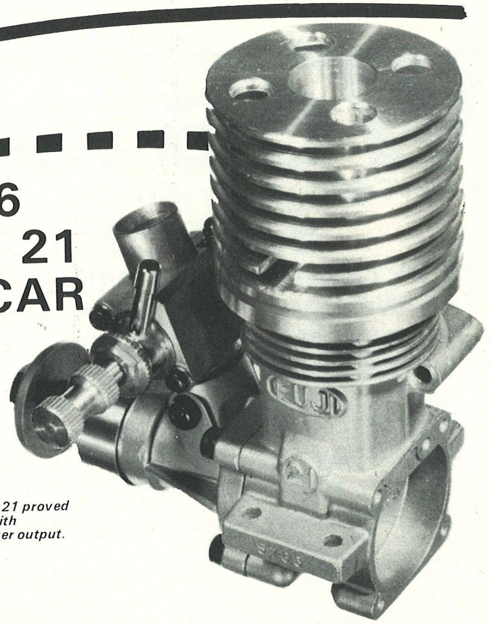
# ENGINE TEST

## No. 6 FUJI 21 SS CAR

by Mike Billinton



Right: the Fuji 21 proved to be robust with moderate power output.

REGULAR READERS of this magazine will know that Tests to date have been of a string of top performing 'Open' class 0.21cu. in. engines all designed to cope with maximum anticipated competition stresses. Of course there are still some top engines yet to be looked at, quite apart from the inevitable new uprated models which surely are to come. Planned future tests are of the *K & B, Enya, OPS* (Rear exhaust) and *HB* Car engines.

Meanwhile — providing some balance — it would be wise to come out of the clouds and consider for a change an engine which does not aim at such heights; but is nevertheless capable of fulfilling the needs of the 'sports' user, at an economic initial price together with appreciably lower running costs.

Several manufacturers provide such engines, the *Fuji* 21 being a typical example having a stated rpm range of a very restrained 2,500 to 18,500. This has to be compared with the much more extreme rpms being reached by some competition engines.

### Mechanicals

Produced in Tokyo by the *Fuji Bussan Company* as one of a range of medium to small capacity sports engines, the '21 Car' engine incorporates several features which distinguish it from many other car engines:

Front crankshaft housing is separate from crankcase, and is located therein by the rear main ball bearing.

Crankshaft has external spiral groove to prevent mixture loss.

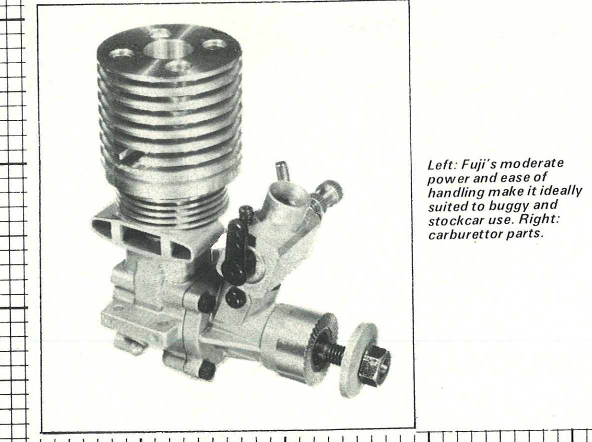
Schnuerle transfer and boost passages angled up to 40° are machined on the inner surface of cylinder liner (that's the *Fuji* I.B.S. system — **I**nner **B**ypass **S**chnuerle) and which does allow easy modifications to passage shape and alignment without the expense of new crankcase castings.

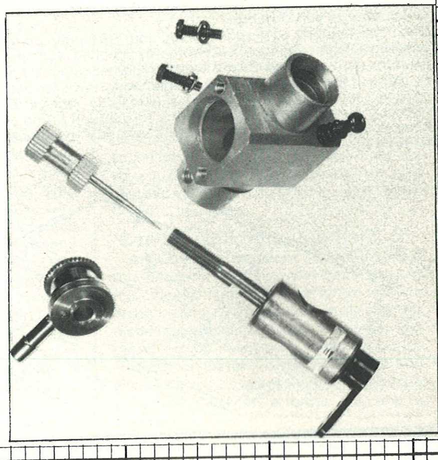
Brass liner is consequently thicker than average (at .10in.) and crankcase thus becomes a relatively simple casting.

Medium silicon piston has strong domed crown (.015in. high) which, when combined with the cylinder head's flat squish band, leads to unusual 'reverse' taper shape to the squish part of combustion chamber. (i.e. potentially, gas is squished towards liner rather than towards the plug, as is usual — but in practice this probably results in just a less swift and direct squishing process, though some remnants of gas probably remain entrapped at the outer extreme limits of the combustion chamber.

Compression ratio is unusually high at 10.9:1 effective (16.9:1 geometric) and this probably contributed to a less than vivid response to a 50% nitromethane fuel.

Transfer Port timings are very high (152°), leaving a small overlap only of 8° (which is half the norm for many top car engines.) The consequence is that the *Fuji* response to any tuned exhaust system is likely to be much reduced.





Left: Fuji's moderate power and ease of handling make it ideally suited to buggy and stockcar use. Right: carburettor parts.

### Power Tests

Although the *Fuji* 21 is aimed at the 'Sports' market where economy and ease of operation are paramount, it was even so decided to subject the test engine to the normal sequence of operations which impose a gradually more strenuous set of conditions as the test progresses. Pinpointing the upper limits of engine operation in this way enables one to define the correct and more sensible area of operation for the engine under review. However it also runs the risk of a heap of scrap metal at termination of test.

This same principle has underlined all the car engine tests to date in *'Model Cars'*.

**Test 1.** In standard open exhaust format, using the 8mm bore carburettor supplied by *Fuji*, 5% nitro, oil, a mix of 10% ML70 synthetic and 5% castor (following manufacturer's wishes). Glow plug was *OPS* standard Long Reach. Suction fuel feed was nominally the system used, but in practice a slight gravity head of fuel existed.

The standard ABC piston/liner fit was quite free from new, requiring only limited running-in to achieve steady torque and rpm figures. Maximum torque was found at 16,000rpm with maximum bhp at a high 27,000rpm; this latter reflecting the fact of a large throat area in the standard carburettor used. Actual values for power were modest only if compared with some top racing units recently tested (and which may not be a fair comparison). Of interest was that rpm were capable of reaching far beyond the manufacturer's claimed range — and with useful torque still available there.

**Test 2.** Equipment changes were now effected — car tuned pipe (at 9.75in. from end of convergent cone inside rear can to piston face) together with pipe pressure air line to pressurise fuel tank.

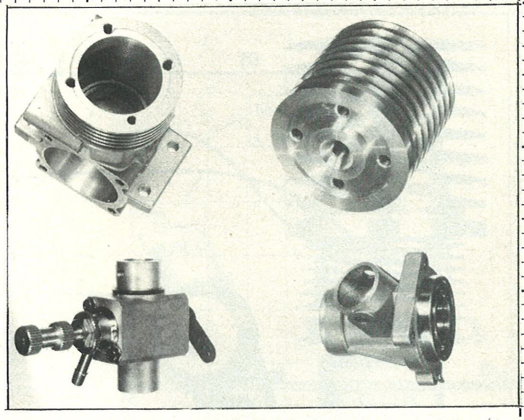
This particular 'change of equipment' followed the recent decision to opt for a new 'standard' to replace the much battered *AMPS* minipipe silencer. Provisionally this standard is to be the *OPS* 'Quiet Tuned Pipe' specificaly provided for 1/8th Scale Class car use. This pipe is obtainable from *OPS Distributors* and hopefully it will provide what's required for some time to come. In this rapidly developing area of performance improves though, it may be that the *OPS* pipe itself will become outmoded in the near future, and the 12% uplift in power which the *OPS* pipe was recently found to have over the *AMPS* minipipe (using *Picco* 3.5) will be seen as but another stage of pipe evolution.

As it happened these considerations had little meaning during this *Fuji* test because *it's* response to fitment of the *OPS* pipe was of a lower order. This is a characteristic of 2-stroke engines having restricted overlap between inlet and exhaust ports. (i.e. the return of the tuned pipe's 4th and last plugging positive acoustic wave before exhaust port closes on the up-stroke should ideally occur only when the inlet (transfer) port has already closed, otherwise this positive pulse can cause a reverse of flow in the transfer passage at certain rpm points which of course will disturb best conditions). Therefore small differences between transfer and exhaust timings (i.e. small overlaps) mean that this reverse flow can more easily occur, and thus place a restriction on possible power gains from the tuned-pipe system.

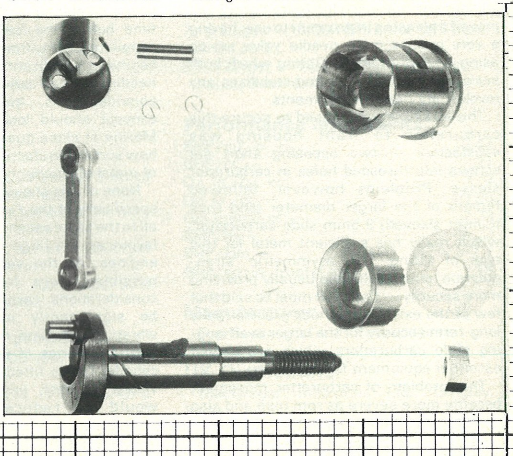
Maximum bhp was reached at 26,000rpm — the tuned pipe having added some 12% to power over open exhaust as compared with 25% increases given by engines having twice the timing overlap of the *Fuji*.

Again in this tuned pipe format rpms well exceeded the manufacturer's claimed range without sign of stress.

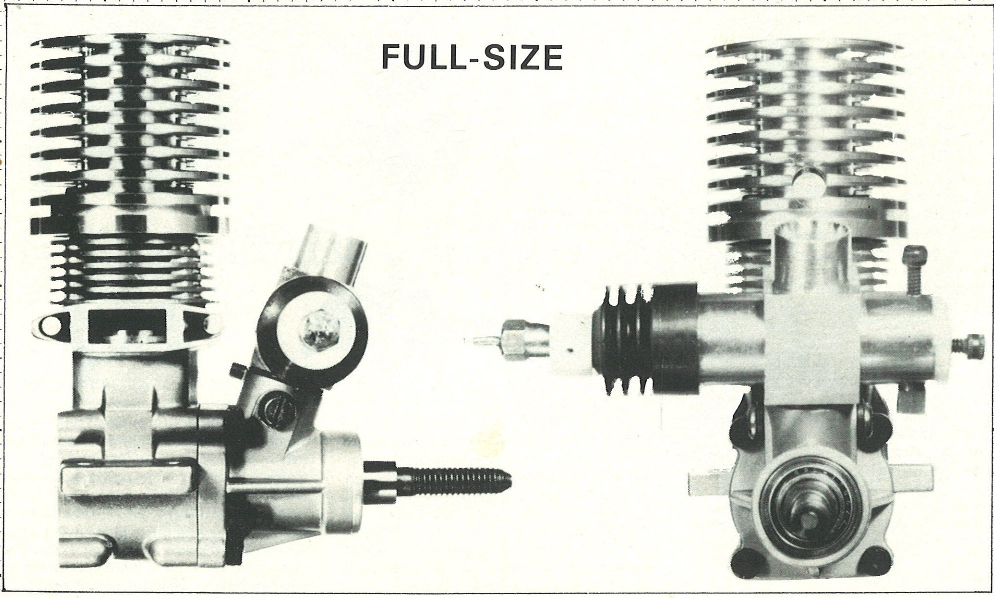
**Test 3.** Changing finally to the top power grouping of 50% nitro, 9.5mm slide carb., and with the *OPS* pipe, soon showed that the *Fuji* was likely to be an economical engine to run because the amount of uplift due to the increase of nitromethane was less than has been experienced with some other engines. Here it is felt the high compression ratio was the likely main cause — and that the engine is more suited to straight methanol fuel unless a C/Ratio



Right: non-moving parts of the Fuji 21 SS. Note the positionable fuel inlet nipple on the carburettor.



Right: reciprocating parts of the Fuji, the spiral groove on the crank helps prevent oil loss.




reduction is effected. This aspect has futher ramifications where tuned pipes are used because of the general principle that the supercharging effect of a tuned pipe can increase cylinder pressures to such an extent that reductions of compression ratio are often advisable. Suffice to say that the *Fuji* 21, not surprisingly, showed signs of distress under these triple pressures and so tests were terminated at just under 20,000rpm.

### Carburettor

The standard 8mm bore *Fuji* rotating barrel style, with tapered slot for mid-range adjustment, was used for Tests 1 and 2 and proved a pleasing instrument to use; having a very precise main needle valve set-up using a small internal 'O' ring which both seals against fuel loss and stabilises any involuntary needle movements.

The locking method used to secure this carburettor to front housing was satisfactory — two opposing short set screws into threaded holes in carburettor sleeve. Problems however, followed fitment of the larger diameter (and thus thinner sleeved) 9.5mm slide carburettor, which really has sufficient metal for this type of fitting. The asymmetric 'strangulation' pinch-bolt style usually providing more security — though it must be said that few of the existent methods provide really long-term security for the larger overhanging slide carburettors which are almost essential equipment for top racing.

This problem of carburettor movement became more severe as rpm rose and also contributed towards test termination at 20,000rpm.

### Car versus Aircraft engine

It is worth making the general point following this test that little seems to be gained from using what are essentially aero engines redefined in a car role, except that production schedules are simplified one imagines, and a flexibility of operational use is maintained. But following the clear lead given by the large engined marine racing classes where solidity and massiveness of construction is the sure-fire route to long life and high power combined, it can only be a matter of time before the 'car' engine is weaned completely away from its 'aero' origins and begins to significantly benefit through not needing to over-concern itself with weight considerations. Anyone doubting this concept should look at say, an *OPS90* Marine at close quarters, and realise just how some manufacturers view the problem of metal elasticity.

None of this should be taken as criticism specifically of the *Fuji* 21 — which is after all to the same essential mechanical design layout as the large majority of other car engines. At the very least, following a possible future freeing from weight considerations, carburettor security could be significantly improved, as would vibration reduction resultant in part from inertia loadings of the normal very high cylinder heads fitted to most car engines. Whilst at best, any crankcase flexures would be reduced thus improving considerably the lot of the already hard-worked reciprocating parts.

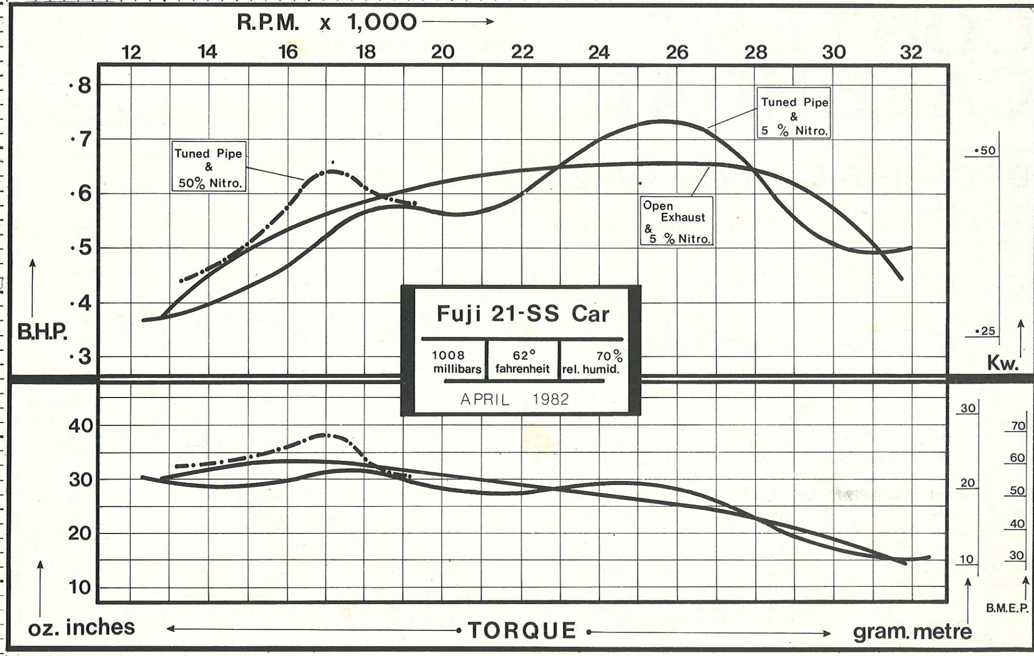
Lest this shades into an engine design feature article, it is right to acknowledge how remarkably well the modern car engine can operate (springing and flexing about though it may be!) at quite incredible rotational speeds. However, now is unlikely to be a time for design stagnation, apart from which engine attrition rates alone during top competition are bound to lead to significant material changes in the future.

### Summary

The *Fuji* 21's main down-to-earth virtues are likely to be economic, both because of low initial cost, and a preference for low (or no) nitro fuels. One could even save on tuned-pipe costs, although some gain in power was achieved particularly if set against likely power output from a standard back-pressure 'dustbin' silencer (not tested here). Equally there is virtue in using *Fuji*'s own carburettors supplied rather than (as is common) replacing it with a more expensive large bore slide carburettor; while glow-plug costs will also be reduced in tandem with the above aspects.

The internal moving parts (rod, piston, crank) proved strong and reliable and seemed capable of withstanding much higher duty than attained here. In all, a motor having distinctive features of its own, and whose main appeal should be to the 'sports' and off-road user.

It is well finished and constructed and within the restraints indicated here should give satisfactory and durable performance.




## FUJI 21SS CAR 2-STROKE ENGINE

### Dimensions and weights

Capacity — .213cu. in. (3.49cc)
Bore — .656in. (16.67mm)
Stroke — .631in. (16.02mm)
Stroke/bore ratio — .96/1
Timing periods —
- Exhaust 168°
- Transfer 152°
- Boost 148°
- Front induction —
  - Opens 43° ABDC
  - Closes 58° ATDC
  - Total 195°

Combustion volume — .22cc
Ex. port height — .236in.
Compression ratios —
- Geometric — 16.9/1
- Effective — 10.9/1

Cylinder head squish — .018in.
Squish band angle — 0°
Piston crown angle — 5°
Squish band width — .13in.
Carburettor bore — 8.0mm
Mainshaft diameter — .472in. (12mm)
Crankpin diameter — .176in. (4.47mm)
Gudgeon pin diameter — .1572in. (4mm)
Induction bore — .333in. (8.5mm)
Overall height — 3.7in.
Overall width — 1.73in.
Overall length — 2.43in.
Con rod centres — 28mm
Mounting holes 36mm × 15.5mm with 3mm holes.
Weight — 9½oz. (.27 kilo)
Frontal area — 4.7sq. in.

### Performance

Max. bhp — .73 at 26,000rpm (OPS tuned pipe/5% nitro and 8mm carb.)
.65 at 27,000rpm (open exhaust/5% nitro and 8mm carb.)
Max. torque — 33oz. in. at 16,000rpm (open exhaust/5% nitro)
38oz. in. at 17,300rpm (OPS pipe/50% nitro) (9.5mm slide carb.)

### RPM — standard propellers

7 × 4 Zinger — 22,300 (5% nitro/open exhaust/8mm carb.)
7 × 4 Zinger — 21,111 (5% nitro/OPS pipe/8mm carb.)
8 × 4 Zinger — 17,050 (5% nitro/open exhaust/8mm carb.)
7 × 6 Zinger — 16,820 (5% nitro/open exhaust/8mm carb.)
7 × 6 Zinger — 16,000 (5% nitro/OPS pipe/8mm carb.)
8 × 6 Zinger — 14,400 (5% nitro/open exhaust/8mm carb.)

### Performance equivalents

| | |
|---|---|
| BHP/cu. in. — | 3.42 |
| BHP/cc — | .21 |
| Oz. in./cu. in. — | 178 |
| Oz. in./cc — | 10.88 |
| Gm metre/cc — | 7.73 |
| BHP/lb — | 1.23 |
| BHP/kilo — | 2.7 |
| BHP/sq. in. frontal area — | .15 |

### Manufacturer

Fuji Bussan Co. Ltd., Tokyo, Japan.

### UK Distributors

MacGregor Industries Ltd., Langley, Berks.