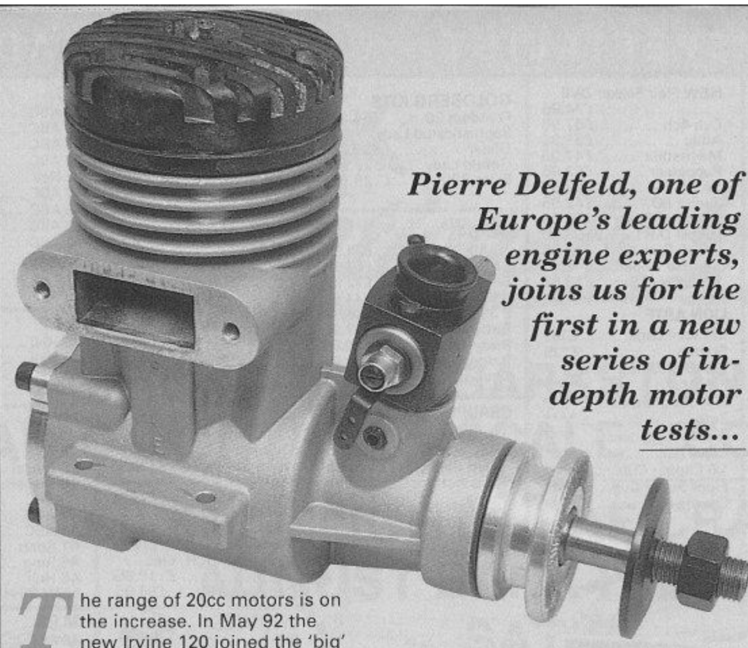
Irvine 120



IRVINE 120 R/C

Pierre Delfeld, one of Europe's leading engine experts, joins us for the first in a new series of in-depth motor tests...

The range of 20cc motors is on the increase. In May 92 the new Irvine 120 joined the 'big' two strokes alongside those from Super Tigre, Webra, Moki and others designed specifically as model motors and not as semi-industrial types (such as the Tartan) which have been adapted more or less successfully. They have been developed in response to the four-strokes with which they share the characteristics of high torque, medium speed and acceptable noise level.

Irvine have chosen for the stroke and bore the over-square ratio (the bore is greater than the stroke), rather than the 'long stroke' favoured by most designers of existing 10cc engines.

The over square design offers undeniable advantages of space: the block is smaller, the overall height is reduced by comparison with the 'long strokes'. The piston speed, however, is lower than that of a 'long stroke' at the same speed. The nett result is that vibrations are less pronounced.

Other engine manufacturers have chosen the over-square design and have increased the bore-stroke ratio to an even greater extent, i.e. Webra 120.

Description

Although the engine is of British design, it is based on the metric system, including the screws, except where it is specifically stated. The prop shaft thread is 3/8 U.N.F. (9.5mm x 24 to the inch); most have AF threads. The nearest metric equivalent would be 10mm by 1mm thread. The engine is exceptionally easy to dismantle and to reassemble.

Crankcase

Investment cast in aluminium alloy, the crankcase is very well made and the exterior design, a model of simplicity, the shape typical of all Irvines. The actual crankcase, the cylinder and the front bearing housing are all incorporated in an integral structure. It is a very robust crank case with a minimum thickness of 4mm. The lugs are wide and long, thus assuring a sturdy mounting. The front bearing housing is stiffened by very substantial gussets. The route of the transfer ducts is traced by the square section protrusion on the outside of the crank case. The cooling fins, few in number (6), are widely separated. The exhaust manifold, equally substantial, is tapped either side (4mm) for the silencer. The interior of the manifold is inclined downwards to assist the flow of exhaust gasses. The carburettor mounting is sited obliquely between the two bearings. The carburettor is secured by two Allen screws with cupped ends. These screws are 3/16in (4.76 mm) with 32 threads to the inch. A shallow groove in the interior of the crankcase proper provides clearance for the big end. The three transfer ducts lead directly from the interior. The Schnuerle port duct is relatively narrow, whilst the lateral transfer ducts are very wide. The interior of the cylinder is machined to a high standard. The top has a groove which locates the liner.

The front bearing housing contains two bearings. The rearmost is a 6004 of Japanese origin, 20 x 42mm caged bearing. The front, also a roller bearing (12 x 28mm) is of the half enclosed type.

Crankcase back plate

There are alternative back plates. The first is the normal type machined from solid, secured by four 4mm Allen screws to the crankcase. Sealing is provided by an O ring. The top has a machined flat to allow clearance for the piston at BDC, whilst allowing the free flow of fuel to the rear transfer port. The second end plate, which is gravity cast, is identical to the first except for the significant difference that it provides a radial mount with a diameter of 114 mm. The three mounting holes, which can take 5mm screws, are spaced at 120 degree intervals on 50 mm radii. This will allow the engine to be fixed directly in place of the OS BGX 1 or the Super Tigres 20, 25, and 30cc.

Crankshaft

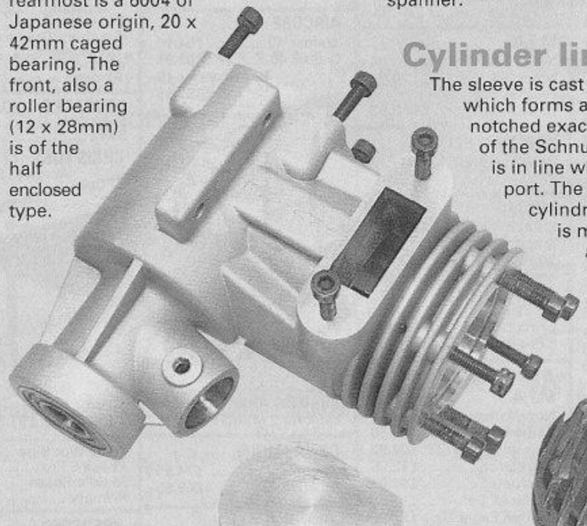
The crankshaft, as one would expect, is machined from solid. The crankshaft web, just over 11mm thick, is balanced by grinding the web to adjust the mass. The web is ground to an angle of 45 degrees on the side opposite the 8mm crankpin. The main shaft measures 20 mm diameter. This is pierced by a rectangular port which is the moving part of the rotary inlet valve. This port leads to the 13.7 mm fuel duct. The forward end of the crankshaft, supported by the front bearing, is 12mm diameter. The usual brass collet secures the prop driver to the prop shaft.

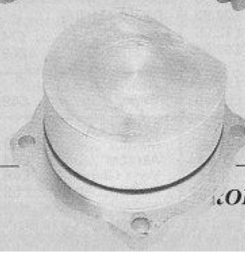
The dural prop driver is adequately proportioned. It is waisted and the front face radially milled in straight grooves. The prop shaft diameter is 9.5mm (3/8") and terminates with a U.N.F. thread as mentioned previously.

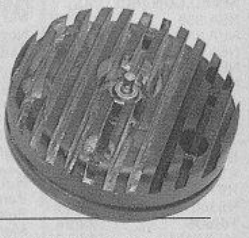
The prop nut is 9/16" (14.28mm). With such a big engine it is preferable to tighten the propeller with a ring spanner.

Cylinder liner

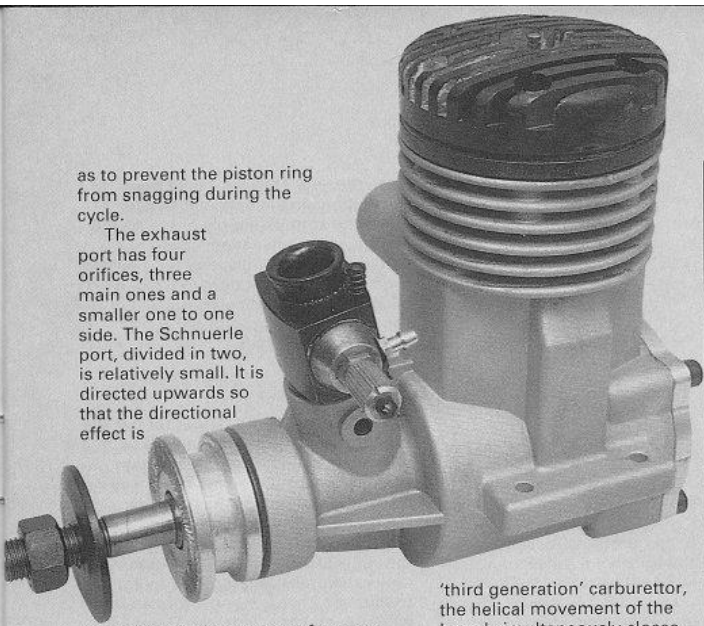
The sleeve is cast iron, the top of which forms a thick flange notched exactly at the centre of the Schnuerle port, which is in line with the exhaust port. The bore is cylindrical, but the skirt is machined to allow easy reassembly of the piston and its ring. Each port is divided so







Top: The Irvine 120 R/C is available from all good model shops and retails at £149.95. Right: A very robust engine, the crankcase has a minimum thickness of 4mm, the head being machined from solid dural.



as to prevent the piston ring from snagging during the cycle.

The exhaust port has four orifices, three main ones and a smaller one to one side. The Schnuerle port, divided in two, is relatively small. It is directed upwards so that the directional effect is very precise. The two transfer ports, situated symmetrically in relation to the Schnuerle port, are divided into three and are directed at the Schnurle port. The sleeve fits easily into the cylinder where there is even slight play.

Piston

The piston is machined from dural alloy. It is cylindrical and slotted at the front of the skirt to allow clearance of the rear ball bearing. The inside has been lightened as much as possible. It is fitted with a Dykes ring. This L shaped ring does not grip the walls of the cylinder; it expands only under compression or the gas expansion in the cylinder. Its top edge is in line with the piston crown. Unlike most piston rings there is no pin. The ring is free to turn in its groove, which explains the need to divide the ports in the sleeve.

The gudgeon pin is free floating in its bearings. It is tubular, with a Teflon disc at each end to reduce friction on the cylinder wall. It is well known for this system to be used on sport motors, but it is rare to find it on a big engine where it is usual for the gudgeon pin to be retained by circlips.

The conrod is machined from HE15 aluminium alloy. It is bushed at each end but does not have lubrication holes.

Cylinder head

The cylinder head is well proportioned. It is machined from solid dural, then anodised black. This colour effectively disperses heat. The exterior has twelve cooling fins. The combustion chamber is hemispherical, the outside edges are rounded. The head locates in the liner in the classic manner. It is secured to the cylinder by six 4mm Allen screws. Sealing is by means of a soft copper gasket.

Carburettor

The carburettor is machined from solid dural. It is coloured black. This colour came off when the engine was cleaned in an ultra-sonic bath. With this 'third generation' carburettor, the helical movement of the barrel simultaneously closes the venturi and the slow running control.

The barrel is fitted via the right side. The helical movement is controlled by the carburettor barrel retaining screw, which locates in a slot milled obliquely in the barrel. The movement is limited by the throttle stop screw on the left of the carburettor body and which is retained by a compression spring. This practice of separating the adjustment controls is becoming more common and in our opinion is a plus.

The slow running control is mounted on the right in a threaded brass assembly. The adjustment is effected by means of the slotted head of the control. The steel throttle lever is also fixed to the barrel by this assembly.

The high speed control is screwed in the left side of the spray bar. This is sealed by an O ring on the spray bar seating. It does not seem possible to fit an extension to this control.

The spray bar has a rectilinear aperture in its centre, which is inclined towards the base of the engine. A compression spring fits over the needle screw in such a way as to take up the resultant play in the barrel.

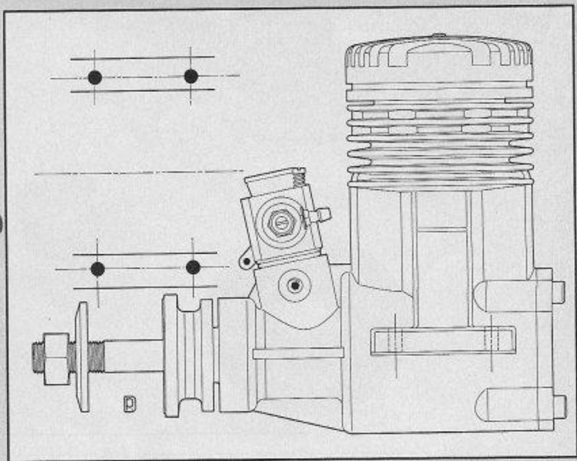
The air intake is 7.4 mm diameter (taking into account the spray bar), giving a net cross section of about 43mm², significantly less than the 52mm² of the Webra for example. The diameter of the venturi where it fits into its mounting is 17 mm. It is sealed by the usual O ring.

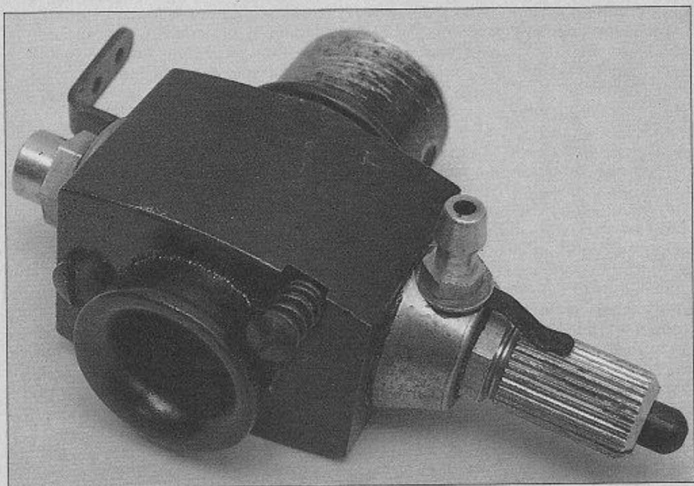
Silencer

The manufacturer has not foreseen the need to provide a silencer. It is expected that for a engine of this type the modeller will adapt the silencer to suit the model. It has, however, holes at 24mm centres, threaded for 4 mm screws, which would enable the fitting of a Super Tigre 4500 silencer.

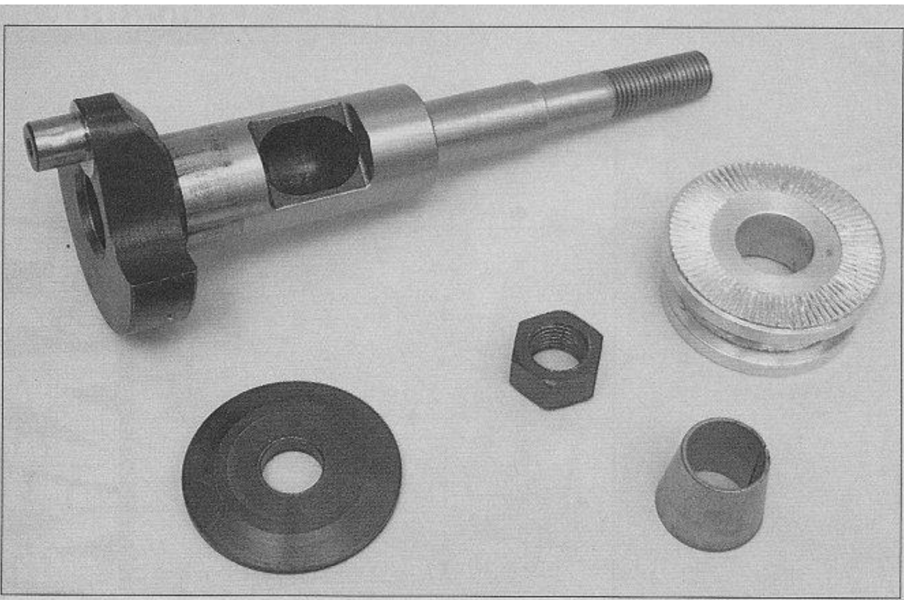
Glow plug

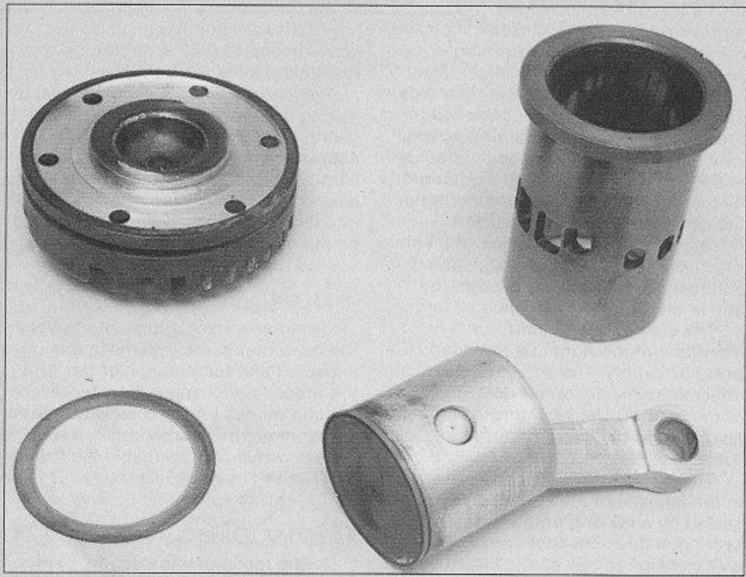
Irvine recommend a variety of plugs for their range of motors: Taylor, OS 8, K & B 11, Fox 1.5 Standard. We have chosen the OS 8, which is effectively the standard plug we use when the





Enlarge this scale drawing by 50% to obtain a full size view of the Irvine 120. Below: The 'third generation' Irvine carb is machined from Dural, anodised black. The main needle would benefit from an extension for ease of use in cowled installations.





Above: Sturdy 20mm crankshaft is machined from solid stock, the web being over 11mm thick. Right: After the tests the combustion chamber parts were found to be in good shape, with minimal wear. There was slight carbon build up, well within acceptable levels.

manufacturer does not provide their own. This plug glowed bright red and consumed about 3.4 amps. At the end of the running in period and the bench tests it was clearly in excellent condition and able to perform over a very long life.

Fuel

The running in and tests were carried-out using our standard mixture of 5% nitro, 20% oil, 75% methanol. The manufacturer recommends 25% oil and 75% methanol. In our opinion, given the high quality of finishes produced by modern standards of machining, 25% oil would seem to be a little excessive. For sport flying, according to the manufacturer, the mixture should be either 20% oil, 80% methanol or 5% nitro, 75% methanol. For competition flying the nitro could be increased to 15%, but the oil content should still be 20%.

By the end of our tests, as the engine was perfectly run in, we used one of our other standard mixtures, i.e. 85% methanol with only 15% oil. With a 15 x 6 propeller, the engine produced 10,200 rpm, varying by 50 rpm which could be accounted for by errors in reading. It would seem appropriate, therefore, to use this formula as it is more simple and less costly, having once put at least three litres or fuel through the engine at 20% oil.

Silencing and pressure tap

We used the Super-Tigre 4500 silencer which fitted very well. This silencer has a wide exhaust outlet. The noise level with a 15 x 6 is only reduced from 108 dB with no silencer, to 100 dB with the silencer fitted. Moreover, it is noticeable that the motor does not lose revs and thus retains the same power level. The silencer is fitted with a pressure tap which, due to the size of the outlet, gives a very low pressure output: 2 mB at 10,200 rpm. Other than this, in spite of the thickness of the pressure line to the tank, oil bubbles were present. This can cause pressure fluctuations in the tank, which can effect the smooth supply of fuel to the engine, with consequent speed variations. Due to this, and because the modeller probably ought to make a silencer to fit a particular model, we carried out the tests without pressurising the tank.

Running-in

We chose a 15 x 6 Zinger for the running-in process, calculating that this mid-range propeller would be most suitable. At the beginning there was no discernible compression, which is typical of the Dykes ring as fitted to this engine; this ring exerts no pressure on the walls of the liner and only opens under the pressure produced by rapid rotation or from ignition. More so than with other piston rings, the Dykes is not initially perfectly round. The running-in process therefore allows the development of a perfect fit to the liner, pre-supposing that this is perfectly round (bear in mind that the ring is free to turn in its groove).

After a litre of fuel had been put through the engine, the compression could be positively felt, both by hand and especially with the starter, which rotates more rapidly. In spite of this, it is not necessary to put the motor on the test bench (except for tuning). It can be taken from the box and fitted directly to the airframe. But slow running should not be adjusted until a litre of fuel with 20% oil has been through it. The viscosity of this mix is greater than that with 15% oil. At this point in the running-in period, it improves the starting.

Starting

Although the manufacturer recommends opening the needle valve two turns for starting, we had to open it three turns for smooth running to begin with and then were able later to reduce this to about 2.5 turns. This difference between the manufacturer's instruction and the actual performance on the bench derives from slight variations, present in most engines, of the positioning of the needle in its housing. The first operation to perform with a new engine is to remove the glow plug and to pour a few drops of fuel into the combustion chamber through the plug hole and through the intake. When the starter is then applied, fuel is ejected through the plug hole. This not only primes the engine, but it is lubricated throughout at the same time. The plug is then re-fitted and connected, and the needle valve opened. The carburettor is opened by 1/4 travel. There is every chance that it will start first time, even if the fuel has not been drawn from the tank to the carburettor. This is especially true if the tank is close to the engine. Subsequent starts were quite easy and did not necessitate priming.

When starting by hand, however, it

is advisable to put a few drops of fuel into the intake and to turn the engine over a few times to disperse the fuel through the engine and so ensure slight hydraulic pressure on the piston ring.

Needle valve adjustment

As with most large motors, the needle valve is situated well away from the propeller. Nevertheless, it is still prudent to adjust the valve from behind with the left hand, as is the general rule. The adjustment is not over-sensitive, but if the mixture is leaned out "just a touch more" to bring it to maximum revs, it cuts out and the only chance of keeping it going is to close the throttle immediately. This is safe enough on the bench, but more risky when fitted in the airframe.

During the course of the bench test it was rarely necessary to adjust the needle. At most it needed the occasional tweak if it slowed slightly.

Pinching the fuel tube quickly stopped the engine. By trial and error, it was possible, above a certain speed, to get it to pick up again if the tube was released.

As the mixture control screw had not been notched, this was done by means of a hand grinder so as to allow accurate counting of the number of turns.

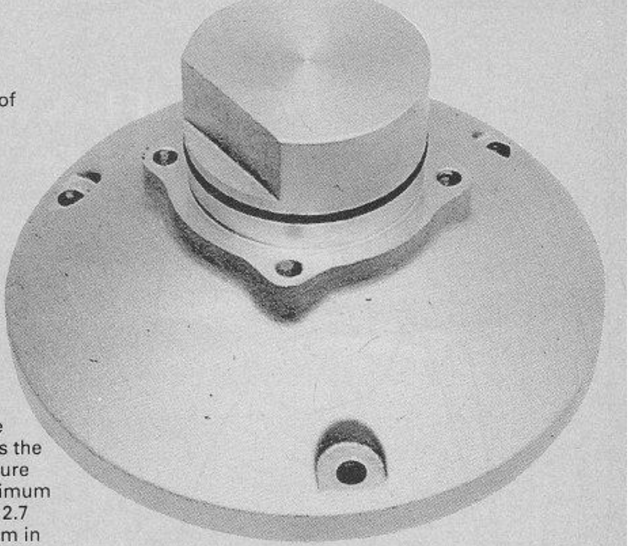
Propellers and power

We have come across more powerful 20cc engines. It would seem that the power level was the conscious choice of the manufacturer when one considers that some of their engines are racers.

The arrangement of the valve timing has a de-tuning effect. The carburettor aperture is small, as is the compression ratio. The latter feature has certain advantages. The maximum power achieved measured about 2.7 bhp (1.98kW) at around 11,200 rpm in the air using a 14 x 8.

The manufacturer recommends propellers ranging from 15 x 8 (9,050 rpm on the ground), to 20 x 6 (5,350 rpm on the ground). This last propeller will develop about 1.68 bhp in the air.

One has, therefore, a wide choice of propellers. I should point out that we used for the first time an 18 x 8 APC composite propeller with a metal hub. We only used it for one test, but during this time it functioned to our complete satisfaction. Moreover, the bore was exactly the same as the diameter of the prop shaft.

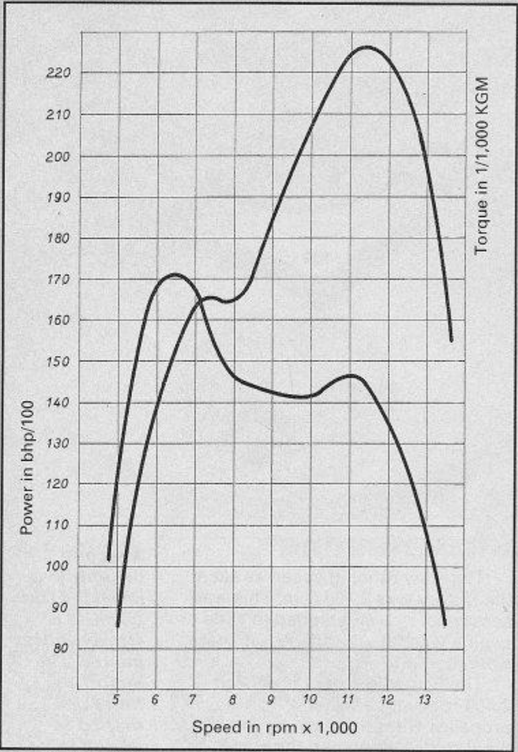


Slow running

The slow running speed as set at the factory was 2,700 rpm. This was somewhat rich and tended to stifle the engine when it was opened up after slow running.

The first adjustment produced 2,400 rpm with a wooden 15 x 6 propeller. Subsequently, by reducing the throttle setting and the slow running jet, we achieved 1,900 rpm with a heavier propeller (APC 15 x 10). This is quite close to the 1,700 rpm claimed by the manufacturers.

A second backplate is provided, this forming a sturdy radial mount. The mounting holes are drilled to match those used on the OS BGX1 and the larger Super Tigre engines.



Specifications

Bore:	**29.5mm**
Stroke:	**29.0mm**
Cubic Capacity:	**19.82cc**
Dry Weight:	**1000g**
Weight of radial mount:	**150g**

PROPELLERS

Size	Make	Material	Speed (rpm)
14 x 4	Airflow	Wood	12450
14 x 6	APC	Nylon + fibres	11200
14 x 8	APC	Nylon + fibres	10200
14 x 10	APC	Nylon + fibres	8300
14 x 12	APC	Nylon + fibres	8150
14 x 14	APC	Nylon + fibres	6650
15 x 4	Airflow	Wood	12800
15 x 6	Zinger	Wood	10500
15 x 8	APC	Nylon + fibres	9050
15 x 10	APC	Nylon + fibres	8400
15 x 12	APC	Nylon + fibres	7500
16 x 5	Zinger	Wood	9550
16 x 8	Zinger	Wood	6850
17 x 6	Airflow	Wood	6850
17 x 8	Tartan	Wood	6700
18 x 6	Tartan	Wood	6850
18 x 8	APC	Nylon + fibres	7250
20 x 6	Tartan	Wood	5350

CONDITIONS FOR THE TEST

ENVIRONMENT		FUEL	
Air pressure	766mm	Running-in and tests	
Temperature	15°	Castor	20%
Humidity	100%	Methanol	75%
Plug	OS No8	Nitromethane	5%
Silencer	Super Tigre 4500		

TIMING CHART

	OPEN	CLOSED	DWELL
Inlet	128° after TDC	128° before TDC	104°
Schnuerle	128° after TDC	128° before TDC	104°
Exhaust	106° after TDC	106° before TDC	148°
Rotary	136° before TDC	46° after TDC	182°

No doubt we could have achieved this figure by using larger propellers. As this engine has excellent breathing, the slow-running, which normally needs to be set somewhat rich so as to ensure a smooth pick-up, plus the fact that the fuel supply is not pressurised, means that it performs happily set just very slightly rich. This also ensures the reliability of the slow running as the plug is less likely to be swamped. That said, the carburettor operates smoothly over the speed range and is quick and reliable.

Vibration

This engine has a very low vibration level. From this point of view it is one of the best engines that we have ever come across. Not only is there little vibration, but it does not shake when slow-running as is the case with quite a few engines. For this reason it would tolerate wooden propellers, on some of which the hubs are not too hard.

Reliability

Reliability over the speed range is on average very high, i.e. more or less 100 rpm either side of the nominal speed. It is even better at slow speeds, which helps to account for the lack of shake. The engine appears not to miss a beat.

Temperature

The engine operates at quite a high temperature. This corresponds with an economic fuel consumption, since in other thirstier engines it is in expelling the excess fuel that the heat is dissipated.

Care must be taken over cooling and the design of silencer used.

Noise level

As already mentioned, the engine is fairly noisy, but at 3/4 throttle the propeller noise can be clearly heard; it is noticeable that the APCs perform better in this respect.

Backfiring

There was no incidence of backfiring or prop shedding. The engine does not flood easily, even when it is filled with the needle valve open. This is not, however, a reason to adopt this practice.

Bearing in mind that the propellers were fitted by means of a ring spanner, which we regard as essential, not one of the propellers slipped. This is largely due to the substantial dimensions of the prop driver.

Rattle

From all that is written above, one would be correct to deduce that there is no rattle in this engine.

Controls

The main needle (which ought to be extended) is easily adjusted. It is secure without being too stiff. There is positively no vibration, nor does it come loose. Having dismantled, examined and reassembled the carburettor (before the bench tests), the barrel retaining screw was not properly tightened; it dropped out and by a miracle was found. This screw is 'thread locked' at the factory, so if you ever need to strip the carb, make sure it is 'locked' back when re-assembled.

Fuel consumption

According to our calculations, the engine uses 22cc per minute at 10,200 rpm. This is relatively economical and is in line with the specifications of the engine, given the size of the carburettor intake, the porting and the power.

Documentation

The first, a printed sheet, contained general instructions. The second, a photocopy, related specifically to the 120. This showed a diagram of the engine and its dimensions. There were also some recommendations on propellers and other information on which we have expanded above.

After the test

The combustion chamber comprises of the piston crown and the cylinder head. The latter was blackened with traces of carbon towards the exhaust port. There was slightly more carbon on the piston crown; it should be cleaned after every four litres of fuel. The piston showed signs of carbon below the level of the piston ring on the exhaust side. These were not significant.

There were some light vertical striations on the piston ring, resulting from the running-in process. Under the microscope one could discern the pores of the metal and some evidence of the machining. The corners of the two sides of the gap in the piston ring were slightly rounded. There was some marking of the piston skirt, but this was of no consequence. The interior of the liner retained a high polish. There was light deposit of carbon around TDC. The crank pin was polished.

When dry, there is some play in the conrod. Bear in mind that, according to some, this should amount to 7/100mm in order to allow a film of lubricant to form. The plug of the crank case end plate had been clearly marked by the big end of the conrod. It might be better to fit a joint of paper or thin card so as to increase the clearance.

Finally, it is worth noting that when dismantling the engine we noticed that one of the carburettor grub screws was missing. It would be sensible to check these for tightness. ●

Translation by Richard Taylor