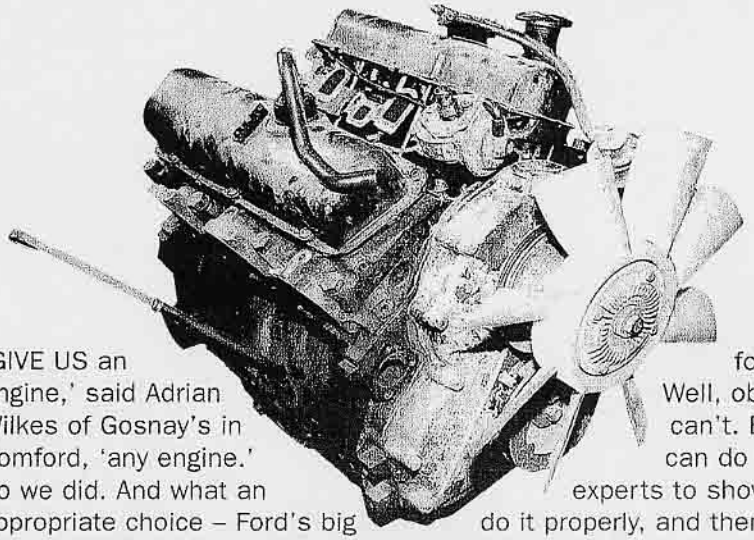
Essex 3-litre V6

Could you rebuild Ford's flagship motor from the Seventies for just £1? Maybe not, but we could do it for you

part one

FANCY AN ENGINE FOR A QUID?



'GIVE US an engine,' said Adrian Wilkes of Gosnay's in Romford, 'any engine.' So we did. And what an appropriate choice – Ford's big V6 going back to its Essex roots.

This was part of the family of new V-engines developed by Ford UK in the Sixties, and first seen under the bonnet of the top-of-the-range Mk IV Zodiac in April 1966. Rough, rugged and a bit of a slapper, it went on to power Mk I and II Granadas and Capris as well as a host of cars from smaller manufacturers – TVR, AC, Gilbern, Reliant and Marcos have all turned to Essex for a bit of extra power.

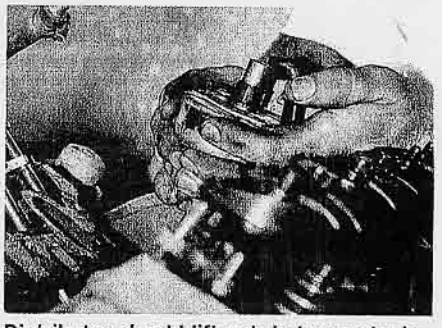
But since the Essex is a for just £1? Well, obviously we can't. But what we can do is pay the experts to show us how to do it properly, and then give the finished article away in an easy-to-enter competition that costs just a pound to enter. Get the idea?

Now, you may well be ahead of me in guessing which particular Essex we sent trundling down the A1 from Peterborough. Ever since editor Will Holman hoiked the original motor out of his Mk I Capri to make way for a Ford V8, we've had a 3-litre Essex gathering dust in the workshop. We knew it was a runner; we knew it was down on power and we knew it would cost a

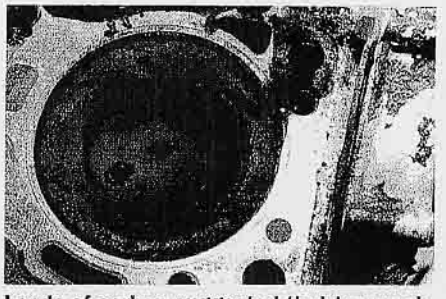
Going topless

THE FIRST step for our expert Dave Woods was to strip off the bits that didn't form part of the rebuild. If you're paying someone else to do the work, you should really do this before handing your engine over, because it minimizes the danger of anything getting broken. It's mostly the bolt-on ancillaries that need removing, stuff like the alternator, distributor, fuel pump and fan.

Unfortunately, not everything was ready to come off just yet. The distributor should have lifted out once its retaining bolt was removed, but corrosion, muck or a mixture of both was locking it firmly in place. And the fan, because it contained a viscous coupling, couldn't be locked into position firmly enough to undo its bolts. It would



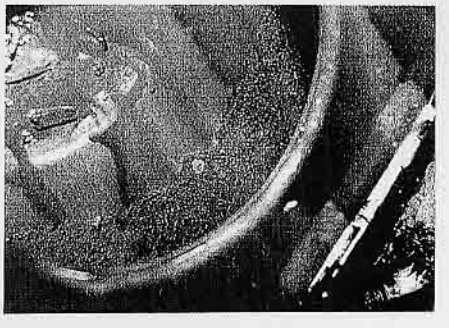
Distributor should lift out, but was stuck. Instead of using force, we left it until later.



Loads of carbon suggested that too much petrol had been sloshing down the bores.

Bearing the strain

STRIPPING any engine involves a bit of a detective work: figuring out both how it has worn and what has been done to it in the past. The fact that the rocker gear was



ave been easier to take this off with the
an belt still in place to provide some grip.
nstead, we had to leave both fan and
istributor where they were until we had
etter access to them.

But Dave did take off the clutch and
ywheel to lighten the load, before lifting
he block onto his engine stand. Whenever
ossible, he prefers to hang the engine off
ne of its side-mounting brackets rather than
n the end of the crank. That way he can
trip the engine from all angles in one go.

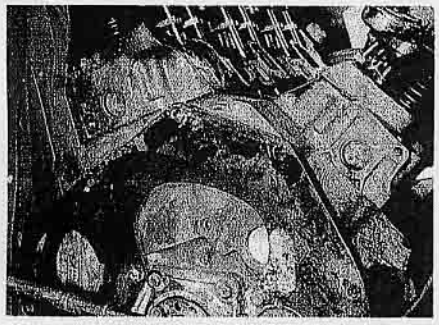
There is no single order that other
omponents have to come off the engine.
)ave started with the front pulley, holding it
tationary with a pry bar held between two
olts in the other end of the crank. Then,
sing one lever on either side of the pulley to
top it getting twisted on its shaft and stuck,
he persuaded it forwards and off the crank.

The timing cover could have come off next, but there is a row of bolts underneath holding this to the sump. So while the engine was this way up, Dave took the heads off. The head bolts didn't feel like they were torqued down properly, but there were none of the usual signs (black lines or bits missing on either the heads or their gaskets) to indicate that the head gaskets had failed and the engine was blowing. But there was a whole lot of black carbon on pistons and valves, showing the engine had been running with the fuel mixture way too rich.

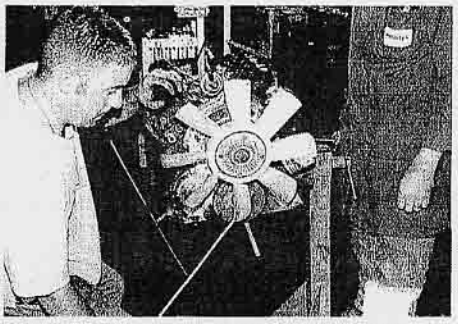
When the heads come off, the pushrods will get lifted up and drop. So if you only expect to be carrying out minor repairs, make a record of where each one came from so that they can go back in the same place.

With the heads off, we got our first view of the bores. These looked good and there was virtually no wear ridge at the top, indicating that the engine had undergone some internal surgery in the past. Unfortunately, the pistons were so carboned up that we couldn't yet read the markings on their crowns to see how far, if at all, the block had been re-bored.

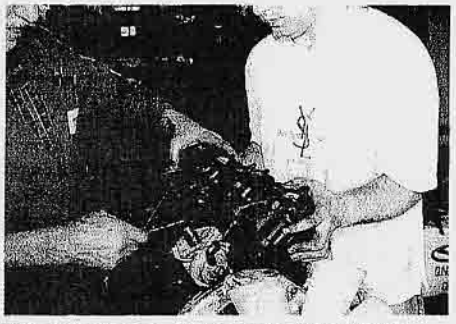
Next step was to remove the timing cover complete with the fan, giving us access to the timing gears themselves. Of these, the smaller wheel on the crank is cast iron, while the larger one on the crank has fibre teeth. The idea is that having fibre meshing with iron is quieter than metal-to-metal contact. It's not unknown for the timing gear to strip the fibre teeth, but this rarely happens unless there is a separate major fault in the engine. In normal use, the cast wheel wears first.



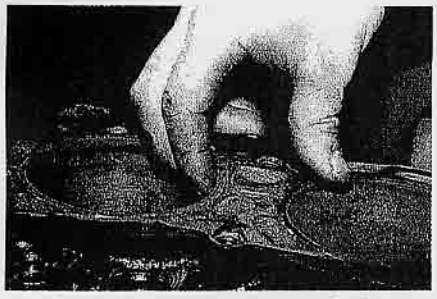
ake care not to damage the backplate, r you may struggle to align gearbox later.



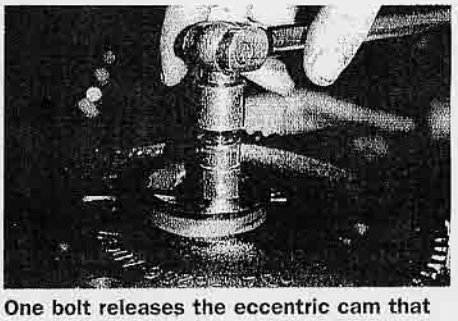
While Dave senior locks the crank, his son applies muscle power to the front pulley.



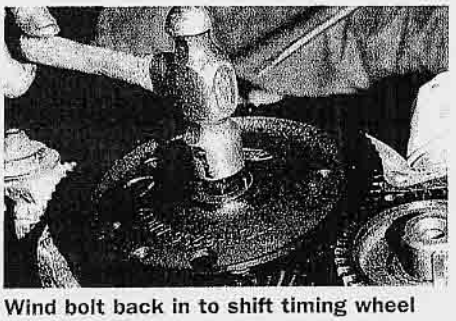
This is when an extra pair of hands is useful, to gather and label pushrods.



ut minimal bore wear suggested this was ot the result of a long-running problem.



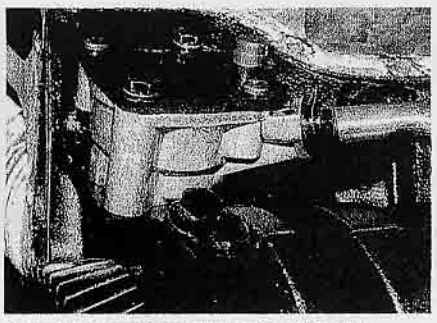
One bolt releases the eccentric cam that drives the mechanical fuel pump up front.



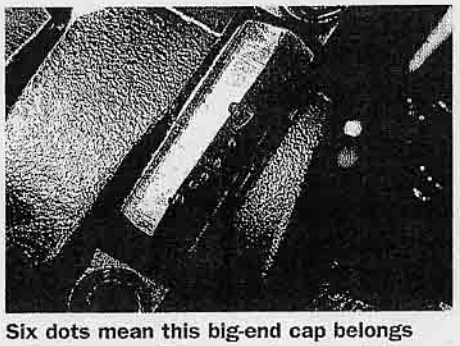
Wind bolt back in to shift timing wheel with gentle taps and a little leverage.

ntirely free of sludge suggested that this
ngine had either enjoyed very frequent oil
hanges or had been recently cleaned, and the
noothness of the bores hinted at over-size
istons. With the sump off, we could add
ome facts to our speculation.

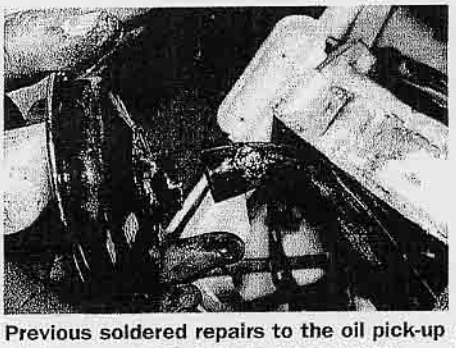
The oil pump was still a light grey colour rather than blackened like the crankshaft webs, which suggested that it hadn't been fitted long. Unfortunately, as we lifted it away the pick-up strainer fell off. This had clearly been broken in the past and soldered back into position. We could also see for sure that the pistons had been out in the past because someone had dot-marked the big-end caps. This is essential because conrods and caps are manufactured as a pair and mixing them up during reassembly will accelerate future wear.



lew oil pump was shiny grey. It will ventually dull like the crankshaft webs.

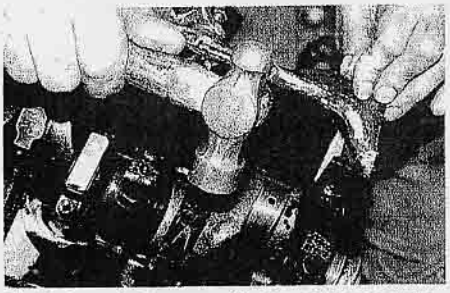


Six dots mean this big-end cap belongs with the conrod from number six piston.



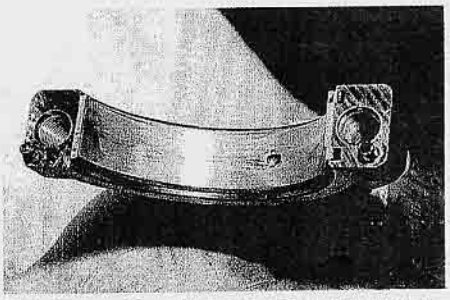
Previous soldered repairs to the oil pick-up strainer proved to be less than durable.

Bearing the strain/cont

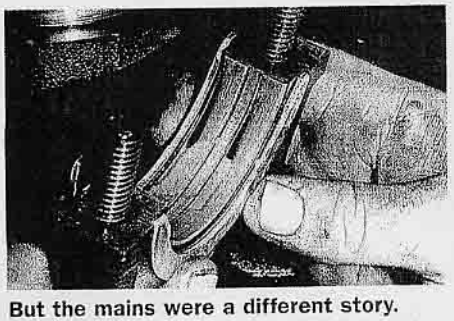


Light taps to loosened bolts will separate conrod and cap, but you must be gentle.

Pistons and con rods can then be pushed out from below. Ours were almost new.



This big-end bearing was worn, but would have stayed quiet in a running engine.



But the mains were a different story. Three of the four were completely shot.

This might not mean anything to us, but

The caps themselves are located on a dowel, and they can be hard to shift. Dave undoes the retaining bolts a couple of turns, then lightly knocks them with a hammer to push the conrods away and break the join. But he stresses that it takes just a light tap – damage the threads in the conrods and you'll have to buy a new set of those too.

The big-end bearings themselves and the crank journals beneath them looked in pretty good shape, with just some slight marking where specks of muck had been carried through in the oil. But when we took the front big-end bearing off, this was in considerably worse shape. The white lining material had worn away in places so that the copper backing below was showing. It might have already started knocking in this condition, and left to its own devices would certainly have started to do so soon. But if that one was bad, the rest were terrible, with virtually no lining material visible.

If you've never examined a shell bearing before, a quick summary of how they work will show why I have described these as terrible. Each bearing is made up of two semi-circles, one sitting in the conrod and the other in the cap. These are clamped around the crankshaft. The main part of the shell is made up of steel and copper for strength, with just a very thin layer of softer tin on the face that sits around the crank.

In theory, this tin is an insurance policy because the crank and bearings should always be separated by a layer of oil and never come into contact with each other. But any muck in the oil scrapes away at the soft lining. Once this has gone, you get hit with a double whammy – the effective diameter of the bearing becomes larger, allowing the crank to slap around, and as this then rubs against the harder shell material, the crank's smooth surface gets damaged.

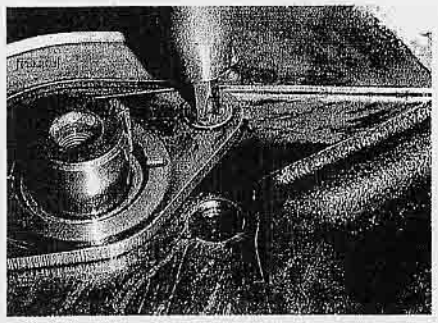
Now for some more detective work. All the bearings were genuine Ford parts, the mains marked BA and the big ends CA. A quick check in an ancient parts book showed that these were standard size and 0.010 inch respectively. Always take the old bearings with you when ordering new ones because some engines had to be line-bored at the factory to correct minor errors, creating, in effect, over-size bearing housings. Put standard size bearings in these caps and the crank will wobble all over the place.

It is quite possible that the engine left the factory with these different-sized bearings fitted because manufacturers in the Seventies still found it cost-effective to re-machine faulty components. But it's also possible that someone splashed out on new pistons and grinding the big-ends journals, then saved a few quid by re-using the main bearings.

Dave is a bit more charitable and suggests a third possibility. With the fuel mixture being so rich, petrol washing down the bores could have diluted the oil, leading to new bearings failing very quickly. This observation is based on many years of bitter experience when customers have paid for a reconditioned engine, only to slap on the

A matter of timing

THE CAMSHAFT was next to come out. This is held by a thrust plate, and the two screws securing this can be difficult to shift because of the locking compound on their threads. An impact screwdriver should shock them loose, but don't use too much



Firm whacks will shift these screws, but take care not to break the thrust plate.

Two heads, no aches

THE HEADS do an incredible amount of work in a running engine and look really complex, but stripping one down doesn't take long. A quick tap on the valve stems with a copper hammer frees them up enough for the valve spring compressor to

Remove pushrod guides early because they're easily broken if left on the heads.

Our experts

GOSNAY'S Engineering in Romford, Essex (01708 740668) have more than 65 years of reconditioning experience. They can supply a huge range of engine components from stock and provide precision engineering services, from a simple skim to a full rebuild of any engine.

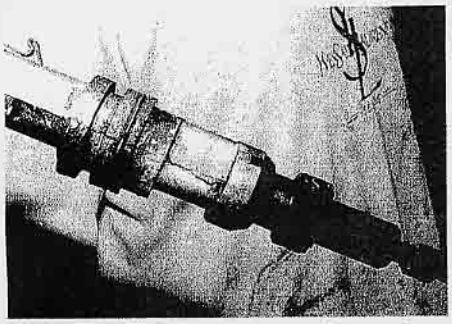
Keeping a watchful eye on our project is Dave Woods, Gosnay's workshop supervisor and one of the company's directors. He's racked up 39 years with the company and is being helped on this job by his son, also Dave, a mere youngster with just five and a half years' company experience.

Next issue:

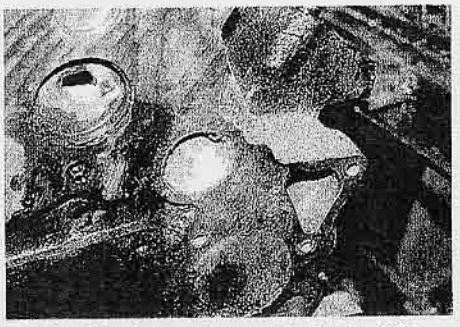
welly – the screws sit in a taper and they can crack the thrust plate.

With the thrust plate out of the way, the camshaft should slide out towards the front of the block. Ours came out part way, but then got stuck. This can happen when crud builds up on the cam next to a bearing. As the cam is slid along and this build up tries to pass through the next bearing, it's too big to fit through the hole and gets stuck. But when a few light taps on a drift failed to shift our cam, instead of reaching for a bigger hammer Dave went in search of the obstruction.

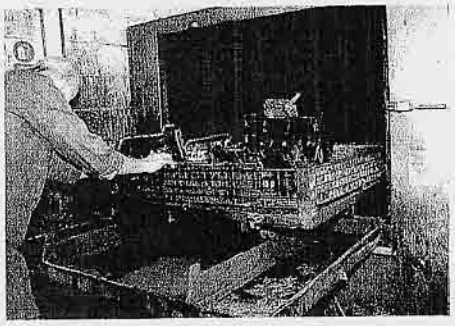
First suspects were the cam followers which could have fallen between the lobes and got the cam jammed, but all of these were already out. Then he remembered that we'd had to leave the distributor in place earlier. This was now snagging on the cam. He knocked it out from below and the camshaft slid out without further aggro. Then, once the filter and the engine front plate had been taken off, the whole lot was loaded into the degreaser for cleaning.



This crud on the distributor shaft was the reason why it wouldn't leave the block.



Rust points to previous water leak, but this shiny core plug had been replaced.

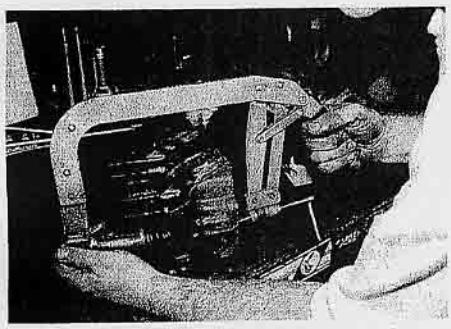


Final step before detailed examination is a thorough clean with chemicals and steam.

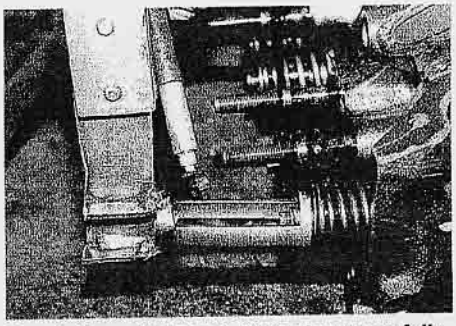
squeeze the springs and free the collets (there's a washer on top of the valve spring, and the collets are the two semi-circular rings that stop it sliding off the end of the valve). Dave picked off the collets with a special tool, although the rest of us can make do with a magnetic screwdriver.

The valves themselves were in reasonable condition and seemed to be seating all right, but both they and the valve seats had a slightly rounded profile instead of a machine-fresh line at 45°. That suggested they had been lapped-in by hand in the past, but that the seats hadn't been re-cut. Waggling the valves in their guides showed that these were slightly worn, but not excessively so.

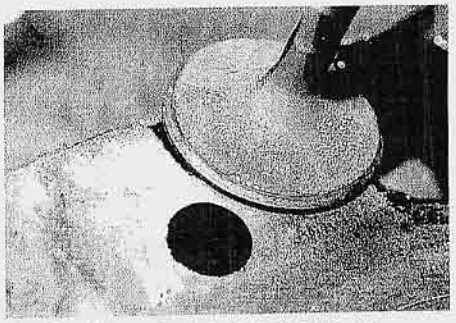
If we were simply cleaning up the faces and re-using the valves, we could leave the guides alone. But we want to convert the heads to unleaded, which involves re-cutting the seats. Whenever you do this, you have to fit new guide inserts too because the cutting machine uses them to locate itself. If your guides are worn, your valves will end up off-centre too.



Dave's universal spring compressor makes a tricky job very simple and costs around £20.



Count the collets and store them carefully. Getting replacements will slow the rebuild.



Seating face of valve is concave, so they've previously been lapped-in by hand.

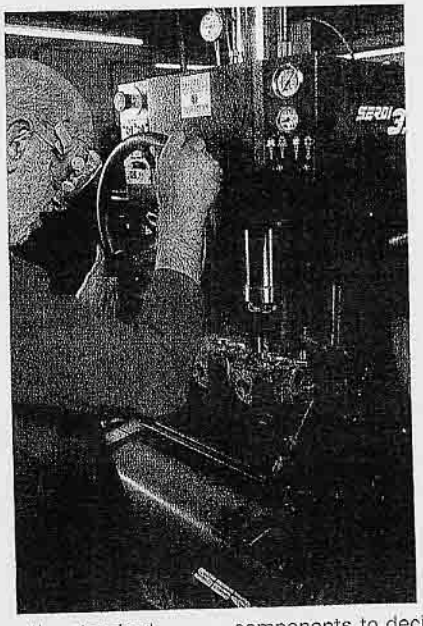
Essex 3-litre V6

Cutters, grinders and milling machines all take chunks out of our motor. But that's good news for the lucky reader who's going to win it

Part two

FANCY AN ENGINE FOR A QUID?

UNWANTED and unloved, this is the engine that editor Holman callously hoiked out of his Mk I Capri and abandoned in the workshop. Surely it didn't deserve such a fate? After all, it might have been down on power but at least it ran after a fashion and didn't belch any more smoke than your average steam train.



So we sent it down to Gosnay's Engineering in Romford and asked them to take a look.

As a rule, they charge a little over £1100 to recondition an Essex V6 to the industry standard BS AU257. That sound's like a lot of money, but then the standard requires a lot of new parts. These have to include new pistons, rings, gudgeon pins and retainers along with new main bearings, big end bearings, thrust washers and small end bushes (if fitted). Then you can add to the list new gaskets, oil seals, core plugs, timing chain, lock washers and a rebore or resleeve and hone for the block.

If necessary, the heads must be skimmed, the guides checked and replaced, the valve seats re-faced and the whole lot pressure tested. Finally the engine has to be tested for oil pressure, compression and oil leaks protected against the ingress of dirt or damage in transit. It doesn't seem quite so expensive now, does it?

Gosnay's director Adrian Wilkes is keen to point out that this is the bare minimum for any engine advertised as reconditioned, and that all engines they sell undergo this treatment.

But we wanted to take a different approach. As well as ending up with a top motor, we wanted the story to be as helpful as possible to those of us working at home on our own projects. That means assessing the individual components to decide which can safely be re-used without compromising performance or limiting engine life, and which require us to dip into our pockets to buy a replacement.

So we persuaded Gosnay's to rebuild it on this basis as a home restoration, or as close to that as they could get while enjoying the benefit of vast engineering experience and top class machining facilities close at hand.

Last issue we watched the father and son team of Dave and Dave Woods strip the Essex down to its individual components and pronounce it as basically sound. This issue we take a closer look to discover which

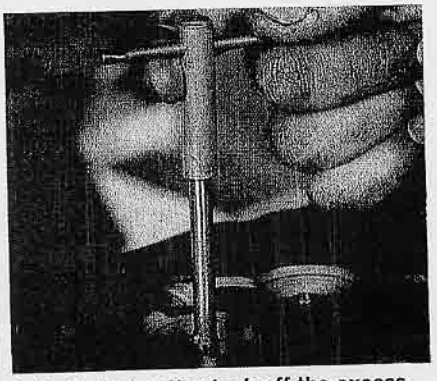
Starting at the top

THE TWO main places to look for wear in the heads are the valve guides and the valve seat faces. If the guides are worn, then oil will get sucked through the gap and into the cylinders. And if the valves aren't able to mate with their seats in an airtight seal, then you will lose compression. Of the two, valve guide wear is the harder for a novice to gauge because it relies on waggling each valve in its guide and deciding whether there is too much play. And that, of course, requires experience.

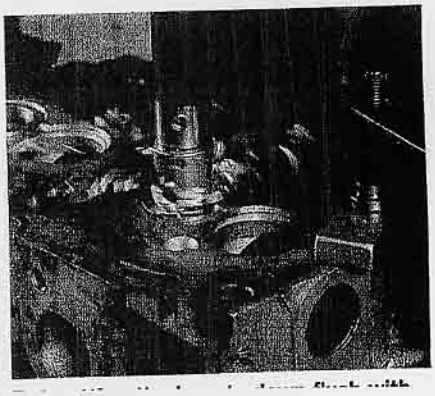
If you aren't confident of judging this accurately, don't worry. Just have a waggle at home before taking your heads along to a machine shop for assessment, then you'll start to develop this engineer's feel.

On the valves and seats, any pockmarks

Rocking the valves in their guides gives a skilled engineer a quick test of wear.



A dedicated cutter took off the excess liner that was sticking out of the guide...



will break the airtight seal. You can get away with slight markings as long as they don't spread right across the seating face to allow an escape route for the gases. But ideally you should lap in the valves using grinding paste to get a totally gas-tight seal.

Dave decided that our guides were within acceptable limits and that the valve seats could be cleaned up. But that was academic really because we wanted to convert the heads to run on unleaded petrol, and that requires new and harder exhaust valve seat inserts. And since the machine to cut these new seats relies on the valve guides to locate itself accurately, we had to replace them as well.

With the right tools and plenty of experience, Gosnay's made replacing the guides and fitting new inserts seem a quick and simple job. But we are talking about many thousands of pounds in machinery investment here, which is why it costs us a few bob to have the work done professionally.

Take the valve guide liners, for example. As the picture sequence shows, Dave used no less than five special hand tools just to fit each of them. And if, for example, the original casting had been broken, he would have needed to fit complete new guides instead of just liners, and that would have required yet more tools.

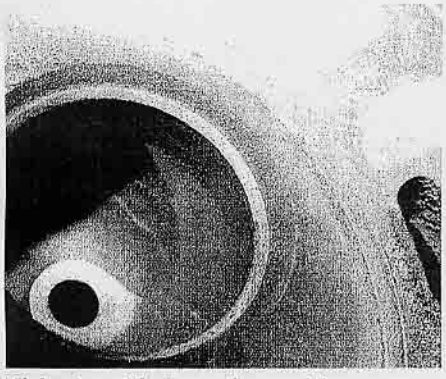
The valves in an Essex run directly in holes bored into the heads without a separate liner. That works well enough, but when these guides become worn, you have to fit a bronze liner to bring them back to size, or bore them out and fit a thin-wall sleeve. Ultimately liners should last longer than the original set-up, partly because an interrupted spiral on the inside helps keep the oil in place.

It was then over to Dave senior to fit the inserts. This is another job that is clearly beyond the home mechanic, but it's interesting to know just what gets done for around £22 per seat.

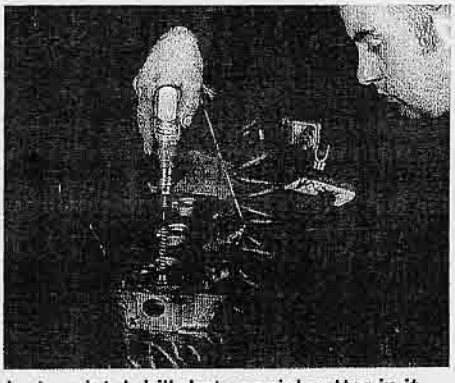
First job is to select the most appropriate size of insert, measure its diameter and set the cutter slightly undersize to create an interference fit in the head. Then, using a state of the art Serdi cutting machine, Dave cuts the heads to the required depth and width. There's plenty of metal for this on the Essex, although great care has to be taken with the 2.8 Cologne unit or you'll break through into the water jacket

While this was going on, Dave left the inserts hanging in a vat of liquid nitrogen to freeze them. That caused them to shrink enough to be an easy fit into the new holes, only to expand as they defrosted to become locked permanently into position. Dave then trimmed them with the same cutter he'd used to cut the holes in the first place.

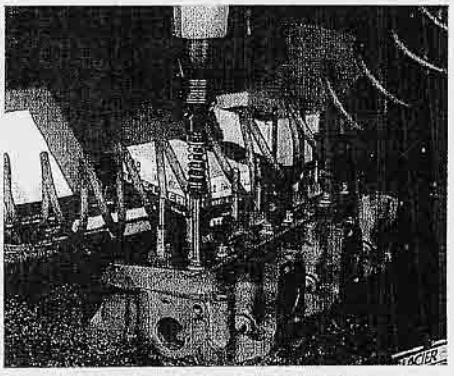
The next stage is to cut the inserts to



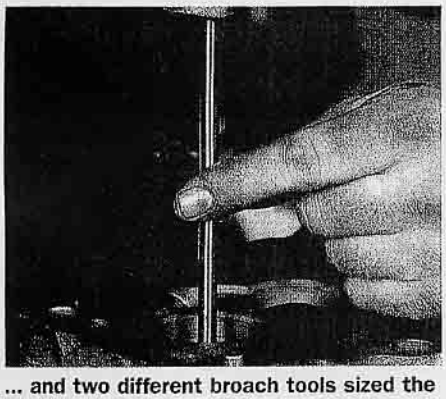
Minimal marking on valve seat faces, so they could have been lapped-in at home.



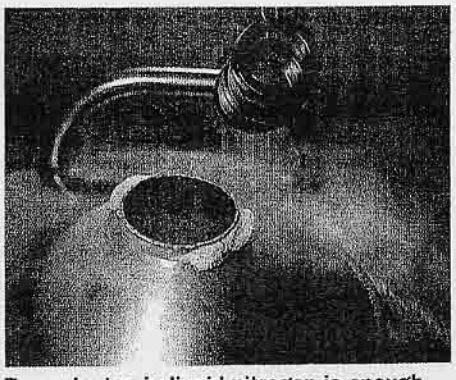
Just a pistol drill, but special cutter in it widened old guides in under 10 seconds.



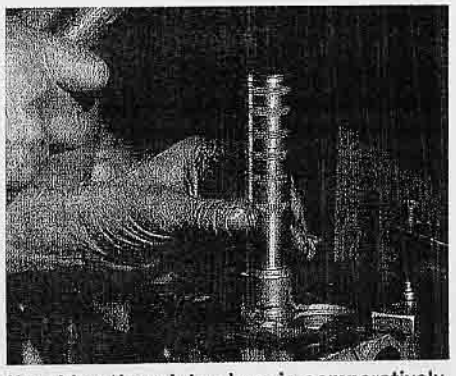
Five seconds more had the new bronze liners pressed firmly into position.



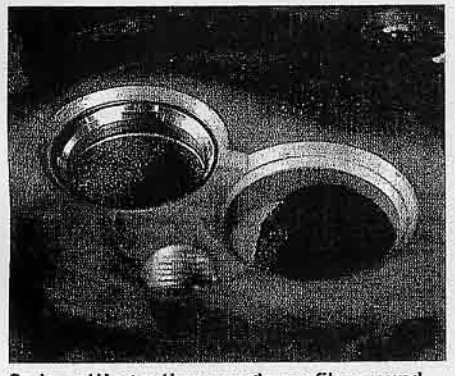
... and two different broach tools sized the internal diameter perfectly for valve stem.



Two minutes in liquid nitrogen is enough to freeze inserts and make them shrink.

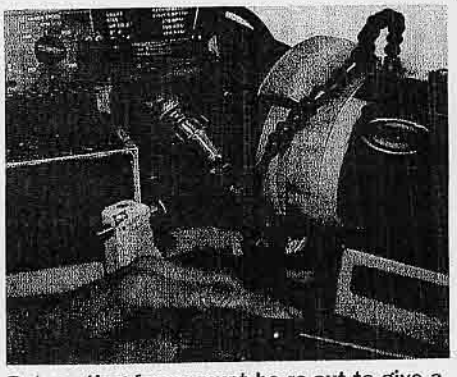


Knocking them into place is comparatively low-tech, but still requires a special drift.



So is cutting a three-angle profile around the face with one pass of the machine.

Pitting is from corrosion. We can re-use because seating face is sound and thick.

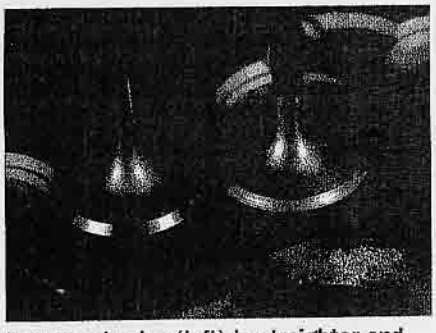


But seating faces must be re-cut to give a perfect seal where they meet new inserts.

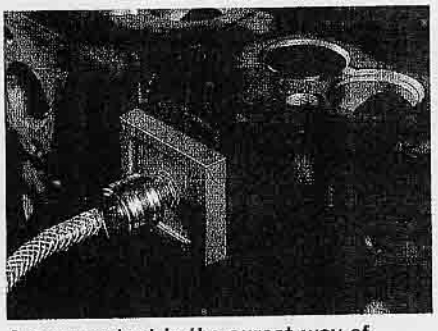
At the top (continued)

shape, and this is where you need the valve guides to be in perfect condition. First the seats are drilled out to the same internal diameter as the originals, and then a single pass with a three-angle cutter takes care of the seating face. After this, lapping in the valves is not strictly necessary and a simple vacuum test will show whether the valves are seating correctly. But once the valves have been refaced on a dedicated grinder, Dave still likes to give each one a few turns with a fine grinding paste.

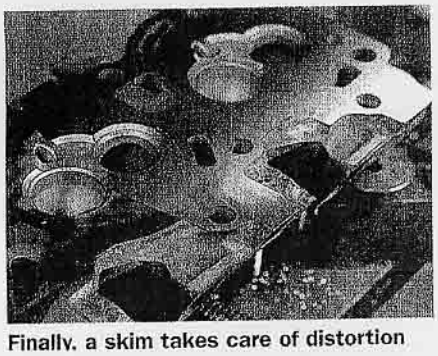
The final step with the heads is to check them for flatness. One of them had a 0.005in bow in the middle. There hadn't been any sign of blowing past the head gaskets, but often this sort of distortion is held in check by the head bolts and only gets released when they are undone. Dave took 0.006in off the head to clean it up, not enough to seriously affect the compression ratio. He also took the same amount off the other head, simply because it's good engineering practice to keep them even.



Re-ground valve (left) is straighter and smoother than uncut version on right.



A vacuum test is the surest way of ensuring the valve is seating properly.



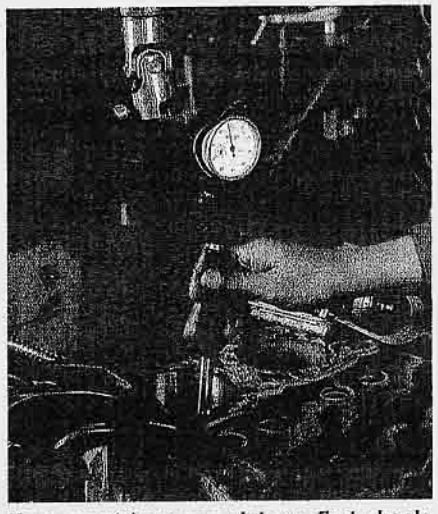
Finally, a skim takes care of distortion

Pistons and bores

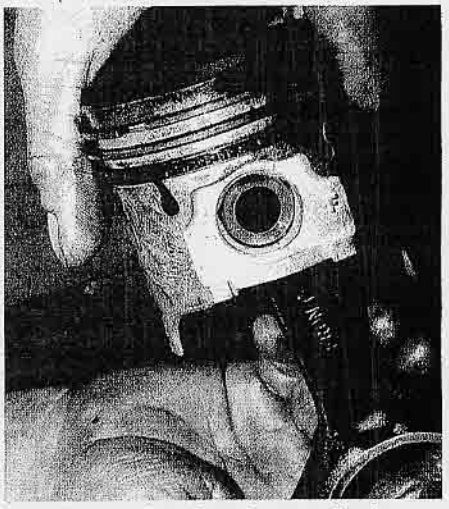
WHEN THE pistons came out, they were too black with carbon to read any size markings on the crowns. But a short spell in the blast cabinet with a very fine media had them shining like new and we could see they were 0.020in oversize.

As we mentioned earlier, Gosnay's would normally replace the pistons as a matter of course. But we wanted to know whether ours could be reused. So Dave measured the cylinder bores to check that they had been bored correctly for these pistons and that they hadn't worn oval. With no problems there, he took a closer look at the pistons themselves.

On these, the gudgeon pin is a press fit into the conrod so there is no little-end bush to worry about. Instead, wear takes place



If you want to re-use pistons, first check that bores and pistons are the same size.



Next, check that there is no vertical movement between piston and conrod...

Getting cranky

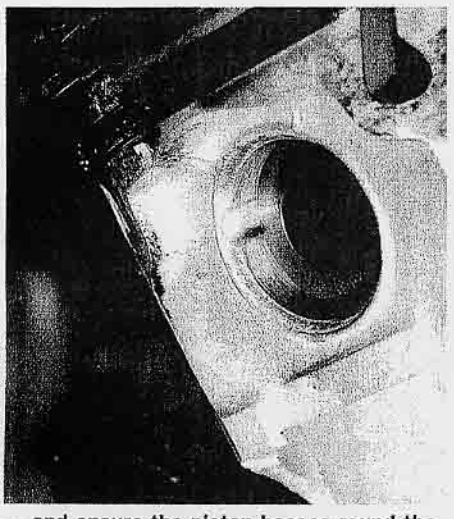
MAHENDRA KUNWARDIA is Gosnay's crank man. He explained that any grooves on the crank bearing journals are bad news because they allow more oil to fit between each journal and its bearing. This in turn lowers the oil pressure and, as insufficient oil gets forced between the surfaces, you end up with metal-to-metal contact and accelerated wear. Our main journals were obviously scored, a result of the shell bearings having been worn down to the copper backing. But the only way of knowing just how deep they went was to grind the journals back until they were clear and smooth.

Grinding reveals how deep the scores are and what size bearing you'll need.

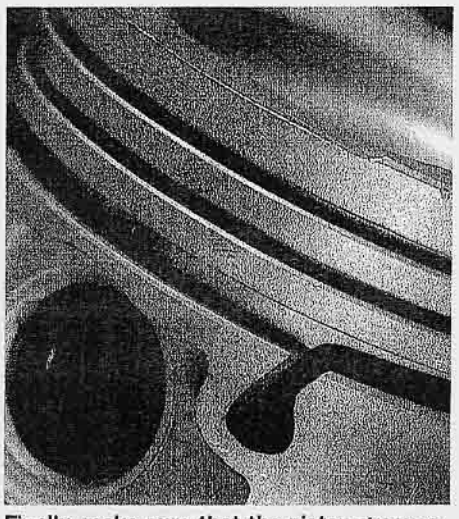
Mahendra's first job was to centre the crank on his grinding machine and measure in the centre for bowing. It was only 0.002in out, which left us a limit of 0.008in to take the journals to the next undersize. If they were still marked at that point, we would have to go down a further 0.010in to the next size. In the event, 0.002in was sufficient to clean off the scoring, so we only had to go down one size. Then a quick polish with a strip of fine emery cloth had it cleaned up and ready for reassembly.

where the piston boss rotates around the pin. Dave couldn't feel any movement when he tried pulling the piston up and down along the conrod and, with the piston slid to one end of the pin, there was no sign of any metal being scraped off the piston boss. So he settled on taking 0.0005in off the bores, basically just enough to take off the glaze and clean the lip at the top, and fitting a new set of rings.

Dave was only willing to re-ring our pistons because he could use standard items. You will hear of people fitting oversize rings to compensate for wear. But these are at best a dodge to clean up a smokey engine in the short run. You can fit special oil control rings to compensate for up to 0.004in of wear, but if your bores are any bigger than this, then you have to bite the bullet and go for a rebore and new set of pistons.



... and ensure the piston bosses round the gudgeon pin are smooth and undamaged.



Finally, make sure that the piston grooves are scrupulously clean or rings won't seat.

Our experts

GOSNAY'S Engineering in Romford, Essex (01708 740668) have over 65 years of reconditioning experience. They can supply a huge range of engine components from stock and provide all manner of precision engineering services, from a simple skim to a full engine rebuild.

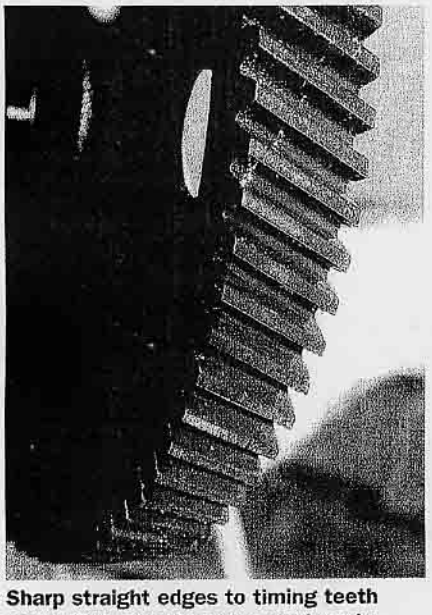
Keeping a watchful eye on our engine is Dave Woods, Gosnay's workshop supervisor and one of the company's directors. He's racked up 39 years with the company and is being helped on this job by his son, also Dave, a mere youngster with just five and a half years' company experience. This issue, Mahendra Kunwardia has lent a hand.

Sample prices

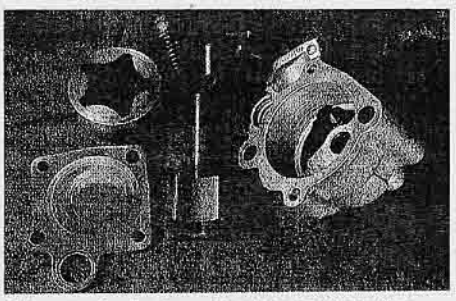
- Supply and fit 12 valve guide liners: £67
- Supply, fit and cut six hardened exhaust valve seats: £150
- Skim both heads: £47 (prices inc VAT)

Next issue: Reassembly explained, and your final chance to win the finished engine for just £1. Don't miss out.

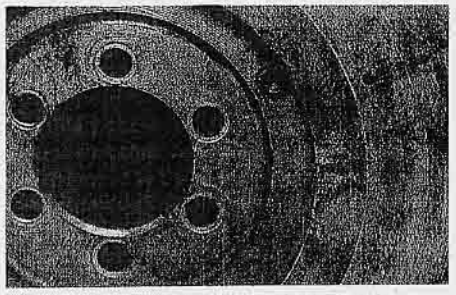
And the rest



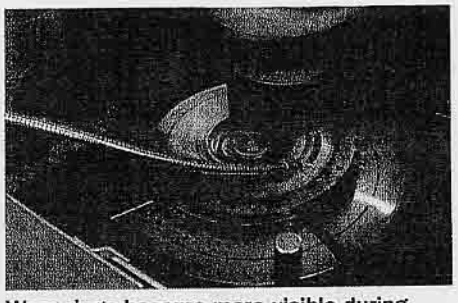
Sharp straight edges to timing teeth mean fibre wheel can be used again.



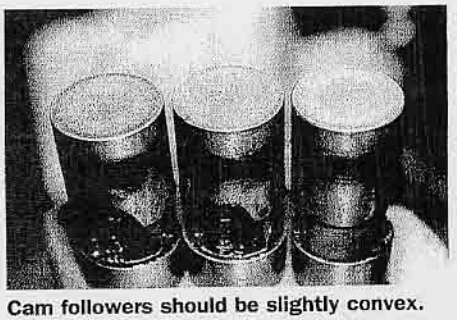
Oil pump looked as good as new on the outside, and was perfect inside too.



Shiny areas on the flywheel are hard spots. In time, they become high spots.



Wear rings become more visible during refacing, but ours needed minimal skim.



Cam followers should be slightly convex. These tops are dished, and need replacing.

WE WERE confident that the oil pump was a recent fitment because the alloy casting was still light grey and hadn't been blackened by use. Stripping it down showed that there was no scoring on the rotor, housing or relief valve and the rotor was a good tight fit with minimal clearance, so we were happy to use it again.

It was a similar story with the timing gear. The fibre teeth looked good when we first took it off, but Dave cautioned that you can only tell properly once it's been cleaned up. Fortunately ours came out of the degreaser with clean, square-edged teeth and got Dave's nod of approval.

The flywheel didn't do too badly either. The ring gear teeth around its outside edge were good, but there were some slight lines and a couple of hard spots on the surface. A light touch with a grinder took care of these; really more of a clean-up than a re-grind.

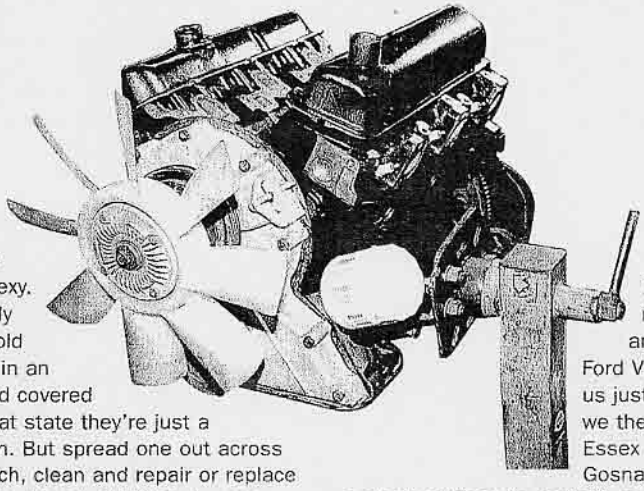
Finally, the cam followers had worn to the extent that their faces had become dished. They'll have to be be replaced, but the pushrods could be cleaned up and re-used. For the cam itself, we'll fit a reprofiled replacement to get the breathing spot on.

Essex 3-litre V6

She's bored, painted and well-oiled. Simon Goldsworthy watches our Essex girl get ready for action

part three

FANCY AN ENGINE FOR A QUID?



IT'S OFFICIAL: engines are sexy. Not necessarily when they're old and tired, sat in an engine bay and covered in grime. In that state they're just a bit of a turn on. But spread one out across your work bench, clean and repair or replace every last piece, then build it back up to fully-functioning perfection and it becomes pure mechanical raunch.

Now, I've little doubt that the guys at Gosnay's who've just rebuilt our Essex are reading this and wondering what the hell I'm on about. But they spend all day, every day rebuilding engines and, just like the Page Three photographer whose idea of a steamy evening is sipping a mug of cocoa and watching Blind Date, their sense of excitement and anticipation has been blunted. For the amateur like you and me, there's nothing quite as exciting as starting the day with a bare engine block and finishing with a complete motor.

But what's the story with this one? Well, when you're talking about sex and raunch, there is a school of though that says 'more is more'. Editor Holman subscribes to this theory, which is why he took the Essex 3-litre V6 out of his Mk I Capri and replaced it with an American Ford V8. That suited us just fine because we then took the Essex down to Gosnay's in Romford and asked them to make it as good as new. So in the January issue they stripped it, and in February they machined out any faults. Now, in our third and final visit, it's time to see how they slotted everything back together.

All of which just leaves us the very enjoyable task of finding a lucky reader to get better acquainted with the old girl. You've got until February 28 to get your name into the hat, using the competition form on page 141. All it costs is £1 per entry, and you can photocopy the form as many times as you wish for multiple entries, or if you don't want to cut up your magazine. It's well worth having a go – there were just over 600 entries for the A-series engine we finished rebuilding in December, making the odds of winning considerably better than on the National Lottery. Sure, we can't offer you the chance of winning several million quid, but we'd rather have a rebuilt Essex any day.

Cleaned and greased

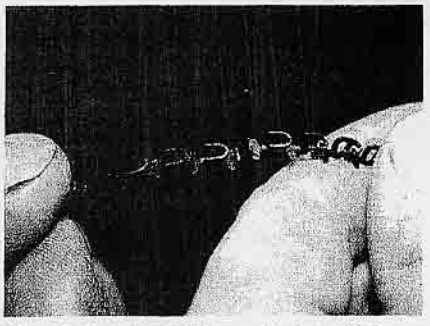
WE STARTED with the block clamped sideways onto the engine stand, much like we left it at the end of part one. But now it was clean, the bores were shiny and the top faces had been lightly skimmed to take off any gasket marks and rust. The father and son team of Dave and Dave Woods had also given it a light dusting of black paint on the outside to stop it developing surface rust while in storage. They'll go over it more carefully again after reassembly to make sure it looks as good as it runs.

But all this cleaning is more than just cosmetic. There are numerous threaded plugs that provide access to the oilways, and all of these have to be uncovered and removed. That way you can get a wire brush and compressed air right inside the block to clean everything out. You have to do the same with the larger core plugs which provide access to the water jacket but, unlike the threaded plugs, these cannot be re-used. Only when the block is thoroughly clean both inside and out can you start to put the moving bits back in.

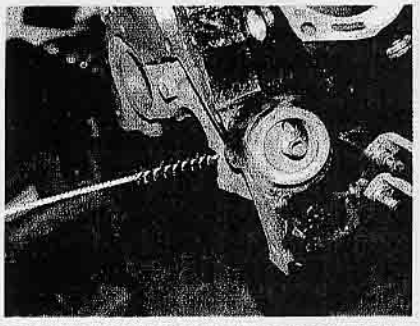
Throughout this rebuild, we've tried to make it as relevant as possible to the DIY mechanic working on a limited budget. This issue is no exception, but the two Daves doing our dirty work have one major advantage over the rest of us. Because they did all the machining themselves, they were confident enough of its accuracy to bolt everything back together in one go. If you give the machining work to one place, buy the replacement parts from another and tackle the rebuild yourself, then you

Six of the best

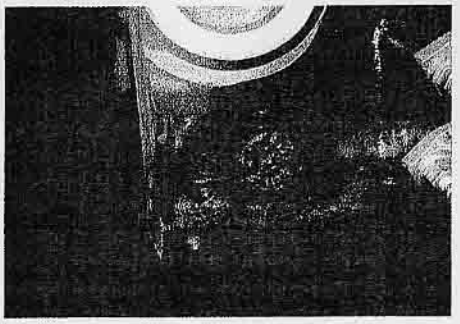
AT THIS point the crank was still very easy to turn by hand. It's only when the pistons go in that it should tighten up appreciably. They were next to go in, but not before Dave had given the bores a quick wipe (with paper rather than a cloth to minimise the risk of stray fibres getting left behind) and a generous squirt of oil. He also staggered the ring gaps to gain a little extra compression during initial start-up, and checked that they were fitted correctly. The



The ring ends of this central portion should butt up together, not overlap.



I need a long wire brush to clean all the galleries. Make sure you don't miss...

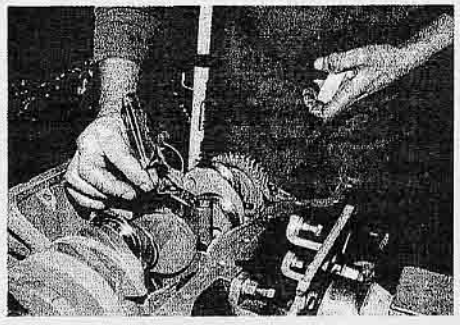


... this threaded plug below the oil filter. It hides a common collection point for muck.

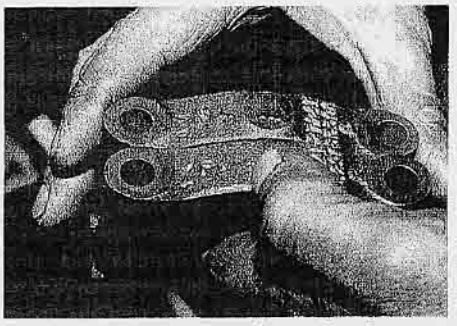
Assembly compound sticks to bearings for longer than engine oil if engine is stored.

ed to check everything more carefully. Turn engine over by hand after each component added to make sure it hasn't tightened up nificantly. And if you suspect that there's en a mistake with either the bearings or journals, use some Plastigauge (£9.50 n specialists such as Frost, 01706 3619) to check the clearances.

The crank is the first bit to go back into block. The main bearings to hold it in sition come in colour-coded packs for top d bottom halves to make sure you get m the right way round. But the two halves re in any case different, because only the s had an oil feed hole. As a general rule, ou're not an experienced engine builder, e your time and look carefully at every nponent. If two sides, two ends or two ves are in any way different, don't put m in until you understand why they are erent and so which is the correct way round. The faces where the back of the bearings need to be clean and dry, but the bearing es themselves have to be lubricated. You n use engine oil for this, particularly if the



Endfloat should be between 0.003-0.006in. Ours was spot on at 0.004in.



Remember to check marks and replace caps into the same place they came from.

motor will be run soon. But if it is likely to end up stored for some time, a graphite past or an oil-based assembly lube will cling to the bearings for longer and provide guaranteed lubrication when the engine is first run.

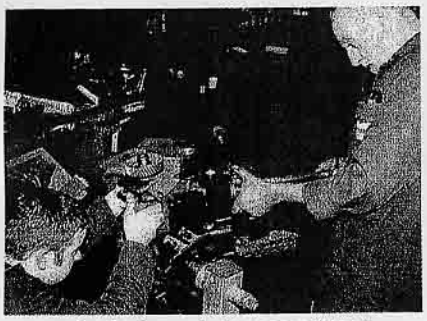
The thrust washers slide around number two main bearing, with the copper face pointing towards the rotating crank. You shouldn't have to force them into position, nor do you want any more than 0.003-0.006in running clearance. If you suspect that something is wrong, then measure carefully to ensure that the thrust washers are the right size – the running faces on the crank may have been machined to true them up with the main bearings themselves. If so, you'll need a different thrust washer.

The main bearing caps were torqued straight up to the recommended 76-83lb ft, and Dave made it look effortless with his long wrench.

two are clearly marked, so getting them right way up is easy. But the bottom one made up of two solid rims that sandwich springy central portion. It's vital that the ds of this central portion butt up against ch other without overlapping, otherwise ey'll stand proud and pick up on the bores. e ends are painted red, so you can locate em instantly and check before fitting the ston into its bore.

The Essex is no different from any other gine in that you need to use a piston ring mpressor to stop the brittle rings from agging on the block and snapping. Oil this liberally and knock it down squarely onto the block before pushing the piston down and into the bore with a hammer's wooden handle. Dave senior prefers to knock each piston through in turn while his son guides the big ends onto the crank and fits them. He can then go back and refit the bolts permanently one at a time, using a dab of locking compound on the threads. He also likes to use new bolts for this because they're much smaller then those holding the main bearing caps down but take more of a battering, and he doesn't want to take the risk of having one break.

With all six pistons in position and resisting movement up and down the bores, it will become difficult to turn the crank by hand at this point. But it should still turn smoothly if you put couple of flywheel bolts back in and use a screwdriver between them as a lever. Never assume that an engine which needs masses of grunt to turn over at this stage will free up in use. Far more likely is that something has been assembled or machined incorrectly. Ignore the problem now and you can be sure that something will fail in use. It's much easier and much cheaper to investigate and sort it out at this stage.



ou can do it alone, but an assistant guide big ends onto crank is helpful.

More assembly lube on the big ends, just in case the rest of the resto takes a long while.

And some locking compound on the new big end bolts stops them shifting.

Sealing it up

THE CRANKSHAFT rear oil seal is a large rubber O-ring. This needs a liberal coating of oil before you push it into the closing plate, and plenty more when you slide it over the crank. You'll also need a smear of sealant on both sides of the plate's paper gasket because this is very thin and the bolts won't reliably crank up enough pressure to seal it.

At the other end, the camshaft can be slid into position. We fitted a re-profiled cam (a reconditioned one where the lobes have been ground back to the original shape and case hardened again). That makes them slightly smaller overall than the original, but only by a minute amount and that can be adjusted out on the valve clearances.

It takes some fiddling to get the furthest end of the cam located properly, but there is a core plug that affords finger access if you haven't fitted it yet. Alternatively you can fit the sprocket bolt and turn it with a spanner until the cam slides home. You know it's gone in far enough when it sits flush with the front of the block. The clamp will hold it in this position, while tightening the timing wheel will pull it forward to the limit of spacer travel. The two crosshead screws holding that clamp in place can do with a dab of locking compound, and a modest tap with an impact screwdriver will nip them up tight.

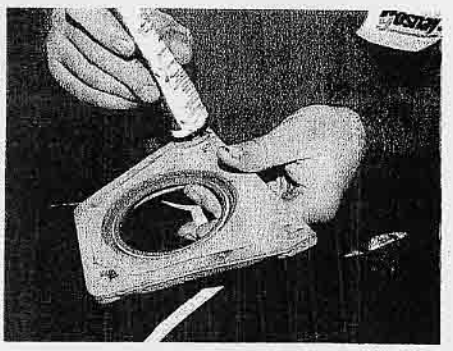
Complex paper gaskets can be tricky to line up, particularly if they've been crumpled up in a packet for years. (Cork gaskets dry out and shrink. Never try to stretch them out in this state because they will break. Soak them in water for several hours to restore some elasticity.) Jointing compound can help by holding gaskets in one place while you smooth them out elsewhere. But when we came to the timing cover gasket, this looked like the wrong one. In fact it had dried and shrunk to the extent that getting the two ends into position left the middle part bulging away from the plate. Fortunately there are plenty of bolts holding this cover on, and they were able to clamp it down. We got as many hands involved as possible so we could locate the gasket at several points, then fit all the others before tightening any down.

Even then, we still didn't get the gasket and front plate to sit flush with the bottom of the block. That's not unusual on these engines, but the thick cork sump gasket is capable of taking up this slack. On engines with a thinner sump gasket, you'll need to slacken off the bolts again, knock the plate round until it is flush and trim off any excess gasket.

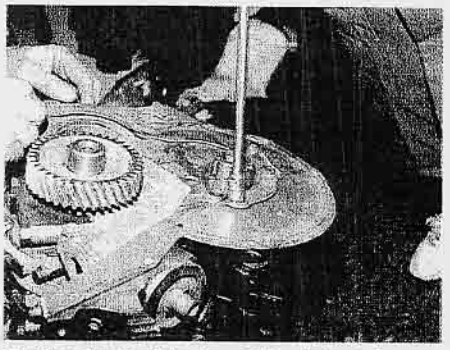
Before the sump could go on, we had a couple of things to take care of. There's a clip holding the driveshaft into the oil pump body. This had been fitted the wrong way round when we stripped the engine – not a disaster, but if you get it right (see picture) it stops the shaft getting pulled out if you ever have to remove the distributor. Dave also primed the pump by filling it with oil. Some of this will drain out as the engine is turned around during the rest of the rebuild, but there'll still be plenty left in there.

The oil strainer had been brazed back onto the pick-up shaft, and Dave took care to ensure there was a good seal between the pipe and the pump. Otherwise, air would get drawn in and pushed around the engine instead of oil. Then the sump could go on, taking care not to over-tighten any bolts that pull into aluminium.

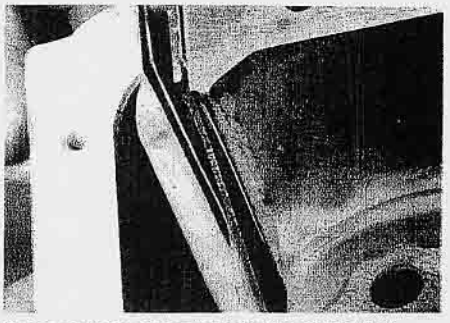
With the bottom end sealed up, we moved on to the timing gear and heads. New cam followers dropped into place after a coating of oil, and the head locating dowels (which had to come out when the block was skimmed) were knocked back in. Then a quick wipe with blue paper cleaned all oil off the head gasket faces (they go on dry) and the heads could be tightened down. Dave does this in three stages of 40, 65 and 90lb ft, working in a diagonal sequence starting at the centre. Then he went around again to make sure that he hadn't missed any.



A non-setting sealing compound helps to stop thin paper gaskets from leaking.



Engine front plate has little integral strength, and needs this reinforcing section.

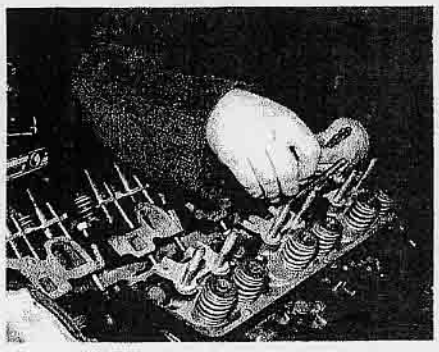


Take care to ensure that the distorted gasket doesn't pop out before bolts go in.

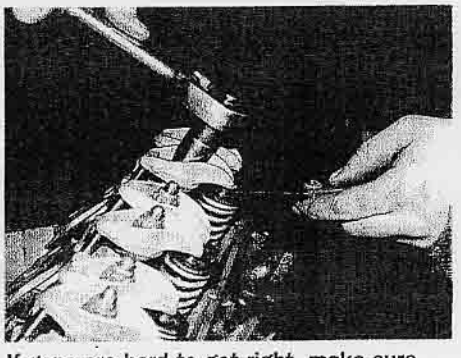
Finishing touches

THE FORKED pushrod guides will go on either way up, but will only line up with the pushrod holes in one direction. When we came to tighten down their fixing bolts, these were very tight. Rather than force them, Dave ran a tap up and down the threads to clean off any surface rust that had formed. That didn't help, so he took a closer look at the threads and discovered that somehow some metric ones had got mixed in with the imperial. The correct imperial ones went straight in, reinforcing the maxim that you should never force something into place. If it won't go, you should go in search of the problem and a bigger spanner is rarely the answer.

The pushrods were followed by the rockers, half-round spacers and nuts. These

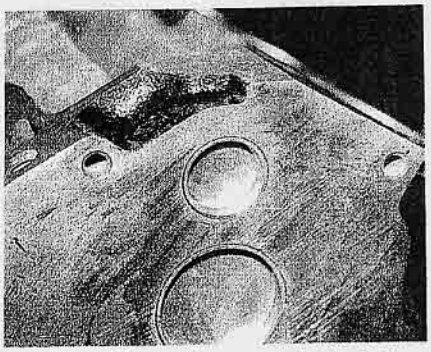


Pushrods have oil hole through the middle, so make sure these are clear.

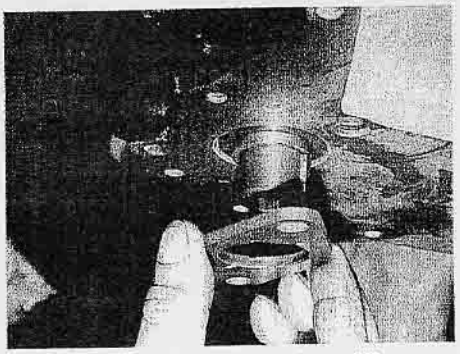


If gaps are hard to get right, make sure that the finger hasn't moved off-centre.

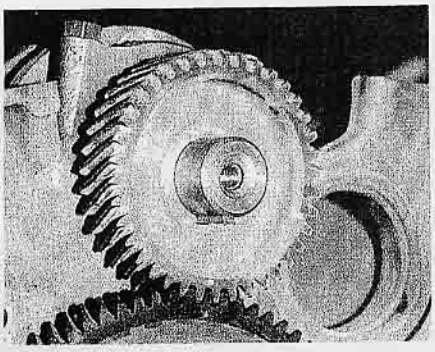
And fill the filter with oil for more immediate lubrication on initial start-up.



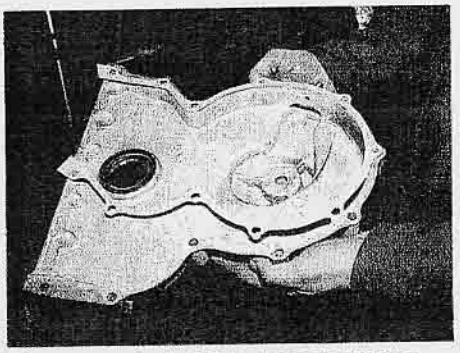
you leave the smaller core plug out at iis stage, it'll be easier to locate the cam.



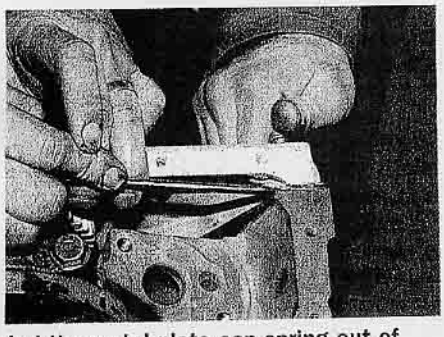
You're aiming to get it to this position, so the clamp sits flush with the front plate.



iming marks must be lined up before he petrol pump cam is tightened.



The wrong gasket? No, just an old one that had dried and shrunk in storage.



And the metal plate can spring out of line too, so don't force reluctant bolts in.

This clip should locate in the groove on the pump and on the shoulder of the shaft.

nuts are crimped on top to provide a self-locking mechanism. That does make them stiffer to turn than you might expect, but also means you only need two hands to set the valve clearances, one for the feeler gauges and one for the spanner. Dave resisted the temptation to tighten them up with an air gun. He doesn't like to use this during reassembly because it doesn't give you any feel for when a thread is about to let go.

On in-line four-cylinder engines, you can set the clearances using the rule of nine: if number one valve is rocking, adjust number eight. If number four is rocking, adjust number five and so on. But the order for V-engines is far more variable so you'll need a workshop manual. Just remember that the cylinders are numbered from one to three starting at the front right, and then four to six starting again at the front, but this time on the left. And rocking? That means that a valve is just moving past the highest point on its cam lobe and starting to pop back out again. Both head bolts and valve clearances will need to be checked again after 500 miles, but the new owner should also be prepared to check the valves earlier if they are noisy (too loose), or so tight that they cause a misfire.

That just left the flywheel and rocker covers to go back on, though we couldn't tighten the covers down yet without the inlet manifold in place. With this engine being used in so many different cars, we have no way of knowing whether the distributor, manifold and front pulley it comes with will be the correct ones for the lucky winner. But whichever bits are eventually fitted, Dave had one final plea to make – please make sure that the carburettor, radiator and distributor are in excellent shape. He's seen too many rebuilt engines suffer damage or give poor performance when dodgy old ancillaries are bolted back on. He's more than happy to rebuild this engine for you again, but it'll cost more than a quid next time.

Our experts

GOSNAY'S Engineering in Romford, Essex (01708 740668) have over 65 years of reconditioning experience. They supply a huge range of engine components from stock and provide precision engineering services, from a simple skim to a full rebuild. Keeping an eye on our engine is Dave Woods, the workshop supervisor and one of the company's directors. He's been with Gosnay's for 39 years and is being helped on this job by his son, also Dave, who has five and a half years' company experience.

Total costs

How the costs stacked up:	
Main bearings:	£36.77
Thrust washers:	£9.73
Big end bearings:	£44.19
Conrod bolts:	£14.38
Piston rings:	£72.16
Gaskets and seals:	£28.42
Head set:	£82.67
Cam followers:	£104.62
Re-profiled cam:	£52.86
Parts total:	**£445.80**
Skim heads:	£47
Fit new guide liners:	£67
Unleaded conversion:	£150
Hone bores:	£51.11
Skim block:	£82.25
Grind crank:	£70.50
Machining total:	**£467.86**
TOTAL EXCLUDING LABOUR:	**£913.66**