ENGINE TEST

Brown Junior A-23: Mike Billinton puts this little gem under his microscope...

THE AMERICAN 'larger than life' philosophy is hardly a complete picture because, as just one example, the production of what is probably the world's smallest commercial model engine, shows their capacities at quite the other extreme. Seemingly almost *too* small to use - even Indoors - the Brown Junior 'Peanut Scale' CO_2 motor tested here must have been daunting in concept, let alone in its practical realisation.

At two grams weight, this incredibly miniscule reciprocating engine is easily lost amongst a few 4BA nuts and bolts...and when disassembled, items such as connecting-rod are almost indistinguishable from a typical modelling pin! All-up weight with the standard small 2.5cc CO_2 'fuel' tank is barely six grams (¼oz), making a viable prospect of the ½oz 'Dining room' model aircraft.

The speed control is the highly effective piston operated ball valve and adjustment to its duration of openings (by raising or lowering the whole cylinder) leads to the expected trade-off between power and duration of run - as shown on graph.

Mechanical details

Cylinder: Turned from mild steel-complete with finning and serrated upper edge to assist finger adjustments. Bore size is a nominal ⅛ inch and actually appears to be honed to final finish...not a nice task at such a small hole size. The lower end of the cylinder is threaded and then slotted to give a 'sprung' screw fit into the lower crankcase - thus providing the required freedom of movement for finger adjustment, without unwanted rotation during engine operation itself. The top end of the bore is also threaded to receive the aluminium alloy cylinder head, which incorporates the one-way ball valve and rubber seals. Thin aluminium tubing (.040in dia) takes the 700lb CO_2 pressure from filler valve to flight tank and from that tank to the top of the cylinder head. This tubing is even more fragile than the customary copper tubing found on CO_2 engines, and much care is needed to prevent kinking and fracture. The advised method of fixing a new length of tubing is by use of 'Instant' Cyanoacrylate adhesive to seal the aluminium tubing to both cylinder head, filler and tank cap. No doubt the adhesive will be easier to obtain than the tubing itself, so this reinforces the need for care, in handling the tubing which comes ready fitted to the engine.

Piston: Formed in plastic with a protusion on the crown to actuate the ball valve. The top edge is slightly expanded so that, when fitted into the bore, it acts much like a piston ring.

Connecting rod: Turned from aluminium alloy, with the shank being approximately .045in diameter. The ball-end plugs into a matching piston socket, to provide a fully rotating 'little-end' joint. The big-end is a drilled hole in the lower end of the connecting rod.

Crankshaft: A one-piece turning in mild steel, and features a counterweighted crankweb. The mainshaft is drilled right through, enabling lubricant to be injected into the base of the engine after the propeller bolt has been removed. The crank-pin is a minute .045in diameter (1.1mm), whilst the crank nose is splined to provide the required friction to the propeller driver.

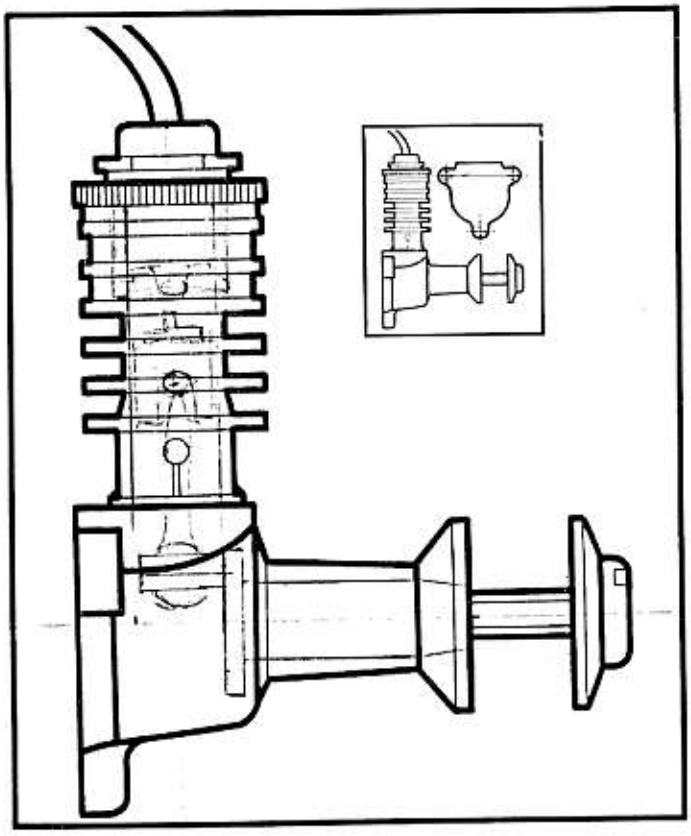
Right, several times larger than life this picture of the Campus A-23 displays the inherent simplicity of this type of engine. Simple in design it may be but at this diminutive size (less than one inch high) production is not so simple...

Crankcase: An aluminium alloy casting, subsequently bored out to accept the crankshaft and the screwed cylinder liner.

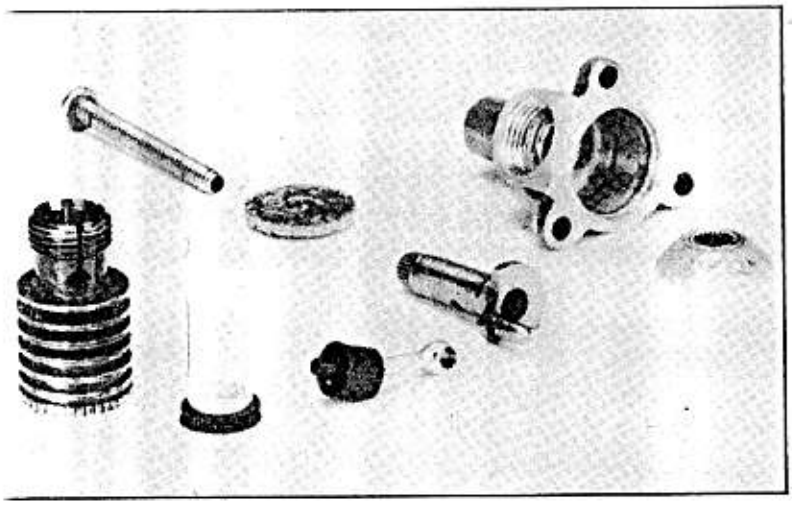
All these relatively mundane features take on new meaning when their very small size is fully appreciated! The piston and conrod can literally fit under a fingernail! Which is not surprising, as their combined weight is less than that of a standard small postage stamp!

Performance

The standard propeller provided with the Brown 'Peanut Scale' engine is a plastic



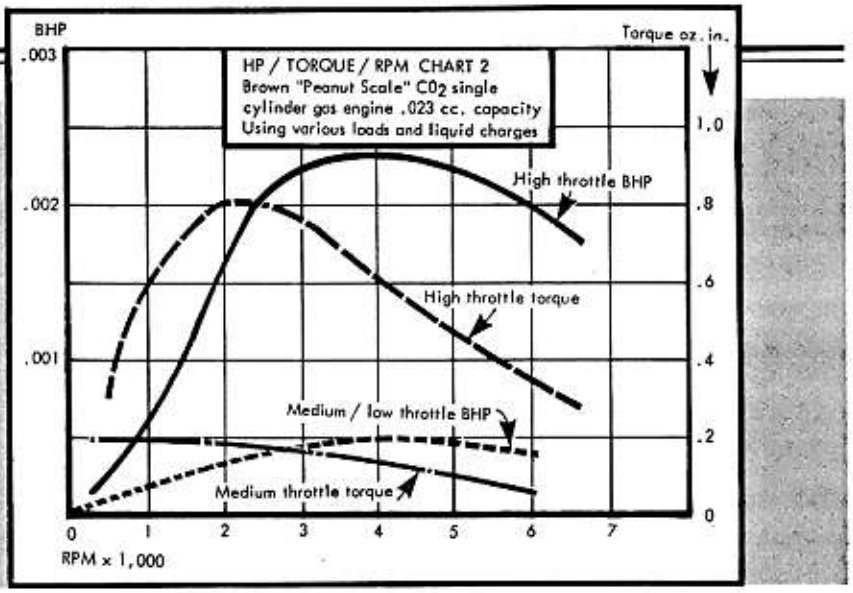
Right, as the full size drawing might have been overlooked we have included a 'four times' side view for longsighted readers. Below, all these parts could be hidden behind one (new) penny! The Campus A-23 is available in the U.K. from SAMS (see ad on p. 656).



4¼in diameter, by 4in pitch. It has generous area and an undercambered section - in fact is a quite high load/high lift device for such an incredibly small capacity unit. Therefore the rpm attained at high throttle openings are really quite creditable. The various torque readings during this test indicated that the propeller is well matched to medium/low throttle settings and which result in running times of between one and two minutes, at rpm around 2,000. However, achievement of longer durations demands either much lower rpm or a larger tank capacity. The use of larger propellers to force lower rpm is both a quicker and, of course, much lighter route to longer durations; ie those more akin to propellers used on the typical Indoor Rubber Scale model. Although no such propeller was to hand during this test, one of the test beams used to measure torque at high throttle/low rpm was certainly of a similar order, being constructed on 'air paddle' lines, ie 2in square paddles set one at either end of an 8in diameter narrow beam. This very high load kept rpm down to 330 at high throttle/liquid charge/and standard tank, in which set-up duration time was around 3½ minutes.

Alternatively, using the standard prop/large 20cc tank/liquid charge/low throttle, led to rpm around 1,000 and a duration of 30 minutes.

As can be surmised (and surely known by all experienced CO_2 operators) there are many combinations of load and throttle settings and resultant rpm which can be used, and of course a wide range of types of models and flight patterns to be achieved. At this stage of 'information gathering' therefore, this writer is uncertain which of the various modes of operation are of greater value during these dynamometer tests. There are some problems in obtaining meaningful torque readings during the rapidly changing power levels on high throttle/high rpm settings, and with this particular sized engine the actual torque being produced at the lowest throttle settings happened to reach down to the lowest possible scale reading of the electronic balance used on this small dynamometer (1 gram steps.) At all other throttle settings the dynamometer proved amply sensitive enough to react swiftly to the various torque levels.



After some 30 separate runs the engine performance began to decline, and it proved necessary to apply lubricating oil (SAE 5) to the running parts; after which the rpm immediately recovered. This and other points are covered in the helpful *Brown Junior* instruction leaflet.

Apart from an initial repair to one of the aluminium gas lines, all operations were trouble free, and the motor was unscathed at the termination of the tests.

Summary

In spite of its very small size, the Brown A-23 proved to be a fascinatingly practical power unit, evidencing no sign of problems resulting from its diminutive size and the manufacturer is surely to be commended for such an audacious subject. Lastly, it does not seem likely that a smaller unit will be made available - to this writer at least - and this is maybe just as well, for the sheer difficulty of seeing and locating such a small device can only become more of a problem with the passing years!

Brown Junior 'Campus A-23' Gas Engine

Dimensions & Weights:

Capacity	.00147 cu.in. (.0241 cc.)
Bore	.121in. (3.07mm.)
Stroke	.128 in. (3.25mm.)
Stroke/Bore ratio	1.06/1
Crankshaft dia.	.0984 in. (2.5mm. nominal)
Crankpin dia.	.0457 in. (1.16mm.)
Crank nose thread	.057 in. x 80 TPI (Amer. 0-80)
Connecting rod centres	.250 in. (6.35mm.)
Width	.44in. (11.2mm.)
Height	.90 in. (22.8mm.)
Length	.55 in. (14mm.)
Mounting holes	3 equispaced .060in. holes on ⅜in. P.C.D.
Frontal area	.21 sq. in.
Weight	2 grams (bare), 6 grams (with small tank and piping.)

Performance:

bhp: .0023 at 4,000 rpm (high throttle.)
.0005 at 4,000 rpm (medium/low throttle.)
torque: 8 oz. in. at 2,300 rpm (high throttle.)
.2 oz. in. at 1,000 rpm (medium/low throttle.)
rpm: 5½ x 3 nylon - 4,500 (high throttle.)
4½ x 4 nylon - 5,070 (high throttle.) & 2,000 (medium)
4½ x 2 nylon - 5830 (high throttle) & 2,700 (medium)
5½ x 6 nylon - 1,200 (medium)

Performance Equivalents:

bhp/cu. in.	- 1.56
bhp/cc.	- .095
oz.in./cu.in.	- 544
oz. in./cc.	- 33.2
bhp/lb.	- .174
bhp/kg	- .38
bhp/sq. in. frontal area	- .011

Manufacturer:

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USA.