00EN078
Date: 1975

INSTALLATION OF REGROUND CAMSHAFTS INTO THE LOTUS TWINCAM

The following article concerns The Installation of new, non-stock camshafts Into the Twincam engine. Particular emphasis is placed on details and possible pitfalls. This article will not deal with camshaft choices. It is left to the reader to pick a cam suitable for his own needs. LOTUS/WEST article 26EN010 lists some possible choices. Although different cams will have their own peculiarities, such as high lift, etc., the general aspects and most details will be the same in most installations. Note that for maximum benefit of any cam more radical than stock a set of exhaust headers will be needed. Although any cam will run with the stock exhaust system, you will not be close to reaching the cam's potential. Some high lift cams may need additional cylinder head modifications such as new valve springs and re-machined valve seats. This may require removal of the head and some machine shop work. Be sure to check the literature before you buy so these additional expenses won't come as a surprise.

CAMSHAFT REMOVAL - Removing the original camshaft is a relatively easy operation with the Twincam. Remove the 8 locknuts securing the cam cover and tap loose with a rubber mallet. Be careful not to drop the four neoprene half-circle plugs located at the ends of each camshaft down into the engine. Rotate the engine to T.D.C., noting the position of the cam sprocket marks and the distributor rotor. This indexing will make reassembly easier. If you have a Polaroid camera, this is a good time to take a photograph for future reference.

Loosen the cam-chain tensioner. Remove the two cam sprocket bolts. Gently tap off the sprockets with the rubber mallet. Let the chain drape down over the water pump. Don't worry about it. If the jackshaft rotates, you can realign it during reassembly.

Unbolt each of the camshaft bearing caps. The bearing caps will probably be numbered, corresponding with numbers stamped into the head. If they are not, number them yourself with chalk or grease pencil. If you plan to reuse the bearings and not replace them, keep the bearings with the caps as a set. Do not get them mixed up. The camshafts can now be lifted from the engine. The cam followers or tappets are now accessible. You may want to leave these in place until you make the preliminary clearance measurements explained in the next section. When you have to removed them, the easiest method is to use a rubber suction-cup tipped valve grinding tool. The tappets simply pull up. They are not retained in any way. If the suction-cup does not work, you may need to use a pair of Channel Locks or screwdrivers. As with the bearings keep each tappet numbered for reference. An egg carton is ideal for this. Also check for cracks. Lotus tappets have been known to crack on occasion.

After the tappets have been removed the valve stem and retainers will be visible. On top of the valve should be the "dime" sized and shaped valve shim. It may be stuck to the under side of the tappet. New shims will be needed. The originals will not work because nearly all modified camshafts are regrinds. This means the cam lobe's profile was obtained by grinding a stock camshaft to new specifications. Consequently, the absolute diameter is smaller than stock, ever for high lift cams. Therefore, thicker shims are required. Normally, stock Twincam shims are in the order of 0.080". Replacements range only up to 0.120". Reground cams require thicknesses of from 0.130" to 0.150" or even greater. This problem is solved by use of the "top hat shim". They are of quite a different configuration from stock: pencil eraser sized with a bottom racefitted over the valve stem. You

should be able to obtain them from the vendor who supplied you with the camshafts. If not, they are available from Cosworth. Also, the Alfa Romeo twincam uses a "top hat shim" that is very similar if not identical. You may use them if you like. They are available from Alfa and Norris Performance Products. They are all the same size. Buy at least 10 or 12 shims in case you overcut or lose a couple. When you get them, check to see that the valve stem does not fit so far into the recess that the shim's bottom edge contacts the valve keepers. Engineer's Blue is a good indicator. If contact exists, lap the edges down with emery.

ESTABLISHING VALVE CLEARANCES - Prior to final assembly the proper cam to tappet clearance must be established. To those of you doing this as part of a top end job in which the cylinder head was removed, the procedure outlined below seems to work best if the head is first bolted to the block. A careful and methodical attention to detail is required. It will be assumed that your reground cam will require the "top hat shims". Typically this type of shim will require that about 0.050" of material be ground off to establish the proper clearance. The clearances should be approximately 0.006" on the intake cam and 0.007" on the exhaust cam. To determine the exact amount to remove from the top hat shim, use the following procedure: Leave the stock tappets and shims in place and lay the new cam in place. Tighten the camshaft bearing caps down evenly to 12 ft. lbs. torque. Bolting down one cap at a time may break a camshaft. Insert the camshaft sprocket bolt and use it to turn the cam. (no danger of contacting the opposing valves exists because with the other camshaft removed, the opposing valves are all closed) Rotate the camshaft so that, in turn, each cam lobe points away from the valve and measure the space between the lobe's heel and the tappet with a feeler gauge. Write down this measurement for each valve. A good precaution is to make several rotations of the cam and several clearance measurements.

When you are sure you know the existing clearances, remove the camshaft and repeat with the other cam on the other side. Withdraw the tappets and measure the thicknesses of the existing shims with a micrometer, Write this thickness below the feeler gauge measurement and add them. For example; your feeler gauge reads 0.060" and the shim thickness is 0.077". The total is 0.137". The desired clearance is 0.006". Subtract this. Therefore, the required top hat shim thickness is 0.137- 0.006 = 0.131".

Top hat shims are sold in only two thicknesses; 0.200" or 0.220", depending upon the source. So quite a bit of grinding will have to be done, and the emery cloth method possible with the stock shims will not work here, easily. If you want to pay for someone else's time, you can have a machine shop grind them for you. Otherwise, use a bench grinder. Take an old valve stem fix the shim to the end and grind on the face of the wheel. Try to set up a spinning motion to the shim to prevent beveled cuts. It is easy to grind past the required thickness so grind to within 0.010", put the shims in the head, retorque the cam and measure the clearance. This will have to be done a couple of times if you are fussy about your clearances. An emery cloth may be used to remove the last two or three thousandths. For those of you installing new cam followers (tappets) some adjustment is possible by swapping tappet-shim combinations. This is due to variations in follower thickness. This might be a solution if you grind too much off a shim. But, only consider this if you have new followers.

FINAL ASSEMBLY - Place the now correctly sized shims over the valves and insert the tappets. Put the camshafts into position and bolt the bearing caps into place. Make sure that they are well oiled. Again, bolt down evenly, or you may break a camshaft. Torque the cap nuts to 12 ft. lbs. You might want to check the clearance one more time.

Check to see that the crankshaft is still @ T.D.C. Bolt the sprockets back onto the camshafts. The

sprocket is doweled to the camshaft. You may want to use offset dowels to degree the cams exactly. See LOTUS/WEST article 00EN063 for an explanation of this procedure. There is a mark, a line usually, on the rim of the sprocket. Rotate the cams so that the marks point towards (inward) each other. The closer the marks are to being horizontal the better. Make sure the chain tensioner is loose. Now, restrain the cams from rotating with Vice Grips and remove the exhaust sprocket. Stretch the chain over the inlet sprocket, engage the exhaust sprocket and push it into place on the exhaust camshaft. This may require some fiddling to get the last sprocket into place. Torque the sprocket bolts to 25-30 ft. lbs.

Check that the crank is @ T.D.C., the timing marks on the sprockets are horizontal and pointing toward each other. The jackshaft may have rotated and changed the Rotor's position. If it is not where it was when you disassembled the cams, loosen the clamp below the distributor body and pull the distributor up until the drive gear disengages. If the rotor is supposed to be pointing to the number one spark plug lead @ a 10 o'clock position, move the rotor to a slightly counterclockwise position so that the engagement of the spiral gears will move it clockwise into position when you seat the distributor body.

A very good precaution is to rotate the engine several times by hand. This will make sure that everything is in order. If you do not do this, and the camshafts are mistimed, use of the starter will bend or break all the valves. Adjust the timing chain so there is 0.50" max play between the sprockets. Replace the four half-circle plugs. Do not overtighten the cam cover, or you will squash the cork gasket and it will leak. Five ft. lbs. is sufficient. You may need to retighten the cover in a few days as the cork gasket settles.

Carburetor alterations - Some adjustments will be needed to the carburetor fuel and air settings, these settings, obviously, depend on the specific cam chosen and it's projected use. Stock Weber main jets are 115, and chokes are 30mm. For mild camshafts such as the Cosworth CPL and equivalents, somewhat larger mains and chokes are needed. A good starting place is 120 mains and 32 or 33 mm chokes. Wilder cams usually need wilder settings. This may not always be true, however. I know of engines that run smaller jets because of better breathing. With milder cams the other jets: acceleration, idle etc. usually need not be changed. All these settings do depend on use, of course. So, you will have to experiment to decide what fits your needs best.

Larry Lim