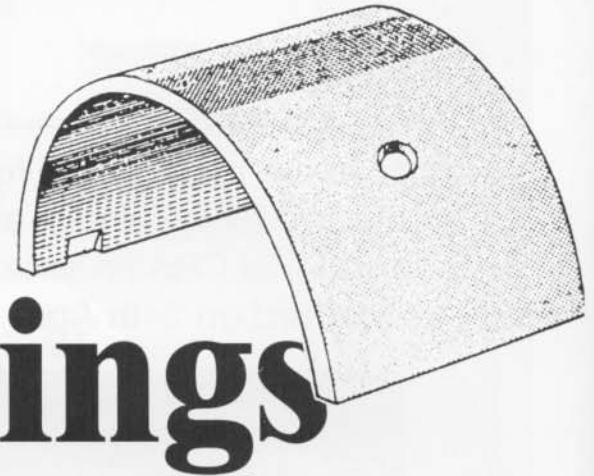
Widely used on parallel twins, thin wall big-end shells are simple to renew, explains **Owen Wright**.

Plain bearings



Imagine the conflict of metal against metal every time a motor cycle is kicked into life. Consider also how the downward thrust of a piston is transmitted to the back wheel through a series of rotating components carried on a train of bearings. In an earlier issue (Bearing essentials, March 1993) I described how various types of rolling element bearings are selected by designers on account of their ability to support rotating shafts with only small frictional losses.

In certain instances however, cost and physical size force designers to consider simpler and more compact plain metal bearings and bushes.

A bush is defined as a cylindrical lining made from a soft but durable material, pressed into an axle hole. In the majority of cases, bushes are intended to carry only moderate loads with varying degrees of lubrication.

A plain big-end bearing however, has to withstand the brunt of all the pulverising effects of combustion and a reciprocating piston's inertia loads. Despite the obvious disadvantage of having no rolling elements, a properly designed plain bearing or bush can be just as efficient as a roller bearing in terms of frictional resistance.

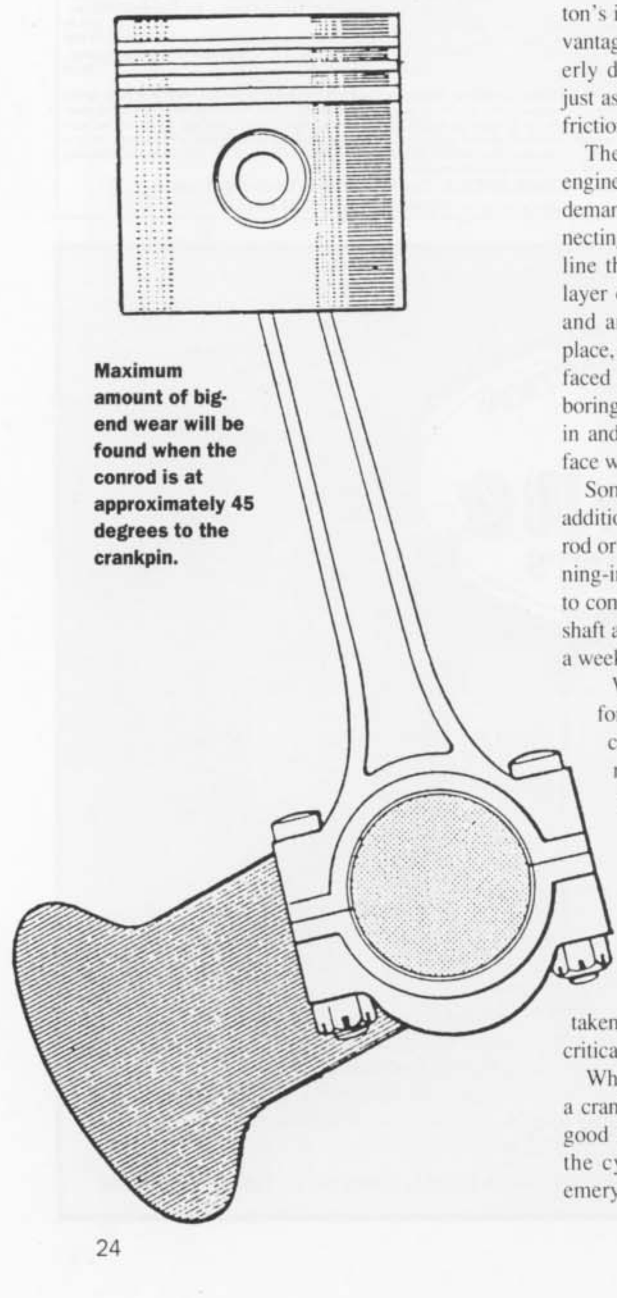
The one-piece crankshafts favoured by engine designers at the start of the motor age demanded some form of split bush at the connecting rod's big-end eye. The old way was to line the connecting rod eye and cap with a layer of white metal: an alloy of tin, copper and antimony. With the end-cap bolted in place, the conrod was machined in a tool that faced off the sides of the big-end as well as boring out the eye in situ. Even then, lapping in and laborious scraping of the bearing surface was required to ensure a satisfactory fit.

Some assemblies involved the removal or addition of shims between cap and connecting rod or the filing down of the cap. Careful running-in was necessary as the fit had to be tight to compensate for initial bedding in. A crankshaft assembly could be on the workbench for a week.

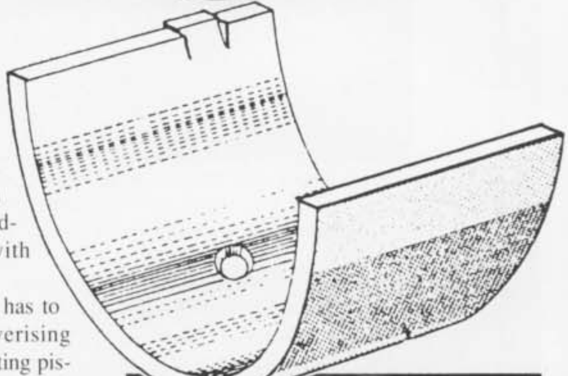
White metal, the material generally used for lining bearings in an earlier age, was commonly known by its American name, Babbitt's metal. In some engineers' reference books it is also called white brass. Tin was the principle metal used and a common combination was 84 per cent tin, 8 per cent copper and 8 per cent antimony. Applying white metal to the conrod was a highly skilled process. Material temperatures, and the time taken during each stage of the process, were critical if the bond was to be successful.

White metal bearings had to be matched to a crankshaft journal with accurate sizing and good surface texture. Without the advent of the cylindrical grinding machine and the emery wheel, production of motor vehicles might never have progressed beyond labour intensive, hand built machines. At the turn of the century, machine tools able to grind the surface of a one-piece crankshaft to a high class finish and accuracy started to make an impact on the infant motor industry.

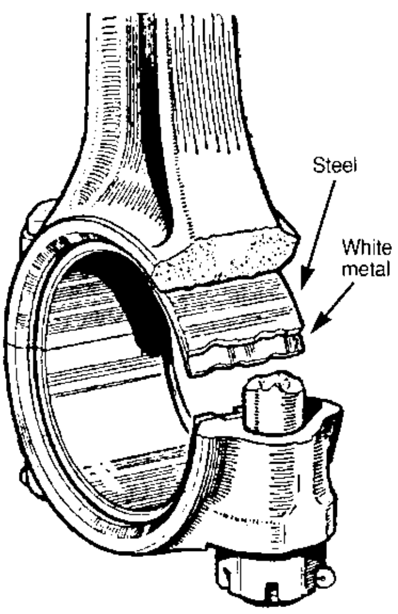
Critical developments in white metal lined, thin wall shell bearings accelerated during WWI when aero engine designers made rapid strides. Allied to an accurately ground crankpin, pre-machined shell bearings dispensed with the need for tedious running in. They only became common in motor cycle engines with the popularity of vertical twin cylinder engines after WWII. There were already some examples of single cylinder engines — such as those made by Royal Enfield — with plain instead of roller bearing big-ends, but they were regarded with suspi-



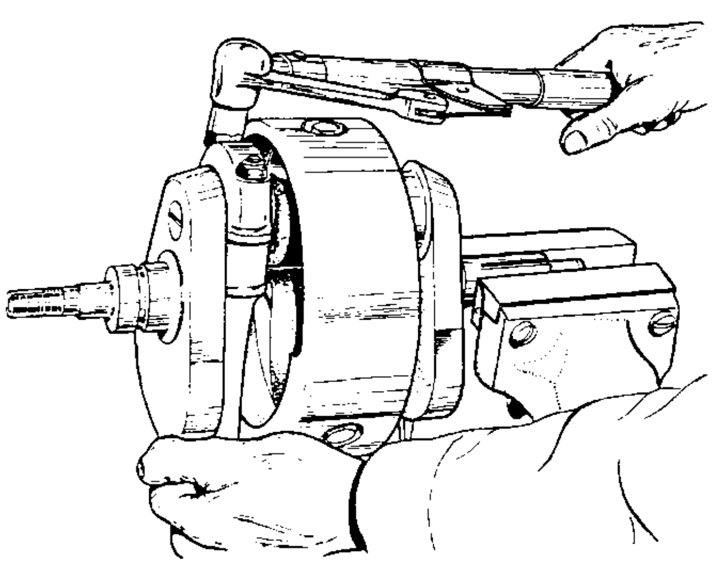
Maximum amount of big-end wear will be found when the conrod is at approximately 45 degrees to the crankpin.



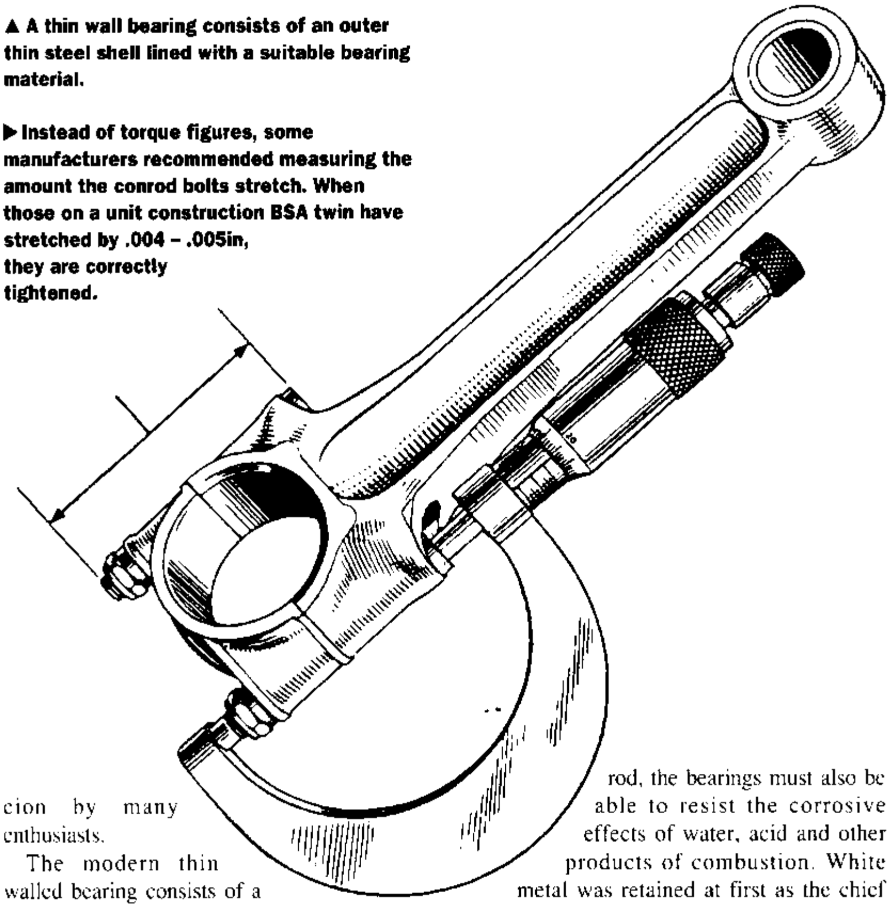
Projections on the square edge of the shell locate them in the eye of the rod.



▲ **A thin wall bearing consists of an outer thin steel shell lined with a suitable bearing material.**



Use a torque wrench to tighten the conrod bolts to the maker's figure.



▶ **Instead of torque figures, some manufacturers recommended measuring the amount the conrod bolts stretch. When those on a unit construction BSA twin have stretched by .004 - .005in, they are correctly tightened.**

cion by many enthusiasts.

The modern thin walled bearing consists of a bearing material fused on to an accurately machined steel shell. The shells are designed for a light interference fit in the conrod or cap to avoid any chance of distortion. Each half features an angle or projection that locates in a groove cut into the conrod and end-cap, to prevent the shell from moving. The surface of the bearing is made to very precise limits. Despite the fact that the actual bearing material is relatively thin, it is more resistant to compression and cracking than an equivalent thick walled bearing.

As well as the ability to withstand fatigue stress caused by the accelerating and decelerating forces of the crankshaft, piston and conrod, the bearings must also be able to resist the corrosive effects of water, acid and other products of combustion. White metal was retained at first as the chief bearing material, although a lead-bronze alloy was sometimes specified for severe loading conditions.

Some British motor cycle manufacturers specified their crankshaft bearings with a top layer of indium. Hazardous particles are harmlessly embedded in this layer, which also acts as a protective compound when the engine is first run.

Ever increased engine outputs have led to improved bearing materials. Modern bearing alloys are a lot harder than their earlier white metal counterparts. This in turn has resulted in the specification of harder shaft materials capable of withstanding contact with particles of eroded bearing. The older Babbitt material was able to absorb these particles into its relatively soft surface. Modern lead-bronze or copper-lead bearings in high performance engines are used in conjunction with nitride hardened shafts.

No bearing will last forever. At some time or other, wear between a bearing and the crank journal is inevitable. Bearings should be replaced as soon as big-ends become audible. If wear is not checked, the lining material will be eroded until the steel backing of the shell comes into contact with the crankpin. The steel backing will score the crankpin, making a re-grind inevitable.

To the inexperienced ear, big-end knock can be mistaken for piston slap or a loose tappet. One way of identifying a worn big-end for certain is to accelerate hard, or labour the engine when climbing a gradient in top gear. The knocking sound will disappear when the throttle is eased back.

If your worse fears are realised, removing the cylinder is the only way to confirm the extent of the wear. Firmly grasp the connecting rod, then pull and push upwards and downwards and check for excessive movement. Do not confuse side-play with up and down movement. The maximum amount of wear can be found when the conrod is at approximately 45 degrees to the crankpin.

When removing the conrod end cap make a note of the bolt positions and end cap. If you have to re-use the bolts because replacements are unobtainable, mark each bolt with a number to correspond with its conrod. The end cap and conrod should already be marked with a serial number by the maker.

Examine the crankpin for scoring and ovality. Shine a torch at an angle on to the surface of the journal to see if it has worn oval. Running a thumb nail along the surface is also a good indicator. Avoid the temptation to remove any scoring with emery cloth. A re-grind is the only long term solution. Thin wall shell bearings ▶

Under pressure

When fitting new shells, don't forget to clean out the crankshaft sludge trap.

GIVEN A continuous supply of cool, clean oil, shell bearings will last a long, long time.

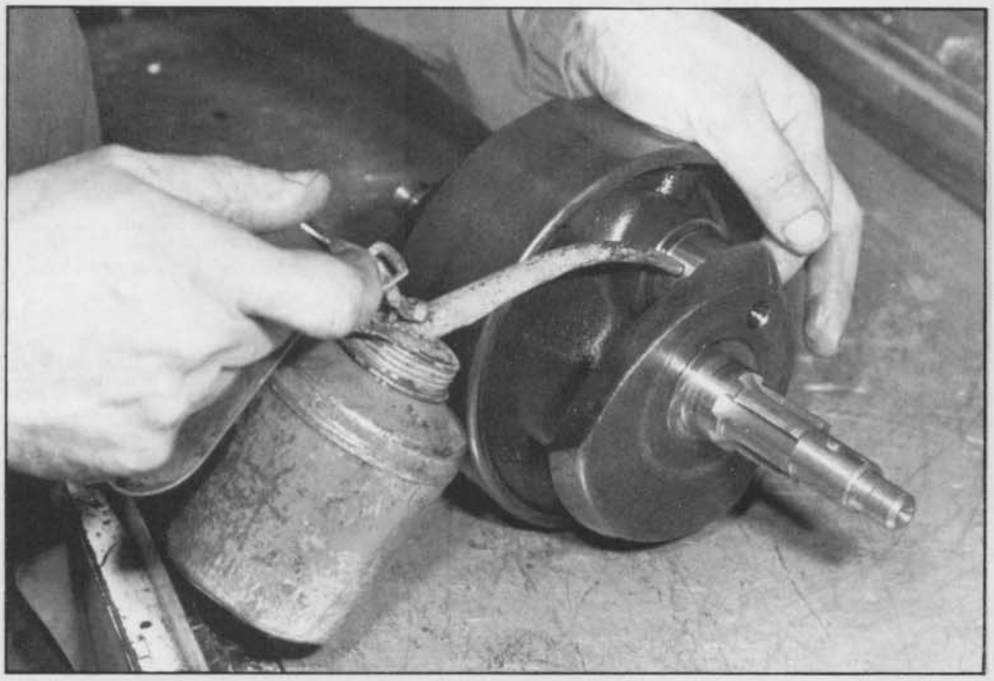
The most important factor in ensuring long bearing life is lubrication. An oil film between the bearing and crank journal, fed and maintained by a pump, provides a cushion that separates the bearing and crank journal in such a way that the two never actually come into contact. This type of lubrication, demanded by a shell bearing, is called hydrodynamic. Movement between the shaft and bearing forms a wedge of oil that separates the two components, rather like a tyre aquaplaning on a wet road.

In theory this means that no wear can take place. Yet contamination of the oil with the products of combustion, and particles carried in the oil from other parts of the engine, gradually erode the surface of the bearing. Adequate filtration, and regular replacement of the lubricant, is clearly vital.

Deterioration of the oil through oxidisation and fuel dilution is another factor bearing designers have to consider. Most modern engine oils boast good anti-oxidisation properties.

If the oil and bearing surfaces get too hot, either through overload or a poorly maintained oiling system, the bearing material will soften and rapidly degenerate under load. The damaged bearing starts to break up, causing further overheating. This creates a vicious circle that leads to final calamity.

The forces acting between the shaft and bearing vary greatly between the point when the shaft is static, under acceleration, or turning at a constant speed. To replace any oil squeezed out by these forces, the flow of lubricant has to be pressure fed into the bearing.



Force oil through the crank feed holes to check flow before assembly.

The oil flow is carefully determined at the design stage, when the specification of the bearings and the lubrication system is treated as a single task. So fitting a larger displacement pump won't necessarily improve lubrication. A pump does not create pressure: it creates flow. Pressure is built up by whatever restricts the flow of oil in, or at the end of, the supply line. Too high a pressure can lead to rapid erosion of working surfaces, especially if the oil is badly contaminated. The effectiveness of the whole lubrication system directly affects bearing life. Regular oil changes and efficient filtration make all the difference. During an oil change it's a good idea to flush out the oil tank and the feed pipes. ■

Plain bearings

demand a precision fit or they will fail prematurely. New shells were normally supplied in standard undersizes -.010in, -.020in and -.030in.

Absolute cleanliness is a must when reassembling a crankshaft, particularly when shell big-end bearings are used. Prepare a clean working area and liberally smear the bearing surfaces with fresh oil from a clean can. Try not to touch the surface of the shells with your fingers. This will reduce the risk of contamination.

The conrod end cap must always be refitted in the original position. Mark the parts before dismantling if they don't already have some form of reference stamp. A torque wrench should be used for tightening new big-end bolts. Consult a manual for the correct setting. Don't use old bolts because each one stretches when tightened up.

Most bearing wear takes place immediately after you start the engine and there is little effective lubrication for a minute or two. So short journeys with frequent stops and starts will bring forward the day when a crank regrind is required. Given a fresh supply of oil, shell type big-end bearings are happiest run at constant speed and temperature. They actually like being used for long periods. Is there a moral there somewhere? ■