Rudge Remedies

No 9 – Main Bearing inspection & replacement – 500cc/350cc 1930 to 1939

Main Bearings

From 1930 to 1939, the 500cc & 350cc machines were fitted with 3 main bearings, a ball and roller race on the drive side and a roller race on the timing side. The original fitments were:

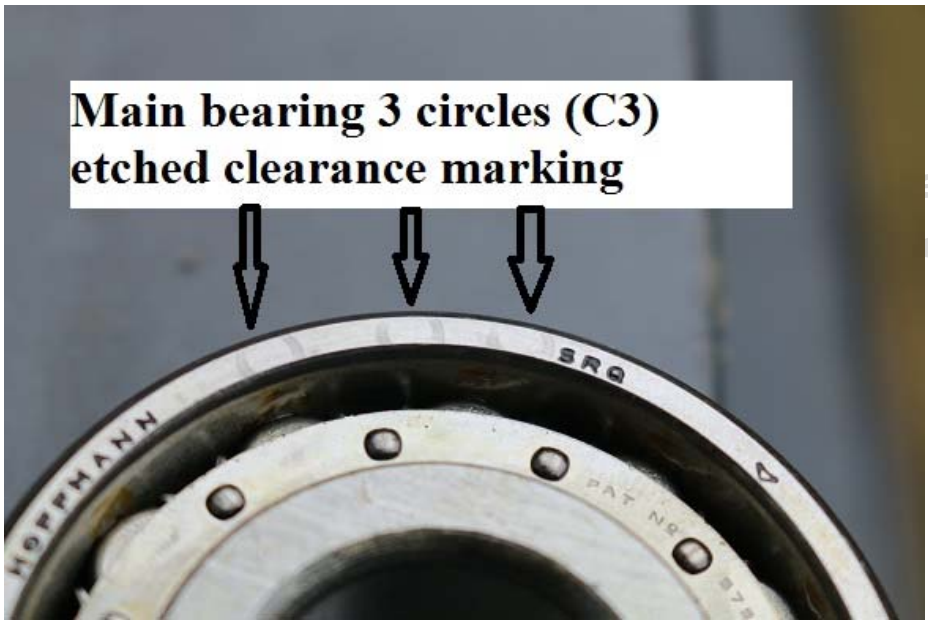
Model(s)	RMS9	RMS9/3	4MRJ 7/8 11 rollers 5/16" x 3/8" long	6MRJ 7/8	(K)MC22
1930	2				1
1931/2 Special & 350	2				1
1931/2 Ulster & TTR		2			1
1933 Special & 350	1	1			1
1933 Ulster & TTR		2			1
1934 All		2			1
1935 All			2		1
1936 Special			2		1
1936 Ulster				2	1
1937-9 Special			1 (RH)	1(LH)	1
1937–9 Ulster				2	1

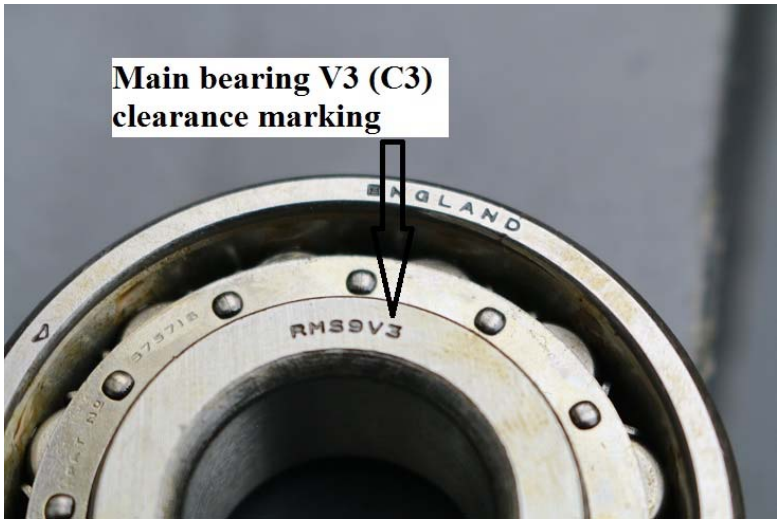
Dimensions: MC22 – 22mm x 50mm x 17mm (note that some bearings contain a slot across the face of the inner bearing race (KMC22). This is of no consequence and was used on some other applications to positively locate the inner race.

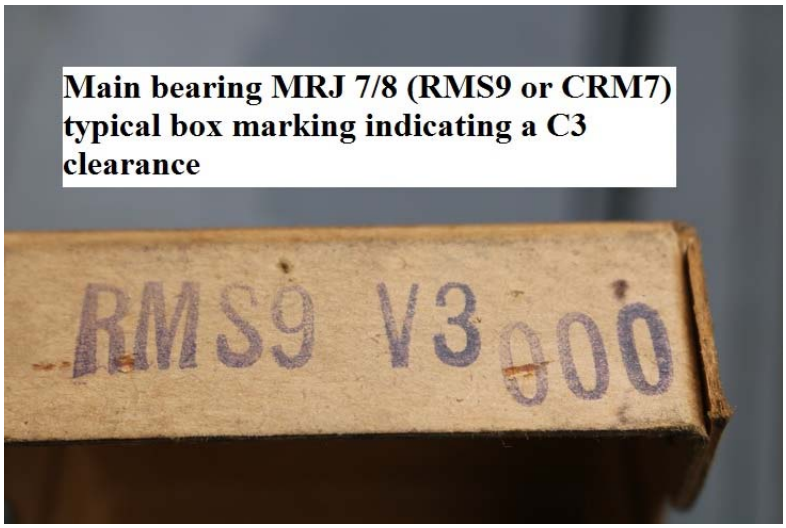
MRJ 7/8 (RMS9) – 7/8" x 2.1/4" x 11/16"

It is clear to see that as engine power developed, the specification of the main bearings changed along with a change in manufacturer. The different MRJ 7/8 prefixes indicate bearings with differing load characteristics. All original bearings had riveted bronze cages supporting the rollers and post 1930 were of C3 fit (RMS9/3 indicates a C3 fit and all MRJ 7/8 bearings had this clearance also). The introduction of C3 fit bearings was a necessity following problems with loose bearing outer rings in 1930 cured for 1931, by reducing the crankcase bearing aperture size for the main bearings from 2.2495" in 1930 to 2.247"/2.248". This reduction increased the clamping force on the outer race with a proportionate loss of internal radial clearance compensated for by using a C3 fit bearing. Bearings are categorised by their internal radial clearance with popular bearings ranging from '0' or C1, to '00000' or C5 fit with C5 having the greatest internal radial clearance. C3 fit bearings ('000') are generally specified for all air cooled engines with aluminium bearing housings where both races are an interference fit because, when fitted, the outer race tends to be squeezed smaller by the contracting aluminium housing and the inner race stretched over the shaft, thus reducing the internal bearing clearance. The fit is generally marked on bearings by either a number of circles etched or scuffed into the outer ring or the 'C' fit etched or stamped into either inner or outer ring face often as a 'V3'. Unless

specified, bearings are now supplied with a ‘CN’ radial clearance between C2 and C3 and are unmarked.







Modern Bearings

Driven by the need for standardisation and cost reduction, modern MRJ 7/8 bearings:

a) Normally come in only one unmarked fit size - 'CN' between C2 & C3;
b) Have steel or nylon cages to support the rollers;
c) Tend to have less but larger rollers with thinner inner and outer races. Typically, modern bearing outer rings are 0.165" in thickness running 10 rollers whereas the original R & M 4MRJ bearings outer rings were 0.180" running 11, 0.3125"x 0.375" rollers.

All these individually (particularly c) or in combination, can cause bearings to lose their internal clearance when fitted to the crankcase leading to premature failure and difficulty in putting the crankcases together or setting up crankshaft end float. (the crankshaft should slide easily from side to side with a 'clonk' with the crankcases bolted together).
In general, C3 clearance bearings should always be used as a starting point with inner race fit tests being carried out as described later in the text. However, where shafts and/or housings are worn, CN or C2 bearings MAY work satisfactorily IF they pass the appropriate fit tests

Bearing Inspection
Before the bearings can be inspected and/or replaced, the engine has to be fully stripped with the crankcases parted and the crankshaft removed. The inner bearing races should be removed from their shafts using a suitable puller or by judicial use of levers behind the thrust washers. Note that with bearings having nylon or steel cages that these will be damaged if leverage is applied to these types of cages. If the bearings may be reused, ensure a note is taken of the orientation of the bearings. Note that the drive side thrust washer is not hardened and may *distort* under excessive leverage and that the timing side thrust washer is hardened and may *break* under excessive leverage. Remove the thrust washers and any shims from behind them keeping timing and drive side separate and clearly labelled. Thoroughly clean the inner races and the captive bearing in the drive side crankcase.
For the roller races, a bearing should be replaced if:

a) The outer track bearing surface or rollers show any signs of pitting, marking scoring or flaking;
b) There is any inner race cage damage;
c) The inner/outer radial clearance is excessive (although this is difficult to judge – as a guide, a bearing with *any* up and down clearance that can be felt should be replaced).
d) The bearing is a loose fit on its shaft (although the shaft may be worn rather than the bearing - see ***Bearing problems*** below).
e) The bearing track where the rollers have run **IS NOT CENTRAL TO THE OUTER RACE**. This occurs when incorrect thrust washers have been used causing a bearing to run off centre. Clearly, if a bearing exhibiting these features were to be reused, the rollers would run on a part unworn surface.
f) Incorrect bearings have been used such as RMS9L/RMF9(lipped bearings).

For the captive ball race, inspection is limited as the actual bearing tracks cannot be seen. The bearing should spin freely and cleanly without rumbling. The inner should have no appreciable play. Comparison with a new bearing is also a good method of determining wear.

As with all bearings, if in doubt, the bearing should be replaced.

Bearing removal/replacement

Timing side roller outer race removal/replacement – Heat the crankcase to 200C using an even heat to prevent distortion (an oven is best). Holding the crankcase horizontally with the timing chest uppermost, bring down the crankcase sharply on to a flat surface which will not damage the aluminium (a wooden surface is best for this). The outer bearing ring should fall out. If the ring is not dislodged by this method after several attempts, it can be removed by drilling 2 small diametrically opposed holes through the bearing housing lip from the timing chest side and using a pin drift to drive the race out. After cooling, the bearing housing should be thoroughly cleaned and re-heated to 200C. The new outer race should be cleaned of any preservative and dropped into the crankcase where it will slide in easily. (this can be facilitated by placing the bearing race in a freezer for ½ hour before fitting). The crankcase should be allowed to cool naturally in a horizontal position to ensure the bearing remains firm against the back of its housing. It should not be necessary to 'drive' the bearing race into position. With the crankcase cooled to room temperature, the inner race should be fitted and checked for clearance. The inner race should slide cleanly into the outer and rotate easily with no hint of 'notchiness'. (remember also that the clearance will be reduced marginally when the inner race is fitted to the shaft as they are, or should be, an interference fit. If the inner race is tight, refer to ***bearing problems*** following. Note that it is **not recommended** that bearing inners and outers are interchanged as a method of obtaining extra clearance.

Drive side roller outer race removal/replacement – Heat the crankcase to 200C using an even heat to prevent distortion (an oven is best). Holding the crankcase horizontally with the timing chest uppermost, bring down the crankcase sharply on to a flat surface which will not damage the aluminium (a wooden surface is best for this). The outer bearing race should fall out. If the race is not dislodged by this method after several attempts, it can be pushed out using the lock ring securing the outer drive side ball race. This method **should be used as a last resort as there is a possibility of damaging the bearing lock ring crankcase threads**. To use this method, **first remove the lock ring grub screw located under the crankcase boss**. With this removed and the crankcase at 200C, the lock ring can be unscrewed (normal RH thread) slowly using a suitable box spanner (22mm box spanner is a close fit) or piece of hexagonal bar (1.28"/1.29" AF). This should push out the bearing race. If the bearing ring fails to move, **do not force the lock ring or this may damage the crankcase threads**. As a last resort, the safest way to remove a stubborn outer race is by grinding through it or turning up a steel blank and welding it inside the bearing ring. This provides a surface to drive the bearing ring out from the outside through the MC22 bearing.
To fit the new roller bearing, follow the instructions in the previous paragraph **after** the drive side bearing has been attended to (see below).

Drive side ball race removal/replacement – First remove the lock ring grub screw located under the crankcase boss. With a suitable box spanner or hexagon bar, unscrew the bearing lock ring (normal RH thread). With this removed, heat the crankcase to 200C using an even heat to prevent distortion (an oven is best). Holding the crankcase horizontally with the drive side boss uppermost, bring down the crankcase sharply on to a flat surface which will not damage the aluminium (a wooden surface is best for this). The bearing should fall out. If the bearing has not been dislodged by this method after several

attempts, it can be ***gently*** drifted out using a suitable drift applied to the inner race. **Note that it is bad engineering practice to apply any pressure to ball race inner races.** Allow the crankcase to cool, thoroughly clean the bearing housing and inspect it for signs of damage indicating that the bearing may have been rotating in its housing. Inspect the bearing lock ring making sure it presents a flat face with no burrs to the bearing. Also inspect the crankcase threads for damage and ensure the lock ring screws in easily. (the threads are often damaged around the grub screw drilling and 'fettling' of the thread here often cures a tight lock ring). To fit the new bearing, re-heat the crankcase to 200C and drop the new bearing in squarely **with the chamfered edge (if there is one) towards the crankcase** to the bottom of its housing. (this can be facilitated by placing the bearing in a freezer for ½ hour before fitting). Immediately replace the bearing lock ring and screw tightly home. Allow the crankcase to cool to room temperature and check the lock ring for tightness. Next check that the inner race of the bearing rotates freely and does not bind on the crankcase lip. If the bearing inner binds, it will be as a result of the bearing recess in the crankcase not being flat generally caused a spinning bearing wearing a groove in the recess bottom thus moving the bearing closer to the lip. The solution to a binding inner is to remove the bearing and polish/machine back the inside face of the lip generally around 0.005" to 0.010".

The grub screw must now be replaced (1/4" x 20TPI Whitworth thread). Often, the hole drilled in the lock ring will **fully** align with the grub screw hole and the grub screw can just be replaced using a spot of thread locking compound. If the lock ring drilling has not **fully** aligned, **do not unscrew the lock ring in an attempt to realign the grub screw as this could subsequently allow the bearing to rotate in its housing resulting in damage to the crankcase.** If no part of the original lock ring hole is visible, the lock ring will need to be redrilled. To re-drill the lock ring to accept the grub screw, it is best to use a pilot to avoid damage to the grub screw thread. (A ¼" Whit bolt drilled down the centre to accept a 5/32" drill is ideal for this). Using a pilot, re-drill the lock ring, clean out any swarf, and fit the pointed grub screw using a spot of thread locking compound. Make sure that the grub screw is not proud of the crankcase surface or it could interfere with the chaincase sealing felt arrangement. If the original lock ring drilling is **partially** visible then redrilling is best avoided due to the probability of the drill wandering into the original hole. Under these circumstances, remove the lock ring reduce its width by approximately 0.005" to 0.010" to reposition the original lock ring hole so that a new lock ring hole can be drilled. An alternative, is to substitute the lock ring with another.

Note that it appears that some later 1939 crankcases were not drilled for a lock ring grub screw! (see above). In this case, the drilling can be added 0.8”/0.88” from the outside bearing face or, as an alternative, threadlock can be used to secure the lock ring once the ball bearing has been installed and the crankcase cooled.

Drive/Timing side inner roller race replacement – If new bearings are being used, the inner roller races should be pressed on to their respective shafts after the thrust washers have been fitted. No shims should be fitted at this stage. After the end float has been calculated and adjustments made to the calculation to centralise the crankshaft, the bearings should be removed (see earlier paragraph) and the appropriate shims added **behind** the thrust washers (Note that shims should **not** be positioned between the bearing and the thrust washer). The bearing inner races can now be replaced. See Remedies No 27 for full bottom end assembly details.

Bearing problems

a) Loose main bearing outer races – Outer races should be a tight fit in the crankcases and it should not be possible to remove them at room temperature. A bearing that has been spinning in use can be spotted by a polished outer as in the picture below. This outer ring is from a timing side bearing where the portion which protrudes from the case can be clearly seen.

Slight looseness can be corrected using Loctite bearing fit but remember that Loctite is destroyed by excessive heat and the bearing race should therefore be replaced after all other work has been completed on the crankcase half. More severe looseness can be corrected by plating the outer surface of the outer race with either copper or nickel. Before plating, the bearing ring should be shielded using 2 disc washers spaced by an internal spacer and held together by a nut & bolt to leave only the outer surface of the race visible. The inner race area should be greased and the discs bedded on instant gasket to prevent penetration of the plating fluid. The central bolt should also be sealed using instant gasket. (see Fig 1 below). Before delivering to the platers, a check must be made to ensure that the central bolt is in electrical contact with the race to ensure plating takes place. A multimeter or battery & bulb can be used for this. The original dimension of the bearing housing was 2.247” to 2.248”, with a nominal bearing OD of 2.250” giving a 0.002” to 0.003” interference fit. (note that as explained earlier, 1930 crankcases had a slightly larger bearing aperture of 2.2495” but ideally, the later 0.002” to 0.003” interference fit should be the aim.)

Fig 1: A bearing outer race prepared for plating

Damage, excessive wear or ovality in the bearing housing can be corrected by sleeving but the close proximity of the main bearing housing to the camshaft bush housing in the timing side crankcase severely restricts remedial work on this side. An alternative to sleeving is welding and remachining but this can cause crankcase distortion if not carried out correctly.. **Note that a loose outer bearing ring in the timing side can be caused by cracking between its bearing housing and the camshaft inner bush housing.**

b) Loose timing side inner roller race – On the timing side, the bearing inner is an interference fit on the shaft. As this shaft is not hardened, over time with numerous fittings/removals, this fit can be reduced and the bearing can spin on the shaft (running a bearing with tight internal clearances can also cause the bearing to spin on the shaft) with consequential damage to the shaft. Running an engine with a loose inner bearing can cause the inner race to move outwards making contact with the outer race crankcase lip causing this to be worn away and resulting in aluminium swarf circulating the engine. In addition, if the engine requires shims on the timing side to achieve correct crankcase end float, these shims WILL BE DESTROYED AND DEPOSITED IN THE SUMP once the engine is run as the loose bearing allows the thrust washer to rotate and damage the shims. Of course, a solution is to replace the timing side shaft but a loose inner race may be corrected by using Loctite which should only be applied after the crankshaft end float has been set. This solution may not be appropriate where the shaft is badly worn. As a precaution, in case the Loctite fails, a lipped bearing can be fitted to the timing side (MRJA 7/8) which will prevent the inner race contacting the crankcase lip. Note that if a lipped bearing is used, the rollers of the inner race with touch the lip of the outer race BEFORE the crankshaft thrust washer touches the bearing outer ring (the normal situation). Because of this, it may not be possible to achieve the correct conrod centralisation or crankshaft end float.
An alternative method is to ‘pinch’ the bearing using a suitable sized shim between the bearing and the half timing pinion. Again, this can only be carried out after the end float has been set. With this method, the inner bearing race is assembled onto the shaft with its thrust washer and correct end float shims. The half timing pinion is now added to the shaft followed by the oil pump drive worm and nut. With the nut dead tight and the bearing pushed hard against its thrust washer, the gap between the back of the timing pinion and bearing race is

measured. A suitable shim of this measured size plus 0.001" to 0.0015" can be placed between the timing pinion and bearing before the valve timing is set on engine reassembly. Note that a shim which is too thick may prevent the timing pinion from seating properly and thus cause the pinion to slip on the shaft. Where a loose fit is to be employed on this bearing, consideration should be given to using a C2 or CN clearance bearing as a C3 clearance bearing ***MAY*** have excessive radial clearance because the inner race is not pressed onto the axle.

c) Insufficient inner/outer bearing radial clearance – This normally occurs for the reasons outlined under ***Modern Bearings*** and under no circumstances should the engine be run with a tight bearing. Replacing the bearing with a C3 variant normally effects a cure. Using a smaller clearance bearing on the timing side where the interference fits can be less can also solve the problem. If a choice is available, a bearing with the thickest outer race should be chosen to limit the reduction in clearance when the bearing is fitted.

d) Loose fit of drive side outrigger ball race in housing – A loose drive side ball race is not in itself a problem as long as the bearing lock ring holds the outer race tightly against the outer crankcase lip. If the outer race turns when the engine is running the race can cut its way through the crankcase lip with disastrous results. A loose bearing will also allow the crankshaft to move laterally allowing the weight of the crankshaft to be transferred to the crankcase outer lip particularly on left hand corners causing the outer lip to break off (common on Dirt Track engines).

e) Loose fit of drive side inner roller race – more often than not, the inner roller race on the drive side is a sliding fit on the mainshaft. Although, in theory, it probably should be a drive fit, a slide fit here is in no way detrimental to an engine for 2 reasons. The first is that with more modern bearings of CN clearance, having an inner race with no interference fit will not decrease the radial clearance of the bearing which can help, particularly if the outer race is in a housing on bottom (tight) limit. Secondly, once the engine shock absorber assembly is fitted on the drive side, the inner roller race is pulled tightly against the KMC22 outrigger bearing inner through the bearing spacer which prevents the inner roller race spinning on the shaft which is hardened anyway and less likely to sustain wear from a spinning bearing than the timing side axle. From experience, most drive side axles have a dimension which allows a slide fit of the drive side inner roller race – probably because this is where most shimming takes place and makes for easier factory engine assembly.

Alternative Bearings

The original roller bearings were manufactured by Rudge Whitworth themselves and carried the coding RMS9 but from 1935 Ransome & Marles (R & M) bearings were used which were coded MRJ 7/8. R & M were subsumed into the Ransome, Hoffman & Pollard group (RHP) and the bearing retained the same coding. However, **identical** roller bearings are manufactured by other manufacturers using the codes RMS9 (SKF etc), CRM7 (FAG), NM7 (STEYR) and PBPV7 (RIV). The outrigger drive ball race, KMC22 has been

marketed by Skefco as bearing reference W5162, SKF as 614944A and SCD as SF 155022A.
The outrigger drive ball race, MC22 can be replaced by a 3mm narrower modern version, 62/22 (22 x 50 x 14) but suitable 3mm thick spacers must be used to ensure correct drive side bearing interrelationship. These spacers are best fitted on the chaincase side of the bearing and ideally, the centre spacer should be hardened and ground. Spacer details are:

Spacer	ID	OD	Thickness
Large spacer	1.610”/1.620”	1.955”/1.96”	3mm (0.118”)
Small spacer	0.866”/0.867”	1.155” Clearance in crankcase lip	3mm (0.118”)

Under no circumstances should this bearing be replaced by any of its roller equivalents (RMC22 etc) as the ball race is positively located in the crankcase and when the shock absorber is in position, it positively controls the end float of the crankshaft. In addition, if a roller version is used, the outer race can be extremely difficult to remove!

Issue Log

Issue 7	Correction of 4MRJ 7/8 roller dimensions, CN clearance classification added
8	Bearing problems e) added
9	Bearing problems pic of outer race added. Dimensions of lock ring hex added
10	RIV brg code corrected to PBPV7. 1939 crankcase lock screw pic/note added.
11	Bearing inspection para e added. Note re using C2 on timing side with loose axle..
12	Pics added for bearing fit identification
13	62/22 spacers added
14	Words added on lock ring hole alignment plus para f on incorrect bearings
15	Words added on checking the MC22 inner bearing for binding. Lock ring hole alignment shim removed