ENGINE TEST

by Mike Billinton

TUNED EXHAUST SYSTEMS ARE OBJECTIVELY EXAMINED BY OUR RESIDENT EXPERT

IN CONTRAST to previous articles, in this issue of *Model Cars* relative performance characteristics of some of the currently available racing class car, tuned exhaust systems (old and new) are investigated. This should provide both a welcome change of pace from the lengthening line of Test Reports on high performance model car engines, and a necessary holding stage on those tests, because of the wide variation in tuned pipe styles developing in the car field. Although the R/C car was in mind during preparation of the article, the findings can be of interest to users in Marine and Aero operations.

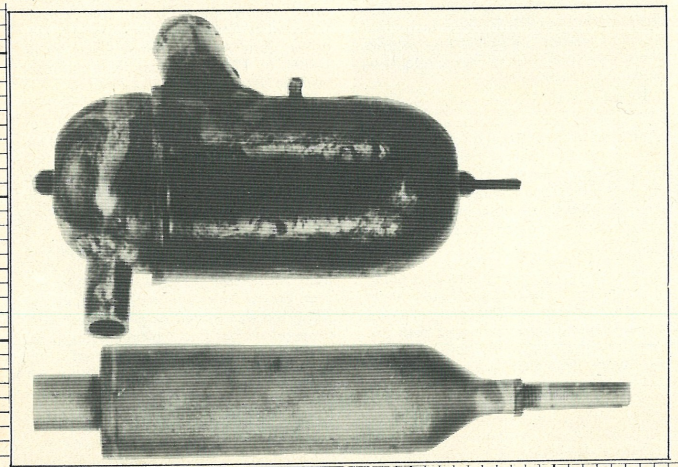
As most readers will know, the tuned pipe proper (twin cone — narrow power peak style) has not been favoured for model car use, for the sensible reason that its sharply defined power band is an unsatisfactory match with the R/C car engine's necessarily very wide rpm range (5 to 35,000 . . . itself a direct consequence of the lack of slip between wheel and ground, together with the very restricting (but very practical) single gear ratio. Were it not for these two 'problems' the engine could happily be allowed to run over a quite restricted rpm range, and thus more sensibly match the 'narrow band' tuned pipe.

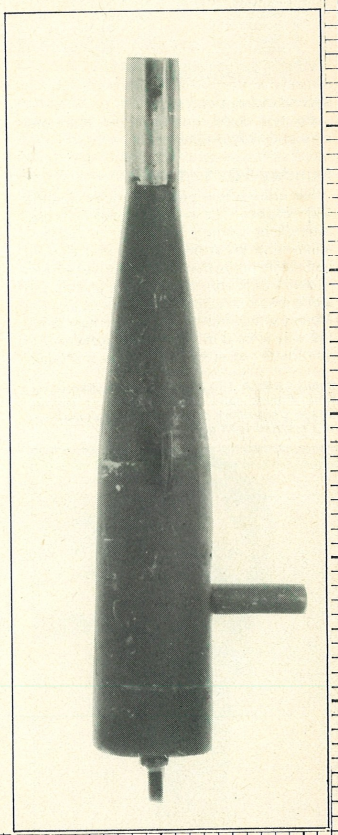
The much wider band 'minipipe silencer' is the favourite solution to the problems. Similar considerations could apply to the boat and aeroplane but are a much less critical matter, due to their use in slipping mediums of air and water which place these craft much nearer to the 'auto-transmission' class.

So the car, having this almost rack-and-pinion type of connection with its track, is forced to use the widest most flexible power source available for reasons of tractability. Car competitors are prepared to live with the lower power output that the minipipe delivers relative to the full tuned-pipe . . . however, the name of this particular open car class is 'competition' . . . and the matter clearly rankled . . . the increased power possibility was known to exist but apparently could not be used. That is, unless auto-transmission was used, or two or more gears. Strictly the elements of this situation remain, but the practical solution chosen for the present is a new generation of full tuned pipe variants which (whether designed empirically or developed as the result of much theorising), have resulted in a wider spread of power than has normally been available from the tuned pipe. This is clear both from this test and from known results on the car circuits.

In a sense these 'new' pipes represent a halfway position between the minipipe and the maximum power tuned pipe. Certainly in the case of one example of this new style, the flexibility of use over a wide rpm range was very marked, and must make it a very sensible piece of equipment to use on the track.

Below: two of the mufflers on test, AMPs (top) Magic Muffler (below). The AMPs muffler has been used during all of the engine tests so far as the standard performance improver. Right: Elite Models developed this exhaust system which Phil Booth and Walt Bailey used to such good effect during the 1981 BRCA Nationals.





Reservations

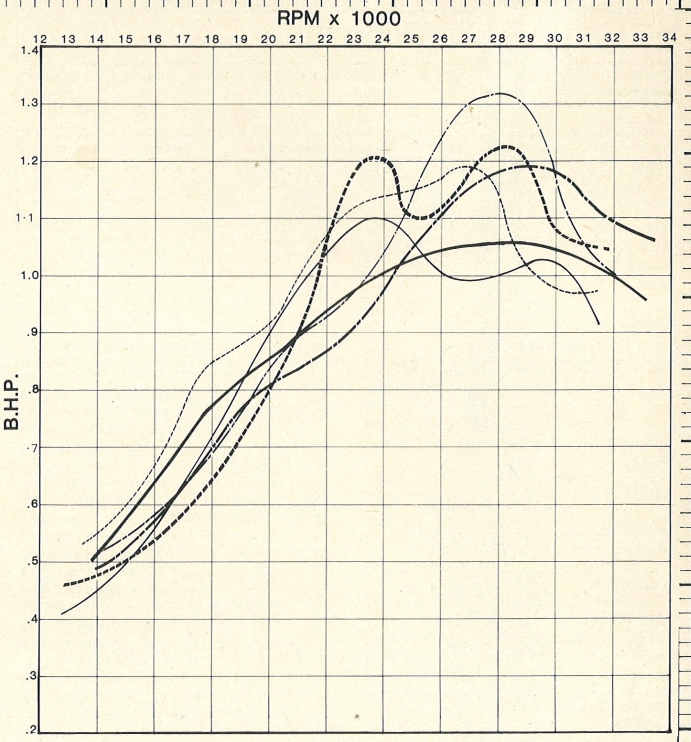
Model Cars editors' intriguing suggestion that this somewhat unusual test should be attempted has, not surprisingly, resulted in a 'can of worms' in more than just the graphic sense; therefore there are several points to bear in mind before making too certain a conclusion from the findings:

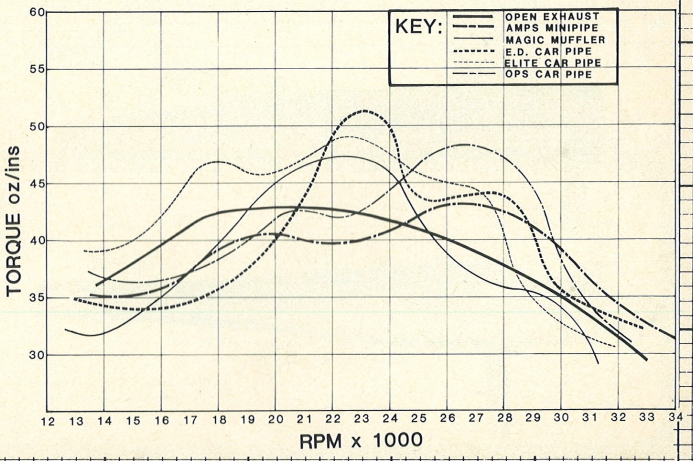
1. To test several pipes against each other demands that there be one constant factor against which to set them, therefore one engine only was used for all the 120 separate wide-open throttle readings, (i.e. an average of 18 spot readings per curve, at approximately 1,000rpm spacing between torque reading points). The use of one engine only also meant that the total test period was kept within a short time span — so minimising atmospheric variables.

2. To ensure maintenance of the engine 'constant' at a consistent level, required conservative operation on five per cent only of nitromethane; a generous 20 per cent of castor oil; and an upper limit to rpm of 30,000. Additionally more positive fuel control resulted from provision of low-pressure air line from the engine crankcase to fuel tank.

3. The *Picco* 3.5 (last issue's Test engine) happened to be available — it was in good, strong condition — its more peaky response during the engine test indicated it might more clearly reveal 'peaks and troughs' in the various pipes — its rear exhaust was a more convenient mounting position for the proposed five pipes, and minimised time-consuming balance changes to the dynamometer.

4. Different results would be likely to follow from the use of alternative engines having porting differences, and it might





Pipe data

Manfr. and type	Weight	Length O/A	Operational length	Outside dia. max.	Inlet dia.	Outlet dia.	Volume internal (to piston face)
	Ozs.	Inches	Inches	Inches	Inches		cc's
AMPs minipipe silencer	3.8	4.4	5.0	2.0	.65	.38	148
Elite tuned pipe	2.1	7.8	10.2	1.32	.53	.30	120
ED MkII tuned pipe	2.0	10.0	11.0	1.45	.58	.31	125
Magic Muffler	2.1	6.6	5.5	1.26	.50	.22	64
OPS tuned pipe	2.3	8.7	10.2	1.27	.57	.30	106

seem more ideal to test the five pipes on a few more samples of currently used engines to give a clearer picture. This may be so, but would be a daunting task on the dynomometer style currently used by the writer.

5. Tuned pipes — like engines or other manufactured items — can vary in their operation as between individual samples — and particularly where a high percentage of hand work is included in assembly.

6. The length of each pipe was fixed at the manufacturer's recommended figure.

As all the pipes are for use in a particular competitive area, then the hoped for result of using those lengths was that all the pipe peaks would lie in a similar rpm area. This turned out to be broadly so; and happened also to coincide with the motor's open exhaust peak.

No figure was available at times of test for the *AMPs* minipipe, so it was fitted at the length used for virtually all engine test runs to date; (5in. piston to pipe end).

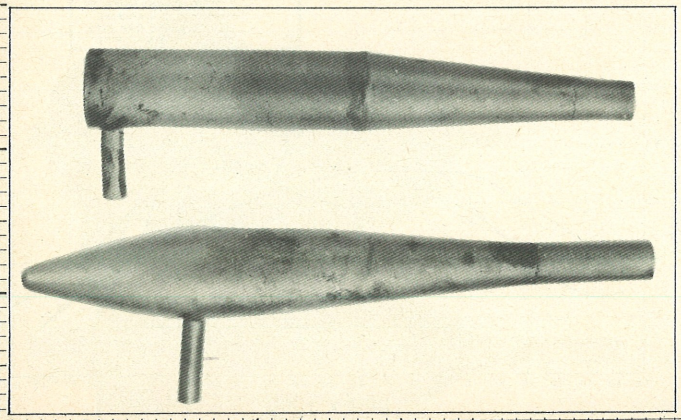
Clearly results could be made to differ if variations in length were made to each of the pipes. Although in general, shortening (say) all the pipes would move their resonant peak points higher up the rpm scale, it is by no means certain that all would benefit equally in power terms. Pipe volume and its relation to internal engine design features all have a bearing; and such a blanket change to pipe lengths might result (say) in Pipe A now being inferior in power terms to Pipe B — and so on. Related to this is another point: the use of higher nitro. fuels (than used here) usually would require a larger pipe volume to accomodate the extra volume of exhaust gas products, otherwise undue back-pressure and over-heating could occur. This simple fact has an importance for the tuned pipe tests run here, because were the whole test to be re-run on high nitro-methane fuel (above say 40 per cent) then the larger volume pipes would probably make a more favourable showing in relation to the smaller volume pipes.

7. Not all known commercial pipes have been tested here, as must be obvious. To that extent the picture lacks completeness. For example, one of the more interesting developments recently seen has been the pipe provided for the OS46 VRM motor (recently tested). Externally appearing to be a standard quiet twincone style ... in fact the rear cone is eliminated in favour of a simple perforated shallow dish set some 4in. back from the first maximum diameter of this pipe, at the end of a parallel section. Whether the pipe's principle is to be considered as based on a quietened megaphone or a large minipipe, the writer's theoretical understanding is insufficient to answer; nevertheless this pipe was instrumental in galvanising the OS46 towards one of the highest bhp/cu.in. figures recorded in model engine tests.

8. It's worth noting that in many cases the jump from the foot of the tuned pipe's torque curve to the high point is almost 'unplottable' and this is most marked when dealing with the older twincone straight taper styles. The only one of the pipes tested here to prove difficult to plot 'on the rise' was the ED car pipe ... the curved cones of which are usually thought to give enhanced flexibility. But of course this ED pipe was of somewhat different layout to normal by virtue of the side exit of the tailpipe.

9. The likelihood was that the many points on the graph would coincide therefore to increase their separation the graph's vertical axis has been 'stretched' — with the result that things may look more peaky and extreme than would be usual on most other graphs.

It will be noted that cone angles and lengths and other 'inside' information in the quiet business end of the pipes have been omitted. Readers will have to decide for themselves the motives (if any) for this. Also of note is that the 'Magic muffler' has not been named as to type. Well; there is some small doubt as to whether it is really only an internally confused form of minipipe. It is certainly not a tuned pipe in the twin cone style, and its performance characteristic are similar to a basic minipipe — its length being of the same order.



Left: OPS produce this exhaust designed to complement the OPS 21, but obviously suited to many more motors. Left: (below) ED No. 2 Car tuned pipe proved peaky on test in spite of the blended curve design.

Observations and conclusions

1. Graphically speaking art has not been allowed to triumph over dynamics.

2. This report adds a little light only to a very large complex area.

3. Having made the various reservations (which all add up to a general reminder that the test was of "those particular pipe samples — at those lengths — on that particular engine — using that fuel only — in particular weather conditions") there remain some broad truths which the writer feels have been revealed during the test; added to which have been numerous previous pipe tests to which the findings here largely conform.

4. Looking at torque curve or bhp curve separately, one can derive different ideas as to worth. The subjective assessment on the day was much more in line with the torque curve picture.

5. It's clear that engines of the two-stroke racing style can be made to stand on their heads by their exhaust systems, the pipes are telling the engines what they may or may not do.

6. Consequently it follows that engine test report findings (as to power and its distribution) can be markedly affected by the choice of tuned or other pipe.

7. It seems that for the engine tests in *Model Cars* at least it will be necessary to move away from the *AMPs* minipipe silencer as the standard piece of equipment used to produce power from exhaust pulses ... because its use on the tracks is declining. The particular model is no longer in production, and in any event our sample is becoming less than sanitary.

8. There are strong indications that the use of the *Elite* pipe could easily lead to a certain feeling that one's engine has a lot of bottom end power.

9. The *AMPs* minipipe was both the quietest and most docile to handle, and were it not for its power disadvantage as revealed against the newly flexible tuned pipes, would still be a favoured item.

10. The *Elite* was almost as docile; but the surprise was a remarkable spread of torque, which, as can be seen, remained above 45oz. ins. over a 9,000rpm span, and over 40oz. ins. over a 13,000rpm span and on the day gave the impression of being almost a constant torque producer ... very unlike the normal tuned pipe proper.

11. The OPS was a clear winner on horsepower grounds, and given lower gearing it should be possible to make effective use of the extra; however it does suffer relative decline at lower rpm points and it becomes a finely balanced choice as to which advantage point to opt for.

12. The possible combinations of pipe type, pipe length, exhaust timing, motor and fuel set-ups, must be legion; but for the single gear car with relatively solid traction, the attractions of strong torque, both low down the rpm scale and widely spready across it, are considerable. If nothing else, the ability to out-accelerate others at the start and out of succeeding corners (and thus place oneself in clear space) must give disproportionate advantage. In addition, any engine which can be made to produce a wide steady band of relatively predictable power must make for a more predictable and easier car to drive; which of itself will produce better lap times.

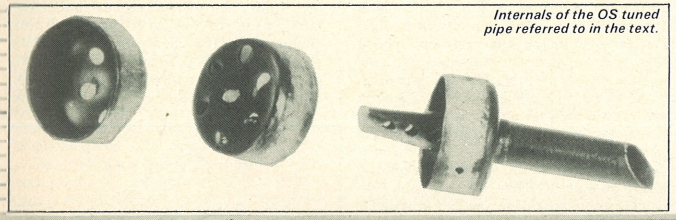
13. Of passing interest is that the *Picco* also survived this additional set of pipe tests — though they were not as demanding as the top performance runs currently being conducted in the engine tests proper. Also of note is that only the one *OPS* L/R glow plug was needed for all the runs ... which goes to show how mild five per cent nitro fuel is.

Test conditions

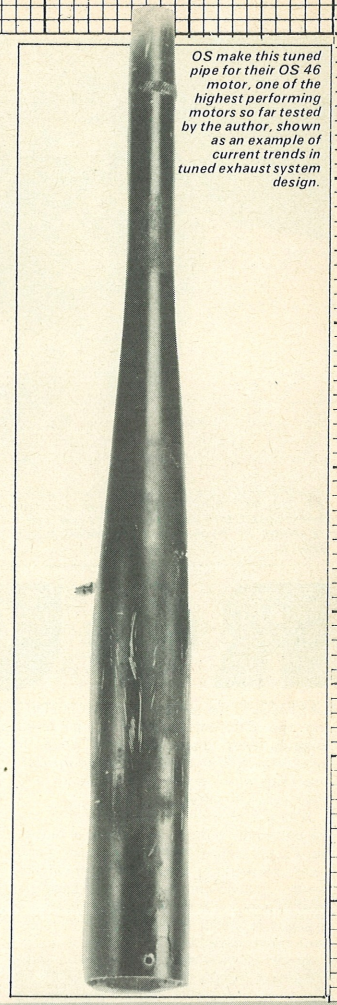
February 7, 1982.
Air pressure 1007mb.
Temperature 54°F
Relative humidity 60 per cent
H/P correction factor 1.01

Test equipment

Picco 3.5cc. Glow plug two-stroke racing engine. OPS two volt glow plug.
Fuel: five per cent nitromethane/20 per cent castor oil/methanol.
Crankcase low-pressure fuel supply system.
Picco 7mm slide carburettor.



Internals of the OS tuned pipe referred to in the text.



OS make this tuned pipe for their OS 46 motor, one of the highest performing motors so far tested by the author, shown as an example of current trends in tuned exhaust system design.

Model Cars

Handy Hint No. 3

Differential Modifications. The accompanying sketch from Mike Wood shows how an *Associated* or *Greeno* axle can be modified to accept *Schumacher* wheels and sleeved tyres.