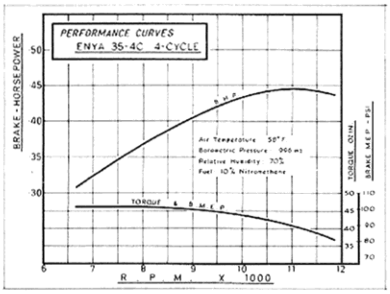
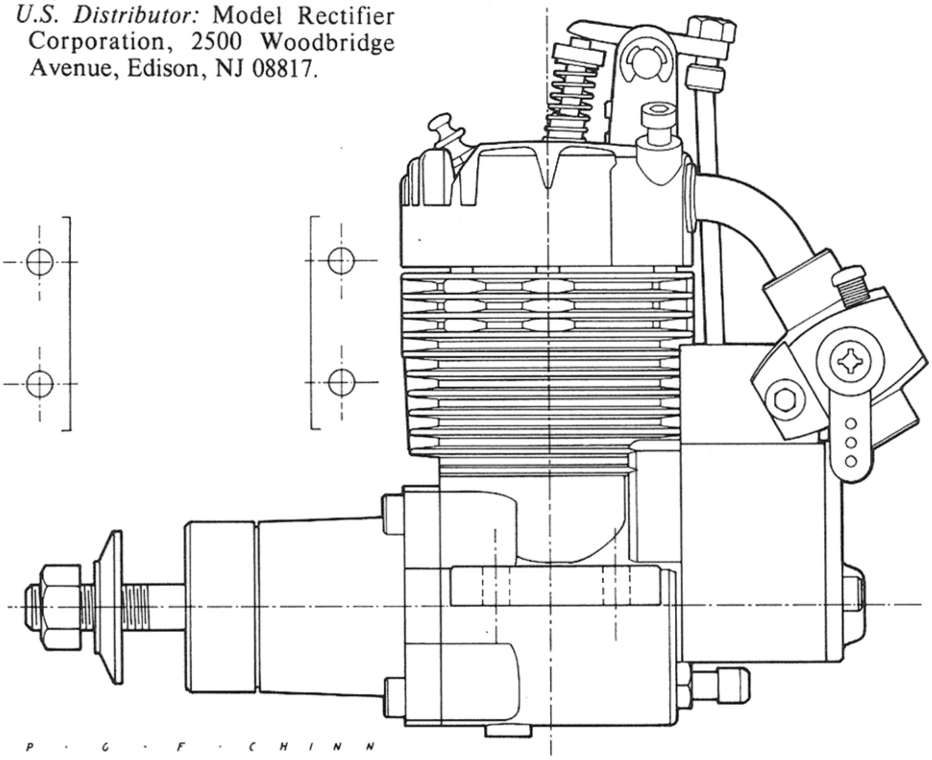
SPECIFICATIONS

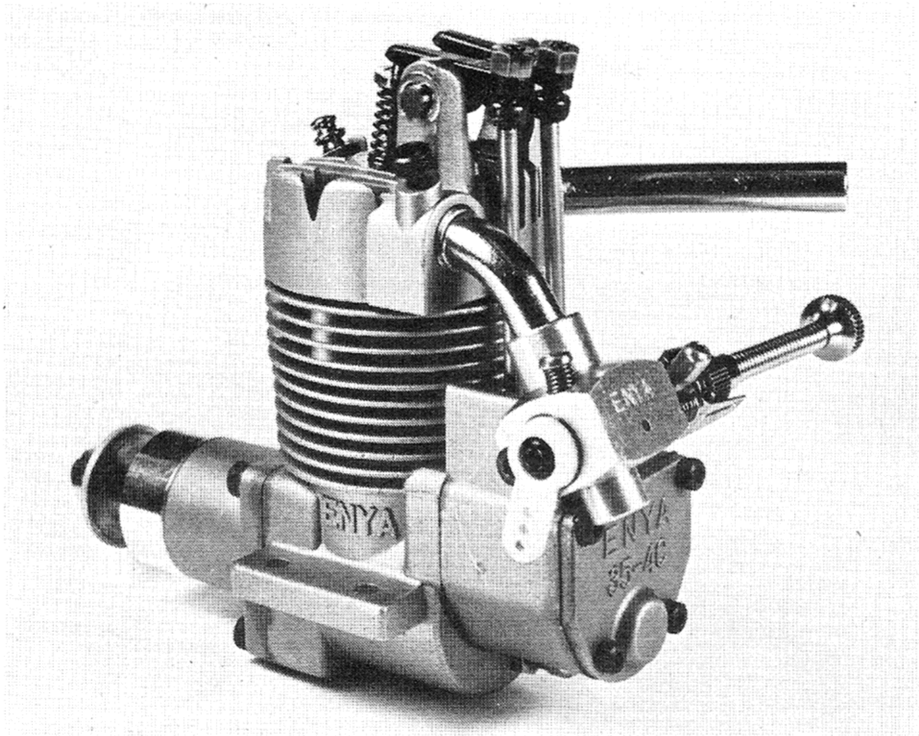
Type: Single-cylinder, glowplug ignition, four-stroke-cycle with pushrod-operated overhead valves. Twin ball-bearing crankshaft. Twin camshafts supported in bronze bushed bearings. Timing pinion shaft supported in twin ball-bearings. Throttle type carburetor with automatic mixture control.
Checked weight: 352 grams (12.4 oz)
Displacement: 5.860cc (0.3576 cu in.)
Bore: 20.95 mm (0.8248″)
Stroke: 17.0 mm (0.6693″)
Stroke / Bore Ratio: 0.811:1
Nominal Compression Ratio: 8.5:1
Specific Output (as tested): 1.24 bhp/cu in.
Power / Weight Ratio (as tested): 0.57 bhp/lb



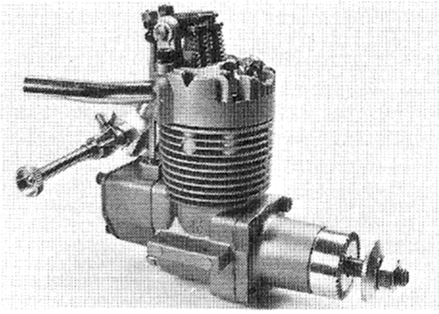
Manufacturer: Enya Metal Products Company Ltd., Nerimaku, Tokyo, Japan.
U.S. Distributor: Model Rectifier Corporation, 2500 Woodbridge Avenue, Edison, NJ 08817.

ENYA 35-4C

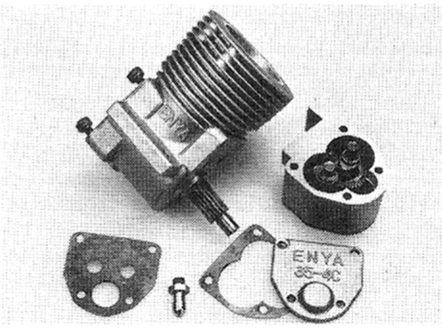




The 35-4C is the Enya brothers' first production four-stroke motor and a good one.



MRC's new 4-cycle offering, the compact and chunky Enya 35-4C.



Twin camshafts are 35-4C feature; fitting is not for pressure, a crankcase breather.

• In line with our policy of bringing to readers as much information as possible on the new four-stroke-cycle motors as they appear on the market, this month we are featuring the Enya 35-4C.

For some thirty years the Enya company has been building model two-cycle engines; engines that, imported and distributed in the U.S. by MRC, have gained a reputation for sound design, quality construction and good performance. With the 35-4C, introduced to their home market in the summer of 1980, Enya became the fourth Japanese manufacturer to enter the four-cycle field.

At 0.3576 cu in. displacement, the Enya 35-4C is small for a four-stroke motor. Only the 0.3035 cu in. Saito FA-30 (see October 1980 *M.A.N.* "Engine Review") is smaller, and both engines provide ample proof that the mechanically more complex Otto (4-stroke) cycle is just as feasible as the Clerk (2-stroke) cycle for these smaller displacements.

As we all know, the four-stroke motor's major advantage is its relative quietness. It also has a lower specific fuel consumption. On the other hand, by modern model two-cycle engine standards, the four-stroke has a somewhat lower specific power output. But, as has been pointed out on previous occasions, the commercial four-stroke model aircraft engine is at an early stage of its development just now. Its present position can be likened to that of the glowplug engine thirty years ago.

One would not wish to see four-strokes "progress" exactly as model two-strokes have done, i.e., to the point where many engines peak at revolutions that can seldom be fully utilized except in racing or speed models and whose noise output has resulted in the loss of countless numbers of valuable flying sites. Nevertheless, if four-strokes continue to gain popularity, competition between manufacturers will undoubtedly result in efforts to increase power.

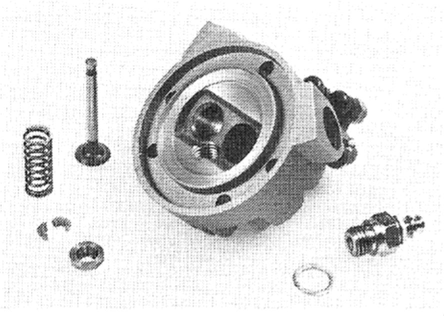
The Enya 35-4C could, in fact, signify the first step towards higher specific power outputs. As the power curve shows, our 35-4C delivered almost 0.45 bhp at 11,000 rpm on 10 percent nitro fuel, which compares quite favorably with average performance levels for sport-type .35 two-stroke engines on mild fuels. It represents a specific output of 76 bhp/liter or 1.24 bhp/cu in., which is about 15 percent better than the levels reached in previous four-stroke engine tests.

The Enya's power/weight ratio, too, is better than average: about 25 percent better than earlier single-cylinder four-stroke levels. Especially when one takes into account the fact that it does not need a muffler, both its specific output and its power/weight ratio are more than good enough to qualify it as a suitable substitute for the typical .29-.35 cu in. two-cycle engine used for multi-channel R/C trainers and sport models.

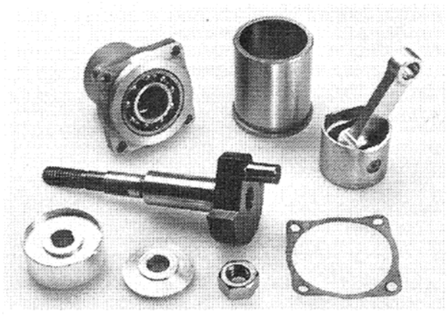
At the present time there are many differences between the various four-strokes on the market, and the feature that most readily distinguishes the Enya from its pushrod-OHV rivals is its use of separate inlet and exhaust camshafts.

Design and structural details are as follows:

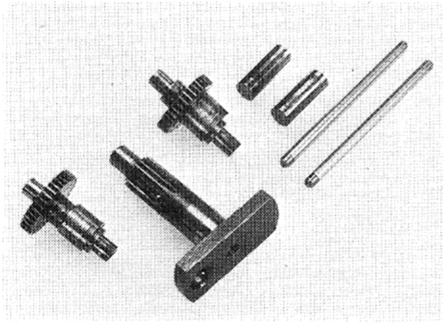
MAIN CASTING. This consists of the crankcase and a full-length finned cylinder jacket in pressure diecast aluminum alloy. The crankcase is open at the front, but closed at the rear where it is fitted with an 8x16 mm 9-ball steel-caged ball-journal bearing for the timing pinion shaft. Externally, the rear of the crankcase also forms the front wall of the timing case and is fitted with a pair of 4 mm i.d. bronze bushes to support the forward ends of the two camshafts.



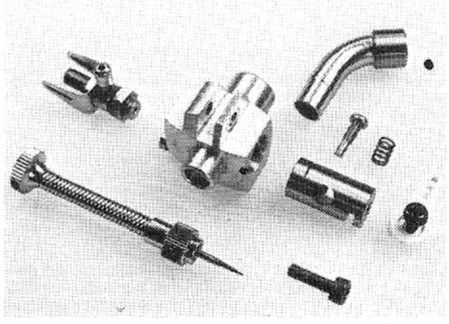
Cylinder head with one valve and spring assembly removed; note split valve collars.



Conventional shaft and front end; cylinder sleeve hard chromed aluminum; no rings.



Camshafts, timing pinion shaft, cam followers are hardened steel.



Special bodied carb is fixed automatic mixture type with airbleed.

CYLINDER & PISTON ASSEMBLY. Two of the features that set the Enya apart from other current four-strokes are its short stroke (S/B ratio only a little over 0.8) and its use of what Enya calls an Al-Chrome cylinder. This is similar in principle to the ABC system pioneered by Super-Tigre in which a ringless aluminum piston runs in a brass cylinder liner having a hard-chrome plated bore, the only difference being that Enya uses an aluminum alloy for the cylinder sleeve. The Enya Al-Chrome (or AAC) system has been successfully used for several years now, in certain of Enya's top-of-the-line Schnuerle-scavenged two-cycle engines, beginning with the 60XF. As with brass, the aluminum liner (in contrast to an iron or steel liner) expands at much the same rate as the piston, so that, if the piston/liner fit is good to begin with, a piston ring is unnecessary. Moreover, heat transference to the surrounding casting is improved.

The 35-4C's short cylinder liner has a minimum wall thickness of 1.85 mm (0.073") and, as is usual when ringless pistons are used, the cylinder bore is slightly tapered towards the top to maintain compression as the piston ascends, while reducing drag on the piston skirt over the lower part of the stroke. In this instance, the bore is just under .002" smaller at the top than at the botton. Incidentally, an allowance is made for this in arriving at the engine's stated bore measurement. Our test motor checked out at 0.8242" or just over 20.93 mm, at the top, compared with the manufacturer's nominal bore measurement of 20.95 mm.

The piston, machined from a special high-silicon-content piston alloy, has a flat head and is fitted with a 5 mm o.d. tubular wristpin. The pin is full-floating and has brass end pads. The connecting rod is machined from alloy bar stock and has bronze bushes at both ends. There is 13 mm between the bosses in the piston, and the conrod upper bearing width, therefore, is a generous 9 mm to reduce the unsupported portion of the crankpin. The rod is 29 mm between centers, i.e., just over 1.7 times piston stroke. The piston weighs 5.8 grams, the wristpin is 2.1 grams, and the conrod 4.2 grams.

CRANKSHAFT & FRONT END. The one-piece overhung crankshaft has a 10 mm o.d. main journal, bored 6 mm i.d. to reduce weight, a 7 mm dia. front journal and a 5.5 mm solid crankpin, 8.9 mm long, on an 8 mm thick crankweb that is extensively cut away each side of the crankpin to produce a substantial counterweight. The shaft runs in a 10 x 22 mm 9-ball NSK steel-caged ball-journal bearing at the rear and a 7 x 19 mm 6-ball NSK shielded bearing at the front, both fully contained in a pressure-cast flanged bolt-on front housing. Ahead of the front bearing the shaft is equipped with a machined aluminum prop driver, keyed in place by means of a pair of flats on the shaft.

TIMING CASE. This houses the timing gears, camshafts and cam followers. It is of pressure-cast aluminum and, with its pressure-cast rear cover plate, is attached to the back of the crankcase with four long 2.5 mm hex socket-head cap screws. It contains the two 4 mm i.d. bronze bushes that support the rear ends of the camshafts and a 5 x 10 mm 7-ball steel-caged ball-journal bearing supporting the rear end of the timing pinion shaft.

CAMSHAFTS, TIMING GEARS, ETC. As already noted, the cam arrangement of the Enya is different from any of the layouts used by other current model four-cycle engines. Instead of having both cams on a single shaft, the 35-4C has separate inlet and exhaust cams, each with its own shaft and timing gear. The two hardened steel camshafts are placed side by side, 10.9 mm between centers, supported in the 5 mm i.d. bronze bushes in the back of the main casting and back of the timing case, as previously noted. Each timing gear is 15 mm dia. x 3 mm wide and has 36 teeth. Cam profiles are of the round flank type and give a lift of 1.9 mm.

The hardened steel pinion shaft is, of course, driven by the crankpin. As observed earlier, the shaft runs on an 8 mm i.d. ball bearing in the rear wall of the crankcase and a 5 mm i.d. ball bearing in the back of the timing case. The pinion, obviously, has 18 teeth in order to provide the 2:1 reduction gear necessary to time the valves.

An advantage of having separate inlet and exhaust cams and fairly fine pitch timing gears is that it is possible to make a change to the timing of one valve without affecting the other. This has, in fact, been done with the Enya 35-4C. Initial pre-production models of the 35-4C had an inlet valve timing of 40 deg. before TDC to 40 deg. after BDC, but in the production model the inlet valve timing gear has been moved around clockwise one tooth. This, of course, is the equivalent of moving the cam back 1/36 of a revolution, or 10 degrees, which, in terms of shaft rotation, retards valve timing by 20 degrees, so that the inlet now opens at 20 deg. before TDC and closes at 60 deg. after BDC. The purpose of this change is to improve performance at higher rpm. The exhaust valve timing is unaltered at 40 deg. BBDC to 40 deg. ATDC.

Incidentally, all engines so far issued have timing marks on the camshaft gears which, when aligned with marks on the pinion shaft, give the original 40-40 timing. It is necessary to remember this if the motor should be taken apart at any time. Make sure that the gears are meshed in accordance with the revised diagram given in the English instruction leaflet issued with the engine.

CYLINDER HEAD. The cylinder head is an aluminum alloy pressure diecasting and includes the two posts supporting the valve rocker shaft. It has bronze valve seats and guides. The valves are side by side, parallel and inclined at 10 degrees to the vertical in a wedge-shaped combustion chamber. The glowplug, located forward of the valves, is inclined at a 30-degree angle, and there are flat squish areas fore and aft.

The head is secured to the cylinder with five 3 mm socket-head cap screws. According to our measurements, the combustion chamber volume is .78 ml, which indicates a compression ratio of approximately 8.5:1.

VALVE GEAR. The valves are 26 mm long with 2.5 mm dia. stems and 8 mm heads. Actually the combustion chamber would have accommodated bigger valves (at least 8.5 mm) and, in view of the fact that the Enya is of better than average performance, it is quite surprising to find that the valves are not larger. The valve springs are anchored to the valve stems in a traditional full-size manner: a tiny tapered steel collar, made in two halves, fits into a groove in the valve stem, and the two halves of the collar drop into a steel cap which locks them in position.

The valve rocker arms are of cast steel and have the usual screw and locknut adjustment for setting valve clearances. The rockers pivot on a single 4 mm dia. steel rocker shaft that is pressed into the rocker-shaft support posts and retained with E clips on the ends. A light coil spring is placed between the two rocker arms to correctly space them.

The valves are opened by 2.5 mm dia., 45 mm long steel-ended aluminum alloy pushrods that are actuated through 5 mm dia., 14 mm long hardened steel cam followers. These run directly in the aluminum timing case material.

CARBURETOR. Carburetor design follows the familiar Enya 'G' pattern: in other words, it is a barrel throttle type with fixed automatic mixture control for part-throttle operation, supplemented by an airbleed screw for idling mixture adjustment. It has a 4.5 mm i.d. choke and an effective choke area of approximately 12 sq mm. The carb is mounted at an angle by means of a single screw on a vertical lug on the timing case.

INLET & EXHAUST PIPES. These are made of 6 mm i.d. copper tube, chromium-plated, with 9 mm o.d. steel collars where they plug into the cylinder head and where each is fastened with a 3 mm setscrew.

PERFORMANCE. The Enya 35-4C is supplied with a good instruction sheet. This includes advice on operating and maintaining the engine, plus a small but useful exploded-view drawing and a list of parts.

The recommended fuel mix for the 35-4C is a standard methanol-based blend containing between 18 and 20 percent lubricant (four-strokes do not need such a high oil content as two-strokes do) and between 5 and 15 percent nitromethane. The lubricant can be either castor-oil or a top quality synthetic. For our tests we used the basic mixture that has been employed for our previous four-cycle engine tests, i.e., 72 percent methanol, 18 percent castor-oil and 10 percent nitromethane.

The recommended glowplug for the 35-4C is the Enya No. 3, which is a hot rated platinum-rhodium element plug having a 4.5 mm reach. The maker's recommended prop for initial running is an 11x6 and the point is made that a heavier prop is preferable for its flywheel effect. If a lightweight wooden prop is used, it is suggested that a spinner (obviously a solidly made, well balanced one) be used for added inertia.

An initial break-in of one hour is advised, during which time the engine should be run slightly rich. The manufacturer warns that the engine may run a bit unevenly at first but will become smoother as the break-in progresses.

Our first impression on starting up the 35-4C was that here was an unexpectedly lively motor. Hand-starting was a bit on the snappy side (finger protection advisable) but otherwise easy. Our starting procedure was as follows: 1) Set needle-valve to approximate running setting and open throttle wide. 2) Rotate prop until inlet valve is just about to open. 3) Choke carb intake with finger and flip prop three times—i.e., through two induction strokes. 4) Remove finger from carb and flip prop once more to make sure combustion chamber is not over-primed. 5) Attach plug lead and allow plug to warm up for 20 seconds. 6) Close throttle to about 1/3 open and flip prop smartly to start.

Two examples of the 35-4C were actually put on test. Both responded satisfactorily to this starting technique. Alternatively, they could be started readily with an electric starter. Always remember, however, that because the carburetor is connected directly to the combustion chamber (unlike a two-stroke where the fuel first enters the crankcase), it is much easier to flood an engine of this type. If an excess of fuel collects in the combustion chamber, this may be enough to prevent the piston from riding over top-dead-center. When an engine is in this condition, never try to force it over compression, either by hand or with a starter.

One thing that we had to watch with the 35-4C was not to lean out the needle too much. It is inevitable with any engine that, when one is searching for peak revs, the mixture will be over-leaned momentarily before the needle is backed off to a slightly richer, safer setting. This point is normally detected by a slight drop in revs and does no harm if the needle is immediately opened up a notch or two but, with the 35-4C, it was found that an excessively lean mix could cause detonation or "knocking." This was present on a variety of prop sizes—i.e., not merely when the engine was heavily loaded with a big prop. An improvement was obtained by using a straight methanol and castor-oil fuel without nitromethane, but the needle-valve was then more critical and the engine tended to cut out abruptly if too weak or too rich.

Interestingly, a significant change was noticed a day or two later when we were running one of the engines after it had rained very heavily and relative humidity was close to 100 percent. Power was slightly down (presumably due to the reduced oxygen content in the atmosphere), but the tendency for the engine to knock when over-leaned was absent. Obviously, properly controlled experiments would be needed before one could be sure that there is a connection here, but it is worth noting that findings such as these are in general agreement with the effects of high humidity or water injection, on detonation, in full-size i.c. engines.

There are three points to observe if you wish to avoid the risk of detonation. First, do not attempt to lean out the needle-valve until the engine has had a reasonable break-in period: we would suggest at least two hours. Second, when finally setting the needle, allow the engine to warm up for a minute or so before adjusting for full power. Third, back off the needle immediately if you hear the slight metallic "ping" that indicates detonation.

One final point before we leave this subject. It should be mentioned that although both our test units suffered from this problem, it may not be encountered with every production sample. It may well be that, before this report appears in print, the manufacturer will have taken steps to eliminate the risk of detonation occurring. A lowering of the 35-4C's compression ratio and/or a modification to the combustion chamber shape should accomplish this. Incidentally, anyone who encounters detonation with any model four-cycle engine and who wishes to experiment can try adding a soft aluminum gasket between the head and cylinder liner to reduce compression. In the case of the Enya 35-4C, a gasket 10 thou thick (and 1.03" o.d. x 0.825" i.d.) will lower the engine's compression ratio of 8.5 (our test motors) to 7.75. Anyone making this change will, of course, need to take up the extra valve clearances by means of the rocker arm adjusters.

On test, the best of our two closely-matched Enyas recorded a maximum torque of 46 oz in. at between 7,000 and 8,000 rpm; but, more important, the torque curve was uncommonly flat and torque declined by only 5 percent at 10,000 rpm and did not drop below 40 oz in. until load was reduced to the point where the engine was running beyond 11,000 rpm.

The power curve plotted from the torque and rpm readings obtained shows better than 0.40 bhp at 9,000 rpm, rising to a maximum of 0.445 bhp at just over 11,000 rpm. This compares well with the factory's claims, which are for a maximum power of between 0.40 and 0.45 bhp. The "practical speed range" quoted by the manufacturer is 2,500 to 10,000 rpm and "critical speed" (which one takes as meaning the maximum recommended rpm, above which valve bounce may set in) is given as 12,000 rpm.

The practical results of the 35-4C's performance characteristics are to be seen in the prop rpm figures obtained on test. The manufacturer's recommended prop sizes for the 35-4C range from 10x6 to 12x4. Our two motors averaged the following rpm on maple props within this group: 10,200 on a 10x6 Zinger; 9,900 on a 10x6 Power-Prop; 9,700 on an 11x4 Power-Prop; 9,300 on an 11x5 Top Flite; 9,000 on an 11x5 Zinger; and 8,800 on a 12x4 Zinger.

These are very good figures, most notably because they are available on props that are of efficiently large diameter and, therefore, particularly well suited to the scale and sport type models for which four-stroke motors are most appropriate.

Although needle-valve adjustment tended to be fairly critical, the throttle worked well. We were able to get a safe, steady idle of 2,400 rpm on an 11x5 Zinger, with instant recovery to full power and progressive intermediate speed control.

Overall impressions of the Enya 35-4C were favorable. The engine is very compact, solidly proportioned, well made, and surprisingly powerful. A couple of these motors driving 10x6 props could be a very nice combination for a twin-engined scale model, for example.

The 35-4C comes complete with a pair of Allen keys, a double-ended wrench and a screwdriver for the various assembly screws and for adjusting the all-important valve clearances. ■