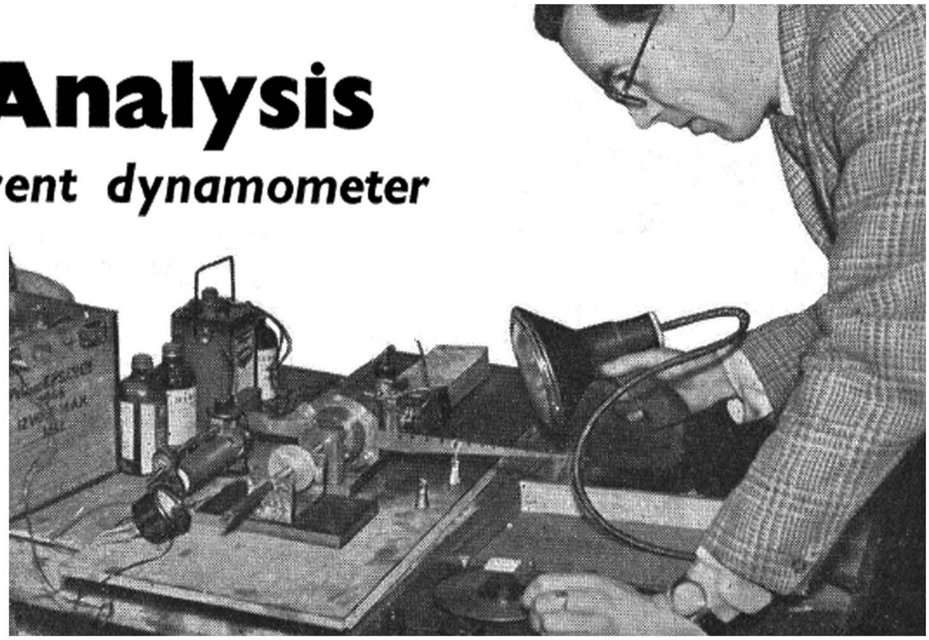
FIRST

Engine Analysis

by the eddy-current dynamometer



The

K & B

Torpedo "15"

TESTED BY R. H. WARRING

THE K & B "15" has excited considerable interest in this country, largely on account of its spectacular performance at the World Championships at Cranfield last August which was, virtually, its world debut. The American power model team were supplied with a stock of "15's" to use in their models, with the gratifying results (to the United States) now well known.

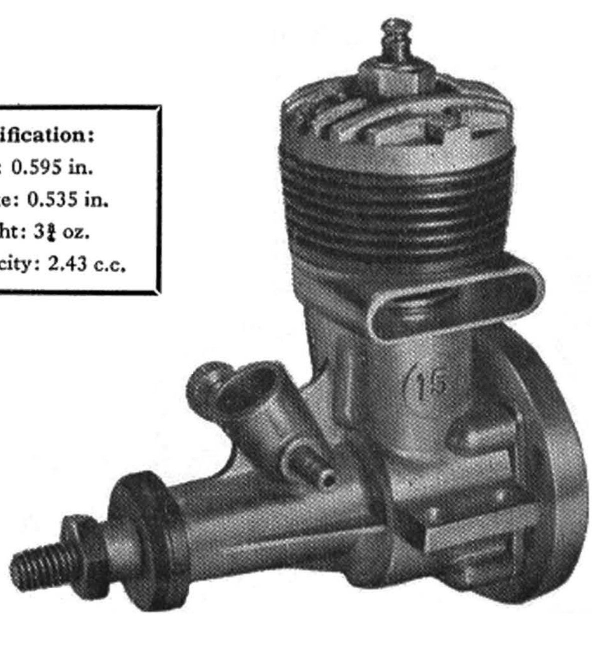
Like the majority of American contest engines (and the majority of all U.S. engine production, in fact), the "15" has glow plug ignition, is light and compact for its size—and beautifully made. The engines used by the American team were actually a batch of pre-production models, essentially similar in every detail except for the fact that the present production "15's" have a green enamelled head. The test engine was one of the "team" engines, well run in and ready for "full speed" operation. It is essential, the makers note, that any new "15" be run-in carefully for a minimum of 45 to 60 minutes with a rich mixture. Piston and cylinder are assembled with such a close fit that high speed running in the initial stages may lead to seizure.

The test engine was, at one period, given an extended run at a speed of around 16,000 r.p.m with no ill effects whatsoever. Cylinder and piston temperatures reached must have been higher than anything likely to occur during normal operation and were, indeed, enough to fuse the cylinder head gasket into a permanent seal. This gasket, and the gasket between cylinder and crankcase unit, is of a plastic type.

With the dynamometer available for use, testing is divided into two stages. First the engine is test run on a normal propeller, and mounted as on a model. It was a significant reminder of how compact American motors are that the "15" exactly fitted bearers on the test bench which had previously been used to mount an E.D. 1.46 engine for running in. Hand starting with a propeller then enabled starting technique to be checked, together with response to controls and general running characteristics.

Summarising these impressions. Starting is quite easy, provided the engine is not over flooded. Direct injection through the exhaust to prime was best, although if the plug was made too wet, a fair amount of flipping was necessary to clear. Response to needle valve control was non-critical. The "15" could be started with the needle valve wide open, closing down to the best running position at leisure. Also noteworthy was the remarkable freedom from vibration at all speeds.

Specification:
Bore: 0.595 in.
Stroke: 0.535 in.
Weight: 3¾ oz.
Capacity: 2.43 c.c.



High-speed consistency

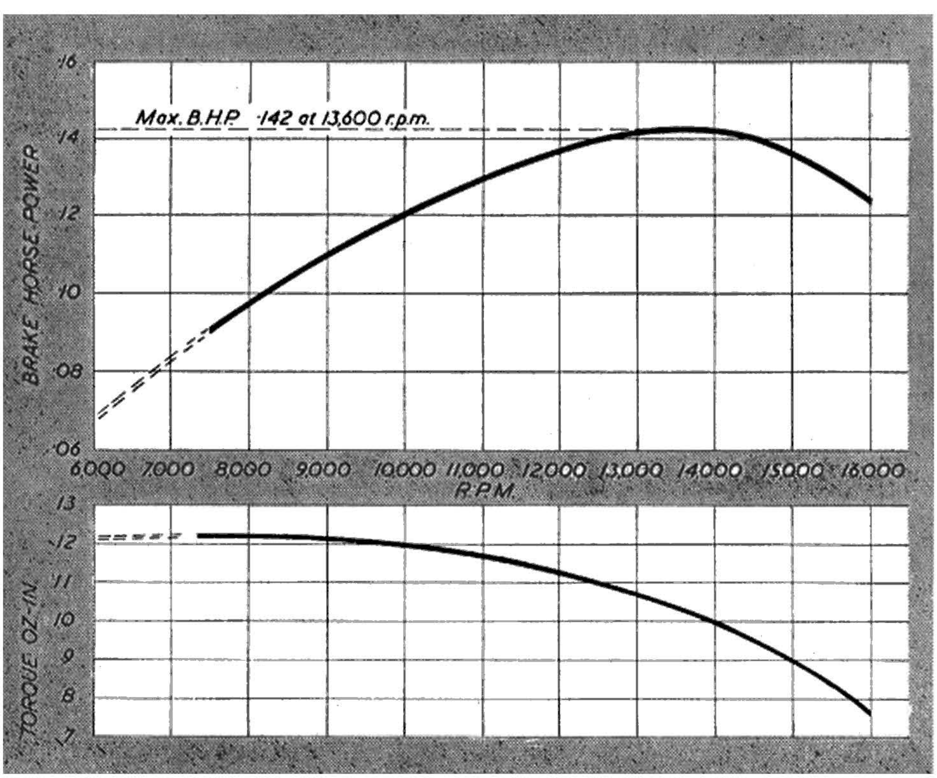
Several different sizes of propellers were tried. The "15" is not at all happy on a large "diesel size" propeller, nor on a propeller with a high pitch. It seems reluctant to pick up speed with a large fan load, with a result that the efficiency of its induction suffers and it becomes harder to get running. Using an 8 × 6 propeller, speed is brought into the "acceptable" range (over 10,000 r.p.m.), starting is easier and running more consistent. The "15" did not run at all consistently on larger props., *i.e.*, at slower speeds. This was subsequently borne out in the dynamometer tests where, despite the smoothing action of the rotor, really steady r.p.m. figures were not maintained until speed exceeded about 11,000 r.p.m.

The next stage in testing consisted of coupling the K & B "15" to the dynamometer and checking torque developed under varying braking loads. In mounting the engine it was apparent that the shaft was fractionally out of alignment with the true longitudinal axis of the engine—possibly not more than a fraction of a degree, but sufficient to be detected. It is unlikely that this affected perform ance in any way and was undoubtedly an inherent fault of the otherwise apparently fautless construction.

On a continuous run, torque was measured at a range of speeds starting from 7,400 up to 16,000 r.p.m. being recorded at any one stage by a stroboscope, and corresponding shaft torque generated measured by a weight on the balance arm attached to the dynamometer casing. It proved particularly easy to hold any one speed and make torque readings at leisure: and also to be able to make a number of individual readings at different stages from 7,400 to 16,000 r.p.m. without having to stop the engine. Readings going "up" were compared with readings coming "down" the r.p.m. scale and were virtually identical. Several separate runs were also made so as to plot final readings as the average recorded on different test runs. Plotted, these joined up into a particularly smooth torque curve, approaching one half of the initial (low speed) torque at the extreme end of the speed range. Carrying the test through to such high r.p.m. figures, too, established the peak of the brake horse power curve, when subsequently plotted.

Best operating r.p.m.

The torque curve is of the type one would expect from an efficient engine, giving a smooth B.H.P. curve with a moderately rounded peak. These figures should be studied together with the recommendation that the engine is most consistent in running at above 12,000 r.p.m. In other words the K & B "15" is best used with light loads (*i.e.* small propellers) when the engine is operating at around peak power. Good power is still available lower down the r.p.m. scale, but in practice the "15' would probably tend to "hunt" and not give anything like the performance indicated by the B.H.P curve, since this latter corresponds to spot readings and not to average readings with that particular load taken over a period of time. In practical language, the K & B "15" might well give a very disappointing performance with a large diameter or high pitch propeller. It is one of those engines that is best operated "flat out."



Its high speed performance is particularly noisy, but pleasantly unlaboured. It seems much happier than a diesel running at the same speed. No doubt much of this is due to the light construction of the piston and the adequately balanced crankshaft. Several good measures have been taken to reduce the weight of the reciprocating parts, such as locating the gudgeon pin above the centre line of the piston (thus enabling lower wall thickness to be reduced) and the use of a polished, drop forged aluminium connecting rod. Also interesting is the oil hole in the big end passing lubricant to the big end bearing an important factor for continuous high speed running.

Design follows orthodox K & B practice with opposed by-pass and exhaust (in contrast to the modern tendency to employ 360 degree exhaust porting on all small engines). The by-pass is of very large area and with a nicely smoothed surface. Considerable attention has obviously been given to internal gas flow for ports are generously filleted and "clean." The air intake is also large in diameter retaining also a large effective diameter since the spraybar crossing it is relatively slender. Suction is perhaps not all that could be desired for starting when using a tank located remote from the engine and possibly experiments with various shaped plugs in the intake might produce interesting results, particularly on control line models.

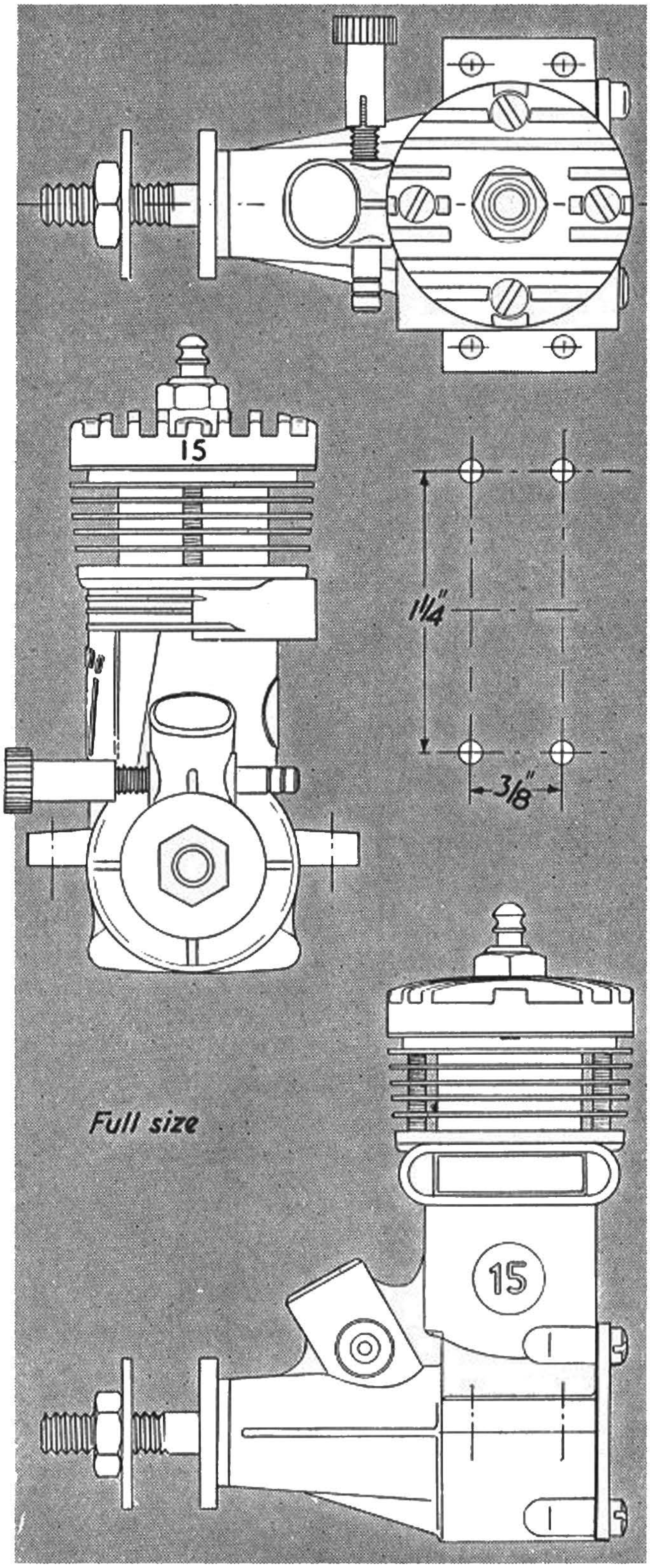
Constructionally one of the outstanding features is the large ($\frac{5}{16}$ in.) diameter crankshaft made from heat treated steel with a crescent-shaped counterweight machined into the web. The surface contacting the bearing is ground to an exceptionally fine finish and hardened.

The propeller backplate fits up against a very sharp taper on the portion of the crankshaft which emerges from the crankcase bearing and, despite its plain design, holds remarkably well. A serrated surface would have been better for gripping the propeller. In fact, to get the backplate to grip the coupling unit used it was necessary to saw-cut the backplate to roughen it. The crankshaft, incidentally, is a beautiful fit in the plain crankshaft bearing which is exactly one inch in length. Thrust loading is taken by a projection of this bearing behind the crankcase front and, assembled, there is a minimum of fore and aft play.

The piston is of hardened steel. The opposed porting arrangement necessitates the use of a baffle on the top of the piston which is well radiused and accommodated in the countoured head at top dead centre position. The piston is actually slightly relieved or "wasted" thus reducing contact area and any tendency to rock. The top $\frac{1}{4}$ inch of the piston is substantially parallel. Tolerances adopted for piston-cylinder fit are very close.

The main crankcase casting, and the head, are of light alloy. The cylinder itself is steel. Two retaining screws extending from the head down through the fins and into the crankcase hold the cylinder down, and also hold down the head, whilst two shorter screws secure the head to the cylinder. The standard short reach K & B plug screws into the centre of the head.

Altogether an extremely well made high speed engine, easy to operate and quite flexible on control. All tests were conducted on Mercury No. 5 fuel which appeared quite satisfactory. Lacking actual data on its flight performance on various types of models we would suggest essentially an engine for free flight power duration and possibly control line speed. One or two examples have been tried in Class A team racers: but using the high pitch airscrews essential to fuel economy, the results have not compared favourably with performance of diesels in current use.



Rev. Check with free flight airscrews:—

ENGINE "A" (Run-in for 45 mins., as per makers advice.)	9 in. × 4 in. KK Truflo . . . 9,200 rpm. 9 in. × 3 in. Tornado Plasticote as advised in U.S.A. . . . 10,600 rpm.
ENGINE "B" (Run-in and subsequently used for several hours—the test engine.)	9 in. × 4 in. KK Truflo . . . 10,400 rpm. 9 in. × 3 in. Tornado Plasticote as advised in U.S.A. . . . 12,200 rpm.

H.E