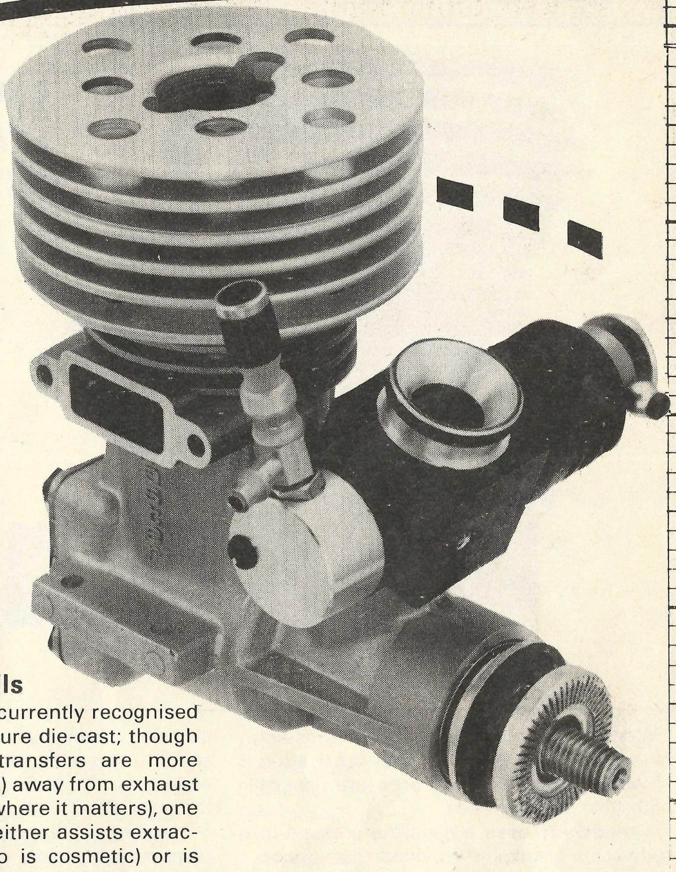
# ENGINE TEST No. 11

by Mike Billinton

## Cipolla 3.5 AAC car — X2



ITALIAN INVOLVEMENT in the engine side of the ⅛ Scale Open Car class is becoming ever more strong for at the 1983 World Champs eight Italian engines featured in the top ten placings. Given natural Latin verve, there is no shortage of manufacturers willing to enter this furious hot-bed of activity in an attempt to displace the *OPS/Picco* stranglehold. Rumours continue of a *Rossi* '3.5;' in the meantime though, we have the reality of the *Cipolla* entry into the car field.

The brothers Alberto and Paulo (also involved in the quite precise area of weighing machine manufacture) are not new to the model engine world — the 'Master' series of engines having been in existence for some six years. Early in 1982 the basic 'new' crankcase appeared which now provides the base for the 'Combat 2.5,' the 'R/C 3.95,' and this 'Car 3.5cc' engine. As yet there is no news of involvement in capacity classes outside these limits.

A significant enlargement of *Cipolla* activity occurred in 1982 with a liaison between them and the *Serpent* team; because such alliances in the past have proven of major advantage in the development and testing of appropriate engine performance.

As one consequence of this there are now 'ABC Car,' 'ABC Buggy' and 'AAC' models available. This latter also appears as a factory 're-work' unit — the 'X2' — and this was the engine used for the formal test.

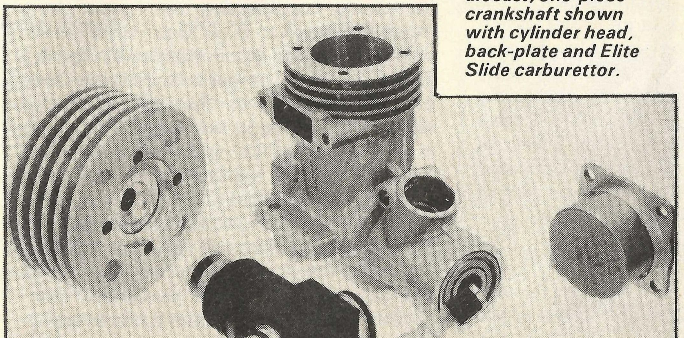
### Mechanical details

**Crankcase** follows currently recognised best practice; is pressure die-cast; though externally the side transfers are more acutely angled (at 14°) away from exhaust than is usual. Inside (where it matters), one wall is vertical. This either assists extraction from die (and so is cosmetic) or is evidence of an internal design change giving weight to the idea of accelerating gas flow up the now rapidly tapering transfer passage.

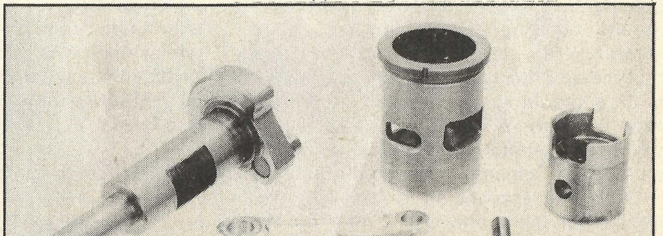
**Liner/piston** here steps slightly outside normal practice — the liner is of aluminium alloy, plated for the *Cipolla* Brothers in Germany using a process known as 'Chemisil Argos Coating.' Not chrome plating, but more akin to the current *OS* 'Nikasil' method where a microscopically fine suspension of silicon carbide particles form part of a base coating (say nickel) which by itself would be too soft to act as a bore surface. Actual metallurgy of the liner/piston combination is not known, but as this liner is likely to expand more with heat than does the normal brass equivalent in ABC engines, then a high-silicon (low-expansion) piston is not required, and in fact would cause loss of seal as the motor warms up. Therefore the *Cipolla* 'AAC' piston is of high-duty (and high-expansion) alloy, and, unlike the cast hi-silicon pistons in the ABC motors, is in this X2 factory prepared motor, milled from solid aluminium alloy.

Upper edge of the piston is 'rounded' and is thus under bore size for a depth of .035in. to the tune of around 0.0035in. Whilst this eases piston progress up the bore, it may also inhibit propagation of the sudden (and supposedly more effective) acoustic wave given with sharp-edged pistons and ports.

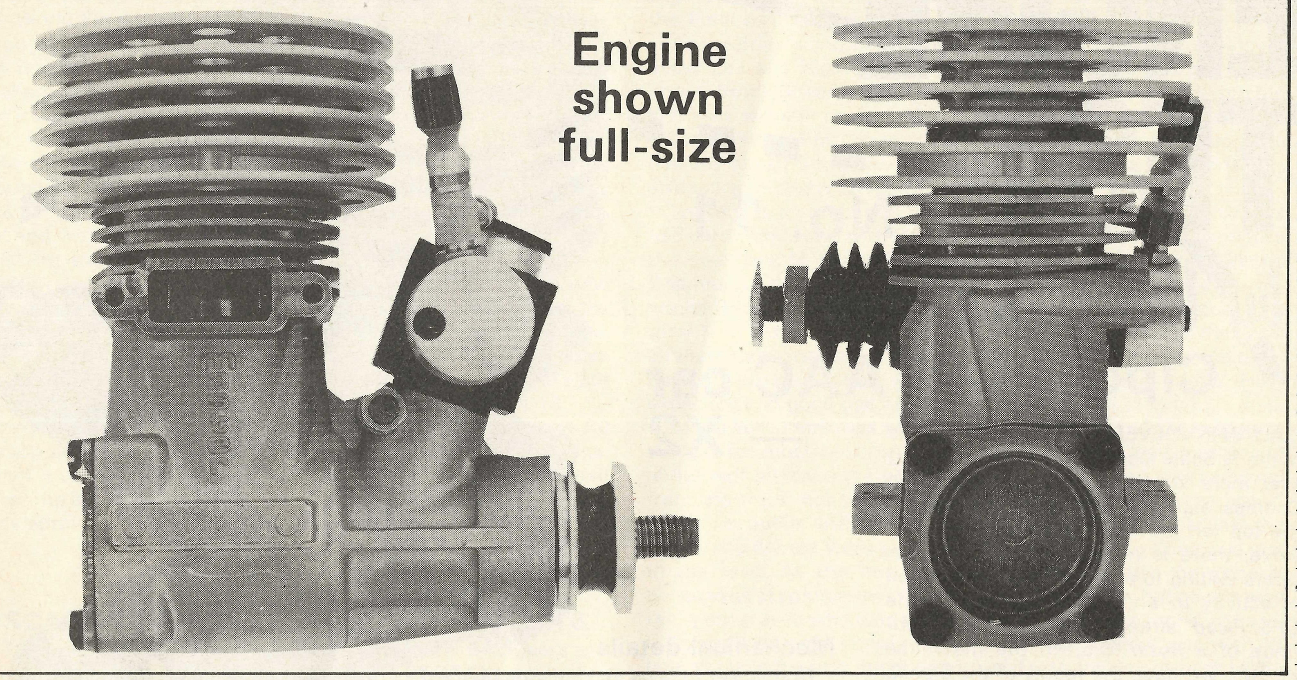
**Gudgeon-pin** is unusually a solid roller — circlipped in place.



*Left: pressure diecast, one-piece crankshaft shown with cylinder head, back-plate and Elite Slide carburettor.*



*Below: crankshaft, con-rod, liner and piston. The liner is plated with an unknown metal combination and is much different to the usual chrome plating of ABC motors.*



**Engine shown full-size**

**Con-rod** is also machined from solid high-duty alloy with single lubrication holes entering at the high-pressure sides of both little and big-ends.

**Crankshaft** uses a separate pressed-in roller as a crankpin. Provided that a good assembly technique is maintained, this is always an attractive option because of the superior surface hardness and finish available in rollers produced commercially for bearing assemblies. An added attraction is that the mainshaft is then more easily fabricated from tougher, much more reliable steels needing no heat or other hardening treatments and which are the cause of rare failures. As the 'pressed-in' crankpin can itself be the cause of a rare failure then this is very much a 'swings and roundabouts' situation. In this 'X2' unit a high-speed main ball bearing is used.

**Cylinder-head** is a large, attractive satin finish alloy heat-sink style with sensible provision for air cooling flow past glow-plug.

**Squish/compression ratio.** This quite unusual aspect seemingly runs parallel with the other 'reliability' factors within the engine, (the tough crank/glow-plug cooling/milled rod/high-duty piston/hi-speed bearing). With squish band clearance set at .041in. minimum *and* tapered up 7° to an even greater clearance, with a resulting geometric compression ratio of only 8.7:1, the final effective (though still static) compression/ratio after exhaust port closes is a very soft 5.9:1!

Of the car engines so far tested in this series, this is the only one to maintain the very shiny piston crown and cylinder head internal finishes even after considerable running. The expected appearance is usually a sand-blasted or even eroded combustion chamber, denoting very close squish clearance and/or plug element vaporising. Significantly, during this test, the one *OPS* 300 plug lasted for all the runs — hardly a phenomenon though, on such a compression ratio.

From the above, the point arises as to how much reliability it's wise to pursue, and with what effect on power levels? Each manufacturer fixes different optimum points here, and Cipolla brothers cannot be criticised for concentrating much effort on the reliability front — somewhat of an Achilles heel in the open car class until recently.

The net result here is a unit which sailed through the test, stripping down at termination to an almost as-new appearance, but which did so following power levels not far short of any achieved by *side-exhaust* engines in this series. Users wishing to trade off a little reliability for some power increase could usefully take out the .020in. copper gaskets under the cylinder head, but it is worth bearing in mind that part of the thinking behind such a large initial squish clearance may well be the likely greater vertical expansion of the high-duty alloy piston and rod as compared to the lower expansion (silicon-bearing) crankcase whilst engine is running. Such a test is being conducted and findings are included at the end as they are not felt to be part of this formal 'as supplied' engine test.

## Power Test One

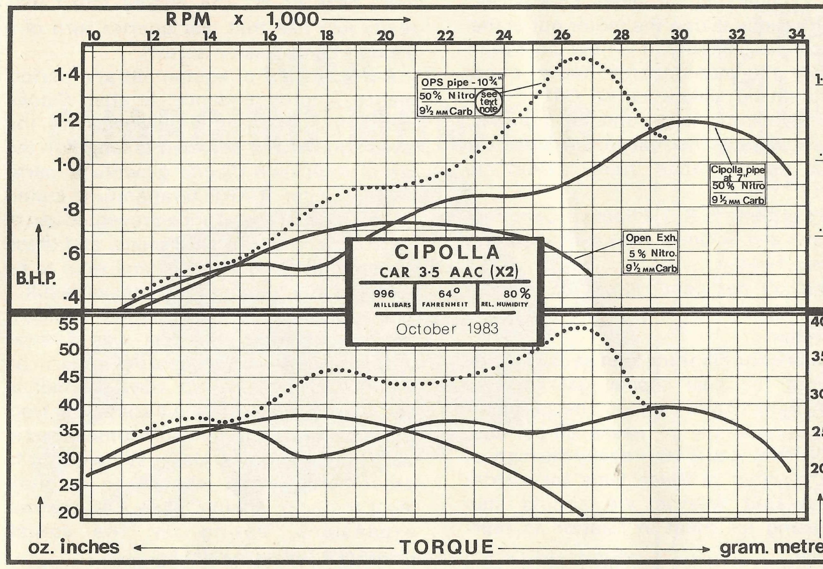
In open exhaust format and using five per cent nitromethane fuel with the manufacturers recommended castor oil at ten per cent (that's more like it), together with the *Bailey* 9mm slide carburettor (as engine comes with none of its own) the RPM checks and torque curves revealed a quite restrained power level compared with other more tightly compressed motors. Of equal significance was the quite low peak BHP point of 21,000rpm. This is very much tied up with degree of compression; i.e. with a given flame-speed, an increase of RPM demands an advance of ignition by extra compression (model diesel operators know this). Added to which as RPM rises above the peak torque point, an ever more rarified gas mixture is reaching the combustion chamber due to increasing gas flow restriction, and which itself allows a compression ratio increase above nominal. None of this is served by an unusually low compression ratio as in this test motor. There are other considerations though as the next tests show.

## Power Test Two

Using 50 per cent nitro/9mm carb/six per cent castor and six per cent ML70 synthetic/*Cipolla* tuned pipe at 7in. plug to max. pipe diameter. This saw power levels increasing considerably with peak being much extended to 30,000rpm (by virtue of short pipe length recommended by *Cipolla*). The proportional power increase over Open exhaust figures was the highest of this series and, although this might be argued, is the result of using a low base open exhaust result in the first place. Nevertheless one is reminded of much early theory and practice in the use of tuned pipes which then suggested that the very high cylinder pressures resulting from tuned pipe 'supercharge' would demand a partial and compensatory reduction of static compression ratio. This seemingly gives away that which has just been gained, but maybe *Cipolla* are re-exploring this avenue. It does depend in the first instance on how successfully the








# Cipolla 3.5 AAC Car — X2

### Dimensions and weights

Capacity — .21174cu.in (3.469cc)
Bore — .6285in. (16mm nominal)
Stroke — .6825in. (17.33mm)
Stroke/bore ratio — 1.08/1
Timing periods
— Exhaust 167°
— Transfer 120°
— Boost 116°
Front induction —
Opens 40° ABDC
Closes 60° ATDC
Total 200°
Exhaust port height — .252in.
Combustion chamber vol. — .45cc
Compression ratios Effective — 5.86/1
Geometric — 8.7/1
Cylinder head squish — .041in.
Squish band angle — 7°
Squish band width — .10in.
Crankshaft dia. — .4722in. (12mm nominal)
Crankpin dia. — .1968in. (5mm nominal)
Crank bore — .335in. (.85mm nominal)
Crank nose thread — .245in. × 28 TPI
Gudgeon pin dia. — .1569in. (4mm nominal)
Con rod centres — 32.5mm
Weight overall with slide carb — 9.3oz (.263 kilo)
Mounting holes — 16.5mm × 38mm with 3mm holes
Width between bearers — 1.21in. (30.7mm)
Width — 1.74in. (44.2mm)
Length — 2.72in. (69.1mm)
Height — 3.3in. (83.8mm)
Frontal area — 4.74sq.in.)

### Performance

**Max BHP** — 1.20 at 30,000rpm (OPS pipe/50% nitro/9mm carb)
.74 at 21,200rpm (open exhaust/five per cent nitro/9mm carb)
**Max Torque** — 40oz.in. at 28,800rpm (OPS pipe/50% nitro)
38oz.in. at 16,800rpm (open exhaust/5% nitro)
**RPM Standard Propellers**
8 × 6 Zinger — 14,920 (Open exhaust/5% nitro/9mm carb)
7 × 4 Zinger — 21,720 (Open exhaust/5% nitro/9mm carb)
7 × 4 Zinger — 21,000 (OPS Pipe/50% nitro/9mm carb

### Performance equivalents

| | |
|---|---|
| BHP/cu.in. — | 5.66 |
| BHP/cc — | .346 |
| Oz/in./cu.in. — | 188.9 |
| Oz/in.cc — | 11.5 |
| Gm metre/cc — | 8.0 |
| BHP/lb — | 2.06 |
| BHP/kilo — | 4.56 |
| BHP/sq.in. — frontal area. | .25 |

**Manufacturer:**
Motore Cipolla, Milan, Italy.
**UK Distributor:** Superspeed Distribution, 145 Newgate Lane, Mansfield, Notts. NG18 2QD.

particular tuned-pipe is made to operate on the given engine (and just what is, the final, *real* dynamic compression ratio on the move). The final figure of 1.20bhp was felt to be a good solid achievement for a side-exhaust unit having such a low compression ratio.

**Note:** This curve has been omitted from graph to prevent confusion as it lays almost above the *Cipolla* pipe curve which is shown.

## Test three

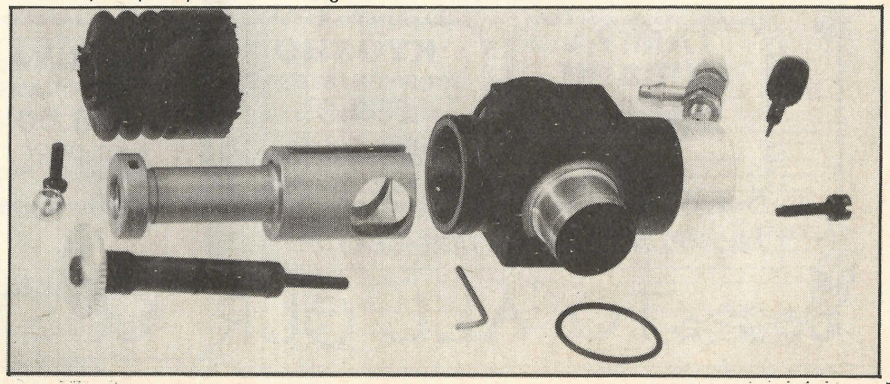
Equipment as Test Two, but with *OPS* latest tuned pipe (as used in *OS* '21VR' Test in last issue 'Model Cars'). This was conducted just to maintain some gauge point with previous engines, although it was operated at shorter length of 270mm (glow-plug to end of rubber silencing can) to achieve similar peaking speed to that of the *Cipolla* pipe. Result was a virtually identical peak performance and placement, although the lower RPM harmonic pulses were somewhat out of phase with each other.

## Summary

*Cipolla Brothers* have entered a daunting competitive area with these 'Master' series of 3.5cc car engines, and in so doing have made an already fascinating area that much more varied and interesting.

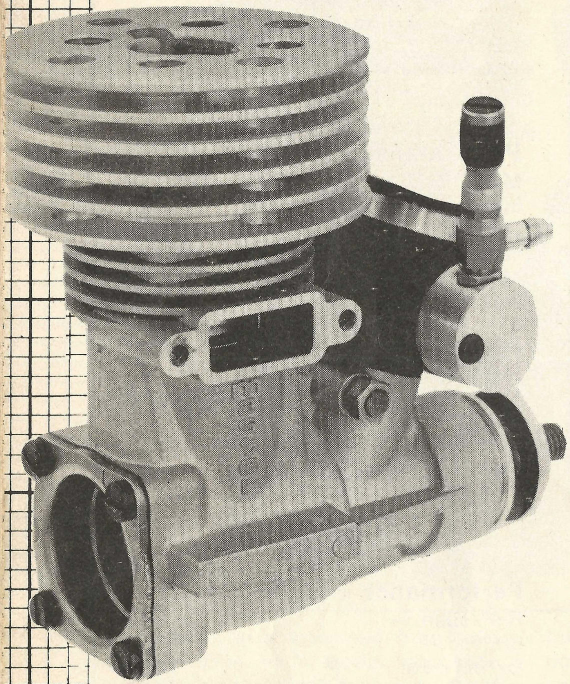
Their rate of development looks promising for the future but even as their motors exist at present they are good solid performers having previous contest successes. Future ones are assured, though the final result of all this world-wide effort towards maximising power and reliability may only be that *all* engines will have too much power for the available circuits (already a situation at some), and thus more emphasis than ever will be placed on driver skills — and no bad thing either! There must always be more to this class than just the engine.

***Below: on display, parts layout for the Elite Models/HB slide carburettor. As with most examples currently available the main needle has been re-positioned to facilitate fitting into the enclosed power pod area of state of the art one eighth scale cars.***



# Test footnote

As the following is felt to be of relevance to prospective purchasers, and has intrinsic



interest in itself, with Editor's agreement, this footnote is added:

Since the main test above was compiled it has been possible to conduct further tests using smaller squish band clearances. Though strictly taking the motor out of the 'as supplied' category, it is now clear that, whatever the manufacturer had in mind, the 'as set-up' clearance of .041in. was both inefficiently large and far removed from dimensions normal to the 3.5cc car engine (these range from .004in. to .016in.).

The resulting 5.9/1 Effective Compression ratio also is units away from the norm of 8½ to 11/1.

Using 50 per cent Nitro/OPS pipe at 10¾in. (plug to max. dia.)/9½mm carburettor.

**Squish band clearance set at .021in.** (by removing the two copper gaskets). As shown with dotted line on the graph — torque surprisingly increased 28 per cent with BHP rising to 1.46 — easily the highest figure reached in these tests for a side-exhaust unit (maybe we should stop apologising for them in relation to rear-exhaust).

This result was very large a consequence of the squish band change, though earlier readings indicated that a small part of the increase could be attributable to longer operating length of the pipe — bringing peak down to a less rarified level and nearer to Open Exhaust peak (generally noted as a better strategy). However this is obscured by fact that with hindsight the Open Exhaust curve itself would have been altered by use of the tighter squish band — both to a higher BHP value and to a higher RPM peak point. The overall effect was really just like that last quarter turn of a diesel's compression screw!

An indication of equipment and performance interdependence is that *Cipolla Brothers* subsequently advised that the large squish was provided to lengthen the life of their own *Cipolla* glowplugs, particularly under 100°F temperature conditions in Italy. Natural pride prevented use of (say) more effective OPS plugs, and these promptly allowed compression ratio to be screwed much tighter with above result.

A last point — combustion chamber appearance after this test was a more normal slight erosion/discolouration. So the .021in. squish may now be near to optimum(?) though it is still some way from the very tightest .004in. sometimes used in competition engines. Users still wishing to experiment further should go carefully least the point about *Cipolla* AAC thermal expansions 'eating up' the squish clearance has any validity.

**ENGINE TEST**