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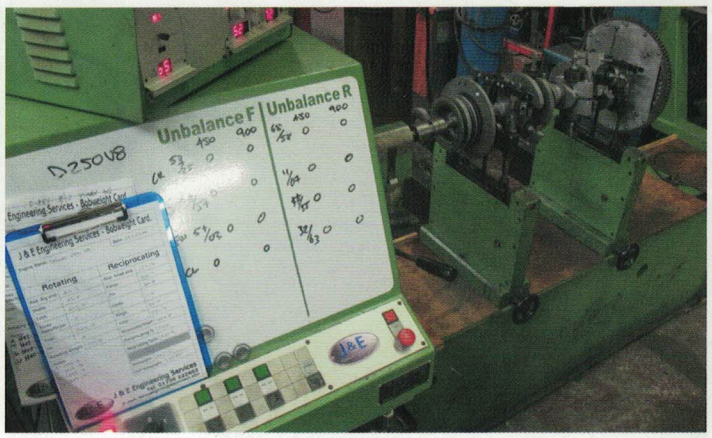
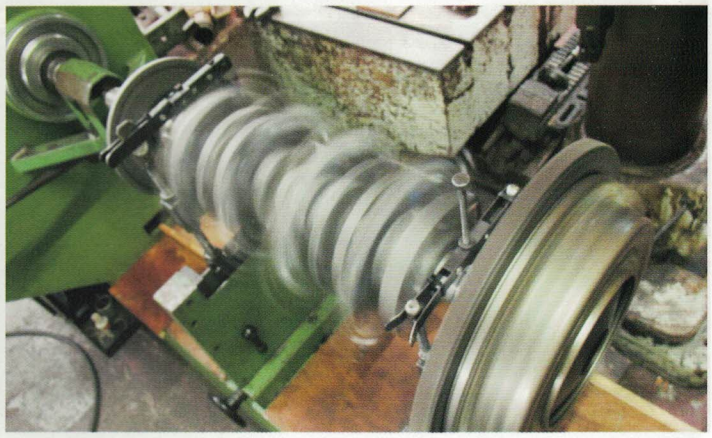
Eric Goes Toyota

(AND GETS A NEW ENGINE - PART 4)

RICHARD LONG





At the conclusion of Part 3, I mentioned that the ongoing engine rebuild had reached the stage whereby the crankshaft assembly: pistons, con rods, crankshaft and the clutch assembly now required balancing. Whatever the Daimler OE balancing spec was for Eric on leaving the factory, this could now be completely disregarded. Not only was the engine now sporting a manual clutch assembly, but the new +.040" pistons would be heavier than the original standard pistons The increased individual weight plus combined weight of these new pistons alone, would have a significant balancing error on the rest of the crankshaft assembly; in essence the whole assembly was now unbalanced and this required rectifying. The process to ensure that each component is individually balanced along with the whole assembly is to put it mildly: a comprehensive, complex and intriguing engineering black art !!

With J&E Engineering Services undertaking the whole engine rebuild, it was satisfying to know that Jonathan, the company owner, also had the required machinery plus the other associated tooling to ensure that the balancing requirement remained in-house. As mentioned, it is a complex subject and I will explain the process of achieving a fully balanced assembly; starting from a completely unbalanced assembly !!

All crankshafts and individual components are balanced at the factory of origin to a standard which is deemed reasonable for normal road use, regardless of engine configuration be it inline or "V". The ROTATING assembly consists of crankshaft, harmonic damper, drive pulley wheel, flywheel (or torque drive plate) and clutch. This assembly is balanced with the use of a dedicated crankshaft balancing machine which spins the shaft, placed on bearings, and looks for fine harmonics (vibrations) running through the assembly at both the front and rear ends.

The machine calculates how much material to add or remove at a certain point at each end and when completed the shaft or complete assembly is fully balanced. This is called dynamic balancing. Static balancing is the balancing of the RECIPROCATING parts these include: piston, gudgeon pin, piston rings, circlips, connecting rod and the big end bearings.

These items are weighed individually, to identify the lightest component at which point all the others can have metal removed to achieve the same weight to within 0.5 grams or less. With an inline engine, be it a straight six or four, this reciprocating balancing doesn't really influence the rotating assembly balance under normal circumstances. This is because one connecting rod and piston is cancelled out by another, provided they are of the same mass.

In a "V" configuration however this is certainly not the case, as one crankshaft pin carries two piston and rod assemblies at different positions in their respective cylinders. This means that the crankshaft balance relies not only on its own counterweights, but also on both piston & rod weights. As you can now start to understand, if I have explained it clearly, this is where the complexity of balancing a "V" configuration unfolds. In order to balance this type of crankshaft, it is imperative that the calculation of both rotating and reciprocating parts must be determined and used.

As mentioned earlier, the big end of the connecting rod and its bearing is called the rotating weight whereas the little end of the connecting rod, the piston pin clips and rings is the reciprocating weight. In order that the crankshaft can be balanced, the use of a weight(s) called a "bob weight" is used and that simulates the weight of these rotating and reciprocating weights on the crankshaft.

As you can imagine, spinning a crankshaft with the pistons and rods attached in thin air would not be advisable and highly dangerous !! Substituting the pistons and rods etc. for the bob weights allows this part of the balancing programme to be carried out safely and accurately. The bob weights total mass is calculated from: the piston & rod little end, big end weights and a balance factor given by the engine manufacturer - which in the case of the Daimler V8, the factor is 50%. Each bob weight is balanced on a straight mandrel to ensure the most accurate results, before one is mounted to each of the four crank pins of the Daimler V8 crankshaft.

In the case of my engine and because of the +.040" after market pistons that were required, it was found during initial balancing that there was a significant vibration / imbalance of about twelve grams at both the front and rear of the shaft. This can be rectified by either adding weight at one point or removing it at 180 degrees opposite. In my particular case, there was not enough real estate to remove - which in balancing terms is a large amount (12 grams) and this meant the weight was added to the counter weight of the shaft. In order to achieve the additional balancing weight, a "heavy metal" slug ("Mallory metal" which is a machinable tungsten approximately twice as heavy as steel) in excess of the twelve grams (because we have to drill a hole to fit the slug) is introduced to the correct area of both front and rear counter weights.

This is fitted with an interference fit and peening to stop it coming adrift in service. On completion of this additional weight, it brought the crankshaft to within an acceptable window that can be perfected by fine grinding and fettling here and there, to get the crankshaft 100% spot on. On completing that, the harmonic damper / pulley is added, then followed by the flywheel and clutch cover to slowly balance the whole assembly piece by piece.

In unmolested form, the "V" configuration crankshaft balance can be improved upon from the mass production manufacturer quite easily. But if the engine recipe has changed by either replacing connecting rods or using oversize pistons because of a re-bore, then balancing must be done - there really are no ifs or buts about this. As you can now ascertain, balancing is a time consuming and complex affair, BUT - crankshaft imbalance will at best rob you of power making tuning very tricky and creates uneven running. Taking a worse case scenario, it can literally tear the engine apart and I have no doubt the engine owner or Edward Turned would not approve of that !!

Finally, if you would like to see a two-minute video of the balancing machine in action spinning my V8 crankshaft complete with the bob weights as mentioned above, please see the following link: www.jandeengineering.co.uk/video.html

To be continued.....