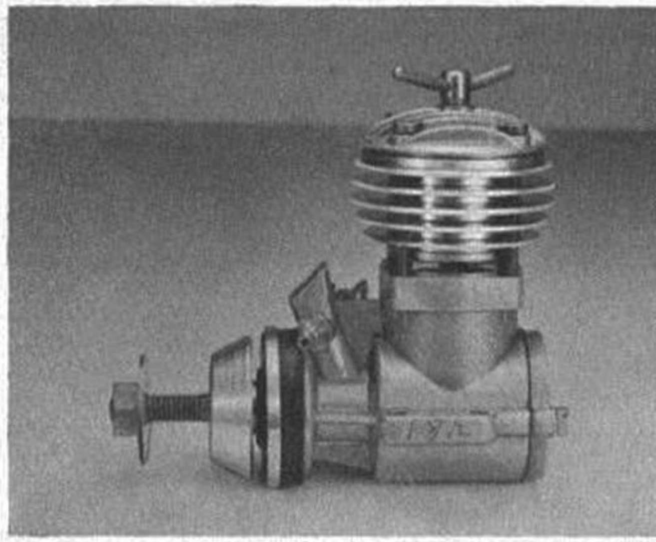
Engine Tests

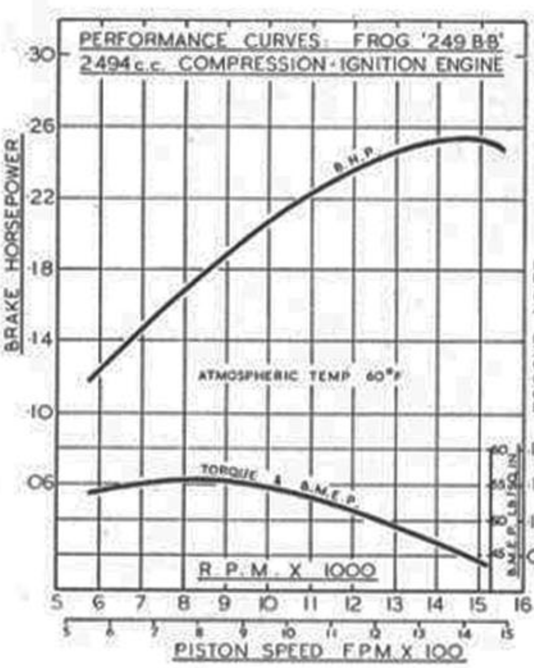
No. 81. The Frog 249 B.B.



FOR some time it has been known that the International Model Aircraft model engine division of Messrs. Lines Bros. Ltd., under the direction of Mr. George Fletcher, have been working on two new diesels to replace existing models in their range. The first of these, the 249 B.B. model, is now in production and was available on the home market from the middle of December. The initial production batches have already been sent to Australia, where Frog engines have always enjoyed good sales, and the new model should, therefore, be available simultaneously in both countries.

Nowadays, model engines from different manufacturers are somewhat prone to follow stereotyped patterns of design and, from a brief description: "shaft-valve, radial-port, beam-mount diesel," we might be forgiven for supposing that the new Frog would be just another engine to a familiar layout. On first sight of the new Frog, however, one is pleasantly surprised to note some originality in its external appearance and this favourable impression is maintained on further examination and test of the motor.

Externally, there is very little to identify the 249 B.B. with any previous Frog engine or, for that matter, with any unit of any other make. The cylinder barrel is noticeably larger than normal, with very deep cooling fins. A second obvious and most unusual feature is the rectangular shaped intake. Thirdly, the front end of the engine is of quite unique appearance by reason of a synthetic rubber oil seal which covers the entire front bearing housing and is retained by a brass ring.



This latter feature is an excellent idea and is one which might be adopted more generally on ball bearing type engines, offering, as it does, protection against damage by virtually eliminating the possibility of any dirt entering the bearing.

Other features of the engine are the forward positioning of the mounting lugs to reduce overhang, the inclined needle valve assembly and the tapered airscrew drive collet.

Internally, the 249 B.B. shows marked departures from previous Frog practice and, in this respect, differs from the Frog 250 model, which it replaces, just as much as in appearance. The cylinder liner employs four radial exhaust ports of relatively moderate area. Between them and steeply inclined to speed the gas flow to the combustion chamber are four circular transfer ports. The liner is flanged at the exhaust belt and fits into a shallow annular seating in the top of the crankcase, thus leaving a 360-deg. transfer passage between the outer wall on the liner and the inner wall of the crankcase. This arrangement is similar to that used in one or two specialised racing diesels and is a layout which lends itself to a certain amount of modification and tuning for extra high performance.

The crankshaft is of a counterbalanced pattern and, of course, is supported in two ball journal bearings. Noteworthy is the extra robust connecting rod and generous diameter crankpin and gudgeon pin. The short-skirted piston has a bevelled crown to which the contra piston is suitably matched.

Specification

Type: Single-cylinder, air-cooled, reverse-flow scavenged two-stroke cycle, compression-ignition. Shaft type rotary valve induction, with sub-piston supplementary air induction.

Swept Volume: 2.494 c.c. (0.152 cu. in.).

Bore: 0.581 in. Stroke: 0.574 in.

Stroke/Bore Ratio: 0.988 : 1.

Weight: 5.8 oz.

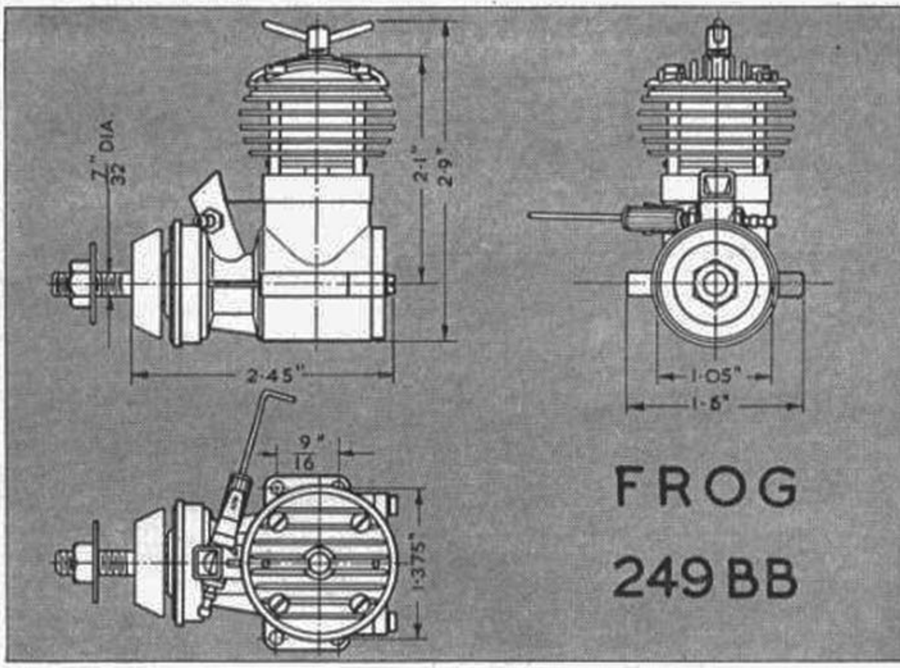
General Structural Data

Pressure-diecast LAC.112A alloy crankcase with integral main bearing housing and mounting lugs. Three per cent. nickel-steel counterbalanced crankshaft, hardened, ground and heat-treated and running in two ball journal bearings. Front bearing enclosed by synthetic rubber oil seal. Cylinder of close-grain mild steel, hardened, ground and honed. Piston and contra piston of Brico cast iron. Connecting-rod forged from R.R.56 alloy. Full-floating gudgeon-pin of silver steel. Machined aluminium alloy finned cylinder barrel, sliding fit over liner. Diecast aluminium alloy cylinder head. Entire cylinder assembly secured to crankcase with four long machine screws. Beam type mounting lugs. Spraybar needle-valve assembly.

Test Engine Data

Running time prior to test: 2 hours.

Fuel used: 40 per cent. technical ether BSS.579, 30 per cent. Shell Royal Standard kerosene, 30 per cent. Duckham's racing castor oil, plus 2-4 per cent. amyl-nitrate.



Performance

The Frog 249 B.B. is quite the most well-mannered diesel that we have encountered for a long time. Starting is exceptional. Without actually making a time check, we had the engine started within a matter of seconds. This required no priming: we merely choked the intake for three or four flicks and, after two or three more flicks to get the feel of the required compression setting, we had the engine running steadily.

The unusual appearance of the 249 B.B. is matched by some unusual operating characteristics. Even on small propellers allowing speeds of 15,000 r.p.m., it remains quite docile and has no tendency to snap around and "bite" the fingers like most other diesels. It is more like a glow-plug engine in this respect. The engine is also remarkably smooth running. We picked up a brief vibratory period in the region of 9,100 r.p.m., but this was not severe and at all other normal operating speeds, the 249 B.B. is smoother than most other diesels of similar size. At twice this vibration frequency (i.e. about 18,000 r.p.m.) the effects are apt to be somewhat more severe and, from information since obtained from the makers, we would suggest that such very high speeds are best avoided. The 249 B.B. has actually been run up to 23,000 r.p.m. but, in any case, such speeds are well outside normal operational requirements.

The engine delivered its best torque at about 8,500 r.p.m., where the equivalent b.m.e.p. reached was over 55 lb./sq. in., a very good figure. The decline in torque was more gradual than is usual, with the result that the maximum output was reached at relatively high speed—almost 15,000 r.p.m. This figure may, at first sight, appear improbable having regard to the relatively modest exhaust port area: it is made possible by an exceptionally long exhaust period (over 170 deg. of crank-angle as compared with a normal maximum of 140 deg.) and the efficient transfer porting. The actual b.h.p. recorded was fractionally under 0.26, an above average figure which is some 60 per cent. better than the M.A. test figure for the previous 250 Frog model.

Control response was entirely satisfactory. The needle valve is positive and the angled control stem is effective in preventing minced fingers. The contra piston fit was good and there was no tendency for the contra piston to seize when hot, yet, at the same time, there was a negligible leakage of oil into the head.

For operation at moderate speeds, the engine will run satisfactorily on various proprietary fuels, but, at five figure speeds, the deficiencies of most commercial blends become increasingly evident as higher speeds are aimed at. The 249 B.B. definitely requires a quite heavily nitrated fuel and at least 3 per cent., but preferably 4 per cent., of amyl-nitrate is required in the fuel for speeds approaching the peak of the power curve. Merely increasing compression is no longer effective at these speeds.

To sum up, this is a worthy addition to the 2.5 c.c. ranks, which is unusually successful in combining pleasant handling characteristics with high performance. It should prove popular.

Power/Weight Ratio: 0.71 b.h.p./lb.
Specific Output: 102 b.h.p./litre.

Engine Materials—5

Hard Brass. The hardness of cold rolled brass sheet, strip and shim stock is classified according to the amount of working (i.e., thickness reduction) it has received during rolling. Thus, grading may range from quarter-hard (soft) brass to half-hard, hard and extra-hard. Spring brass is obtained by still further reduction in thickness.

Meehanite. A cast-iron which has been "innoculated" with calcium silicide, while in the molten state, immediately prior to casting. This produces a fine graphitic structure and a material of improved mechanical properties. It is widely used in model engines for pistons and cylinders.

Molybdenum. Molybdenum is sometimes used in alloy steels employed for model engine crankshafts, etc., e.g. nickel-chromium-molybdenum steel. Such steels have good fatigue resistance and hard wearing properties. Similarly, molybdenum-iron cylinder liners are to be found on some racing engines (e.g. Dooling 61) the molybdenum in this case serving to increase strength and resistance to heat.

Nickel Steels and Nickel-Chromium Steels. These alloy steels, with or without the further addition of molybdenum, tungsten vanadium, etc., are widely employed in model engine construction for crankshafts and, to a lesser extent, for cylinders and cylinder-liners. Such steels are tough and hard, offering resistance to shock with good wearing properties.

Nitralloy Steel. Nitralloy steel may be used for cylinders and cylinder liners (e.g. Mills engines) and is the term applied to alloy steels which are surface hardened by impregnation with nitrogen, the process being known as nitriding.

Phosphor-Bronze. Phosphor-bronze is frequently used for main bearings, connecting-rod bushings, etc., where hard wearing properties are required. Phosphor-bronzes of this type are alloys of tin and copper with up to 1.5 per cent. phosphorus.

Platinum-Iridium. Platinum-iridium alloy is employed for the wire filaments on the majority of glowplugs. Iridium, avery hard metal, is employed to strengthen the soft platinum.