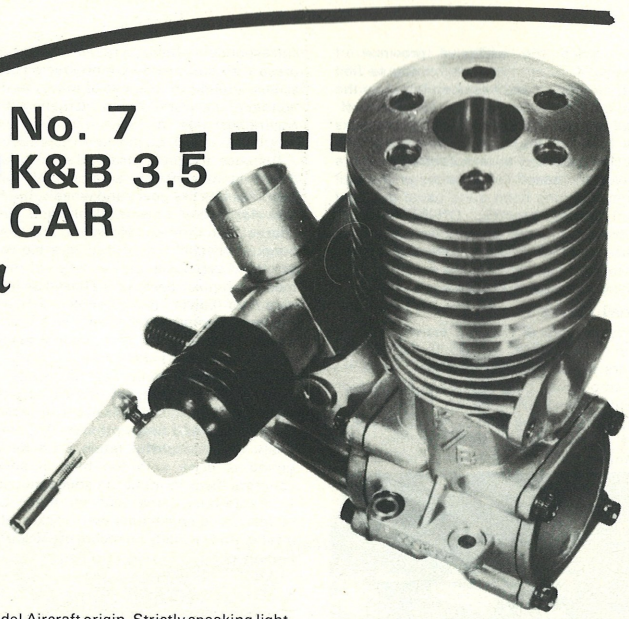
ENGINE TEST - - - No. 7 K&B 3.5 CAR

by Mike Billinton

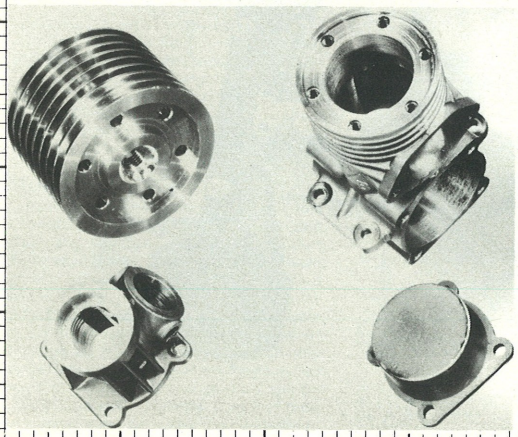


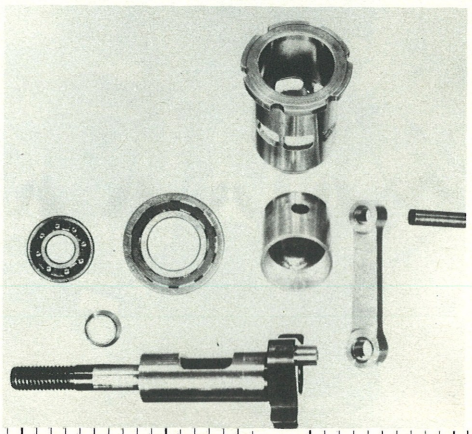
THE RACING ENGINE which was subjected to test this time emanates from the USA — and that means *K&B*. The point itself is a striking one, given the degree of technological advancement and competitiveness which the US has represented in the post-war era.

That *K&B* should be the continent's sole large scale producer of medium capacity model *racing* engines seems a significant historical and economic feature of the modelling 80s.

The 1976 *K&B* 40SR11 (their first out and out ABC rear exhaust racing engine) happened to be first engine tested in a serious way by this writer, so the 3.5 Car engine provided more than usual interest, having as it does many features in common with the 40. In particular the Car engine under test revealed a torque band (in open exhaust format) almost as wide and flat as had the 40. No engine so far handled has equalled that SR11 in this respect, with the 3.5 now coming a very close second to it. Apparently then, a similar design philosophy runs throught the *K&B* racing engine stable. More basically the *K&B*s remain among the lightest of available racing machinery — reflecting in part their Model Aircraft origin. Strictly speaking light weight of itself should be of little value to Car and Marine racing engines; on the contrary they can benefit structurally from more substantial sections of metal. However, *K&B*s rarely reveal any weakness which could be attributable to lack of metal, and in practice (writer has used several 40s in C/L speed) they appear as robust as other racing engines — the lightweight, in other words, seems well-designed; the main aluminium alloy die castings in particular being quite refined in this respect.

Below, left: K&B castings, note the reinforcing ribs on front housing and main case. Below, right: reciprocating parts, which are substantial, as would be expected. A high-speed main bearing is factory fitted; bear this in mind when comparing prices!





Test engine

First released in 1977 as a semi-sports R/C and F/F unit — it was subsequently redesigned (for release early 1982) and this later type as tested here is now even more suited to the high rpms and stresses to be found in the Car and Marine sectors.

A dramatic opening test for the new engine was a 24 hour endurance event in Florida last December in an *Associated* RC300 car prepared and driven by a team from *Associated Electrics* of California.

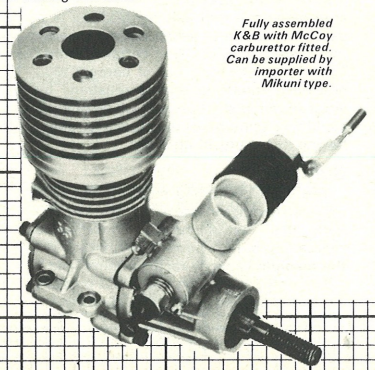
The *K&B* powered to 1st place 2¾ hours ahead of 2nd place and some of the engine equipment is of interest: Pipe — a *McCoy* minipipe muffler. Fuel — 30% Nitromethane with synthetic oil (from UK but make not known). Carburettor — *OPS* 9mm slide. Filter — *OPS*. Plug — *OPS* also an RC300 (confusing, these numbers).

Same engine was used throughout the 24 hours; and nice to see the same plug hanging together for such a long period under quite arduous duty — the *OPS* thick element plug is acquiring quite a reputation for itself in the racing areas of Marine and Car.

The engine received for test had the same low exhaust timing of the earlier model (148°), making it a reasonable match for the typical minipipe. An alternative liner for more positive tuned pipe response and giving 170° timing is available.

Although adopting the now customary 2-stroke ABC with front induction layout, the new *K&B* 3.5 has a number of interesting features which differentiate it from other Open class car engines:

Front Crankshaft Housing is separate from crankcase and has pronounced structural webbing to resist the strong side-thrust forces imparted by spur gearing in car use. Because of this separation, the four housing bolt heads are drilled to allow security wiring to be fitted. This is a vital point where high rpms are concerned. Thread-lock is an option here, though *excessive* amounts can cause blocking and stripping of threads on disassembly. A turned spiral groove on the crank bore between front race and induction stub 'screws' oil mist backwards into engine, and which would otherwise be attempting to escape via front bearing. Induction stub itself is thick-walled enough to resist distortion, whilst the two Allen grub screws have a full ⅛in. depth of engagement in the alloy. So *K&B* have here recognised a general point of weakness, particularly where large heavy slide carburettors are to be secured at very high rpm. Were weight of no consequence however, one could envisage even more security at this point. No failure occurred at this point though during the test.



Fully assembled K&B with McCoy carburettor fitted. Can be supplied by importer with Mikuni type.

Aluminium crankcase rear cover is chromed on its inner face, so preventing abrasion of this part by the connecting rod's normal attempts to move backwards off the crankpin; thus resulting in a fine aluminium dust which becomes an effective grinding paste to reduce engine life somewhat. Of course not all engines are affected by this con-rod movement (or it is a variable according to engine condition), but such is the situation existent within the modern racing 2-stroke crankcase at 35 to 40,000rpm that the prevention of this possible problem must be a worthwhile exercise.

Crankshaft now has accurate nose threads (¼ × 28 TPI) lathe turned *in situ* as opposed to the more normal die-stock method — which is certainly quicker to produce though marginally less accurate. Hardened crankpin is a separate pressed-in part, and a new move by *K&B* is the modification (as standard) of both *ball-races* supporting crankshaft by fitment of glass-filled nylon ball retainers which are both shatterproof and low-friction. With most other engines such bearings are specialist items to be fitted by the owner after purchase.

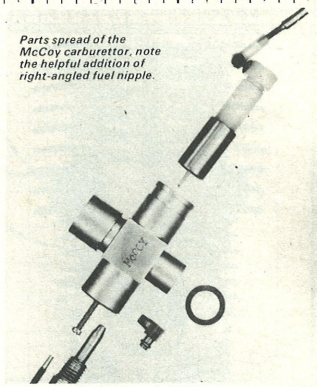
Crankcase now has added web-bracing both to the mounting lugs and to exhaust stack — and seems a very sensible logical improvement — long overdue on a range of racing engines now available, and which are not getting any less powerful as the years go by!

Transfer passages/ports remain somewhat individual in layout, with the two boost passages being two quite separate paths up to cylinder liner. All four ports are now at a low timing of 118°, with exhaust port being 30° ahead at 148°. The latter is now bridged by a vertical bar which might seem old-fashioned, but is an interesting mechanical and thermodynamic retrenchment adding more rigidity to the weaker exhaust side of the combined crankcase/liner set-up, and also provides an easier path in any case for the piston's upward travel in a liner which is microscopically bowed forwards away from exhaust port due to asymmetric heat expansion and compression stresses.

Cylinder liner itself is now thicker wall and so crankcase has been opened out to accommodate. Therefore liner interchange between earlier and later models is not possible without machining. Cylinder bore is 1thou. tight at top of piston's stroke.

Un-ringed hi-silicon **Piston** has *K&B*'s unusual blind gudgeon pin bore — which is not an easy job to accurately finish — but difficulty is justified by elimination of crankcase charge loss through pin leakage path to atmosphere. Piston is externally honed, and is one of the few engines in which this expensive extra process is carried out.

Cylinder head is now a characteristically tall machined heat-sink style; giving an even higher compression ratio that the earlier model — at two units more it's now at 10.8/1 *effective* — which is among the highest yet handled in this series of tests.



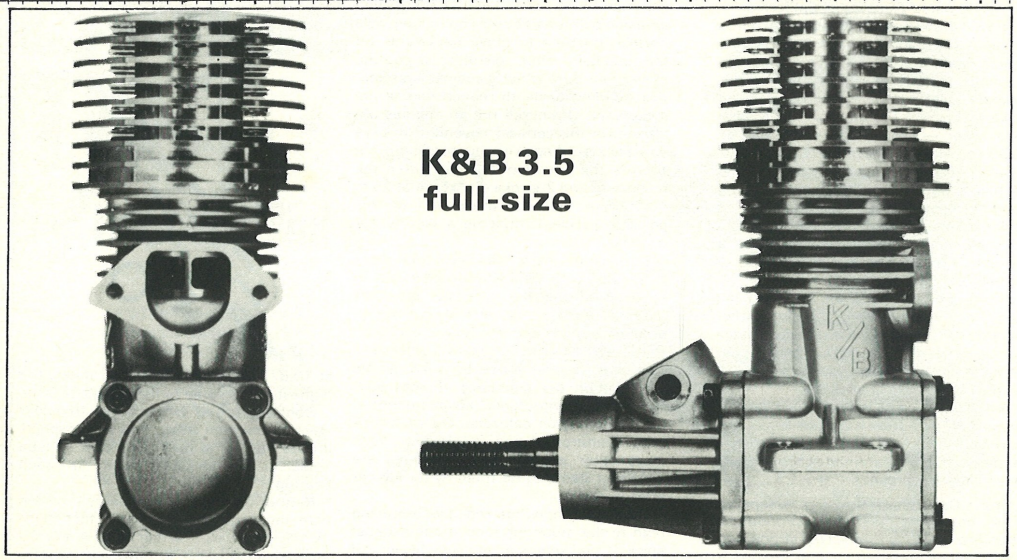
Parts spread of the McCoy carburettor, note the helpful addition of right-angled fuel nipple.

Connecting-rod is machined from bar stock aluminium alloy, and is phosphor-bronze bushed at both ends with oil lube holes at low-pressure points of each bearing.

Neither clutch nor flywheel is provided with the engine; *K&B* reason that these usually form part of car kits. A normal tapered steel collet is however standard provision.

Reflecting the strong pressure of outside specialist manufacturers in the Open Car Class, *K&B* also do not provide a specific carburettor with their car engine. There are now several makes of large bore slide carbs. available and the front housing stub bore of 12mm allows fitment of many of these standard 9 to 10 mm bore units. It would be possible to accommodate even a 12mm bore carb. by boring the housing to say 14mm. The problem of security though would then loom larger — ideally some outrigger support for extremity of carb. might be advisable in this case.

For this test *K&B* sent one of the more recent specialist USA slide carbs. — the 9.5mm bore *Dick McCoy* model, and which plugs straight into the 3.5 with an 'O' ring seal. Incorporating rubber bellow equipped steel barrel having linear motion and carrying a fixed position tapered needle to allow progressive variation of mixture ratio as throttle closes. Main jet location is adjustable lengthwise to allow variations to mixture range. Final position will depend on flywheel/car inertia, power/weight ratio of whole vehicle, tyre slip, gear ratio, nitromethane content etc., therefore track testing will be vital in arriving at full power acceleration throughout the speed range of a particular car. Tuned pipe style (and its tuned length) itself provides yet another variable to affect fuel requirement across wide rpm range needed for the car's large speed envelope. In all a seemingly impossible task for any carburettor. In probability carbs. are providing exact requirement at only one or two points — elsewhere



in the throttle range is likely to be 'acceptably good enough'.

It's fair to say that no dynamometer test is going to equate with all those variables, but on a comparative static basis the *McCoy* carburettor was as positive as any so far handled in translating from idle rpm (3.5K) to maximum rpm on any of the loads used, both on *OPS* Tuned Pipe and on Open Exhaust.

Of more interest was the overall solidity and integrity of fuel settings which the *McCoy* carburettor exhibited, and in this area it is unlikely to become unreliable or physically frail. Out on the track this is much more important than whether the precise optimum range of mixture ratio settings can be arrived at — whether on this *McCoy* model or any other make at the present time.

Actual control of main jet fuel supply is with tapered needle formed from Allen head bolt running in plastic seal. In practice this was able to 'self-operate' when running above 28K in the very rigid dyno environment. In-car use such involuntary motion of the needle may not happen. To cure this on the dyno, an extra neoprene tubing seal ensured adequate needle stiffness.

Topping the carb. venturi is *McCoy*'s own air cleaner — a hard foam 'bee-hive' — very light and compact. This just presses into position within alloy spacing collar.

Power Test 1

Equipped with small bore carb. (Perry 7mm), the recommended *K&B* idle bar glowplug, 5% nitro., 15% castor with 5% ML70 (synthetic), and open exhaust, a range of initial rpm checks found the *K&B* to be right near the top figures reached on a 7×4 Zinger in this series of tests, with only the *Picco* 3.5 out-performing it at that 22/24,000rpm area. At this stage, quite inconclusive of course, because apart from differing air densities affecting rpms, the matter of determining the peak power points was yet to be resolved.

Mercifully (for the writer) the ABC era has allowed truncated running-in periods — (the *K&B* was no exception) 20 minutes proving quite enough to enable stable running.

Torque figures then arrived at proved again the *K&B*'s high performance in this open exhaust format, and confirmed what the rpm findings were suggesting. The final bhp curve usefully covered a very wide rpm range (14-33,000rpm) and its peak of .96 at 26,000rpm was also in line with the above points.

Power Test 2

A switch was now made to the current piece of pipeware — the *OPS* Quiet Car pipe. This standard twin cone tuned pipe was fitted at 9¾in. piston face to end of rear cone's tail pipe inside can. Also used in this test was the *McCoy* slide carb. and 50% nitro with 14% ML70 and 2% castor oils. Plug was still the *K&B*. Normally a racing engine using this combination would result in considerable power increases, but it became clear on going up through the rpm range that the tuned pipe here was unable to produce major effect (compared with some previous results), and this was almost certainly because of the previously mentioned low exhaust timing. It is clear that 165° plus is needed for full effect, together with overlaps between exhaust closure and transfer closures of around 15° minimum. Therefore pending re-test of the *K&B* on the piped liner (which gives 170°), this part of the test remains in a sense incomplete. The result of 1.2bhp is nevertheless quite creditable, and has the advantage of being less 'peaky' than higher exhaust timings would lead to.

Power Test 3

For two reasons the above equipment was again used but this time with pipe length fixed at 11¾in. It was felt that many operators would use it in this way — either because the *OPS* manifold 'out of the box' gives such a length and/or because the car layout may well dictate such a figure. Not surprisingly, the maximum torque figures were now reached at much lower rpm area of 19,000rpm, and led to a bhp figure just below Test 2.

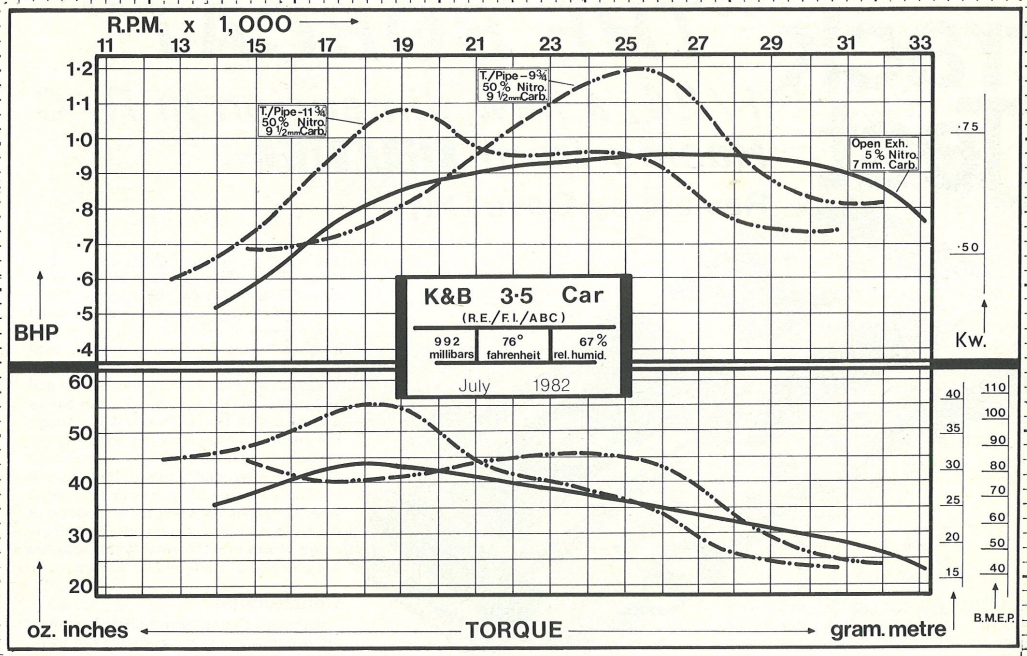
Relative displacement of the best torque area along the rpm axis in this way is a useful feature, and whilst not necessarily the fastest way to go, certainly must improve acceleration out of corners plus providing enhanced engine reliability by virtue of rpm restriction, and which of itself could win some races (albeit slower ones) having high rates of attrition!

Summary

The *K&B* performed much in line with reported findings in real use, and in keeping with this manufacturer's considerable reputation for high power/weight ratios in the medium capacity racing engine field.

The only reservation one could possibly have (and applies to *all* Car engines so far tested) is that much may yet be gained — specifically in the Car and Marine areas — by the use of more substantial sections of metal. Largely ignoring the resulting weight problem in this way one would hope to claw back on the power side most of the reduced power/weight ratio, by virtue of greater rigidity giving greater geometrical truth during running operations at 30,000rpm plus. The writer may be wrong here, but an abiding impression after testing several of these top Car engines at 25 to 40,000rpm is that, given the elastic nature of metal and the fearful hassle vibration-wise found in these rpm areas, that the various engine parts are both stretching and moving about relative to each other and that nothing but good can come from making them stay still and unbending. This would be difficult to verify or to put a number on — probably much easier to go and make some really solid unit using standard internals of known performance.

In the meantime the essentially low weight *K&B* 3.5 appears to have a full pipe potential yet to be realised in this series of tests, and must await the 170° liner. An informed guess at this point suggests 1.4bhp or so. In Open Exhaust format though it sits very near to the top figures, and indicates that *K&B* remain a force to be reckoned with, however isolated they may appear to be in the USA context.



K&B R/C 3.5cc Car Engine

Dimensions and weights

Capacity	.213cu. in.	(3.48cc)
Bore	.6513in.	(16.54mm)
Stroke	.639in.	(16.23mm)
Stroke/Bore	.98/1	
Timing periods	Exhaust	148°
	Transfer	118°
	Boost	118°
	Front induction opens	42° ABDC
	closes	58° ATDC
	Total	196°
Exhaust port height	.208in.	
Combustion chamber vol.	.24cc	
Compression ratios		
Geometric	15.5/1	
Effective	10.8/1	
Cylinder head squish	.012in.	
Squish band angle	2°	
Squish band width	.125in.	
Crank dia.	.4724in.	(12.0mm)
Crank bore	.3285in.	(8.3mm)
Crankpin dia.	.188in.	(4.77mm)
Gudgeon pin dia.	.156in.	(4mm nominal)
Con. rod centres	1.22in.	(31mm)
Piston weight	.14oz.	(4gm)
Weight (with 7mm carb.)	8¾oz.	(.248kilo)
Frontal area	4.63sq. in.	
Mounting hole spacing	36mm × 16mm × 3mm holes.	
Height	3.6in.	
Width	1.7in.	
Length	2.6in.	

Performance:

Max BHP:
1.20 at 25,400rpm (OPS Tuned pipe/50% nitro/McCoy 9½mm carb.)
.96 at 26,200rpm (Open Exhaust/5% nitro/Perry 7mm carb.)
Max torque:
55oz. in. at 18,400rpm (OPS pipe/50% nitro/McCoy Carb.)
44oz. in. at 17,800rpm (Open Exhaust/5% nitro/Perry carb.)

RPM standard propellers:
7×4 Zinger — 22,830 (Open Exhaust/5% nitro/Perry 7mm carb.)
7×6 Zinger — 17,070 (Open Exhaust/5% nitro/Perry 7mm carb.)
8×6 Zinger — 14,980 (Open Exhaust/5% nitro/Perry 7mm carb.)

Performance equivalents:

BHP/cu. in.	5.63
BHP/cc	.345
Oz.in./cu.in.	258
Oz.in./cc	15.8
Gm.metre/cc	11.2
BHP/lb.	2.19
BHP/kilo	4.84
BHP/sq.in. frontal area	259

Manufacturer:

K&B Manufacturing, Downey, California, USA.

Distributor:

Irvine Engines Ltd.