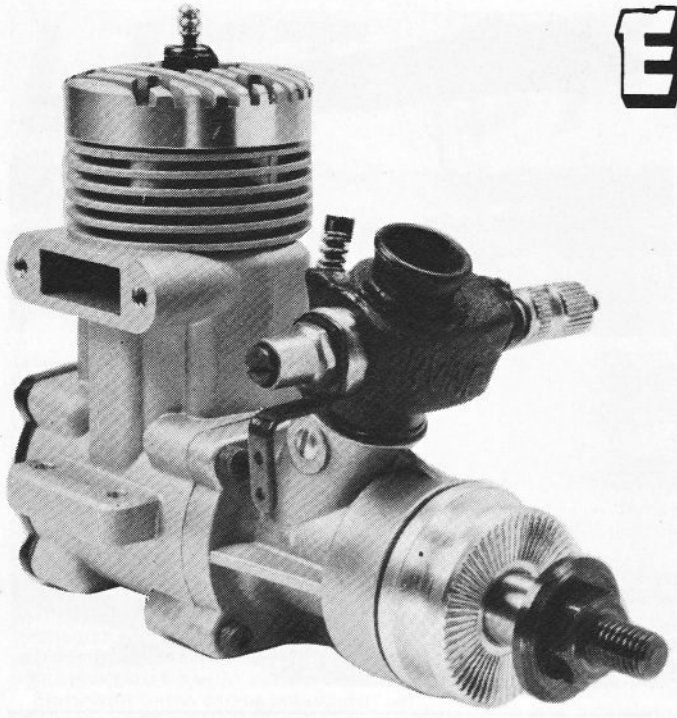


ENGINE TEST BENCH

Irvine SPORT 40 MK II

Described by PETER CHINN

IT IS EXACTLY five years since the original (Mk. I) Irvine Sport 40 was dealt with in the Radio Modeller test series. The current Mk. II model follows the basic design of the Mk. I insofar as it is a twin ball-bearing, front rotary valve motor with a Dykes ringed piston running in a Schnuerle-scavenged cylinder, but the improvements that have been incorporated in the Mk. II are more numerous than might be supposed from a casual glance at the engine. They include a completely new front end — shaft, housing, bearings and prop driver — a new cylinder liner, completely revised porting and a new carburettor.

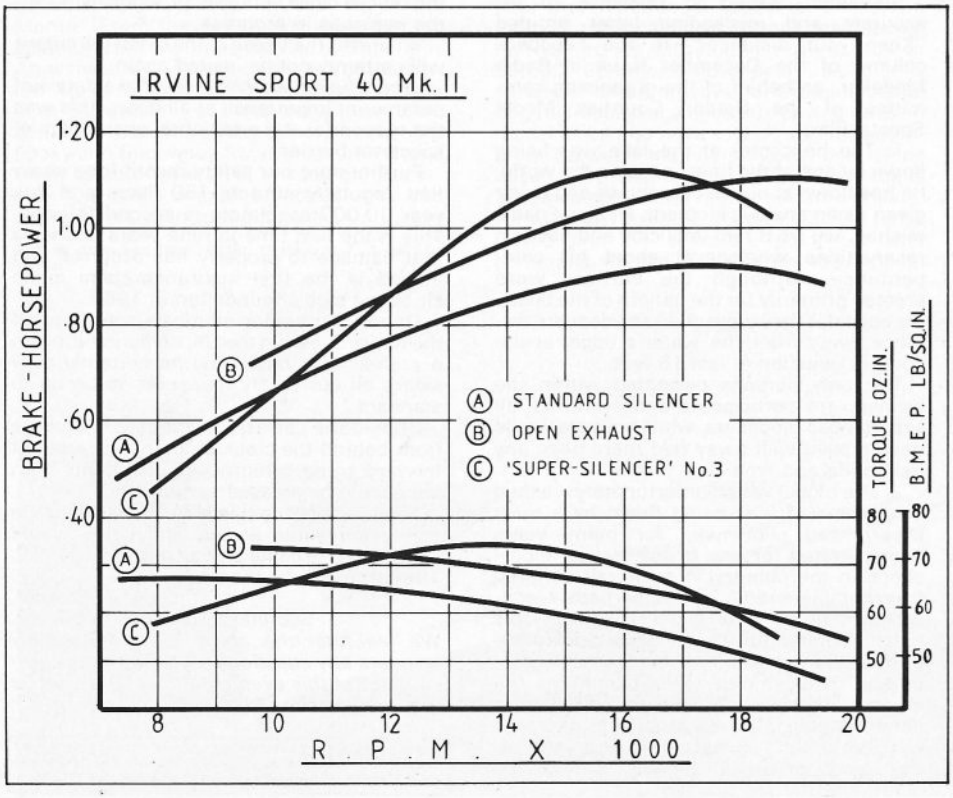
The engine is still supplied with a standard Irvine non-baffled expansion chamber type silencer, but the manufacturer is now offering, as an optional extra, a tuned mini-pipe type silencer that gives very much better performance. An additional series of tests were carried on the 40 Mk. II with one of these silencers fitted and, as we shall see, this released considerably more power and, most importantly, this extra power was achieved at *lower* peak rpm so that the engine can make better use of it by turning bigger props.

More about this in a moment. Let us first have a look at the engine's component parts.

Design and Construction

Main casting. An aluminium alloy investment casting, this comprises the crankcase barrel and finned cylinder casing with the usual beam mounting lugs and an exhaust duct drilled and tapped for silencer attachment. Large well-proportioned transfer passages are located front and rear and, opposite the exhaust, there is a small cavity for transferring gas to the third port.

Cylinder liner. This is produced from a steel investment casting in which all ports are ready formed. The engine is, of course, of the



Performance Data

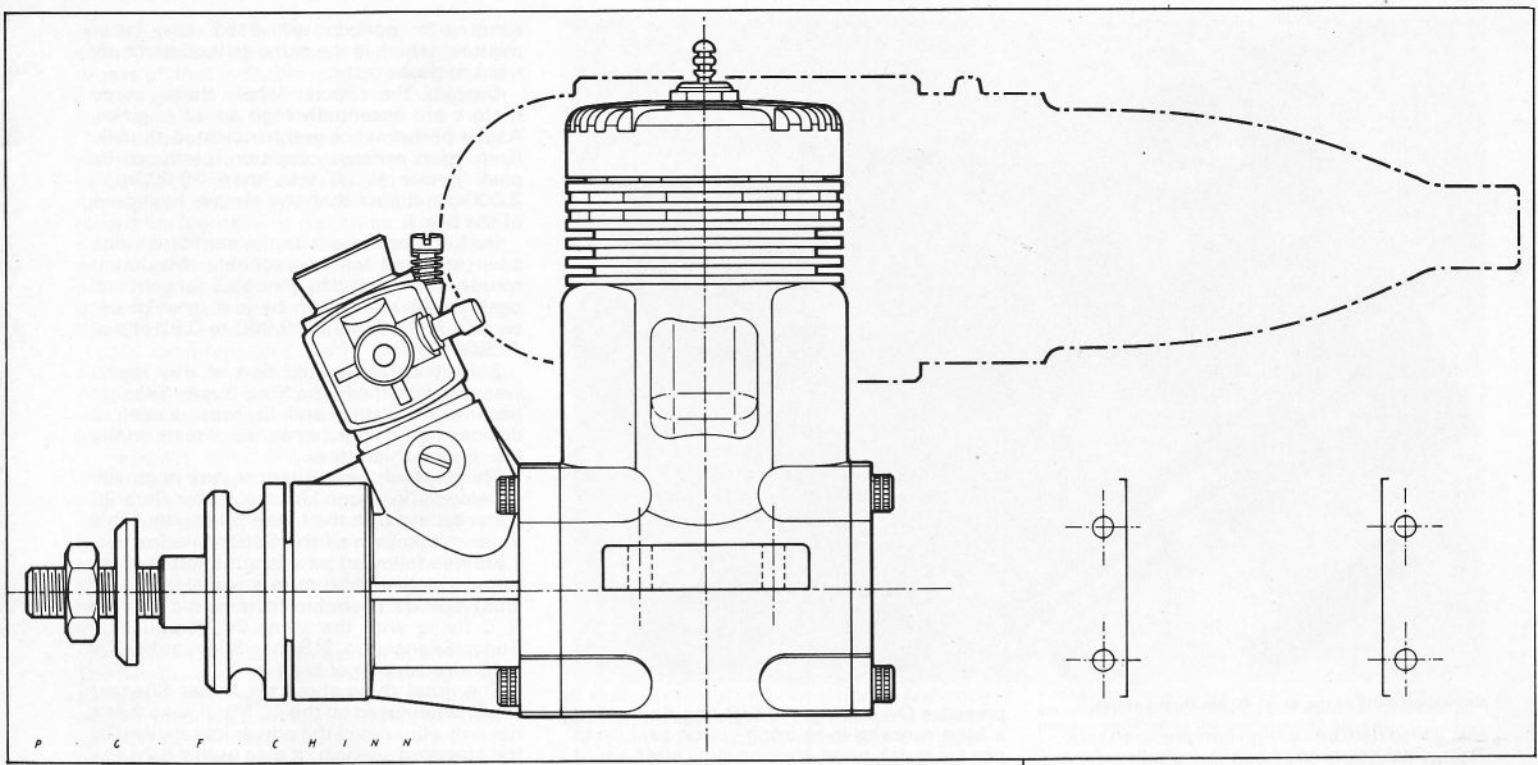
Power output, gross: 1.10bhp at 19,000rpm.
Power output with standard silencer: 0.92 bhp at 17,500rpm.
Power output with Super-Silencer No. 3: 1.12bhp at 16,200rpm.
Torque, gross: 74oz. in. at 10,000rpm.
Equivalent bmep: 73lb./sq. in.
Torque with standard silencer: 67oz. in. at 9,000rpm.
Equivalent bmep: 66lb./sq. in.
Torque with Super-Silencer No. 3: 74oz. in. at 13,500rpm.
Equivalent bmep: 73lb./sq. in.
Specific output, gross: 168bhp/litre.
Specific output with standard silencer: 141bhp/litre.
Specific output with Super-Silencer No. 3: 171bhp/litre
Power/weight ratio, gross: 1.49bhp/lb.
Power/weight ratio with standard silencer: 0.97bhp/lb.
Power/weight ratio with Super-Silencer No. 3: 1.12bhp/lb.
Typical rpm (maple props.):

	A*	B*	C*
12×5 Top Flite	9,450	9,900	9,300
11×6 Top Flite	10,800	11,400	10,900
11×6 Power Prop	11,500	12,200	11,800
10×6 Top Flite	12,600	13,350	13,500
9×7 Zinger	13,300	14,050	14,500
9×6 Power Prop	14,300	15,100	15,400
8.5×6 Zinger	16,600	17,400	17,400
9×4 Zinger	16,800	17,900	17,600

**A – With standard Irvine expansion chamber silencer.*
**B – Open exhaust.*
**C – With Irvine 'Super-Silencer' No. 3.*

Test Conditions

Fuel used: 75 per cent methanol, 20 per cent castor-oil, 5 per cent nitromethane.
Glowplugs used: K&B 1.5 volt long-reach idle-bar (Tests A & B); Taylor 1.5 volt long-reach (Test C).
Silencers used: Irvine expansion chamber (Test A); Irvine Super-Silencer No. 3 (Test C).
Air temperature: 12°-14°C.
Barometer: 755-765 mm Hg.
Relative humidity: 74-76 %.



Schnuerle-scavenged type but, unlike the Mk. I (which had the conventional arrangement of a centrally bridged exhaust port, two main transfers and a third inlet port) the Mk. II employs Irvine's special multiple port bridging. This divides the exhaust into three individual ports, the main transfer ports into six (i.e. three each side) and the 'third' port into two. The bridges are angled through the 1.6mm thick cylinder wall to form vanes which guide the incoming gas in the required direction. They also have advantages from the production standpoint: they eliminate the need to peg the piston ring against rotation and enable the gudgeon-pin to be located by PTFE pads instead of circlips.

As indicated in the data table, port timing is fairly conventional.

Crankshaft, bearings and front housing. The most obvious difference between the Mk. I and Mk. II is the newer engine's massive front end, brought about by the abandonment of Mk. I's ½in. (12.7mm) crankshaft in favour of a 15mm size. Matching this is a ⅜in. dia. front journal and massive crankweb with pressed-in 7/32in. dia. solid crankpin. The shaft is bored 0.400in. (10.16mm) for the gas passage and the valve port, 14.6mm long and occupying 17.2mm of the shaft circumference, increases the valve port area by approximately 60 per cent to almost 250sq. mm. As noted in the data table, the intake port is uncovered for 205 degrees of crank angle, closing quite late at nearly 60 deg. ATDC.

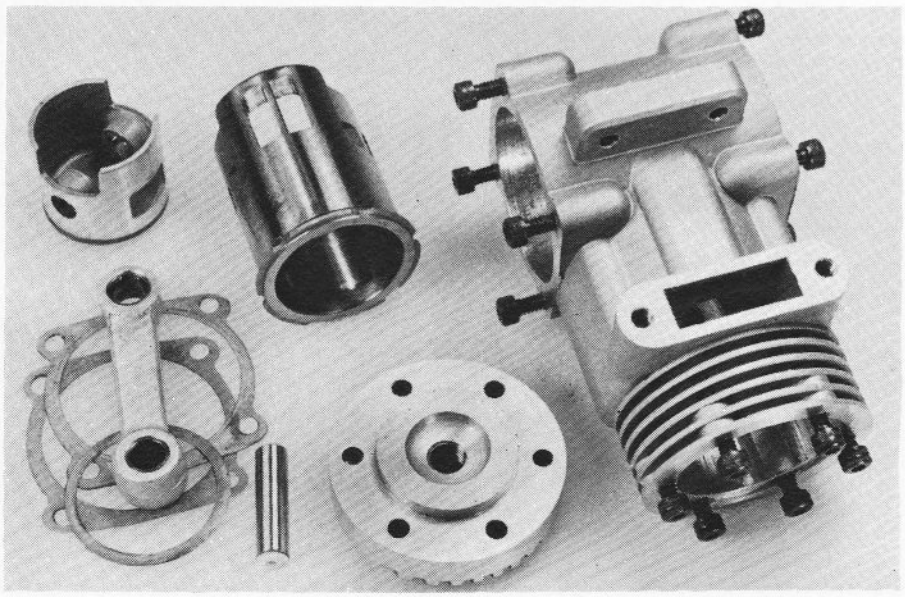
The shaft runs in a ⅞in. OD 7-ball steel-caged ball journal bearing at the front and in a 10-ball steel-caged bearing at the rear, both installed in a new, heftier front housing that includes a 13mm ID intake boss and is aligned with the crankcase barrel by the projecting 1⅛in. OD of the rear bearing. Six 4-40 UNC Allen cap screws tie the housing to the crankcase. An enlarged prop driver, having a 26.7mm dia. drive face, is mounted on the shaft by means of a brass split tapered collet. The ⅜in. dia. shaft terminates ¼in. in front of the driver face and is used to accurately centre the propeller, which is retained by a replaceable ¼-28 UNF stud, nut and washer.

Piston and connecting-rod assembly. The piston is investment cast in low-expansion silicon-aluminium alloy. It has a flat crown and a rectangular skirt window on the left side through which gas enters the third port cavity. The skirt is also extensively cut away at the bottom, fore and aft, to avoid masking the entrances to the transfer channels. The piston is equipped with a single low-pressure Dykes type piston ring and a 0.203in. (13/64in.) OD tubular gudgeon-pin with PTFE pads. The piston and ring weigh a modest 6.0gm, plus 2.3gm for the gudgeon-pin.

The connecting-rod is a sturdy alloy forging, bronze bushed at both ends, 33.8mm (1.85 × stroke) between centres, and weighs 5.3gm.

Cylinder head. A feature of the Mk. I was its very high-compression cylinder-head. The

Cylinder head parts of the Irvine Sport Mk. 2.

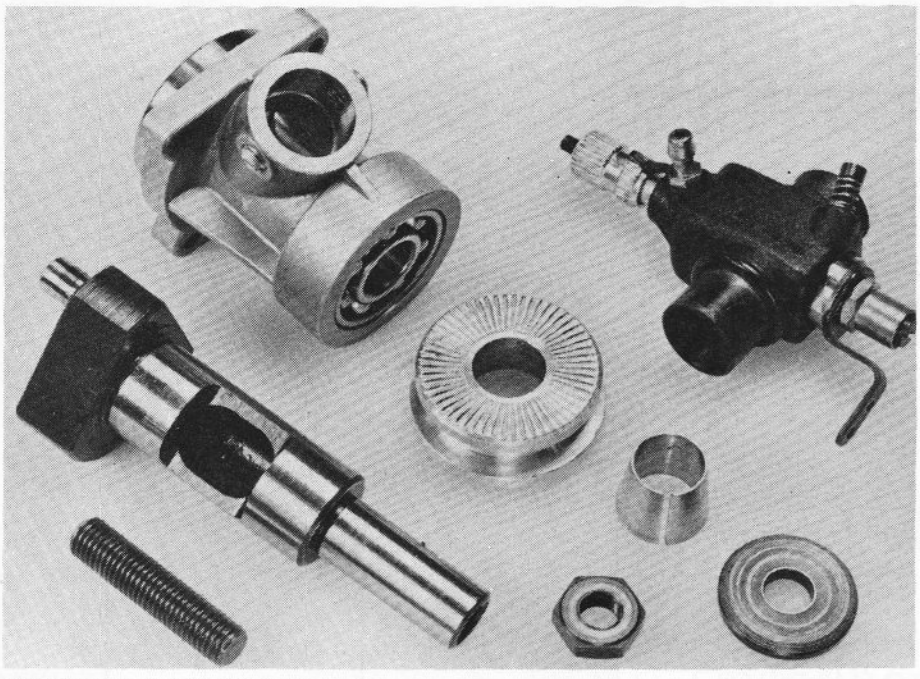


General Information

Manufacturer: Irvine Engines Ltd., Brunswick Industrial Park, New Southgate, London N11 1JL.
UK Distribution and Service: As above.
Type: Single-cylinder, Schnuerle-scavenged, side-exhaust, glowplug ignition two-stroke with crankshaft rotary-valve and twin ball bearings.
Bore and stroke: 0.840 × 0.720 in. (21.34 × 18.29 mm).
Stroke/bore ratio: 0.857:1.
Swept volume: 0.3990cu. in. (6.539cc).
Measured combustion chamber volume: 0.50ml.
Nominal compression ratio (full stroke): 14:1.
Effective compression ratio (exhaust closed): 10.3:1.
Measured port timing:

Exhaust period:	144°
Transfer period:	124°
Third port period:	116°
Rotary-valve opens:	33° ABDC
Rotary-valve closes:	58° ATDC

Carburettor: Irvine barrel-throttle two-needle adjustable automatic mixture control type. Effective choke area: approximately 25sq. mm.
Silencers: (i) Included with engine: Irvine expansion chamber type. Volume 80ml. Outlet area 50sq. mm. (ii) Optional extra: Irvine Super-Silencer No. 3 enclosed tuned mini-pipe type.
Checked weights: 335gms (11.8oz.) less silencer; 428gms (15.1oz.) with Irvine expansion chamber silencer; 453gms (16.0oz.) with Irvine Super-Silencer No. 3.



Crankshaft parts of the Sport 40 are shown above.

Mk. II also features a high compression ratio. The combustion chamber is a shallow ½in. (12.7mm) dia. bowl surrounded by a wide (4.3mm) flat squishband. With the 5thou. copper gasket fitted to the test engine, compression ratio checked out at a nominal 14:1, reducing to 10.3:1 when checked against the swept volume above the exhaust port. Six 4-40 UNC Allen cap screws tie the head to the cylinder.

Crankcase backplate. In place of the cast aluminium backplate fitted to the earlier engines, the Mk. II has a moulded glass-reinforced black nylon back cover. This is a firm fit in the crankcase barrel and is secured with four 4-40 cap screws.

Carburettor. The Mk. II is equipped with an Irvine automatic mixture control carburettor. The earliest version of this carburettor, as originally fitted to the Mk. I, had a cast aluminium body. Later, a glass-reinforced nylon was used, but was found to be insufficiently stable and was soon replaced by the present material, a glass-reinforced polyester. The carburettor is of the familiar two-needle type with the idle needle mounted in the throttle barrel and moving inward with it to reduce fuel flow, through the jet, as the throttle rotates along a helical path towards the closed position. Both adjusting needles are fitted with O-ring seals to prevent air or fuel leakage. There is the usual throttle-stop adjustment and the throttle arm is also adjustable.

Standard silencer. This, supplied with the engine, is a conventional pressure diecast aluminium alloy expansion chamber. It is of generous volume (80ml) and has a 50sq. mm outlet area.

Super-Silencer No. 3. This is of welded aluminium construction. It consists of a large diameter (¾in. OD) tuned length exhaust pipe (approximately 7.7in. long from the engine's exhaust duct), surrounded by, and exhausting into, a cylindrical expansion chamber 1⅜in. OD × 4⅜in. long. The latter has a coned rear end that reduces to a 6.3mm ID (i.e. 31sq. mm) tailpipe. The complete unit extends 8⅝in. behind the cylinder axis but weighs a reasonable 4.2oz. — barely one ounce more than the standard silencer. It is fixed to the engine's exhaust duct, in the same way as the standard silencer, with two 6-32 UNC socket head cap screws. No additional support is required.

Performance

Despite its high compression ratio, the 40 Mk. II, like its predecessor, has pleasantly docile handling qualities. With its low-pressure Dykes ring, the test engine needed a little running-in to bring piston seal up to par for quick hand-starting but, after about 30 minutes' running time, compression was good, giving a satisfactory bouncy 'plop' as the prop was flicked over and providing quick, positive starts.

The manufacturer's fuel recommendations are for a 75/25 mixture of methanol and castor-oil to be used for running-in; followed by 80/20 methanol/castor-oil or 75/20/5 methanol/castor-oil/nitromethane for general use. After a one-hour initial running-in period, we used the latter mixture, which is the same as is customarily used in these tests.

Despite the 'Sport' label, these Irvine motors are essentially high speed engines. As the performance graph indicates, the Mk. II, in open exhaust condition, produced its peak power at no less than 19,000rpm, 2,000rpm higher than the already high peak of the Mk. I.

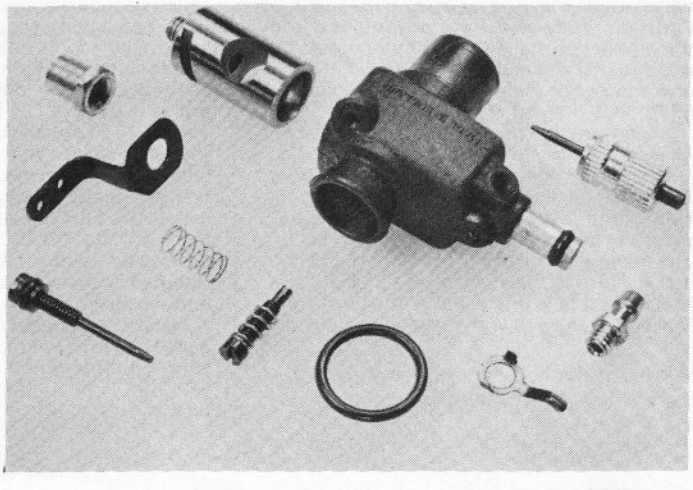
Performance loss with the standard Irvine silencer fitted was reasonable. Maximum torque was reduced by about 9.5 per cent and peak power was down by just over 16 per cent from 1.10bhp at 19,000 to 0.92 bhp at 17,500rpm.

Shortly before publication of this report was planned, the Irvine No. 3 Super-Silencer became available and it was therefore decided to run a further series of tests on the Mk. II with this fitted.

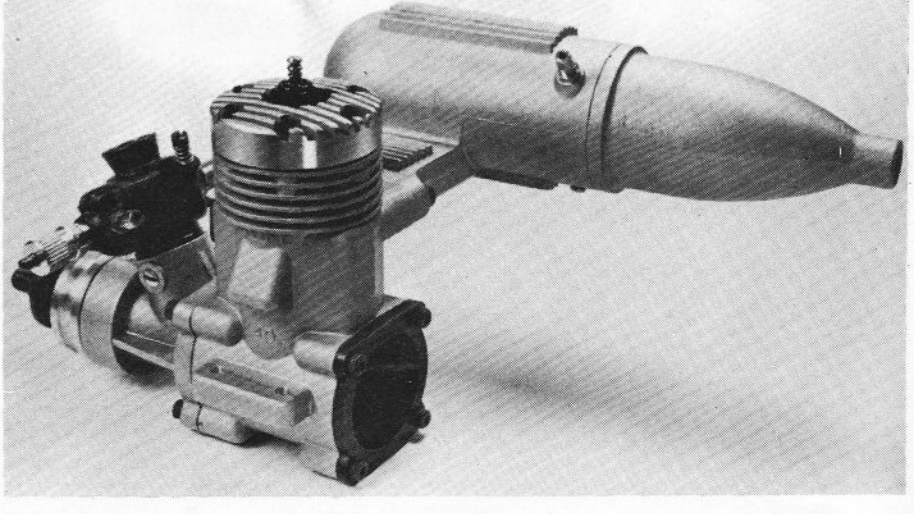
This type of tuned silencer was originally developed (in a smaller version) for Club-20 pylon-racing with the Irvine 20 engine. (This version is known as the Super-Silencer No. 1.) It was followed by a lengthened version, tuned to deliver maximum power at the lower shaft speeds desirable for non-racing type R/C flying with the Irvine 20. (This is the Super-Silencer No. 2) Super-Silencer No. 3 is a 40 size version of the No. 2.

The great thing about the Super-Silencer No. 3, when used on the 40 Mk. II, was that it not only eliminated the power loss caused by the standard silencer: it also pulled back the peak of the power curve to around 16,000rpm while allowing the engine to actually develop slightly more power than when running with the exhaust totally unrestricted.

In practical terms, this means that, over much of that part of the engine's *practical* load range — i.e. on the propeller sizes appropriate to the vast majority of models to which a 40 R/C engine is applicable, the



Right, the Irvine automatic mixture control carburettor is dismantled. Below, the Sport 40 fitted with the standard Irvine expansion box silencer.



power available with the Super-Silencer added, will be equal to, or even slightly in excess of, that available in open exhaust trim and very much above that obtained when the standard silencer is fitted.

A clue as to how the Super-Silencer affects performance, on various propeller sizes, can be gleaned from a brief study of the propeller rpm figures quoted in the data table. For the record, incidentally, it has to be stated that the figures for the engine when equipped with the Super-Silencer, were obtained under slightly different conditions than when the engine was tested with and without the standard silencer, but a brief check on a couple of propellers, with the standard silencer, at this later date, did not lead one to suppose that comparative performance would be markedly different from the results given.

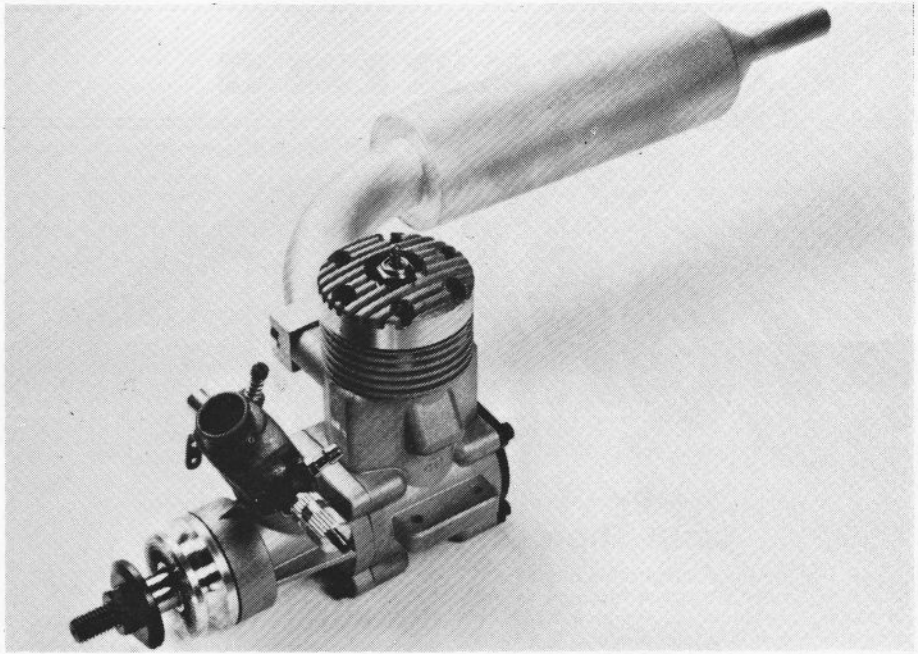
Especially after allowing for some rpm build-up in the air, the figures show, for example, that, on a 10 × 6 (a popular size for a 40) the Mk. II, when fitted with the Super-Silencer, should give better model performance than when run without a silencer and a very big improvement (1,000rpm plus) compared with the performance achieved with the standard silencer.

The Mk. II was easy to handle at all times. The needle-valve was non-critical — perhaps a trifle too much so when running on straight suction feed: we found it preferable to use an exhaust pressurised fuel system with both silencers. There was an increased delay in response to needle adjustment when the Super-Silencer was used and it was necessary to take this into account when adjusting the engine for peak performance.

The throttle worked well, with reliable idling speeds of around 2,500rpm on a 10 × 6 and safe recovery to full power. Vibration levels were moderate and while some users may, perhaps, prefer to add a bracket to support the rear end of the Super-Silencer, all tests were carried out without any such additional support, with no untoward effects.

We suffered a couple of burned-out glow-plugs in the course of the original series of tests, incurred when running at speeds around the bhp peak with the standard silencer, but no plug problems were encountered in the later tests on the Super-Silencer for which, incidentaly, a single Taylor plug was used. Stripped down at the end of this second series of tests — now having accumulated five or six hours running, most of it quite vigorous — the engine itself was also in excellent condition, apart from one of the Teflon gudgeon-pin pads which had just begun to fray around the edges. Users who habitually 'cane' their engines, might care to bear this in mind with all motors that use pads instead of circlips. A stitch in time saves nine and replacing the pads before they wear out, at a cost of a few pence, will save the price of a new cylinder liner.

Altogether, this was a most interesting and illuminating test of a nice engine.



Fitting the Irvine Super Silencer No. 3, shown here attached to the Sport 40, gives a significant increase in power compared to the conventional silencer.