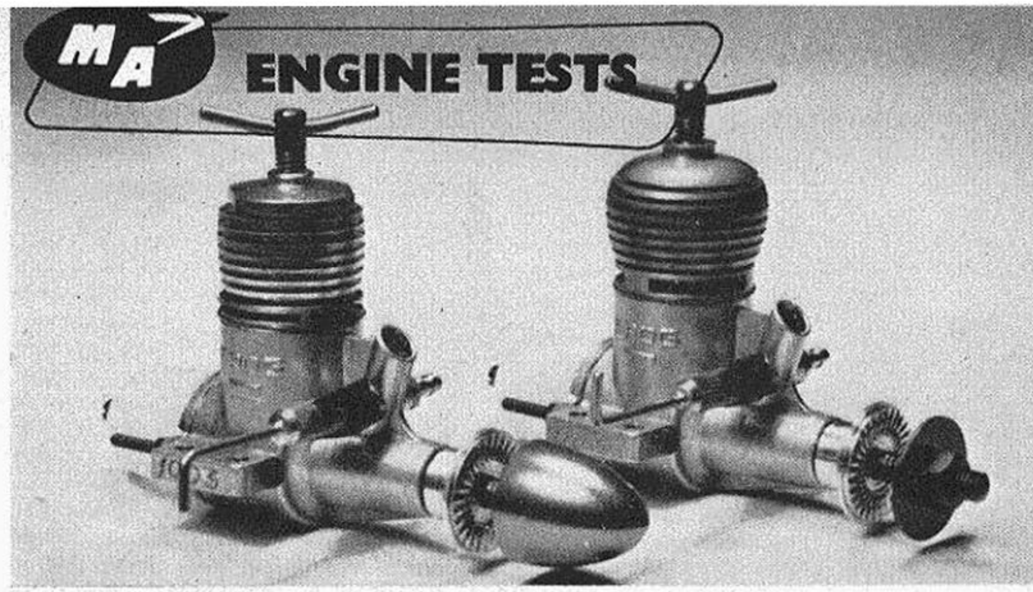


A special double test of two new Frog motors

the 100 Mk. II & 150 Mk. II R

". . . rate these two new British engines highly in the 1-1½ c.c. group on a performance-quality-price basis"

IN announcing their new Type "R" version of the well-known Frog 150, International Model Aircraft Ltd. advertise that it has an output of "over 100 b.h.p./litre." Our test report reveals a maximum output of 0.152 b.h.p., a specific output of nearly 103 b.h.p./litre, so this claim would appear to be well justified.

The new Frog 100 Mk. II, which appears on the market simultaneously with the 150R, is another unit of above average performance in its capacity group. The test of this model resulted in a maximum exceeding 0.11 b.h.p. at the exceptionally high peaking speed of 16,000 r.p.m.

Our dynamometer tests were on single examples only; obtained slightly in advance of release date in order that this report could be prepared to coincide with the engines' appearance in the model shops. Past experience has shown, however, that Frog motors are relatively consistent as regards developed output and it seems reasonable to assume that average production examples will, in fact, follow the performance characteristics of our test samples fairly closely.

Both these new Frogs are a development of the Frog 150 Mk. II engine which followed the original 150-D introduced in 1951 and from which, too, the 149 "Vibramatic" model stemmed a little over two years ago. The 150R and 100 Mk. II retain the 150's shaft type induction system and both are superior in specific output to the 149.

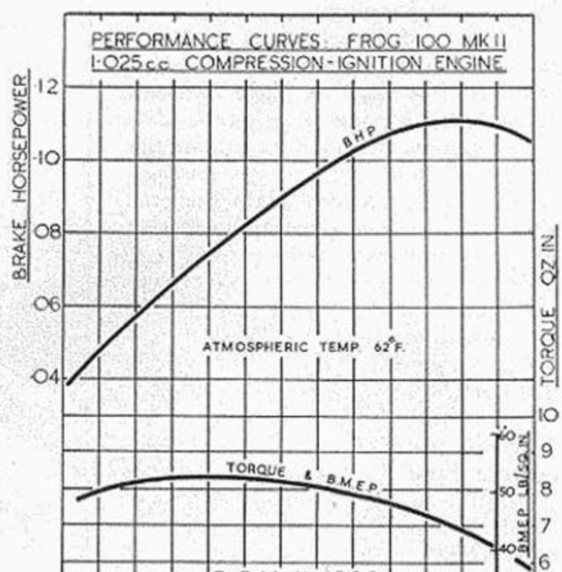
Frog "100" Mark II

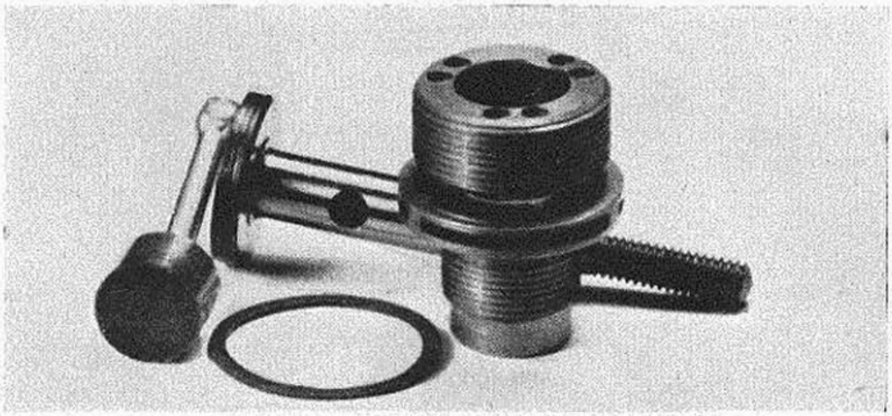
The original 1 c.c. Frog "100" was one of the very earliest British mass-produced model diesels and first appeared in 1946-7, a simple design based, essentially, on the Frog 175 petrol engine which was I.M.A.'s first model internal combustion motor. Later, in the summer of 1948, it appeared in a "Series II" version, with modified cylinder design. Only in name is the new Frog 100 similar to the old model, however.

As we have said, the 100 Mk. II is based on components of the 150. To reduce the swept volume, by nearly 50 per cent., to its present figure, while leaving the existing crankcase and crankshaft intact, required reducing the bore by 0.084 in. thus increasing the minimum thickness of the lower part of the cylinder wall from approximately 1/10 in. to approximately 9/64 in. As a consequence of this very thick wall, the opportunity was taken to try a new and unusual type of multiple transfer passage.

In this, the transfer passages do not take the form, usual with screw-in cylinders, of internal or external grooves or flutes. Instead, the passages are actually drilled vertically through the wall, parallel to the cylinder axis, between the inner bore surface and the outer, threaded surface. These passages, 3/32 in. dia. and of which there are six, arranged in pairs at 120 degree intervals, discharge into a wide, annular chamber, gas being admitted to the cylinder via three wide radial ports.

Although the external cylinder dimensions are much the same as for the 149 and 150, no attempt has been made to utilise a thick cylinder wall at the upper and hottest part of the cylinder, the external diameter of the liner being substantially





The novel transfer porting of the "100" is clearly shown in this photo.

reduced to provide a minimum wall thickness, above and below the threads, of less than 1/32 in. One therefore assumes that experiments in this connection revealed no advantage in using a thick cylinder on the 100 Mk. II.

A word of advice concerning the cylinder liner may be appropriate here. It is probably best to avoid dismantling the liner from the crankcase, but, if this must be done, the utmost care should be exercised in removal, subsequent handling and replacement, as the top part of the cylinder, from the flange upwards, is connected to the heavy, lower, threaded portion by only three very thin vertical bars between the transfer ports. The tensile strength of these is no doubt quite sufficient to cope with the normal loads imposed by combustion, or even with careless operational handling, but it would seem desirable to avoid any action that may load these in shear, such as excessive tightening.

The rest of the engine is much the same as the 150 model and, in some respects, the 149. A plain disc-web crankshaft, having a 9/32 in. diameter journal, with a 5/32 in. circular valve port and 5/32 in. gas passage, runs in a Vandervell plain bearing. The rotary valve gives an induction period of approximately 155 degrees, opening 40 degrees after b.d.c., and is supplemented by a substantial sub-piston air induction period.

Externally, the engine is readily distinguished by a new gold-anodised alloy cylinder barrel and a blue anodised spinner nut. Like other current Frog diesels, it is well made of hard wearing materials and is of neatly finished appearance with well-produced castings, tumbled to a pleasing satin finish.

Specification

Type: Single-cylinder, air-cooled, reverse-flow scavenged two-stroke cycle, compression ignition. Crankshaft type rotary valve induction with supplementary sub-piston air induction. Radial exhaust and transfer porting with flat top piston.

Bore: 0.416 in. Stroke: 0.460 in. Stroke/Bore Ratio: 1.106/1.

Swept Volume: 0.0625 cu. in. (1.025 c.c.).

Weight: 3.3 oz. including tank.

General Structural Data

Pressure diecast LAC.112A aluminium alloy crankcase and main bearing unit with detachable rear cover. One piece non-counterbalanced hardened crankshaft with 9/32 in. dia., 15/16 in. long journal and 5/32 in. dia. crankpin, and running in Vandervell steel-backed sintered-bronze main bearing. Brico centrifugal cast iron piston with $\frac{1}{8}$ in. dia. full-floating gudgeon-pin and drop-forged RR.56 alloy connecting-rod. Cylinder liner of case-hardened mild-steel, screwed into crankcase, flanged and seating on fibre gasket. Machined and anodised finned cylinder barrel screwed on to cylinder liner. Alloy prop driver, taper fitted to crankshaft. Solid alloy spinner nut. Spraybar type needle-valve with double spring ratchet device. Detachable, rear-mounted nylon tank, attached with single screw to crankcase rear cover. Beam mounting lugs, plus provision for two-point radial mounting.

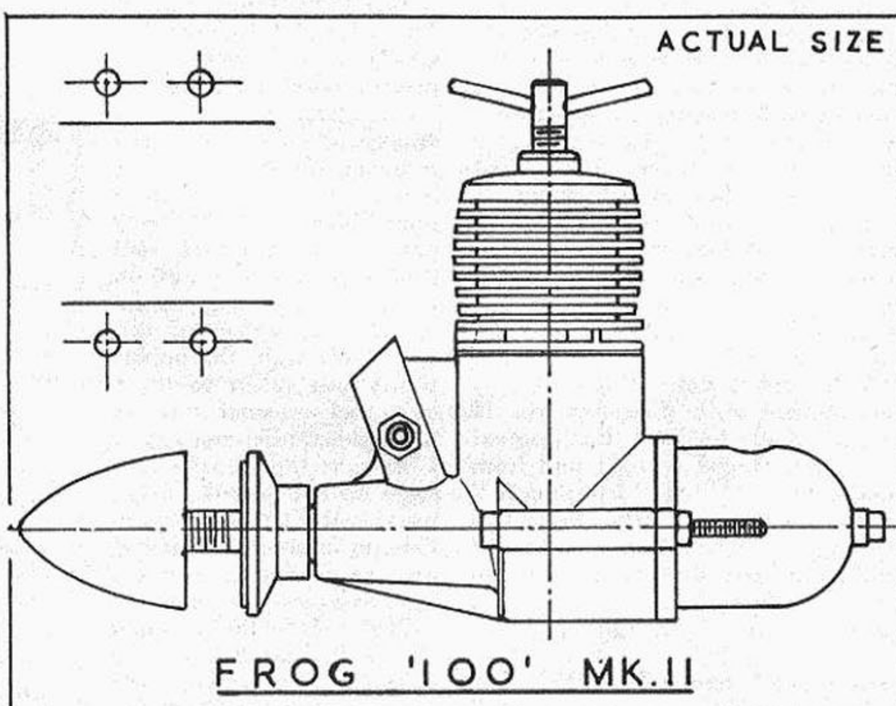
Test Engine Data

Running time prior to test: 2 hours.

Fuel used: Shell "Powa-Mix" (nitrated, with castor-oil lubricant).

Performance

Our "100" liked to be fairly wet for starting, both cold and hot. Priming through the ports helps to loosen up the engine when cold, but it is possible at all times to start the motor with choking only. During tests we started the engine by opening the needle-valve a half-turn beyond the normal running setting and choking the intake for three or four turns of the prop after the fuel had reached the needle-valve. The 100 starts quite easily and under a wide variety of loads. It is only necessary to remember that, if the engine fails to start readily, under, rather than over-choking, is likely to be the cause.



Both controls are easy to operate and are responsive without being critical. The engine will run with the needle-valve open a full half-turn either side of the best setting. Unlike many diesels, the 100 is not happy if persuaded to run on a very weak setting, however. About one half turn open from the minimum setting at which the engine will run without cutting out, seems to be best. The compression setting is easy to find and the contra-piston moves smoothly without any tendency to stick when the engine is hot. There was, however, a slight tendency for the compression adjustment to run back, on our test engine, at speeds above 16,000 r.p.m. Such a tendency would not, however, bother the average modeller, since these very high speeds will seldom be used.

The 100 has a healthy crack to its exhaust note which reminds one slightly of the Arden 099 of fond memory. It also has a remarkable speed range, with the maximum horsepower developed at exceptionally high r.p.m. At the lower end of the r.p.m. scale, there is little to indicate the high potential output of the engine and the latter becomes evident only as one decreases the load and discovers that torque is remarkably well maintained. The result of this is that the engine reaches 0.10 b.h.p. at 12,500 r.p.m. and goes on to exceed 0.11 b.h.p. at a peak of 16,000 r.p.m., a performance which places the Mk. II 100 well above average performance in its class and renders it comparable with the best yet seen in the 1 c.c. group.

Power/Weight Ratio (as tested): 0.715 b.h.p./lb.

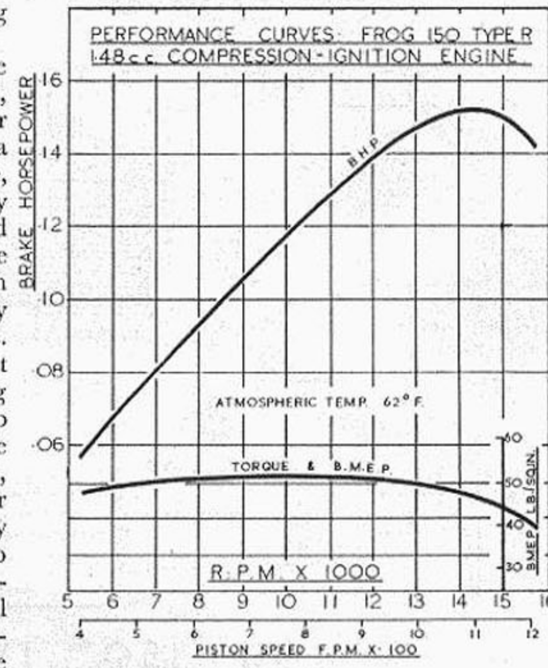
Specific Output (as tested): 102.7 b.h.p./litre.

Frog " 150 " Type R

Having achieved an output with the 100 Mk. II, which closely approached that of the existing 1.48 c.c. " 150 " model, Frog designer George Fletcher was prompted to investigate the possibility of bringing the latter engine up to similar standards of specific output.

The main modification adopted was a new short-skirt piston and this has been responsible for a quite remarkable increase in performance, due to the very considerable degree of sub-piston air induction (amounting to some 80 degrees of crank angle) now obtained. It is conceivable that a small part of this gain is due, also, to the reduced drag of the short piston length and to the reduction in reciprocating weight.

The actual power increase that has been obtained is, according to our tests, rather more than 20 per cent., a remarkable enough figure, yet one which, if one may judge by the makers' quoted prop/r.p.m. figures for the two types, is no exception and has been substantially exceeded in their own tests. It is interesting to note that these modifications bring the power of the 150-R up to well above that of the 149 " Vibramatic " model, which has the same cylinder as the 150. A similarly modified piston was also tried on the 149, incidentally, but with less useful results, there being considerable blow-back through the automatic induction valve and the 149 will therefore remain unchanged for the present. The 149 continues to retain the advantage of lower fuel consumption.



In practically all other respects, the 150-R is the same as the Mk. II 150 that has been in production for several years. It has the same heavy, radially ported cylinder, in which three external flutes and inclined circular ports are used to transfer the charge. (This is a modification from the original 150 design of 1951 which had internal transfer grooves.) The Type R is distinguished externally from the standard 150 Marks I and II by a blue anodised cylinder barrel.

Specification

Type: Single-cylinder, air-cooled, reverse-flow scavenged two-stroke cycle, compressed ignition. Crankshaft type rotary valve induction with supplementary sub-piston air induction. Radial exhaust and transfer porting with flat top piston.

Swept Volume: 0.0903 cu. in. (1.480 c.c.).

Bore: 0.500 in. Stroke: 0.460 in.

Stroke/Bore Ratio: 0.92/1.

Weight: 3.4 oz. including tank.

General Structural Data

As for 100 Mk. II model.

Test Engine Data

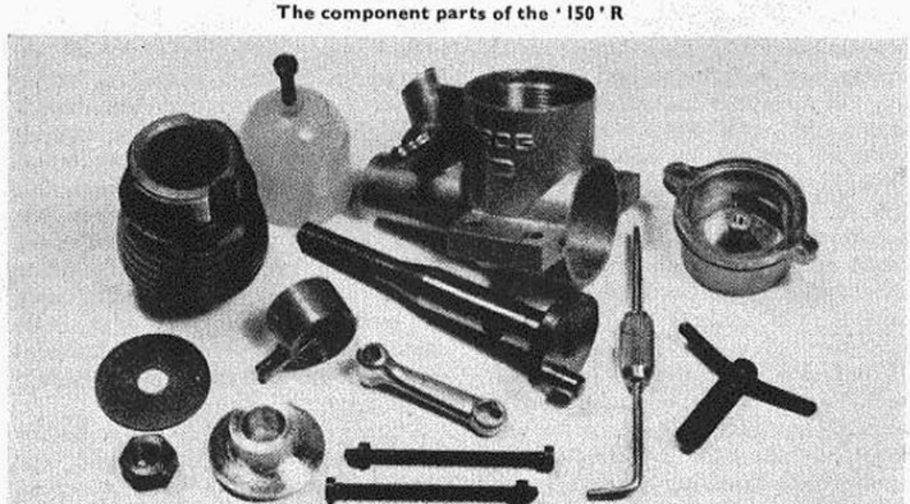
Running time prior to test: 2 hours.

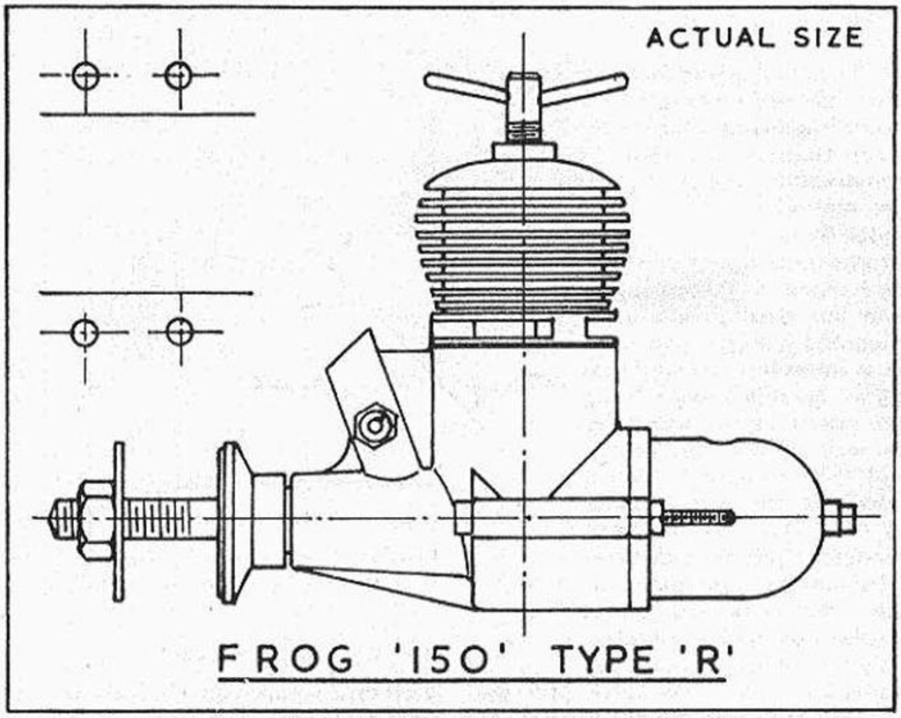
Fuel used: Shell Powa-Mix.

Performance

Our first experience of the Type 150-R (at that time unnamed) was gained some six months ago when a prototype unit was tried out. We ran the engine for a total of some

The component parts of the '150' R





20 hours, and it is worth noting that there was a negligible variation in the performance of the engine during this time. In other words, the Frog is not an engine that has to be run-in for hours before it is ready to settle down to work: normally, one hour of running-in will be adequate, after which one can expect a long period of consistent service.

The second engine, obtained for this report, closely matched the performance of the first, but had one minor fault not revealed by the earlier engine or by the 100 Mk. II: namely a tendency for the contra-piston to stick in the bore when hot. This is not, of course, an uncommon characteristic of diesels and may not trouble the average user unduly. It is only necessary in such cases, to start the motor on a low compression setting and to approach the required setting gradually and after the engine has warmed up. It does tend, however, to complicate test procedure where it is necessary to obtain accurately the optimum setting under various loads, since one cannot persuade the contra-piston to return to a lower setting when the compression screw is slackened off, while running.

Starting characteristics of the 150-R were excellent and required less priming than the 100 Mk. II. One choked flick of the prop was the only preliminary required to secure a warm restart. Apart from the extra tight compression adjustment mentioned, the controls were positive in operation and non-critical.

The 150-R ran fairly hot and there was the tendency, usual with this type of layout having a crankcase mounted tank, for fuel to boil in the tank after a run of a minute or two. Running characteristics, however, were quite pleasant, there being no excessive vibration and no undue loss of power on warming up, provided the engine was propped for speeds in excess of 11,000 r.p.m. static.

As with the Mk. II 100, there is no real indication of the true capabilities of the engine until r.p.m. are allowed to rise well into five figures and it is discovered that the torque curve is much flatter than normal. As a consequence, the peaking speed of the 150-R is over 2,000 r.p.m. above that of the earlier 150 model and the maximum output realised on our test of 0.152 b.h.p. at approximately 14,500 r.p.m., is certainly one of the best performances yet recorded with a 1.5 c.c. diesel irrespective of type, price and nationality.

Power/Weight Ratio (as tested): 55.5 b.h.p./lb.

Specific Output (as tested): 107.3 b.h.p./litre.

In brief, we would rate these two new British engines highly in the 1-1½ c.c. group on a performance-quality-price basis.