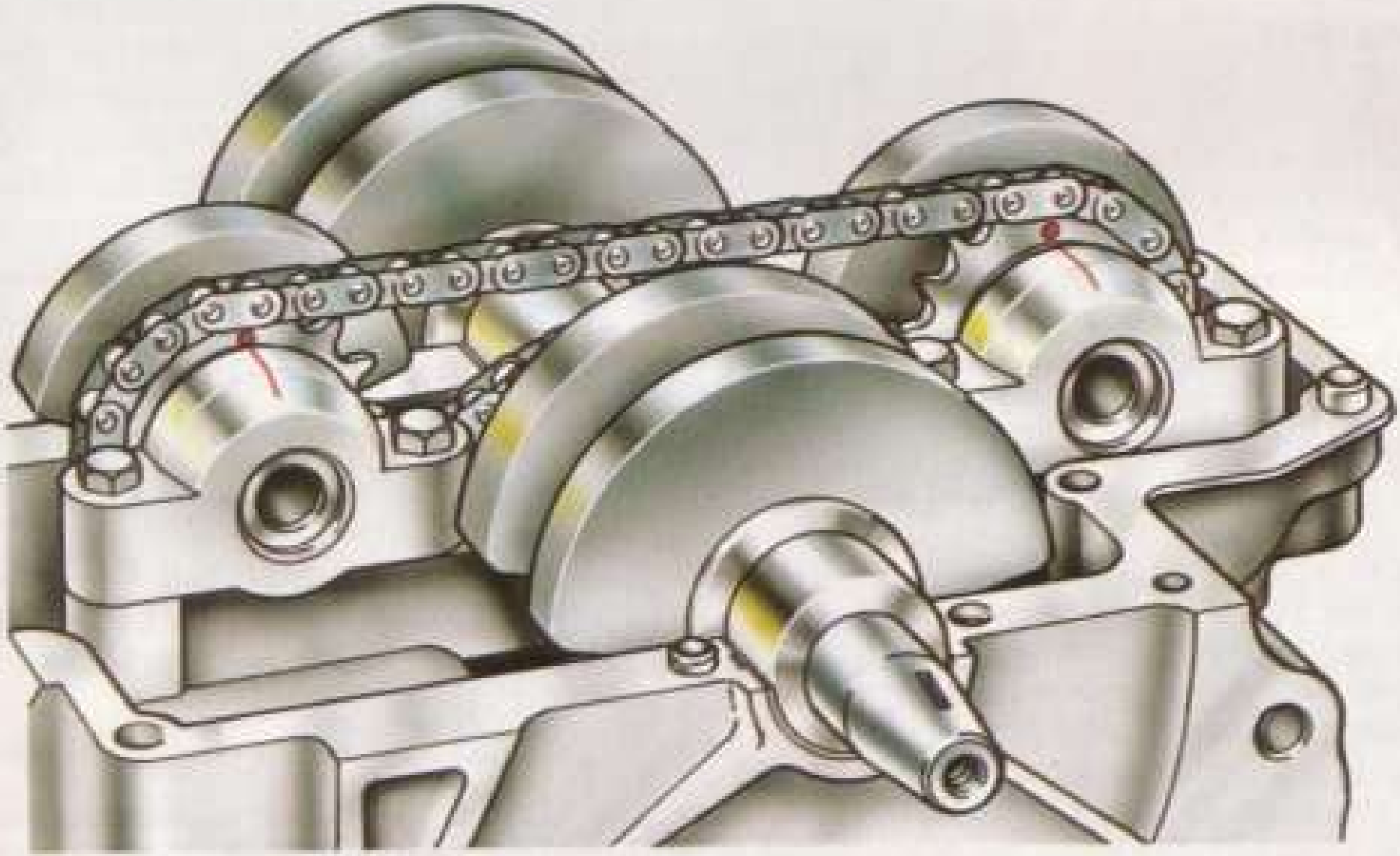
Kawasaki Z400 timing

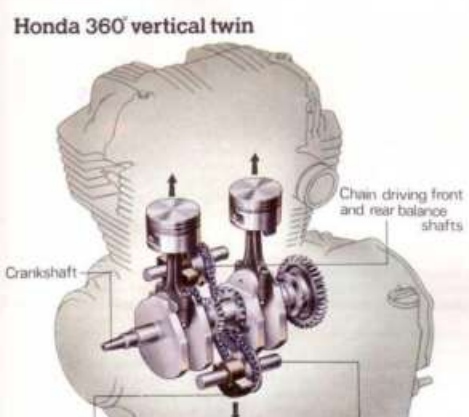


Balancer shaft servicing

Balancer shaft service

Stripping and reassembling engines with balance shaft arrangements involves certain procedures particular to their type. Here we show how to tackle a bottom end overhaul on the relevant models made by the big four Japanese manufacturers.

Honda 360° vertical twin



1. The CB400T has balance shafts placed fore and aft of the crankshaft. They are chain driven

Balance shafts are used in some engines in order to make the motor smoother by damping out vibration and so provide the rider with a more comfortable ride. Most single cylinder and parallel twin engines counterbalance the reciprocating mass of the piston and upper connecting rod assembly with a weight in the crankshaft (see pages 56–59). However this alone is only partly successful in reducing vibration and manufacturers have to resort to other means to reduce its effect further. Engine mounting arrangements such as Norton's Isolastic mountings, and other vibration damping details, such as rubber mounted handlebars, are some examples.

One solution to this problem is the use of counterbalancing shafts, fitted in the crankcase and driven from the crankshaft. The shafts are fitted with out-of-balance weights which generate their own forces when rotated to act in opposition to those set up by the crankshaft. Thus the two forces effectively cancel each other out. Of course the forces still exist so the crankcase must be rigid enough to contain them and let them act against one another.

In practice there are two means of arranging balance shafts in an engine, depending on its design. In the first case there is the single and the 360 degree parallel twin cylinder engine which both share the same balancing problems. Such twins are more likely to suffer from vibration because they run at a higher crankshaft speed, usually have a larger capacity and probably a less rigid crankcase structure. However, the even firing of the twin may be an asset. For these types of engine two balancing shafts are necessary, both rotating in the opposite direction to the crankshaft.

In the second case, where a 180 degree crankshaft layout is used for a parallel twin, the design problem is different, and the reduction in vibration can be obtained with a single shaft, with two balance weights on it, running in either direction. On a 4-stroke engine the 180 degree layout gives an uneven firing interval but this is acceptable and common practice on many twins whether they are fitted with balancer shafts or not (fig. 2).

Counterbalance shafts are always fitted in the crankcase of the engine and when two are used they are situated in front and behind the crankshaft. The shafts may not be in a direct line with each other, and usually one lies on the horizontal crankshaft axis and the other is offset; this layout assists further in cancelling out the minor out-of-balance forces.

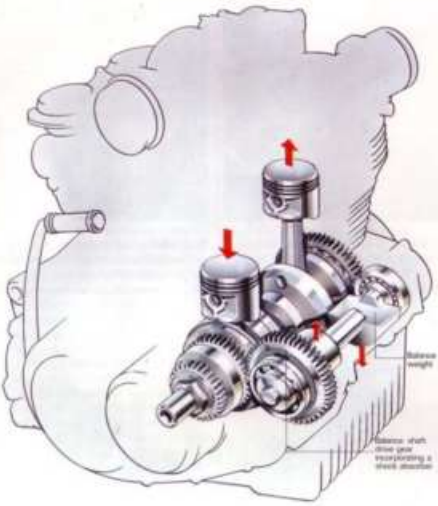
In most cases access to the balance shafts is obtained by splitting the crankcase in the normal manner so that if work needs to be carried out on items such as the crankshaft or bearings, the balance shaft(s) can be dealt with at the same time. In some cases the balance shafts have to come out before the crankshaft can be removed, but if not it makes sense to remove and inspect the balance assembly parts anyway, having already carried out so much of the dismantling work. It may also be necessary to strip the balance shafts or their drive because of faults in them, and, of course, if this happens the opportunity should be taken to inspect all the other items which have to be dismantled at the same time.

Balance weights run on bearings and these can wear after high mileages, and the shock absorber mechanism, which usually incorporates springs or rubber blocks, can also deteriorate and thus need renewing. In most cases the shafts are chain driven and some form of adjuster is built in to enable the chain free play to be set. Although the chains operate under ideal conditions and should have a very long life, it is always possible that a fault has arisen requiring the chain to be renewed.

Splitting the crankcases

All the Japanese engines currently using balancer shafts have crankcases which split horizontally. Splitting horizontally is dealt with on pages 1079–1083, and rebuilding is detailed on pages 1110–

Suzuki 180° vertical twin



Artwork by Arts

2. The Suzuki GS425 has a single gear-driven balance shaft in front of the crankshaft

1115. In nearly every case you must drain off the oil and remove the engine unit from the frame (see pages 618-624 and 647-652). The exception is the Yamaha XS500 whose balance shaft can be removed with the engine in the frame.

Check whether the top half of the engine requires to be disturbed because on many engines the balancer shafts and their drives can be removed without touching the head or the barrel. Take the plugs out so that the engine can be turned over more easily and remove the side covers from both sides. Only dismantle any items which will prevent the lower half of the crankcase coming away. Thus the clutch, primary drive, generator and gearchange mechanism can in most cases be left in place.

Dismantling the shaft mechanism

The simplest balance shaft to dismantle is that on the Yamaha XS500 which can be removed while the engine is still in the frame. To do this first remove the rotor, starter chain and the outer bracket from the left side of the engine and the clutch from the right side. This will allow access to the single balance shaft drive chain.

Access to every other balance mechanism requires a crankcase split. In all cases, however, there is no need to disturb the upper engine assembly. First remove the lower crankcase half. At this stage it is necessary to make a note of the position of the balance shafts and weights in relation to the crankshaft. This is vital as they must be placed in exactly the right position on reassembly or the engine timing will be completely thrown out.

Gaining access



3. On the Honda XL250 removal of the clutch cover reveals the balance weight at the top right hand corner



4. To gain further access, remove the clutch unit and the primary drive drive gear from the casing



5. Now remove the oil pump drive gear and the intermediate gear followed by the oil pump unit

Nelson Bergstrom

Continued



6. Removal of the generator cover reveals the generator flywheel. The stator remains in the cover

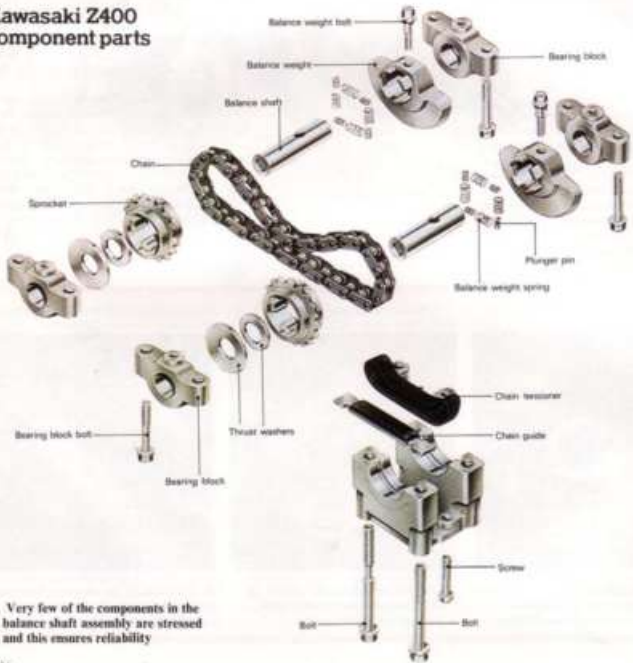


7. A special extractor is needed to dislodge the flywheel. Do not try to tap it free with a hammer



8. Turn the engine over to check that all the timing marks are located on the chain and sprockets

Kawasaki Z400 component parts



9. Very few of the components in the balance shaft assembly are stressed and this ensures reliability

The details of chain removal vary from bike to bike. On the Yamaha XS500 the drive chain runs over four sprockets: a drive and a driven sprocket arranged in pairs. The sprockets have alignment dots and you must make a note of their position. On the Suzuki GS400 and GS425 the single balance shaft runs across the front of the engine on the split line and is gear driven by the crankshaft. It is aligned by dot markings on the balance shaft driven gear and the crankshaft driving gear. Honda and Kawasaki employ two balancer shafts fitted either side of the crankshafts on some of their models, notably Honda's single cylindered XL250, XL500, XR-250 and XR500, the 360 degree parallel twin CB250T and CB400T and the Kawasaki Z400. On the Kawasaki make a note that the balance shafts are aligned when the two bright links in the drive chain align with the punch dots on the drive sprockets when the webs on the balance weights and the crankshaft point downwards (fig. 20). In this position the pistons are at TDC and the oil holes in the main journal are just visible. On the Honda twins you must align the 'TC' line on the front weight and the 'TH' on the rear weight with the horizontal line of the crankcase split while the weights are horizontal and the 'B' mark on the crankshaft is also aligned with the case split line (fig. 19).

Once you have noted the correct balance shaft alignment you can proceed to dismantle the shaft(s) and weights. On the Suzuki GS400 and GS425 the balance shaft lifts straight out of the crankcase. Once the whole assembly is out of the crankcase simply pull the two ball races off the end of the balancer shaft and pull off the driven gear which incorporates the torsion damper. On the Yamaha XS500 first pull out the upper jockey sprocket shaft. This will release the chain and now you can remove the free running sprocket. Undo the retaining nut and lock washer and remove the balance shaft sprocket which, as in the Kawasaki system, contains a damping mechanism. Next remove the circlip which retains the shaft bearing on the right side of the crankcase, pull the bearing out, and then push the whole balance shaft out through the right side. You can then pull out the bearing behind the drive sprocket. On the Honda twins you must first remove the oil strainer. This frees the rear balancer shaft which you can then simply pull out. Next loosen the support casting retaining bolts evenly to avoid distorting the casting, and remove the casting. Lift out the rear balance weight and label it along with the rear shaft to avoid confusion on reassembly. The front balance weight is mounted on an eccentric shaft which is used to adjust the chain tension. The chain tension adjusting mechanism comprises a spring which is keyed into the shaft. Pressure on the chain can be adjusted by loosening a clamping nut on the adjusting quadrant which is fixed to an arm splined to the front balance shaft. Remove the clamping nut and take off the spring on the other end of the shaft. Make a note of exactly how the spring fits to the crankcase and the shaft. Then simply withdraw the bal-

Extracting the balance weights



10. To split the cases, remove the retaining screws and tap the cases apart. Take care of any dowels



11. The balance assembly remains in the upper half. This engine has a second weight on the gearbox layshaft



12. To remove the front shaft extract the circlip that retains the drive gear in place



13. Hold the gear in one hand and pull the shaft out of the casing from the the right. Take note of any shims



14. The gearbox layshaft and the front shaft drive sprocket can now be removed as one unit



15. The shaft can now be pulled out of its holder. Note the location of the bearings and shims

Continued



16. The shaft and its component parts are now ready for inspection. This varies according to the model



17. Examine the bearings for excessive rattle. If the shims or location washers show wear, replace them



18. Check the splines in the weights and on the shafts for cracks or wear. Replacement is the only cure

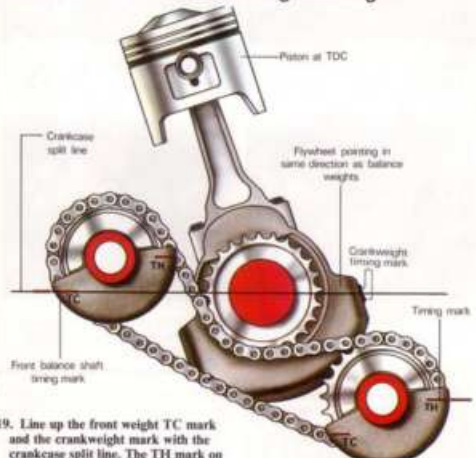
Nelson Hargreaves

ance shaft from the crankcase. This will free the front balance weight and the drive chain. Remove these from the crankcase and label them both to avoid any confusion.

The Kawasaki Z400 and the larger Z750 feature two chain driven balance shafts running in a pair of blocks either side of the crankshaft. First pull away the centre main bearing to allow access to the balance chain and its guide. Pull off the four support blocks and then carefully lift away the whole assembly. You should remove each balance weight in turn to avoid mixing up the parts. Pull away the balance blocks and remove the shims and thrust washers carefully noting their position. Next tap the drive sprocket off the balance shaft. There is no need to unbolt the balance weight from the shaft unless the shaft is worn.

Once you have dismantled the balance assembly you can continue by examining it for wear or damage.

Honda CB 400T balance weight timing



Steve Cook

19. Line up the front weight TC mark and the crankweight mark with the crankcase split line. The TH mark on the rear weight must also line up with the bearing holder shoulder

Examining the balance shafts

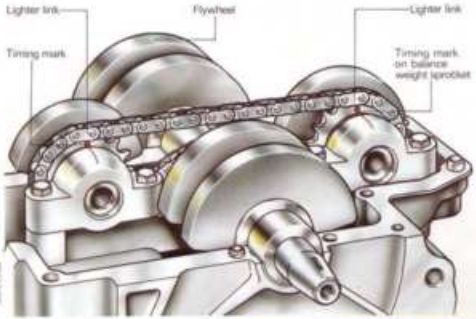
The main areas for attention on the balance shaft assemblies are the shaft bearings, the drive chain and the damper assemblies. To check a ball race for wear first clean it in paraffin then, holding the centre between your thumb and forefinger, spin it while listening for a rattling noise. Renew the bearings if they are worn. Shake the sprocket and the spring damping mechanism on the Suzuki GSs, Yamaha XS500 and Kawasaki's Z650 and Z750. If the springs rattle dismantle the damper and renew the springs. On the Honda twins you must remove the balance weights from the shaft to gain access to the damper mechanism. Make a note of the position of the balance weight in relation to the drive sprocket. Punch marks on both components show alignment. Remove the circlip which secures the parts together and inspect the rubber damping blocks. Renew them if they are damaged in any way. If the drive chain has stretched to the end of its adjustment you must renew it.

Reassembly

In most case reassembly is a straightforward reversal of the dismantling process. If you have taken the drive sprocket off the balance shaft(s) note that it is keyed on. Also take care to locate the balance shaft bearings properly – in most cases there are locating pins which fit into the crankcase.

On Honda twins first refit the front balancer together with the shaft tension spring. To tension this wind the shaft three quarters of a turn in an anticlockwise direction. Next lay the rear balance weight in the drive chain and assemble it into the support casting. Then insert the rear shaft and check the balance shaft timing. Fit the oil strainer noting that one of the securing bolts

Kawasaki Z400 timing



20. Align the bright links in the chain with the marks on the sprockets when the flywheels point upwards

locks the rear balance shaft.

On the Kawasaki Z400 first fit the balance weight assemblies together with the bearing blocks and then mesh the chain so that the two bright links align with the dots on the sprockets. Hold the drive chain taut and lay it into the crankcase so that it meshes with the crankshaft. Check the timing of the balance assemblies once more, and if correct, bolt down the bearing blocks and the main bearing cap once the chain guide is in place (fig. 23).

On the Suzuki GS400 simply place the balance shaft in place, making sure that the timing marks on the balance shaft sprocket and the crankshaft align.

On the Yamaha XS500 take care to locate the bearing pin correctly and do not forget to refit the right side bearing circlip. The balance shaft sprocket only fits in one position and the correct timing is achieved by positioning the drive chain. Refit the two idler sprockets and then recheck the timing.

With the balance shaft assemblies refitted you can continue to rebuild the engine and refit it into the frame.

Finishing off

In all cases except for the Yamaha XS500 you must refit the engine in the frame: for details of this see pages 677–680. When reassembling the parts always oil them generously, especially bearings, which can suffer serious damage if left without oil even for just a few moments. Before you start the engine turn it over by hand and see if it turns freely with no strange noises.

Reassembly



21. Refit the weight to its shaft and ensure that the timing marks on the shaft and the weight align



22. The drive sprocket on the crank must have its timing mark aligning with the cutaway on the crank

Continued



23. For final timing each bright link must align with all three timing marks on the sprockets



24. At this point the cutaway on the front weight must align with the mark in the crankcase



25. The slightly hidden rear weight must also align with a similar mark at the back of the crankcase