on head gasket, back plate, oil pump, rear oil seal housing gaskets, smear around core plugs and oil seals before fitting. ***Instant gasket*** on sump, f. cover, cam gaskets and cam D-plugs and on head to block rubber. ***Fire gum*** on all exhaust joints.

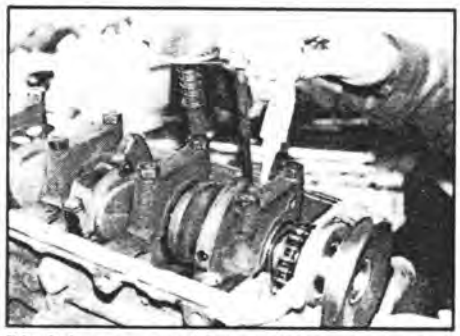
Tools: as part one but with the addition of a piston ring clamp, a good set of feeler gauges and if you do not own them and find you require them borrow a timing disc and dial gauges.

The workshop manual gives all the fits and clearances and torque settings. You cannot do an engine rebuild without it.

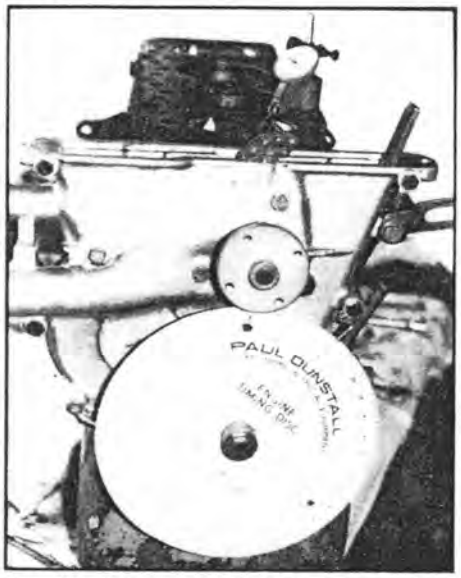
The head was assembled next; the valves were ground in, in the usual way, then fitted in with new valve springs, new cam shells and camshafts were required. The tappet clearances were done on the bench and when correct the head was mated to the block. Offset dowels had to be used in order to achieve the correct valve timing. (If the standard dowels were retained then the valve timing would be a whole tooth out with the strong possibility of valves hitting the pistons, or the engine would be extremely rough).

The engine was painted in the correct Lotus grey (not red, yellow, pink or blue – they were grey when they left the factory), and then the ancillaries were fitted, namely the fuel and oil pumps and the distributor. The carbs were overhauled next; completely stripped down, cleaned and reassembled with all new gaskets and seals. New pump diaphagms, springs and rods were required (see part one).

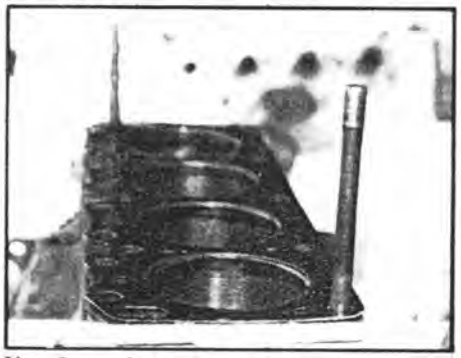
Although now outside the £1,500 limit the owner had mentioned his speedo was not working; he had replaced the cable and right angled drive unit to no avail. As a working speedo is required by law and the gearbox was out of the car anyway it was senseless not to rectify the problem. The propshaft flange nut had become loose allowing the gear to slide out of contact with the speedo drive gear going into the right angled drive unit. Apart from a broken cable this is the most common



Block is now assembled and Hermetite Instant Gasket is used on both sides of the sump gaskets and corks.



Use of a dial gauge to find the true top dead centre; then the timing disc can be fixed in the correct place.



Use of two adapted head studs to guide the head down. Note the head gasket is thinly coated with Wellseal on both sides.

cause of speedo failures on the five speeds. The front and rear oil seals were replaced (leaking), as were all the gaskets. The extension housing bearing was replaced as well.

With a new gearbox mounting the gearbox was placed back in the car followed by the engine, the exhaust manifolds were laid in and then the new engine mountings were bolted up, the alternator fitted and then the carbs, radiator and all the connections made good. The car was raised up on the ramp only to find that the new stainless steel manifolds (supplied by the owner and made by a well known firm) were going through the gearbox. After two hours of heating and bending the whole system fitted as it should (this

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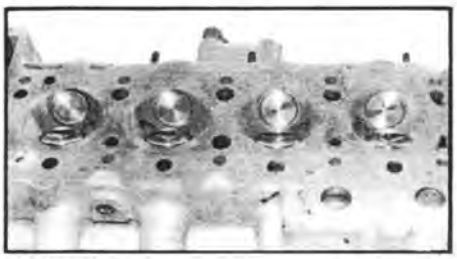
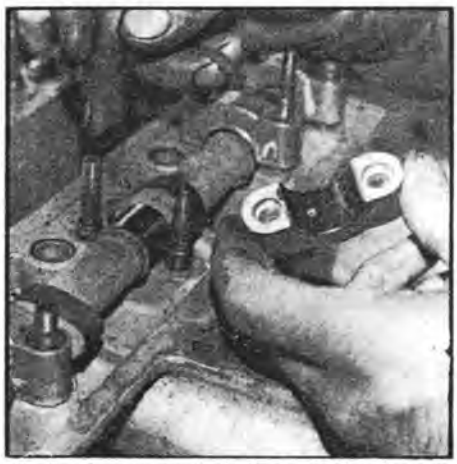
Lapping in the valves. Engineering blue is used to show any imperfections on the seat face. When an even "colour" is seen the seating face is perfect.

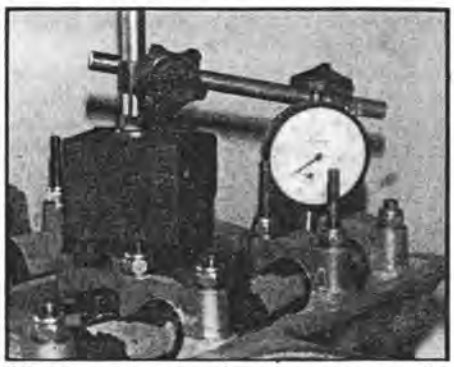


All the valves in.

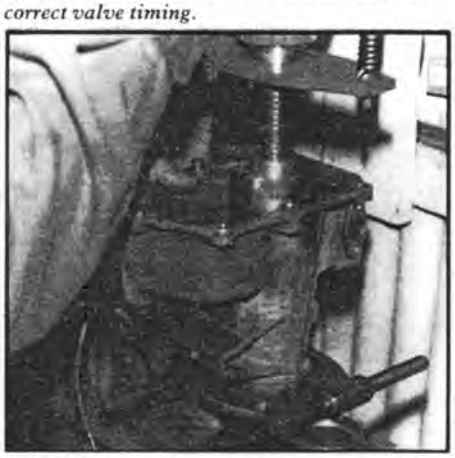


Placing the new camshafts in. Again Graphogen is used on the bearing surface.

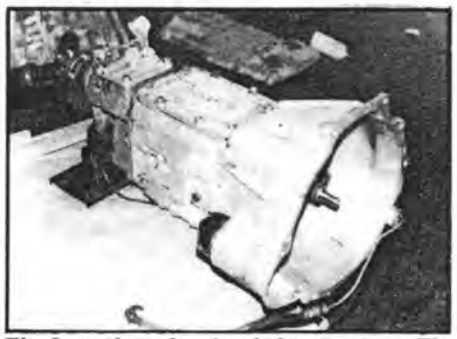
Measuring the valve clearances. With all new valves, seats etc. start with a nominal 80 thou. shim and work up.



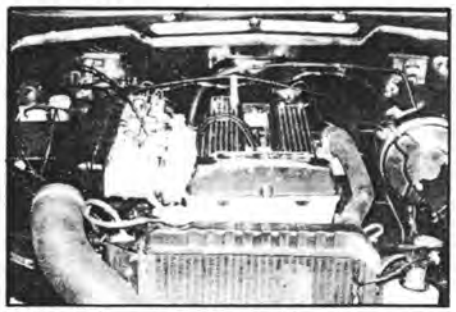
All clearances measured — always use new nyloc nuts. The dial gauge is set to measure the exact point of full lift on the cam and used in conjunction with the timing disc, the degree of offset for the dowels can be worked out in order to give the correct valve timing.



Using the press to remove the extension housing bearing.



The 5 speed gearbox just before re-fitting. The 'box goes in first followed by the engine; this is much easier than struggling with both already bolted together.



All back! Note the new braided fuel line, and new brake servo. All water hoses were replaced as well, since all were perished.

included bending the downpipe and silencer as well, since the set was way off). God knows if these firms are going to copy the original, for pity's sake they should get it right as the failure to do so cost the owner £20 in unwanted fitting charges.

All the fluids were done, battery connected and the engine was spun over without the plugs in until the carbs were primed. With the plugs fitted the engine fired and ran immediately. The timing was set with the strobe and the carbs were set up. Finally a 30 mile road test was done before the owner received his car back with strict instructions to run it in properly; i.e. not to exceed 3,000 rpm for the first 1,000 miles, then increase by 500 rpm over the next 500 miles and then gradually increase the rpm until the maximum revs are achieved at 3,000 miles. An oil change must be done at 500 miles and at 1,000 miles we will have the car back to check the valve clearances and chain tension etc. By looking after your engine in this way and sticking to the 3,000 service schedules (which hardly any of you do with very expensive disasters later on) the engine will be fine for 70-80,000 miles before the bearings have to be replaced.

A few points to finish with: so much drivel has been written about the twin cam engine that I have to put the record straight; they are the most reliable of engines, and in their production period only two warranty claims were prevalent. Oil usage (in fact not a problem since owners were told that the engine was designed to do around 400 per pint), and the water pump (but in nine cases out of ten it was owner-induced by overtightening the fan belt). They *do not* leak oil, the water pump *does not* fail every three minutes as some "specialist firms" lead us to believe and they *do not* eat ring gears and starter motors. Sadly the engine is a twiddler's paradise – carbs bolted solid, mixture screws anywhere but where they should be, high pressure oil pumps pouring oil out of every gasket, starter motor locating plate broken, wrong bendix etc. (110 tooth ring gear, 9 tooth bendix is what the factory fitted from day one, *nothing else*). Water pumps when they are genuine (please make sure you get everything, not just the Ford Anglia bearing as some people dish out) and correctly installed will last for at least five years. I will stop now before I give too much away as I am in the process of writing a book on the twin cam engine which will be published by Osprey next year and will give the full history from its inception to its end including a full strip and rebuild of the engine. There will be over 350 photographs and all the power figures you will ever want.

If you get stuck please don't hesitate to phone or write to **Fibreglass Services**, Charlton Saw Mills, Charlton, Singleton, Nr. Chichester, West Sussex, telephone Singleton 320. Don't go blindly on and wreck your engine. □