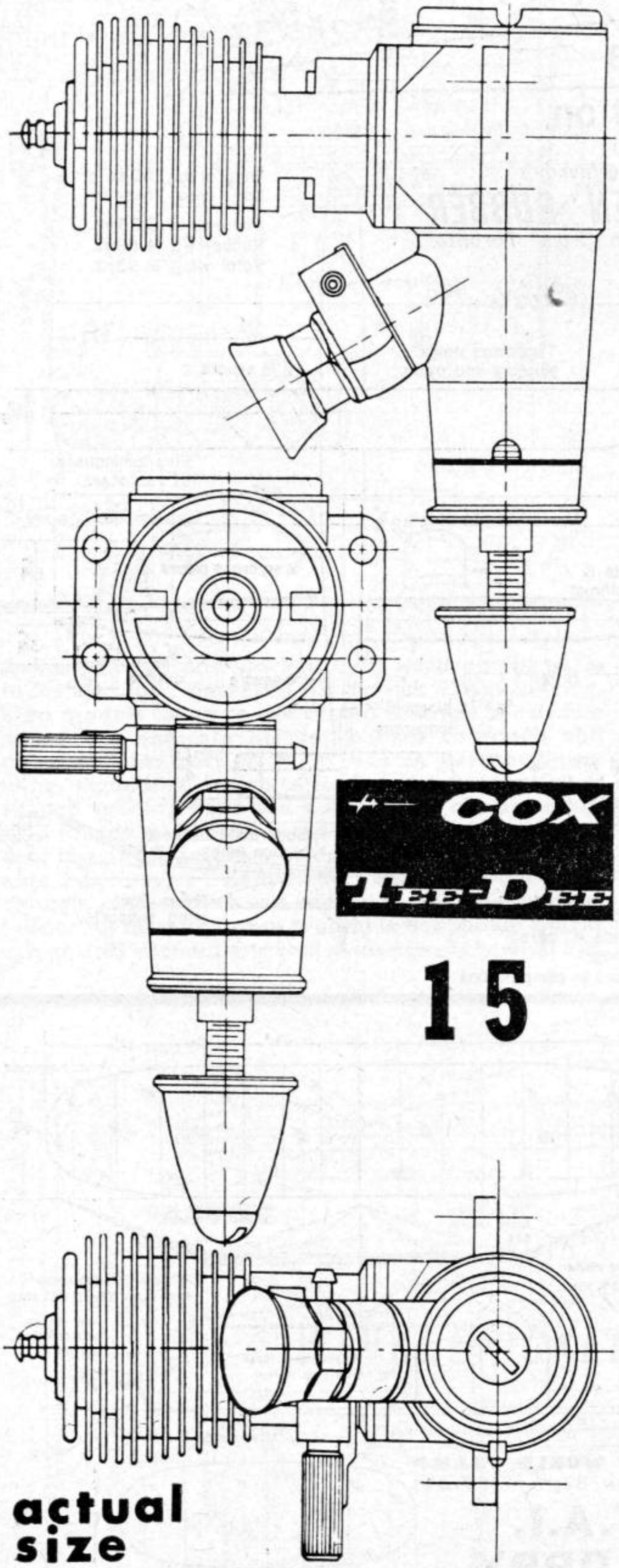
ENGINE ANALYSIS

No 91

by R. Warring

COX TEE-DEE 15



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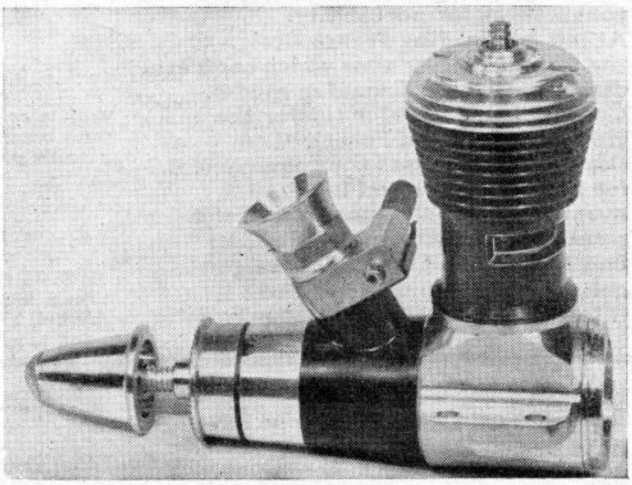
BASICALLY SIMILAR IN geometry throughout to the Cox .010 described in October, 1961 report—all the Cox Tee-Dee series are virtually scaled to an identical design—the Tee-Dee 15 gives a truly remarkable performance which quite outstrips that of any other plain bearing engine, diesel or glow, of similar size. In many respects the Tee Dee 15—and thus the whole Tee Dee range—is a development of the original Cox "Olympic".

The bottom end is, of course, entirely re-designed around the Cox version of conventional shaft induction instead of reed valve. The bearing is plain, honed to finish, and carries a very hard, very large diameter shaft ($\frac{7}{16}$ in. o/d). The shaft is stepped to give a long rear journal and a short front journal, ground to finish over the journals and the crankpin. A rectangular port .290in. wide and $\frac{7}{16}$ in. long is cut in the shaft (finished with perfectly vertical edges, not just milled in by one operation) and exactly matches a corresponding port in the crankcase unit. The crankcase is then surmounted by a hard nylon type plastic injection moulding, which seats on a taper and also locates positively radially. A screwed-on collar then holds this moulding in place and the intake tube and carburettor assembly screws into the moulding to complete the induction system in most efficient manner.

The shaft itself steps down to a stub $\frac{1}{4}$ in. diameter length immediately in front of the bearing, which is splined to carry the propeller driver (machined from light alloy and anodised gold). The propeller shaft consists of a .161in. diameter steel screw, screwing into the shaft, carrying on the front a turned dural spinner in lieu of a washer.



As with all Cox engines, virtually all parts are turned from solid bar stock (with the exception of the plastic moulding) on automatic machines capable of working to very high accuracy, high surface finish, and with piston and cylinder units produced under controlled conditions for absolute accuracy of the order of millionths of an inch. As a consequence, there is no case of "selective fitting" when assembling. Tolerances held are such that all parts fit and the order of fits obtained is probably considerably higher than those developed manually. For the same reason, Cox engines need little or no running-in and although the test Tee-Dee 15 was given about an hour's running before taking any final readings, there was no change in performance.

The Tee-Dee 15 is essentially high revving, demanding a relatively small size of propeller. Peak r.p.m. on static test we found to be between 17,000 and 18,000 r.p.m., depending on fuel used. Running was consistent and strong at even higher speeds, indicative of more than adequate porting and correct timing. Induction is between approximately 55 degrees after b.d.c. to a little over 40 degrees after t.d.c. and gas flow is no doubt assisted by the "reservoir" space formed by the plastic housing, leaving a sort of accumulator chamber above the actual port. With pressure feed, fuel can literally pour into the intake throat at high speed running so that virtually liquid fuel is sucked in when the port opens. The needle valve control under such conditions becomes extremely non-sensitive and needs a considerable amount of adjustment to arrive at optimum settings. One gets the impression that the more fuel that is poured in, the higher the speed for a given load, but such speeds are not held consistently without careful adjustment.

Although we found the Tee-Dee 15 very easy to handle, starting characteristics on smaller propellers are definitely not as good as in the case of other Tee-Dee engines. The compression ratio is so high that it is rather like starting an over-compressed diesel. A good strong flick is required and then more often than not, the engine starts backwards and continues to run backwards at a moderate speed. As a point of interest, when running backwards it is often possible to be leaning out the needle to produce a backfire, when the engine immediately runs in the *right* direction—and provided the needle can be opened again quickly enough, will continue to run the right way. We also found it possible to produce "right way" starts by flicking gently *backwards* initially. The best answer with 7in. diameter propellers or smaller, seems to be finger choke until the fuel line is full, prime through the exhaust and then flick smartly. Exhaust priming is also most effective for starting.

Propeller R.P.M. Figures

Nitro Methane Content		0 Frog Redglow*	15% Record Nitrex	20% Castor 25% Methanol 55%	50% Castor 25% Methanol 50%
Top Flite	7 x 6	15,100	15,200	15,400	17,000
	8 x 4	15,000	15,000	15,200	16,800
	8 x 6	12,000	12,000	12,500	—
	9 x 4	12,000	12,000	12,400	—
	10 x 3½	10,200	10,200	10,200	—
K-K	7 x 4	17,000	17,000	17,800	18,800
(nylon)	7 x 6	14,300	14,400	14,500	15,700
	8 x 4	15,000	15,000	15,200	16,300
Frog	7 x 4	16,500	16,600	17,000	18,400
(nylon)	8 x 4	14,500	14,800	15,000	15,800
Trucut	7 x 4	17,800	17,800	18,000	18,900
	8 x 4	15,500	16,000	16,000	—

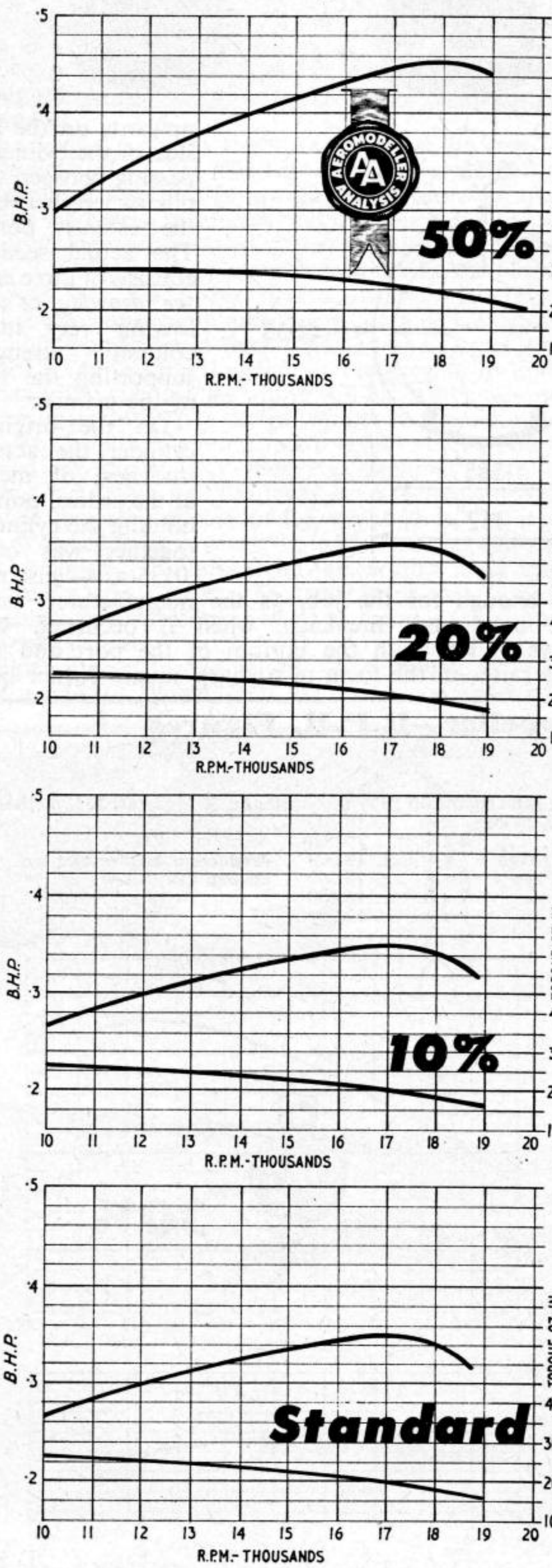
* Although Frog Redglow contains no nitro methane, it is not a true "straight" fuel since it contains a small proportion of other ignition additives.

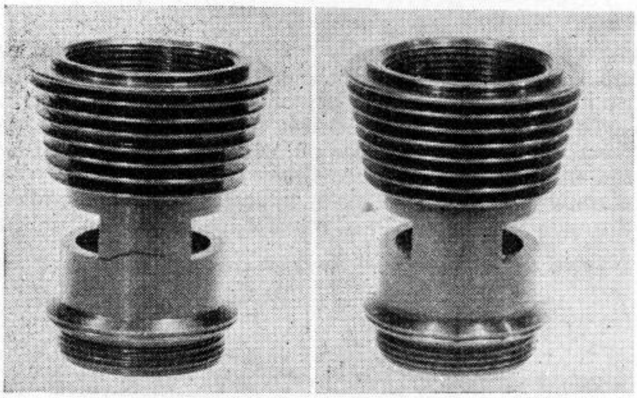
Performance we found to be excellent on straight fuel (with non-nitro additives—*see* PROPELLER—R.P.M. figures), yielding a peak B.H.P. of around .35 at 17,000. We could not improve on this figure over a period of a number of runs on different days, although undoubtedly higher figures have been obtained with individual engines. Nor did we find any appreciable difference in performance using 10 per cent. and 20 per cent. nitro methane in the basic fuel—only a very slight gain in the latter case and virtually no difference with 10 per cent. On stepping up the nitro methane content to 50 per cent., however, there was a very appreciable gain throughout the whole power range explored, realising a peak B.H.P. of .455 at 18,000.

The particular difficulty using a high-nitro fuel (50 per cent.) is that it is extremely destructive to the glow element. We burnt out six heads, making some ten separate runs on 50 per cent. nitro fuel. Further, the original cylinder was not strong enough to take these fuels. The problem of whether or not to continue "high nitro" testing was finally solved, when the cylinder cracked at the bottom of the exhaust ports on a 20,000 r.p.m. run (with destruction of yet another element).

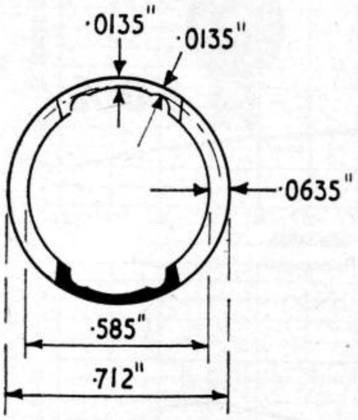
This was a pure structural fault—just not enough metal holding the cylinder on, subsequently rectified by the manufacturers. The cylinder is of soft steel with diametrically opposed rectangular exhaust ports milled through the walls. Two transfer passages are milled

First test engine b h p curves below





Crack on first test engine, and new type thick cylinder, at left. All Cox TD's will have thicker barrels in future.



upwards on the inside of the cylinder, passing between the pillars left between the exhaust ports. The actual section consists of three arcs *see drawing at left* leaving very little column strength supporting the top of the cylinder.

On the original cylinder the actual thickness of metal at the critical points holding the cylinder together was only .0135in. — just not man enough for the job, as the manufacturers have since confirmed. Breakage, when it occurred, was always in line with the bottom of the port and the stress raiser in the form of a sharp square corner here has been relieved by putting in a radius (nominally .025in.). At the same time, wall thickness of the cylinder has been *increased* by .010in., making the thin part measure .0235in. instead of .0135in., after the cylinder has been bored and honed. *Having received a new cylinder for examination, we are convinced that no further breakage of this type should occur.*

The use of nitro methane in the fuel is definitely beneficial. Although we found little or no improvement in power performance, using up to 10 per cent. nitro, and only a small gain with 15 per cent. nitro, adjustment is less critical. With 20 per cent, nitro and higher nitro mixtures, there is a definite gain, almost directly proportional to nitro content. Unfortunately, the original engine was wrecked before intermediate fuels between 20 and 50 per cent. could be investigated. A subsequent replacement again employed the original thin cylinder which, not being the current standard, we did not feel justified in exposing to similar "high nitro" strains. Propeller r.p.m. figures were virtually identical to our original test data on low nitro fuels, but definitely "up" on 30 per cent. nitro used as a practical maximum and with castor content reduced to 20 per cent. No 30 per cent. nitro figures were available on the original engine for the direct comparison and so a separate B.H.P. graph is shown *below left* for the second engine.

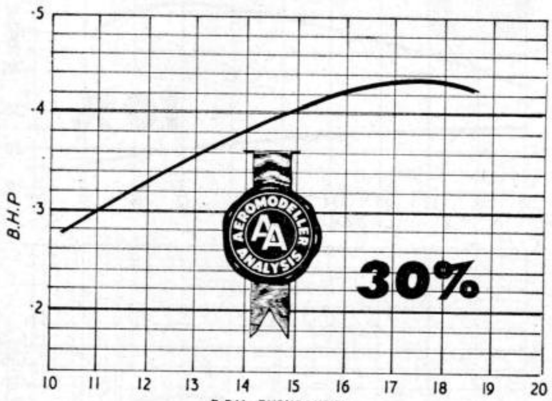
We rate the Cox Tee-Dee .15 as an outstanding production which should achieve considerable prominence in the contest field—as well as making an equally good sports motor, for it was quite happy turning at 10in. x 3½in. propeller at 10,000 rp.m. plus. Pressurisation is not necessary but may be advisable for contest work where the engine is being operated at peak r.p.m. and tends to require a more critical needle setting for consistent performance. A pressure tap point is provided on the plastic housing (intake moulding)

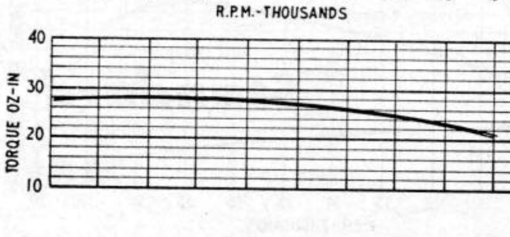
Propeller—R.P.M. Figures

Second test engine on 30% nitro methane, 20% castor, 50% methanol:

K-K nylon	7 x 4	... 18,300
	8 x 4	... 16,000
Frog nylon	7 x 4	... 18,000
Top Flite	8 x 4	... 16,200
	7 x 6	... 16,400
	9 x 4	... 12,900

Production engine test on advised fuel, below:





Specification

Displacement: 2.449 c.c. (.1494 cu. in.)
Bore: .58465in.
Stroke: .556in.
Bore/Stroke ratio: 1.05.
Bare weight: 4 ounces.
Max. power: .35 B.H.P. at 17,200 r.p.m. on straight fuel } *Original test engine*
.455 B.H.P. at 18,000 r.p.m. on 50% nitro methane }
.44 B.H.P. at 17,000 r.p.m. on 30% nitro methane—*production model.*
Max. torque: 27 ounce-inches at 10,000 r.p.m. on straight fuel } *Original test engine*
30 ounce-inches at 10-12,000 r.p.m. on 50% nitro methane }
Power rating: .143 B.H.P. per c.c. on straight fuel.
.18 B.H.P. per c.c. on 30% nitro methane (*original production model*).
.186 B.H.P. per c.c. on 50% nitro methane *(production model)*.
Power/weight ratio: .088 B.H.P. per ounce on straight fuel.
.11 B.H.P. per ounce on 30% nitro methane *(original production model)*.
.114 B.H.P. per ounce on 50% nitro methane *(production model)*.

Material Specifications:

Crankcase: machine from light alloy bar stock.
Intake housing: injection moulded plastic.
Cylinder: mild steel (integral fins).
Cylinder head: turned from light alloy (integral glow element).
Back cover: machined from solid.
Crankshaft: hardened steel $\frac{7}{16}$in. diameter.
Connecting rods: hardened steel (machined). Ball and socket little end.
Piston: hardened steel (hardened on walls only), flat top.
Propeller shaft: .161in. N.S.F. steel screw and spinner (turned from light alloy).
Venturi intake: machined from light alloy.
Carburettor collar: light alloy (anodised gold).
Needle: steel (spring ratchet).
Propeller driver: machined from light alloy (anodised gold).
Manufacturers: L. M. Cox Manufacturing Co., Box 476, Santa Ana, California, U.S.A.
U.S. Retail Price: $12.98. Price in G.B. 124s. 0d.
British importers: A. A. Hales Ltd., Potters Bar, Middlesex.