# ENGINE TEST BENCH

## by PETER CHINN

## *OS Max 50 FSR-H*

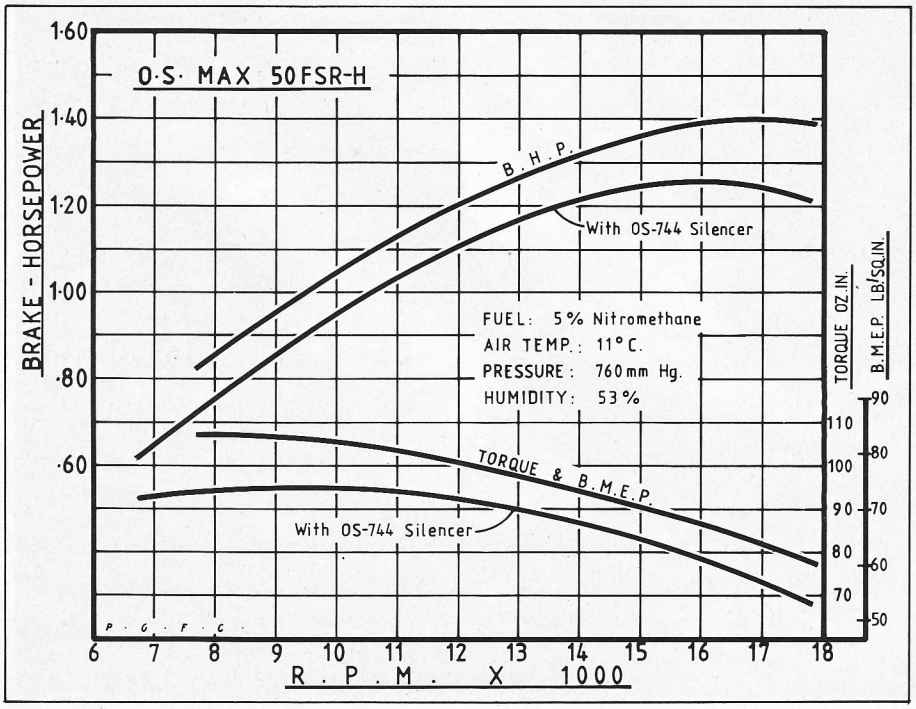
An engine designed expressly for helicopters, the OS 50FSR-H is shown here fitted with the optional G-222 silencer. The larger OS-744 is less expensive and equally efficient.

AMONG THE British **O.S. Products** company's best customers, are the retail helicopter specialists and it is clear, from reading helicopter expert John Heaton's 'Heli-Pad' column in Radio Modeller, that the current .50 size O.S. motor is one of his personal favourites, often fitted in preference to .60 size engines in a variety of well-known helicopter designs. Therefore, in view of the fact that the O.S.50 (specifically, to give it its correct title, the Max-50FSR-H) has been available in the U.K. for more than three years, a report on it has long been due.

The Max-50FSR-H was designed expressly for helicopter use. It is not simply a chopper version of an existing motor. Nor is it a stretched .40 or .45. It was designed, from the outset, as a helicopter engine, a little more beefy than it might otherwise have been and considerably heftier than the usual .40 or .45 size motor. It is suitable for use with .60 size clutch assemblies and the O.S. 60/61 size sileners. There is a standard 'fixed-wing' 50FSR, but this is actually a version of the helicopter engine, rather than the other way round: the 50FSR was introduced only after the helicopter engine had been put on sale, and it came about largely as a result of requests from the manufacturer's American and European distributors.

The general design of the engine follows standard O.S. Schnuerle-scavenged two-stroke practice. It differs from the O.S. 61FSR-H (and, for that matter, from the smaller .45FSR-H model) in having a one-piece main casting, of which the front housing is an integral part, like the O.S. Max-90FSR. Like all O.S. helicopter engines, including the recently introduced 'baby' model, the Max-28F-H, it is made only in a ringed piston version — i.e.there is no 'ABC' model.

Unlike most of the 'fixed-wing' O.S. engines (including the standard Max-50FSR), the 50FSR-H is supplied without a silencer, but the factory offers a choice of two existing OS silencers, the OS-744 type (as supplied with the standard 61FSR motors) and the cylindrical G.222 type. The latter, a rather expensive 'all machined' device, is the type that was used for our test of the Max-61FSR-H last year, so, for the 50FSR-H, we used the stock OS-744. Incidentally, for use where silencer installation parallel to the crankshaft axis is not convenient, a 90-degree adapter is available (O.S. part number 26625403) that fits between the engine's exhaust duct and the silencer inlet duct.




### Design and Construction Summary

*Main casting.* This sturdily proportioned pressure diecast aluminium component comprises the crankcase, front housing and finned cylinder jacket. It has substantial beam mounting lugs and is braced with horizontal and vertical webs, plus a vertical stiffening rib below the divergent exhaust duct which is drilled and tapped for silencer attachment. The intake boss has a 13.5mm i.d. and the transfer and third port channels are well shaped and of generous volume. The crankcase has an i.d. of 32mm and a wall thickness of 3.5mm.

*Crankcase backplate.* Pressure diecast aluminium alloy, secured with four M3.5 × 0.6 hexagon socket head cap screws.

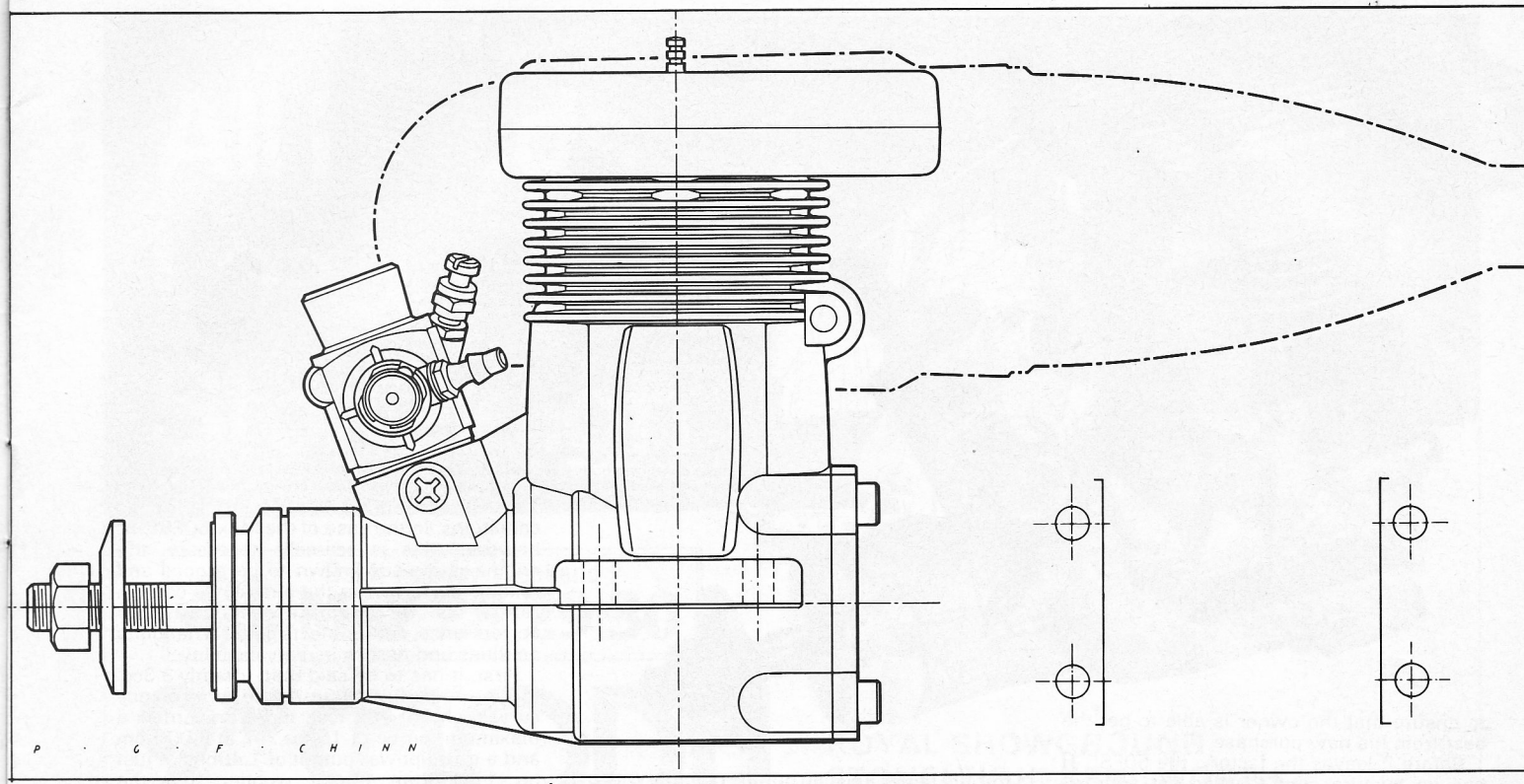
*Crankshaft and bearings.* machined in one piece, the crankshaft has a 15mm o.d. main journal, a $\frac{3}{8}$in. dia. front journal and a 6mm hollow crankpin on a T-type crankweb with crescent counterweight. The main journal is bore 11mm for the gas passage and this is fed

### Performance Tests

**Power output, gross (less silencer):** 1.40bhp at 17,000rpm.
**Power output, net (with OS-744 silencer):** 1.26bhp at 16,000rpm.
**Torque, gross (less silencer):** 107oz./in. at 8,000rpm.
**Equivalent b.m.e.p.:** 83 lb./sq. in.
**Torque, net (with OS-744 silencer):** 95oz./in. at 9,500rpm.
**Equivalent b.m.e.p.:** 74lb./sq. in.
**Specific output, gross:** 169 bhp/lt.
**Specific output, net (OS-744):** 152bhp/lt.
**Power/weight ratio, gross:** 1.52bhp/lb.
**Power/weight ratio, net (OS-744):** 1.06bhp/lb.

### Test Conditions

**Running time prior to test:** Approximately 1 hour.
**Fuel used:** (i) 80 per cent methanol, 20 per cent castor-oil (running-in); (ii) 75 per cent methanol, 20 per cent castor-oil, 5 per cent methanol (tests).
**Glowplug used:** O.S. No. 8.
**Silencer used:** OS-744 expansion chamber.
**Air temperature:** 11°C (52°F).
**Barometer:** 760mm (29.92in.) Hg.
**Relatively humidity:** 53 per cent.




from a 15mm long rectangular valve port. At the front end, the shaft terminates in a standard ¼-28 UNF thread.

Bearings consist of a 15 × 28 mm 10-ball NTN steel caged ball journal bearing at the rear and a ⅜ × ⅞ in. 7-ball NMB steel caged shielded ball journal bearing at the front.

*Piston and connecting-rod assembly.* The piston has a flat crown and is machined from a gravity diecasting in low-expansion silicon-aluminium piston alloy. It is fitted with a single low-pressure Dykes type piston ring that is radially pinned to prevent the ring gap from rotating and entering the ports. The piston has an average crown thickness of approximately 2.2mm and a minimum skirt thickness of 1.0mm. The skirt has large rectangular cutaways, fore and aft, to prevent its masking the entry to the main transfer passages.

The connecting-rod is relatively short at 36mm (1.714 × stroke) between centres. It is machined from high-duty aluminium alloy and is bronze bushed at both ends. The small end eye is 8mm wide and has a single oil hole. The big end is 6mm wide and has two oil holes. The rod shank is rectangular in section, 3.6mm thick and tapers in width from 9.6mm at the bottom to 8.7mm at the top.

The piston is coupled to the conrod with a fully-floating 5.5mm o.d. tubular gudgeon-pin. It is highly finished and is closely fitted to equally well finished bearing surfaces in the rod and piston bosses to minimise wear. The pin is retained by wire circlips at each end. Complete with ring, the weight of the piston checked out at 7.8gms and this was increased to 10.3gms with the gudgeon-pin added. The conrod weighed 5.3gms.

*Cylinder liner.* The cylinder liner has a 26mm o.d. and a wall thickness of 1.8mm. It is located in the main casting by the usual top flange. Scavenging is via a conventional Schnuerle-plus-third-port system, with a fairly long blowdown period, the two angled transfer ports that flank the exhaust opening 13 degrees later than the exhaust, while the upwardly inclined third port is timed to open 8 degrees later still. The exhaust port is centrally bridged and has the outer lower corners swept up slightly to ensure that the chamfered corners of the piston skirt cutaways do not uncover the exhaust at the top of the stroke and risk dilution of the crank-case mixture with exhaust gases.

## General Information

**Manufacturer:** O.S. Engine Mfg. Co. Ltd., Osaka 546, Japan.

**U.K. Distribution and Service:** O.S. Products Ltd., Brunswick Industrial Park, New Southgate, London N11 1JL.

**Type:** Single-cylinder, Schnuerle-scavenged, side-exhaust, glow plug ignition two-stroke with crankshaft rotary-valve and twin ball-bearings.

**Bore and stroke:** 22.4 × 21.0 mm (0.8819 × 0.8268 in.).

**Stroke/bore ratio:** 0.937:1.

**Measured combustion chamber volume:** 0.82ml.

**Nominal compression ratio (full stroke):** 11.0:1

**Effective compression ratio (exhaust closed):** 8.3:1.

**Swept volume:** 8.276cc (0.5050cu. in.).

**measured port timing:**
Exhaust period: 148°
Transfer period: 122°
Third port period: 106°
Rotary-valve opens: 34° ABDC
Rotary-valve closes: 50° ATDC

**Carburettor:** O.S. Type 5B adjustable automatic mixture control type. Choke dia. 8mm. Effective choke area 30sq. mm.

**Silencer:** Extra. Choice of standard OS-744 (volume 126ml, outlet area 57sq. mm) or G.222 (volume 106ml, outlet area 95sq. mm).

**Checked weights:** 418gms (14.7oz.) less silencer; 539gms (19.0oz.) including OS-744 silencer; 534gms (18.8oz.) including G.222 silencer.

The liner is of steel and, like all the more recent up-market O.S. engines, both ringed and ABC, has this company's exclusive non-electrodeposited composite plating which provides an extremely hard, highly corrosive-resistant, low-friction surface, inside and out.

*Cylinder head.* This is of the 'heat-sink' type, rectangular in shape, 58mm long and 46mm wide with tapered section cooling fins above and below a 4.5mm thick base plate. The upper fins are 5.5mm deep and the lower ones 4mm. Most of the fin area is located behind the cylinder axis, but the head can be turned through 180 degrees, should the engine be used in any installation where the cooling airflow is from the rear of the engine.

The head is machine-finished from an aluminium alloy pressure diecasting having a cast-in brass thread insert for the glowplug. It seats, in the usual way, on the flange of the cylinder liner. There is a 0.4mm (16 thou.) soft aluminium gasket between the joint faces and the head is tied to the main casting with six M3.5 × 0.6 hexagon cap screws. The combustion chamber shape features a 15mm dia. bowl surrounded by a 3.7mm wide squishband.

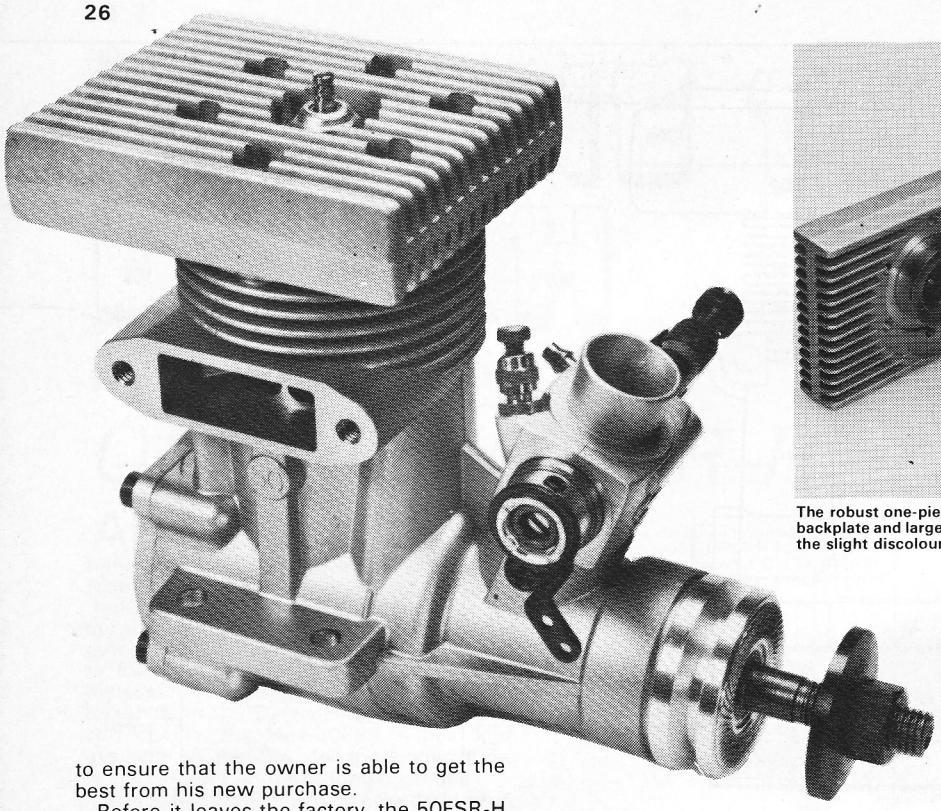
*Carburettor.* This, an O.S. Type 5B, is of the adjustable automatic mixture control type. It has a pressure cast aluminium body and a ground steel throttle barrel and has provision for altering fuel flow at idling speeds by means of a recessed screwdriver slot in the outer end of the throttle barrel. Between the idling mixture setting and the full throttle mixture setting, fuel is automatically metered to suit operating speed by the helical movement of the throttle barrel.

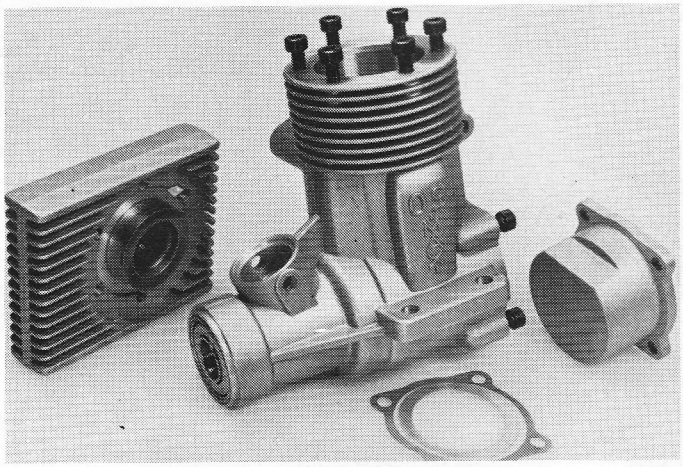
In design, construction and mode of operation, the Type 5B carburettor is essentially the same as the Type 7B described in the September 1982 'Test Bench' article. The main difference between the 7B and the 5B is that the Type 5B has a smaller diameter choke (8mm instead of 8.8mm) which reduces effective choke area from 38sq. mm to 30sq. mm approximately.

*Silencer.* As explained in the introductory remarks, the Max-50FSR-H is supplied without a silencer, so that the user can choose the type best suited to his requirements. The standard OS-744 silencer chosen for this report is a conventional expansion chamber type of fairly large volume and modest outlet area. It is made from two aluminium alloy pressure diecastings and has longitudinal cooling fins top and bottom. It is fitted with a brass nipple for tank pressurisation and is attached to the engine with two M4 × 07 Cr.Mo. hexagon socket cap screws.

## Performance

While the instruction leaflet that accompanies the 'fixed-wing' Max-50FRS is the usual two-page sheet, the 50FSR-H is supplied with a totally different four-page leaflet. Sensibly, the factory has endeavoured to provide the additional information desirable with a helicopter motor,





The robust one-piece body casting of the Max 50 FSR-H is shown above along with the backplate and large heat sink cylinder head. Photos were taken after tests, which explains the slight discolouration of the head. Right side view of the engine is shown on the left.

to ensure that the owner is able to get the best from his new purchase.

Before it leaves the factory, the 50FSR-H has its mixture control valve set approximately correct and the new owner is advised not to disturb this unless it is shown to be necessary in subsequent tests. (Admittedly, when one buys a new engine one cannot always be absolutely certain that a previous customer has not already had his itchy little fingers on it and upset an adjustment but, happily, the chances of this happening with the 5B carburettor are rather less as the mixture control valve is recessed in the throttle barrel and can only be reached with a screwdriver.) Should adjustment of the valve eventually be shown to be necessary, the procedure for doing so will be found in the leaflet. Also explained is a method of checking and re-establishing the basic factory setting.

As we have remarked on a previous occasion, bench tests cannot be expected to reveal all the qualities or shortcomings of a helicopter engine under actual flight conditions. In the case of the Max-50FSR-H, however, this is scarcely necessary: the engine is already known to be a good and reliable performer in the air. All we can do, really, is to examine its statistical performance, determine its general handling qualities and assess its serviceability.

First, it has to be said that, for only 8.3cc, this is a powerful engine. As the performance curves show, our test motor recorded a maximum torque of 107oz./in. at 8,000rpm and a gross power output of 1.40bhp at just on 17,000rpm. Small wonder that the 50FSR-H has proved capable of successfully powering models normally flown on 10cc engines. Of course, it is not quite as powerful as its bigger brother, the Max- 61FSR-H (nearly 1.7bhp gross on test) or good Schnuerle-scavenged 10cc motors from other manufacturers, but it is actually better than almost all the cross-flow scavenged 10cc R/C engines tested in the past.

Handling and running qualities were equally satisfactory. The 50FSR-H started easily and ran steadily and smoothly under a wide range of loads holding full-throttle speeds from below 8,000rpm to over 18,000. There was a slight power loss on warming up when the engine was loaded below about 9,500rpm with the silencer fitted, but over the rest of the load range, the 50FSR-H held impressively steady speeds with commendably modest vibration levels.

The throttle, as was to be expected, worked very well indeed. The engine idled safely, well below the minimum speed required for helicopter use, and the response over the rest of the speed range was excellent, as one usually finds with the current O.S. automatic mixture control carburettors.

As the OS-744 silencer was originally designed for the Max-60FSR engine (and continues as standard equipment for the Max-61FSR) it was not surprising to find it causing appreciably less power loss when coping with the lower volume of exhaust gases emitted by the 50. It has been noticeable, over the years, that many engines react unfavourably to a small and/or restrictive silencer when lightly loaded. The 744 equipped 50FSR, in contrast, sounded perfectly happy at all speeds and ran like a turbine at the peak of its power curve. Provided that the OS-744 can be accommodated, there would appear to be no very good reason for spending the extra money on the rather expensive G.222 type silencer offered as an option.

Stripped down and examined at the end of a rigorous series of tests, the 50FSR-H was found to be in excellent condition and one has to confess to being in the somewhat unusual position of being unable to find anything to legitimately criticise. O.S. make a lot of different engines, two-strokes, four-strokes and even a Wankel rotary, but, taken all round, this .50 model seems to be one of their best.

Parts of the Type 5B carburettor are shown on the left. Useful features include adjustable throttle arm, O-ring seals on easy to adjust needle valve and idle-mix valve, excellent throttle stop assembly and provision for fitting external control extension to needle valve.

Below: the moving parts of the engine are shown.