LOOSE FILLINGS

IN THIS ISSUE ...

Rob Saward has been investigating ...

JACK BRABHAM'S RELIABLE V-TWIN COOPER

By early 1953 there were 17 Coopers in Australia, 11 of them with 'big twin' engines. The new circuit at Mt Druitt was becoming the hotbed of Cooper racing, where the cars were very fast in the short races, but none seemed able to run at speed for long; retirement rates were high. When Jack Brabham bought his one-owner, one-meeting, no-engine Cooper Mk4 sometime before June 1952 (can anyone pinpoint the date?) and installed the BSA/JAP 500cc engine built up by Ron Ward and himself, little did he know what he was letting himself in for. From his first appearance at Castlereagh Sprints in June 1952 and two circuit meetings, the last at Parramatta Park where he broke a conrod in practice, he did very few miles with the car. In September, Brabham discarded the hybrid single and fitted a Vincent twin. His first appearance at King Edward Park hillclimb in October showed promise but a high first gear hurt his times. At the next three Sydney circuit meetings (one at Parramatta Park, two at Mt Druitt) the car was stopped successively by a dropped valve, magneto failure and magneto drive problems. However Brabham was a methodical chap and he sorted the problems one by one. At the Druitt meeting on February 12 1953, when the photo below (from the Graham Howard Collection) was taken by O.C.Turner for the ARDC, it all came together. The Brabham Cooper ran well for 5 races and went home

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A TALE OF TASMANIAN COOPERS Part 2

by Rob Saward

Continued from Loose Fillings 44

Dave Powell purchased the green Cooper Mk5-41-51 in early 1961 (as mentioned previously in Tasmania with Jock Walkem) from John Hartnett in Victoria (for more see *Loose Fillings 25*). Over the next 7 years, while both the Powell Coopers were active in Tasmania, the cars were identified by most of those involved as simply 'the red car' or 'the green car'.

During the period between November 1960 and April 1962, the red car was converted to take a BSA 500cc Gold Star engine, as an alternative to the Vincent. The car appears not to have been raced during this period. In April 1962, the red car re-appeared at a race track, entered at Symmons Plains by Powell for Hobart driver Richard Snow, in BSA-engined form. In September 1962 Powell advertised the red car for sale in *Australian Motor Sports* as a "1098cc Cooper Mk IV Vincent to Lighting specification, with P.Irving conversion", or alternatively "fitted with BSA Gold Star engine" for £50 less. The car was not sold, and was in BSA-engined form for the rest of its Tasmanian career.

During 1964-1966 the red car was driven by Powell's son D.H. (Dave Jnr) Powell with various BSA engines, both alloy DBD34 Gold Star and iron B33 types. Powell Junior retained the green Mk5 but sold the red Mk3 to his friend John Soundy, who was one of a group who rented a house from Powell Snr in the Hobart suburb of Dynnyrne. During 1966-67, Soundy and Powell Jnr had great fun with their two Cooper BSAs, sharing spare engines (mostly iron-barrel rather than Gold Star spec by this time). Another of their group, Alan Gifford, also drove the Soundy car in private practice on a few occasions during this period.

During 1968, John Soundy became concerned by cracks in the Cooper wheels and sold the red Cooper to Ian Glover of Hobart. Soundy and Glover recount the story, that after they had rebuilt the engine, Soundy bump-started the car down the steep driveway at Glover's mother's house at Moonah and drove it around a long block to return. He had to get a fair bit of momentum to get up to the shed, could not stop at top and went through the back wall of the shed!

Ian Glover painted the car yellow and used it often over a 2-year period then sold it to Ian Gravely in 1970 when National Service beckoned. Gravely did not race the car, and sold it to Barry Holman and Barry Harbottle, of Glenorchy, Tasmania a few years later. The car ended up with Rob Kirkby in Melbourne in the late 1970s and after some scattering of its parts after Kirkby's death we hear that most of it has been recovered and it with Ivan Glasby in Sydney (see *Loose Fillings* #37 article by Kerry Smith).

Dave Powell Snr's first meeting with the green Cooper Mk V purchased from John Hartnett with 1098cc JAP 'Alfin' V-twin engine, was at Symmons Plains in February 1961. Over the next 3 years until 1964, Powell raced the car at nearly all Tasmanian race meetings and hill climbs. Powell was remarkably competitive, gradually lowering the under 1100cc lap record at Baskerville to 1.10.9, compared to Walkem's 1.14.4 in the same car six years earlier with the smaller JAP engine.

In *Australian Motor Sports* October 1964, the car was advertised for sale:

MkV Cooper JAP. Colour – Hawthorn Green. Complete body panels. Good tyres. New axles. Half shaft and Repco stage III universals. Engine 1098cc alloy racing JAP. Flywheels rebalanced and big end by Vic Chiron. Complete rebuild, ready to race. C-ratio 14-1, 95bhp at 5800rpm, fitted two 1 7/32" GP carbies, twin SU float bowls, integral petrol pump. Spare pistons, valves, Norton gearbox pinions and engine sprockets and puller. Flying ¼ mile,126 mph, standing ¼ mile 13.8 seconds. £475 ONO.

The car was unsold; Powell Snr raced the car often in 1965, before he changed to Holden and Morris Cooper S touring cars and handed the green Mk5 Cooper to his son Dave Jnr, who on several occasions used both the red Mk3 and the green Mk5 at the same hill climb or standing start ¼ mile event. Dave Junior later described the big JAP twin as a very nice engine to drive.

Dave Powell Jnr raced the Mk5 with JAP engine in early 1966 before replacing it with a BSA single over the winter racing break. In November 1966 the car was still quite original, with good body panels and original suspension, but through 1967 and 1968 Powell Jnr gradually modified the car's front suspension (replacement of the leaf spring with coils and upper wishbone), removing the pannier fuel tanks and losing all the rear bodywork. By the end of 1968 it was a very tired, much raced, crashed and modified car.

Powell changed to an Elfin Formula Vee in 1969 and the Cooper was sold to Tasmanian Peter Dobson, who took the car with him to Queensland in the early 1970s. It was purchased and partially restored by Brian Reed in the late 1970s, and sold to Peter Harburg in recent years.

The author gratefully acknowledges the assistance of Randall Langdon, late Graham Howard, John Soundy, Ian Glover, Ian Graveley and Kerry Smith. Photographs come from the Jock Walkem collection (via Randall Langdon), www.oldracephoto.com, Winston Saward and John Soundy.

Below: John Soundy in the ex Powell red Cooper Mk3, with its 1952 Lex Davison-commissioned body, having an off-track moment at Symmons Plains in about 1967.

Keeping Old Things in Place
Part 2: bearings and housing

by Terry Wright

Continued from Loose Fillings 44

In his long standing and still useful book Tuning for Speed, Phil Irving recommends a 'thou per inch' diameter for the interference fit of main bearings in crankcases and camshaft/ bush running clearances of '2 thou'. Disappointingly he doesn't provide much more advice on this topic and puts forward the caution 'Where the amatuer tuner does not possess detailed knowledge of the minimum clearances essential at certain points he should consult the makers'. No longer being able to telegraph 'PRESTWICH, TOTTLANE, LONDON' for advice, I have been wondering what sort of fitting practice was appropriate for the manufacture of replacement components for old motorcycle-type engines and gearboxes. No doubt the conclusions may apply to almost any 'obsolete engineering'.

Not covered so far is the topic of rolling bearing fits. The manufacturers' publish manuals with tables in which the appropriate grade of installation fits and tolerances can be looked up for the type of loading, the application and sizes in question.

The ideal arrangement is to have both inner and outer rings tight for high rigidity and accurate running with class *K* or *M* (there is no *L*) for a housing of cast–iron or steel and *j* or *k* for a shaft. Generally this is only possible when one of the two bearings is of a separable type such as a cylindrical roller and if that is not the case then one ring on one bearing supporting a shaft must be loose to accommodate thermal movement in service or assembly requirements.

A loose outer ring is sometimes recommended in the bearing manuals but it is not normally an option when engine and gearbox bearings are in light alloy housings. In this situation the outer ring must be tight and the inner ring loose with an appropriate loose fit grade for the shaft of *g or h.*

The table below shows my tabulations and conversion to inch dimensions of the deviations for imperial bearings with a range of loose (g5) shaft sizes.

Bearing housings are a big problem because the values in the manuals only apply to steel or iron housings where there is little or no differential expansion between the bearing and the housing. In motorcycle-type engines and gearboxes we are normally dealing with bearings mounted in aluminium (and even worse magnesium) alloy casings where the differential expansion coefficient is of the order of 0.000012 per deg C.

A typical racing engine crankcase temperature rise might be up to 90degC and then the normal bearing interferences in the manuals are nothing like enough. In this case when an outer ring is fitted to a light alloy housing (rather than iron or steel), class M for the housing will not retain the bearing when the engine reaches full operating temperature. Such an installation will see a bearing running loose and rotating while maybe trying to hammer its housing out of round at less than half that temperature rise. In fact, says Phil Irving in his *Motorcycle Engineering*, a 2½ inch diameter racing main bearing may need cold interferences of 0.003 to 0.004"

The problem is that when a bearing is pressed or shrunk into a housing, a proportion of the interference is taken up by the housing crushing the outer ring. This reduces the internal bearing clearance so there are practical limits to how much interference can be tolerated. Suggested factors for transfer of outer ring interference into bearing'crush' range from 20% to 60% with the higher value applying to thinner rings.

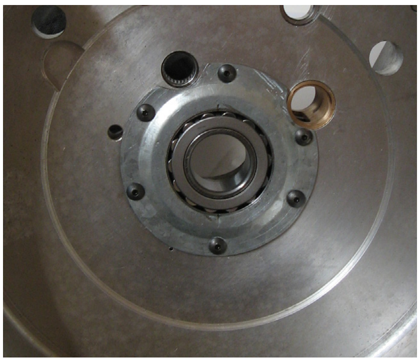
For a 2.5" diameter bearing the normal ('C0') internal clearance is in the range 0.001" to 0.002" so if the transfer is, say 50%, the interference that would close-up the minimum internal clearance when cold would be 0.002", close enought to the Irving 1:1000 figure which would be .0025". With a larger clearance 'C3' bearing, the internal clearance is in the range .002-.004" so with 50% transfer of interference the interference that would close up the minimum internal clearance when cold would be 0.004"

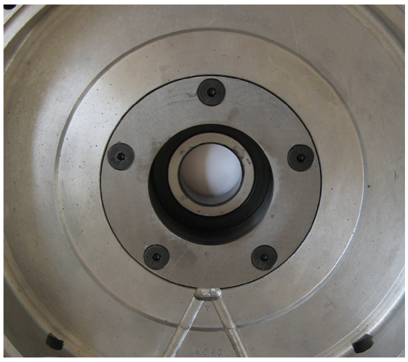
Simple calculations can show that an interference ratio of the order of 1.1:1000 (ie slightly more than 'one thou per inch') is needed to keep a racing main bearing tight at a temperature rise of the order of 90degC. Clearly a normal bearing internal clearance (C0) may not accommodate this sort of crush when the engine is cold. Higher clearance bearings (C3) are available but generally only in metric sizes.

An interference ratio of 1:1000 is then about both the maximum *and* the minimum interference for a C0 class bearing and physical retention may be needed for main bearings. Examples of how this might be done include the screws which retain the main bearing sleeves in JAP engines and the profiled washer which retains the timing side main bearing on a Manx Norton.

To go tighter than 1:1000 would need a C3 clearance bearing which could be fitted at an interference ratio of up to, say, 1.5:1000. For most practical purposes the above discussion on main bearing fits can be simplified to a set of rules-of-thumb for air-cooled high-reving engines as follows:

- For C0 (normal) clearance bearings in aluminium housings use an interference of up to 1:1000 and physically retain the bearing.
- For C3 (larger) clearance bearings in aluminium housings use an interference of 1.3 - 1.5/1000.
- For bearings in cast-iron or steel housings use a clearance of +0.0005"/0.0000"
- For bearings with 'tight' shafts machine shaft +0.0005"/0.0000"
- For bearings with 'loose' shafts machine shaft 0.0000"/-0.0005".





Above: approaches to main bearing retention. Right, standard JAP 1100 Mk1 drive-side retaining ring. Left: author's pressed washer retaining a modern timing side bearing.
Left: author's table of shaft deviations and fits.

Shaft dia	Loose shaft g5i		Inner-ring		Fits		Mean fit*
	Thousands of inch		Thousands of inch		Thousands of inch		Inches
	high	low	high	low	high	low	
3/8" to 3/4"	-0.10	-0.36	0.20	-0.20	0.56	-0.10	**0.0003**
3/4" to 1 1/4" 1/4"1/4"11/4" 1/41/4"	-0.10	-0.47	0.20	-0.30	0.67	-0.20	**0.0004**
1 1/4" to 2"	-0.10	-0.63	0.20	-0.30	0.83	-0.20	**0.0005**
Mean	*-0.1*	*-0.5*	*0.20*	*-0.27*	*0.7*	*-0.2*	***0.0004***

COOPER WISHBONE SUSPENSION & ITS SWING-AXLE CHALLENGERS

One time Lotus engineer and Cooper 500 owner Tony Caldersmith looks at the 1951-2 struggle for 500cc supremacy

In the early post war period, when 500 racing was getting underway, there were numerous limitations imposed on designers, not the least being the poor availability of good racing tyres. Another factor was the limited development of suspension systems, particularly for light cars, which in England tended to use non-independent systems (i.e. MG TC beam axles) and very basic chassis designs, usually simple channel-section structures.

So designing a very light car for the new 500 racing scene set some interesting challenges for their usually amateur designers. There was initially a follow-on from the British hillclimb specials, such as *Dorcas* and *Freikaiserwagen*, but this was quickly left behind by some of the more innovative builders such as Cooper, Bicknell (Revis), Keift, Arnott and Bottoms (JBS).

John and Charles Cooper recognised from the start that they needed independent suspension on both the front and rear wheels and made the inspired choice of using the front suspension from Fiat's 500 Topolino. This comprised a top transverse leaf-spring and lower wishbones, which Cooper used on both the front and rear of the car.

This system initially proved adequate for location, steering and braking loads for these relatively light vehicles as follows;

- The top leaf provided the springing medium, as well as the upper lateral and longitudinal location for the hub upright.
- The lower wishbone provided the lateral and longitudinal location for the hub as well as a pickup point for the tubular shock absorber/damper.

The near central mounting of the spring, which formed the upper suspension link, was a lot closer to the centre of the vehicle compared to the lower wishbone pivots and this resulted in geometry where the outer loaded wheels had increasing undesirable positive camber in a cornering situation. The effective length of the early Cooper top lateral link is probably about 60% greater than the lower link. While the effective length of a leaf-spring acting as a suspension member in flex is less than a solid arm, the change in the these applications is probably less than 3% in effective length and would not compensate for the difference between the top and bottom suspension links.

The front and rear geometry was essentially the same and therefore both the front and rear wheels would have similar

Demonstrating a touch of oversteer, the great Ken Wharton expertly power-slides his new Cooper twin out of Shelsley Walsh's 'Top Ess' in June 1950. Photo www.stilltime.com positive camber under cornering loads. The car's relatively low centre of gravity limited the amount of roll and therefore kept the positive camber of the loaded wheels to a usable amount for most drivers in the early days.

The competitiveness of 500 racing influenced Coopers to make the chassis change from ladder to multi tube in the 1952 Mk6. The change was clearly designed to improve the rigidity of the chassis and therefore improve the predictability of the handling, which had come under some criticism. It was tough enough dealing with the positive camber change and a locked rear axle aggravating handling changes in power on/off situations, but a flexible chassis had made the early cars a handful. They improved that further in the 1954 Mk8, by moving to Cooper's 'curved tube' chassis design which they continued to use on their sports and racing cars up to their 1959 F1 cars.

There were virtually no geometry changes in the Cooper 500 suspension until the 1954 Mk8 when declining competitiveness induced Cooper to upgrade their suspension by revising the front spring pickups. The original central bolted spring location was eliminated and replaced with a 'curly leaf' which provided the lateral location but allowed the main spring to flex around the load point in such a way that it also gave some roll resistance (acted like a roll bar). By widening the front spring mounting/pivot points from 305mm to 393mm and using the curly leaf, Cooper effectively reduced the length of the spring when it was acting as the top link under cornering loads and reduced, if not eliminated, the positive camber problem. .

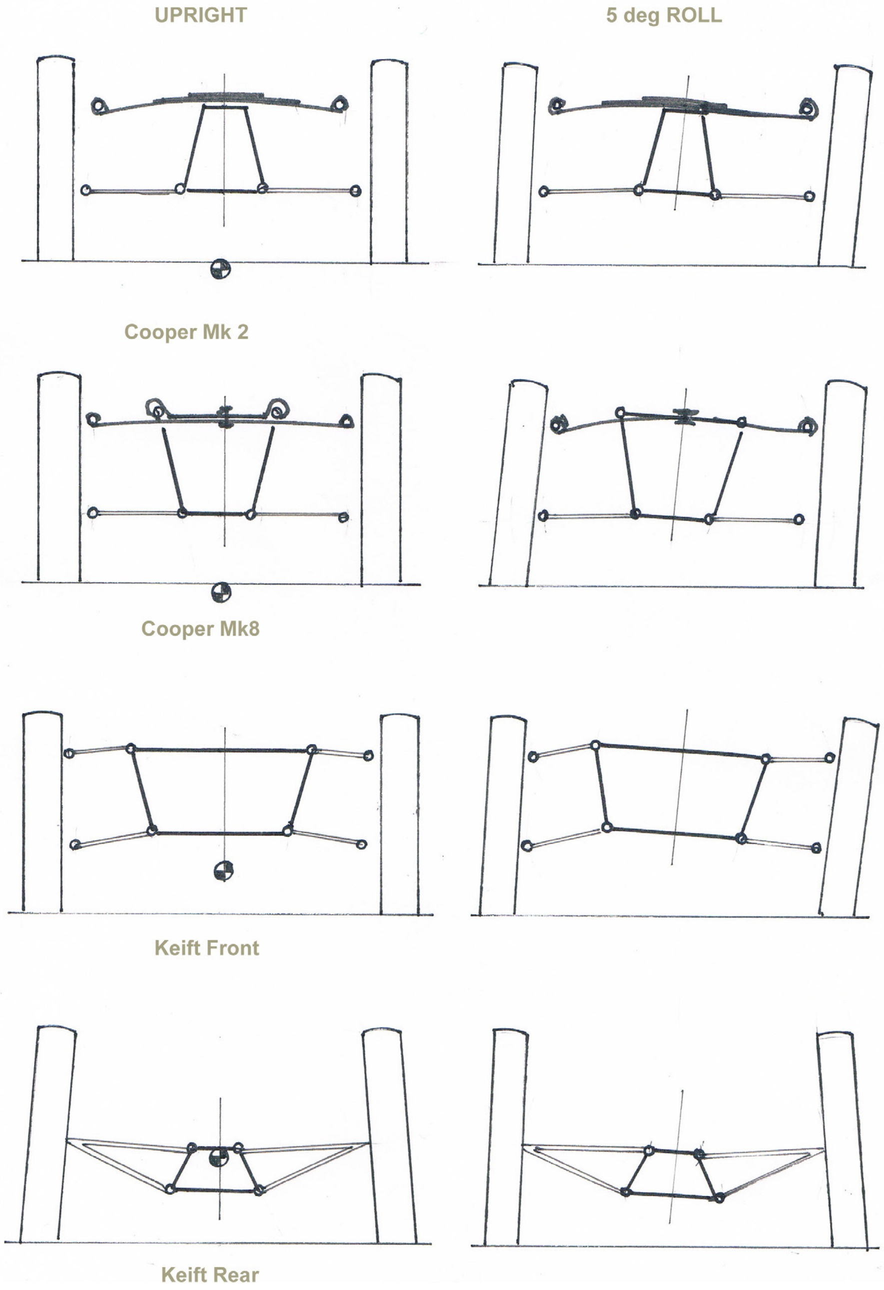
The curly leaf/improved roll resistance concept was also incorporated in the rear suspension of the 1955 Mk9 still further improving its cornering capability. The top spring had limited for and aft locating capability and was eventually replaced by a tubular wishbone in the later F2 and F1 cars, where the top spring would have been unable to cope with the greater braking loads. Cooper's final designs lowered the centre of gravity which minimised any roll-camber changes and resulted in the dominant 500 car by the end of the 500 era.

Most Cooper 500s used a solid rear axle to deliver the power to the rear wheels, although a limited-slip differential was available as an extra. A solid axle tends to need a steady flow of power so as not to upset the handling and that, coupled with Cooper's positive-camber rear suspension geometry, meant that to get the best out of the car, the driver needed to develop smooth cornering techniques. Stirling Moss' smooth style meant he was able to get the best out of his Cooper when in competition with drivers whose previous experience had been on cars that were not so sensitive to abrupt power or steering movements.

The Cooper V-twin cars used basically the same suspension as the 500s, with a change in the number of spring leaves to cope with the greater weight of the bigger engine being the only variation,

These bigger-engined Coopers had an increase in wheelbase to accommodate the larger engines, which would have made little difference to their handling. The major difference was the extra power. Effectively doubling the power available meant that the driver had the capability to control the cornering by the application of throttle. The V-twin Cooper was probably the first Cooper model that could be drifted, as opposed to steady-on-line cornering, which was designed to minimise power loss and speed in a 500.

While Coopers tended to dominate the 500 (Formula 3) grids, there were some one-off and limited production cars that displayed interesting design ideas, some succesful and some not.



These roll diagrams by Tony Caldersmith show the slightly reduced negative camber of the Cooper Mk8 compared with the earlier versions. The principal benefit though was in roll stiffness, a new concept for Coopers. The Keift shows some geometry faults which Moss and Parker, in their special versions, were doubtless able to offset by adjustment and driving skill.

Continued from page 5

In the very early days of the new formula 3, builders came up with a wide range of concepts, including engines, but once the Cooper appeared, it almost dominated the designs competitors used and Fiat suspensions were everywhere. Almost as quickly the engine scene resolved into two options; JAP or Norton, with Norton eventually becoming the dominant engine.

There were a number of innovative designers who sought competitive advantage, if not in engine selection, then in chassis design. A couple of notable examples were as follows:

● **JBS**: had twin wishbone suspension front and rear, but unlike Cooper the top wishbones were shorter than the lower wishbone, resulting in the wheels retaining an upright attitude under cornering loads. These cars were very competitive and if it was not for the fatality of Alf Bottoms in 1951 they may well have become the leading 500 design.

● **Keift**: used a similar geometry on the front suspension to JBS, but reverted to swing half axles at the rear. The second generation Keift designed and built by Dean Delamont, John Cooper (not the Cooper of the Cooper Car Co) and Ray Martin and driven by Stirling Moss also included adjustable suspension, resulting in Moss being able to set the car up to suit his driving style. This combined with a substantial weight advantage made this prototype car succesful, a situation that did not seem to translate into the later production versions.

A few of the one-off 500 builders used swing axles at the rear, for simplicity, cost, low weight and the ability to get negative camber on cornering, the latter by setting the car up with substantial negative camber at rest. Fortunately, the racing tyres of the period (usually Dunlop R1) had a more rounded tread than the later racing tyre developments that were focused on maximising tread footprint by keeping the tyre upright during corning and that meant they were still able to provide reasonable adhesion under camber change.

The post-war 500 formula and the larger 1172 formula were the catalysts for the racing revolution that began the English domination of grand prix racing that started in the ‘sixties. The need to compete in formulas where the power available was much the same for all competitors created a focus on handling and chassis design. Success came from both innovation and evolution, both succesful characteristics of the Coopers’ approach to making 500s.

Continued from page 1

with 2 wins (including the scratch race for the fastest cars) and no retirements, having raced hard with Tom Sulman’s Maserati 4C all day. By contrast, Dick Cobden’s Cooper JAP 1100 was unplaced, with several retirements. At the next Mt Druitt meeting on March 22, Brabham repeated the dose with 4 wins and a second out of 5, again including the scratch race. There was more Cooper opposition this time, with Marshall (Mk4), Cobden and Hirst (Mk5s), all with 1100 JAPs. This performance prompted the *Australian Motor Sports* scribe to wax lyrical: “*One of the most amazing sights seen in New South Wales for a long time occurred at this Mt Druitt meeting, when four Coopers all got going at once to put on some fine close racing during the day. Keeping up with the bad reputation of these cars for reliability, three of them performed somewhat erratically as the day wore on, but that of Jack Brabham kept running on like a chaff cutter and scored four wins and a second from five starts. Brabham’s preparation of his HRD Vincent engined car was a personal tour de force for repeating last months efforts. His perseverance with this car, which has heart-breakingly played up and broken things for over 6 months, has been well rewarded.*”

FROM ALLAN FREEMAN

Dear Garry,
It was good to receive *Loose Fillings 43* via Ian Garmey, and as usual I enjoyed reading it even though my ‘500’ days were 60 years ago!

This note is just to add to David McKinney’s ‘Big Twin’ article. I’m always amazed how well he does with his long range research as it is hard enough to dig up details when you’re ‘on the spot’ let alone when you’re resident in the UK.

At the first Ardmore GP there was also another driver with an 1100 JAP - Syd Jensen in one of Ron Frost’s JBS’ in which he had installed it. He too was a retirement but I think it was in the latter stage of the GP and I don’t know what his problem was. As far as know he only used Nortons in all his Cooper 500s.

In my case the engine in my Cooper was an 8/80 JAP ex Tom Sulman which he had used in England pre-war in a Skirrow midget on the speedway. After the war he brought it back to Sydney along with the Sulman Singer but never got around to using it again.

To put the record ‘straight’’ I did make fastest NZ driver twice in practice but the incorrect grid position didn’t make any difference as a con-rod ‘let go’ on lap 11 and that was the end of my race - and of the 8/80 too! Bill Lee had brought out two new 500 JAPS with his Mk5 Cooper and kindly sold me one which I used from then on.

Allan Freeman,
New Zealand

BITS & PIECES

● Not a lot of racing has been done over the winter period, however Brian Simpson ran at the long-track Winton meeting, August 10-11, in the Derry Greeneklee Cooper Mk9 and had a win in a 7 lap event. At the short-track Winton meeting in late May three air-cooled cars ran, Derry in his Mk5 Cooper 1100 JAP, Brian Simpson in the afore-mentioned Mk9 and, making a return to racing after a 13 year sabbatical, Alan Morton in the Alba Triumph 650.

● Garry Simkin ran his Cooper Vincent Mk4 at Morgan Park in Queensland in July, a great circuit which is well suited to aircooled cars. The next event for these is Wakefield Park, Goulburn NSW on September 27-29 for the HSRCA meeting and it's possible that up to four Coopers will be running.

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