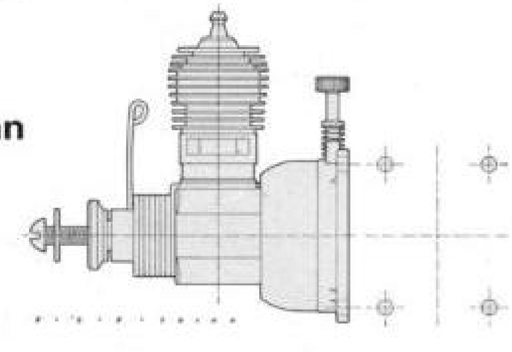
ENGINE TEST

by Peter Chinn



COX PEE-WEE ·020

FOR MANY YEARS the L. M. Cox Manufacturing Company Inc. of California have enjoyed the distinction of producing the world's smallest production model internal-combustion engine, namely the tiny 'Tee-Dee .010' which has a swept volume of less than one-hundredth of a cubic inch or 0.163cc.

The Cox 'Pee-Wee' model that is the subject of this month's report, has twice the displacement of the Tee-Dee .010, but is still a very small engine indeed. Complete with its integral fuel tank and starter spring, it weighs only 24 ½ grammes or less than seven-eighths of an ounce. The combined piston displacements of *thirty* Pee-Wees would still not quite equal the volume of one Merco 61. No other engine manufacturer is making engines as small as the Pee-Wee at the present time.

The Pee-Wee is not a new engine: it has been with us for a great deal longer than most, having first come on the market in *1957*. It has not changed very much in the intervening 18 years: in fact we found it necessary to make a side by side comparison of the current model with a 1957 model to discover just what had been changed.

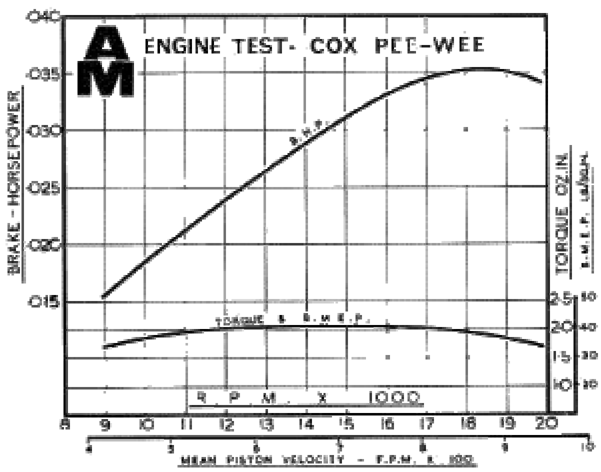
In common with other Cox engines, the Pee-Wee uses a machined, rather than cast, aluminium alloy crankcase. The shape of this has been slightly modified from that of the earlier Pee-Wee motors : the external shape of the crankcase nose, forming the plain unbushed crankshaft bearing, is now parallel instead of curved. The cylinder, too, has been slightly modified. It has thicker walls, larger diameter lower fins and slightly narrower exhaust ports.

Another alteration is the provision of a wire gauze filter screen over the air intake which is located in the centre of the fuel tank backplate. The engine is of the reed valve type and the tank and induction unit is similar to. but on a smaller scale than, that of the 0.8cc Cox 'Black Widow' engine featured in the August 1974 AM Engine Test article.

The rear induction unit is an exclusively Cox design that combines the crankcase back cover with reed-valve housing, fuel tank, and induction tube, and the radial mount backplate with needle-valve, in a self-contained assembly that attaches to the crankcase with four screws. The needle-valve is actually installed in the top of the tank backplate and the fuel/air mixture is conveyed through the centre of the tank via the induction tube that is an integral part of the bell-shaped aluminium fuel tank. Mixture then enters the crankcase through the reed-valve housing which projects into the rear of the crankcase. The thin beryllium-copper reed valve is X-shaped and is retained by a wire circlip.

The engine's top-end design is basically the same as that which has distinguished all Cox engines for the past twenty-five years and uses a one-piece machined steel cylinder that screws into the crankcase and is surmounted by a screw-in combined glowplug/cylinder-head unit. The piston has a hardened skirt and is permanently attached to a hardened steel connecting-rod through a ball-and-socket joint. The cylinder has two diametrically-opposed internal flute type transfer passages and two rectangular exhaust ports. The bottom edges of the latter are below the bottom of the piston skirt at the top of the stroke and thereby allow a short period of sub-piston supplementary air induction into the crankcase.

Those who wish to use a side-mounted or inverted installation, can do so very simply by withdrawing the four backplate screws and rotating the engine on its tank unit through 90 or 180 degrees. This leaves the tank filler and vent tubes (also needle-valve) conveniently located at the top.



Performance

Cox engines have always been among the better made products of the model industry and particular attention is given to precision finishing of the vital working parts, such as the piston, cylinder and bearing surfaces. Because of this, the Pee-Wee does not suffer the problems that have beset some other very small displacement motors, where poor fitting and consequent mechanical deficiencies and inadequate gas sealing have resulted in starting troubles and indifferent performance. It also means that the required running-in time is negligible.

The Pee-Wee, despite its small size, is quite easy to start and requires no special knack or technique, other than to ensure that one does not flood its tiny combustion chamber with too liberal a prime. No prime is necessary for restarting the engine when it is warm.

Like other Cox reed-valve engines, the Pee-Wee is equipped with a spring starting device. This consists simply of a coil spring mounted on the crankcase nose. The free end of the spring is shaped so that it can be drawn forward and hooked around one prop blade but will spring back out of the way when the engine starts.

The Pee-Wee can be started by merely flicking the prop but the spring, instead of merely bumping the engine over compression, really does spin it rapidly and this has two advantages. First, the engine is more likely to start promptly and, second, it is unlikely to reverse its rotation and run in the opposite direction. Kicking back on starting and running the wrong way is not entirely unknown with some rotary-valve engines, but it is a very common complaint with reed-valve motors since the induction timing is not fixed and a reed valve motor is quite happy to run in either direction. Using the starter will almost invariably prevent this from happening. Even if you are an 'expert', therefore, there's no need to feel a 'loss of face' in resorting to the starter spring.

The range of available commercial props suitable for the Pee-Wee is very small indeed but, happily, Cox's own 4 1/2in dia. 2in pitch prop, supplied for use with the Pee-Wee, is well matched to the engine's power curve. On test, our Pee-Wee, running on 25 per cent nitromethane fuel, delivered its peak power output at approximately 18,500 rpm. The Cox 4 1/2 x 2 was turned at 17,400 rpm, which suggests that the Pee-Wee will quickly accelerate up to its peak or slightly higher in flight. We also tried the engine on an old 4 1/2 x 2 1/2 Cox prop (which it turned at 13,700 rpm), on a 4 1/2 x 3 Top Flite wood (14,800), a 4½ x 4 Cox (11,100) and a 5 x 3 Tornado nylon (10,900 rpm).

Very small displacement glow plug engines do not usually take happily to being loaded with too large a prop and although the Pee-Wee pulled remarkably well on some of the bigger sizes, there would certainly be no point in attempting to prop the engine for less than 11,000 rpm. If the user wishes to exploit the engine's full power output, it is probably best to aim for a static rpm of not less than 15,000 to 16,000 rpm - the lower figure for coarse pitches and the upper figure for fine pitches.

When one gets down to an engine of such tiny dimensions as the Pee-Wee (where a couple of fingers, side by side, will hide it from view) things are apt to become rather a fiddle, so we are happy to report that adjusting the needle-valve was not at all critical. The engine slowed either side of the optimum setting, instead of cutting out abruptly if adjusted too 'lean', so it was quite easy to arrive at the required adjustment.

The Pee-Wee came through our test procedures completely unscathed and the glowhead element also survived.

Power/Weight ratio (as tested): 0.65 bhp/lb.
Specific Output (as tested): 107 bhp/litre.

SPECIFICATION

Type: Single cylinder, air-cooled, glowplug-ignition two-stroke with reed-valve induction. Plain bearings. Spring starting device, Integral fuel tank.
Bore: 0.300 in.
Stroke: 0.282 in.
Swept Volume: 0.01993 cu. in. - 0.3266cc.
Stroke/Bore Ratio: 0.94:1.
Checked Weights: 24.5 grammes - 0.86oz. (with starter spring)
23.0 grammes - 0.81 oz. (less starter spring).

GENERAL STRUCTURAL DATA

Crankcase' and main bearing unit machined from extruded aluminium alloy bar. Hardened and ground steel *crankshaft* with machined-in crescent counterbalance, 0.161 in. o.d. divided main journal and 0 .080in. die. crankpin. Shaft end knurled for pressed-on machined aluminium alloy *prop driver* and tapped for prop retaining screw. One-piece machined steel *cylinder* with Integral fins and blued external finish. Steel *piston,* case-hardened on skirt surface only and fitted to ball-ended hardened steel *connecting-rod.* Screw-in aluminium alloy *glowhead* with platinum alloy ignition coil and seating on .002 in, soft copper gasket. *Crankcase back-plate, reed-valve housing, induction pipe and fuel tank* machined in one piece from aluminium alloy. *Reed valve* of .001 in. copper-beryllium shim. Pressure diecast zinc alloy *fuel tank backplate.* Complete tank and induction assembly secured to crankcase with four screws. *Starter spring* of .034 in. dia. spring steel wire.

TEST CONDITIONS

Running time prior to test: Approx. 10 minutes.
Fuel used: 25 per cent nitromethane, 25 percent Newton R castor oil, 50 per cent methanol.
Air Temperature: 23°C (74 F).
Barometer: 1016mb (30 .00in. Hg.).
Silencer used: None.