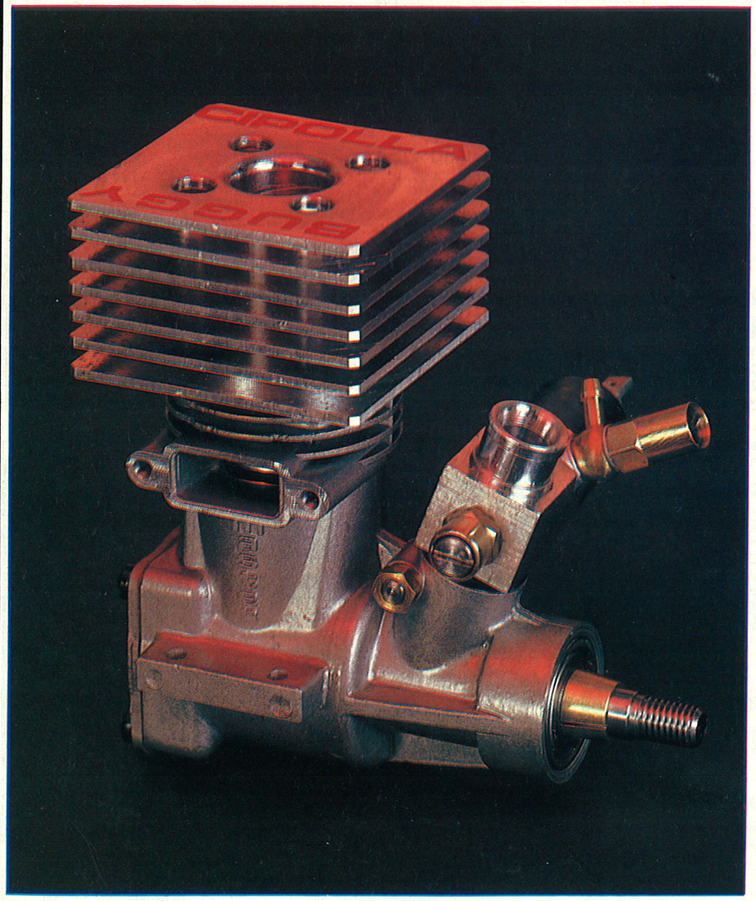
POWER CURVE

by Mike Billinton



Mike Billinton takes an in depth look at the Cipolla 3.5cc Buggy engine

After some nine years of model engine production, the brothers Alberto and Paulo are still showing unusual restraint in not allowing too hasty an expansion of their design range ... with just two crankcase sizes (nominally for 1½cc and 3½cc units) covering the capacity limits to which they are currently committed. However, the 13 models which do result from this quite small base cover a large range of model types: (1½cc. R/C and C/L,) (2½cc. C/L Combat and R/C,) (3½cc. Car and Marine,) and 4cc. R/C.) Adding further variety, 3 liner/piston styles are variously used — Ferrous, ABC and AAC. All engines are available in glowplug format, with the addition of a Diesel version in the 1½cc. size.

The 3.5cc. Buggy engine tested here, is a typical sample of this Cipolla range and, as set-up, is clearly well matched to this particular form of car racing.

Mechanical details

Crankcase — this is the now quite standard robust and reliable one-piece casting, having Schnuerle transfers and single boost ports. The external appearance of the transfer passages is misleading because one inside wall is actually vertical, and results in a sharply tapering transfer duct which must accelerate gas flow as it enters cylinder.

Crankshaft — Pursuit of sheer power being slightly less important in the Buggy engine allows retention of the standard 12mm. shaft diameter where as top circuit racing engines are increasingly adopting the 13mm. size. Use of a separate pressed-in hardened roller to serve as the crankpin enables Cipolla to use a non-hardened though very tough steel for the main shaft, and which therefore is unlikely to suffer mechanical fracture.

Piston — in high silicon aluminium alloy, and features a 'rounding-off' of the top edge to give a crown diameter .005in. under nominal bore size of .630in. This particular point makes assessment of the precise port timings a problem but is frequently used to ease early running-in, to protect the vulnerable top edge of the plain piston, and to minimise heat expansion problems at this hottest part of the piston. Having said that, some manufacturers find no need to follow this route.

Liner — turned from the normal brass, this part appears to be chromed internally in the equally normal way, though the manufacturer indicates a specialised treatment (probably based on the semi-metal element Boron) has subsequently been used called 'Tetraboro', and which imparts superior wear resistance to the already hard wearing chrome plating. Exhaust port is angled down some 20°, with boost port angled upwards 60°. In making allowance for the severe rounding of piston top, all port timings are effectively quite extreme, with a resulting very high 188° of exhaust timing. The 'blow-down' angle (ie. the period between exhaust closure and transfer opening) is nevertheless still not large at 24°, and so tuned pipe performance uplift is not likely to be as vivid as may be expected from high exhaust timings in conjucntion with large blow-down periods.

Connecting-rod — in aluminium alloy, this is milled to substantial dimensions from solid, and has no bushings at either big or little ends. Both ends are however drilled for lubrication.

Gudgeon pin, like the crank-pin, is a solid roller of very high finish, and appears to have been 'commandeered' from full-size needle roller races.

Cylinder head — Where earlier models of this engine were distinctively anodised gold, this latest 'heat-sink' head is not plain turned and milled to the natural aluminium finish, and is almost equally eye-catching with red lettering. The more interesting aspect of this head however, is the large squish clearance of .030in. and the resultant very low Effective compression ratio of 6.6/1. These points generally result in lower cylinder pressures and much longer glow-plug life — either of which are reliability features deemed paramount in the 'Buggy' engine. A previously tested Cipolla Car X2 engine was similarly set-up and showed definite power increase when squish clearance was reduced from .041 in. to .021in. So it really is a question of the levels of power versus reliability required for the particular event, and Cipolla, in common with many other manufacturers, opts to deliver their engines to the customer in the 'greater reliability' mode.

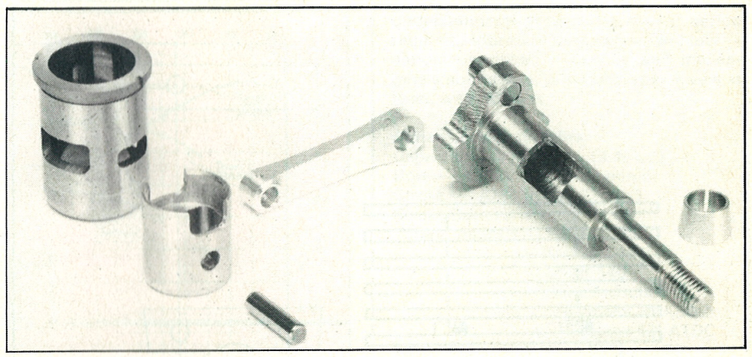
Carburettor — Similarly, the choke size of this machined from solid aluminium alloy unit is a quite small, easy to operate 7mm. dia., giving very smooth throttle response and good controllable fuel settings.

A steel barrel slide is used with throttle stop adjuster nut incorporated at servo arm end. Secondary needle is fitted as normal at opposite end of carb. body and, together with main fuel needle, is 'O' ring sealed against air/fuel leakage. Wall thickness of the carb. boss inserting into crankcase is quite thick and well resisted distortion from the normal (and brutal) pinch-screw method of fixing.

The frequent contrary result when this carb. wall is thin (where maximum choke size is sought) is for the carb. to loosen after a short period of high RPM running. A standard plastic/paper air filter is available from this manufacturer, as well as a variety of exhaust manifolds, tuned silencers, clutch shoes and carburettors.

Power Tests

Prior to Torque tests, a longer than average running-in period (for an ABC engine) appeared necessary, and propellor RPM's recorded here were those achieved after some half an hour running. The harder than normal liner 'Tetraboro' surface seems the main cause of this, and the result is likely to be a longer than average operational life for this Cipolla Buggy engine.



Note roller pressed into crankweb to serve as crankpin. Con-rod is well machined from solid. Roller also used for gudeon-pin.

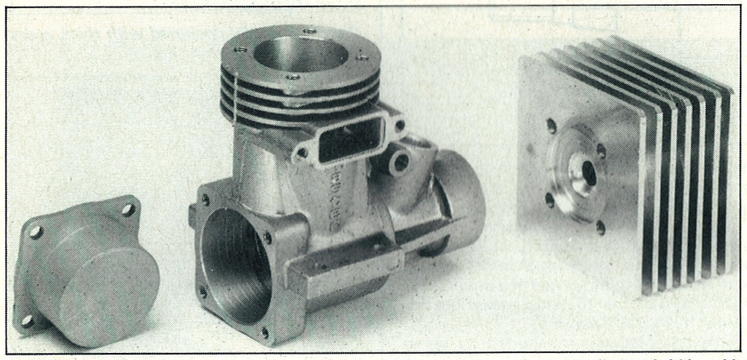
In pursuit of extra information, it was decided on this occasion that assessment of fuel consumption would be useful, and these figures were monitored in silencer and tuned pipe forms only.

Test One. Open Exhaust. 10% Nitromethane/10% Castor oil. Cipolla glow-plug Special.

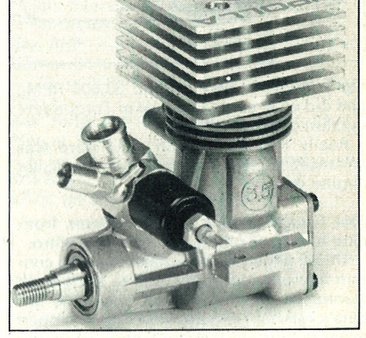
This fuel was used throughout all the following tests, and is as manufacturer's recommendation ... it is inexpensive, places little strain on engine parts, and is very kind to glow-plugs. As no direct comparison with the top circuit car engine performances was being looked for here, it seemed preferable not to use the 'normal' 50% Nitro. fuels used when testing such engines. In this initial open exhaust format, Torque production covered an extremely wide and flat band — very similar in values and distribution to that of an earlier tested Picco Buggy engine.

Test Two. Cipolla standard silencer. 10% Nitro.

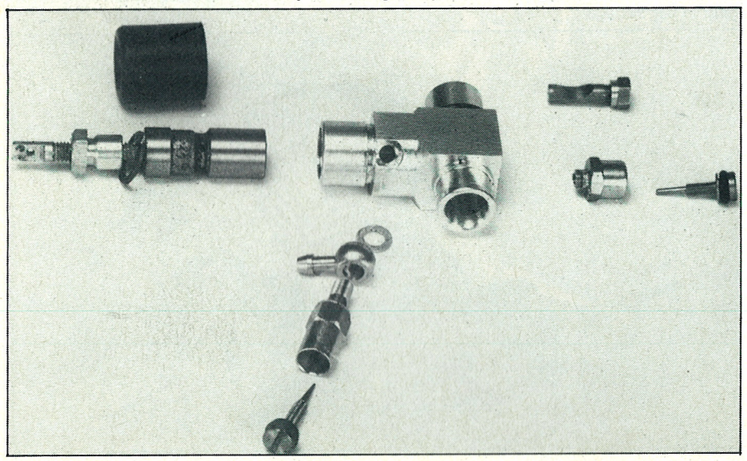
This silencer is of similar style to the longer unit used on the 4cc. R/C aircraft engine, but its more compact dimensions make it of use in the more constricted car layout. Its effect on power and noise levels was quite marked, and it may well be a sensible choice where noise problems particularly need to be avoided.



The 'standard' crankcase is used for 2½, 3½ and 4cc engine sizes. Large 'heat-sink' head is now polished aluminium finish.



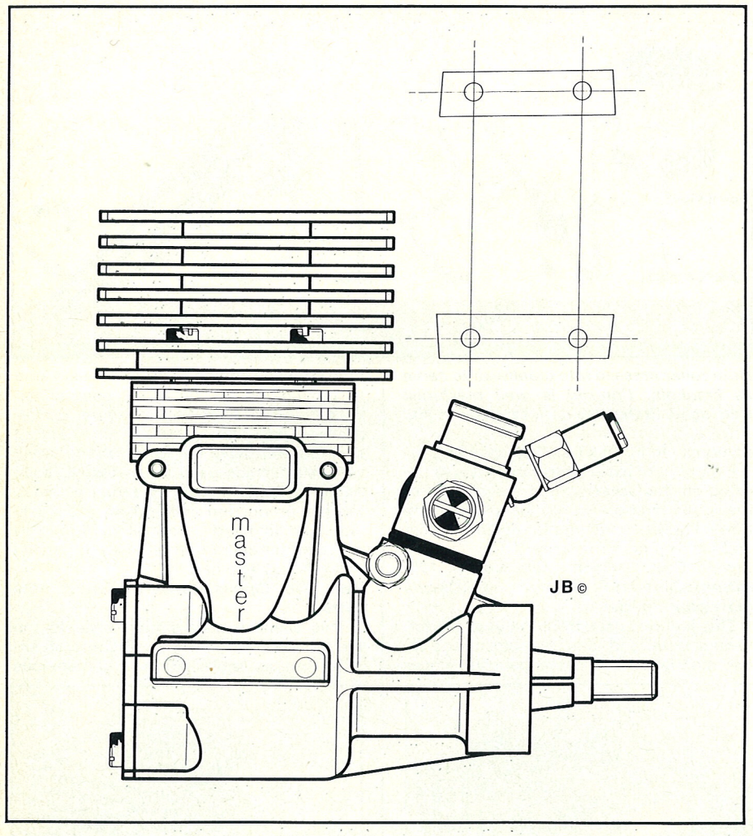
Steel barrel slide is held captive by 'Anderton' clip. Throttle stop adjustment is by threaded nut at left of steel barrel. Secondary (mid-range) adjuster is at right.



Test three. OPS tuned pipe. (Set at 280mm. from glow-plug to end of rubber can.) 10% Nitro.

Of particular interest here was the possible interaction between required pipe length and that rather exotic exhaust timing of 188°! and the result was the logical outcome that 'all things being equal, then an exhaust port which remains open longer (higher timing) will require a speeding-up of piston movement if correct resonance is to be re-established' ... i.e. an RPM increase will be called for.

So, this length of 280mm., which normally gives correct resonance around 26,000 RPM when used with exhaust timing around 160°, now can only achieve similar correct resonance with the 188° timing of this Cipolla Buggy engine at much



higher RPM — here around 33,000 RPM., and did so at some expense in Torque production at lower RPM's.

Really the pipe length used here was an unsatisfactory match to this particular engine design.

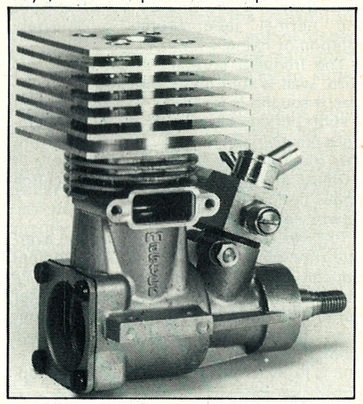
Test Four. OPS pipe now at 335mm. from plug to end of rubber can and 10% Nitro.

This change was undertaken both to confirm that previous point, and to bring peak resonance down and much nearer to engine's natural HP peak RPM when in open exhaust form. In fact the length arbitrarily chosen this time over-shot the probable ideal length by around 15mm., but nevertheless still led to a better result and a good rise in maximum HP to .97 at 22,200 rpm and with considerably improved Torque at all RPM compared with the previous 'over-short' pipe length. Although not tested here, it is likely that an improvement may be forthcoming by use of a pipe length nearer to 320mm. to bring maximum HP nearer to 26,000 RPM.

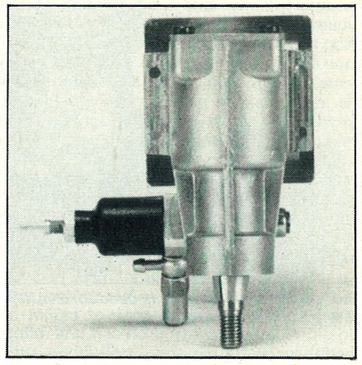
This last test was concluded by some checks on Idling performance and throttle transition, and the latter proved outstandingly crisp and certain, with no apparent fuel mixture degradation anywhere in the intermediate range of throttle movement. Admittedly this writer has yet to provide some load on the dynamometer which would be akin to the real inertia of a 5lb. car under hard acceleration, so it is possible that real car operations may see this throttle response in a different light. Lastly the Cipolla glow-plug survived all 55 separate runs but for the one at maximum resonance on the short pipe length — at 32,500 RPM.

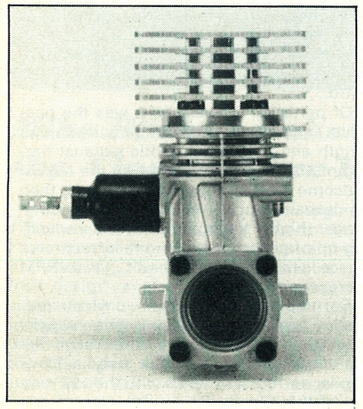
Summary

This Cipolla 3.5cc. Buggy ABC SL ST (its full title) was an exemplary performer in all ways, with the possible exception of the

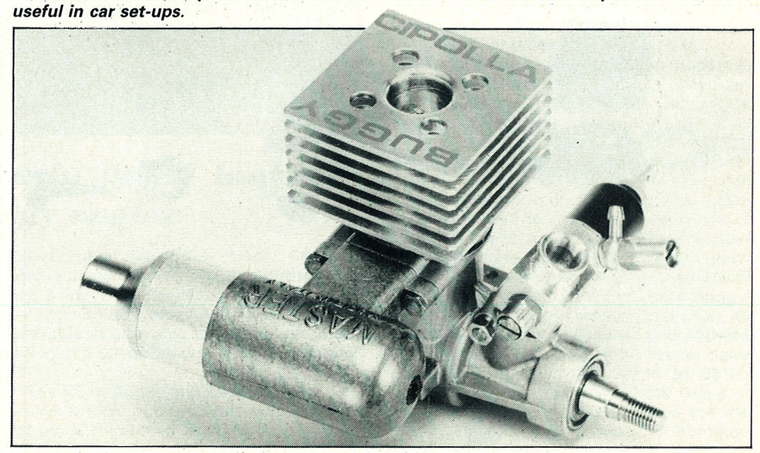


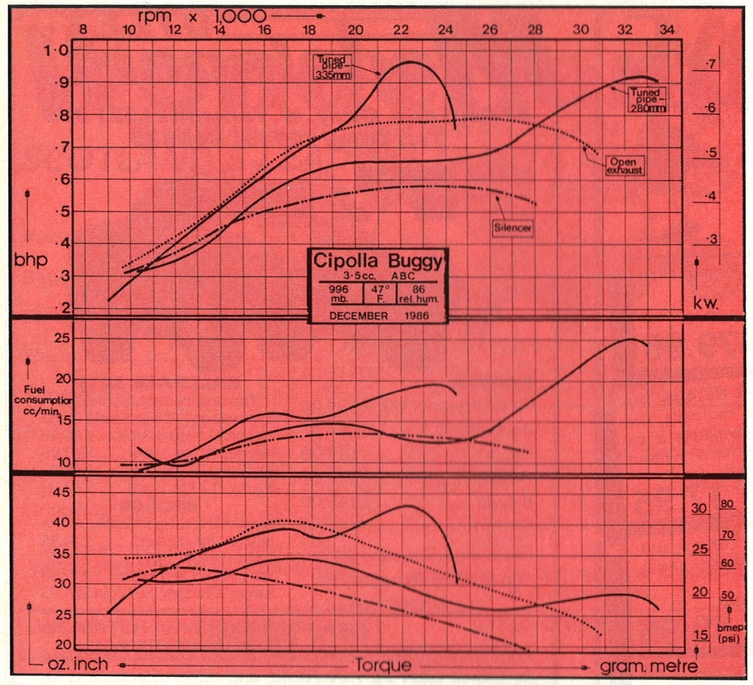
Case is soundly designed with thick webs supporting front housing.

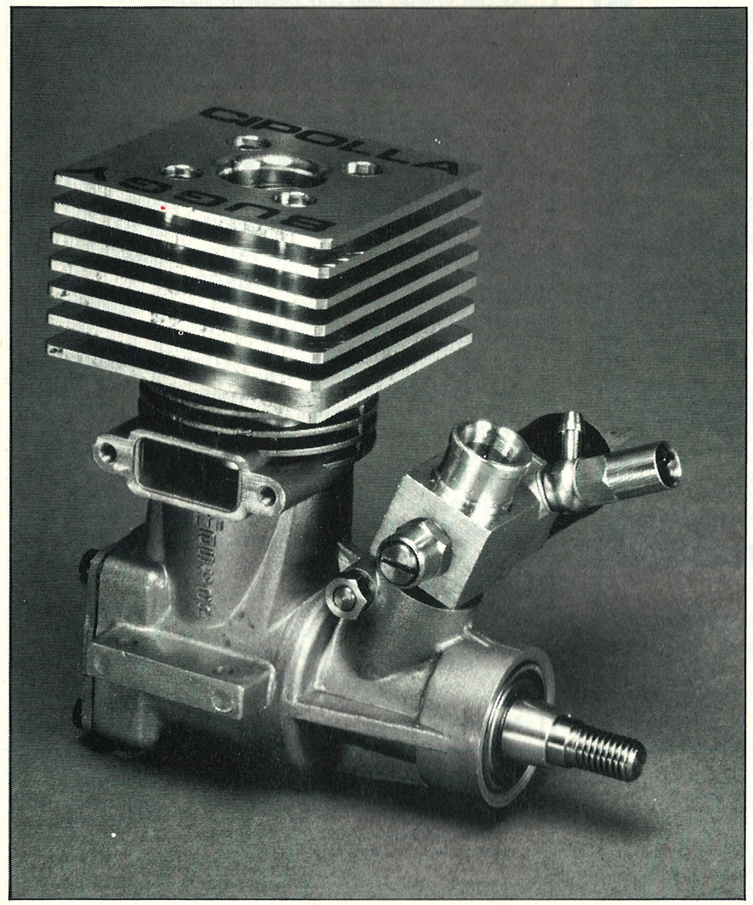




This standard small Cipolla silencer can be used in aircraft but its compactness makes it useful in car set-ups.







understandable longish running-in period required. Vibration levels were very low — almost unnoticed in fact — and the engine's soundness, at these power levels at least, was obvious.

Dimensions & Weights:

Capacity — .2113 cu.in. (3.46 cc.)
Bore — .630in. (16mm nominal)
Stroke — .6780 in. (17.22mm.)
Stroke/Bore ratio — 1.076/1
Timing periods — Exhaust 188°
— Transfer 134°
— Boost 140°
— Front Induction
— Opens 38°ABDC
— Closes 52° ATDC
Exhaust port height — .239in. (6.09mm.)
Compression ratios — Effective — 6.6/1
— Geometric — 9.65/1
Cylinder head squish — .030in. (.8mm nominal)
Squish band angle — 0°
Squish band width — .117in. (3mm.)
Crankshaft dia. — .4722in. (12mm.)
Crankpin dia. — .1957in. (5mm.)
Crank bore — .339in. (8.63mm.)
Crank nose thread — .242in. x 28 TPI (¼ UNF.)
Carburettor bore — .28in. (7mm.)
Connecting rod centres — 32mm.
Mounting holes — 38mm. x 16.5mm. x 3mm. holes
Width between bearers — 1.22in. (31mm.)
Width — 1.74in. (44.2mm.)
Length — 2.48in. (63mm.)
Height — 3.43in. (87mm.)
Frontal area — 5.2 sq.ins.
Weight overall — 9.95 ozs. (.282 kilo)

Performance:

Max. BHP — .97@ 22,200 RPM (OPS pipe at 335mm./10% Nitro.)
— .79 @ 25,800 RPM (Open exhaust/10% Nitro.)

Max Torque — 43 oz.ins. @ 22,100 RPM. (Pipe at 335mm./10% Nitro).
— 41 oz.ins. @ 16,700 RPM. (Open exhaust/10% Nitro)

R.P.M. on Standard propellors:

	Open ex.	Silencer	Pipe-335mm
8 x 6 Zinger	14,650	13,220	—
7 x 6 Taipan	17,774	15,250	—
7 x 4 Taipan	21,970	19,380	24,660

Performance Equivalents:

BHP/cu.in. — 4.59
BHP/cc. — .28
Oz.in./cu.in. — 203.5
Oz.in./cc. — 12.42
Gm.metre/cc. — 9.25
BHP/lb. — 1.56
BHP/kilo — 3.44
BHP/sq.in. frontal area 8 .186

Manufacturer:

Motore Cipolla, Milan, Italy.

UK Distributor:

Sailplanes International, Unit 6, Cwmtillery Ind., Estate, Abertillery, Gwent, NP3 1LZ.

Pinch-bolt mounting for carb was rock-steady throughout — probably because carb wall was thick enough to withstand distortion.