# PETER CHINN'S RADIO MOTOR COMMENTARY

## Running on fresh air, almost . . .

No doubt many readers have heard of the annual Shell-*Motor* Mileage Marathon. Sponsored in the UK by Shell UK Oil, in co-operation with *Motor* magazine and with the help of the Bugatti Owners' Club, the competition is for petrol-engined vehicles and the winner is the entrant whose machine covers the course (at present six laps of the Club Circuit at Silverstone, to be completed in not more than 38 minutes) on the least amount of fuel — the fuel being standard Shell motor spirit of 97 Research Octane Rating.

Other countries are now running similar events, each differing in some way from the UK original, but all having one thing in common: the realisation of mpg far in excess of anything that would have been thought possible only three or four years ago.

Until recently, the most widely favoured engine used to power the Marathon machines has been the 50cc Honda four-stroke moped unit, suitably modified to produce less power and greater fuel economy. However, since this excellent little motor, even when de-tuned, still produces more power than is necessary to propel the lightweight 'cars' that have been developed for these events, much of the time is spent in freewheeling, the technique being to accelerate up to a speed somewhat above the required average speed and then to switch off the engine and coast until another boost of power is required.

Of course, acceleration, even of a meagre kind, is what gobbles up fuel: i.e. engines are at their most economical when pulling a suitably matched load at a *steady* speed and at an evenly maintained operating temperature. For this reason, over the past two or three years, some of the teams involved, most particularly those drawn from the motor and aircraft industries' apprentice groups, from research institutes and from the universities, have been looking elsewhere for their power units and, as a result, yours truly has found himself involved in a consultative capacity.

Here, we have to admit that, when first approached, early in 1979, for our views on the problem (the brief then being that the engine would need to be a single-cylinder of between 15 and 30cc, we rejected the idea of using a model aircraft engine to beat the Honda. In the interests of economy, a two-stroke (model or chainsaw type) was ruled out and there was no commercial four-stroke model engine available that seemed likely to offer the level of performance, on petrol, envisaged by the entrants.

However, we had reckoned without the immense improvement in vehicle design that the next year or so would bring about and which would drastically revise our thinking about the actual bhp required to propel a Marathon machine.

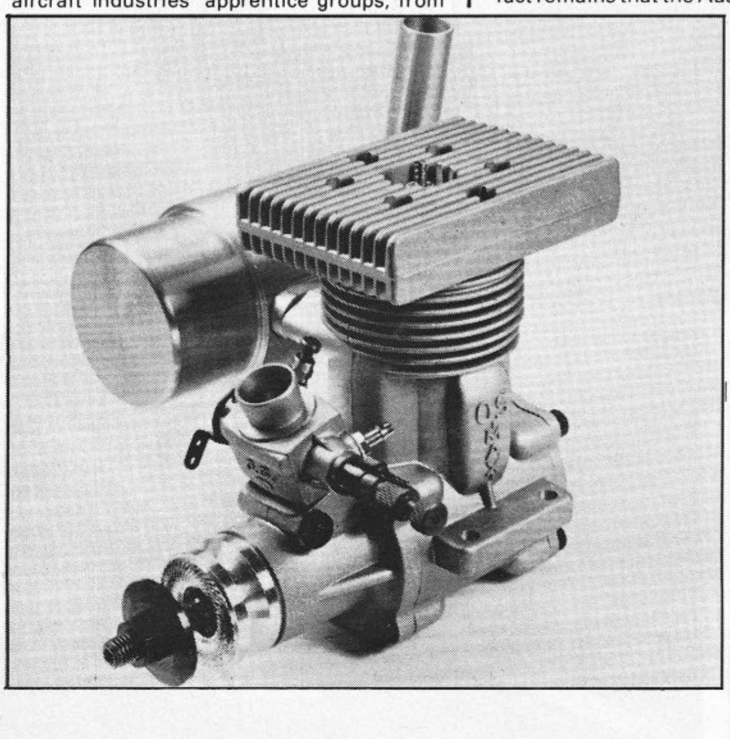
Some attempts with model engines were made by others, but it took the entry into the fray of the Australian Orbital Engine Company team, with their highly sophisticated 1980 entry, to prove just what could be done with a 10cc four-stroke model aircraft engine.

The O.E.C. machine was powered by a modified O.S. FS-60, running on straight petrol, with a separate lubrication system and spark ignition. At the Warwick Farm motor racing circuit in New South Wales, it achieved a consumption figure of 2,685 miles per gallon, no less than 1,000mpg better than the British best, set with a Honda-engined car. It should be pointed out that the track conditions of the UK and Australian events were not identical: it appears that the Australian circuit favoured the smaller engined car by virtue of being flatter with wider radius curves, but the fact remains that the Aussie effort was a most worthy one and their performance certainly poses an interesting question for the modeller . . .

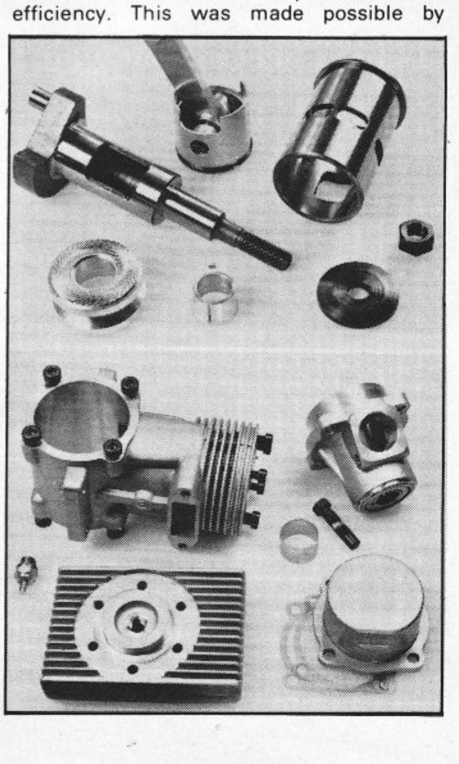
How on earth do you get an FS-60 to run on fresh air? Fresh air? Well, almost . . . How else can you describe a fuel consumption of less than *one ounce per hour*?

The first thing that has to be understood is that the O.E.C. team had designed a vehicle that needed an extremely low power output to keep it running at the required average speed of 25km/hr. The frame was constructed from steel tube and aluminium and the wheels were lightweight racing cycle wheels with high-pressure tyres and specially built hubs to cope with side loading in turns and to keep rolling resistance at a minimum. To reduce aerodynamic drag, the driver (who lay prone) and chassis, including the single driven rear wheel, were encased in a lightweight streamlined fibreglass shell and the two exposed front wheels had Mylar film discs to eliminate drag from the wheel spokes. The complete vehicle, ready to go, weighed a mere 23kg. To move this little lot and its 6½-stone girl driver, O.E.C. calculated that they would need only about one-tenth of the FS-60's rated peak bhp. Accordingly, the engine was detuned to run at a mere 1900rpm (less than a fifth of its normal peaking speed).

Petrol has a much higher calorific value than methanol and only produces less power because so much less of it can be burned for a given weight of air, but this, of course, is a big advantage where fuel consumption is so vitally important. Usually, petrol requires a lower compression ratio but, in the O.E.C. conversion of the O.S. FS-60, the compression ratio was actually raised — from approximately 9:1 in the standard engine, to no less than 15:1 — for improved thermal efficiency. This was made possible by



*Left: Optional extra for use with OS Max-61FSR-H is special helicopter type silencer. Although OS61 helicopter engine looks like a standard 61FSR with a heat sink head, it actually incorporates many other subtle modifications including special carb, and a different shaft with revised induction timing.*
*Right: Max-61FSR-H castings are to usual high OS standards. Working parts include 17mm shaft (with smaller shaft thread) and special ultra-hard-wearing low-friction cylinder plating.*



designing a completely new cylinder-head and, for their work on this, O.E.C. engineers had much experience to call upon from their development work on the Sarich orbital engine.

The actual combustion chamber shape (like that of one or two of the modified Hondas) follows the principles established by the Swiss engineer Michael May with his May 'Fireball' head design. This not only allows a higher compression ratio to be employed; it also permits considerably weaker fuel/air mixtures to be used. The effectiveness of the design has recently been convincingly demonstrated nearer home, incidentally, with the introduction of the new HE version of the Jaguar V-12 engine. This uses May heads, enabling the previous 9:1 and 10:1 compression ratios to be increased to a remarkable 12.5:1, at the same time permitting the use of a substantially leaner mixture which, in conjunction with higher overall gearing, improves fuel consumption by around 20 per cent with no loss of performance.

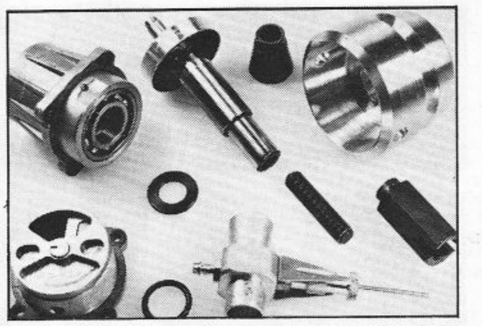
Apart from its special combustion chamber shape and high C/R, O.E.C.'s head for the O.S. FS-60 had water-cooling in addition to deep cooling fins. This was necessary because of the lack of a cooling airstream within the car body. Very necessary, not only because the engine was to run on petroluem fuel rather than alcohol, but also to time ignition more precisely, was the conversion from glow-plug to spark ignition. This took the form of a Lumenition electronic system timed optically from a slotted steel disc driven by the camshaft.

The Mileage Marathon rules make no concessions in regard to the use of 'petroil' mixtures: the lubricant content counts as fuel. The FS-60 was therefore run on straight petrol and lubrication was taken care of by using crankcase pressure fluctuations to circulate SAE-30 motor oil from a small reservoir. Other modifications included a special small venturi carburettor of O.E.C. design and a large steel flywheel to assist low-speed running.

One ounce of fuel per hour... Not since the pre-war American NAA contest rules limited free-flight power models to 1/16oz. of fuel per pound of model weight, have such modest quantities of fuel been contemplated... Now, how about a fuel consumption marathon for models?

## O.S. 61 Helicopter Engine Tested

The O.S. Max-61FSR-H is a special helicopter version of the standard ringed piston Max-61FSR. It has a similar power output but has been specially modified to emphasise those qualities that are of particular value for helicopter work. Apart from the most obvious external difference of a large rectangular 'heat sink' type head to aid heat dissipation in the typical chopper installation, it has a different crankshaft and front housing and the 61FSR's 5/16-24 UNF front end is replaced by a smaller 1/4-28 UNF shaft to facilitate adaption to standard helicopter drive assemblies. The shaft main journal remains at the large 17mm dia. of the

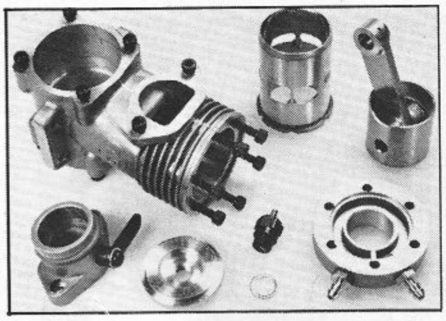


other O.S.61 shaft-valve motors, but has modified induction timing and a special Type 7B-H carburettor, exclusive to the 61 FSR-H, is used, both these mods being aimed at providing the reliable mid-range control and the rapid, predictable response that is desirable for safe helicopter operation.

Prop rpm tests, of course, have little relevance to helicopter engines and our test figures are therefore confined to the torque and bhp levels determined from our usual dynamometer tests. These indicated above average maximum torque and a gross output close to 1.7bhp on 5 per cent nitro fuel, to put the engine well up to expected levels for a modern 10cc high performance Schnuerle-scavenged aircraft engine.

Mere dynamometer tests cannot, of course, tell us how good an engine will be in a helicopter under actual flight conditions, but the tests did at least show that the Max 61FSR-H possessed a consistently steady and linear response to the throttle. These engines leave the factory with the carburettor adjustments set, approximately, for the best all-round performance, but the procedures for setting up the carb are fully covered in the comprehensive instruction leaflet issued with the engine. Adjusting an engine in a helicopter is not so simple as in a fixed-wing installation and many users feel happier if they can run-in the engine for a while on the bench and then check the throttle under different loads by using different prop sizes. The O.S. instruction leaflet suggests that this can be done by first fitting the 61FSR-H with a large (14-16 in. dia.) prop to find the full load needle-valve setting: the throttle is set wide open and the needle-valve adjusted on the rich side of the full power setting. To check the low-speed mixture, the prop is then changed to a 10×6 and, without touching the main needle (which would be too rich for full power under such a light load) the mixture control valve is adjusted to provide the best performance with the throttle in the idle position.

Unlike the standard Max-61FSR engine, the 'H' model is supplied without a silencer. The regular OS-744 silencer can be used. Alternatively, a rather expensive machined cylindrical expansion chamber of German origin is available. We ran tests with one of these and found that it cut the top end power output by nearly 20 per cent to 1.36bhp at 15,700rpm. We also checked the engine with a 3in. tailpipe added to this silencer. This had the effect of changing the course of the torque



*Above: K&B 7.5 top-end parts include two-piece watercooled head, generously ported liner and new heftier conrod. Above left: steel valve disc replaces aluminium rotor of earlier K&B 6.5 Marine. Shaft has tungsten counterweight. Flywheel is of aluminium.*

curve quite surprisingly: there was quite a marked drop in maximum torque, but an improvement at speeds above 13,000rpm, which pushed the peak bhp up to 1.43 at just over 16,000rpm.

The engine incorporates a number of features to make life easier for the operator. We found it easy to start and it ran smoothly and steadily.

As with all the up-market O.S. motors, a look inside the 61FSR-H reveals that it is finely engineered and admirably finished.

Further details of the engine will be found in the accompanying specification table.

## K & B 7.5 Marine

This high-performance American marine unit is a development of the K & B 6.5 Marine introduced in 1976. As its title suggests, it has a nominal capacity of 7.5cc, but no official bore and stroke figures are quoted in the literature accompanying the engine. However, a check on the bore and stroke measurements of two 7.5s (one an aircraft version) supplied by the UK distributor, Irvine Engines, gave figures of 0.872in. × 0.760in. when averaged and rounded to the nearest .001in. These indicate a swept volume of 0.454cu. in. or just under 7.44cc, while the full-stroke compression ratio works out at 12.4:1.

Outwardly, the 7.5 Marine differs very little from the 6.5 Marine but, as both bore and stroke are increased (the 6.5 is 0.840 × 0.720in.) most of its working components are new. There are also certain modifications (some also featured by the current version of the 6.5) that can be expected to contribute to durability as well as to performance.

In place of the aluminium rotor of the original 6.5, for example, a steel valve disc is used. It remains open for some 210 degrees of crank angle, timed, according to our measurements, from 35 deg. ABDC to 65 deg. ATDC. A heftier conrod, as befits a racing marine unit, machined frm 7075-T6 alloy, is used. It is bronze bushed at both ends and end float at the small end is controlled by aluminium spacers between it and the piston bosses. The piston, produced from a gravity die casting is, of course, ringless and runs in a chromed bore brass liner.

Scavenging follows the usual K&B

# O.S. Max-61FSR-H

### General data

**Type:** Single-cylinder, front rotary-valve, side-exhaust, Schnuerle-scavenged two-stroke with twin ball-bearing crankshaft.
**Bore and stroke:** 24 × 22 mm (0.9449 × 0.8661 in.)
**Stroke/bore ratio:** 0.917:1.
**Measured combustion chamber volume:** 0.94ml.
**Nominal compression ratio (full stroke):** 11.6:1.
**Swept volume:** 9.953cc (0.6073cu. in.).
**Exhaust period:** 146°.
**Transfer port period:** 120°.
**Third-port period:** 112°.
**Rotary valve opens:** 34° ABDC.
**Rotary valve closes:** 48° ATDC.
**Carburettor:** O.S. Type 7B-H adjustable automatic mixture control type with 8.8mm choke and 38sq. mm effective choke area. O.S. IFC needle-valve assembly available as optional extra.
**Silencer:** Extra. Choice of standard O.S.-744 or special O.S.-G222 helicopter silencer.
**Weights:** 547 grammes (19.3oz.) less silencer.
663 grammes (23.4oz.) with O.S.-G222 silencer.
**Required bearer spacing:** 42mm.

### Performance tests

**Power output, gross (less silencer):** 1.69bhp at 16,500rpm.
**Power output, net (with G222 silencer):** 1.36bhp at 15,700rpm.
**Torque, gross (less silencer):** 130oz. in. at 8,000rpm.
**Torque, net (with G222 silencer):** 115oz. in. at 8,000rpm.
**Equivalent gross b.m.e.p.:** 84lb/sq. in.
**Specific output, gross:** 170bhp/litre.
**Specific output, net:** 137bhp/litre.
**Power/weight ratio, gross:** 1.40bhp/lb.
**Power/weight ratio, net:** 0.93bhp/lb.
**Test conditions:** 5% nitromethane fuel; air temperature 12°C; pressure 760mmHg; relative humidity 68%.

*Continued on page 1041*