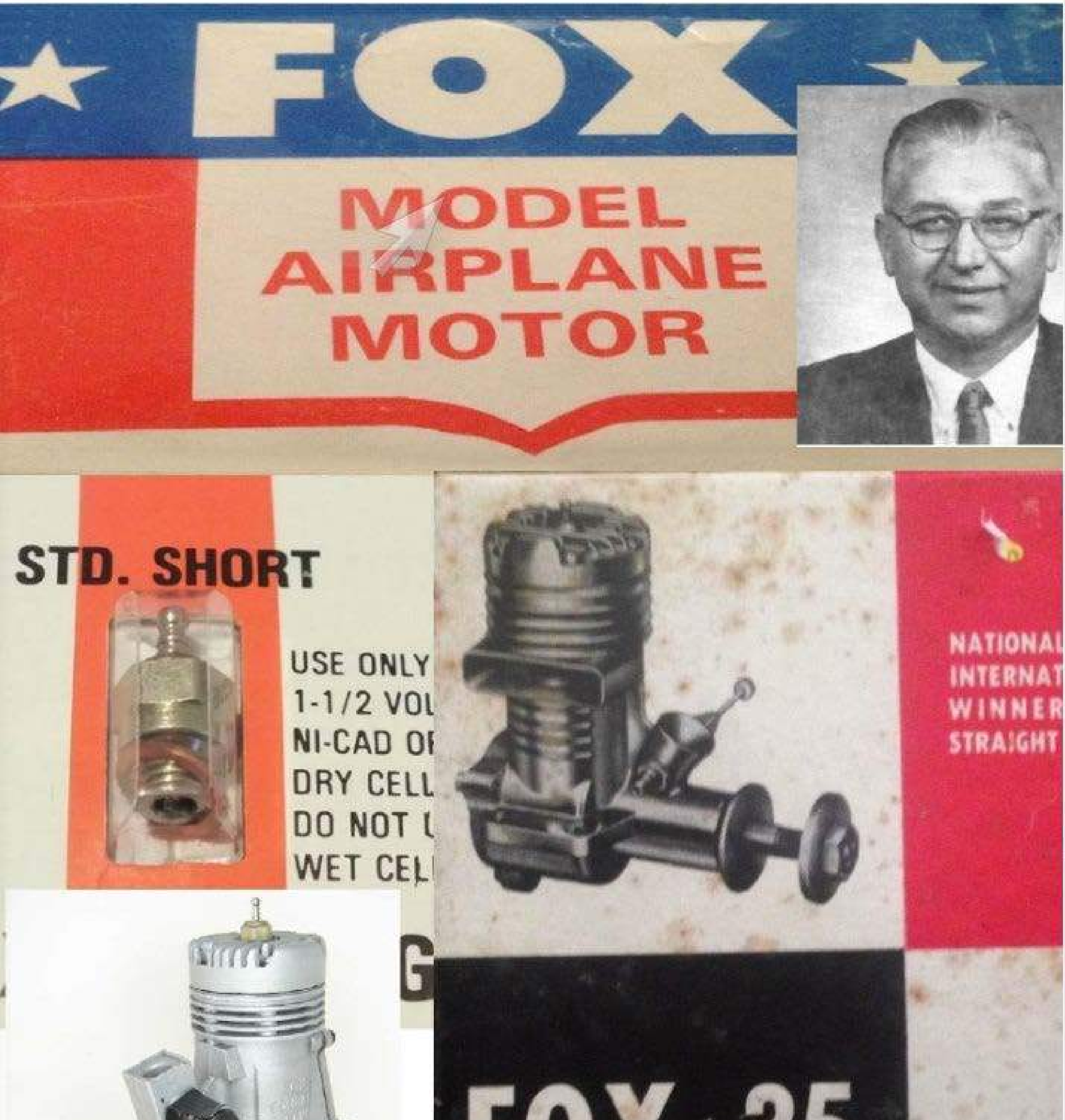
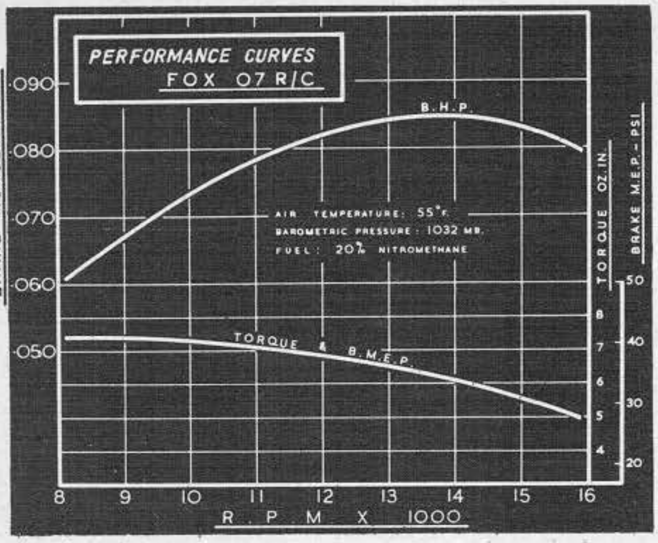
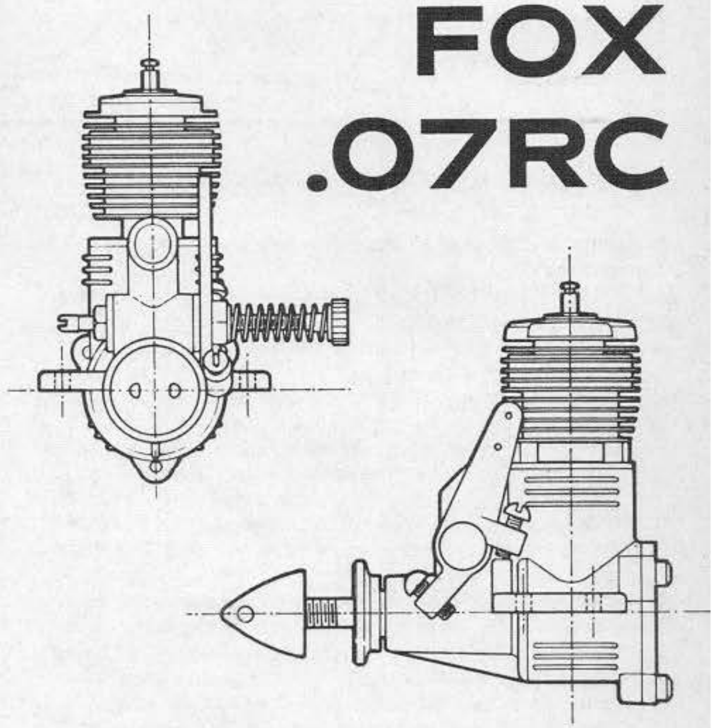

FOX
MODEL AIRPLANE MOTOR
STD. SHORT
USE ONLY
1-1/2 VOL
NI-CAD OF
DRY CELL
DO NOT
WET CEL
NATIONAL
WINNER
STRAIGHT
FOX 35

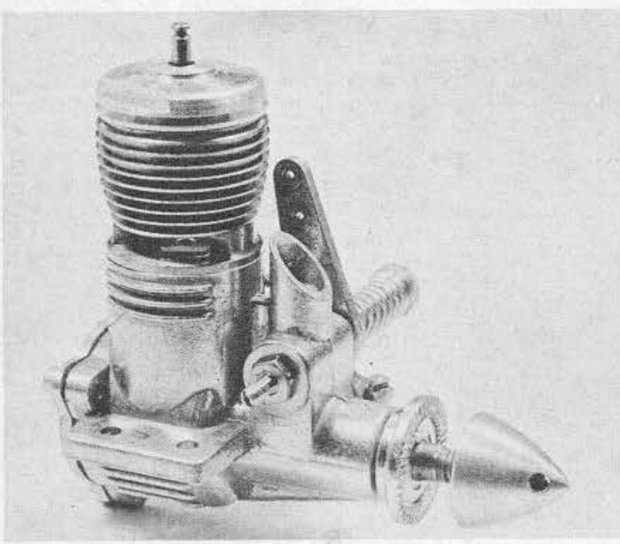
ENGINE REVIEW

FOX .07RC

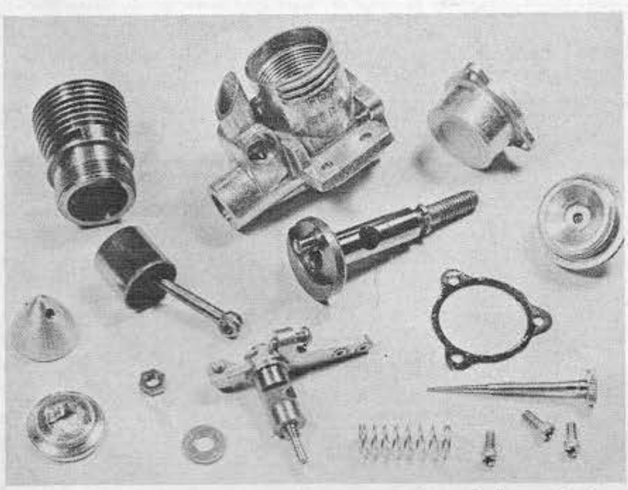


1/2A RC WITH GOOD HIGH AND LOW SPEED CHARACTERISTICS ARE OUTSTANDING FEATURES OF THIS LATEST IN FOX ENGINES.





Fox's new .07RC, weight only 1.8 ounces, is first small motor to have throttle with independent high speed and low speed mixture controls.



Parts of the .07RC are nearly all new. Only the cylinder and piston assembly taken from the original .07. Note wide mounting lugs on case.

By P. G. F. CHINN

► The original Fox 07, introduced three years ago, was withdrawn at the end of 1963 and, since January this year, a new model has been in production, the 07RC, which, as its designation implies, is aimed at the radio-control field. The 07RC is one of the smallest and lightest throttle equipped engines yet to be offered.

Although outwardly similar to, and fitted with the same cylinder assembly as, the 07, the 07RC is virtually a new engine throughout. It has a new crankcase, backplate, crankshaft and prop attachment assembly, plus, of course, the addition of throttle parts.

The engine has been designed expressly for small escapement operated single-channel airplanes. It is important, with miniature escapements, that loading should be at a minimum and, with this in mind, Duke Fox abandoned the idea of a coupled exhaust-intake system and concentrated on evolving a simple carburetor throttle that would be feather-light in operation, yet effective within the rpm range required for such models. This throttle is of the semi-rotary pattern, with butterfly action favored by Fox, but, unlike the simple throttles of some small engines, has the refinement of a two-jet fuel system. The operation of this will be described in a moment.

In general, the basic design and construction of the Fox 07RC is orthodox. Only its .07 cu.in. displacement is a little out of the ordinary. In overall dimensions, the engine is only a little bigger than the average 049 and it is scarcely any heavier—perhaps ¼-oz more than the average. It has, in fact, been designed to fly (*Continued on page* 38)

models ordinarily powered with .049 motors. Where it scores over these (and this is where the 40 percent extra displacement comes in) is in its ability to turn useful "R/C size" props, such as 7x3 or 7x4.

Base component around which the 07RC is assembled is an aluminum pressure diecasting, comprising crankcase, lower cylinder housing and main bearing. Bearer spacing necessary to accommodate the crankcase, is the same as the original 07, but enlarged mounting lugs with wider bolt hole spacing, are used for better support. As an alternative to normal beam mounting, firewall mounting via the backplate attachment lugs is possible, by using longer 2-56 screws—preferably with the addition of an aluminum backing plate. Here, it is worth noting too, that the 1964 model Fox 049 radial tank mount assembly (cost $1.75 including screws and gaskets) can be fitted to the 07RC. However, except in cases where the airplane has been built for a firewall mounted motor and cannot be converted to beam mounts without extensive modification, it is probably better to use beam mounting, which, if properly done, is more rigid and thereby reduces vibration losses.

The hardened, counterbalanced crankshaft has a ¼-in. dia. journal and a 7/64 in. dia. crankpin. Its 11/64 in. dia. circular valve port leads into a 5/32 in. bore gas passage through the journal. Ahead of the ground journal, the shaft has three short lands, which engage keyways in the machined aluminum thrust washer, to provide a firm non-slip drive to the prop. Unlike the original 07, the 07RC has a full length threaded propshaft section integral with the shaft, and an aluminum spinner-nut, instead of a short crankshaft and prop retaining screw.

Normal Half-A practice, of a hardened piston, ball jointed to a steel conrod, and running in an unhardened one-piece cylinder, is used. The piston has a flat head and is permanently attached to the conrod. The cylinder screws into the crankcase and is vertically located by a flange below the exhaust port. Two diametrically opposed exhaust ports are used in conjunction with a single internal bypass flute. Screwing into the top of the cylinder, the aluminum head has an integral ignition filament which will operate satisfactorily on nickel-cadmium boosters. Don't use a lead-acid cell unless you use adequate dropping leads or have a suitable resistance in the circuit.

At the base of the air intake, that part of the casting comprising the carburetor throttle housing, is extended to the full width of the main bearing and is bored to accommodate the machined steel throttle valve. The throttle valve is ¼-in. dia. and is drilled and threaded through its center, to take, from one side, a threaded steel needle-valve and, from the other side, an externally threaded brass needle-valve jet. By a simple but ingenious arrangement, this is made to provide an independently adjustable idling jet and an adjustable high speed jet that comes into use only when the throttle is in the high speed position.

To take the high speed jet first. The amount of fuel that this admits is metered, in the normal way, by the needle-valve. However, the actual jet releasing fuel into the airstream through the carburetor is a small hole in the underside of the throttle valve, offset to one side where it is only exposed to the airstream when the throttle is in the open position and the jet registers with a small notch in the supporting housing.

The low speed jet, on the other hand, is located in the center of the throttle valve where it feeds continuously into the airstream. It is, however, possible to meter the amount of fuel released to the low speed jet by screwing in, or out, the brass needle-valve jet. To do this, the fuel hose is removed to reveal a screwdriver slot and the brass needle-valve jet can then be turned, after slightly slackening the lock nut. Inside the throttle valve, the tip of the brass needle-valve jet is tapered and it is this taper which, itself acting like a needle-valve, meters the amount of fuel which gets through to the idling jet.

Securely fitted to the other end of the throttle-valve is a diecast aluminum actuating arm and this is fitted with two stop screws, the upper one for adjusting the low speed setting of the throttle valve and the lower one for adjusting the high speed setting.

Fox suggests that a low speed of 6000 rpm is a practical minimum for this engine and our tests confirmed this. It is a general rule that small R/C motors do not reliably throttle down as low as the big multi engines and an "idling" speed of half the high speed is a realistic figure for an engine of this small size and is one which the 07RC will achieve without any trouble. This, of course, is quite adequate for small single-channel model requirements, the low speed giving useful cruising power after the required height has been reached on full power. Our 07RC ran especially happily on a 7x3 Top Flite wood prop, turning up better than 12,000 rpm on Missile Mist fuel, with a reliable 6,000 rpm low speed.

Torque tests of the 07RC indicated maximum torque at between 8,000 and 9,000 rpm, with peak power occurring at around 14,000 rpm. Because of the resulting relative flatness of the power curve, the engine was not unduly critical to prop size and would deliver a useful level of power when propped for a static rpm of anywhere between say, 11,000 and 14,000 rpm. However, don't be misled into using a 6x3 or even a 6x4 prop merely because the 07RC looks so much like a Half-A. Such a prop will take it past its peak horsepower revolutions and throttling usually won't be as good. A 7x3 should be about right and will, in most cases, be better for the airplane. The engine will also turn up quite useful rpm on some 7x4's: ours bettered 11,000 on a Power Prop 7x4.

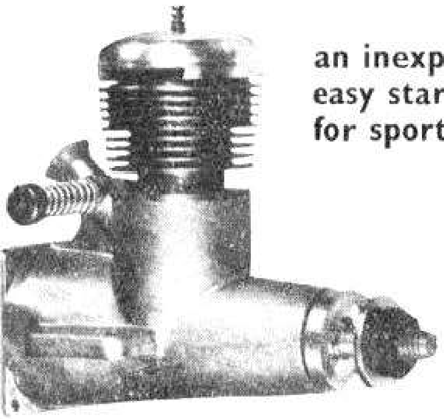
Apart from a tendency to start backwards on small props (again, the use of a 7x3 will eliminate this) the 07RC was docile and simple to handle. Fox suggests that the proper high speed needle adjustment is a rich 2-cycle, occasionally giving a 4-cycle burp. This, in fact, is an adjustment which the 07RC seems to adopt quite willingly. We found the needle adjustment for a continuous lean two-cycle to be quite critical.

As we commented at the beginning, the Fox 07RC is one of the smallest and lightest throttle-equipped engines now available. It should be welcomed by those modelers who like to build small lightweight R/C ships and who wish to add throttle control.

Summary of Data

Type: Two-port, two-cycle with opposed exhaust ports and single bypass. Shaft type rotary-valve intake.
Weight: 1.8 oz.
Displacement: 0.0698 cu. in. or 1.144 c.c.
Bore: 0.460 in. Stroke: 0.420 in.
Stroke/Bore Ratio: 0.913 : 1
Specific Output (as tested): 1.22 bhp/cu. in.
Power/Weight Ratio (as tested): 0.75 bhp/lb.
Price: $10.95
Manufacturer: Fox Manufacturing Company, Station A, Fort Smith, Arkansas

. . . the FOX ·09



an inexpensive easy starter for sport work

Designed as a low-priced sports engine with the emphasis on being suitable for beginners, the Fox "09" is particularly interesting in employing sideport induction. As far as this country is concerned, sideport induction, characteristic of the original spark-ignition motors, has survived only in the Mills diesel (and that design dates back some fifteen years). In America, sideport induction has been almost unheard of as a production design since the famous Ohlsson series. The limitation, as far as high speed engines are concerned, is that with sideporting the intake port cannot be opened as early as desirable without also having excessive opening after top dead centre, causing blowback down the intake tube. Hence it has always been considered that a sideport arrangement cannot induct enough fuel for high speed running.

The Fox "09" certainly shows that as far as sheer running *speed* is concerned, the generalisation does not necessarily apply. It ran quite happily on load speeds beyond 16,000 r.p.m. and achieved its peak power output between 13,000 and 14,000 r.p.m. However, it must be borne in mind that the power output achieved was only moderate, due principally to the limitations imposed by the method of induction. But Duke Fox makes no claims for this to be a "performance" engine and in producing an engine which will start easily and run consistently and well he has achieved a technical success.

A particular advantage resulting from the sideporting is a terrific amount of suction lift, so that priming by finger choking is no problem at all. Also the engine likes to be quite wet for starting and will run steadily over a whole range of needle settings, whilst four-stroking, with a positive transition to two-stroking when the mixture is finally leaned right out. The slightest movement of the needle past "minimum lean" setting cuts the Fox at once, so a logical running setting would be slightly on the rich side.

A marked disadvantage, is that the timing being perfectly symmetrical, the engine will start and run with equal readiness in either direction. In fact, at one stage on test it was more often running backwards from a normal flick start than forwards. Whilst granting the point that this makes the Fox "09" an excellent "pusher" motor using standard propellers (looks well as a pusher too), it is equally aggravating—and possibly confusing—not to be sure which way round the motor *is* running without "feeling the draught". But we will completely endorse that this motor does start very easily and the plug is reasonably long lasting, provided no more than 1·5 volts are applied to it for heating.

The Fox "09" was initially run through a series of tests on a 25 per cent. nitrated fuel, after finding a reluctance to two-stroke on standard Mercury No. 5. Later, however, a number of test runs were repeated with perfectly satifactory two-stroke running on non-doped (methanol-castor) fuel, and with no very marked fall off in performance. The fuel particularly specified for the American market is "Missile Mist" which has a nitromethane content. On our assessment, the compression ratio of the engine was suitable for firing undoped fuels, and the use of highly doped fuel for the majority of runs possibly aggravated the tendency to "fire back" and start in the reverse direction.

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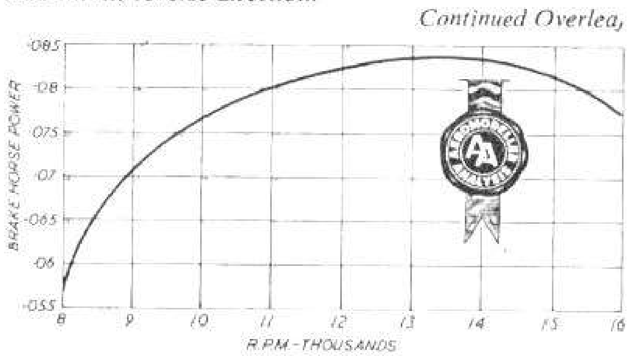
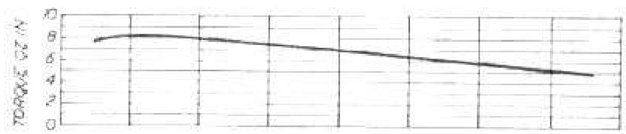
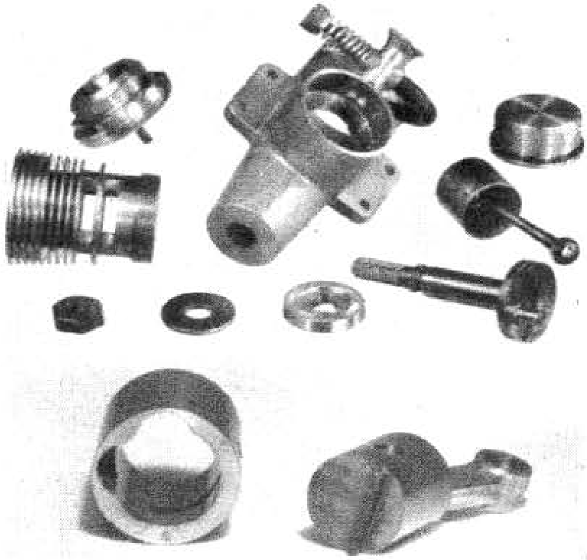




Engine Analysis (cont.)

Photos show salient Fox ·09 features



Constructionally, the Fox "09" features a "solid" tapered crankcase casting which is virtually unrelieved except for the beam mounting lugs and the lower cylinder housing. The rear of the crankcase forms an integral tank by the fitting of a suitable cover plate and gasket, the normal back cover being screwed well inside the casting and approximately level with the back of the cylinder. The intake tube is cast in with the crankcase, opening into the cylinder housing. Resulting position of the needle valve is most unfortunate—right in the line of the exhaust and making any prolonged adjustment a most painful process.

Its cylinder is relatively massive for an American glow engine and is machined from mild steel and left soft. The bore is finished by honing, the twin exhausts and twin transfer ports, both diametrically opposed are cut in the cylinder walls underneath each other and immediately above and below a thin flange. When the cylinder is screwed into the crankcase this flange seats against the crankcase casting, no gasket being employed.

Cylinder threading is on the bottom portion of the cylinder. The remaining length of cylinder up to the flange thus forms an annular space with the crankcase casting, into which the intake opens, transfer being controlled by movement of the piston. The design relies on the lower cylinder threads themselves to seal this annular intake volume off from the crankcase. To this end a relatively deep thread is used and the threads are well formed. Certainly this is a simple solution to what could have been a difficult production problem and it appears to work quite satisfactorily.

An extremely thin walled piston is mounted on the connecting rod with a ball and socket joint. It is hardened and ground to bore size and to achieve this and still leave the material inside ductile enough to peen over to trap the ball-end connecting rod, all surfaces of the piston other than the outside walls are copper plated. Thus these surfaces do not harden during the hardening treatment. The connecting rod itself is machined and is extremely thin—only ·118 in. diameter at the bottom end and tapering off towards the top ball end.

The crankshaft is also quite tiny, $\frac{1}{4}$ in. overall diameter stepping down at the front to a $\frac{3}{16}$ in. diameter threaded length. It is quite substantially counterbalanced on the web and the whole shaft is hardened with journal surfaces and $\frac{1}{8}$ in. diameter crankpin ground to finish. The shaft runs simply in a hole drilled and reamed in the solid front section of the crankcase casting in terms of what can best be described as a "rattling good fit". Certainly there is enough play at the front of the bearing actually to *see* the clearance space, whilst examination of the shaft itself shows it to be running on two high spots, one at each end of the bearing.

The cylinder head is a light alloy machining which screws into a recessed portion in the top of the cylinder, incorporating an integral glow plug which is essentially a separate unit pressed into the head and then lightly peened to lock in place. A burnt out element calls for a replacement head, although it would appear readily possible to adapt the head to take a standard glow plug, should this become necessary (*e.g.*, for engines purchased in this country and failing a supply of replacement heads). It is rather surprising, in fact, that an integral element has been used in an engine of this size.

Summarising, a very clever design and a nicely made engine which, for its price, must be something quite exceptional in value in the States. We endorse its easy starting and good running characteristics, but it is rather a "lot of engine" for the power it delivers.

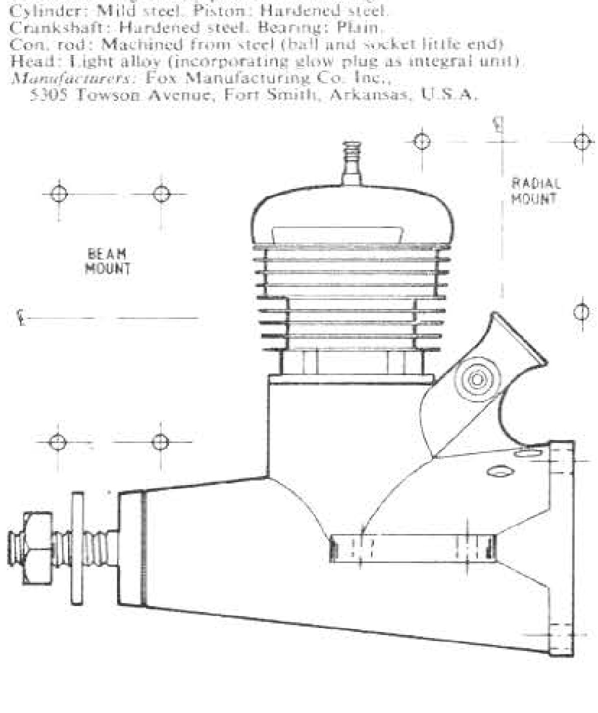
PROPELLER — R.P.M. FIGURES

diameter x pitch	*r.p.m.*
7 x 4 Frog nylon	10,000
6 x 4 Frog nylon	15,200 (14,500)P
8 x 4 Trucut	8,800
8 x 3 Trucut	9,400 (9,200)P
7 x 4 Trucut	10,800
7 x 3 Trucut	12,600 (12,000)P
6 x 4 Trucut	12,700
6 x 3 Trucut	13,400 (13,000)P

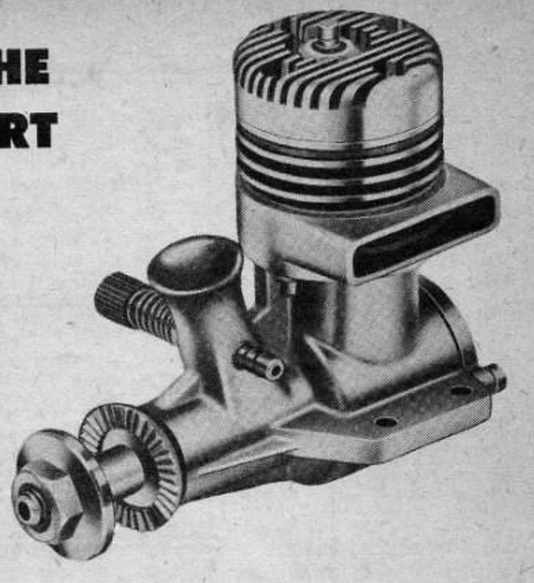
25 per cent. nitromethane content in standard methanol/castor fuel
P straight methanol/castor fuel.

SPECIFICATION

Displacement: 1·639 c.c. (·099 cu. in.)
Bore: ·530 in. Stroke: ·453 in.
Bore/Stroke ratio: 1·17 Bare Weight: 3 ounces.
Max. B.H.P.: ·084 B.H.P. at 14,000 r.p.m.
Max. Torque: 8 ounce-inches at 9,000 r.p.m.
Power rating: ·051 B.H.P. per c.c.
Power/Weight ratio: ·028 B.H.P. per ounce
Material specification:
Crankcase: Light alloy pressure die-casting.
Cylinder: Mild steel. Piston: Hardened steel.
Crankshaft: Hardened steel. Bearing: Plain.
Con. rod: Machined from steel (ball and socket little end)
Head: Light alloy (incorporating glow plug as integral unit)
Manufacturers: Fox Manufacturing Co. Inc.,
5305 Towson Avenue, Fort Smith, Arkansas, U.S.A.



LOGGING THE MOTOR MART



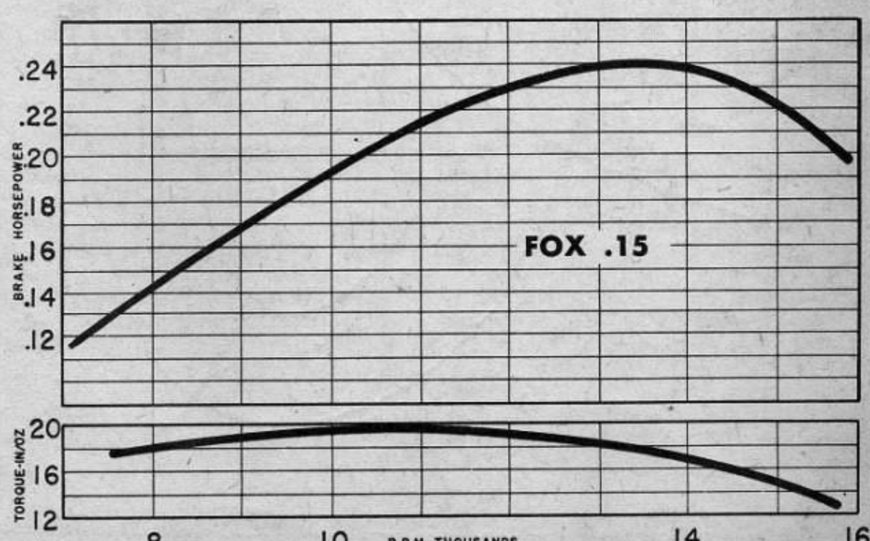
FOX. .15

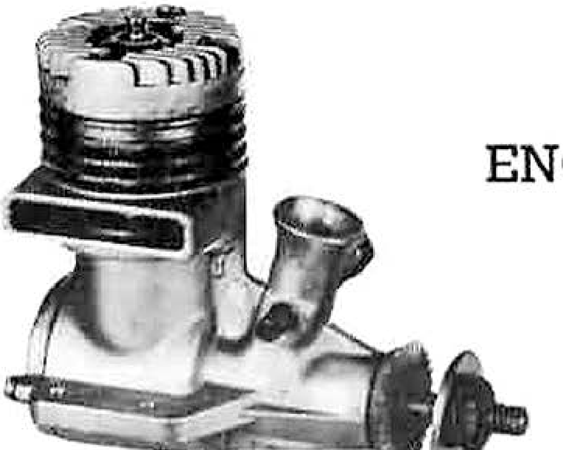
DATA:

Bore: 59"
Stroke: .55
Displacement: .15 cu. ft.
Bore to stroke ratio: 1.07 to 1
Bare weight: 3.8 oz.
Max. torque: 19.6 in. oz. at 11,000 r.p.m.
Max horsepower: .24 at 13,400 r.p.m.
Power rating: 1.6 h.p. per cu. in.
Power to weight ratio: 1.01 h.p. per lb.
Cylinder head: Die cast aluminum, 4 mounting screws No. 4-48, .010" aluminum gasket
Cylinder: Steel alloy, squared ports, lapped fit with piston
Piston: Melhanite, 1/10" high baffle; flat top
Piston pin: Hardened steel rod, no end pads
Connecting rod: Die cast aluminum
Crankshaft: Hardened steel, counterbalanced, squared port, spline drive, No. 10-32 threads
Crankcase: Die cast aluminum includes 3/8" i.d. bronze bearing, beam mounting lugs, right-hand exhaust, venturi intake
Spray bar: Brass, press fit in intake, 2 rings for fuel-line sealing
Prop mounting: 3/16" diameter hole required, No. 10-32 nut
Manufacturer: Fox Manufacturing Co., Fort Smith, Arkansas
Price with glowplug—$6.95

● The Fox .15 is what might be called "A real good engine." It is low in first cost and if the materials used are as good as the larger Fox engines, and they appear to be, the .15 should outwear many models.

The engine handles easily with hot or cold starts and is not easily flooded if one remembers that it is not a through exhaust type engine. Speed adjustment is quite broad and a range of props from 6" through 10" in diameter are handled well. It was noted that the coiled spring to retain the needle valve setting has an interesting action. After creeping up to the maximum r.p.m.'s, by adjusting the needle valve while watching the strobotac, the r.p.m. readings always dropped when we let go of the needle. The spring, it seems, was partly wound up by the needle being turned for adjustment and returned to a slightly rich setting when the finger pressure was removed. The action, of course, is just what should be done before launching a model because the engine will lean out in the air due to the reduced prop load.





ENGINE ANALYSIS No. 61

by R. H. Warring

FOX 15

American 2·5 c.c. glow-plug engine rapidly gaining popularity in Britain

THE Fox 15 is a beautifully compact 2·5 c.c. glow motor weighing just 4 ounces. Whilst not specified as an out-and-out "performance" engine, it also packs a healthy power output, peaking at nearly ·22 B.H.P. between 13,000 and 14,000 r.p.m. This, of course, is a static test figure which is always unflattering to glow motors. In the air they appear to have the ability to speed up far more than diesels which is why a static power figure—or even a static propeller r.p.m. figure—is very rarely a fair comparison between these two types.

The specimen tested had already had some use and was well run in. Main bearing fit was quite slack and there was very little compression when turned over—typical of the "ideal" set up for a high-revving glow motor. That last comment, in fact, characterised the Fox 15. It is a high speed motor and is not particularly happy either for starting or running at speeds below about 10,000-11,000 r.p.m. Yet its running is steady and sustained well past the peak, up to an 18,000 plus figure achieved on a tiny plastic propeller.

Needle valve control proved somewhat sensitive on the fuel used (Mercury No. 7). The Fox 15 definitely seems to prefer a lean mixture for starting (one, or at the most two, choked turns), and a slightly rich setting for running. Running on a lean mixture it had a tendency to cut abruptly due to a slight change in the fuel supply—probably aggravated by the fact that the effective suction lift is quite small. Excessive choking or priming for starting simply produced a "wet" engine which showed no signs of clearing itself.

Apart from this tendency to be slightly critical on needle setting, running was very consistent at all load-speeds above 12,000 r.p.m. Possibly some slight gain in performance could have been realised with a more highly doped fuel (Mercury No. 7 containing only 13 per cent. nitromethane) but could not be expected to come up to top racing performance. But for sport flying and control line work, the Fox 15 is a most useful power plant.

For free flight an 8 x 4 propeller would appear best; and possibly 7 x 6 for control line.

Constructionally the Fox 15 features a soft mild steel cylinder machined with integral fins. A substantial flange takes the exhaust port cut-out at one side, and diametrically opposite, the transfer is machined upwards into it in a half-moon shape. The transfer overlaps the exhaust to a considerable degree and opens only very shortly after the exhaust.

The piston is of lightweight form, machined from cast iron, and with a flat deflector offset to the transfer side on the top. The fully-floating gudgeon pin is quite small (only 1/8 in. diameter) and is unhardened while the cast cylinder head incorporates a shaped combustion chamber and attached to the cylinder with four mild steel Phillips head screws. Two of these screws are long and extend down into the crankcase casting to hold the cylinder unit in place and a gasket is fitted for sealing the cylinder flange against the crankcase casting.

Walls of the casting are quite thin, especially in the crankcase bottom itself, but strength appears quite adequate. The main bearing is bushed with a bronze sleeve which is micro-finished to bore size.

The 1/4 in. diameter hardened steel crankshaft steps down sharply to a 3/16 in. diameter threaded length, its intake port is cut square and the crank web is machined away in rather elaborate fashion for weight saving and balance. Crank pin diameter is 5/32 in. (nominal).

A cast propeller driver locates on three splines machined on the crankshaft and butts right against the main section of the shaft. The shaft at this point does appear a little vulnerable, particularly as it is hardened.

Specifications

Technical Data

Displacement: 2·415 c.c. (·147 cu. in.)
Bore: ·591 in.
Stroke: ·537 in.
Bore/Stroke ratio: 1 : ·908
Bare weight: 4 ounces
Max. power: ·218 B.H.P. at 11,500 r.p.m.
Max. torque: 18 ounce-inches at 11,000 r.p.m.
Power rating: ·09 B.H.P. per c.c.
Power/Weight ratio: ·055 B.H.P. per ounce

Material Specification

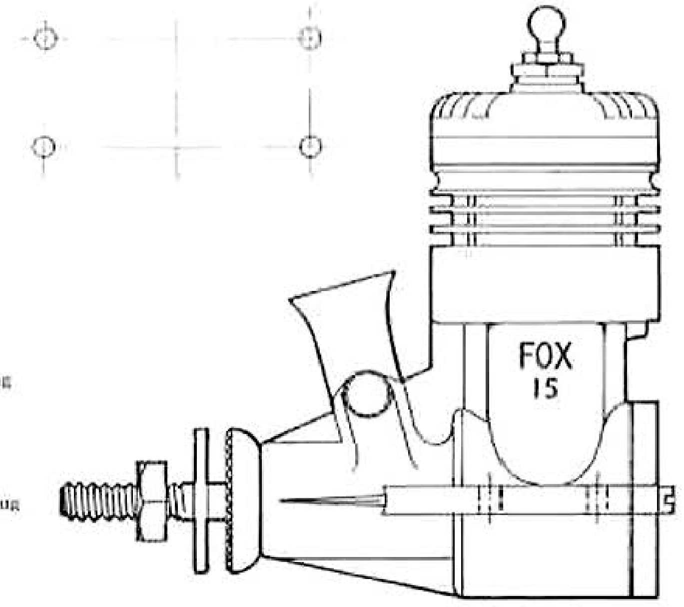
Cylinder: Mild steel
Piston: Cast iron
Crankcase: Light alloy die casting
Connecting rod: Light alloy die casting
Cylinder head: Light alloy casting
Main bearing: Hardened sleeve
Crankshaft: Hardened steel
Propeller driver: Light alloy casting
Spraybar: Brass
Back cover: Light alloy die casting
Glow Plug: Standard KLG glow plug used for tests

Manufacturers

FOX MANUFACTURING COMPANY INC.,
Fort Smith, Arkansas, U.S.A.

Importers

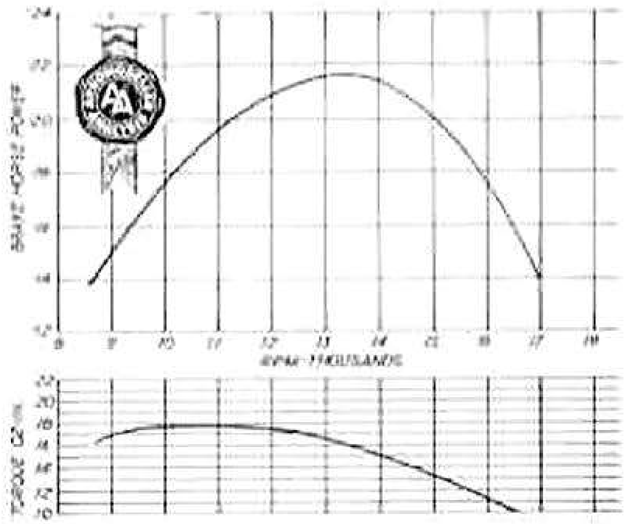
H. J. NICHOLLS LTD.,
308 Holloway Road, London, N.7



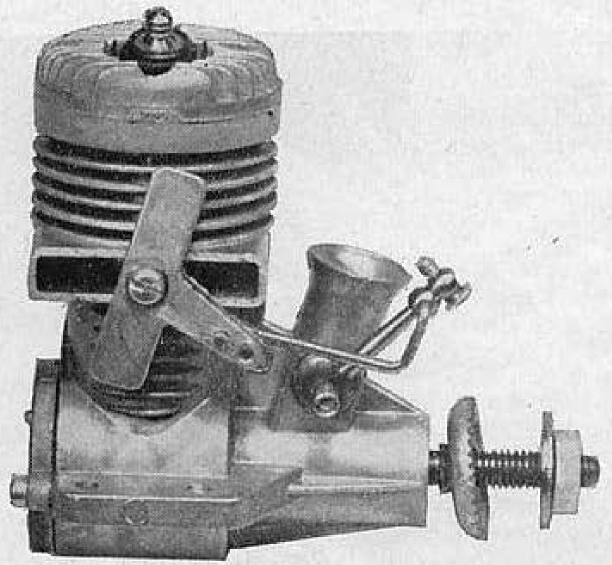
Propeller—R.P.M. Figures		
Propeller dia. x pitch		*r.p.m.*
7 x 4	(Frog nylon)	14,250
8 x 4	(Tiger)	13,200
9 x 4	(Trucut)	10,200
8 x 4	(Trucut)	12,800
8 x 3	(Trucut)	13,000
7 x 4	(Trucut)	14,900
7 x 3	(Trucut)	15,800
6 x 3	(Trucut)	16,500

Fuel used: Mercury No. 7

Prop speeds and Power curve



Altogether the workmanship and finish of the Fox 15 is excellent and we have nothing but praise for the way in which both the weight and overall size of the engine has been kept to a minimum, consistent with adequate strength and simplicity of design.



ENGINE ANALYSIS

NUMBER 124

By R. Warring

FOX 15 R/C

DUKE FOX is one of those energetic engine manufacturers who has gone out to produce just about every type and size of engine modellers could want—all glow, of course—and at the same time appears never satisfied with a production design, for there are always new models, detail differences and re-designs coming out. The Fox 15 is one of the standard models which have survived unchanged since 1962 and in its straight or 'X' form offers high-revving performance at a very low price ($6.95 in America). Actually it is a little on the flimsy side for high speed work, and for such duties is made available with alternative (and much more expensive) crankcase, cylinder and piston and con. rod assemblies.

The Fox 15 R/C features the normal 'X' construction plus an original design of throttle unit and otherwise appears unchanged. A substantial aluminium spacer, approximately $\frac{1}{16}$ in. thick, is fitted under the head to increase the head volume and thus reduce the compression ratio, making it suitable for operating on low-nitro fuels (with, naturally, a loss of high speed performance). We found the 15 R/C ran smoothly and well on a straight fuel.

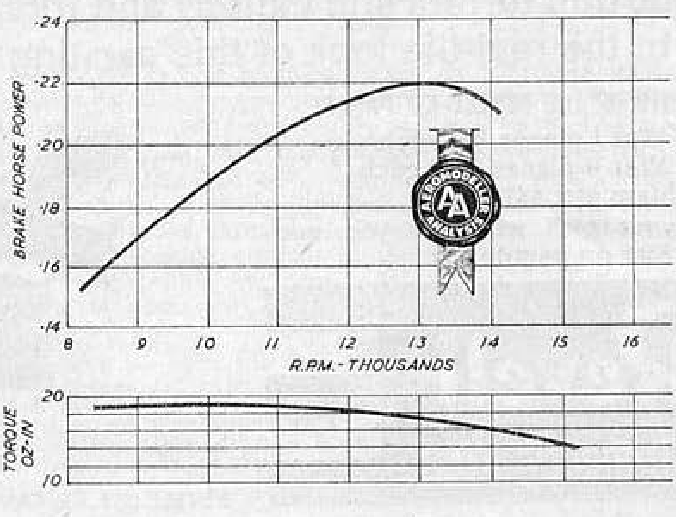
The throttle unit is interesting, not only because it is different from the usual barrel type but also because of its efficiency in providing positive progressive response and rapid pick-up from slow running to full throttle. We found it virtually impossible to 'beat' the throttle by even the most rapid movement, and pick-up was just as rapid after running at slow speed for an extended period. In fact, it is about the best functional throttle we have come across to date on an engine of this size—and ideal for radio control.

We originally thought that it would prove troublesome through air leakage, since the moving throttle assembly is a very loose fit in the intake tube, with plenty of slack movement from side to side. This does not appear to have any effect on running, so can only be said to be advantageous in providing a very free throttle movement.

The throttle starts off life as a typical 'barrel' or cylinder which can rotate in the intake but the centre section is reduced by flats on either side to give what is, in effect, a rectangular spray bar with spray holes in each of the flats. In the normal (open) position, it does present a normal thick spraybar appearance, in fact. Rotation of the throttle then turns the flats until they become angled to the airflow entering the intake, presenting progressively more and more restriction. The bulk of the intake area is closed in the 'slow' position, but with a compensating air passage provided by a groove at the top of one of the flats. This throttle movement — more of a 'butterfly' than a barrel action—is connected to a conventional exhaust flap by a wire link, producing a marked degree of silencing in the slow running position.

A simple adjustable stop is provided by a screw in the top of a wire arm for the slow running setting, this screw bearing against the front of the stub exhaust casting. There is no forward or high speed stop, which is a bit disconcerting for bench running since the throttle can be advanced past the full speed position and start again to act as a throttle by richening the mixture once more. If pushed too far forward the top of the arm carrying the 'stop' screw can foul the propeller. In a model installation, of course, it would be a simple matter—and necessary —to arrange for a high speed 'stop' on the actuating linkage to position the throttle correctly for fast running. This position is not critical, nor is the slow speed running adjustment. Whilst it is possible to adjust the latter to give bare 'tick-over' revs of the order of 3,000 r.p.m. or less, we found that this did to some extent modify the instant response of the throttle, especially when using a small propeller. It was found best to sacrifice some speed at the slow end and adjusting to drop the normal flat-out speed by about one half. This should still result in sufficient loss of thrust for most R/C applications.

Constructionally the Fox 15 R/C is fairly orthodox American practice—as far as a Fox engine is



ever orthodox—with a very light, thin-walled crankcase casting incorporating cylinder and intake tube. A stub exhaust is cast integral with the cylinder with a pillar in the centre which is tapped for the screw holding the pivoted exhaust flap (also a pressure die casting).

Component materials

The cylinder liner is of soft steel, with thin walls with a narrow flange at the top to locate the liner for depth when inserted in the crankcase unit. Transfer and exhaust ports are rectangular in shape and cut directly in the liner walls. The corresponding transfer passage is of generous proportions and formed in the casting.

The piston is of cast iron, again unhardened, and is of plain form, thin-walled, with a relatively tall and thin deflector on the crown, arc-shaped at the top to match the contours of the head. Connecting rod is a light alloy pressure die casting or forging, and the gudgeon pin is press fitted. The finned head is a pressure die casting and is relatively deep with a considerate mass of metal. Head shape is contoured with the plug offset to one side and angled. The head attached via four Phillips head screws extending down into the crankcase unit with the aforementioned spacer fitting a machined groove in the bottom face of the head and resting on the flanged top of the liner. If this spacer is removed there is virtually no clearance between the piston deflector and head at top dead centre.

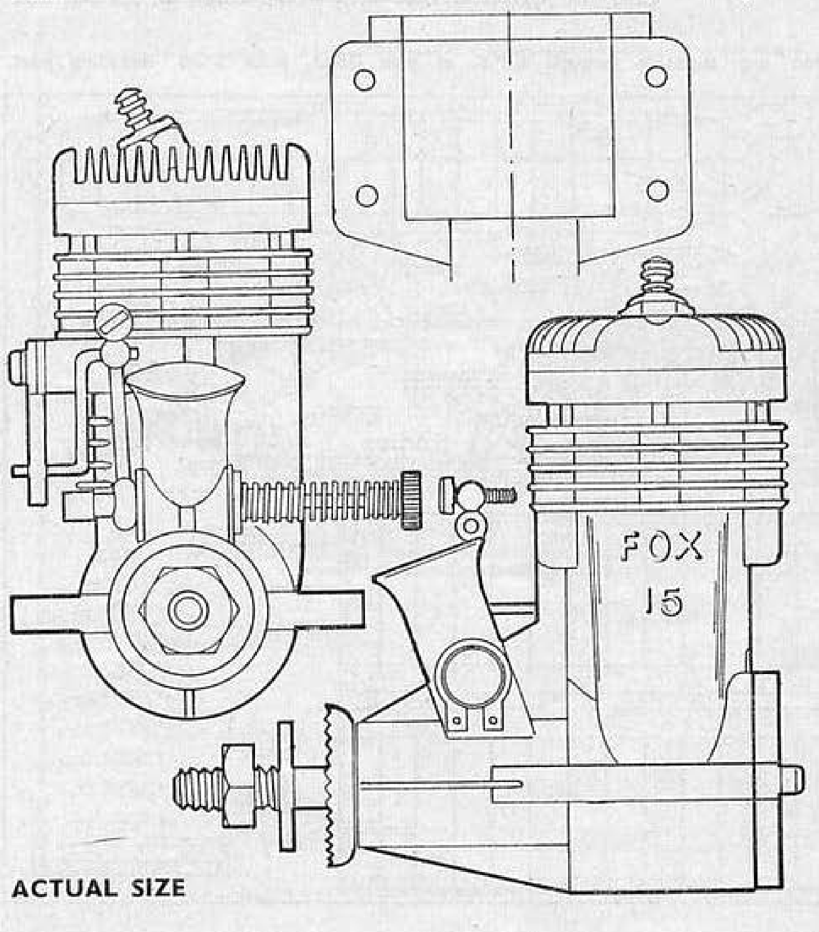
Crankshaft is of hardened steel $\frac{3}{8}$ in. diameter, stepping down abruptly to a .189 in. diameter threaded length immediately in front of the journal. Intake port is $\frac{5}{16}$ in. x $\frac{1}{4}$ in. cut square, opening into a $\frac{1}{4}$ in. diameter central hole in the shaft. The crank web is circular in form with a machined crescent shaped counterbalance weight. Crankpin diameter is .155 in. The shaft runs in a well fitted bronze bush, journal length being only 1 in. If anything the shaft appears to be slightly 'waisted' giving a slightly tight, but by no means excessively tight fit.

Immediately in front of the journal the shaft is keyed to take the prop driver, which is a simple and very light alloy casting with a good serrated gripping face. We feel that the protruding length of shaft is on the vulnerable side, and another minor criticism here is that the prop retaining nut could have been a full nut to advantage, rather than a half (thin) nut.

A sportsman's engine

The test was made on the basis that here is an R/C engine designed to run on the cheapest possible fuel. No attempt has been made to extract absolute power in the accompanying figures. We have used the engine just as would an average sports flier. Reducing the thickness of the spacer under the head to increase the compression ratio would undoubtedly improve performance, although possibly at the expense of needing nitrated fuel to promote smooth running at high speeds. On straight fuel we took test running up to 15,000 r.p.m. and beyond with propellers and running remained quite smooth.

Summarising, we would rate the Fox 15 R/C high as a radio model engine, especially for smaller models where power requirements are not so critical and light weight is useful. It scores particularly on having a very good throttle and a low level of vibration when running. It is also an extremely light engine for its displacement and therefore suits many 1.5 c.c. designs.



ACTUAL SIZE

Specification

Displacement: 2.42 c.c. (.1476 cu.in.).
Bore: .590 in.
Stroke: .540 in.
Weight: $3\frac{3}{4}$ oz.
Max. power: .22 B.H.P. at 13,000 r.p.m.
Max. torque: 19 oz.-in. at 10,000 r.p.m.
Power rating: .091 B.H.P. per c.c.
Power/weight ratio: .059 B.H.P. per oz.

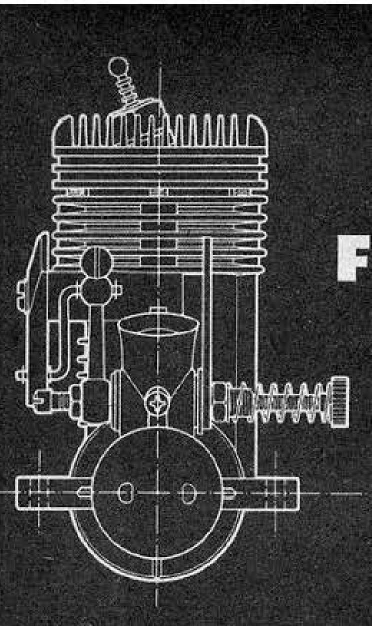
Material specification
Crankcase unit: pressure die cast light alloy.
Crankcase back cover: pressure die cast light alloy, attached by two screws.
Cylinder liner: Leaded steel (unhardened).
Piston: cast iron.
Cylinder head: light alloy pressure die casting.
Connecting rod: light alloy.
Crankshaft: alloy steel, hardened and ground to finish.
Main bearing: bronze.
Throttle: rotating spraybar in brass; unit retained by spring circlip.

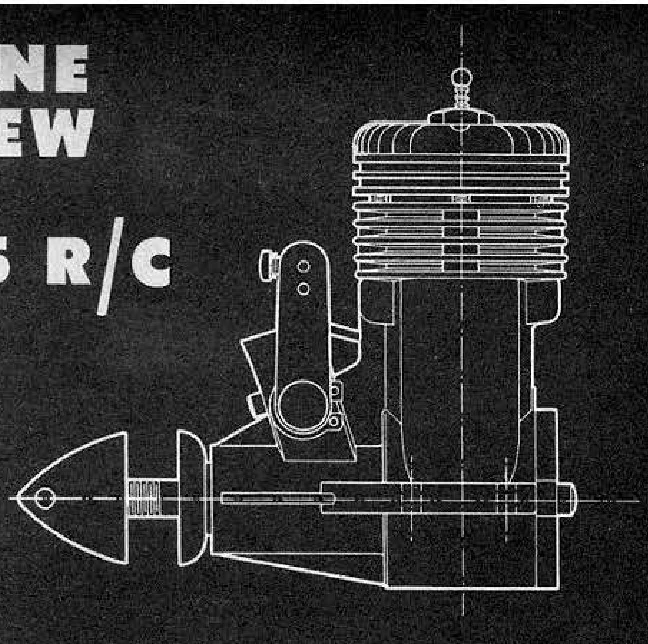
Propeller — R.P.M. Figures

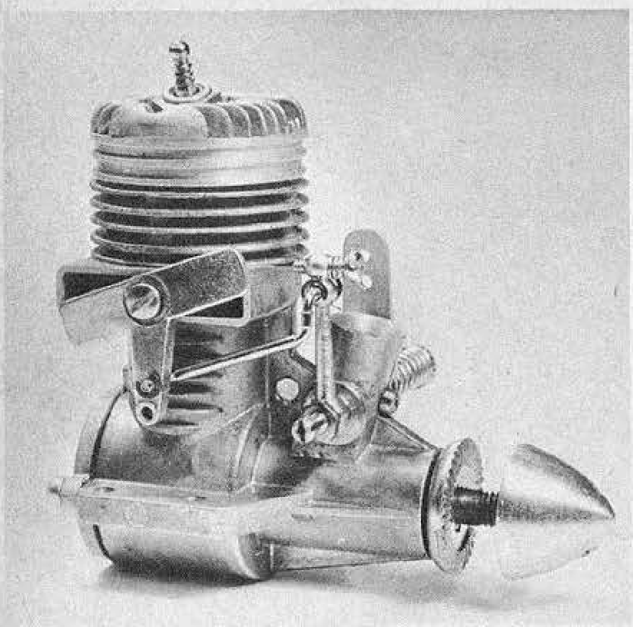
Top Flite (nylon)	8 x 6	10,200
	9 x 4	10,500
	8 x 4	13,200
	7 x 4	14,900
Trucut	8 x 4	13,000
K-K (nylon)	9 x 4	10,800
	8 x 4	12,800
	7 x 6	12,400

Fuel used: Mercury 45.

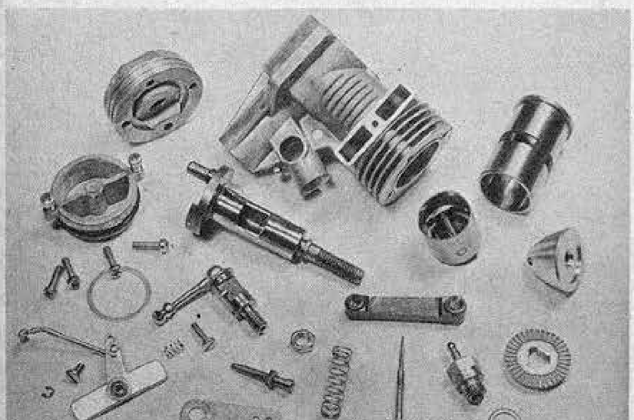
ENGINE REVIEW • FOX .15 R/C



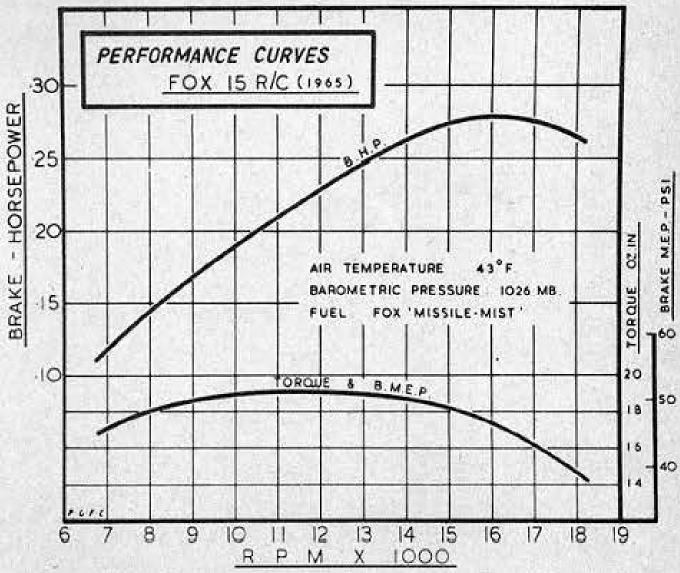




External changes are minor and include spinner-nut, machined head, extra throttle arm and improvements to the throttle linkage and adjustment.



The inside story of the new .15 R/C. Included are more costly 15XX grade piston and connecting rod, plus new twin jet throttle and E ring clips.



By P. G. F. CHINN

NEW DELUXE VERSION OF THE OLD LOW-PRICED FOX .15 R/C HAS NUMEROUS REFINEMENTS AND BIG BONUS IN POWER.

► Three years ago Fox announced the first Fox 15 R/C based on the low-priced 15X engine and costing only $8.95. The new 1965 15 R/C is a development of this engine and is listed at $14.95.

At first sight, the $6 price increase may seem to be hard to justify, since external changes do not appear to be all that significant.

Therefore, before we go any further with this report, we would like to put on record the following facts and findings concerning this new model.

1. The 1965 15 R/C is equipped with the special piston/cylinder assembly and connecting-rod that were the main features of the $15. Fox 15XX competition engine.
2. The original 15 R/C, when fitted with these XX grade parts was sold, to special order, at $20.
3. The 1965 15 R/C has many additional refinements including a more complex throttle. (*Continued on page* 56)

4. The power output of the 1965 15 R/C is greatly improved, the peak bhp on test being raised by over thirty percent compared with the original 15 R/C. The new engine is also very slightly lighter.

Let's take a closer look at the modifications that have been made to the new engine.

To take the throttle assembly first, a machined steel throttle valve rotor, with separate high-speed and low-speed jets, is used in place of the earlier brass rotor which had no provision for adjusting idling mixture strength. The rotor (of the usual Fox pattern in which intake air is directed each side of a flattened center portion instead of through a cross-hole) is drilled axially and threaded to take, from the right-hand side, a brass needle-valve jet and, from the opposite side, the externally threaded valve needle. The fuel metered by the needle-valve and released into the interior of the rotor, is then fed into the intake via two jet holes, one (the idling jet) placed in the center of the rear "flat" and the other one (the high-speed jet) placed in the bottom of the rotor and offset to one side.

Since the rotor is supported in a circular bore intake, this offset location of the high-speed jet means that it is only exposed when the throttle approaches the open position. At low speed settings, the jet is masked by the surrounding housing and thereby becomes inoperative. The idling jet, on the other hand, remains exposed at all times and feeds continuously.

The correct mixture strength for normal full speed running is controlled by the needle-valve in the usual way. However, as we have already remarked, the same needle-valve also feeds the idling jet. Therefore, to effect control of the amount of fuel released by the idling jet, this has its own metering adjustment. To operate it, one first removes the fuel delivery tube, thereby uncovering a small screwdriver slot in the end of the brass inlet fitting that is also the needle-valve jet. After slackening the locknut on this, one can screw the brass jet in (to lean out the idling mixture) or out (to enrichen idling mixture). The brass jet is, itself, acting as a needle valve here, since its tip, (in addition to being drilled to accept the regular needle-valve tip), is extremely tapered and projects beyond the position of the idling jet hole and thereby controls the amount of fuel fed back to the idling jet.

As before, the throttle is coupled to a centrally pivoted plate type exhaust valve but many refinements have been made to the whole assembly. Formerly, provision for escapement or servo linkage was on the exhaust valve only. On the new engine, an additional (and adjustable) actuating arm is fitted on the left hand side at the carburetor. There is also a stop screw in the front of the carb to set the full-speed position and, on the stop screw which sets the idle adjustment, a spring has been added to reduce the risk of this becoming unscrewed through vibration. Spring retaining clips are now fitted to both ends of the rod coupling the exhaust plate to the carburetor throttle.

The main body casting of the engine is basically the same as the original model except for a shorter, bigger bore intake. This has had approximately 9/64 in. machined off its height and about .018 in. added to its bore. The cylinder head retains the familiar Fox wedge pattern combustion chamber, but has the addition of two annular fins or ribs externally. Superficially, the drop-in leaded steel cylinder liner is unchanged. However, closer examination reveals that the cylinder ports have been lowered quite substantially and this has had the effect of reducing the exhaust and bypass durations by around 12 degrees. Our measurements gave the new 15R/C an exhaust timing of 68-68 deg. and a bypass timing of 60-60.

The decompression spacer used under the cylinder head on the original 15 R/C and 15X, is omitted and an extra 10 thou. gasket is added in its place. The substantially higher compression ratio resulting from this, contributes much of the improved power of the new model. The glowplug is now a Fox Shieldmaster short-reach R/C type with disc pattern shield. The improved piston, as on the 15XX engine, is lightened by having unwanted metal milled away each side of the wrist-pin bosses but leaving an annular rib above the wrist-pin to minimise ovality. An unusual feature of the piston is the fitting of the wrist-pin which is semi floating and can only be inserted from the front, the rear wrist-pin hole being very slightly tapered. The 15XX grade connecting rod, replacing the cheaper pressure diecast rod of the older model, is fully machined from 24ST aluminum and is color anodized red.

Finally, appearance has been improved with the substitution of the regular hexagon prop nut by a neat machined aluminum spinner-nut.

Two samples of the 15 R/C were submitted for test and examination indicated that they had been run only very briefly. However, virtually no break-in time was called for. Naturally, we were cautious about leaning out the engines too soon, but a short series of runs totalling no more than 15 minutes on each, convinced us that both were ready to be given their head. Just to make sure that they would be sufficiently loosened up before being tested for power output, however, we put in a further 30-40 minutes running on each engine. The opportunity was taken to record some prop rpm readings during this time and these yielded the following averages on Missile Mist fuel: 8900 rpm on 10x3½ Top-Flite wood, 9,900 rpm on 9x4 Tornado nylon, 10,500 rpm on 8x6 Top-Flite nylon, 12,200 rpm on an 8x4 Power-Flite nylon, 14,200 rpm on an 8-4 Power-Prop, 15,000 on a 7x4 Tornado nylon and 16,700 rpm on a 7x4 Power-Prop.

These prop figures seemed to indicate that the 1965 15 R/C would have a somewhat different torque curve than the earlier model and would peak at substantially higher rpm. This much was, in fact, confirmed by the dynamometer test in which maximum torque rose from less than 17 oz.in. to over 19 oz.in. and maximum power was realised at just over 16,000 rpm instead of slightly less than 14,000 rpm. The actual peak bhp recorded on our test was very nearly 0.28 bhp compared with 0.21 bhp for the original engine.

Incidentally, after we had completed tests on the engine and plotted the performance curves, we noticed that the output of 0.28 bhp we had obtained was precisely the figure claimed in a recent Fox ad., as was 3500 rpm minimum idling speed obtainable on an 8x4 prop. We had found it possible to get the engine to idle as low as 3000 rpm but pickup was then unreliable: in fact, under the cold conditions obtaining at the time of testing, we found that the 15 R/C preferred to be set for an idling speed of about 3800-4000.

Starting was easy, the engine tending to prefer to be fairly wet for a cold start, but, when hot, re-starting readily without priming or choking, provided that the fuel line remained full. The 15 R/C would also re-start quite easily with the throttle in the idling position. The engine was easy to adjust, the needle-valve being especially non-critical.

To summarize then, the new 15 R/C unquestionably has many worthwhile advantages over the original model. It is light, powerful (it is certainly one of the most powerful R/C 15's available anywhere) and easy to handle. One final point: its appetite for glow filaments seems to be commendably modest: no plugs were burned out during extensive tests which included running speeds of up to 18,000 rpm.

Summary of Data

Type: Loop-scavenged two-stroke cycle with shaft rotary-valve induction. Coupled intake and exhaust throttle valves.

Weight: 3.7 oz.

Displacement: 0.1476 cu.in. (2.419 c.c.)

Bore: 0.590 in. Stroke: 0.540 in.

Stroke/Bore Ratio: 0.915 : 1

Specific Output (as tested): 1.88 bhp/cu.in.

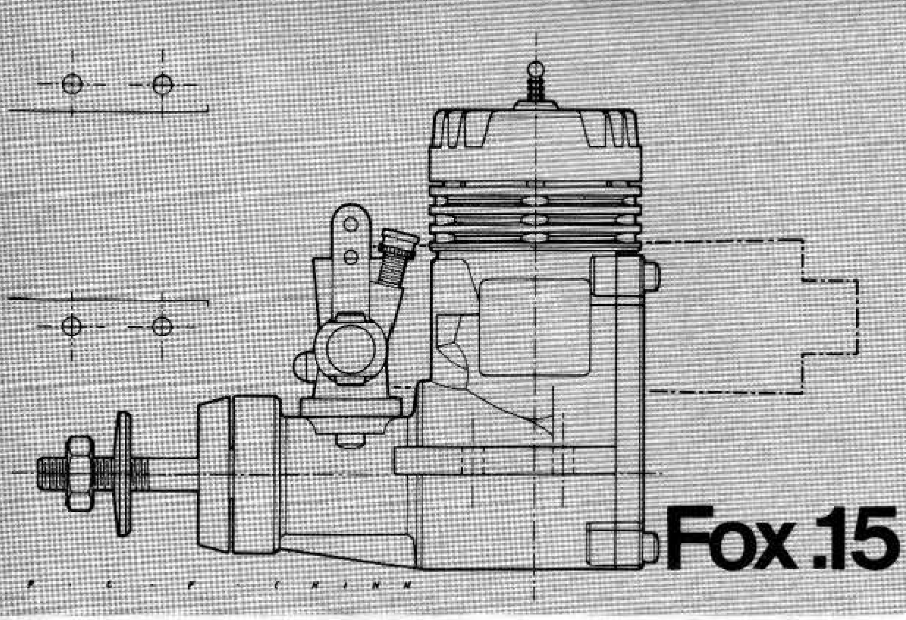
Power/Weight Ratio (as tested): 1.20 bhp/1b.

Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas, 72903.

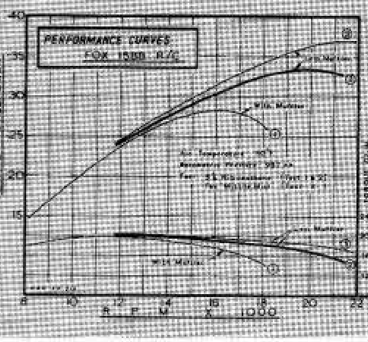
Price: $14.95

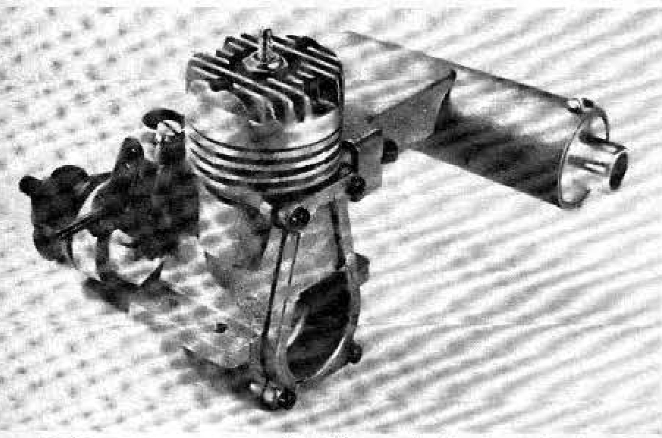
ENGINE REVIEW

BY PETER G. F. CHINN

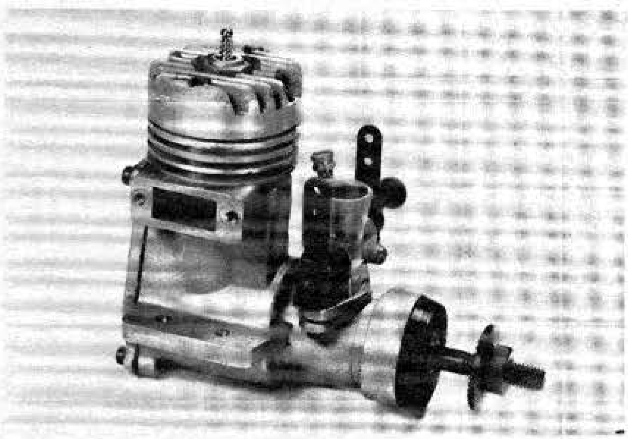


Fox .15





Engine carries no name or identifying marks but is unmistakably Fox!



Dual throttle arms are adjustable, prop stud replaceable as well.

This new model Fox 15 features Schnuerle porting, twin ball bearings, interchangeable heads with lots more top power.

• This recently introduced Schnuerle-scavenged motor is the first entirely new Fox 15 for nearly fifteen years; that is to say, since the 15X replaced the original Fox 15 model in January 1962. Over the years we have dealt in these columns with five engines based on the 15X design: the standard 15X and 15XX contest engine, the 15X R/C and the 1965 and 1970 15 R/C models.

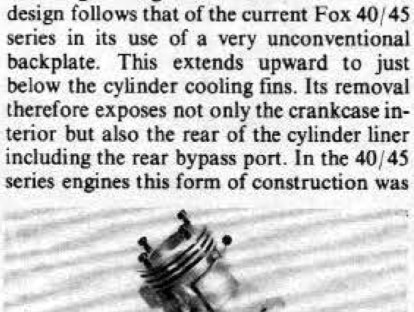
All these earlier Fox 15's were open-loop or crossflow scavenged motors with bushed main bearings and were notable for their compact overall dimensions, light weight (under 4 oz) and low cost (the standard 15X originally sold for only $6.95). The new Schnuerle-scavenged engine is physically larger, is more heftily constructed and offers the option of a bronze bush or twin ball-bearings to support the crankshaft.

For this report we chose the ball-bearing model. Most of the component parts are common to both versions but where they differ is explained in the design and construction notes that follow.

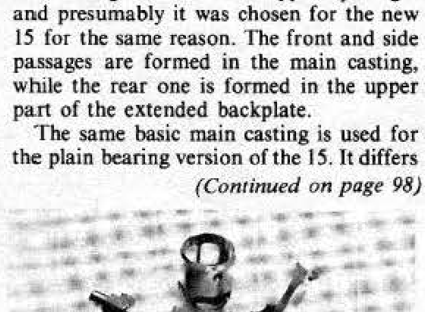
MAIN CASTING. The main casting comprises the crankcase, cylinder jacket and bearing housing. It embodies large beam mounting lugs, a rectangular exhaust stack and a flat diamond shaped saddle on which the flange-fitting carburetor is mounted. Its design follows that of the current Fox 40/45 series in its use of a very unconventional backplate. This extends upward to just below the cylinder cooling fins. Its removal therefore exposes not only the crankcase interior but also the rear of the cylinder liner including the rear bypass port. In the 40/45 series engines this form of construction was adopted to simplify the problem of coring the casting for the three bypass passages and presumably it was chosen for the new 15 for the same reason. The front and side passages are formed in the main casting, while the rear one is formed in the upper part of the extended backplate.

The same basic main casting is used for the plain bearing version of the 15. It differs

(Continued on page 98)



New 15 resembles current Fox 40/45 series in layout with usual crankcase and backplate.



New Cylinder head features interchangeable inserts for different compression ratios.

only in that it is fitted with a full-length bronze bushing and has the o.d. of the front housing machined down to a smaller diameter and tapered in profile.

CRANKSHAFT AND BEARINGS. The hardened steel crankshaft has a larger diameter main journal than that of previous Fox 15 motors. This is now 10 mm o.d. compared with ⅜" (9.5 mm) of the earlier models and runs in two 10x19 mm 9-ball steel-caged bearings. The integral solid crankpin is 4.7 mm (nominally 3/16") dia. and counterbalancing is by cutaway web flanks and a shallow crescent counterbalance.

The shaft is bored 6.35 mm (¼") for the gas passage which is fed from an 11 mm long rectangular valve port. This uncovers a parallel sided intake port for a 190° induction period, timed, according to our measurements, 40° ABDC to 50° ATDC.

At the front end, the shaft is fitted with a 3/16" dia. prop stud and has the familiar Fox short spline type fitting for the steel prop drive washer.

A different crankshaft is installed in the bushed bearing motor. It has a smaller crankpin (3.9 mm, or a nominal 5/32" dia.) on a 360° crankdisk with crescent counterweight. The shaft we examined also had a larger gas passage (6.7 mm or 17/64" i.d.).

CYLINDER AND PISTON ASSEMBLY. The drop-in steel cylinder liner has a 0.590" bore, a .048" wall thickness and is located in the casting in the usual way by a flange at the top. It has porting arrangements that are very similar to those of the Fox Hawk 60. The exhaust port is on the right side and is flanked fore and aft by bypass ports angled to direct incoming gas to the left side in the approved Schnuerle manner. Here the two streams are met by an upward flow from the inclined "third" or "boost" port but instead of using a single port of moderate area here, the 15, like its big brother, has two elongated ports of very large area.

Cylinder port timing features a long exhaust period of 160° of crank angle. The flanking bypass ports, according to measurements on our test sample, are open for 132° and the boost ports for 126° of crank angle.

The lapped piston, machined from Meehanite, has a flat deflectorless head and a wide skirt-port. Internally it is machined to provide adequate bosses for the wristpin plus an annular stiffening rib above the bosses. The unbushed connecting-rod is machined from extruded alloy bar and is coupled to the piston with a lightweight tubular wristpin. The latter has an o.d. of 3.9 mm (5/32" nominal) and is retained by wire circlips. Reciprocating weight, as in previous Fox 15s, is low. The bare piston weighs 5.4 grams or 6.1 gr. with wristpin. The conrod weighs 1.7 gr.

CYLINDER HEAD. This is of a new two piece design, comprising a finned die-cast outer component and a machined central insert or "button" as Fox calls it. The button plugs into the top of the cylinder bore and forms the combustion chamber, held in place by the finned part which is tied to the main casting by four screws. The idea is to enable different head buttons to be used for low, medium or high compression. The combustion chamber shape is unusual in that it comprises a wide (3.5 mm) sloped band surrounding a small diameter but deep central depression containing a Fox short-reach glowplug.

CARBURETOR. The unusual flange-fitting carburetor is of typical Fox design and differs appreciably from the R/C carbs used by most other manufacturers. It features a butterfly type, rather than a barrel type, throttle valve and has separate low-speed and high-speed jets, each with its own mixture adjustment.

The carburetor has a die-cast aluminum body into which is fitted a steel semi-rotary throttle valve. The latter is milled to form flats front and rear to allow intake air to pass each side of it when in the open position. It is drilled axially and threaded to take, from the left side, a conventional needle-valve and, from the opposite side, a threaded tubular fuel inlet fitting. The fuel, metered by the needle-valve and released into the interior of the throttle valve, is then fed into the intake via two jet holes. One of these (the low-speed jet) is placed in the front "flat" and the other one (the high-speed jet) is located in the bottom of the throttle-valve and offset to one side. Below the throttle valve the carburetor bore changes shape, as a result of which the offset high-speed jet is completely masked as the throttle is closed and the engine then runs only on its low-speed jet.

The correct mixture strength for full-speed running is determined, in the usual way, by means of the needle-valve. However, as noted in the preceding paragraph, the same needle-valve also feeds the low speed jet. To control the actual amount of fuel released through the low-speed jet, therefore, this has its own adjustment via the threaded inlet fitting previously mentioned. This fitting can be screwed in or out as required. The inlet fitting itself acts as a needle-valve here since its tip, in addition to being drilled to accept the main needle-valve tip, is externally tapered and projects just beyond the position of the low-speed jet hole in the throttle-valve. Its precise position thereby controls the actual amount of fuel fed back to the low speed jet.

Both adjustments are provided with ratchet devices to hold mixture settings and there are adjustable throttle arms on both sides. There is a screw at the rear of the carb for setting the idling speed.

The carburetor effective choke area is approximately 13 sq. mm., a quite generous area for a 2.5 cc motor.

MUFFLER. This resembles previous Fox closed front designs. It comprises a die-cast aluminum alloy body and inlet duct, with a machined bar stock full length tubular insert. The latter has an i.d. of 8 mm and exhaust gases escape into it via six entry slots on the side opposite that facing into the exhaust stack. The entry slots have a total area of approximately 60 sq. mm. while the outlet area is 50 sq. mm. The muffler fits firmly over the engine's exhaust stack and is secured with two hexagon head screws into threaded holes in the stack that are drilled and tapped to angle inwards.

The muffler weighs just over 1.2 oz.

PERFORMANCE. In the interest of easy starting, the bushing type Fox Schnuerle 15 is normally supplied with a low compression head button, whereas, with the ball-bearing motor, a medium compression head is the standard fitting. Our test motor, being of the latter type, was presumed to have the medium compression head. We checked the nominal geometric compression ratio and found this to be approximately 12.5:1 which is fairly high. One has to take into account, however, the engine's lengthy exhaust period of 160° which means that the effective compression stroke is slightly shorter than on engines having more conservative timing in the 130°—140° bracket. The medium compression head button used by the 15BB is stated to release somewhat greater power, still with reasonably easy starting characteristics. However, for those who wish to experiment and seek maximum contest performance from the 15BB, Fox will also be offering two high compression head buttons, one for use with FAI fuel and one for use with nitro.

For this new Fox 15, Duke Fox recommends either "Duke's Fuel" (approx 10% nitro) or "Missile Mist" (approx. 25% nitro). We started with a series of runs on our standard R/C test fuel (containing 5% nitro-methane) in order to obtain comparative sets of readings, both with and without muffler, and then later switched to Missile Mist for a third set of readings. The Fox ran perfectly satisfactorily on the standard 5% mix—in fact it fired steadily and smoothly and with only slightly less power on a straight 75/25 methanol/castor-oil break-in fuel. While this ability to run well on little or no nitro may be only of academic interest to the majority of readers, it is a point in the engine's favor so far as export markets are concerned because in most countries outside North America, nitromethane is still very expensive or, in some cases, completely unobtainable.

Fox 15's have never been noted for low speed torque and the new Schnuerle 15 is no exception. It likes to be allowed to rev. Maximum torque was realized at around the 12,000 rpm mark and, on 5% nitro, less muffler, our test unit actually reached its peak output at nearly 20,000 rpm where a figure of over 0.33 bhp was determined.

Adding the muffler made very little difference to the *maximum* torque recorded. With the engine loaded for speeds below 12,000 rpm, torque dropped off markedly but not noticeably more than had been the case without the muffler fitted. At higher speeds, however, the gap between the figures achieved with and without the muffler began to widen and, as the torque curve declined, the power curve levelled off to a much earlier peak at just over 16,000 rpm, power output being reduced to slightly above 0.28 bhp.

Switching to Fox Missile Mist fuel had only a slight effect on output when the engine was relatively heavily loaded but, when it was allowed to rev freely on a light load, the extra performance available on this more powerful fuel began to show itself. As a result, peak brake horsepower was lifted to 0.37 at around 21,500 rpm.

What all this means in terms of available performance on typical props is that if you are using anything larger than an 8x4 prop, it will make little difference which fuel you select or whether you use the muffler or not, since there will be only 200-300 rpm difference between the minimum and maximum speeds achieved.

For example, on Power-Prop 8x6 (11,500 rpm) and 8x5 (12,600 rpm) propellers, the 15BB was only 200 rpm faster on Missile Mist, less muffler, than on 5% nitro with muffler. In contrast, if you have a model that is small and light enough to fly on, say, a 7x3½ prop, you can expect rather different results. Checked on a Bartels epoxy-glass-fiber prop, our 15BB turned 17,700 rpm on 5% nitro with muffler, 18,700 rpm less muffler and 19,100 rpm on Missile Mist less muffler.

In practice it is probable that most users will opt for an 8x4 prop. We would suggest choosing one of the faster types—i.e. those having low torque absorption. On 8x4 Power-Prop (wood) and Taipan (nylon-glassfiber) props we obtained speeds in the 13,500 (5% with muffler) to 13,800 rpm (Missile Mist, less muffler) bracket but on a Cox 8x4, these figures can be raised upwards of 1,000 rpm to the 14,700—15,200 rpm bracket. This will bring the engine closer to its peak output and, on the muffler equipped engine, peak power should just about be reached on one of these props when the model is airborne and the engine speeds up under the reduced load conditions of actual flight.

Incidentally, we agree with Duke Fox that wood props are preferable in the interest of safety and although the Cox 8x4 seems quite strong enough to withstand the centrifugal loading of the speeds we recorded, the oft-repeated warning to keep behind the whirling prop, when the engine is running at, or near to, full throttle, still needs to be borne in mind.

Other props tried on the 15BB included 9x4 Top-Flite nylon (10,300 rpm), 9x4 Taipan nylon-glass (11,300), 7x6 Taipan nylon-glass (13,400), 6x7 Bartels epoxy-glass (15,000), 7x4 Power-Prop wood (17,300), 7½x3¾ Bartels epoxy-glass (17,600) and 7x3 Top Flite wood (20,600 rpm). These figures were recorded, less muffler, on Missile Mist fuel.

In terms of sheer power output, this new engine is, as one would expect, the most powerful Fox 15 to date. For example, its gross power output of 0.37 bhp at 21,500 rpm on Missile Mist is 27% higher than our previous best for a throttle-equipped Fox 15 on Missile Mist (0.29 bhp at 15,000 rpm for the 1970 model 15 R/C with high compression head).

Handling qualities of the new Schnuerle 15 were very good overall. The engine started from cold easily and warm restarts were practically first flip irrespective of whether the throttle was open or closed. We found the needle-valve adjustment a bit insensitive and it took a little time to find the optimum setting for each load but, as soon as this had been determined, the engine ran steadily and with a modest level of vibration. The throttle worked well. Straight out of the box, on an 8x4, the engine throttled down to a safe 2,800 rpm. This was combined with instant recovery and a good mid-range.

We used Fox short reach 1.5 volt R/C plugs for the tests. We changed them twice during the tests but all three survived. The engine itself also came through our rigorous test program in good shape.

Accompanying each of these new Fox 15's very informative notes on carburetors, which are well worth reading, incidentally, whether or not you are a Fox owner.

SUMMARY OF DATA.

Type: Single cylinder, Schnuerle scavenged two-stroke cycle with shaft type rotary-valve and twin ball bearings. Throttle type carburetor. Manufacturer's muffler optional.

Checked Weights: 6.0 oz (less muffler)
7.2 oz (with Fox muffler)

Displacement: 0.1504 cu. in. (2.464 cc)

Bore: 0.590" (14.99 mm)

Stroke: 0.550" (13.97 mm)

Stroke/Bore Ratio: 0.932:1

Measured Nominal Compression Ratio: 12.5:1

Specific Output (as tested):
1.88 bhp/cu.in. (5% nitro fuel, with muffler)
2.22 bhp/cu.in. (5% nitro fuel, less muffler)
2.46 bhp/cu.in. (Missile Mist, less muffler)

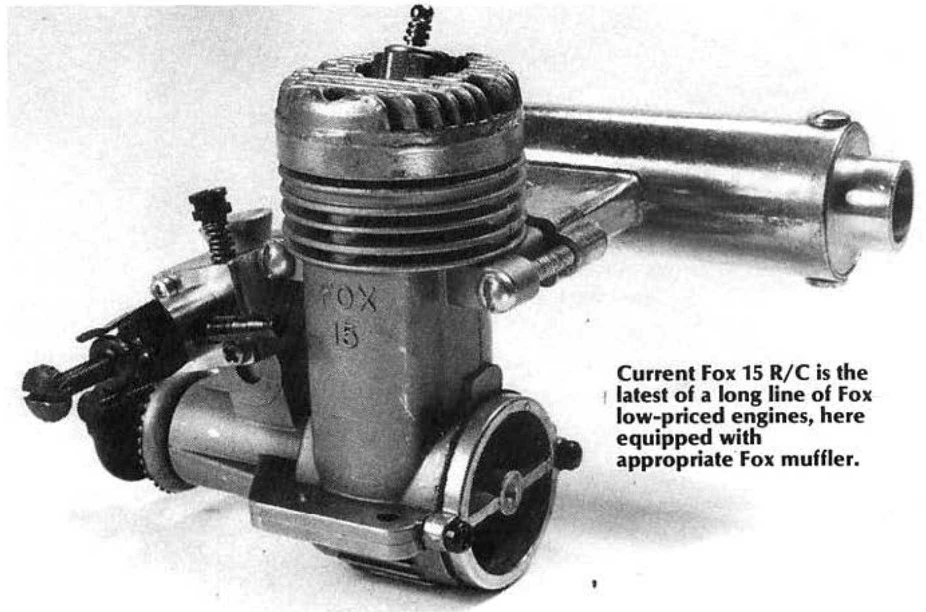
Power/Weight Ratio (as tested):
0.63 bhp/lb (5% nitro fuel, with muffler)
0.89 bhp/lb (5% nitro fuel, less muffler)
0.99 bhp/lb (Missile Mist, less muffler)

Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901. ■

FOX 15 R/C

SPECIFICATIONS

Type: Air-cooled, single-cylinder, side-exhaust two-stroke-cycle, with crankshaft rotary valve and crossflow scavenging.
Bore: 0.590 in. (14.99 mm)
Stroke: 0.540 in. (13.72 mm)
Displacement: 0.1476 cu in. (2.419cc)
Nominal Compression Ratio (full stroke): 7.5:1
Speed Control: Fox 2-needle automatic mixture control carburetor.
Checked Weights: 125 grams (4.41 oz) bare, 153.5 grams (5.41 oz) with muffler.
Mounting Dimensions:
Crankcase width: 24 mm
Length from prop driver face: 55 mm
Height above CL (less glowplug): 51.2 mm
Bolt hole spacing: 31.75x12.7 mm (1¼x½ in.)
Manufacturer's Claimed Power Output: Not stated. (See text.)
Manufacturer: Fox Manufacturing Company, 5305 Towson Ave., Fort Smith, AR 72901.



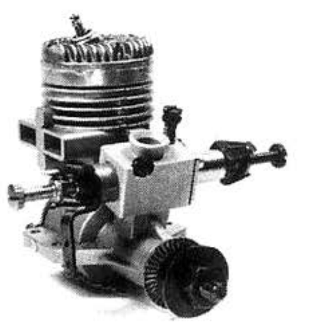
Current Fox 15 R/C is the latest of a long line of Fox low-priced engines, here equipped with appropriate Fox muffler.

THE old-established Fox company currently offers a choice of two engines in the .15 cu in. class. The more advanced of the two, the Schnuerle-scavenged 15BB, was dealt with in the December 1985 *M.A.N.*

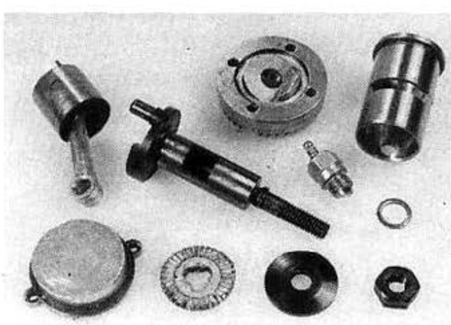
The other one, described here, is a much simpler engine, but is one that performs a vitally important function. The Fox 15 is by far the lowest-priced .15 size engine on the U.S. market and, these days, when we are quite used to seeing new engines that cost hundreds of dollars, it is as well to remember that young beginners still need low cost motors. The Fox 15 can be bought for little more than half the price of most other engines of the same displacement.

Why is it cheaper? Like many Fox engines, the 15 does not win any medals for a fancy outside appearance, but there is no lack of quality where it really matters. The fact that the Fox 15 can be so competitively priced, comes we would guess, from the fact that its major tooling costs must have been written off ages ago. Although it seems hard to believe, this engine had its origins in the Fox 15X of 1962. Faithful readers of the *M.A.N.* "Engine Review" columns who still happen to have their 1962 issues handy (!) can check this by referring to the July and December issues of that year for test reports on, respectively, the free-flight/controlline model 15X and the throttle-

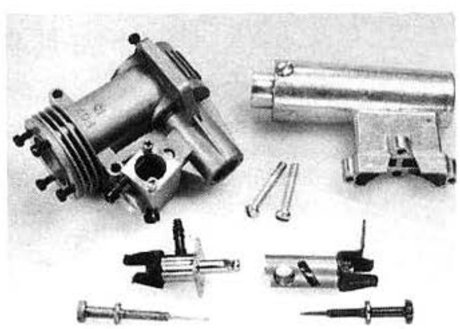
(Continued on page 106)



Latest Fox 15 R/C is fitted with new two-needle carburetor providing automatic mixture control.



Fox 15 uses traditional crossflow porting with lapped cast-iron piston running in steel cylinder sleeve.



Main casting with carburetor disassembled. Muffler is an optional extra and contains a slotted outlet tube to reduce noise.

FOX 15 R/C

(Continued from page 25)

equipped 15 R/C.

There have, of course, been periodic updatings (an improved 15 R/C was tested for the November 1970 *M.A.N.*) particularly in regard to the speed control system. Early models had pivoted exhaust baffles linked to the carburetor, until these were made obsolete by the adoption of mufflers. And to facilitate muffler installation, the engine's body casting has twice been modified with the addition of attachment lugs. The latest change has been the switch to a twin-needle type automatic mixture control carburetor like that fitted to the more expensive 15BB R/C model.

Looking at the engine as a whole, it is, as the photos show, a simple and straightforward design. A single casting embraces the crankcase, cylinder jacket and front housing and this uses an alloy having good bearing properties thereby eliminating the need for a bronze bushing for the ⅜ in. diameter crankshaft journal. The drop-in leaded-steel cylinder sleeve is generously ported and the lapped Meehanite piston, which has a straight baffle on a flat head, is coupled to the connecting-rod with a pressed-in wrist-pin. The cylinder-head forms a wedge shaped combustion chamber and is fitted with a Fox short-reach idle-bar glowplug.

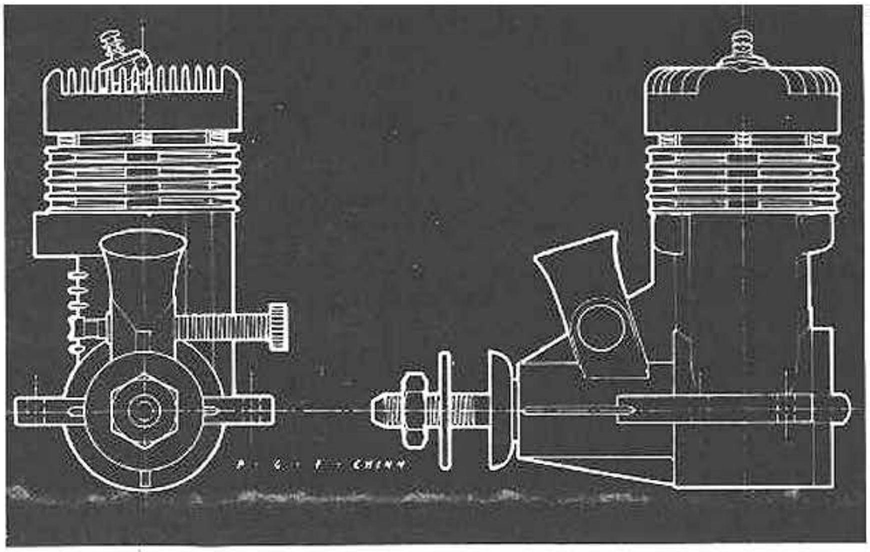
In past *M.A.N.* tests, Fox 15s have been run on various fuels and with different compression-ratios. Unlike some of the more recent large Fox engines, which have been set up to run on straight methanol/castor-oil fuels, the 15s like a medium nitro fuel. They have performed well on Fox Missile-Mist fuel and the last 15 R/C to be tested produced 0.29 bhp at just under 15,000 rpm, when running on Missile-Mist and a 0.010 in. head gasket, as fitted to the current model. The recommended prop size for general use is an 8x4.

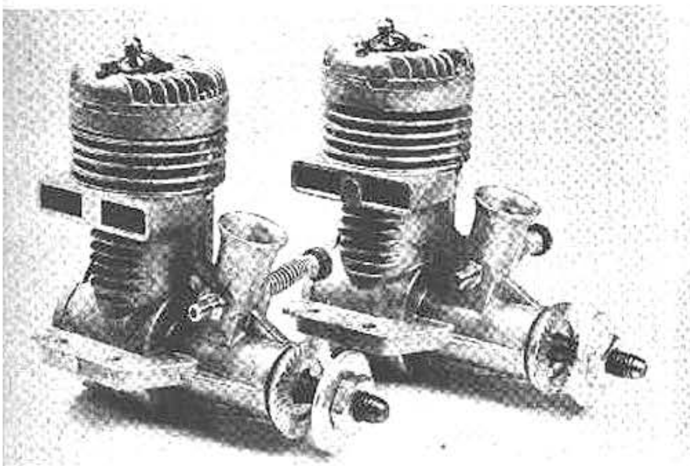
Finally, a word about the Fox's big brother, the Eagle-III. If, after reading Dan Santich's favorable comments in the April *M.A.N.*, you still have any doubts about how well one of these can perform, just fish out your old copies of *M.A.N.*, and check our full test report on the Eagle-III in the October 1981 issue. Then newly on the market, a much improved redesign of the Eagle-II, the Eagle-III more than held its own, powerwise, with contemporary imports, especially for the way it handled big props.

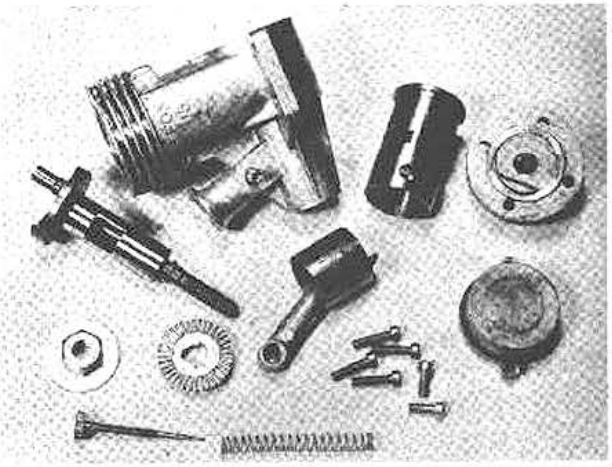
engine review

by P. G. F. CHINN

fox 15X







Fox 15XX contest engine left above and 15X sport engine. Former indentified by lowered head, faced off stack and XX stamped under lug.

IS THERE A DIFFERENCE BETWEEN SPORT AND RACING ENGINES? THIS MUST HAVE BUGGED YOU FROM TIME TO TIME. THEREFORE, OUR REVIEW OF THE STANDARD AND THE COMPLETION FOX .15's ANSWERS THIS PROBLEM.

► When Fox ads claimed 0.5 horsepower for the new Fox 15X, there were more than a few raised eyebrows. We must therefore make clear, immediately, that this figure does not apply to the stock 15X. The 15X is actually being made in three distinct versions.

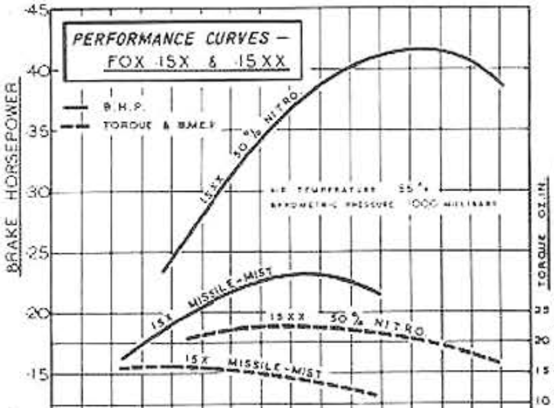
The first is the standard 15X, selling at a modest $6.95. Identical in design, but using a lightened piston, machined connecting-rod, super quality main bearing and a higher compression ratio, the 15X is also available in an "XX" competition version selling at $15. Thirdly, the factory will, in due course, offer a fully-modified racing version at $30.

Our present report deals with the 15X and 15XX models. Our tests revealed a remarkable progression from sport type performance towards top grade contest performance, as the two engines were tested. Astonishing as it may seem, the 15XX, running on a racing grade fuel containing 50 percent nitromethane, actually developed 140 percent more power than the 15X running on ordinary 5 percent nitro fuel. In terms of prop speeds, rpm went up by nearly 3,000 on an 8x4 Tornado and by 5,700 on a 7x3 Top-Flite prop.

An illustration of how power was increased through five separate stages is contained in the following prop/rpm extracts from our test notebook.

Rpm on 8x4 Power Prop:

(Continued on page 58)



Engine Review

(*Continued from page 28*)

15X	using Fox Superfuel:	12,500 rpm.
15X	using Missile-Mist:	13,400 "
15XX	using Fox Superfuel:	14,700 "
15XX	using Missile-Mist:	15,100 "
15XX	using 50% nitromethane:	16,200 "

Owners of stock 15X engines can convert them partially or completely to 15XX specification by the installation of optional replacement parts. First and cheapest modification, is to discard the decompression spacer under the head to increase the compression ratio. This will raise both power and peak operating speed and can be followed by the replacement of the standard die-cast conrod by the special machined rod (part No. 1507XX–$4.50). This rod is more durable and will permit extremely high speeds (well over 20,000 rpm) to be used without risk of failure. Finally, the lightweight piston, with matched sleeve (Part No. 1504XX–$6.00) and XX crankcase with super quality bushing (Part No. 1501XX–$5.50) will complete the transformation. Keen hop-up fans will probably want to try opening up or radiussing ports, converting to pressure feed etc. Duke Fox has a word to say about this in his new "Model Flyers Handbook", normally costing 25 cents, but available free of charge by mailing the flap from your Fox 15 carton to the factory. Alternatively, as we have said, a full factory modified racing motor will be available at $30.00.

The 15X supersedes the earlier Rocket 15 engine. It is virtually a new motor throughout and about the only part that is unchanged is the crankcase cover. The most unexpected development is the abandonment of the Desaxe, or offset, cylinder that has been a trade-mark of all previous Fox loop-scavenged motors. Unlike the Rocket 15, which had an integrally finned cylinder, the 15X follows the tradition of the bigger Fox motors and employs a one-piece crankcase and cylinder casting with drop-in sleeve.

The cylinder sleeve is of leaded mild steel, ground on the OD and ID and finished with a cross hatch hone. This, Fox tells us, is done with a stone specially prepared by mixing 2,000 mesh natural abrasive with a Bakelite bond and the surface is a duplicate of the Gisholt super finish process. The piston is of Meehanite-E cast-iron. It has a flat crown with a straight fence baffle which is higher at the center than at the sides, a shape that was decided upon after tests on innumerable alternative designs. Internally, the stock piston has a continuous wrist-pin band. The XX piston is lightened by having this band machined away each side, leaving only sufficient material to form adequate wrist-pin bosses, plus an annular rib above the wrist-pin to resist distortion. The wrist-pin is a fairly modest ⅛ in. dia. and is of hardened steel. It is solid and is pressed into the rear wrist-pin hole, but is free-floating at the front, the object being to prevent any distortion occuring due to unequal thermal expansion. The stock conrod is diecast, but the XX rod is machined from 24 ST alloy. The latter, incidentally, is color-anodized red.

The crankshaft is machined from case-hardening mild steel and is hardened to a Rockwell hardness number of C-58. Both the main journal and crankpin are ground to a high finish. The journal has a diameter of ⅜ in. and a ¼ in. bore gas passage. It has a full disc web and a crescent counter-balance. Ahead of the journal, the shaft steps down to 3/16 in. dia. for prop mounting and carries three short lands to engage the diecast prop drive washer. The valve port in the shaft journal is rectangular, 9/32 in. long and registers with a circular intake aperture in the main bearing. It gives a measured intake timing of approximately 45 deg. ABDC–45 deg. ATDC. Other timing measurements include an exhaust period of 148 degrees and a bypass period of 136 degrees of crank angle.

The diecast cylinder head is interesting in that it carries its short-reach glow plug inclined at 20 degrees to the cylinder axis so that no irregularly shaped pocket is formed in the wedge shaped combustion chamber. Fox has chosen the wedge combustion chamber after countless experiments with all types of head shapes over the years. The head is deeply finned and is secured to the main casting with four Phillips screws, the flange of the cylinder liner entering an annular channel in the head on the XX version and making the gas tight joint via two .010 in. soft aluminum gaskets. On the stock engine, one of the gaskets is omitted and is replaced by a 1/16 in. thick decompression ring or spacer. This very substantially reduces compression and is recommended for stunt, sport and radio-control flying. Removal of the spacer is recommended for speed, combat, rat-racing and contest free-flight.

Two 15X and one 15XX engines were received for test. Our first task was to break in the two 15X's. After one hour's break-in time on each engine, the best of the two was picked for further break-in and test. Actually, there was not a great deal of difference between the performance of the two stock engines, the maximum variation being to the order of 300 rpm at around 13,000. Incidentally, the Fox 15 is not an engine that demands a long and tedious break-in. We found that it could be safely two-cycled almost immediately (taking care not to run the engine too lean of course) which means that in-flight break-in is perfectly permissable after an edequate ground check.

We found the 15X easy to start, using orthodox practice of a prime when cold, or a couple of choked preliminary flips of the prop when hot. Preliminary tests were run on standard Fox Superfuel (5 percent nitro) but in stock low-compression condition (i.e. with head spacer in place) and under the cool climatic conditions prevailing, the engine obviously required a hotter fuel and our power and torque curves for the 15X therefore show the performance subsequently obtained as a result of further tests on the maker's recommended Missile Mist fuel, which is a blend of intermediate nitro rating. Under light loads, this actually added up to 1,800 rpm and, surprisingly, raised the horsepower peaking speed by nearly 3,000 rpm for an output of 0.23 bhp at 17,000. There was, in fact, a substantial all-round improvement on this fuel, giving quicker starting and steadier running with less critical needle adjustment, especially in the higher rpm bracket.

Preliminary tests on the 15XX after a two hour break-in, were also carried out on Superfuel. Starting was a little less easy than with the 15X, but, due to its higher compression ratio, the 15XX showed a spectacular power increase on this mild fuel. Using a prop matched to the bhp peaking speed of the 15X on Missile Mist, the 15XX actually proved over 2,400 rpm faster *on Superfuel*, whereas substituting Missile Mist, added only a further 500 rpm. Fox claims, however, that, under suitable conditions, this engine will respond to up to 70 percent nitro and a series of tests were therefore made on hotter fuels, culminating in a full test on a 50 percent nitro mix. On this, prop speeds went up a further 900-1,200 rpm over the useful speed range and resulted in a peak output of 0.415 bhp at 20,500 rpm.

It must be emphasized that the Fox 15 is essentially a high-speed motor and that, to make full use of its performance, it requires smaller props than are normally employed with 15's. The engine, even in XX form, does not develop especially high maximum torque and so does not produce quite such high power, on props larger than 8x4, as some other 15's under similar conditions. The 15XX torque curves, however, are very flat and, as a result, the engine, as we have seen, really begins to come alive at 20,000 rpm speeds. It is perfectly happy at these speeds and we ran the 15XX several times for minutes on end at a smooth 22,000 rpm without so much as burning out a plug. It will also go a good deal faster than this on a suitably chopped prop (Duke Fox claims that the full race special will hold together as high as 32,000) although no useful purpose appears to be served by propping for speeds much above 20,000 as in-flight rpm will then be well past the speed at which peak bhp is developed.

To us, testing the 15X and 15XX was an interesting experience and we look forward to trying the factory racing special version in due course.

Summary of Data

Type: Loop-scavenged two-cycle with shaft rotary-valve intake.

Weight: 3.6 oz.

Displacement: 0.1476 cu. in. or 2.419 c.c.

Bore: 0.590 in. Stroke: 0.540 in.

Stroke/Bore Ratio: 0.915:1

Specific Output: 15X (as tested in Missile Mist fuel): 1.55 bhp/cu. in.
15XX (as tested on 50% nitro fuel): 2.75 bhp/cu. in.

Power/Weight Ration: 15X (as tested on Missile Mist fuel): 1.02 bhp/lb.
15XX (as tested on 50% nitro fuel): 1.84 bhp/lb.

Prices: $6.95 (15X), $15.00 (15XX).

Manufacturer: Fox Manufacturing Co., Station A, Fort Smith, Arkansas.

PETER CHINN tests the

FOX 15X

2·42 c.c. Glow Plug Motor

IMPORTED by Holt Whitney & Co. Ltd., and distributed by Bradshaw Model Products Ltd., the American Fox 15X is now to be found among the stocks of most model shops. In the U.S., the Fox 15X retails at a mere $6.95—under fifty shillings—and even with U.K. purchase-tax and customs duty added, it remains one of the cheapest 2½ c.c. engine on the British market.

Unlike most imported engines (many of which, in the past, have been sold in the U.K. on their attraction as specialised competition engines) the Fox is likely to draw the attention of the "ordinary" modeller because of its low price.

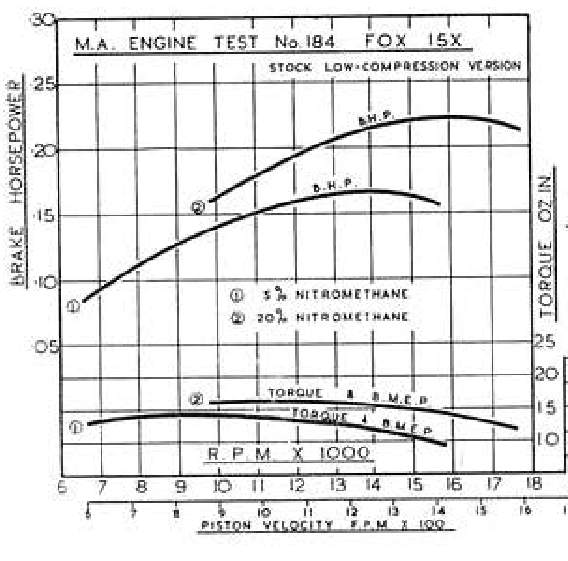
Let us make clear, therefore, that, in its "stock" condition, the 15X is not a contest engine in the generally accepted sense. It is not an especially powerful engine but it is very light, compact, suitable for many different applications and is easy to handle. It does not have the elegant external finish of some of the more expensive American motors, but it is functional, well planned and, we believe, will prove to be serviceable and good value for money.

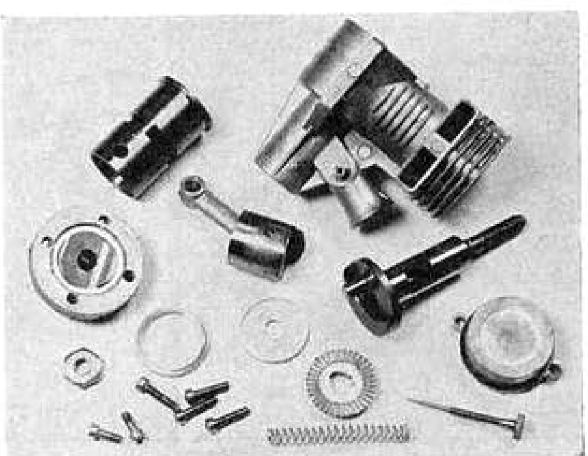
Actually, as was explained in the "Latest Engine News" column in the June issue, the Fox 15X can be modified to produce much higher performance. As supplied, the engine has a very low compression ratio and, in this condition, is especially recommended for beginner and general purpose applications, for C/L stunt, for R/C and for scale models. The actual power output on standard fuel is not greater than for a good 1.5 c.c. diesel, but since the Fox's weight is also no greater, it could, of course, be used as an alternative to the diesels for such applications.

For contest work, the stock low-compression 15X responds exceptionally well to the use of increased nitromethane. The use of a medium nitro content fuel such as Cox (blue label) Glow Fuel, will add anything up to 2,000 r.p.m. to the performance obtainable on ordinary methanol/castor fuel, while a hot racing fuel containing, say, 50 per cent. nitro will increase performance still further. In view of the current supply difficulty with nitromethane, however, a cheaper and more practical means of increasing the 15X's performance is to substantially raise the compression ratio by removing the "decompression spacer" under the cylinder head and replacing it with an additional 0.010 in. gasket. This gives equal or superior results to the use of nitromethane—so much so, in fact, that one wonders whether the standard compression-ratio is not unnecessarily low.

Apart from this very simple modification, optional parts can be purchased for the 15X for contest use. Where the engine is intended to be lightly loaded and run at very high speeds (such as in speed C/L work, for contest F/F or in boats where the engine is started out of the water) it is recommended that the 15XX type connecting-rod be used. This is a machined dural rod, colour-anodised red and replaces the diecast conrod of the standard engine. A lightened piston with matched cylinder liner is also available from the factory, as is a complete 15XX type main casting with a better quality bronze bearing.

At the present time, the complete





15XX type engine is not being offered in Britain and since the parts required to convert the 15X to 15XX specification cost more than double the price of the standard engine, our present report is being confined to the former. For the benefit of those interested, however, it may be remarked that we have, in fact, tested a 15XX type engine submitted by the Fox factory and on a mild fuel this engine delivered nearly twice the power of the stock engine, reaching 0.32 b.h.p. at 19,000 r.p.m., this being boosted to over 0.40 b.h.p. on 50 per cent. nitromethane.

In general appearance, the 15X, unlike its predecessor the Rocket 15, looks similar to the larger Fox engines. It has a one-piece cylinder-block/crankcase/main-bearing unit but dispenses with the Desaxe offset cylinder arrangement common to its bigger brothers. The cylinder liner is a push fit in the casting, flanged at the top where it is held secure by a diecast deeply finned cylinder head and four screws. The head features a wedge shaped combustion chamber with the glow-plug inclined at 20 deg. so as to bring it flush with the undersurface of the head.

The piston is of cast-iron with a straight baffle (which is higher at the centre than at the sides) and a continuous gudgeon-pin band. The small end is unusual in that the gudgeon-pin is pressed into the rear gudgeon-pin hole but is free-floating in the conrod and front gudgeon-pin hole. Cylinder port timing is 74 deg. BBDC-74 deg. ABDC for the exhaust and 68 deg. BBDC-68 deg. ABDC for the transfer.

The crankshaft has a full disc type web with the addition of a crescent counterbalance. It has a ⅜ in. dia. journal with a ¼ in. bore gas passage and a 9/32 in. long valve port. The latter registers with a round intake aperture in the main bearing to give an orthodox 45 deg. ABDC-45 deg. ATDC induction timing.

The engine is very light for a 2½—just over 3½ oz—but is of reasonably robust construction. The one-piece main casting is well braced against crash damage and substantial beam mount lugs are carried forward to help strengthen the bearing housing.

Specification

Type: Single-cylinder, air-cooled, loop-scavenged two-stroke cycle, glow-plug ignition. Crankshaft type rotary valve induction.

Bore: 0.590 in. Stroke: 0.540 in.

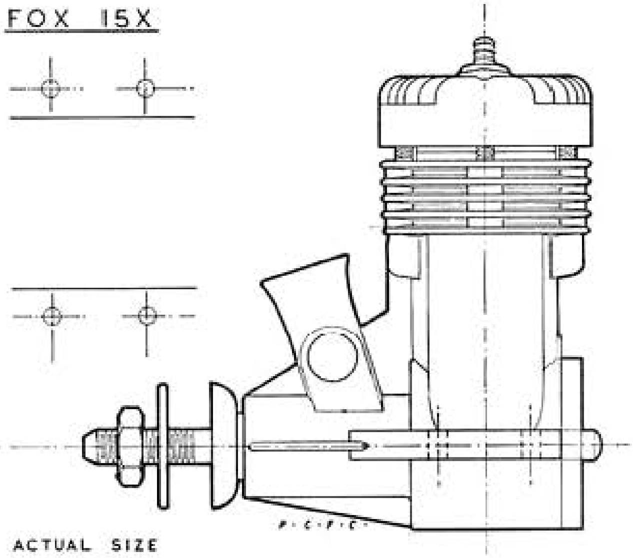
Stroke/Bore Ratio: 0.915 : 1.

Swept Volume: 0.1476 cu. in. = 2.419 c.c.

Weight: 3.6 oz.

General Structural Data

Pressure diecast aluminium alloy crankcase/main-bearing/cylinder housing with bronze main bearing bush and drop-in leaded steel cylinder liner. Meehanite cast-iron piston with flat crown



ACTUAL SIZE

and straight baffle and pressed in ⅛ in. dia. solid hardened steel gudgeon-pin. Diecast aluminium alloy connecting-rod. Counterbalanced crankshaft machined from case-hardening mild steel and hardened to Rockwell C-58. Ground finish on main journal and crankpin. $\frac{3}{16}$ in. dia. threaded length for prop mounting. Diecast aluminium alloy prop driver engaging three short lands machined on crankshaft. Pressure diecast aluminium alloy finned cylinder head with $\frac{1}{16}$ in. duralumin decompression ring and 0.010 in. soft aluminium gasket. Cylinder head secured with four Phillips screws. Pressure die-cast aluminium alloy backplate secured to crankcase with two Phillips screws. Pressed-in brass spraybar, one-piece steel needle and coil spring tensioning device. Beam mounting lugs.

Test Engine Data

Running time prior to test: 2 hours.

Fuels used: (a) 5 per cent. nitromethane, 65 per cent. methanol, 30 per cent. castor oil. (b) 20 per cent. nitromethane, 55 per cent. methanol, 25 per cent. castor-oil.

Ignition plugs used: K & B KB-1S glowplugs as supplied.

Air temperature: 56 deg. F (13 deg. C).

Barometer: 29.5 in. Hg.

Performance

Two 15X's were received for test. One showed slightly higher performance (about 2 per cent. greater r.p.m.) at the end of a nominal one hour period of running-in and was therefore used for subsequent performance tests. As received, one engine had a burned-out glowplug and a second plug burned out during running-in. Despite this discouraging start, however, no further plug trouble was experienced in numerous subsequent runs on both engines, including r.p.m. of up to 20,000 and on fuels with up to 50 per cent. nitro.

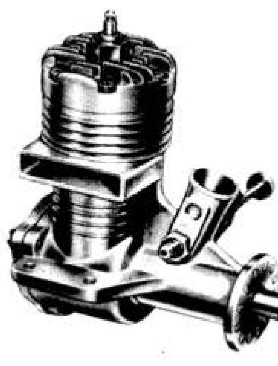
Starting was trouble free, using the standard procedure of a prime through the exhaust when cold and finger choking the intake when hot. Starting was, however, a little quicker on the 20 per cent. nitro mixture and this gave steadier running, especially at speeds above 14-15,000 r.p.m., and also less critical needle adjustment.

On test, torque developed by the 15X was at a moderate level, emphasising the importance of propping this engine for r.p.m. near the b.h.p. peaking speeds if maximum available performance is to be realised. Using the low nitro fuel, for example, the 15X reached a maximum of 14.7 oz. in. torque, or slightly under 40 lb./sq. in. b.m.e.p., at around 9,000-9,500 r.p.m. and resulting in a maximum b.h.p. of slightly less than 0.17 at 14,000 r.p.m. By switching to the hotter fuel, output was pushed up to approximately 0.225 b.h.p. at 16,000 r.p.m.

In general, a prop size no larger than 8 × 4 (F/F) or 7 × 5 (C/L) would be advisable for the 15X if high performance is required. This applies not only to the standard engine on mild fuel but also when hotter fuels or higher compression ratios are used, since the b.h.p. peaking speeds are then also higher. We would, in fact, suggest that an 8 × 3½ Top-Flite prop or any other "fast" 8/3-8/4 prop be tried for F/F. An 8 × 4 Power, for example, should give a static r.p.m. of not less than 12,500, rising about 1,000 r.p.m. on 20-30 per cent. nitromethane and a further 1,000-1,500 with high compression.

Power/Weight Ratio (as tested): 0.75 b.h.p./lb. (5 per cent. nitro); 1.00 b.h.p./lb. (20 per cent. nitro).

Specific Output (as tested): 69.4 b.h.p./litre (5 per cent. nitro); 93.0 b.h.p./litre (20 per cent. nitto).



Fox 19

"Duke" Fox redesigns his smallest powerplant into a very efficient Class A.

■ The redesigned Fox .19 can now take its rightful place as a member of a fine family of engines. It is good-looking, well-made and dependable in operation. Outwardly the appearance is not unlike the well-publicized Fox .29 and .35. Bore is .650 inch, stroke .700 inch and weight 4¾ ounces. The extended venturi has provision for the addition of a second needle valve for two-speed operation.

NEW FEATURES

The throat diameter has been reduced in the casting, thus eliminating the need for the plastic insert found necessary in the old version. The cylinder head, main cylinder and crankcase and the rear cover plate are high pressure aluminum castings. The by-pass area and exhaust stack have been enlarged; the intake and exhaust port areas remain unchanged.

The new .19 now incorporates an offset cylinder which places the piston slightly to the right (exhaust side) of the crankshaft center line. This results in a straighter line power stroke and takes part of the strain off the aluminum connecting rod. The hardened and ground crankshaft is quite rugged and heavily counterbalanced. The cast iron piston with its straight baffle is slightly relieved below the wristpin, thereby eliminating unnecessary friction or oil drag.

The steel wristpin is fitted with a brass pad at each end. The steel cylinder liner is ground and honed to a good finish and is held in place by the aluminum cylinder head. Two copper washers of different thicknesses separate the head from the cylinder casting. These appear to be used as spacer washers.

The brass needle valve body is easily removed and reversed if desired. The blunt tipped steel needle valve is securely held as adjusted by a two pronged brass spring tensioner.

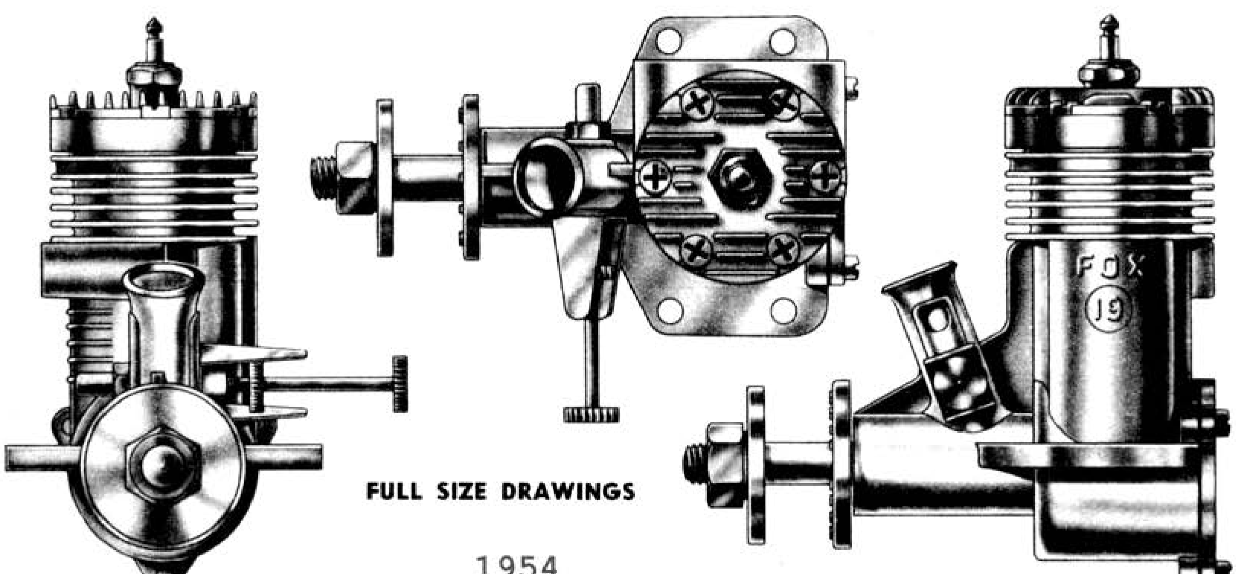
The whole line of Fox engines has proven outstanding in stunt models. They are also excellent scale and free flight performers. The new .19 should fit in nicely.

TEST RUN RESULTS

The engine tested was fitted very closely and required considerable break-in time. However, it was quite easy to start. Restarting while hot was not entirely easy at first but toward the end of the test, restarting while hot was no longer a problem.

It is capable of running with an exceptionally rich mixture which makes it ideally suited for 2-speed operation. "Duke" Fox states that his .19 performs most efficiently at 11,000 to 13,000 rpm. Slightly over 13,000 rpm was attained with a 9/4 propeller.

Included with the engine is a very comprehensive instruction manual which covers installation, operation notes: propellers, glow plugs, fuel, dis-assembly, cleaning the motor, repair policy and a complete parts list.



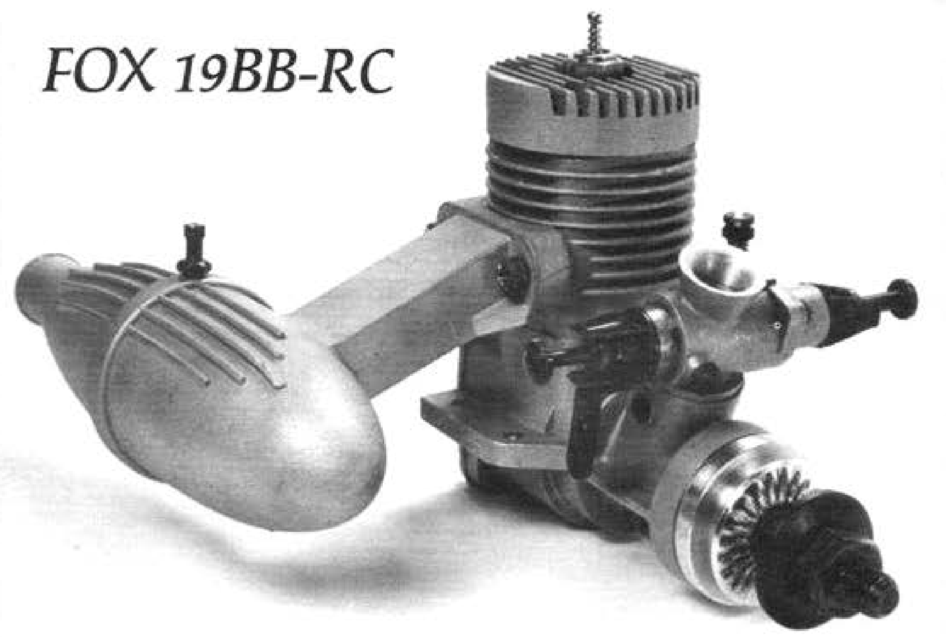
FULL SIZE DRAWINGS

1954

ENGINE REVIEW

by PETER CHINN

FOX 19BB-RC



Like other recent Fox engines, 19BB is designed to run well on economical no-nitro fuel. Large volume muffler causes negligible power loss.

SPECIFICATIONS

Type: Single-cylinder, Schnuerle-scavenged two-stroke cycle, with crankshaft rotary-valve and twin ball bearings. Throttle type carburetor with automatic mixture control. Convertible from side to rear exhaust.

Checked Weights: 230 grams (8.1 oz) less muffler; 275 grams (9.7 oz) with muffler

Displacement: 0.1991 cu in. (3.263cc)

Bore: 0.650 in. (16.51 mm)

Stroke: 0.600 in. (15.24 mm)

Stroke/Bore Ratio: 0.923:1

Measured Compression Ratio (full stroke): 10:1

Effective Compression Ratio (exhaust closed): 7.6:1

*Performance Data—as tested:**

Power Output, Gross: 0.49 bhp at 17,500 rpm

Power Output, Net: 0.43 bhp at 16,500 rpm

Torque, Gross: 34 oz-in. at 10,000 rpm

Equivalent b.m.e.p.: 67 lb/sq in.

Torque, Net: 32 oz-in. at 10,000 rpm

Equivalent b.m.e.p.: 63 lb/sq in.

Specific Output, Gross: 2.46 bhp/cu in.

Specific Output, Net: 2.16 bhp/cu in.

Power/Weight Ratio, Gross: 0.97 bhp/lb

Power/Weight Ratio, Net: 0.71 bhp/lb

*Gross figures = less muffler, with 25% nitromethane.

Net figures = with muffler and straight fuel.

Manufacturer: Fox Manufacturing Company, 5305 Towson Ave., Fort Smith, AR 72901.

THE PURCHASER of a Fox 19 has a number of options. For less than the cost of just about any engine of the same size, he can have the standard bushed bearing, crossflow-scavenged Fox 19 and get at least as high a performance from it as he would from any imported rival of the same type. When we tested the original control-line version of this engine back in 1974, it outpaced the opposition by a sizable margin. It was no surprise when British modelers picked this American engine for the then-new Club-20 pylon racing class. Currently, Fox is offering an improved model of the standard Fox 19 in both control-line and radio-control versions, the latter with a new, small edition of the Fox Mk.X automatic mixture control carburetor.

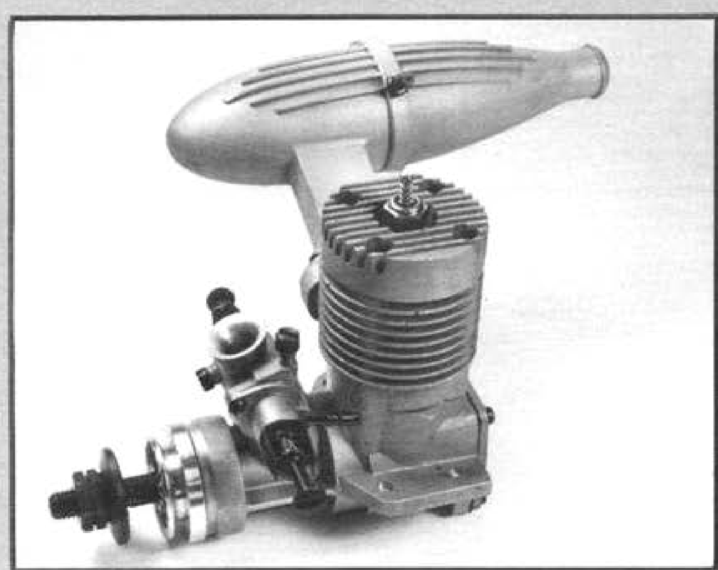
Alternatively, for those who want a "state-of-the-art" design, there is the recently introduced Fox 19BB which features a Schnuerle-plus-third-port scavenging system, a twin ball bearing crankshaft, and a separate cylinder jacket that enables it to be converted, without additional parts, from a conventional side-exhaust layout, to a rear-exhaust configuration.

It is this new and more powerful model that is the subject of our test report this month. First, a few words about its component parts.

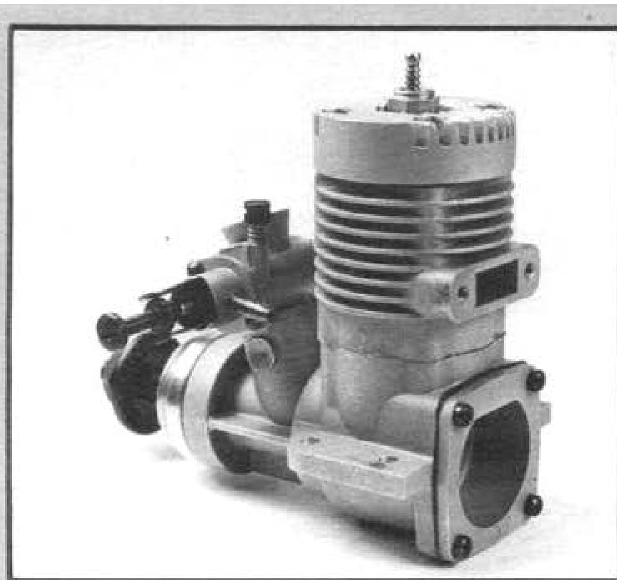
CRANKCASE. This is a well executed pressure die-casting that incorporates a sturdy front housing, well braced with horizontal and vertical webs and large beam mounting lugs. The carburetor boss is bored 7/16 inch (11.1 mm) and has a generous outside diameter of 5/8 inch. The crankcase is faced off just above the crank chamber, where it incorporates four short identical channels, so that the three bypass channels in the cylinder casting are always fed with fresh gas, irrespective of whether the exhaust is located at the rear or either side. Between the channels (i.e., at 90-degree intervals) the case has four vertical holes, tapped 4-40 for the cylinder attachment screws. The pressure cast backplate, attached with four 3-48 screws, is stepped to clear the piston at BDC and to avoid undue masking of the rear bypass entry when the cylinder is in the side exhaust positions.

CRANKSHAFT AND BEARINGS. The crankshaft, machined from 8620 steel bar and case-hardened, has a separate 1/4-28 prop stud which, of course, means that in the event of its being bent in a crash, or otherwise damaged, it, rather than a complete crankshaft, can be replaced, and for about one-sixth of the cost of a new shaft.

The crankshaft has a metric size (11 mm) main journal and is carried in two 11x22x6 mm 9-ball steel-caged bearings that are specially made for Fox. The shaft has an integral 4.7 mm (0.186 inch) diameter crankpin on a counterbalanced web and a 7.5 mm (0.295 inch) bore gas



The Fox 19BB owner has choice of two special mufflers with angled entry ducts. This is alternative tilt-up type.



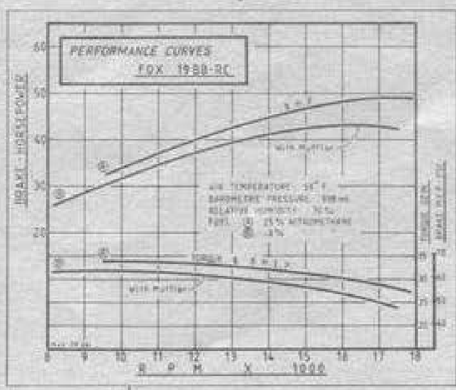
The 19BB features a separate cylinder assembly which can be rotated to provide left, right, or rear exhaust.

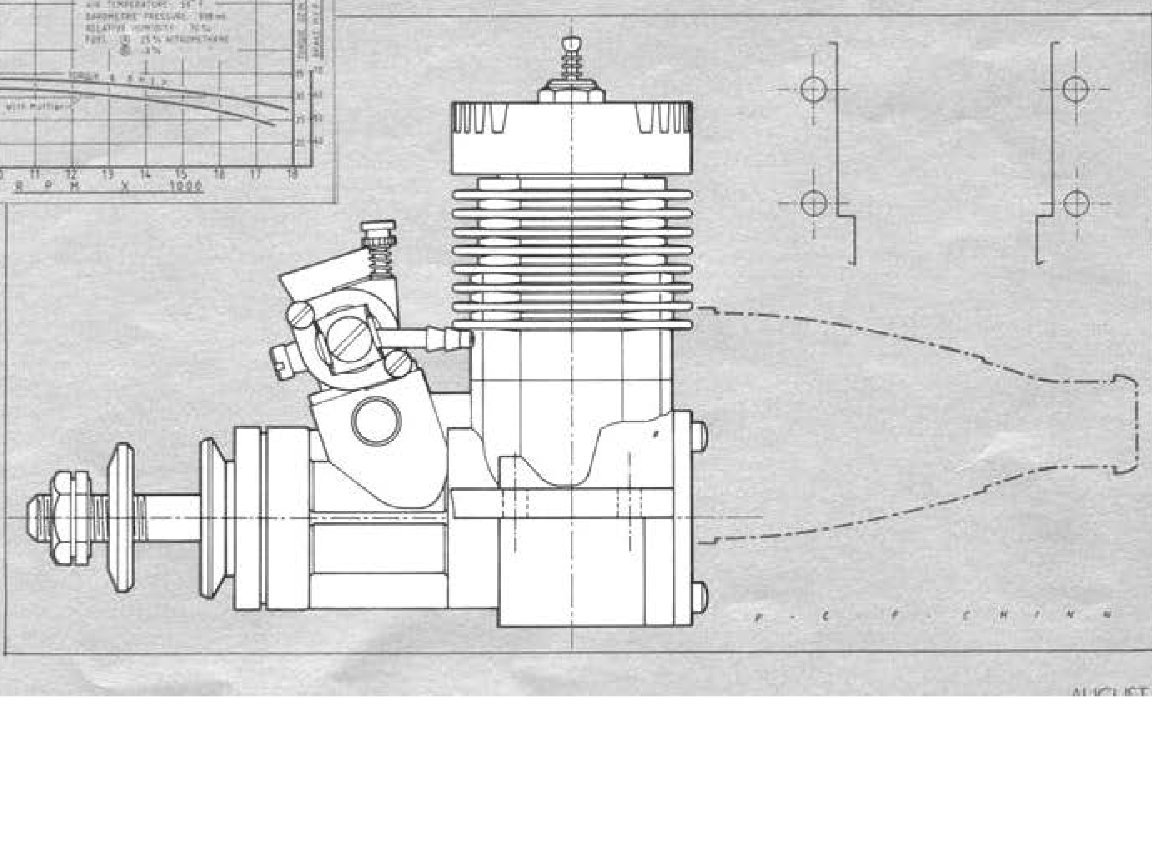
passage fed from a 12 mm (0.472 inch) long rectangular valve port. The latter uncovers the parallel sided intake from 38 degrees after bottom dead center to 50 degrees after top dead center.

Immediately in front of the main journal, the shaft reduces to 0.300 inch diameter and has the familiar Fox short splines to which a machined aluminum prop driver is fitted. The latter is relieved on its rear face, forming a lip that surrounds the front bearing and helps protect it from foreign matter. The prop drive assembly is completed by a steel hexagon nut and a steel washer, serrated on its inner face.

CYLINDER LINER AND BARREL. The cylinder liner is machined from leaded steel bar (a reliable old favorite used in numerous Fox engines) and is a slip fit in a pressure die-cast aluminum finned jacket or barrel. As previously noted, the latter, complete with liner, can be rotated through 90 degrees to place the exhaust to the rear, or through 180 degrees if the user wishes to have the exhaust on the left-hand side of the engine, rather than the right. The barrel incorporates well-shaped bypass channels to supply the three inlet ports in the liner, which is axially located, in the usual way, by a flange at the top.

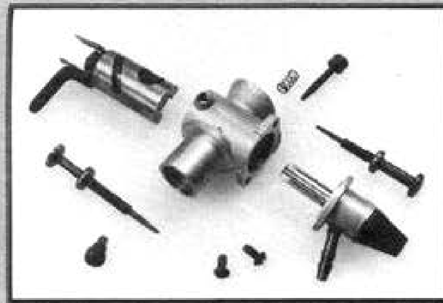
Cylinder porting is of the Schnuerle-plus-third-port type. A single unbridged exhaust port is flanked, each side, by a bypass port sharply angled away from the exhaust to direct gas flow to the opposite side of the cylinder. Here there is a fairly large third port angled to redirect gas flow upward into the combustion chamber.





Engine has traditional Meehanite lapped piston in a steel liner.

Most of the castings for the Fox 19BB are shown plus the finned head seen left.



Two-needle automatic mixture control carb has an orthodox adjustment procedure.

Port timing of the engine used for our tests included a 138 degree exhaust period, a 122 degree main bypass period and a 116 degree third-port period.

PISTON AND CONNECTING-ROD ASSEMBLY. The ringless piston, machined from an innoculated cast iron (Meehanite), has a flat crown and includes an annular rib above the wristpin to ensure roundness. It is equipped with a 0.156 ($^{5}/_{32}$) inch diameter solid wristpin that is a close fit in the piston bosses and is retained by wire snap rings. The engine features a very sturdy conrod that is machined from 2024-ST aluminum bar and is fitted with phosphor-bronze bushes at both ends. The oil hole for the crankpin end is drilled at an angle into the upper half of the bearing where, in a two-cycle engine, the load is always concentrated. The rod is 1.125 inch (1.875 x stroke) between centers.

Checked reciprocating weights included 7.0 grams for the piston and 1.5 grams for the wristpin. The conrod checked out at 2.8 grams.

CYLINDER HEAD. Made in two parts, the head consists of a machined combustion chamber insert (or head button as Fox descriptively calls it) tied down by a pressure die-cast finned outer component. The insert is machined from 2011-T3 aluminum alloy bar. It features a small (9.3 mm) diameter, fairly deep (3.7 mm) bowl surrounded by a broad (3.6 mm) flat squishband. There are two main reasons for using a separate machined bar stock insert. First, it allows better dimensional control of the combustion chamber. Second, it provides a more suitable material for the threads for the glowplug.

The checked chamber volume of the test engine was 0.36 milliliters. This indicates a nominal compression ratio of 10.0:1 or an effective compression ratio (i.e., based on the volume of the cylinder above the exhaust port) of 7.6:1.

The four 4-40 screws securing the complete cylinder assembly (head, head button, cylinder liner, and jacket) to the crankcase are 1½ inches long and are specially made for the engine from alloy steel in the Fox factory. The reason for using these special screws, rather than less costly commercial grade screws, is that the

(Continued on page 112)

ENGINE REVIEW

(Continued from page 30)

latter tend to stretch, which could allow the cylinder assembly to loosen.

CARBURETOR. Contrasting with most Fox carburetors of the past (including some ingenious ones which worked very well but were not so popular with modelers used only to run-of-the-mill designs), the carburetor fitted to the 19BB-RC works on the familiar two-needle automatic mixture control principle. It has a pressure cast aluminum body and a steel throttle barrel which describes a helical path, moving into the body as it is rotated toward the closed position. The barrel carries with it the adjustable secondary needle which enters the fixed jet tube and restricts fuel flow at reduced throttle openings.

The carburetor has a 0.271 inch bore choke and a large jet tube diameter of 0.180 inch. Taking these choke and jet tube dimensions into account, the choke area can be worked out at approximately 14.5 square mm, but the true choke area is, in effect, rather larger than this because the barrel is counterbalanced 0.190 inch to receive the end of the jet tube at small throttle openings. When the throttle is open, this substantially lessens the degree of choke restriction created by the large diameter jet tube.

MUFFLER. This is a conventional expansion chamber type of pressure die-cast aluminum. It has a fairly generous volume of 40cc and an outlet area of some 65 square mm. The inlet duct is angled at 20 degrees to the horizontal and the purchaser has the choice of two versions, enabling the body of the muffler to be located above or below the level of the exhaust port. The muffler attaches to the engine's exhaust stack with two short 6-32 screws.

Incidentally, the mufflers are listed as "Tilt-Down" and "Tilt-Up" types. This refers to the muffler position with the exhaust located as supplied—i.e., on the right side of the engine. If you are planning to relocate the exhaust stack to the left side, it will be necessary to use a "Tilt-Up" type muffler for the lower position, and vice versa.

PERFORMANCE. For our tests of the Fox 19BB-RC we used the Fox "Tilt-Down" muffler (Part No. 90220) with the cylinder in the position as installed at the factory, i.e., with the exhaust on the right. The engine comes complete with a Fox long-reach idle-bar type glowplug.

The most interesting thing about the performance of the 19BB-RC is how very little its power output is affected by (a) the use of the muffler and (b) changes in fuel. We ran tests both with and without the muffler and on 0%, 5%, 10%, and 25% nitromethane fuel.

So far as fuel is concerned, our findings clearly bear out Duke Fox's claim that the 19BB-RC will run well with no nitro in the fuel, particularly in warm weather. At the time of testing (April) the weather was not very warm (just below 60° F) and we were prepared to find that the 19BB would need a little nitro. In fact, the addition of 5% nitro had a barely measurable effect. Even with 25% nitro, prop rpm were increased by only 2% or 3%. The muffler had even less effect. Over most of the rpm range, it caused virtually no power loss.

Our performance curves show the results of two series of tests run under "least favorable" and "most favorable" conditions: the former on a straight 80/20 mixture of methanol and castor oil and with the muffler fitted; the latter on 25% nitro fuel and with an open, totally unrestricted exhaust.

It will be seen that adding the muffler *and* using inexpensive 80/20 fuel cut the recorded peak power output from 0.49 bhp at 17,500 rpm to 0.43 bhp at 16,500 rpm, a total loss of 12%. This, under such conditions, is a very small power loss indeed. As followers of these test reports will know, a 12% difference might well be accounted for by the nitro content alone, while it is customary for mufflers to cause rather more power loss than 12%.

Naturally, the loss of power caused by a muffler, with any engine is, to a large extent, linked to its effectiveness in attenuating noise levels. A muffler of large volume, but a small outlet area, will be more effective than a small volume muffler with a large outlet area. The Fox 19BB muffler has a large diameter outlet, for an engine of only 0.20 cubic inch displacement. Its outlet area of 65 square mm is, in fact, 25% larger than the engine's exhaust port area. One would not expect this muffler to be as effective as it would be with an outlet area of, say, 30 square mm. But the Fox muffler is also of quite large volume (40cc) which allows the exhaust gases to expand quickly when they leave the cylinder and this is beneficial in that it reduces pressure (and thus noise level) when the gases are released from the silencer to the atmosphere.

The maker's recommended prop size for the 19BB-RC is an 8-inch diameter of 4 or 5 inches pitch. Current Fox advertising claims 17,000 rpm on an 8x4. On an 8x4 Power-Prop maple, our test motor reached 16,500 rpm on straight fuel with the muffler fitted and 17,200 rpm on 25% nitro fuel, less muffler. This prop, it will be seen, would be a trifle too small for the best performance in flight as, after allowing for the reduction in load on the prop, as the aircraft accelerates up to normal flying speed, the engine would actually be turning at speeds beyond those at which it develops its maximum power output.

In these circumstances, the alternative recommendation of an 8x5 or, possibly, an 8½x4, would be better. Some of the speeds recorded with the 19BB-RC, on these and larger props, included: 14,600 rpm on an 8x5 Power-Prop, 14,200 on an 8.5x4 Zinger, 13,100 on a 9x4 Power-Prop, 12,200 on a 9x4 Top Flite, 12,000 on an 8.5x6 Zinger, 11,600 on a 9x5 Top Flite, and 11,200 rpm on a 10x4 Zinger. All these figures were taken with the engine running on no-nitro fuel and with the muffler fitted.

The general handling and running characteristics of the Fox were good. Nowadays, it is customary to use electric starters and, although it is part of our standard procedure to check the hand-starting qualities of engines on test, we have to confess that, as an engine may be stopped and started up to a hundred times in the course of a full test program, we always have an electric starter standing by to hasten matters when needed. In fact, at no time, in the course of checking prop rpm figures for the Fox, did we find it necessary to resort to using the starter. The engine hand-started easily and was very docile, showing no tendency to bite one's fingers even on the smallest diameters.

There is no doubt that, power apart, a good nitro fuel, like Fox Missile Mist, still offers an advantage in that it makes for greater flexibility, i.e., less critical needle-valve adjustment, usually better throttling and, very often, steadier running, but there is nothing to complain about in the way that the 19BB runs on straight no-nitro fuel. Properly adjusted, the throttle worked well, with a safe 2,600 rpm idle on 9-inch diameter props, rising to 3,000-3,200 on the 8-inch diameters.

Engines with lapped ferrous pistons and cylinders sometimes need a lengthy break-in and, in the past, we have often had cause to be grateful for Duke Fox's "Lustrox" polishing compound as a means of freeing off a tightly set-up new motor. This, however, was unnecessary with our 19BB-RC, which was quite free from the beginning. It was, of course, subjected to the usual basic rich-mixture break-in procedure, but quickly showed that it was capable of holding a fully leaned out run without tightening up. Over-leaning would simply cause the engine to cut out cleanly as the mixture became too weak to support combustion.

Incidentally, Duke Fox tells us that pistons are initially fitted fairly tight but each engine is motored over for several minutes before put on the test rack. Not all manufacturers, nowadays, test run their engines before despatch. Fox motors are test run with a control-line type intake assembly, and R/C carburetors are installed afterward. In this way, the customer does not get a carb gummed up with residual oil. Carburetors are first checked on an air gage to insure that they have no clogged passages or incompletely drilled holes.

All in all, the 19BB-RC is a nice little motor: easy to handle and with plenty of go. It is best when not over-propped: use a prop that will allow it to run full-throttle at not less than 12,000 rpm static. The engine is sturdily built and should be capable of standing up to hard use and, because it also runs so well on less expensive fuel, it should be economical to operate.

Peter Chinn, c/o *Model Airplane News*, 837 Post Road, Darien, CT 06820. ■

SCALE NEWS

(Continued from page 49)

ellipses. Now it should be even easier and might even be fun with the new drawing tool marketed by Put-Lines Mfg. Co*.

There are a lot of drawing aids on the market, but this exceptional tool is somewhat remarkable. It can draw straight, parallel, or angled lines without being lifted from the drawing. It can strike an arc or a circle, is effortless to use, and should be attractive to those who hesitate using protractors, T-squares, triangles, and scales. Therefore, it can often take the place of several conventional tools. It could make that next drawing a mite easier and a lot quicker. If anything, it will show that drawing lines does not represent an art left solely to the professional draftsman.

Making Homemade Fuel Tanks

Sometimes we find ourselves backed into a corner when it comes time to mount a fuel tank. The things usually left to last should have been thought about in the designing stages. Provisions should be made for tank installation and servicing, well before the construction begins.

So, we find that the standard commercial tank just doesn't fit, or we have to settle for a smaller, less desirable size—not exactly practical if we are going to be on the verge of running dry in the downwind leg. How about making our own out of brass or tin stock? The U-control boys of years ago always made their own. Not surprising is the fact that a custom-made tank that uses less room always results in more volume. So you can have your original volume and use the leftover space.

Shim stock, available at most surplus metal supply houses, is sufficient. You should look at something between .010 and .015 in thickness. Stock that's thicker than .015 is not really beneficial and is just added weight. Stock thickness less than .010 could be too fragile. Although it is easy to manage and simple to solder, it will require strengthening beads in the walls or else it will constantly "oil can" upon filling and emptying.

The first order of business is to make a mock-up of paper, foam, or balsa—anything that can quickly approximate the desired size and shape of our homemade tank. A couple of quick dimensions can quickly tell us if we are close to our desired volume.

Square off your dimensions as much as possible. In other words, if it's not a perfect square or rectangle in one view, round off the numbers so you can get a "ballpark" sum. After figuring your total volume in cubic inches, simply multiply by the factor of .55 to come up with a resulting volume in ounces.

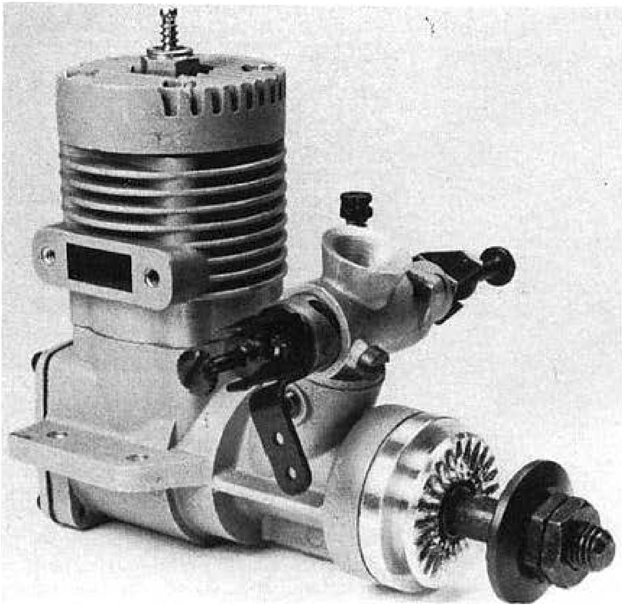
For example, if your proposed homemade tank is going to measure 2x2½x3½ inches, the volume in cubic inches is 17½ cubic inches. Multiply this by .55 and the resultant volume is 9.6 ounces (2x2½x3½) x .55 = 9.6 ounces. Chances are this 9.6-ounce tank is occupying a space that only allowed a four- or six-ounce commercial tank.

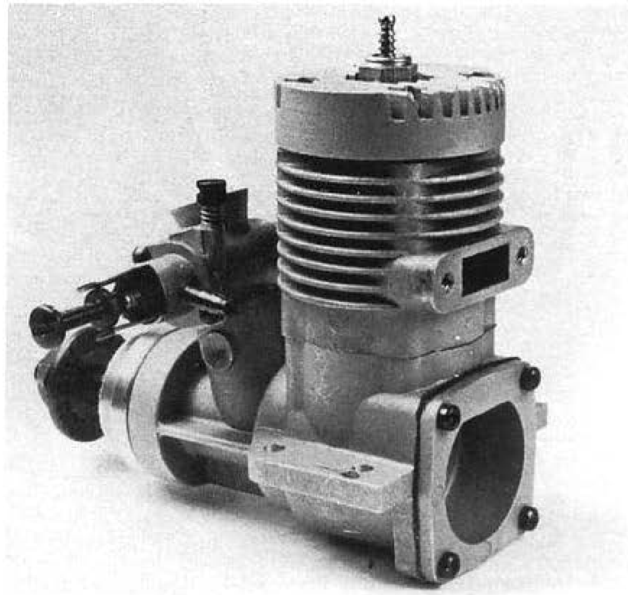
The sketch shows one way of laying out a flat pattern for a simple rectangular tank. It would be practical to try a few samples out of paper or cardboard stock before soldering, just in case your dimensions came out a little large.

Notice the sketch that shows a partially completed assembly with one side left open. There are really two approaches to the fuel lines, and the side opening allows access for some soldering in one of the cases. This sketch shows permanent lines soldered to the tank and another sketch shows an access hold for the Sullivan tank stopper assembly. I prefer the tank stopper approach. It allows regular cleaning of the inside of the tank—you would be surprised at the accumulation of oil after a few hours of use.

As you'll notice on the sketch, solder a reinforcing ring, the inside diameter equalling the i.d. of a standard Sullivan tank, which is .70. Solder this ring to the front face of the tank to give a little beef to the tank as you tighten up the stopper.

In the other approach with the fixed fuel lines, you will notice that these lines (the pickup and the overflow) are soldered on the inside. That's the reason for the one side being left open. Adding this bit of solder takes the load off the front of the tube where it enters the tank. If you didn't do this you could conceivably bend the line from the outside and distort the desired position of the line on the inside. Your fuel pickup could stick up in the air to a slight degree, and you couldn't get to it to correct the problem. A dab of solder on the inside before final assembly will insure a rigid mount of these lines. This will not be a problem if the front face of your tank is made from heavier gauge tin or brass. I only bring it up if you are using thin-gauge shim stock. Using thin-gauge stock, you will find that the difference in weight compared to a conventional nylon tank is negligible.





Above left: entirely new Fox 19BB is first Fox engine of this size to feature Schneurle scavenging and twin ball bearing shaft. Above right: feature of Fox 19BB is a separate cylinder jacket and 90° transfer channel enabling exhaust to be rotated to rear or either side.

plus-third-port layout of a single unbridged exhaust flanked, on each side, by transfer ports that are inclined slightly upward as well as angled towards the opposite side of the cylinder where the incoming charge joins the upward flow from a relatively steeply inclined third port.

Using the 3.5 crankcase and retaining the same ball bearings has enabled the 2.5 to have a large diameter crankshaft main journal (12mm) which, in turn, has permitted the use of a generous rotary-valve area. That a large valve port area is more important than having a large bore gas passage through the shaft, has become more widely recognised in recent years and it is not surprising, therefore, to find that, while the valve port in the shaft is actually larger than that of the 3.5, the cross-sectional area of the gas passage, through the shaft, has been reduced by just under 29 per cent (i.e. exactly in accordance with the smaller swept volume of the 2.5).

The OPS 2.5 is to be made available in a total of five models, each of which is identified by a different set of suffix letters. Shown in our photos are the side exhaust *2.5 Speed SLA-STD* (free-flight, combat, etc.) and its throttle-equipped variant, the *2.5 Speed SLA-RCA*. For similar applications but having a rear exhaust, are the *2.5 Speed SPA-STD* and *2.5 Speed SPA-RCA*. These four models have standard exhaust timing, are intended for use without a tune exhaust system and are nominally rated at 0.65bhp at 23,000rpm. The remaining model is the *2.5 Speed SPA-VAE* control-line speed engine, which has extended exhaust timing to make full use of a tuned pipe and, for this model, OPS are claiming the pretty phenomenal performance of 1.35bhp (1.33bhp if one wants to quibble about the difference between imperial and metric engineering units) at 33,000rpm. For this model, OPS are installing glow heads, with a choice of squish or bell-shaped combustion chambers, in place of the regular head with separate plug. There are also replacement ball-bearings with special high-speed cages and a nitro pipe for use in non-FAI speed events.

All engines use the same crankshaft, which, as already noted, has a 12mm main journal. The front journal is 7mm dia. and the 4.5mm crankpin is integral with the crankdisc which has peripheral counter-balancing slots. These slots were originally sealed but, notwithstanding the relatively large volume of the 3.5 size crankcase and the reduced pumping efficiency that this must mean, Piero Muzio of OPS tells us that the engine was found to rev faster without the sealing ring, so it is being omitted from the production model. Feeding a 7.5mm bore gas passage, the rectangular valve port is 13.4mm long and is open, according to our measurements, from 35deg. ABDC to 60deg. ATDC.

Cylinder port durations of the engine examined were: exhaust 145deg; transfers 124deg; third port 126deg. The combustion chamber volume checked out at 0.28ml, giving a compression ratio of 9.8:1 with the standard head and 0.2mm (8thou.) aluminium gasket fitted. The head is made in two parts and the combustion chamber shape is typically OPS, with a sloped squishband surrounding a deep, part-spherical central bowl.

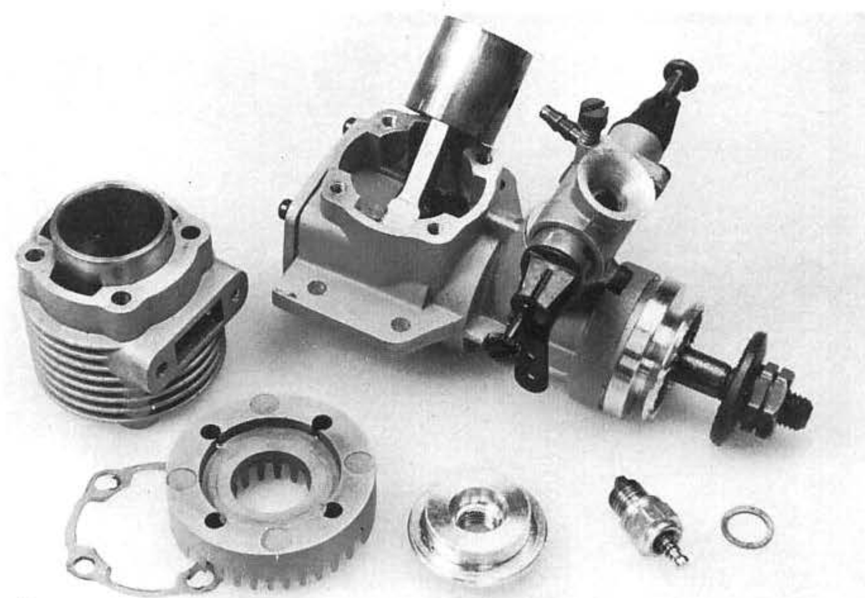
The engine has a 12mm i.d. intake boss and the standard model is fitted with a machined venturi having six peripheral jets and a 4mm throat — i.e. a choke area of 12.6sq. mm. The throttled version is fitted with a Perry carburettor having a generous 6mm choke size.

The OPS 2.5 Speed needs a 30mm bearer spacing, is 56mm high (less plug) above the centre-line and weighs 207g (7.30oz.) in standard FF/CL trim or 225g (7.94oz.) with R/C carb.

1982 Fox 19BB

Back in 1974, we featured a standard model Fox 19 in the Engine Test series in AEROMODELLER. It turned out to have an unusually good power output for a plain-bearing, crossflow-scavenged motor, recording nearly 0.40bhp at 17,000rpm on ordinary five per cent nitro fuel, a level of performance which was subsequently confirmed by the engine's popularity and success in the early days of Club 20 pylon racing. An improved version of the crossflow Fox 19 is still in productio, in both standard and throttle-equipped types, as is its companion model, the Fox 25. (The latest version of the latter was, in fact, the subject of our Engine Test report in the January AEROMODELLER this year.) Now, however, the Fox company has introduced the new model illustrated here, the 19BB.

The 19BB is an entirely new design and, unlike the older model, features both Schnuerle scavenging and a twin ball bearing shaft. It is also rather unusual in that it gives the customer the option of side or rear exhaust — not by his having to make a choice at the time of purchase, but by providing the engine with a detachable cylinder jacket that, complete with liner, can be rotated through 90 or 180 degrees. Four long screws tie the cylinder, complete



Fox 19BB with cylinder assembly removed to show how cylinder jacket and liner can be located for side or rear-exhaust. Note also two-part head with generous squish area.

with two-component head, to the crankcase. According to our measurements, the combustion chamber volume is 0.34ml, giving a compression ratio of 10.6:1.

Cylinder porting follows the orthodox Schnuerle-plus-third port layout and is very conservative as regards timing with (according to our measurements) a 130 degree exhaust period, a 110 degree main transfer period and a 106 degree third port period. The engine is of the lapped type with a flat crown cast-iron piston running in a steel liner. The machined conrod is bronze bushed at both ends.

The crankshaft and bearing set-up is a little unusual in that the main journal runs in the same sized bearings (11 × 22 mm, 9-ball, steel caged) front and rear. The shaft has a 4.7mm (nominally $\frac{3}{16}$in.) dia. crankpin on a $\frac{7}{32}$in. thick crankweb, counterbalanced by cutaway web flanks. The valve port, 12mm long, is narrower than the intake aperture, which it uncovers at 40 deg. ABDC and closes at 52deg. ATDC. The intake boss is $\frac{7}{16}$in. (11.1mm) bore and is fitted with a Fox two-needle carburettor with adjustable automatic mixture control.

In the past, when fuels containing generous quantities of nitromethane were still relatively cheap in the United States, most Fox motors were intended to be run on such mixtures. Now that nitro is expensive in the US, as well as elsewhere, Duke Fox's newer motors are being set up to run on much lower nitro contents or even, in the case of the larger engines, on straight methanol and oil mixtures. The new 19BB will still give its best performance on a fuel containing around 25 per cent nitromethane but, for most purposes, a 5 or 10 per cent nitro content is entirely adequate and, in warm weather, a no-nitro mixture can be used.

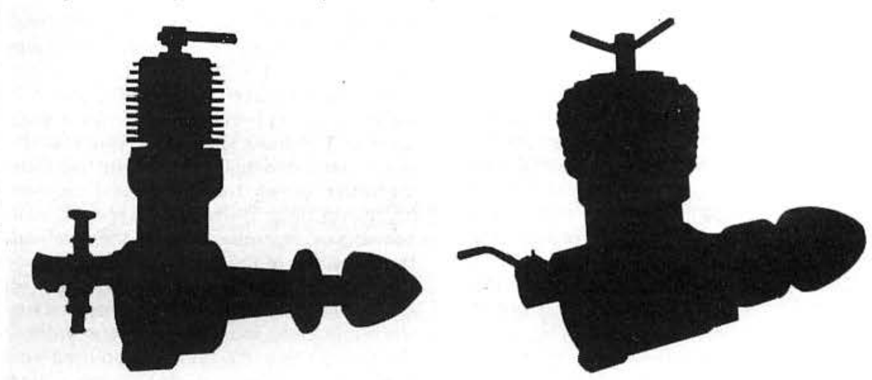
The Fox 19BB has a bore and stroke of 0.650 × 0.600in., which gives a swept volume of 0.1991cu. in. or 3.263cc. It calls for a 30mm bearer spacing, is 57.5mm high (less plug) above the centre line and weighs 230g (8.1oz.). Not available at the time when our test model was received, but expected soon, will be a pair of Fox expansion chamber silencers offering a choice of high or low mounting positions.

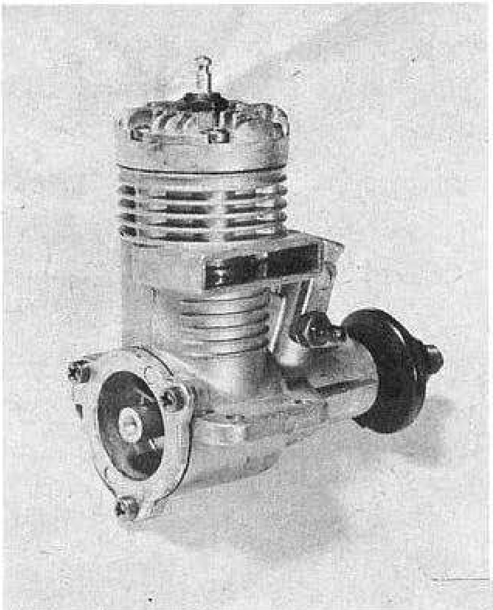
Four-Stroke News

The Enya company is bringing out a 10cc four-stroke, the 60-4C. It has valves operated from twin camshafts mounted side by side behind the crankcase like the 35-4C and 404C, but has enclosed rockers and pushrods like the O.S. FS-40. The 13cc Saito FA-80T flat twin has a new carburettor with separate chokes and needle-valves for each cylinder.

COLLECTORS' CORNER

These silhouettes are of diesels of the late-forties/early-fifties period. Identifying the one on the left should be easy: the one on the right a bit more difficult. (Answers on postcards as soon as possible, please, so that names of the knowledgeable can be published in the September issue).

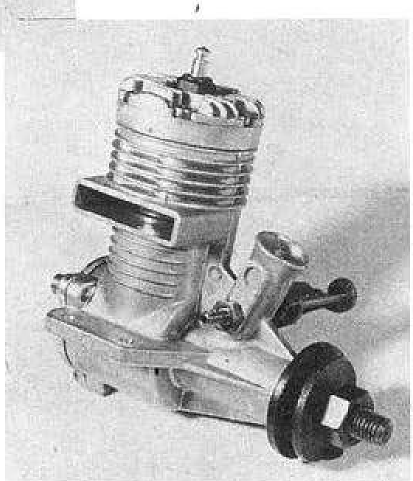




Engine Review

by E. C. MARTIN

Fox .25



Provision is made for easy two-speed installations or a 29R pressure feed can be added.

One of a new series of engines, the Fox .25 may look familiar, but it introduces a number of new finepoints.

► There is no doubt that the basic Fox 29 design formula has over the years proved itself peculiarly suited to the requirements of control line aerobatics. True, many other engines share the glory, and yet it is more than coincidence that so many closely resemble the Fox in basic design. It can be justly argued that model engines are such simple things that inevitably they must closely resemble one another, and yet despite this fundamental simplicity we seldom see a new engine appear that does not embody some new development, some new refinement of detail that gives it the slight edge to warrant its introduction, and the result of this constant change, so gradual we hardly notice it, is the vast difference between the engine of today and that of ten years ago.

In the course of development work on the larger .35 with a view to using very high compression ratios, the behavior of the various stressed components of the engine was examined during the application and removal of loads similar to those anticipated from high-cylinder pressures. During each cycle of the engine the forces trying to separate the cylinder from the crankcase rise from a slightly negative value to a very high positive figure when the piston is at top dead center. At this point, when the combustion chamber volume is at its smallest, there is very little of the cylinder wall exposed to the pressure from which the force is derived. The area of the piston crown and cylinder head, however, remain the same at all times. Since the direct force acting on any one component is proportional to its area exposed to the pressure, it will be evident that at Top-Dead-Center the actual disposition of stress will try to burst the piston crown and cylinder head, whereas the cylinder itself will not be sustaining much bursting stress but will be very busy keeping the head anchored, in effect, to the crankshaft bearing, and therefore be

(*Continued on page 55*)

Engine Reviews

(*Continued from page* 34)

in tension. The overall effect of this is that all the parts deflect slightly, and the head being attached to the cylinder by screws disposed outside the cylinder walls, bulges and tries to dish the top cylinder flange inwards. This in turn causes a contraction of the cylinder bore, which grips the piston, and an appreciable amount of friction is set up.

This is a handicap common to engines of all sizes and is partly responsible for the well-known wear pattern which tapers to a maximum at the top of the bore. It is a fault difficult to remedy because if a suitable taper is machined into the bore so that there is no bind under combustion pressures, there will be compression loss under the relatively low pressures existing before firing occurs. Rigidity is therefore the best solution, with design which carries the effect of head strain away from the bore.

An engine having this fault, which includes the majority of model engines, will obviously require a prolonged break-in time to wear this tightness out of piston and bore, and when it does it may have very poor compression at cranking speed and yet have more zip than ever before. Most of us have had engines which go like a bomb on time borrowed from the scrapheap, and have heard the opinion that compression is an unnecessary convention.

It is difficult, as with most transient conditions in engines, to tell whether, and to what degree this is happening. It was measured on the Fox by boring a bore sized hole in a cylinder head, and inserting an air gauge which registered the bore sizes as the cylinder head hold down screws were tightened. This revealed a built-in bind additional to the friction appearing during operation, and was probably even greater than shown by the air gauge when a complete head was installed. Obviously the relief of this malady should show worthwhile gains, and has contributed to a quite remarkable improvement in experimental engines. The Fox .25 embodies the remedy in the form of cylinder head retaining screw bosses which extend from the top flange of the main casting right down to the bypass and exhaust belt. The screw tappings are deeper than before and longer screws used. The stress is therefore transmitted away from the top of the bore and distributed axially along its length. The bosses in conjunction with the cylinder cooling fins greatly increase the rigidity of the whole casting.

Main bearings and bushing materials have also come under review. The importance of keeping friction to a minimum becomes acute as shaft diameters and rubbing speeds increase, and since it has always been a characteristic of Fox engines to have the smallest diameter crankpin equal to the task in order to minimize friction, it is not surprising that the large mainshafts dictated by rigidity and gas passage requirements should give rise to close scrutiny of bearing materials. Apparently aircraft quality cast bronze has been found to combine lowest friction with greatest resistance to pounding in the Fox application and is incorporated in the .25 with a 7/16" diameter mainshaft. This permits the use of a 5/16" diameter gas passage with lots of beef remaining, and, in conjunction with a cleverly cut valve port, results in a very strong shaft. This valve port, measuring 9/32 by 5/16 is cut by first milling a flat in the shaft that is slightly wider than the finished port, and then broaching out a hole in the flat into the gas passage. This method produces no sharp corners and edges on the shaft surface from which cracks can originate, and provides a large port with the least weakness. The use of a ground crankpin has necessitated changes to the counterweight to allow the grinding wheel full traverse along the pin. The crank web is now 3/16" thick all over, but neatly milled away on either side of the pin so that the mass remaining counterbalances all rotating weight and about one-third of the reciprocating weight. A four-groove splined drive and 1/4 thread completes a very attractive crankshaft.

A material which seems especially successful for cylinder liners is the leaded steel used in the Fox range together with iron pistons. This combination feels right, and when worked together dry quickly produces its own lubrication. It is claimed to be proof against seizure on the hottest fuels and under no circumstances of reasonable treatment does the engine sag because of heat. The use of thin walls on both piston and liner is doubtless made possible by these materials, together with the improved casting design.

A long intake, provided with a removable ¼" bore restrictor, is equipped with registers for two spraybar assemblies for modification to two-speed operation, and for those wanting the ultimate in power a boss is provided in the rear cover which may be tapped out to take the 29R pressure feed valve assembly.

The conrod follows the usual current Fox design with 3/16" big end, and 5/32" small end embracing a ground tubular wrist pin with brass end pads. The fit on the crankpin is extremely good.

The cylinder head employs the recessed blowout proof sealing system developed by Fox, and which seems to be the complete answer.

We have praised the needle valve design before in these columns and while it is foolhardy to state that anything is beyond improvement, it is safe to say that we are not a bit surprised to see that this component has remained unchanged for a considerable time.

Performance and Handling

We often see and hear comments upon the fuel lift capabilities of engines and it is generally understood that a high lift denotes suitability for aerobatics and promise of smooth performance. This is not necessarily the case. It is simple to make any engine lift fuel two feet or so by progressively opening the needle valve as the fuel tank is lowered. The limiting factor is usually the jet size. The engine cannot be started by hand with high lifts, and its ability to perform this feat is no indication of what it will do with a fixed needle setting in the air. Lift can obviously be increased by restricting the intake, and this can be carried to the point where the engine has very little power but makes a highly efficient fuel pump. Similarly valve timing can be retarded to increase lift. However, the hard facts of the matter are that fuel suction is inversely proportional to engine power because to gain fuel you have to restrict the admission of air, therefore one cannot have exceptional power with phenomenal lift at the same time. Further, what good does high lift do when you have got it? There is only one fuel air ratio on which an engine will give its maximum, and any alteration of fuel level alters this ratio and hence reduces power. Raise the fuel level and the engine runs rich, lower it and she runs lean, and the spread of mixture tolerance for maximum power has very little to do with the engine, but depends almost entirely on the fuel. Alcohol is far less fussy than gasoline, for instance, and is the main reason for the smoother operation of glow motors in stunt jobs compared with spark ignition. Fuel lift variation figures would therefore be of very real interest if applied to fuels tested in an engine with a fixed maximum power needle setting, but give no real clue to the value of an engine unless reviewed in the light of all other pertinent data. A formula could be developed to include all this data and produce an overall efficiency factor for engines, but unless all engines are designed to do the same work, it would only mislead. The issue is quite simple as far as the assessing of engine suitability is concerned. High power at high R.P.M. means susceptibility to sagging in violent maneuvers. High power at medium R.P.M. as typified by Fox stunt engines promises the best compromise between power and flexibility, especially where the intake is three or four times as long as its bore, and moderate power at low R.P.M. usually gives very high lift but an engine that is very sensitive to changes of attitude and mixture strength, and it is this type which tends to die just when you are pleading for power, yet it has the greatest lift of them all.

All the Fox stunt engines give their maximum power between 10,000 and 12,000 R.P.M. for the above reasons, and that is one of the main factors behind their success. The best engine in any branch of contest work is invariably the best made best specialized compromise. No engine can be that in all branches.

Getting back to the case in point, we can afford space for the above digression simply because, to cover the handling and operation of the .25, we have only to say that it behaves like a Fox.

Test

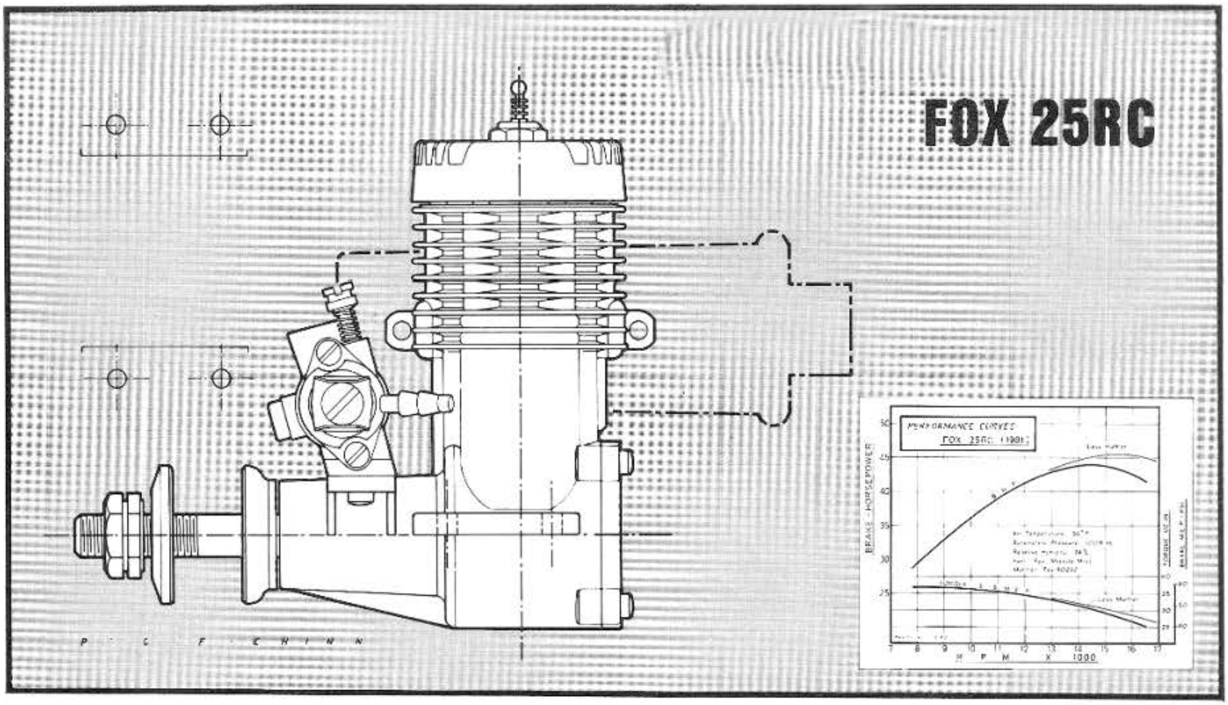
Plug—O.K. Long Reach.

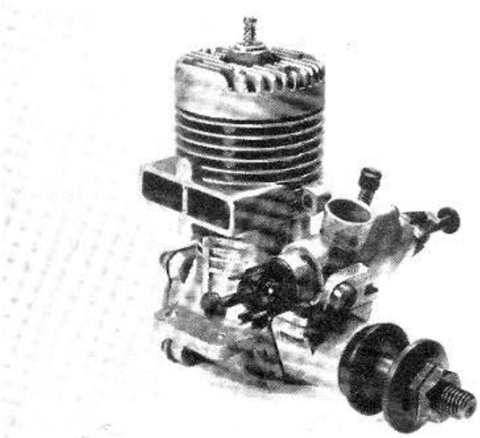
(*Continued on page* 58)

Running Time Prior to Test—1 hour.
Bore—.738 Stroke—.600 Weight—4½ ozs.

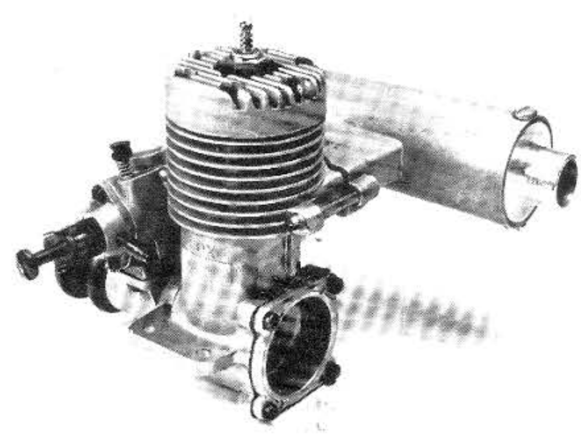
Power Prop	*R.P.M.*
10 x 6	12,000
9 x 6	12,800
7 x 10½	13,500
7 x 9	14,200
7 x 8	14,600
Top Flite	
10 x 6	11,100
9 x 8	11,300
9x 6	12,100
8 x 8	12,250
8 x 6	12,800

ENGINE REVIEW

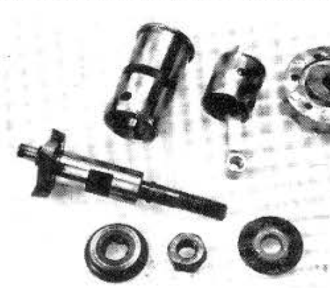




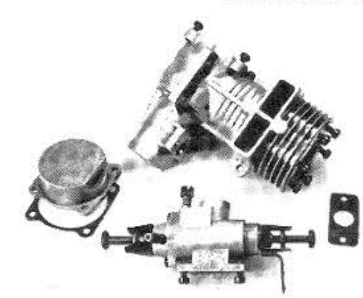
Above average performance and lower than average cost make the Fox 25RC a worthy contender in its class.



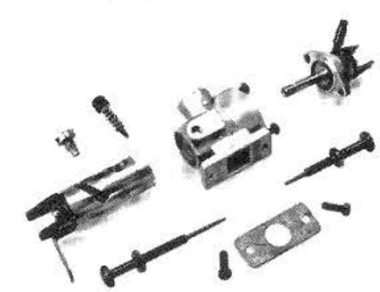
Fox muffler for the 25RC is a revised Type B with closed front end and it utilizes an improved method of attachment.



The 25RC is easy to disassemble for servicing, part replacement.



Matte finish main casting and a sturdier front end than early model; carb is new.



New type carb breaks with Fox traditions with conventional mixture control layout.

SPECIFICATIONS

Type: Single-cylinder, crossflow-scavenged, side-exhaust two-stroke cycle, with crankshaft rotary-valve and bronze bushed main bearing. Throttle type carburetor with automatic mixture control.
Checked Weights: 195 grams (6.9 oz) less muffler; 238 grams (8.4 oz) with muffler.
Displacement: 0.2470 cu in. (4.047cc)
Bore: 0.680 in. (17.27 mm)
Stroke: 0.680 in. (17.27 mm)
Stroke / Bore Ratio: 1:1
Measured Compression Ratio: 7.2:1 (full stroke)
Power Output (as tested): 0.455 bhp at 15,500 rpm less muffler; 0.44 bhp at 14,600 rpm with muffler.
Specific Output (as tested): 1.84 bhp/cu in. less muffler; 1.78 bhp/cu in. with muffler.
Power / Weight Ratio (as tested): 1.06 bhp/lb less muffler; 0.84 bhp/lb with muffler.
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, AR 72901.

by Peter Chinn

• In almost half a century of commercial model aircraft engine production, a lot of motor manufacturers have come and gone. Of course, any engine collector will tell you that as a result of severe production cutbacks during WW II and an unprecedented demand for model motors on both sides of the Atlantic in the early postwar period, numerous second-rate engines appeared on the market, all of which had sunk without trace by 1950. But the truth is that very many more manufacturers have either gone out of business or otherwise given up making miniature i.c. engines during the thirty years that have elapsed since that time. Even the last fifteen years have seen the disappearance of about forty different makes.

All this adds up to one inescapable conclusion: any manufacturer who has survived from the immediate postwar years to the present day must have consistently offered products that have earned him a lot of satisfied customers. Today, the number of manufacturers, world-wide, who can claim to have successfully spanned this period can be counted on the fingers of two hands, and one of the best-known of them is Duke Fox.

The first Fox engine to be offered to the modeling public was the Fox "Hi-Torque" .59 rear rotary disc-valve spark-ignition motor made in California in 1947. The motor for which Fox is best remembered, however, is the famous Stunt 35, winner of innumerable control-line aerobatics contests throughout the world and now in its fourth decade of production. Over the years, a wide variety of types and sizes, ranging from .049s to the current 1.20 cu in. flat-twin, has come from Fox's Arkansas-based factory and, despite the preponderance of imported makes now on the U.S. market, no less than 36 different Fox engines have been featured in the *M.A.N.* "Engine Review" test reports during the 22 years that they have been published.

The 1981 Fox 25RC that is the subject of this month's report was introduced last fall. Actually, it is a development of a design that first appeared some nine years ago and which was dealt with, in its standard free-flight/control-line version, in the July 1972 *M.A.N.*, but the model now covered is the throttle-equipped "RC" (radio-control) version, which has a number of improvements plus a new carburetor and a new muffler. We feel that it deserves inclusion in the "Engine Review" series because it offers particularly good value, especially for the newcomer to the hobby who is looking for an inexpensive engine to power a trainer. It is easy to handle, yet more powerful, by our reckoning, than other crossflow-scavenged bushed bearing engines of similar size.

Construction details are as follows:

MAIN CASTING. A one-piece body casting is used comprising the crankcase, cylinder casing and bronze bushed main-bearing housing, together with the usual beam mounting lugs, a rectangular exhaust stack on the right side and (an exclusively Fox feature) a flat saddle on the crankcase nose to which the carburetor is secured with two screws.

Distinguishing the current model from the original 25, the casting has a larger o.d. main-bearing housing and thicker mounting flange for the carburetor. Also modified is the method of muffler anchorage, which is via a pair of lugs, located fore and aft on the cylinder casing, instead of tapped holes above and below the exhaust stack.

Finally, the casting has a bead-blasted grey matte finish which, we think, looks better than the tumble polished surfaces of the original engine.

CRANKSHAFT. The sturdy one-piece case-hardened shaft has a 7/16" nominal (0.436" measured) o.d. journal and a 5/16" (0.314" measured) gas passage. It has a larger diameter crankpin than the earlier 25 shaft. Measured diameter is now 0.185" (3/16" nominal) instead of 0.155" (5/32" nominal). The shaft is counterbalanced by cutaway web flanks each side of the crankpin and a crescent counterweight opposite.

The shaft has a rectangular valve port, 5/16" long, and this uncovers a circular intake port in the main bearing for a somewhat longer induction period (approx. 189 deg. instead of 175 deg. of crank angle) than in the earlier model. The rotary-valve now opens at 43 deg. ABDC and closes at 52 deg. ATDC, according to our measurements of the test motor.

At the front end, the shaft steps down to a 1/4" dia. propshaft length with four short splines for the prop driver and the usual 1/4-28 UNF thread. The prop driver and prop retaining washer are now of steel, instead of aluminum, and both have serrated surfaces to ensure a firm grip on the prop.

CYLINDER LINER. The cylinder liner or sleeve is a slip fit in the main casting and is located in the usual way by a flange at the top. The sleeve is of leaded steel, with a wall thickness of .044", and uses a single unbridged rectangular exhaust port with, diametrically opposite, a single unbridged rectangular bypass port. The exhaust is timed to remain open for 133 deg. of crank angle and the bypass for 116 deg., according to our measurement of the test engine.

PISTON & CONROD ASSEMBLY. The ground and lapped piston is machined from Meehanite. It has a flat head with a straight baffle 5/32" high and 3/32" thick. A 1/8" solid wristpin is used, pressed into the rear piston pin hole, which is slightly tapered for this purpose. Above the piston bosses there is an annular stiffening rib to assist in maintaining piston roundness. A stronger connecting-rod, machined from bar stock, is used in place of the pressure diecast rod of the early engines.

CYLINDER HEAD. This is a pressure casting with tapered fins and is shaped to form a wedge pattern combustion chamber on the exhaust side of the piston baffle. It is channeled to fit over the flange of the cylinder sleeve with a 10 thou. soft aluminum gasket and is secured to the cylinder case with six Phillips head screws. A Fox long-reach glowplug is located vertically in the center of the head.

Measurement of the combustion chamber volume of the test motor indicated a nominal (i.e., full stroke) compression ratio of 7.2 to 1.

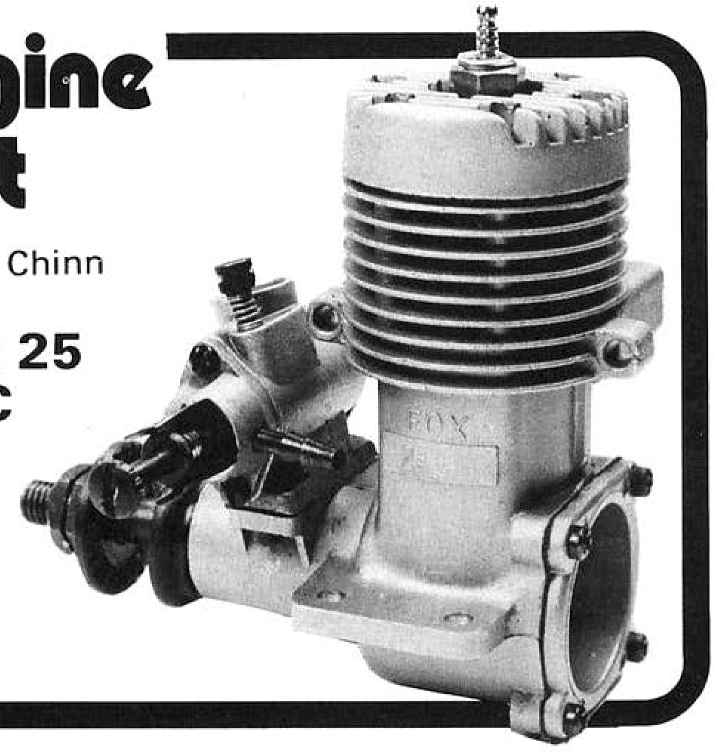
CARBURETOR. After many years during which Fox carburetors have always been of different and sometimes quite ingenious design, 1980 saw a change of policy in which Fox carbs moved closer to the basic design principles used by the majority of other R/C engines. In other words, a barrel throttle with circular choke is now used, the barrel moving axially as it is rotated and carrying with it a separate low-speed needle which reduces fuel flow through the jet tube as the throttle moves towards the idling position.

The decision to fall into line with more familiar carburetor design was not taken, we are sure, because of any shortcomings that it would have worked just as well with a new cylinder head and a single plug. ■

Engine Test

by Peter Chinn

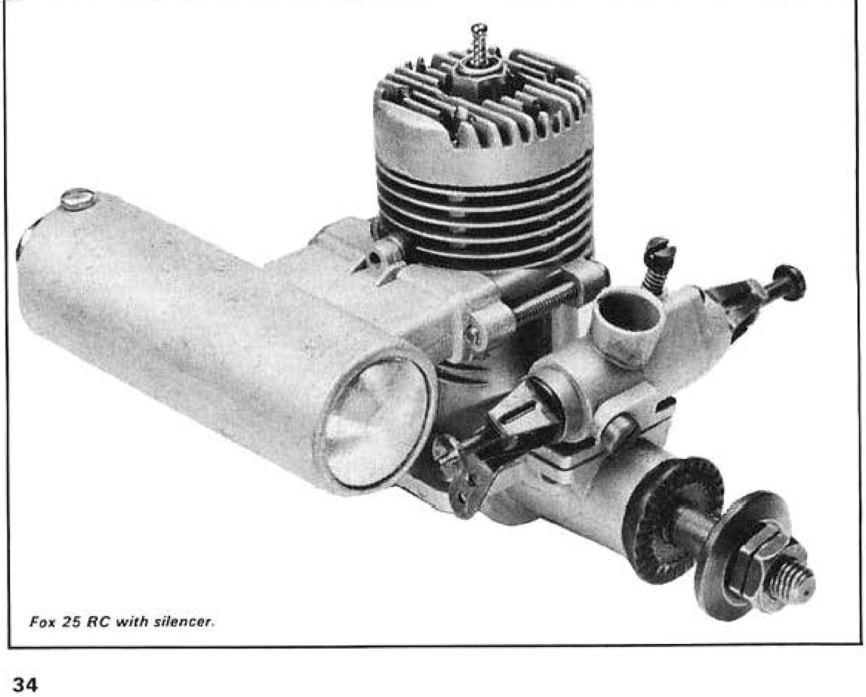
Fox 25 R/C



1982 marks the thirty-fifth anniversary of the appearance of the first Fox engine. 'This was the 9.72cc Fox 'Hi-Torque' .59, a rear rotary-valve twin ball-bearing spark-ignition engine of distinctive design and appearance. In 1949, it was followed by what was to become the most widely used and most successful control-line aerobatics engine of all time; a winner of countless contests and an engine that is still in production today: the Fox Stunt 35.

Since that time, the American Fox company has produced vast numbers of engines of all types, ranging from .049 cu.in. (.8cc) beginners' engines, to a big twin-cylinder 1.2 cu.in. (20cc) unit. Fox's most popular engines, however, have always been in the middle displacement sizes from .19 cu.in. to .40 cu.in. and one such current model is the Fox 25.

The first Fox 25 was introduced in 1972 in both standard and throttle equipped



Fox 25 RC with silencer.

1981 FOX 25RC

SPECIFICATION

Type: Single-cylinder, glowplug ignition, crossflow scavenged two-stroke, with shaft rotary-valve and side exhaust. Bushed main bearing. Throttle type carburettor with adjustable automatic mixture control. Carburettor interchangeable with plain venturi and needle-valve assembly.

Bore: 0.680in. (17.27mm)

Stroke: 0.680in. (17.27mm)

Swept Volume: 0.2470 cu.in. — 4.047cc **Stroke/Bore Ratio:** 1.00:1

Nominal Compression Ratio (full stroke): 7.2:1

Checked Weights:

195 grammes —
6.9 oz (less silencer)
238 grammes —
8.4 oz (with silencer)

GENERAL STRUCTURAL DATA

Pressure diecast aluminium alloy crankcase / cylinder-casing / front-housing unit with bronze bushed main bearing. Pressure diecase aluminium alloy backplate secured with four Phillips screws. Counterbalanced one-piece case-hardened steel crankshaft with 7/16in.dia. 7/16in. dia. main journal, 5/16in. bore gas passage, 3/16in. dia. crankpin and 1/4-28. UNF propshaft thread. Steel prop driver keyed to shaft by short splines. Drop-in leaded-steel cylinder liner located by flange at top. Ground and lapped Meehanite cast-iron piston with straight baffle and 1/8 in.dia. solid gudgeon-pin pressed into tapered hole in rear piston boss. Machined aluminium alloy connecting-rod with plain eyes. Pressure diecast aluminium alloy cylinder head with wedge pattern combustion chamber and channeled to fit over flange of cylinder liner with .010 in. soft aluminium gasket and secured with six Phillips screws. Flange mounted Fox two needle AMC carburettor with pressure diecast aluminium alloy body and steel throttle barrel. Fox 'B' size silencer (optional) with pressure diecast aluminium alloy expansion-chamber/entry-duct and machine aluminium alloy baffle tube.

TEST CONDITIONS

Running time prior to test: 1½ hours

Fuels used: (i) 5 per cent nitromethane, 25 per cent castor-oil, 70 per cent methanol. (Running-in and Test 1). (ii) 25 per cent nitromethane, 20 per cent castor-oil, 55 per cent methanol. (Test 2)

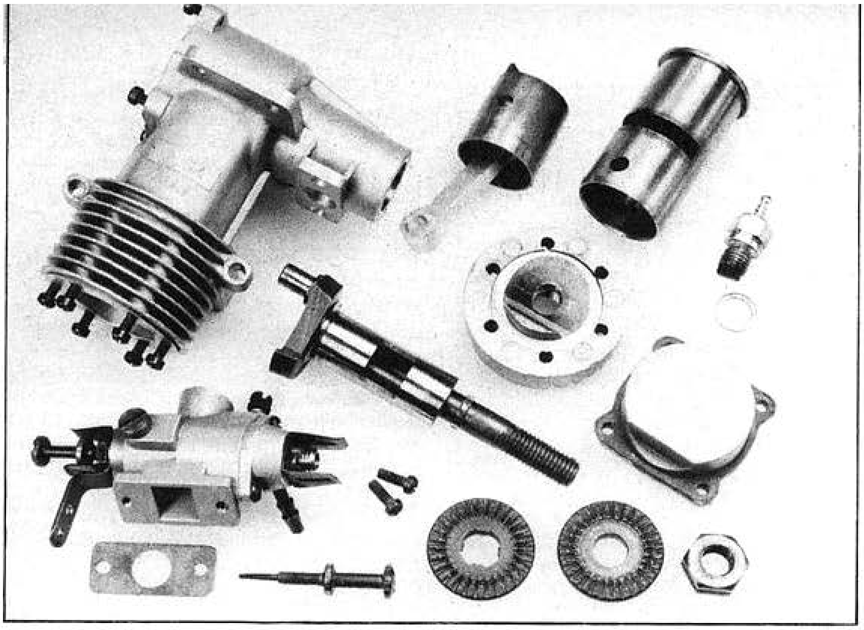
Glowplug(s) used: Fox 1.2 volt RC long-reach.

Silencer used: Fox Type B, P/N 90222.

Air temperature: 13° (56°F)

Barometric pressure: 756mm (29.76in.) Hg.

Relative humidity: 74 per cent.



Parts of the Fox 25RC. Traditional Fox construction: simple and durable.

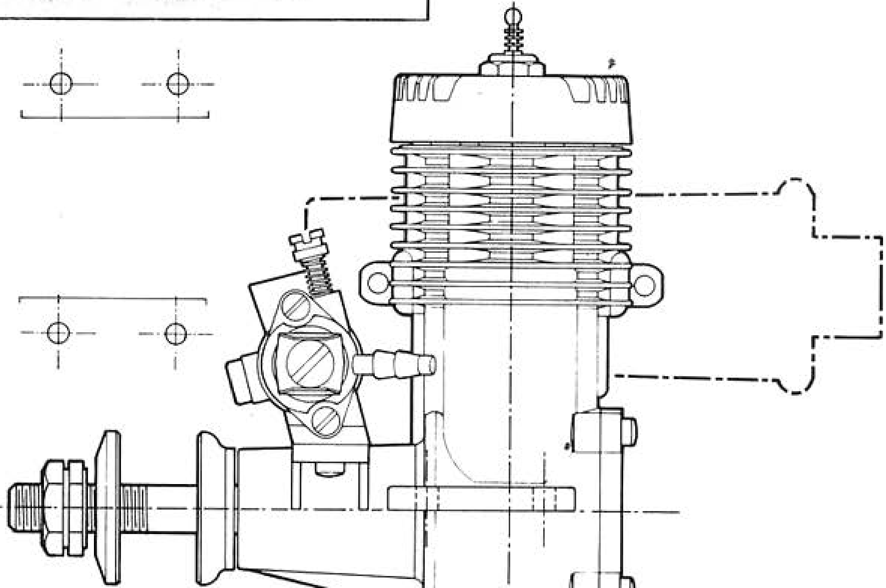
versions and the standard version was dealt with in the A.M. Engine Test series in the same year. Since that time, the 25 has been steadily improved, culminating in the new 1981 version that is the subject, in its throttle-equipped variant, of this report.

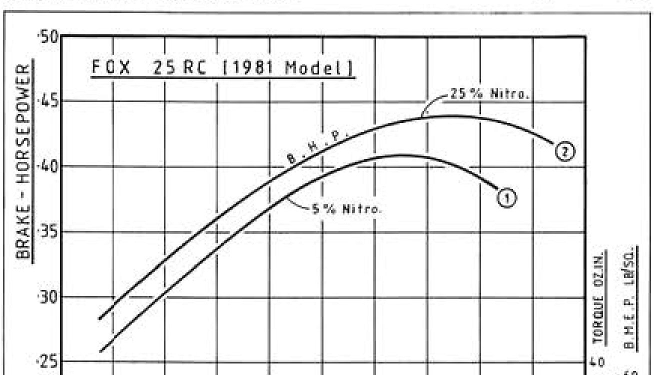
Although, in overall dimensions and general appearance, the 1981 motor is not greatly changed, most of its component parts are new or have been modified in some way and all the changes are for the better, as we shall see in a moment.

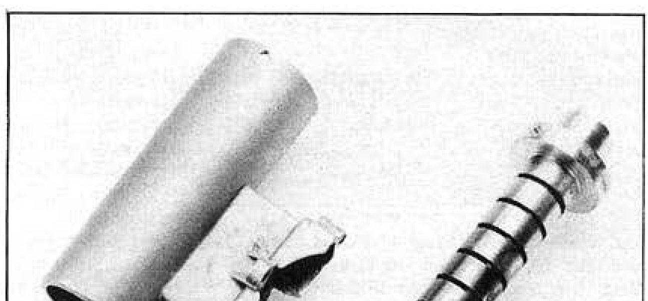
For example, the main casting, in the interests of increased durability, has a larger o.d. main bearing housing and a thicker saddle for the distinctive flange-mounted carburettor. Also changed is the method of securing the silencer, which is by means of a pair of lugs, located fore and aft, instead of tapped holes above and below the exhaust duct. A bead-blasted matt surface is now used on the casting which, one feels, looks better than the original tumble-polished finish.

The crankshaft, counterbalanced, as before, by a crescent counterweight and by cutaway web flanks, now has a 20 per cent larger diameter crankpin and its rectangular valve port uncovers the circular intake port for a lengthened induction period, beginning at 43 degrees after bottom-dead-centre and closing at 52 degrees after top-dead-centre. The prop driver is now of steel instead of aluminium. The cylinder-liner's two unbridged diametrically opposed ports are open, according to our measurements, for 133 degrees (exhaust) and 116 degrees (transfer).

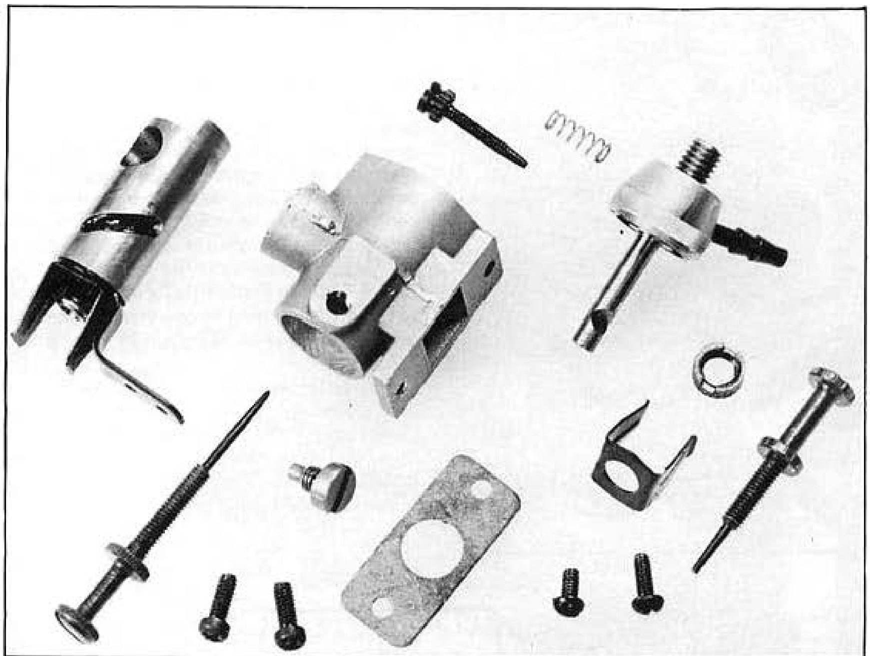
The carburettor is of a new type. In the past, Fox carburettors have invariably been of distinctively different design. They have generally worked well but have called for a different adjustment procedure. As a result, some modellers, used to the







Improved Fox 'B' silencer features diecast body and machined baffle tube.



Parts of the new automatic mixture control carburettor as fitted to the latest Fox 25RC and 19RC engines.

sequence of adjustments applicable to the now popular "two needle" type, have found the earlier Fox carbs slightly confusing. The new Fox carburettors, therefore, incorporate the basic design principles now used by most other manufacturers. That is to say, a barrel throttle with circular choke is now employed, the barrel moving axially as it is rotated, carrying with it a separate, adjustable, low-speed needle, which reduces fuel flow through the jet tube as the throttle moves towards the idling position. As before, however, the carb has flange mounting, rather than the usual spigot mounting. The effective choke area is just over 14 sq.mm.

As already noted, the method of attaching the silencer is now fore and aft, rather than top and bottom. Also, the silencer itself has a rim that fits around the exhaust duct to make a stronger assembly, much less likely to be damaged in a crash. The silencer has a modest volume of 25 ml and contains a full length radially-slotted machined aluminium tube through which gases escape via a generous 85 sq.mm. outlet.

Performance

Most Fox engines, particularly the small and medium sized ones like the 25, are intended for operation on Fox "Missile-Mist" fuel. Fox fuels are not obtainable in the U.K. but a British equivalent is available in Model Technics' GN-25 fuel, or in a 25 per cent nitromethane content, castor-oil lubricated home-brew mix, as quoted in the data table. However, in view of the very high cost of nitromethane outside the United States, the majority of U.K. customers tend to opt for a milder fuel; commonly a 5 per cent nitro blend. For this report, therefore, tests were carried out on a 5 per cent mixture as well as on the recommended 25 per cent blend.

Starting and Running Fox glowplugs are available in standard or R/C (idle-bar) types and with long or short reaches. They are also made in two ranges: the original type, identified by a plated body, which is now nominally rated at 1.2 volts and is for use with nickel-cadmium or dry cells, and the 2 volt type, which has a black body and is for use with the lead-acid cells more commonly used in the U.K. the engine is normally supplied with a 1.2 volt long-reach plug. Therefore, if you are intending to employ a 2-volt cell with this plug, make sure that you use long dropping-leads, or a suitable resistance or rheostat so that the applied current is not excessive. Check by removing the plug: the element should glow a reasonably bright red, but not a brilliant yellow-orange.

Starting qualities of our test model Fox 25RC were good. Before replacing the plug, and having followed the maker's setting-up instructions, the cylinder was primed with a few drops of fuel through the plug hole. This produced an instant first-time cold start. Warm (non-primed) re-starts were also prompt.

The engine was given a total of approximately 90 minutes' running time before test figures were recorded. Only about 15 minutes' running were required to reach the point where the 25RC, with the silencer fitted, was able to hold a steady full throttle 11,200 rpm on a 10×4 Zinger prop. At the end of one hour this figure had risen to 11,500 rpm, but no further improvement was detected during the remaining 30 minutes and the engine was then considered ready for testing.

As regards actual running qualities, the 25RC ran quite well on the 5 per cent nitro mix, except when lightly loaded for speeds in excess of 12,500 rpm when there was some unevenness of firing, accompanied by increased needle-valve sensitivity. As most owners will probably be using the engine for R/C trainer or scale models, when a 9 × 5 or 10 × 4 prop would be appropriate — i.e. when static rpm is below 12,000 — this is unlikely to be a problem.

There is no doubt, however, that this Fox does run better on the higher nitro blends. In addition to providing extra power (reflected in prop rpm increase of 300-400), the 25 per cent nitro mix gave steadier running, greater tolerance to mixture strength variation at the top end and better throttle response.

Power The Fox silencer is not so quiet as, say, the equivalent O.S. silencer, but does not absorb so much power. In fact, it is only at speeds in excess of 14,000 rpm that any power loss becomes discernible.

As the performance curves show, a peak power output of 0.44 bhp at 14,600 rpm was determined on 25 per cent nitro with the silencer fitted. Removal of the silencer raised this figure only marginally to approximately 0.455 bhp at 15,500 rpm. These are very good figures and are among the best we have recorded for a plain-bearing crossflow-scavenged engine in this capacity group. Switching to the 5 per cent nitro fuel, as expected, lowered torque (mostly by between 6 and 8 per cent) and resulted in a peak bhp of 0.41 at 13,500 rpm.

Typical speeds obtained on maple wood props and using 25 per cent nitro, included 10,200 on a 10×5 Top Flite, 10,900 on a 9×6 Zinger, 11,550 on a 10 × 4 Top Flite, 11,800 on a 10×4 Zinger, 11,700 on a 9×5 Zinger, 12,200 on a 9 × 5 Top Flite, 12,800 on a 9×4 Top Flite, 13,000 on a 9×4 Zinger, 13,700 on a 9 × 4 Power Prop and 14,100 on an 8 × 5 Zinger.

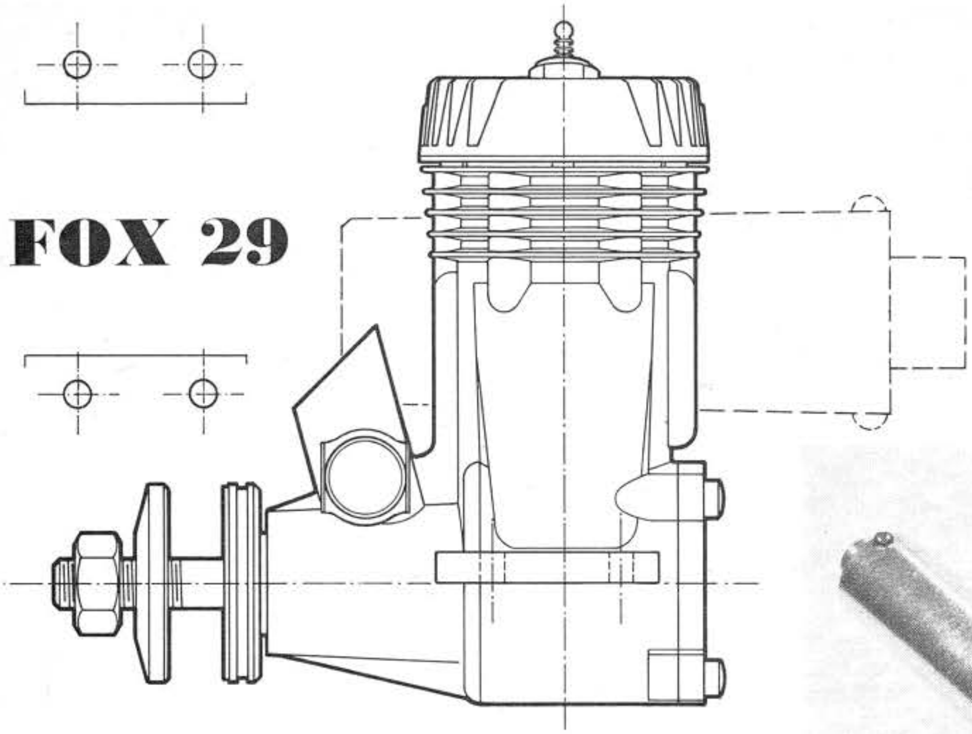
Throttling The new Fox carburettor worked well. The best running setting on 25 per cent nitro with the test engine were: main needle 2 turns open; low-speed needle 1¾ turns open. These settings allowed a minimum safe idling speed of 2,600 rpm on 10 inch diameter props, rising to 2,800/3,000 on 9 × 4 props.

Comment

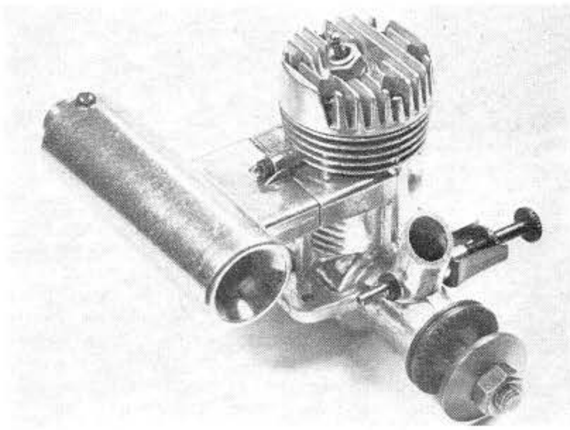
Fox engines are not found on the shelves of every dealer, some of whom claim that they are not sufficiently "pretty-looking" for their customers. To this, one can only report that Fox motors are well finished where it matters most, i.e. inside, and that overall they have a very good reputation for durability.

Manufacturer: Fox Manufacturing Company, Fort Smith, Arkansas, U.S.A.

U.K. Sales & Service: (i) Fox Mfg. Co. UK, The Haven, Rixey Park, Chudleigh, Newton Abbot, Devon. (ii) Model Aircraft (Bournemouth) Ltd, Norwood Place, Pokesdown, Bournemouth, Dorset.



FOX 29



ENGINE TEST by Peter Chinn

MORE THAN twenty years' experience in producing medium-size glowplug motors of simple construction that are easy to service yet of good performance, is at the back of this recently introduced American motor.

The current Fox 29 has the distinction of being by far the lowest priced 5 c.c. engine on the U.K. market at the present time. In fact, it costs less than some 1½-2½ c.c. motors. Intended, primarily, for control-line work – specifically stunt or general-purpose 'sport' use – it will undoubtedly appeal to those who have a limited budget but who nevertheless favour larger models that cannot be adequately powered by smaller engines of similar price.

The design and construction of the 29 are typically Fox. It is built around a one-piece body casting comprising crankcase and cylinder casing, has conventional open-loop or crossflow scavenging, a lapped piston and a plain (bushed) main bearing. The piston is of Meehanite cast-iron with straight baffle and runs in an unhardened steel cylinder-liner with a large centrally-divided exhaust port timed to remain open for some 142 degrees of crank angle. The transfer port period – as measured on our test sample – is also quite long at 134 degrees.

The hardened crankshaft is counterbalanced by means of cutaways each side of the crankpin and is coupled to the piston by an unbushed conrod of machined aluminium alloy. The shaft has a rectangular valve port and is fed from a circular port in the bearing to give a timing of 40 degrees ABDC to 45 deg. ATDC.

The cylinder head features the usual Fox wedge-shaped combustion chamber but is of a new external shape with very deep tapered fins and has an inclined glowplug. The plug fitted to the test motor was the standard U.S. fitting; namely a Fox long-reach type intended for use with not more than 1.5 volts. Purchasers are warned not to use a 2-volt lead-acid cell unless a suitable resistance or adequate dropping leads are employed, in which case, the owner should first remove the plug and check that the 'glow' is not excessive – i.e. bright red, *not* orange-yellow. The alternative would be to fit the engine with one of the new Fox 2-volt plugs. These can be identified, externally, by their black body finish.

Available for use with the 29 is the Fox 'B' size silencer. This, which also fits the *current* Fox 25 and 36 engines (i.e. those equipped with silencer attachment lugs) consists of an outer diecast aluminium shell and inlet duct, and an inner perforated tube through which the exhaust gases are discharged. Both the area of the perforations (which are in the form of a series of radial slits) and the area of the tailpipe outlet are very large indeed and, while offering somewhat limited 'silencing', cause virtually no power loss. There is a choice of two types of silencer: one with closed front (as used for our tests) and one with an open front to promote a scavenging flow of air through the inner tube of the silencer. On test we found no more than 100 r.p.m. difference under load between the two, although there might possibly be a very slightly greater difference in the air with forward movement giving a faster airflow through the open-front type.

While these silencers are not particularly cheap compared with the low price of the engine itself, they are quite compact and only add 1½ oz. to the weight of the engine.

Performance

Experience with the Fox 29 indicated that this motor is not suitable for operation on 'straight' fuel – i.e. one containing only methanol and lubricant. Our test motor needed a *minimum* of 5 per cent pure nitromethane (or 7-8 per cent commercial denatured nitromethane). One must remember that most American engines are operated on fuels containing nitromethane, and compression ratios are normally selected to suit such fuels.

The maker's recommended fuel for the Fox 29 is Fox 'Missile Mist' which is stated to contain 25 per cent nitromethane and it is obvious that the engine has been set up to run best on such a mixture.

On test, we found that, compared with the performance on Fox 'Missile Mist', the attempted use of straight methanol/castor-oil fuel caused the loss of 1,200 r.p.m. on a 9 x 6 prop. This was not due solely to the higher power output resulting from the use of nitromethane. It was also due to the fact that use of a 'cold' fuel in an engine set up for a 'hotter' mixture was causing ignition to be retarded. This was evident from the fact that some power could be regained by reconnecting the battery lead to the glowplug while the engine was running.

In due course, Missile Mist will, we understand, become available in the U.K. Meanwhile, one could use another U.S. imported fuel, such as K&B 'Supersonic-500' or 'Supersonic-1000' (both available through Irvine Engines) or a home-brew containing, say, 10-20 per cent nitromethane. As already stated, our test motor needed a minimum of 5 per cent nitro. On test, this, with a 9 x 6 prop, was about 700 up on straight fuel. Under lighter loads however (e.g. on props intended to allow the engine to get near to its b.h.p. peak in the air), 5 per cent nitro was not enough to avoid a falling off in power as the battery lead was disconnected. Our performance tests were therefore carried out on Missile Mist.

The general handling qualities of the Fox 29 were entirely satisfactory. Starting was good, using the orthodox procedure of priming the cylinder when the engine was cold and simply choking the intake when restarting it warm. The needle-valve, with its new larger control-knob, was much more convenient to adjust than the old type and held settings precisely.

Typical prop r.p.m. recorded on test included 9,900 on a 10 x 6 Top-Flite maple, 10,300 on a 10 x 5 Punctilio, 10,600 on a 10 x 5 Super glass-nylon, 11,200 on a 9 x 6 Top-Flite maple, 12,600 on a 9 x 5 Top-Flite standard wood and 13,000 on a 9 x 4 Tornado nylon. The 29 is not critical as regards prop size and, thanks to its useful low-speed torque, has good pulling power over a quite wide range of load speeds. Maximum torque was nearly 40 oz./in. at about 7,500 r.p.m., while the peak output, just short of 0.48 b.h.p., was reached at some 15,000 r.p.m.

SPECIFICATION
Type: Single-cylinder, air-cooled, glowplug-ignition two-stroke with crankshaft rotary-valve and bushed main bearing.
Bore: 0.738 in.
Stroke: 0.700 in.
Swept Volume: 0.2994 cu. in. or 4.907 c.c.
Stroke/Bore Ratio: 0.9485:1.
Checked Weights:
214 grammes — 7.55 oz. (less silencer)
255 grammes — 9.00 oz. (with Type B extractor silencer)
257 grammes — 9.07 oz. (with Type B closed silencer)

GENERAL STRUCTURAL DATA
Pressure diecast aluminium alloy *crankcase/cylinder-casing/front-housing* unit with bronze bushed main bearing and drop-in steel *cylinder-liner*. Pressure diecast aluminium alloy *crankcase backplate* secured with four screws. Hardened steel counterbalanced *crankshaft* with 0.500 in. dia. journal, 0.345 in. bore gas passage and integral 0.218 in. dia. solid crankpin. Lapped cast-iron *piston* with straight baffle, annular stiffening rib above bosses and 0.156 in. dia. solid *gudgeon-pin* retained by wire circlips. Machined aluminium alloy *connecting-rod* with plain eyes. Deeply finned pressure diecast aluminium alloy *cylinder-head* with .010 in. aluminium gasket and secured to cylinder casting with six screws. Blued steel *prop drive washer*, retaining washer and hexagon nut. Steel 7.26 mm. i.d. choke insert retained by brass spraybar. Beam mounting lugs.

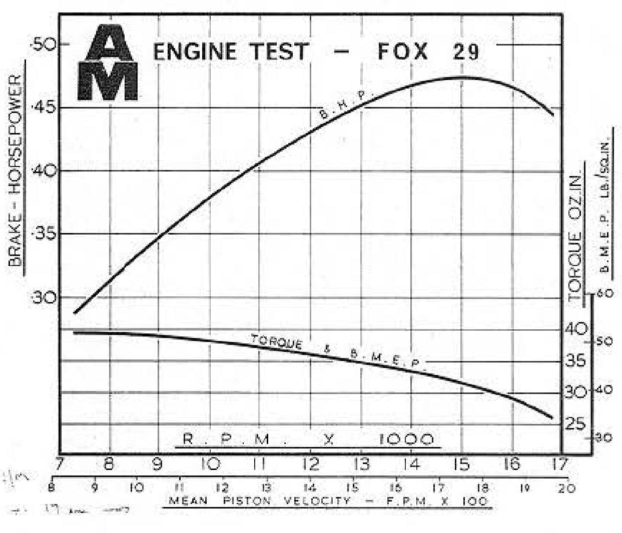
OPTIONAL EXTRAS
(i) Size B open-front silencer, P/N 90211
(ii) Size B closed front silencer, P/N 90212
(iii) Aluminium propshaft extension, ½ in. P/N 90401
(iv) Steel propshaft extension, ½ in. P/N 90402
(v) Aluminium propshaft extension, ¾ in. P/N 90403
(vi) Steel propshaft extension, ¾ in. P/N 90404

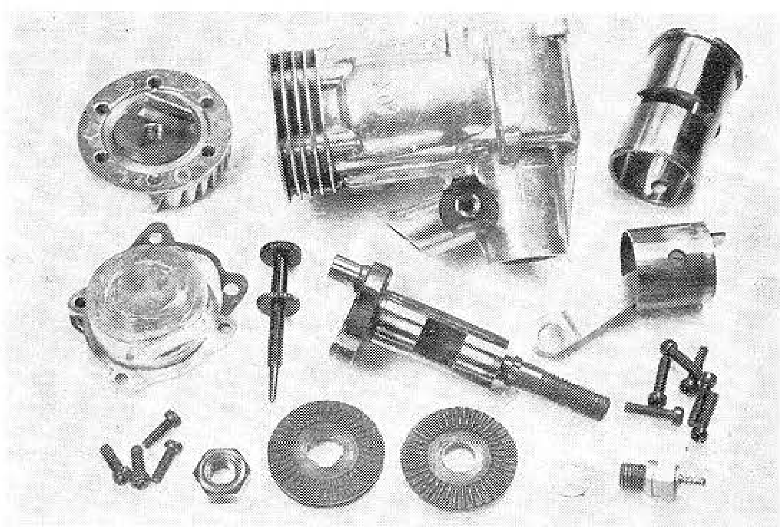
TEST CONDITIONS
Runnning time prior to test: Approx. 1 hour
Fuel used: (i) 75 per cent methanol, 25 per cent Duckhams Racing Castor-oil (Running-in). (ii) Fox 'Missile Mist' (Tests).
Glowplugs used: Fox standard 1.5 volt platinum-rhodium filament long-reach.
Air Temperature: 13 deg. C. (56 deg. F).
Barometric Pressure: 29.70 in. Hg.
Silencer: Fox 'B' closed front type.

Unquestionably, this new Fox 29 is very good value. Admittedly, the attraction of its remarkably low initial cost, is slightly reduced by its need for more expensive fuel. This could, one feels, be overcome if the manufacturer were to offer it on the U.K. market with a slightly higher compression ratio.

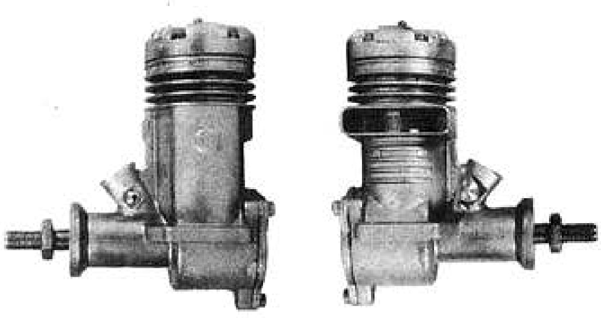
Power/Weight Ratio (as tested on Fox Missile Mist fuel with silencer): 0.84 b.h.p./lb.

Specific Output (as tested on Fox Missile Mist fuel with silencer): 96 b.h.p./litre.

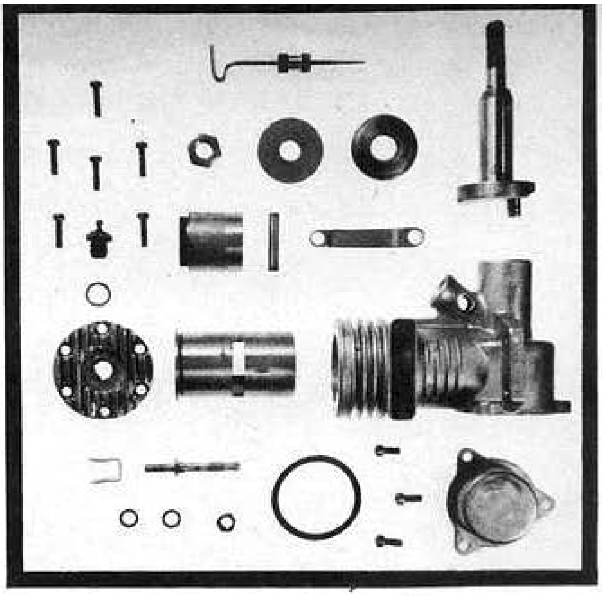




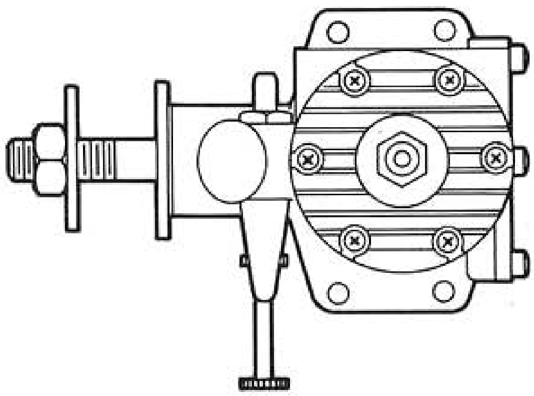
ENGINE REVIEW



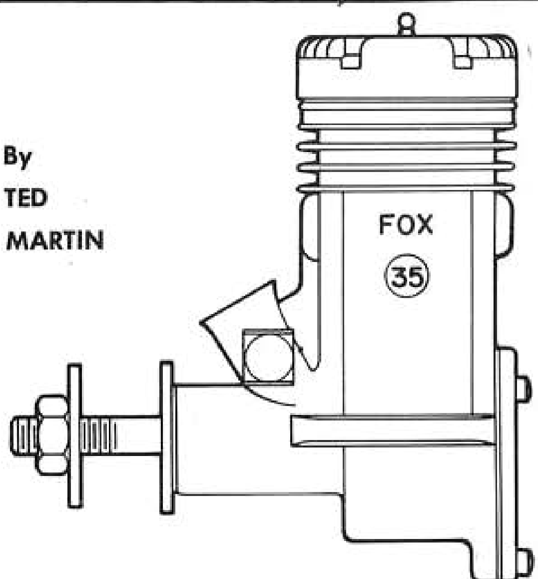
Fox .29

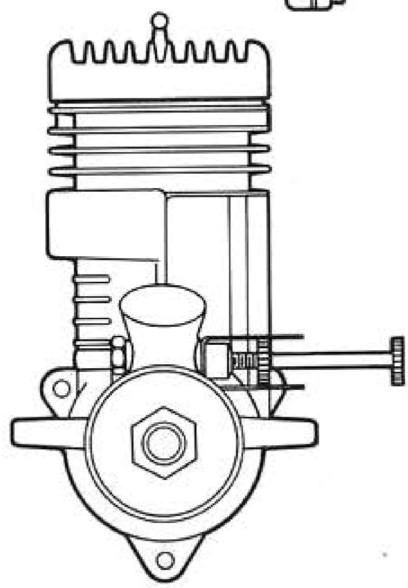


An authoritative discussion of the many factors that have made the .29—and its .35 brother—so successful as stunt model powerplants.



By
TED
MARTIN





▸ The Fox .29 and its overbored companion, the .35, are aimed at stunt U-control; the fact that they are Spartan engines with no luxurious plated fittings and eye-catching color schemes means nothing when you see them perform. In common with its full size counterpart, the modern model engine has to be specifically aimed at some particular application. The days of the general purpose power unit are now but happy memories. As a stunt engine, the Fox is renowned. Why?

The Fox is very lightweight for its displacement and this permits a light model. This saving in weight offers the alternatives of a smaller wing area to achieve a pre-determined wing loading and, reduced drag and increased speed, or instead, retain a normal wing area with the advantages of the most exceptional maneuverability, owing to low wing loading. To realize this advantage demands rock steady carburation so that power output remains constant, regardless of the variable head of fuel occasioned by changes of attitude and therefore tank position in violent maneuvers. The Fox has this important property; while to the casual eye, it just looks like any other front rotary setup, there are actually a number of important small details which make the difference. When one considers that the ideal fuel/air in an alcohol burning engine is around one part fuel to eight of air by weight (in other words, about 5000 times as much air as fuel by volume), it is understandable that minute details in carburetor design can have a vital effect on overall efficiency. However, the main requirement of a stunt carburetor is that it should exert a powerful suction sufficient to overcome fuel inertia set up by the 'G' effect of violent maneuvers.

Three factors in the Fox contribute towards this ideal condition. First, rotary valve timing (*Continued on page* 52)

Engine Review

(Continued from page 20)

gives early opening and early closing without the degree of overlap featured in racing engines. This means that, regardless of rpm, there is no tendency to blowback as in the case of later timing. This is a great aid to setting the needle valve prior to launching; suction remains fairly constant in relation to engine speed at all times so that needle can be set near maximum revs on the ground. Fuel feed will remain satisfactory at increased revs developed in flight and also just when you need it during the reduced speed in a tight maneuver. With racing timing, however, there is a tendency to suck the mixture in and then blow some of it out again at low revs, making it necessary to set needle rich on the ground so that it will lean out to the best mixture at speed in the air. Thus, in a tight maneuver, when the racing engine slows down, mixture may go haywire giving a power sag which every stunt flier has experienced.

The next factor which regulates suction is the cross sectional area of intake at the point where jet is located. This, in conjunction with displacement of the engine, governs the velocity at which air passes over spraybar, and in turn determines amount of turbulence created underneath the spraybar where, in the Fox, jet

(Continued on page 54)

is located. It is this turbulence or area of low pressure which actually sucks fuel from the tank. It is a useful tip to bear in mind that, for maximum suction in any engine fitted with a spraybar, the best location for the jet hole is on the underside. You can vary this suction as desired simply by rotating the spraybar. Incidentally, a very common source of erratic running is an air leak where the flexible fuel line is hooked up to the engine and also the tank, since it is a source of trouble that can easily be eliminated when there are so many other complex bugs to deal with in engine operation, it is a good idea to make sure of these connections by binding them with wire. Pinhole vents are another fallacy. Air has to go into the tank to let fuel out. The easier it can get in the better. It pays to keep tank vents on the generous side to avoid blocking.

The third contributing factor towards effective carburation in the Fox is location of the jet in the closest possible proximity with crankshaft port. This means that almost as soon as the rotary valve begins to open fuel laden air will enter. In engines, large and small, which employ any length of plumbing between jets and inlet port, there is always a tendency for neat air to enter first because, while valve is closed and mixture is not moving, fuel droplets deposit themselves on intake walls. This obviously upsets mixture strength, a variable amount depending on engine speed.

In practically all other respects, the Fox is a compromise between performance giving features and weight economy. To achieve adequate strength with the least amount of metal, the entire engine, with exception of working parts, jet assembly, cylinder head and end cover, is pressure diecast in aluminum alloy with a cast-in crankshaft bearing bush. For rigidity, heat dissipation and trouble free simplicity, this arrangement is hard to beat and might well be studied by full size designers.

The cylinder is fitted with a drop-in floating liner whose ports line up with gas passages cast in the block. It is retained by the cylinder head with a self-bonding gasket between the joint. This gasket, incidentally, should always be renewed when an engine is reassembled. The head is retained by six Phillips head screws on a good rugged flange which no amount of overtightening will distort. The drop-in type liner is superior to the shrunk type if properly fitted because it is less prone to heat distortion and is easily removed for replacement. Unlike most high performance engines, where piston is relieved on the skirt to minimize drag, the Fox features an almost fully lapped piston and has the bore relieved from the port belt downwards. There is very little to choose between the two methods on the score of piston alignment and slap as the amount of extra clearance is only about two ten thousands of an inch.

The bypass and exhaust ports are of the large cross sectional area usually associated with racing engines but are not so high, with the result that the effective stroke is longer, which makes for higher torque at low rpm. The Fox therefore breathes well with consequent high maximum output without unduly handicapping its pulling power when loaded down to slow speeds.

The piston is of conventional design for an opposed port engine but in common with the wrist pin, has been kept as light as possible consistent with adequate strength. The piston baffle is slightly higher than usual for an engine of this size and contributes in no small measure to ease of starting and high volumetric efficiency, because it ensures that as little mixture as possible escapes through exhaust port during bypass phase. An old rule of thumb for two-cycle design is that baffle should be at least as high as bypass port. In the Fox, it is slightly higher than the exhaust with proportionately greater efficiency, though probably any further increase would begin to have an opposite effect because of pocketing in combustion chamber with a straight fence baffle.

Crankshaft is one of the heaviest ever seen on a .29, being 7/16" diameter, with a 5/16" diameter gas passage and a square rotary valve port. Conversely, however, the crankpin is rather on the small side, being only 3/16" diameter, whereas experience has shown that a 1/4" diameter pin is none too large for this size of engine. The large shaft is of course excellent as it provides great rigidity, a low bearing load per unit area, and allows a highly efficient gas passage. As to the crankpin, one considers that this bearing is just as heavily loaded as the main bearing and also works under less favorable conditions of lubrication and variable rotational loading in relation to the rod. A little more metal than is absolutely necessary for adequate strength could be left around the small diameter rod bearing. Actually, there is enough clearance in the crankcase to accommodate a larger bearing; the explanation that comes to mind for not using it is that a small diameter may have lower frictional losses when lightly loaded. However, there were no signs of rod bearing wear in these tests which usually show up any weaknesses an engine may have.

The minor details that are thoughtful and noteworthy on the Fox include a spraybar design which is unusual in that overtightening the needle merely tends to tighten the spraybar retaining nut instead of loosening it, as on most engines. Also, the needle is formed in such a way that, although situated close to the prop, it can be easily adjusted without danger to knuckles. The mounting lugs are strong and unlikely to get damaged in a crash, and lugs provided for retaining the backplate are substantial enough for use as radial mounts if necessary. The prop driving disc is made of steel and is strong and foolproof, fitting onto a substantial and positive taper. The prop is retained by the good old-fashioned and practical 1/4" nut.

Starting from cold is improved by priming the bypass through exhaust ports with a few drops of fuel. Hot starting is easily accomplished by choking intake for one flip.

Needle control is smooth and positive with a running tolerance on nitrated fuels of about four turns. The .35 is if anything slightly easier to handle than the .29, though both engines are extremely manageable.

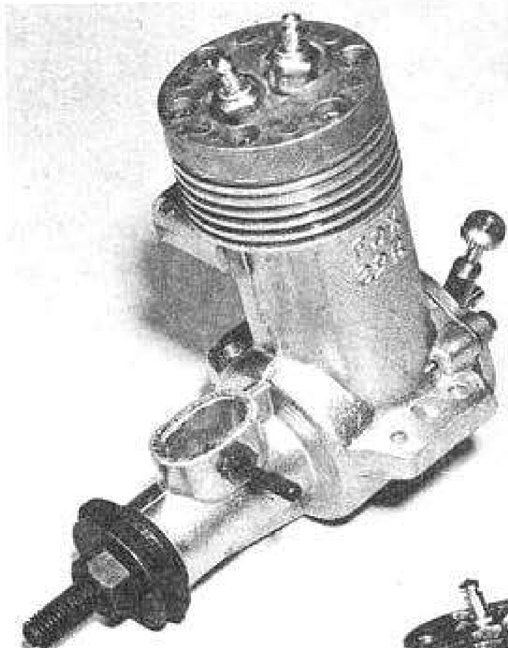
In conclusion, it is evident from performance figures that the extra displacement of the .35 shows to most advantage at lower speeds; on engines tested, output was almost the same at peak power. The .35 will therefore accommodate really tight aerobatics more easily.

It is necessary to stress particularly in the case of these light weight stunt engines that, owing to there not being much mass to absorb vibration produced, it is vitally important to use really solid mounts.

Plug—Ohlsson Std. long reach, as supplied (1-1/2 volts to start); Fuel—Supersonic 1000;

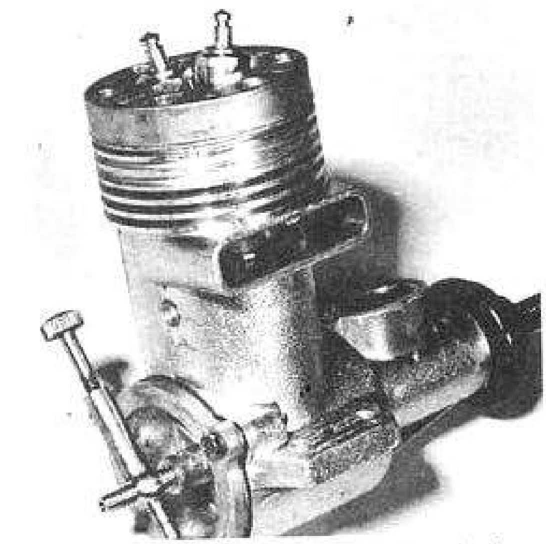
Running time prior to test—seven hours per engine (NOTE: Makers guarantee full power as purchased.); Bore (.29)—.738"; (.35)—.800"; Stroke (Both)—.700; Weight—5-3/4 ozs. approx.

Power Prop	*RPM (.29)*	*RPM (.35)*
10x8	11,500	11,900
10x6	12,400	12,750
9x8	12,600	13,050
9x6	13,700	14,100
8x8	14,050	14,500
8x6	14,800	15,250
7x10-1/2	13,900	14,500
7x9	14,650	15,100
7x8	15,000	15,500
Top Flite	*RPM (.29)*	*RPM (.35)*
10x8	10,400	10,850
10x6	11,500	11,900
9x8	11,650	12,200
9x6	12,700	13,150
8x8	13,100	13,600
8x6	13,900	14,300



Engine Review

Fox 29R



Granddaddy of all venturis distinguishes the latest Fox. Double glow plugs spell reliability. In lower picture, rear needle for pen bladder tanks is seen.

By E. C. MARTIN

Designed expressly for racing, on "jungle juice" fuels, this new engine introduces new, and improved, features.

► There must be something in the theory of thought association because our first view of the exciting new Fox 29R brought back to us the heady smell of castor oil and burning rubber, the scream of tires and engines wound to disintegration. This may be a far cry from model airplanes, but when you look deeper the model racing engine has it all, pocket sized, and it plays on the same emotions. The new Fox has something in common with the mighty Offenhauser. It is big and hairy, completely purposeful, and it sounds like more than oil and metal can stand. In every feature it is a racing engine.

Size is the keynote of the 29R. The rather handsome looking ashtray on the front is, in fact, the daddy of all air intakes, and the skinny looking intake on the back is actually the needle valve assembly. The cylinder head boasts no less than two electric corks, and the manufacturer seems to be using up surplus .59 crankshafts. All this adds up to new standards of performance with a closely approached target of one brake horsepower, or two hundred BHP/Litre. This kind of steam has only been equaled by a few highly modified Dooling .61's in race cars, and never in any unblown engine in the full sized field. Getting such a performance from a .29, where the frictional losses are relatively higher, is a considerable achievement.

The 29R is a special-purpose competition engine designed entirely around nitrated fuels. It is only meant for jungle juice and is quite unexceptional on anything less. But, given the right brew, it is claimed to operate continuously at 20,000 RPM with a life span at least the equal of any other .29, and does not suffer from a lean run. The instruction manual includes a list of polishing operations and other tidying up modifications which the owner can carry out with simple tools in order to extract the last drop of power, although such work will not be necessary until the

(*Continued on page* 49)

Engine Review

(*Continued from page 44*)

opposition turns up with the same equipment. Should anyone get the idea that this relatively expensive engine is sold in a condition requiring considerable work to get in the money, let us hasten to say that it comes out of the box a potential winner; but in order to save the time of those who like the most from the least, the correct way to do the job is described, and useless work thereby avoided.

Every feature of the construction warrants detailed description and though it might be quicker to say "imagine one hot 60 with a small piston and you are thinking of a Fox 29R" there is actually a lot more to it, but you would not be far wrong dimensionally.

The crankshaft is high-quality steel, case hardened, and a full half inch in diameter with an extra high precision ball bearing at the inner end. Each bearing is noise tested as an indication of correct rolling action, and is identical with the inner bearing used in the best .60 racing engines. The crankshaft at a ½" diameter is considerably beefier than in earlier Foxes and is balanced by a heavy counterweight which also damps some of the reciprocating weight.

A very rugged conrod, machined from dural bar, with bearings 5/16" long, takes the thrust from a case-hardened wrist-pin, which is tubular and fitted with brass end pads. The Meehanite piston, machined from bar, is milled out around the wrist-pin supports, and has a straight baffle in common with the standard engines. The skirt is not relieved and the wrist-pin bearings are 1/16" above the mid-length position, which, in conjunction with the long conrod, reduces piston side loads.

The cylinder liner is machined from a leaded steel having a low frictional coefficient, and a resistance to seizure under conditions of poor lubrication. Part of the unusual power derived from this engine is undoubtedly due to this quality, in combination with the self-lubricating properties of the Meehanite piston.

The permanent-mold casting of the crankcase is extremely interesting in many ways. At first sight, it appears as if no effort has been made to minimize the internal volume to obtain high pumping efficiency, since there is a lot of clearance between the crank disc and the piston skirt at bottom dead centre, and consequent dead space which, in conjunction with the large bypass passage, must give a low base-compression ratio. However, compression above or below the piston absorbs power, and there is a compromise between power gained from efficient charging, and power lost from achieving it, which will give the best performance at the crankshaft, where we want it. It is the old story of borrowing from Peter to pay Paul. You can get tremendous BMEP on paper, and in practice find that all the urge has gone into driving the supercharger. Duke Fox built some engines which had provision for varying the crankcase volume while running. He found the best value, and then designed the 29R crankcase accordingly. Since he apparently feels that piston friction is a major performance bottleneck, he has built the extra allowable dead space into the cylinder height, thus requiring a longer conrod which assumes a shallower angle at midstroke than a short rod, and consequently reduces piston side loading. It is contrary to all the rules and regulations, but the acid test is what gives at the end of the crankshaft, and not, as it used to be, how many miserable milligrams extra it took to get it.

In addition to these measures for giving the piston an easier time, Duke Fox is almost unique in favoring the Desaxe, or offset, cylinder. It is much easier to machine a mold, and the casting itself and its jigs and fixtures, when everything is on a common centerline, and it is for this reason that the offset cylinder is so seldom seen. However, it has a number of theoretical advantages with no obvious reason for them not being practical advantages. The piston side loads can be equal on both power and compression strokes, thus reducing the maximum value as compared with a symmetrical setup, and the ports stay open longer, thus having the same effect as increasing their height, but without the usual disadvantage of reducing the effective stroke. Important to the modeler is the fact that the bypass does not steal half of one beam mounting lug, and as far as he is concerned the offset cylinder is more symmetrical than a conventional type.

The air intake and crankshaft rotary valve port are no less than ⅜" wide by ⅝" long, and communicate with a 11/32" dia. gas passage. The air velocity through such large openings is so low that if the engine is mounted sidewinder, cylinder outwards, the centrifugal force at speed will throw the fuel out of the intake in opposition to the induction stream drawing it in; consequently the engine will starve and run erratically. A richer needle setting will not cure this trouble, and the best solution is to mount the cylinder inwards and so augment the induction. The reason for this behavior is that since the engine is designed exclusively for pressure fuel feed, there is no need to provide any venturi or restriction in the intake to create suction to draw the fuel from the tank. Volumetric efficiency and maximum power decrease as suction is increased. Therefore, with virtually no suction, a useful amount of extra power is made available. The many people who have increased the intake diameter of their racing engines have no doubt found that the extra power usually goes hand in hand with fuel feed difficulties, owing to inadequate suction, and that relocation of the fuel tank towards the outside of the flying circle is frequently necessary. The Fox 29R, therefore, takes advantage of this source of power, and the modeler is relied upon to lay out his fuel system accordingly. For speed and power duration, where a short run is required, a pen bladder tank, which provides a fairly high pressure, gives an almost constant pressure feed and no problems should be encountered, as long as the engine is not mounted the wrong way. However, when a longer run demands a fuel container of larger capacity, it will be found that finger stalls and toy balloons are capable of only a very low pressure and, consequently, the fuel feed is much more susceptible to attitude and centrifugal force. It is therefore very important to box in, or positively locate, tanks of the large and floppy variety, in a

(*Continued on page* 52)

IMPORTANT NOTE—Duke Fox reports that warm weather causes overheating of twin-plug engine. Owners who return a two-plug head to the factory will receive a one-plug head in exchange.

Test

Plugs:—2-O.K. ¼ x 32 Long Reach as fitted.
Fuel:—Standard test: Supersonic 1000
Special test: 50% Nitromethene, 10% Nitroethane, 10% Methanol, 30% Castor Oil
Running time prior to test: 1½ hrs.

Bore: .738" | Stroke: .700" | Weight: 7 ozs.

Power prop	Fox .29('55) (SS 1000)	Moir Fox .29 (SS 1000)	Fox 29R (SS 1000)	Fox 29R (Special Fuel)
10 x 8	11,500	12,000	12,100	12,200
10 x 6	12,400	12,800	13,000	13,150
9 x 8	12,600	13,200	13,350	13,500
9 x 6	13,700	14,250	14,400	14,600
8 x 8	14,050	14,600	14,800	15,050
8 x 6	14,800	15,400	15,750	16,100
7 x 10½	13,900	14,600	14,850	15,100
7 x 9	14,650	15,300	15,700	16,000
7 x 8	15,000	15,800	16,200	16,500
Top Flite				
10 x 8	10,400	11,100	11,250	11,350
10 x 6	11,500	12,000	12,200	12,300
9 x 8	11,650	12,350	12,500	12,650
9 x 6	12,700	13,250	13,400	13,650
8 x 8	13,100	13,800	14,000	14,250
8 x 6	13,900	14,550	14,800	15,050

positon similar to that necessary for a conventional stunt tank with the tank and jet centers in line with the aircraft in flying attitude. Those who have never used this type of fuel system before will be highly delighted with the rock-steady engine behavior arising from the elimination of frothing and pressure variation, and will quickly become reconciled to the untidiness of the installation.

Those who have two-speed control in mind should realize that much of this 29R performance is due to the fuel system, and that modifying the engine for two-speed operation will chop off the top of the power curve. Although with a properly designed intake the engine will undoubtedly still be outstanding, it is nevertheless a pure competition engine, and is best used in the manner for which it was designed.

The needle valve assembly is screwed into a boss on the center of the backplate, and does not communicate with the inside of the crankcase at all. It is simply mounted on the backplate. The valve body is provided with two connections, one pointing aft for bladder tank attachment, and the other at right angles for the fuel line which goes to the fuel spray nozzle in the intake. The way to use this layout is quite simple but must be carried out intelligently, if flooding and bad starting is to be avoided. The bladder is bound with thread or soft wire onto the needle valve, the needle is opened, and the bladder squeezed to exhaust all air, and the needle closed. The fuel line is also bound onto its connection, but is only slipped over the nozzle connection in the normal way. To fill the tank the line is removed from the nozzle, the end slipped over the nozzle of a fuel can pump, and the needle opened and the bladder pumped up with fuel. A certain amount of air will inevitably get into the tank and, after filling, the model should be held tail down to let this air rise to the needle valve. By opening the needle a crack, this air will escape through the fuel line, after which the line will fill up with fuel. When it is full, the needle should be closed and the line connected to the engine. It is desirable for a first time start to have the line full right up to the nozzle. The engine should now be primed through the exhaust and started. While it is running on the prime the needle should be gradually opened until the engine is running correctly. Because this is a pressure system, the needle will be found to be very sensitive and a little practice is necessary to find the right opening before the prime runs out. However the valve assembly is extremely well made and behaves logically and progressively. Once you have the knack the thing is easy. With larger, lower pressure tanks the needle will be less sensitive and more turns open will be needed.

The reason for having two glowplugs on the 29R is one of insurance against losing out on a competition start because of a burned out plug. It is not necessary to use both or even have both in working order. For contest use they should be checked and then, after installation, it is a good idea to solder a piece of wire across the two center posts so that the battery leads only have to be connected to two places, ground and one plug. This doubles battery drain, but it is a lot more than double the insurance.

Since the two plugs screw into the head at an angle, their centerlines forming a V, their bottom ends are also at an angle with the flat-topped combustion chamber, so that one side of the plug is in a recess. Apparently it is advantageous to remove some metal from the center of the head so that the plug elements are not masked. The bottom of the plugs would then be flush with the combustion chamber surface. All this will be self-evident when you look at your engine, and is a tip from the designer. Another point mentioned by Duke Fox is that, unless the engine is thoroughly warmed up on the ground, there is a risk of the plugs cooling off in the air, owing to the slipstream. This is unlikely to become evident on the bench, but can be detected by irregular firing not unlike pre-ignition.

Pressure fuel feed offers an excellent opportunity for taking advantage of the slipstream to provide an air ram to the intake, as it will not effect carburetion materially with regard to mixture strength, and it will pack in a little extra air, the theoretical increase in power being about two percent at 100 m.p.h. The ram effect also helps to overcome induction resistance arising from the centrifuge action of the crankshaft in the front rotary valve.

Handling and Performance

To someone new to pressure fuel systems this engine can be expected to behave in an unusual manner, and one cannot therefore compare it with conventional engines as a measure of handling ease. However, the issue is simply one of getting used to something different which in every important way is a considerable improvement. The exercise of common sense, plus the awareness of two fundamentals, is all that is required to get reliable starting and performance. These two points to remember are; first, that when the needle is open, a fixed amount of fuel is going into the intake regardless of engine speed or whether the engine is running or not; and second, that you have a positive pressure on the needle at all times and therefore finer adjustment is required, with flooding being the most likely danger.

Comparison of the figures below shows the steady progress in the development of the Fox .29, and interpolating the figures of the 29R on special recommended fuel mix, for which the engine was designed, it appears that the gap between the earlier engines gets wider and wider as the RPM goes up. With 16,500 on the ground, 18,000 would be a normal estimate for operation in the air. However, since the power curve is apparently still rising steeply where our standard test finishes, it is probable that between 19,000 and 20,000 would be reached on 7 x 8 prop. The very large percentage of nitromethane in this mix would only really show at ultra high speeds in an engine having such good breathing equipment as the 29R, because at lower speeds the engine can get almost all the oxygen it wants from the atmosphere. An increase of 1,500 RPM over a standard Fox at the top end represents a very considerable increase in BHP, and even more is claimed to be available after carrying out prescribed polishing.

FOX 29X ***(continued)***

(unusual in American engines). The crankpin is also drilled out ·120 in. dia. The main bearing is a bronze sleeve force fitted into the crankcase casting.

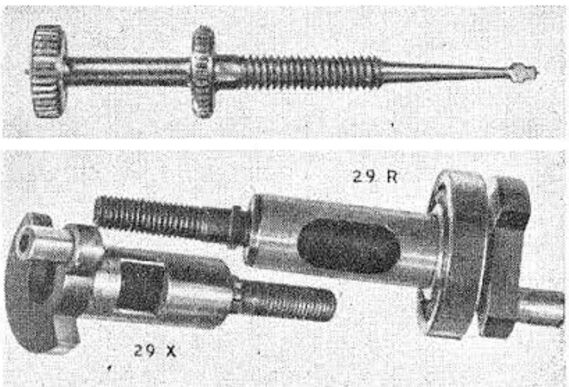
All the running fits are exceptionally good. It is obvious, in fact, that considerable attention has been given to all the parts that really matter. There was also far less evidence of roughness on the other parts than in some other Fox engines examined.

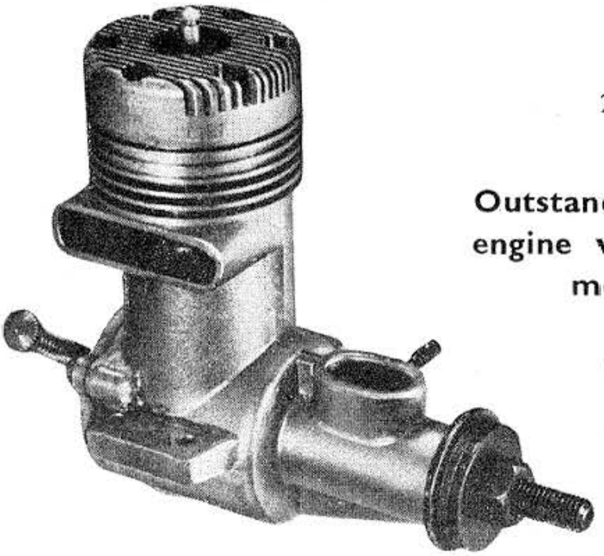
The intake tube is fitted with a sleeve, considerably restricting the diameter, which would appear to indicate that this model is intended for "stunt", "combat", team race (or radio) application. A somewhat enhanced performance could probably be realised for racing work with the sleeve removed, although no tests were made.

Provision is also made for the fitting of a second spraybar assembly for two-speed operation, by drilling through the casting at the appropriate point. The needle valve itself is ingenious in having a "spade" on flat near the end of the taper—presumably to bear against the inner diameter of the spraybar and eliminate any possibility of the needle point vibrating and possibly upsetting the fuel mixture. In view of the extreme non-sensitivity of the needle valve as a control, however, this refinement hardly appears necessary—or may possibly be a major reason for the insensitivity.

Summarising we rate the Fox 29X as an easy engine to handle, one without any apparent vices, sturdy and with an above-average perf.rmance for a plain bearing engine of this size. From the engineering point of view, too, it is exceptionally well fitted and a credit to the manufacturer's techniques.

Larger than life Fox needle shows the bearing end, also used to atomise fuel. Crankshaft comparison shows port differences between Stunt and Racing engines





Outstanding plain-bearing, pressure-fed racing engine with a potential performance above most other engines of similar size

FOX 29R

THE 29R IS a unique design of racing engine which you will either drool over if you are an out-and-out speed control-line fan, or regard as an extremely irritating and highly unnecessary piece of machinery. This racing Fox is undoubtedly a very powerful engine—with a potential performance probably far and above most other engines of its size.

We say "potential" because in our experience, operating this engine can be a tricky—even frustrating—business. Starting is not a particularly difficult job, only everything has to be just right, and whilst this can be set up quite satisfactorily for bench-running tests, operating the engine in a model could be quite another question. Consistent starting, we found, was a two-man operation—one to flick over the propeller and one looking after the fuel control. This engine is no toy and, whilst not exactly being frightening, is one which you treat with a certain amount of respect. It demands much more in technique than the average pen bladder pressure fed engine. Yet having mastered the starting technique we had no particular troubles—or qualms—about hand-starting on a 7-inch diameter propeller.

The basic difference between the Fox 29R and other engines is this method of fuel induction. The engine is of the crankshaft rotary valve type, but the shaft opening and intake is so enormous that the conventional method of sucking in a spray of fuel-air mixture is no longer effective. Instead, liquid fuel is poured into the intake through a small tube located in the normal jet position, the rate of flow controlled by a needle valve mounted on the back of the crankcase.

To get a satisfactory fuel flow the supply must be pressurised—either by locating the tank well above the engine (about two feet is adequate) so that it flows under gravity; or by using some form of pressurised tank, like a pen bladder.

Fox recommends a mixture with a very high proportion of nitromethane. We found a 50 per cent. nitromethane proportion the maximum miscible with methanol and castor (without the addition of a mixing agent, like ether) and used this for our tests. This mixture appears very hard on glow plugs, so another very necessary technique would appear to be the selection, by practical tests, of a suitable plug for the actual mixture employed.

No detailed tests were undertaken with the Fox because of the somewhat limited appeal of this specialised design but rough measurements of torque and speed over the range 14,000-18,000 r.p.m. indicated at maximum B.H.P. output somewhat in excess of .6 at around 17,500 r.p.m. which figure is probably pessimistic as regards the maximum potential of the design.

Duke Fox himself makes the point that the people who buy this class of engine will want to rework it, polishing the interior surfaces, etc., so he has concentrated on the highest standard running fits. Certainly the engine "feels" very nice, with general freeness all round and excellent compression seal. It is one of the few glow motors, for instance, which you can effectively "hydraulic" like a diesel.

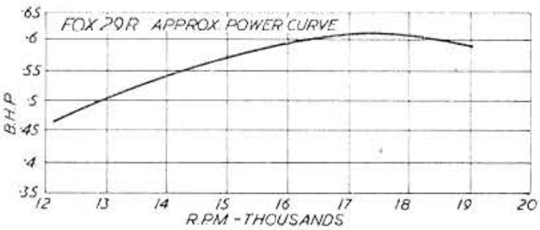
The overall size of the Fox is quite massive, particularly cylinder height. The design layout follows conventional "glow" practice, with transfer and exhaust diametrically opposed, the die-cast crankcase unit incorporating lower cylinder, exhaust and transfer and cooling fins. The cylinder liner is of leaded steel alloy and a plug fit in the casting when cold. The cylinder is heavily de Saxe or offset relative to the crankshaft to relative the piston of side loading. The piston is of cast iron, ground with a "matt" finish for oil retention with the appearance of a scratchy surface, but actually very fine and smooth. It is different in this respect of appearance from the more expected "cross hatch" pattern associated with micro-honing.

After withdrawing the liner, the piston can be removed only by withdrawing the gudgeon pin first, which is done through a hole in the cylinder jacket.

The crankshaft is a huge affair, $\frac{1}{2}$-in. diameter stepping down at the front to a $\frac{1}{4}$-in. N.F. thread. The crank pin, turned integral with the web, is 25-in. diameter. A tough connecting rod is machined from flat alloy bar.

The crankcase bore (intake) is ·360 in. and the inlet port cut in the wall $\frac{11}{16}$ in. long by $\frac{11}{32}$ in. wide. The timing of the intake port is quite normal, in fact it closes somewhat earlier than most engines of racing type.

We found the grip provided by the shallow knurling on the prop driver marginal. Even when tightened the very high torque generated on starting tends to accelerate the shaft away from the propeller and the knurling



then grinds through the propeller hub face as soon as any such movement takes place the serrations are filled and grip destroyed. As a consequence the shaft accelerates away from the propeller and unwinds the prop nut.

Summarising, a lot of practical "know-how" has undoubtedly gone into the development of this engine with the achieved object of producing a really "hot" racing engine. As we said at the beginning, if you are a speed fan you will almost certainly fall for it, and get a lot of satisfaction in experimenting with different compression ratios and fuels, and internal polishing.

FOX 29R

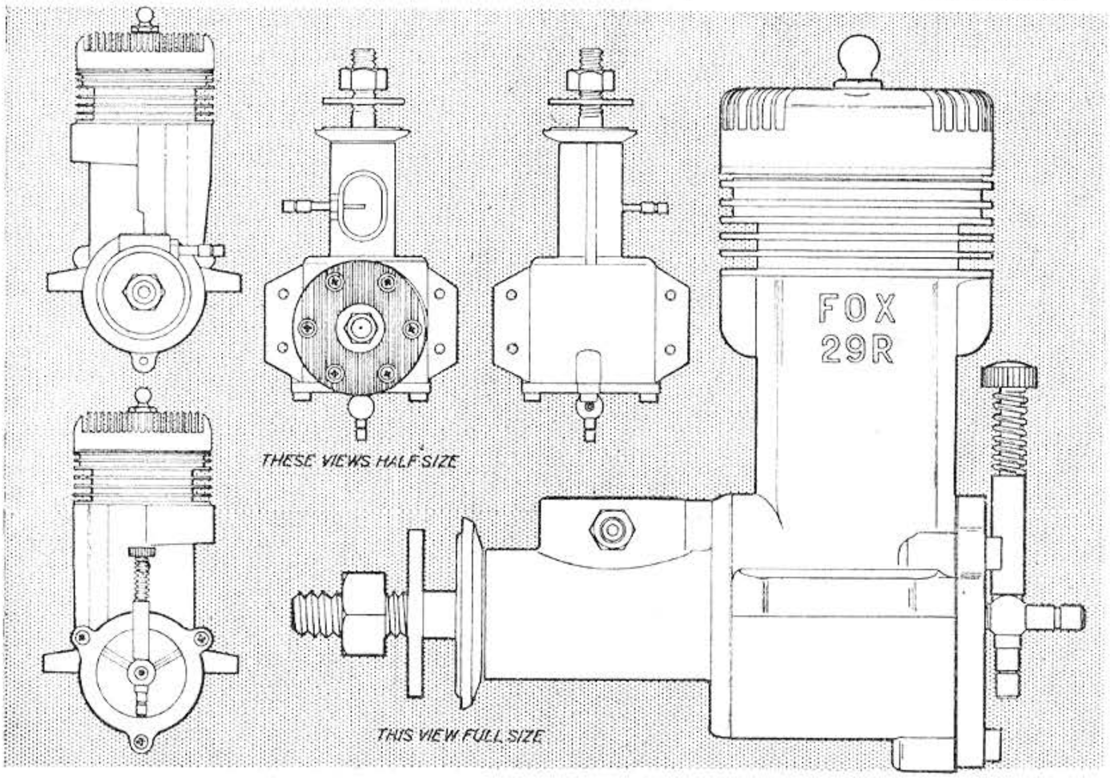
PROPELLER—R.P.M. FIGURES

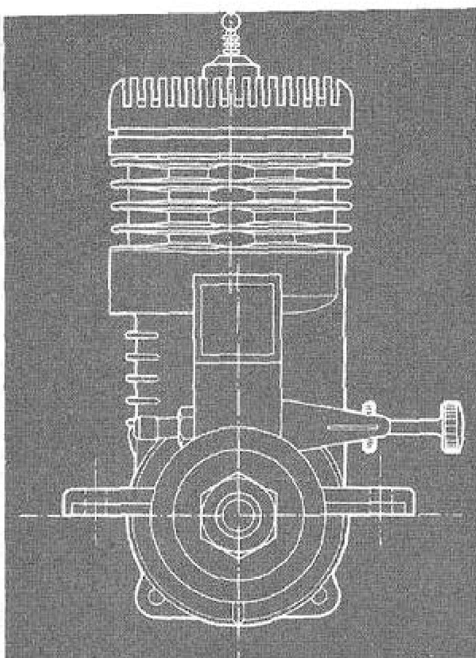
Propeller dia. x pitch	*r.p.m.*
8 x 5 (Stant)	16,500
8 x 4 (Stant)	18,000
8 x 6 (Stant)	14,800
8 x 8 (Stant TR)	14,500
9 x 6 (Stant)	13,700
7 x 6 (Stant)	18,400

Fuel: 50% nitromethane, 25% methanol, 25% castor.

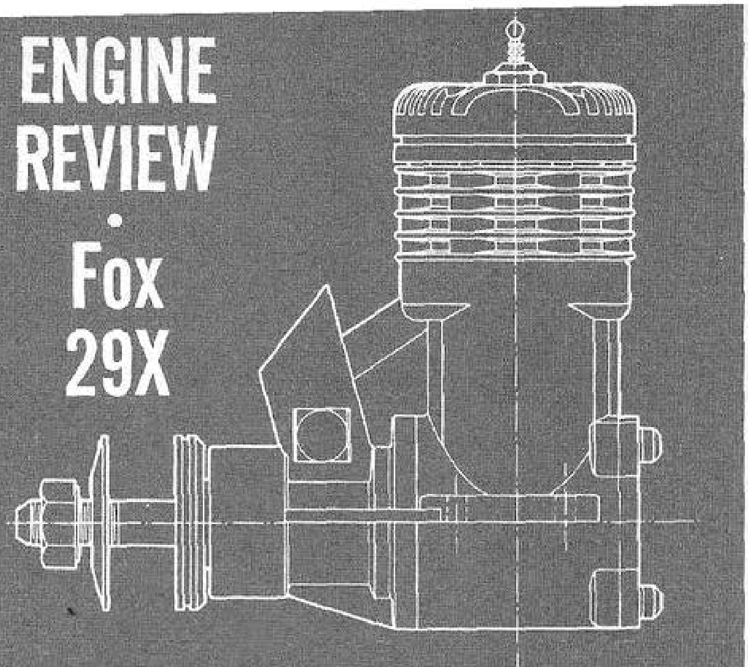
SPECIFICATION

Bore: ·733 in.
Stroke: ·697 in.
Displacement: 4·896 c.c. ·298 cu. in.
Bore/Stroke ratio: 1·06.
Max. B.H.P.: approximate figure 0·61 at 17,500 r.p.m.
Bare weight: 9 ounces.
Power output: approximate figure ·125 B.H.P. per c.c.
Power/weight ratio: approximate figure ·068 B.H.P. per ounce.

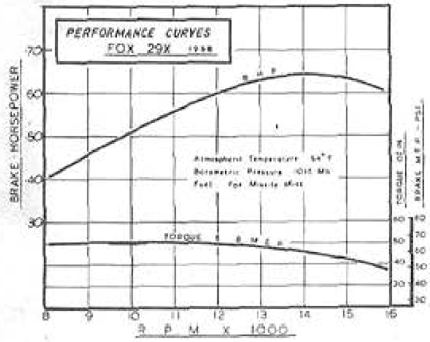




ENGINE REVIEW • Fox 29X



By PETER G. F. CHINN . . . Contrary to what we hear regarding the American engine manufacturers deserting the field, 'tisn't so as can be seen from this latest Fox entry in the engine Sweepstakes. Fox's 29X confirms that American engines still better most rivals for performance and value.

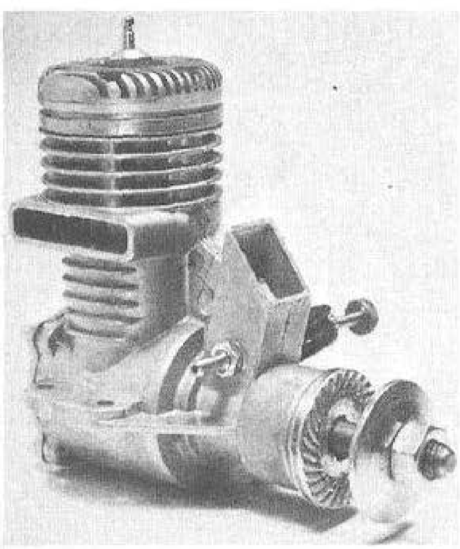


► Whether we like it or not, it has to be admitted that most of the new engines that have come on the market during the last year or two have been of foreign manufacture. In a way it is fortunate that, with many domestic motor manufacturers busy with other work, satisfactory imported engines are available to fill the gaps. Nevertheless, it is good to see that 1968 is not proving to be completely devoid of new and competitive American products.

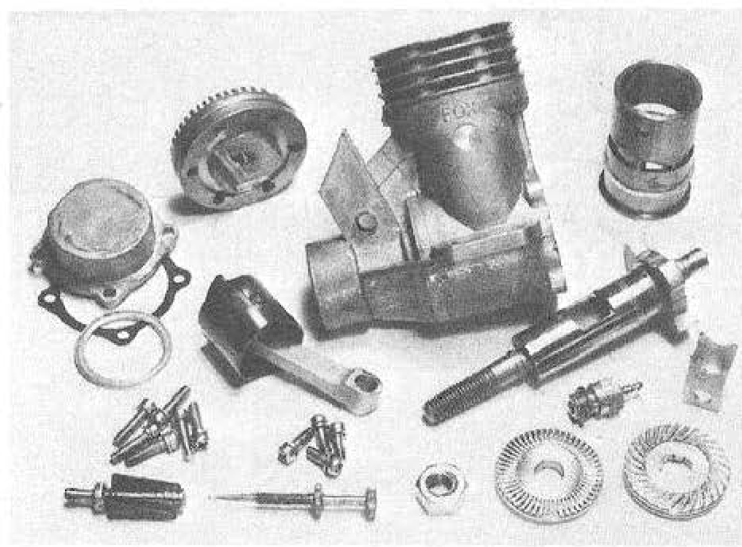
In particular, we are thinking of the new Fox 29X.

This is a motor that is built to a familiar and proven Fox formula. It is basically a mixture of parts common to certain other models in the Fox range, cleverly blended to produce a powerful, yet easy to operate motor that is as good as, if not better than, any other .29 at anywhere near its modest price of $14.95.

Our test 29X (*continued on page 67*)



Externally, 29X looks very much like 36X and is interchangeable for two class F/F contest work.



Parts disclose typically Fox design with simple but robust construction, the result of many years of development in the .29-.40 cubic inch size engines.

equal the performance of our test sample following careful break-in, on similar fuel. As we shall point out later, even more power can be obtained from the 29X if the user needs it.

Like all the middle displacement Fox engines, the 29X uses a one-piece main casting embracing the crankcase, front housing, and cylinder casing. The casting is, in fact, the same as that used by the 36X engine. Like the 36X, the case contains a single needle-bearing to support the ½ in.dia. crankshaft journal at the rear end. At the forward end, the shaft runs direct in the crankcase material.

The crankshaft is hardened and is similar to that of the 36X, except for a slightly shorter stroke (0.700 in. instead of 0.715 in.). It has a 7/32 in. dia. solid crankpin and is fairly generously balanced by a crescent counterweight in addition to having the web flanks cut away either side of the crankpin. The gas passage through the shaft is large—⅜ in. bore—and is fed from a rectangular valve port which registers with a rectangular aperture in the bearing. The intake period is lengthy: the valve opens at 33 degrees ABDC and closes at some 57 degrees ATDC (our measurements) for a total intake duration of 204 degrees of crank angle.

As on the 36X, the carburetor intake is rectangular in section. It has a ⅜ inch square restrictor, reducing the choke diameter to 9/32 in. and this is further restricted by a 9/64 in. dia. spraybar. Incidentally, if you have occasion to remove the spraybar (e.g. if it is desired to relocate the needle-valve on the opposite side) make sure that it is replaced with the two diametrically-opposed jet holes facing fore and aft rather than vertical. Some engines are not fussy in this respect, but the 29X will tend to run lean with the jet holes vertical, so much so that the needle will have to be backed off to the point where it is hanging on only by a couple of threads.

The piston and cylinder assembly are the same as those of the expensive 29XBB model. Cylinder bore is 0.738 in. but the cylinder sleeve has the same o.d. as the 36X and therefore has a very much greater wall thickness (.068 in.). A very wide, centrally divided, exhaust port is used. This occupies more than half the cylinder circumference: 200 degrees to be precise. It remains open for 140 degrees of shaft rotation, timed approximately 72 deg. BBDC—68 deg. ABDC, or, more correctly, 72-68 degrees each side of the crank position when the piston is at the bottom of its stroke. (Like all the other Fox models to which it is related, the 29X is a desaxe engine. That is to say, its cylinder axis is offset sideways relative to the crankshaft, in the direction of rotation. Therefore, the uppermost and lowermost positions of the crankpin no longer coincide with the positions of the piston at the top and bottom of its stroke.) The exhaust opening leads the bypass by approximately 5 degrees, i.e. the bypass period is 130 degrees.

The lapped Meehanite piston is typically Fox, very light with a thin skirt and thin vertical baffle, higher at the center than at the sides. The small diameter (5/32 in.) solid wrist-pin is also a Fox feature and is now restrained against contact with the cylinder walls by wire internal snap-rings within the piston bosses. The conrod is of machined aluminum alloy, unbushed, and the complete piston and rod assembly weigh less than ½ ounce.

The cylinder sleeve has a flange at the top, by which means it is located, in the usual manner, in the cylinder casting but a soft aluminum 10 thou. gasket is used between the flange and the top of the casing. A gasket of similar material is used for the cylinder-head joint. The cylinder-head is of diescast and machined aluminum, identical with that of the 29XBB and uses a wedge type combustion chamber. The head is held down with six screws and has a centrally located Fox standard long-reach glowplug.

A word about Fox plugs. For many years, Fox bought plugs from other makers. However, when most plug manufacturers started using ceramic insulators, Duke Fox undertook the development of his own plug. Duke told us that he was not althogether happy with ceramic seals because all previous experience had shown that his engines ran faster on non-ceramic seal plugs. The answer was found in a material used primarily for jet tail-pipe joints and guaranteed to withstand a temperature of 1800 deg.F. This material, moreover, does not crack, as do the seals of some plugs, if overtightened in the head.

The next step was to find a better element material. After many hundreds of tests, an alloy of platinum, iridium and rhodium was selected in place of the platinum-iridium alloy most commonly used. Another plug problem dealt with was the welding of the element. Here, the core piece is now gold plated and weld failure has been virtually eliminated. Incidentally, Fox R/C plugs now come with a machined-on idle-bar to eliminate any slight risk of the bar becoming detached and damaging the engine.

The overall dimensions of the Fox 29X are exactly the same as those of the 36X and it is about 0.3 oz. heavier (due to the thicker cylinder sleeve). The two engines are therefore virtually interchangeable for two-class (B/C) free-flight competition with the same model. The 29X has ample power on suitable prop sizes to make it competitive for free-flight in a model mainly intended for a .36 cu.in. engine.

Our test 29X was first broken-in and then checked out on a 5 percent nitromethane fuel. The engine was fairly free from the start but was, nevertheless, given a nominal break-in of one hour consisting of a series of short runs, starting with one minute rich runs and ending with a full 4-5 minutes at the optimum setting. At this time, it was established that the engine would turn a 10x6 Top-Flite at 10,300 rpm and an 11x4 Top-Flite at 11,200 rpm which is very good for a 29 running on such a mild fuel.

Starting was excellent at all times. For a dead cold start, the 29X was primed fairly generously through the exhaust port and, provided that the fuel line was full, the engine would start within 2-3 flips of the prop and keep going. Hot starts were readily obtained by first choking the intake for one or two preliminary turns, following which the 29X would usually go first or second flip. The only complaint we have about handling is the same one that we have voiced before—namely, the uncomfortably close position of the needle-valve to the prop.

Tests were then conducted on the recommended Fox Missile Mist fuel. This fuel added 400-500 rpm to the prop speeds quoted above. Other prop/rpm figures obtained included 10.100 rpm on an 11-5 Top-Flite wood, 10.900 rpm on a 10x6 Tornado nylon, 12,400 on a 10x4 Tornado nylon, 13.000 on a 10x3½ Top Flite nylon, 13.800 on a 9x5 Top-Flite wood and 14.500 on a 9x4 Top-Flite nylon.

Maximum torque obtained on test, also on Missile Mist, was 51 oz.in. (which, equivalent to a bmep of 67 lb/sq.in., is very good) at between 10,000 and 11,000 rpm. The torque curve was notably flat, the engine delivering an almost constant torque from 8,000 to 12,000 rpm, followed by a gentle decline and thereby resulting in a fairly flat power curve with the peak at around the 14,200 rpm mark and a very good bhp of 0.64.

It should be noted that these figures are for the engine in standard trim, as supplied, complete with carburetor venturi insert and running on suction feed. Fox does not actually list a pressure fitting for the 29X but there can be no doubt that, for uses other than those (e.g. C/L stunt) requiring suction feed and maximum fuel lift and where the user wishes to extract the last ounce of power from the engine, it will be worthwhile to remove the insert and run on pressure feed. The engine can be fitted with a 36XBB backplate (part No.36BB-11, price $3.00) and pressure nipple or, alternatively, the existing backplate can be modified to take the pressure fitting (part No.3521, price 50 cents) by shortening, drilling, and tapping the central spigot.

In addition, of course, the engine can be run on a more potent fuel, such as Fox Blast. Combining the higher torque obtainable with Blast with the higher peaking speeds made possible with a less restricted intake, it is quite conceivable that outputs exceeding the 0.80 bhp mark may be realized.

The 29X owes its origin primarily to the Fox 35X engine that first appeared some five years ago and which set a new standard of performance in low priced engines. Unquestionably, the 29X is a most worthy descendent of that famous motor.

Summary of Data

Type: Single cylinder two stroke cycle with crankshaft rotary-valve and single needle bearing.

Weight: 8.1 oz.

Displacement: 0.2994 cu.in. (4.907 c.c.)

Bore: 0.738 in.

Stroke: 0.700 in.

Stroke/Bore Ratio: 0.949:1

Specific Output (as tested): 2.14 bhp/cu.in.

Power/Weight Ratio (as tested): 1.26bhp/lb

Price: $14.95

Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901.

MODEL ENGINE REPORT

Duke's 29X

■ By adding "X" the unknown to an already potent .29 the Fox Manufacturing Co. offers still another motor. In discussing the 29X Duke Fox said, "Once in awhile something comes out a little bit better than we have any right to expect, I feel that this happened in the case of the 29X . . . you might say that it is one that has come about through evolution. All of the parts except the cylinder head are interchangeable with either our 29R or Combat 35."

Duke went on, "The die cast aluminum crankcase differs from the stunt 35 in that the fin diameter is 1/16" larger, the main bearing is a 1/16" larger and the rear cover has four screws instead of three. Also the by-pass is both wider and deeper."

From our observations we would say that the crankcase of the 29X, identical to that of the 35 R/C Special, appears to be a composite of previous designs and incorporates the better features of each. The result is a motor that is surprisingly energetic at all speed ranges and has the structural strength to stand up under hot fuels and repeated crack-ups.

During our test period we found this motor to be smoothest running in the higher speed ranges. Although it can be idled down to 2,000 rpm on an extremely rich needle valve setting, at this low speed it appears to be a bit rough running and vibrates considerably. This trait although undesirable in some applications should not cause any eye brow raising as it is natural with any motor that is intended for operation in the higher rpm range. At 4,000 rpm the 29X begins to smooth out and from 7,000 rpm on upward it is as smooth as silk.

Some engine designers have long held that broad needle valve adjustment and ease of starting must be sacrificed to some extent in motors capable of speeds in excess of 15,000 rmp. Large intake ports and advanced timing are not usually conducive to these two features. The 29X however seems to disprove these views. Here is a motor capable of speeds in excess of 18,000 rpm yet possessing the fast starting characteristics of all Fox motors. The needle valve adjustment is about the broadest we have experienced. With our test motor any position between two and six turns open gave the same fast starts. Highest rpm was recorded with the needle valve set at one and three quarters turns open from a fully closed position. Repeated starts were accomplished whether the motor was hot or cold by either choking in the conventional manner or by priming directly into the open exhaust port without resetting the needle valve.

Main crankcase, including venturi, fins head and backplate are die cast of aluminum alloy. A restrictor is fitted to the venturi and is held in place by the brass needle valve body. The tapered steel needle valve is of the "T" type recently introduced by Fox. Main bearing is bronze and features an oil groove. The one piece crankshaft is of alloy steel, surface hardened to Rockwell C-58. Both the main and crank pin are ground to insure roundness and a smooth finish. The counter weight is formed by milling the excess material away from each side of the crank pin. Fuel induction is via an almost square rotary valve of above average size for a motor of this displacement.

Piston is cast mechanite machined and ground to a smooth finish and features a flat top and straight baffle. It is relieved a slight amount below the wrist pin so that bearing against the cylinder sleeve is only on the upper half of the piston. This results in a faster break-in and less oil drag when the motor is running. The hollow steel wrist pin is fitted with brass pads to prevent cylinder scoring. Connecting rod is machined from 24ST aluminum and is rectangular in cross section.

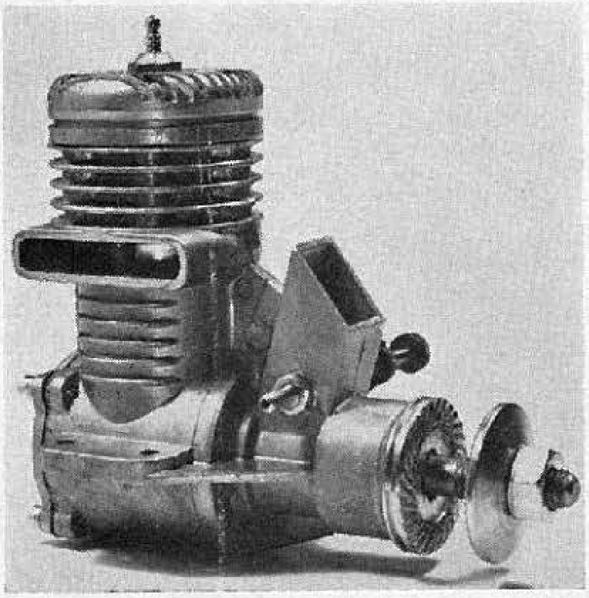
Cylinder liner, machined from an anti-galling leaded steel alloy is a hand push fit into the main crankcase casting. It is not keyed. It seats with a protruding lip fitting a circular groove in the head. An aluminum shim ring acts as a gasket between the top of the crankcase casting and the liner but no gasket is used between the liner and the head. Six Phillips head screws hold the head; four more plus a paper gasket prevent leaks at the rear cover. Propeller drive is via a heavily knurled steel drive washer keyed to the crankshaft.

(*Continued on page 56*)

Quite a bit of fine lapping compound was still evident in our test motor which we feel had much to with shortening the usually lengthy break-in period required with Fox motors. Should you encounter this same condition, we would suggest that after the motor is completely broken in to your satisfaction it be thoroughly washed out to remove any remaining traces of this red compound. Allowing it to remain in after the break-in period will only shorten the life expectancy of the power plant.

Both Fox fuel and K&B Supersonic 100 were used in our tests. No noticeable difference was recorded with either fuel. Running with a 10/6 wide blade wood prop our 29X registered 10,000 rpm. A 9/6 turned 13,500 rpm. With a 9/4 plastic, rpm jumped to 15,500; a narrow blade 7/9 hit about the same. Highest rpm attained during our test was 18,500 using an 8/4 wood Tornado propeller.

Specifications. Bore .738 inch; stroke .700 inch; displacement .299 cu. inch; rated hp at 10,000 rpm 0.50 (average); compression ratio 6:1; weight 6¼ oz.; fuel variation 15 inches.



ENGINE TEST
by Peter Chinn
FOX 29X (1968)

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THIS ENGINE, introduced earlier this year (and not to be confused with the older model Fox 29X's produced between 1958 and 1962) is the latest offering from the Fox Manufacturing Company of Fort Smith, Arkansas, U.S.A. Coming at a time when engine prices, in general, have been moving upward, the new Fox 29X remains quite reasonably priced ($14.95, or approximately £6 5s., in the U.S.) for a 5 c.c. engine capable of a fairly high level of performance.

The ancestry of the present 29X can be traced back to the Fox 35X engine which appeared in 1963 and which, itself, set a new standard of performance for low-priced engines. The 35X was later developed into the 36X and it is on the main casting of this engine that the 29X is based. Overall dimensions of the 29X, together with bearer and bolt hole spacings, are identical with the 36X.

Other parts of the 29X have been taken from the Fox 29X-BB twin ball-bearing rear-induction C/L speed type motor. This is typical of Fox design and manufacturing practice which is to ring the changes on certain proven Fox components and combinations to evolve models for different sections of the market. The new 29X is not aimed precisely at any specific contest application. Rather, it is a multi-purpose engine which the purchaser can use for general free-flight or control-line work, including contest F/F, C/L stunt or even (with simple modifications) a bit of 5 c.c. speed work at a club or inter-club level. It really has no exact counterpart in any 5 c.c. engine at present produced in the U.K.

Like other related Fox models, the 29X uses a one-piece casting to include the crankcase, cylinder casing and main bearing housing. It contains a single needle-bearing to support the rear end of the crankshaft journal while, at the front end, the shaft runs direct in the crankcase material. The crankshaft is of case-hardened steel, with a solid crankpin and fairly generous counterbalancing. The large diameter shaft journal (½ in.) has a correspondingly large gas passage (⅜ in.) fed from a rectangular valve port which uncovers a similarly shaped aperture in the bearing to give a quick-opening, quick-closing and very long induction period of some 204 degrees of crank angle. The big ⅜ in. square rectangular carburettor intake is equipped with a detachable venturi restrictor having an i.d. of 9/32 in.

The piston and cylinder liner are exactly the same as those used on the very much more expensive Fox 29X-BB.

The cast-iron piston, of typical Fox design, is light (0.34 oz.), with a flat crown and thin straight baffle. The solid gudgeon-pin, quite small in diameter (5/32 in.) is retained by wire circlips which engage grooves in the piston bosses. The connecting-rod is of machined aluminium alloy with plain eyes.

The cylinder liner has an extremely wide exhaust port which occupies 200 degrees of the cylinder circumference and remains open for 140 degrees of crank angle. Like other related Fox engines, the 29X is a Desaxe (offset cylinder) type engine and cylinder port timing is therefore slightly asymmetrical, the ports opening and closing approximately 2 degrees earlier than would otherwise be the case. The transfer period is approximately 130 degrees.

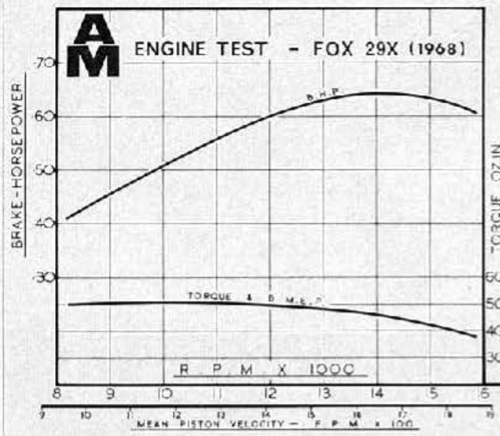
The cylinder head is also the same as that of the 29X-BB. It has a wedge-shaped combustion chamber and closely spaced machined fins. It is held down with six Phillips screws and has a recessed 10 thou. soft aluminium gasket. There is also a shim of similar material under the cylinder liner flange.

As supplied, the 29X is intended for operation on normal suction feed, the venturi restrictor being small enough to provide ample fuel lift from an ordinary tank. There is, however, a central cast-in spigot in the backplate, which could be drilled and tapped to take a crankcase bleed-off fitting to pressurise a sealed fuel tank and thereby enable an unrestricted intake to be used to release extra power for speed or contest free-flight work.

Performance

Handling qualities were very good right from the start. The engine responded readily to orthodox starting preliminaries; namely, fairly generous exhaust priming, when cold, and a one- or two-turn suck-in, when warm. The 29X was reasonably docile and could be hand-started on

Tough, yet light construction is a feature of all Fox Products, as seen in component view at right.



props down to 8 in. dia. without showing any signs of undue viciousness. Response to the needle-valve control was fairly slow, so that it was necessary to pause after making an adjustment to determine its effect before making any further readjustment towards the optimum setting, but the engine was not critical as regards the precise setting. As on most Fox engines, the needle-valve control is short, rather close to the prop and tends to be a bit stiff to operate, so that care is needed to avoid bringing one's knuckles or finger tips into contact with the prop.

As received, our test sample, which had been briefly check-run at the factory before despatch, was fairly free and needed little running-in. We gave it a total of one hour of accumulated running time before test began.

The manufacturer's recommended fuel for the 29X is Fox 'Missile Mist' and our performance graph shows the torque and power curves plotted from tests made on the engine using this fuel. A similar performance should be obtainable with home-brew mixtures containing around 20 per cent nitromethane. The maximum torque, which exceeds 50 oz. in. at between 9,000 and 11,000 r.p.m., is very good, as is the maximum power output indicated, at exceeds 50 oz. in. at between 9,000 and just over 14,000 r.p.m., of 0.64 b.h.p.

The above figures were obtained with the engine in standard trim. Somewhat higher power (probably with the b.h.p. peak at between 15,000 and 16,000 r.p.m.) can be expected by removing the restrictor and resorting to a pressurised fuel feed. Higher torque (and b.h.p.) should be realised with still more powerful fuels containing 40 to 50 per cent nitromethane.

The 29X nevertheless runs extremely well and with a quite good power output on more 'cooking' varieties of fuel. We made some brief checks on a typical C/L stunt type fuel containing 5 per cent nitromethane. These indicated that maximum b.h.p. would be in the region of 0.50 b.h.p. – rather better, in fact (despite the 29X's smaller capacity) than we obtained, last year, on our test of the well-established and much favoured Fox 35 Stunt engine.

Typical prop revolutions obtained with the 29X running on 'Missile Mist', included 8,500 r.p.m. on an 11x6 Top-Flite wood, 10,100 r.p.m. on an 11x5 Top-Flite wood, 10,400 on a 10x6 Top-Flite nylon, 10,900 on a 10x6 Tornado nylon, 12,400 on a 10x4 Tornado nylon, 13,800 on a 9x5 Top-Flite wood and 14,500 on a 9x4 Top-Flite nylon.

All performance figures were taken with the 29X in standard 'open exhaust' trim. The makers do not offer a silencer for the 29X. A possible solution here would be to use the Tatone 'Peace Pipe' Model 102 which will fit the 29X without modification to the engine.

SPECIFICATION

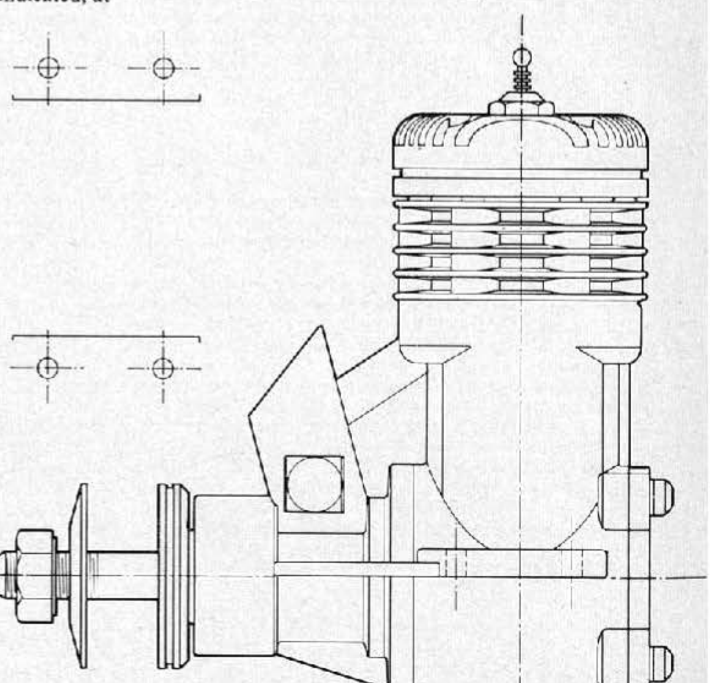
Type: Single cylinder, aircooled, glowplug ignition Desaxe two-stroke with crankshaft type rotary-valve and single needle-bearing.
Bore: 0.738 in. **Stroke:** 0.700 in.
Swept Volume: 0.2994 cu. in. = 4.907 c.c.
Stroke/Bore Ratio: 0.948:1
Weight: 8.1 oz.

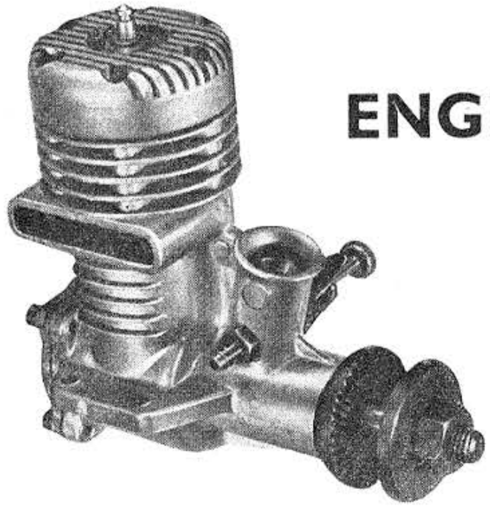
General Structural Data

Pressure diecast aluminium alloy *cylinder/crankshaft/main bearing unit* with drop-in unhardened steel *cylinder liner*. Detachable pressure diecast aluminium alloy *crankcase backplate* secured with four screws. Case-hardened steel counterbalanced *crankshaft* having ½ in. dia. journal, 7/32 in. dia. crankpin and ⅜ in. bore gas passage and supported in one caged needle-bearing at rear end. Lapped Meehanite *piston* with baffle and hardened 5/32 in. dia. solid *gudgeon-pin* retained by wire circlips in piston bosses. Machined aluminium alloy unbushed *connecting-rod*. Pressure diecast aluminium alloy *cylinder-head* with recessed .010 in. soft aluminium gasket and secured with six screws. Machined steel *prop driver*. Brass spraybar type *needle-valve assembly* retaining aluminium choke insert and reversible for left or right hand control. Beam mounting lugs.

TEST CONDITIONS

Running time prior to test: 1 hour.
Fuel used: Fox 'Missile Mist' (approx. 20 per cent nitromethane rating).
Glowplug used: Fox long-reach, platinum-rhodium filament, as fitted.
Air temperature: 54 deg.F.
Barometer: 30.00 in.Hg.
Silencer type: Nil.





ENGINE ANALYSIS No. 47

The latest engine from one of America's leading manufacturers for Team racing, stunt or combat flying

FOX 29X

by R. H. WARRING

BASICALLY THE FOX 29X has been evolved from the 29R and the Combat 35 engines, all parts being interchangeable with one or other of these models, with the exception of the cylinder head. Unlike the 29R, however, the 29X adopts a conventional layout with normal induction.

The 29X is a sturdy, rugged engine with excellent smooth running characteristics and plenty of power. Despite its high output it is an easy engine to handle, is free from marked vibration except at very high speeds, and is also easy to start.

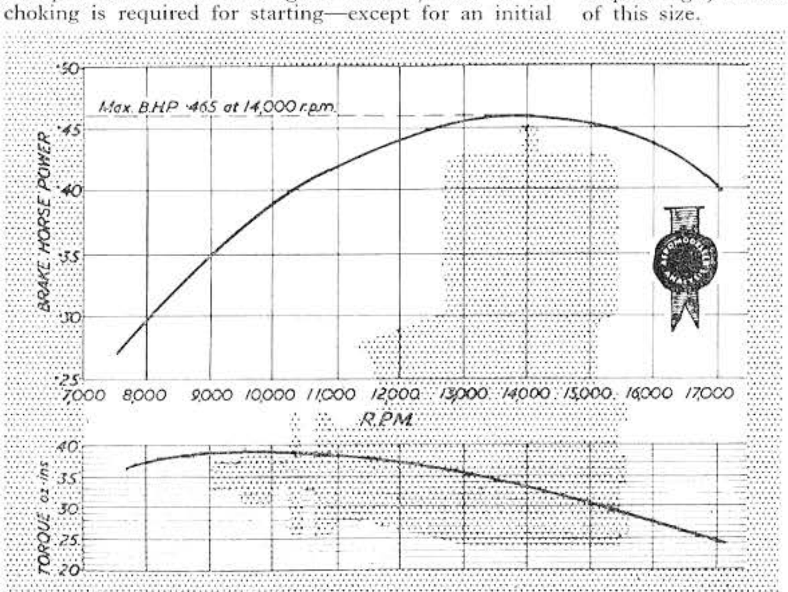
The compression ratio appears fairly high and using a doped fuel there is a marked tendency for the engine to kick back when hand starting, with increasing nitromethane content. With 20 per cent. nitromethane the kick-back is quite noticeable, demanding a powerful flick for starting. A maximum of 10 per cent. nitromethane would appear about the limit for normal operation with easy hand-starting without decreasing the compression ratio.

Starting characteristics are exceptionally good, there being no tendency to falter once running. Starting when hot deteriorates with straight fuel, but is again easy with a doped fuel. Due to the good suction, little or no choking is required for starting—except for an initial choke when cold, if only to "degum" and free the engine. *All the handling tests were conducted in particularly cold March weather and may not be typical because of this.* It is a flattering point, however, that despite near-freezing temperature no trouble at all was experienced in getting the Fox 29X to hand-start on any size of propeller.

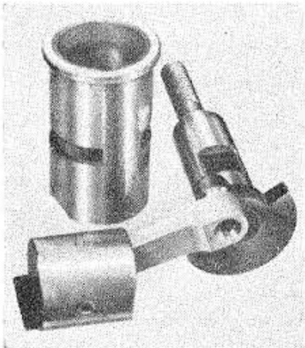
Good torque is developed at low speeds, without the engine showing any signs of exceptional power output. Running is quite steady and consistent but the Fox sounds happier at higher speeds (10,000 r.p.m. and above). At speeds above 16,000 r.p.m. the performance was very steady, although there was a noticeable tendency to vibration. At all speeds the needle valve control is exceptionally non-sensitive, allowing plenty of time for adjustment.

Useful power peak

Maximum power output on test was developed at 14,000 r.p.m., and maximum torque at 10,000 r.p.m. The 29X tends to run quite hot and unless properly cooled with an airstream performance is affected by overheating (e.g. as could occur in a close cowl without adequate venting for airflow through). Fuel consumption is quite high, without being excessively so for an engine of this size.



SPECIFICATION
Displacement: 4·896 c.c. (·2955 cu. in.)
Bore: ·738 in.
Stroke: ·697 in.
Bore/stroke ratio: 1·06
Bare weight: 7½ ounces
Max. B.H.P.: ·465 B.H.P. at 14,000 r.p.m.
Max. torque: 39 ounce-inches at 10,000 r.p.m.
Power output: ·095 B.H.P. per c.c.
Power/weight ratio: ·062 B.H.P. per ounce
Material specification:
Crankcase unit: light alloy pressure die casting
Cylinder liner: alloy steel
Piston: Meehanite
Connecting rod: machined from 24 ST aluminium alloy
Main bearing: Bearing bronze
Crankshaft: alloy steel, surface hardened to Rockwell "C" '58
Head: light alloy
Spraybar: brass
Manufacturers:
Fox Mfg. Co. Inc.,
5305 Towson Ave., Ft. Smith,
Arkansas, U.S.A.



Basic components of the 29X show remarkably little out of the ordinary, yet the plain appearance belies the high performance obtainable. Piston and cylinder are interchangeable with the 29R, but connecting rod and crankshaft are longer on the racing engine

Fuel used: 20% Nitromethane, 50% Methanol, 30% castor.

PROPELLER—R.P.M. FIGURES	
Propeller dia. x pitch	*r.p.m.*
10 x 6 (Topflite)	12,500
12 x 4 (Trucut)	8,200
10 x 4 (Trucut)	10,000
11 x 4 (Trucut)	9,800
9 x 4 (Trucut)	13,700
8 x 8 (Trucut)	12,200
8 x 6 (Trucut)	14,500
8 x 4 (Trucut)	16,000
10 x 4 (Stant)	12,500
9 x 4 (Stant)	13,300
9 x 9 (Stant)	10,400
8 x 4 (Stant)	16,100
8 x 8 (Stant)	13,500
7 x 4 (Stant)	17,500

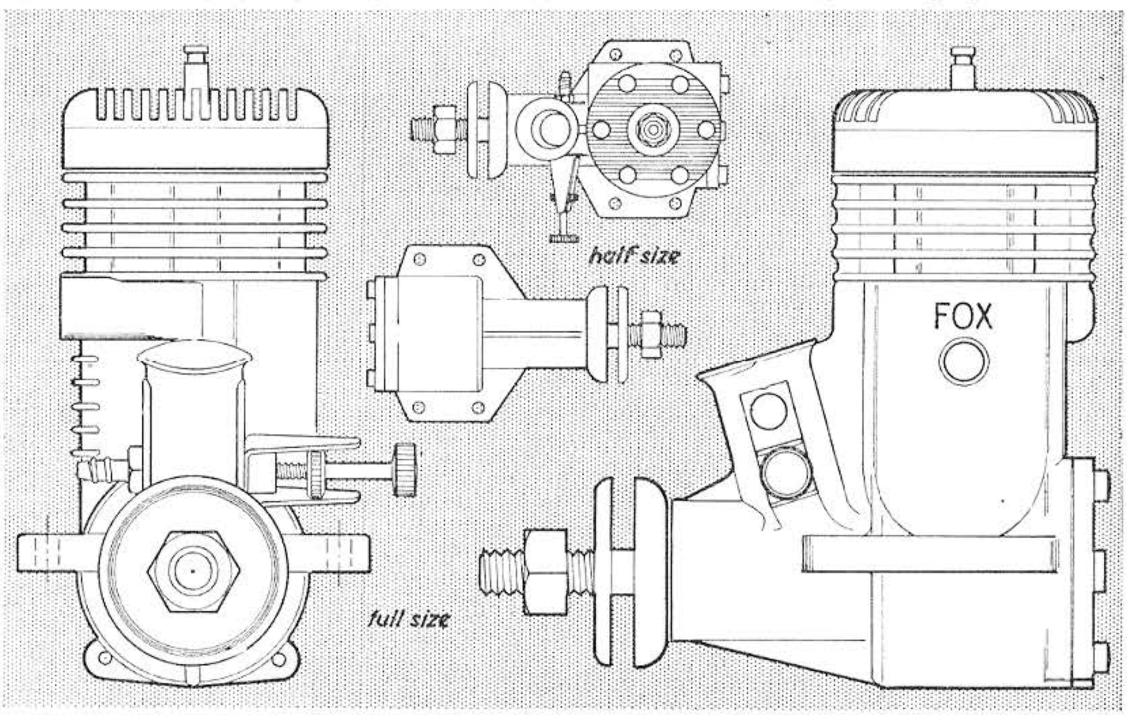
Constructionally the Fox 29X employs a light alloy crankcase casting incorporating the cylinder barrel, exhaust stub and induction tube, into which fits the liner capped by a light alloy head. The only machining operations on the casting are drilling through the induction tube (and inserted main bearing shell), reaming the main bearing for the bronze bearing shell, and the barrel reamed to fit the liner and the top faced, drilled and tapped for the head screws.

The liner is fully machined from leaded steel, turned, reamed and honed internally and ground externally to a plug fit in the crankcase casting. The top of the liner is flanged and seats on top of the cast barrel with a thin aluminium gasket under the flange. Ports are rectangular, of large area and depth, and milled in the liner walls. The bottom of the liner is ground away in a half-moon shape on the transfer side, presumably for con. rod clearance since the cylinder is slightly de Saxe.

The piston is fully machined from a Meehanite billet, ground externally, and is a beautiful job lightened to logical limits. The gudgeon pin is $\frac{5}{32}$-in. in diameter, drilled to take brass end pads. To dismantle, the liner must first be withdrawn and the gudgeon pin "fiddled" out through the hole in the rear of the crankcase casting, when the piston falls free and the con rod can also be removed. The latter is machined from light alloy stock and is of substantial proportions.

The head has an annular recess to fit the liner flange, into which is fitted an aluminium gasket. Compression ratio can be adjusted by removing this gasket, or adding another, if required. The head is contoured with a cross slot to match the straight deflector on the top of the piston, and is of substantial proportions to eliminate warping or distortion.

The crankshaft is a massive unit, although relatively short in length. It is machined from alloy steel hardened and ground to $\frac{1}{2}$-in. diameter stepping down abruptly at the end of the bearing length to a $\frac{1}{4}$-in. diameter threaded length. The port is rectangular, approx $\frac{3}{8}$ in. x $\frac{5}{16}$ in., drilled, milled and possibly finished by broaching. The central hole through the crankshaft is $\frac{11}{32}$-in. diameter. The crank web is machined away to provide counterbalance and the $\frac{7}{32}$-in. crankpin ground to finish



(unusual in American engines). The crankpin is also drilled out ·120 in. dia. The main bearing is a bronze sleeve force fitted into the crankcase casting.

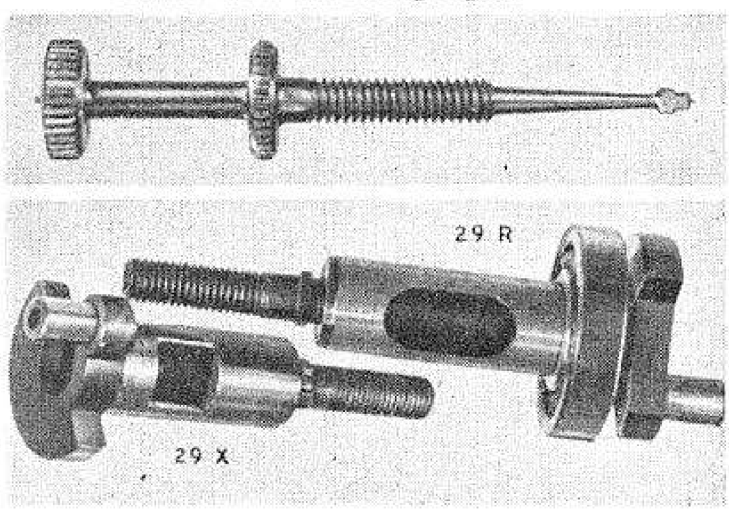
All the running fits are exceptionally good. It is obvious, in fact, that considerable attention has been given to all the parts that really matter. There was also far less evidence of roughness on the other parts than in some other Fox engines examined.

The intake tube is fitted with a sleeve, considerably restricting the diameter, which would appear to indicate that this model is intended for "stunt", "combat", team race (or radio) application. A somewhat enhanced performance could probably be realised for racing work with the sleeve removed, although no tests were made.

Provision is also made for the fitting of a second spraybar assembly for two-speed operation, by drilling through the casting at the appropriate point. The needle valve itself is ingenious in having a "spade" on flat near the end of the taper—presumably to bear against the inner diameter of the spraybar and eliminate any possibility of the needle point vibrating and possibly upsetting the fuel mixture. In view of the extreme non-sensitivity of the needle valve as a control, however, this refinement hardly appears necessary—or may possibly be a major reason for the insensitivity.

Summarising we rate the Fox 29X as an easy engine to handle, one without any apparent vices, sturdy and with an above-average performance for a plain bearing engine of this size. From the engineering point of view, too, it is exceptionally well fitted and a credit to the manufacturer's techniques.

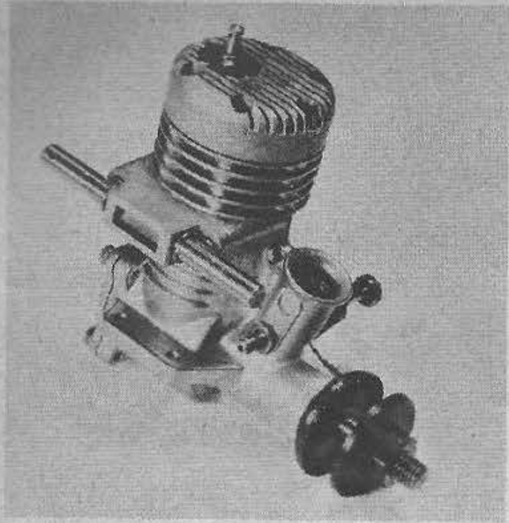
Larger than life Fox needle shows the bearing end, also used to atomise fuel. Crankshaft comparison shows port differences between Stunt and Racing engines



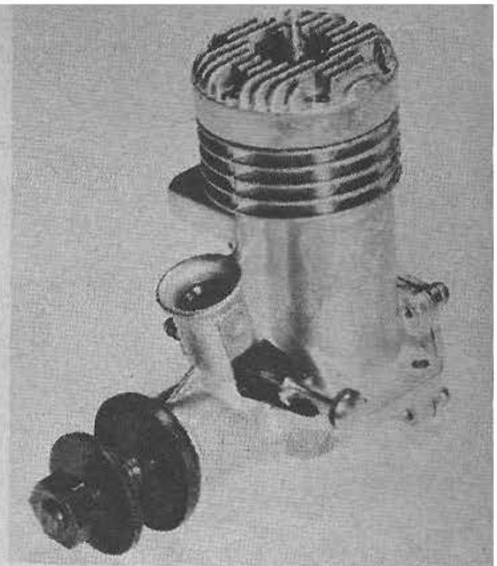
by E. C. MARTIN

Engine Review

Fox. 35



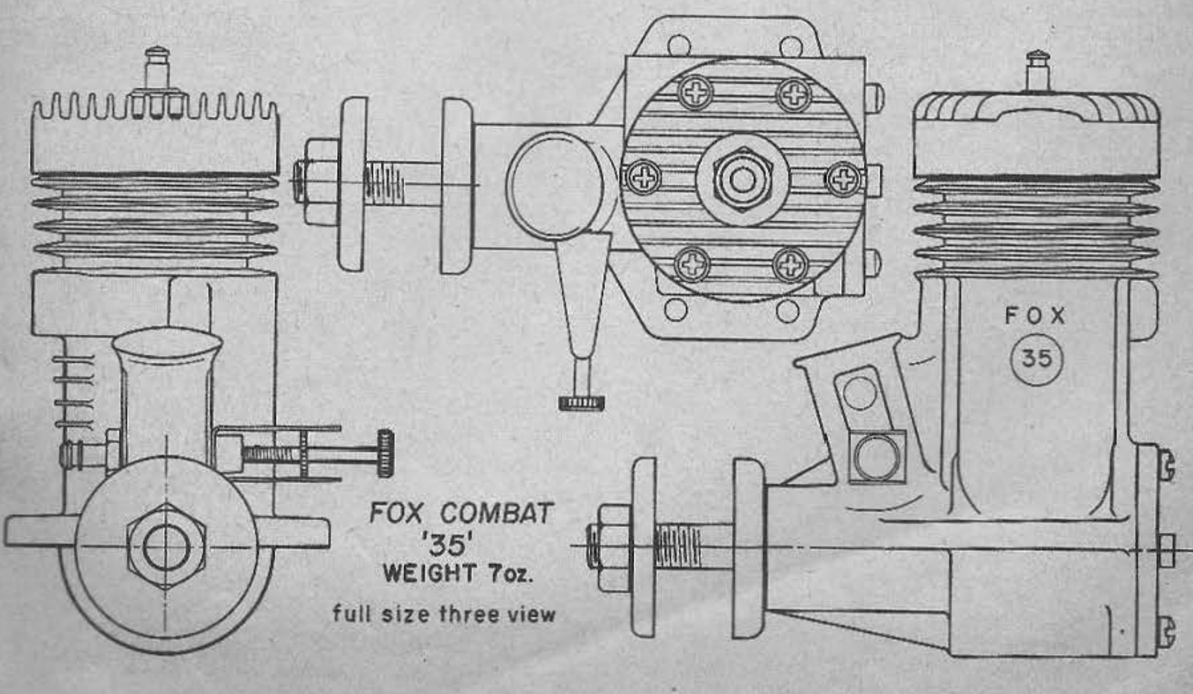
R. C. SPECIAL ◄



► COMBAT SPECIAL

► With the Fox .35 firmly established in stunt, and the 29R in speed circles, two new special purpose engines have appeared under the Fox banner. Basically the two engines are very similar and embody several notable refinements which will doubtlessly find their way into the other engines in the range. Of greatest interest, however, are the ways in which the design is adapted to the very different requirements of radio control use on the one hand, and the sustained hammering of combat flying on the other.

Taking the two engines piece by piece let us see what does which and why. The main casting is exactly the same for both engines except for two tapped holes in the exhaust stack for the exhaust throttle attachment, and two lubrication grooves in the main bearing on the RC version. A radio engine usually runs for long periods and with fine pitch props can attain quite phenomenal revs in long dives. The combat engine never has the load removed by long dives and, therefore, does not reach such high revs. The use of grooves in the radio engine suggest that light-load high revs cause more of a bearing problem than normal load normal revs. This makes more sense when it is realized that much of the bearing load is not caused by combustion pressure but by the effort of overcoming the inertia of the piston in the course of stopping its travel and getting it moving in the opposite direction. At T.D.C. this load is opposed, and therefore effectively reduced, by combustion pressure. However, when (*Continued on page 47*)



FOX COMBAT
'35'
WEIGHT 7oz.
full size three view

indicated point. Cover hole temporarily with masking tape. When you have test-flown your sharp Cutlass and are satisfied with her balance, replace the small piece of wood cut out, sand and touch up with colored dope.

Before firing up your little mill, we recommend you testwhip your sharp Cutlass on eight or 10-foot lines. U-Reely Control is handy for this job, and for all flying, for that matter. If your Cutlass needs any down control to whip on short lines, or if she hunts vertically, add ballast until she smooths out. Properly balanced, she is sensationally stable.

When you've gotten the setting right, hook up 40-foot Orlon lines, crank up and fly. Control response is more leisurely than in conventional lay-outs, and at low speeds this configuration is slightly nose heavy. Best to land her fairly fast. Best of all is to hand launch and pay out from your U-Reely control.

Engine Review

(*Continued from page 35*)

an engine is overrevving, it cannot breathe enough air to do very much real combusting and so this relieving pressure is considerably reduced, while inertia loads increase as the square of the piston speed. Result, more bearing load in RC engine and remedy more oil, hence added oilways.

As described in the recent test of the Fox .25, the new Foxes have ribs for the cylinder head hold down screw tappings which extend right down to the exhaust stack. It was found that this prevented a tendency for the cylinder bore to distort and grip the piston when the head was tightened.

Profiting from experience with the 29R, the new engines have half-inch diameter main bearings, which are bushed with high quality bronze after much investigation of alternative materials, and ⅜" intake bores. These are first class .60 racing engine dimensions and give good cause for serious thought about future development of the big stuff. It seems possible, if incredible, that a half inch shaft is not big enough for a .60. The ball-bearing manufacturers say that their bearings are overloaded in a sixty but the right size will not go in the crankcase. Interesting problem if big radio ships get down to cut-throat racing.

Identical pistons of lightweight design from bar stock are used in both engines, but the cylinder liners differ considerably. The Combat engine has high, wide ports suggesting the expected degree of potency, while the radio machinery has ports that are 25% lower and a 10% narrower exhaust. This has the effect of reducing the BHP produced by impeding gas flow, but increasing the torque output by keeping the expanding gases in the cylinder for a longer crank angle period, with consequent advantage on big props. Although the geometric compression ratio remains the same, the effective compression ratio is raised by the use of lower ports, and the presence of an aluminum ring between the liner flange and the top of the main casting shows that port timing and compression ratio have been adjusted carefully to best advantage.

The cylinder heads are entirely different. While the Combat head is the familiar Fox shape with center plug and recess for the straight piston baffle, the radio version illustrates by its sheer novelty that it did not get that way quickly or easily.

Of all the various methods used to obtain power control of the glow-plug engine, exhaust throttling is probably the most practical. Two needles and rich mixture is dirty, and pickup uncertain as the plug cools. Intake throttling is clean but again the plug cools. Exhaust throttling keeps the plug hot by keeping heat in and preventing the transfer of cold fuel from the crankcase. When designing an engine especially for exhaust throttling, one has the opportunity of locating the plug in the best practical position for keeping hot and giving consistent part-throttle performance, without losing too much at the top end. The figures show that big prop performance is superior on the radio engine, while the combat engine keeps going up as the prop gets smaller.

The radio port setup runs out of breath over about 12,500. The fortunate thing here is that the means of gaining torque for big props also limits the tendency to overrev in dives. Having both types of engine to play with, gave us the opportunity to swap heads and see the effect of exhaust throttling on a conventional plug location, and then swap piston and cylinder liner assemblies to see what the throttle unit did to the combat power. The conclusions are perhaps surprising, inasmuch as the throttle unit takes very little power away from the combat engine despite the fact that the full open throttle area is less than half the area of the exhaust port., However, the combat engine would not run as well at part throttle and showed a tendency to load up and then hunt. The radio head helped a little here, but the real improvement came from the radio liner with its different port timing. In the air the behavior well may be different because temperature is the governing factor with part-throttle glow plugging. With a cool slipstream the head design must make a considerable difference and

(*Continued on page 50*)

the aim behind the radio head seems to be to keep the plug element well clear of the cool charge blasting out of the bypass ports.

One assumes that gas flow from the by-pass focuses about the center of the combustion chamber, and therefore we locate the plug there for maximum power, and even tilt it towards the by-pass in some cases, so that fresh, easily ignitible gas is surrounding the ignition source. Since the glow plug gets its heat partly from the catalytic action of the platinum filament upon the alcohol fuel, and partly from the combustion heat of the previous charge, it follows that as soon as you reduce the amount of charge and the amount of combustion heat, the plug will cool off. The object then must be to take advantage of all the heat available without exposing the element to any cooling influence. The fact that this is accomplished by locating the plug to the rear of the head and by masking it in a deep hole, suggests that the catalytic heating is far less important than the combustion heating, as no mixture is likely to make contact with the filament until compression forces it into the hole just before ignition occurs. This may also have the desirable effect of retarding the ignition during part throttle running. Anyway, whatever the real reason may be, the fact is that the radio Fox with offset plug works very dependably on the bench over a wide speed range.

The construction of the throttle unit is neat and simple, and it is easily operated from any servo or escapement by a longitudinal torque rod. Forty-five degrees of rotation covers the range from full power to engine shut-off, and a lever covering this movement can be used. Since the throttle spindle can be rotated full circle continuously, a reversible drive is not necessary and a cycling rubber driven system can be used with full power and shut-off twice per rev, ninety degrees apart. Half power comes at about twenty-five degrees after full power.

A pressure die-cast body fits over the mouth of the exhaust stack with a raised boss projecting into the stack for location. The gas passage through the body is half the width of the stack and so leaves room on either side for two long screws which pass through the stack into tappings at the extreme corners of the stack where it blends with the cylinder, and so retain the body. Beyond the countersunk screw heads the body is reamed through to receive the throttle spindle which intersects the gas passage. The portion of spindle in the passage is cut away on either side to leave a 1/16" thick blade which is edged on to the flow at full power, and completely blocks the passage and strangles the engine when turned. The spindle is retained by a small snap ring at each side of the body, and has a hole for coupling to the actuator at the rear end.

Elsewhere, the construction of the engine follows recent Fox practice with counterweighted crankshaft, squared shaft port, steel-splined prop driver and the standardized Fox mounting dimensions. The offset cylinder giving symmetrical disposition of the cylinder between the mounting lugs continues, and the intake features indentations for positioning a second spray bar and a restrictor retained by the jet assembly. The Radio engine has a 9/32" restrictor while the Combat runs slightly larger with 5/16.

One of the biggest contributions to small engine progress to be found in the Fox range is the steady improvement and development of the humble needle valve, and yet another step has been made. A threaded needle in a tapped hole must result in a certain amount of waggle if the thread has the necessary clearance to allow it to be turned easily. Even if the thread is on the tight side the long slender needle still projects a long way beyond the support of the thread and so can vibrate. Clicker type setting devices also tend to flex the needle from side to side and upset the progressive transition from one extreme to the other. What has always been needed is an additional support at the tip of the needle, but the necessary passage of fuel past this support has up to now been the big difficulty. By a very tricky example of machining the Fox needles have grown a small knob at the extreme tip. This knob is a good fit in the small bore of the spray bar, and fuel passes it, by means of a flat ground on two sides of the knob. The tapered part of the needle being larger at the fat end than the knob means that fuel regulation and shut-off are accomplished by regulation of the aperture where the small and large bores of the spray bar join, in the usual way. The needle is thus positively supported at both ends and stays adjusted no matter what.

Handling and Performance

The instruction leaflets for these two engines warn the user not to crank a flooded engine. A flooded engine which is locking hydraulically will not crank, but it can be forced over. The fuel will not compress so something else has to give. In this case it will either be the wrist pin bending, or the piston caving in. Most engines show their indignation by a bent conrod.

We mention this because through sheer hamhandedness we bent a pin, and had to resort to some very careful surgery to get it out without more damage. Having bent it straight in a couple of vee blocks it continues to give good service, and there is nothing to be alarmed about. However, the reciprocating parts of Fox engines are made as light as practicable to give top performance, and nothing the engine will do will hurt them. The fault lies in the operator, so these engines must be handled with reasonable care.

There is nothing special to say about starting and running. The improved needle is no different on the bench from other Fox parts which have always been excellent. The improvement will show in small things on the field. The exhaust throttle is simple, reliable and progressive. You turn the rod and the engine slows down. You turn it a bit more and the engine stops. Doing it by hand it seems critical but with the precise motion of an actuator it should be perfect. Pick-up from closed throttle is really excellent and the true value of the system is clearly demonstrated by this faculty. The precise setting for tickover at about 2,000 rpm is really critical and all play in the operating mechanism should be avoided. On the other hand the difference in thrust between 2,000 and 4,000 rpm on a 10 x 8 is not very great, so that it may be that in the air the settings are not as fussy as they seem on the bench.

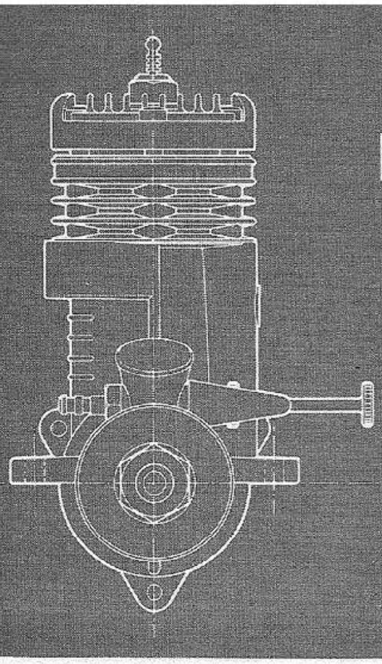
Test.

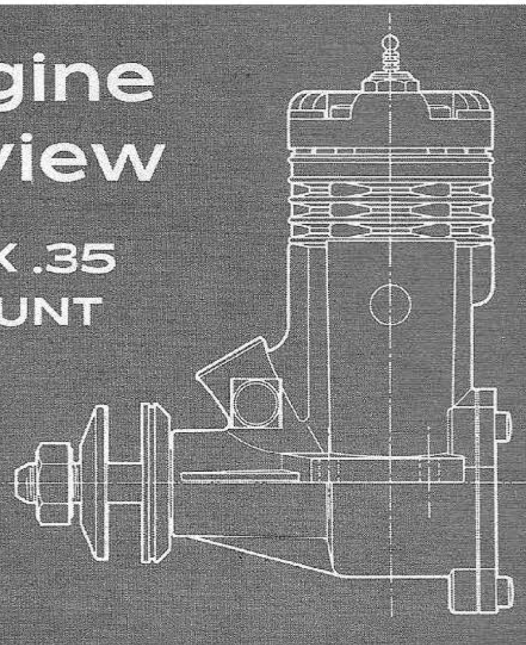
Plug: ¼–32 O.K. Long Reach.
Running Time Prior to Test: 30 mins. Combat. 1 hour Radio.
Bore: .800.
Stroke: .700.
Weight: 6.3 ozs. Combat 7 ozs. Radio.

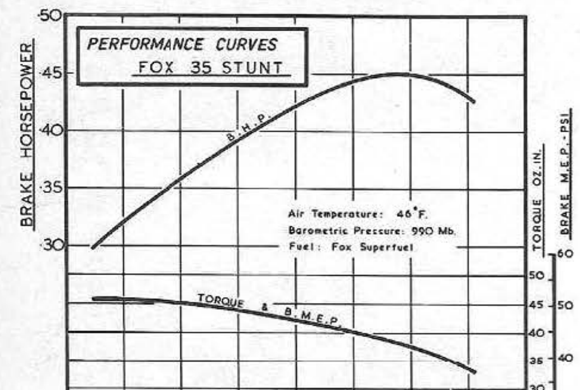
Power Prop	*Combat*	*Radio*
10 x 8	12,050	12,200
10 x 6	12,900	12,600
9 x 8	13,300	12,700
9 x 6	14,300	13,600
8 x 8	14,600	13,700
8 x 6	15,300	
7 x 10½	14,600	
7 x 9	15,200	
7 x 8	15,600	
Top Flite		
10 x 8	11,100	11,300
10 x 6	12,050	12,200
9 x 8	12,400	12,300
9 x 6	13,400	12,800
8 x 8	13,900	13,150
8 x 6	14,600	

Engine Review

FOX .35 STUNT





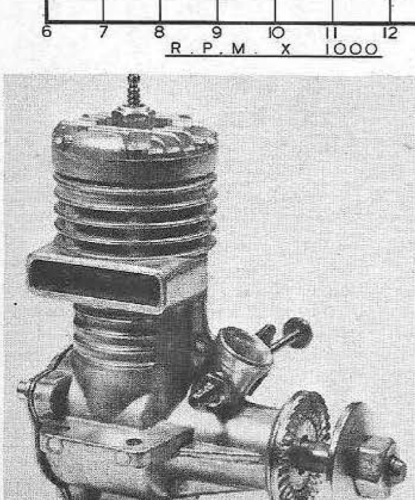


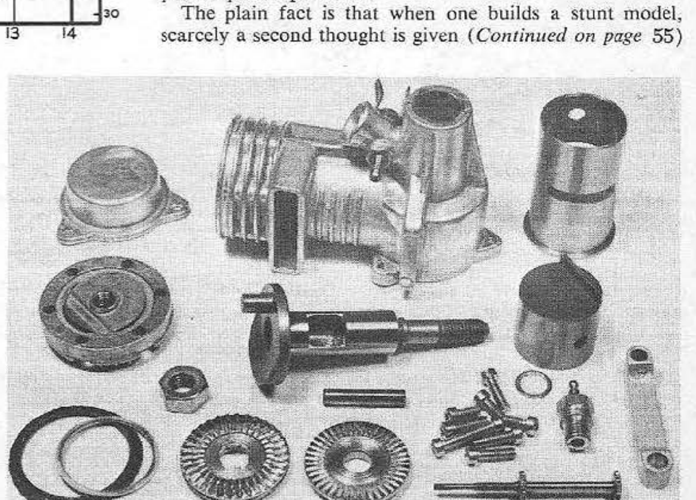
After 18 years of production, the Fox .35 is still world's Number One Stunt engine. A deserved reputation of performance keeps it on top.

By PETER G. F. CHINN

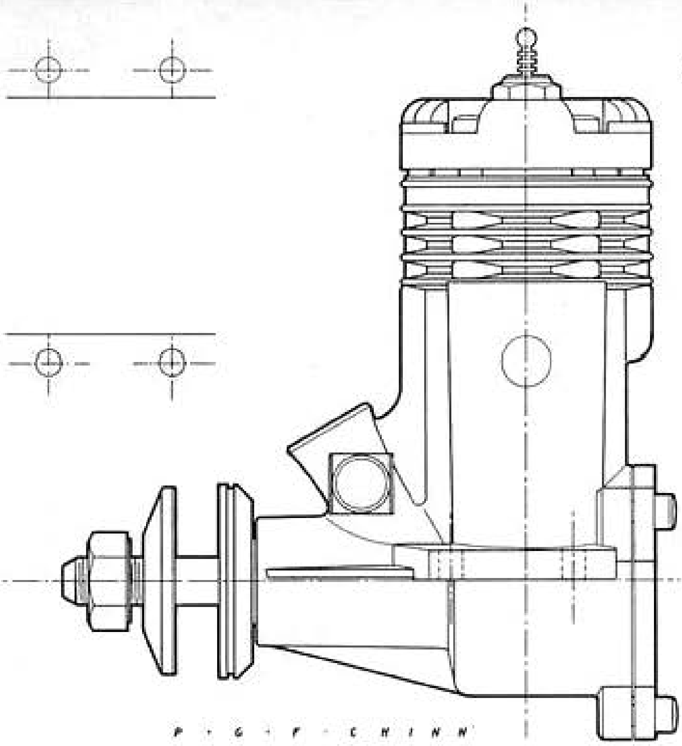
► Who reads the Engine Reviews? Potential purchasers of the engines concerned, obviously, but they are also followed by readers who want to know more about a particular motor or its performance statistics, or who want to compare one motor with another merely because of an all-round interest in engines. All of which is fortunate because, so far as helping a C/L stunt fan to decide whether or not to buy a Fox 35 is concerned, you could say that a magazine report is quite superfluous.

The plain fact is that when one builds a stunt model, scarcely a second thought is given (*Continued on page* 55)





Fox .35 stunt motor is the lightest (6.4 oz.) and most compact 35 extant. Made for aerobatics, not speed, it was designed and ported accordingly.



SPECIFICATION

Type: Single cylinder air-cooled, loop-scavenged two-stroke cycle, glowplug ignition. Crankshaft type rotary-valve induction. Bronze bushed main bearing.
Bore: 0.800 in. **Stroke:** 0.700 in.
Swept Volume: 0.3519 cu. in. = 5.767 cc.
Stroke/Bore Ratio: 0.875 : 1
Weight: 6.4 oz. (less silencer)

General Structural Data

Pressure diecast aluminium alloy *crankcase/cylinder-block/front housing* unit with cast-in bronze main bearing bush and drop-in unhardened steel *cylinder-liner*. Detachable pressure diecast aluminium alloy *crankcase-backplate* secured with three screws. Case-hardened steel counterbalanced *crankshaft* with 0.437 in. dia. journal, 0.312 in. bore gas passage and 0.187 in. dia. solid crankpin. Lapped Meehanite *piston* with baffle and 0.153 in. dia hardened tubular *gudgeon-pin* with brass pads. Machined duralumin, unbushed *connecting-rod*. Pressure diecast aluminium alloy *cylinder-head* with recessed .010 in. soft aluminium *gasket* and secured with six screws. Machined steel *prop driver*. Brass spraybar type *needle-valve assembly*. Beam mounting lugs. Provision for 3-point bulkhead mounting.

TEST CONDITIONS

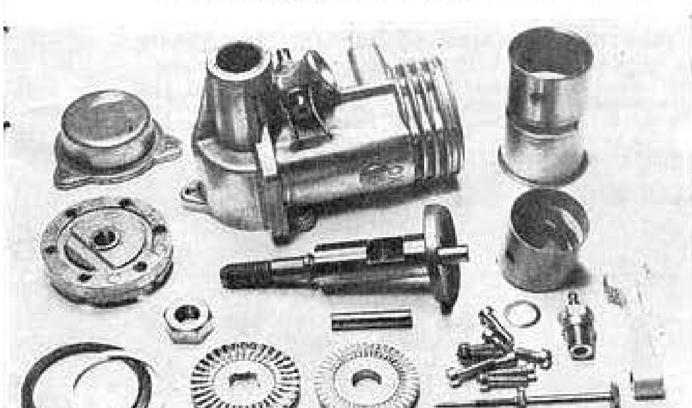
Running time prior to test: 2 hours.
Fuels used: (a) 5 per cent pure nitromethane, 25 per cent Duckham's Racing Castor-oil, 70 per cent I.C.I. Methanol.
(b) Fox Superfuel.
Glowplug used: Fox "Glowmaster" long reach, platinum filament, as fitted.
Air temperature: 46 deg. F. (8 deg. C)
Barometer: 29.2 in. Hg.
Silencer type: Nil

The short air intake has a 9/32 in. throat diameter, no separate venturi insert being used. The needle-valve assembly is of the spraybar type, the latter having a diameter of 0·130 in. A heavy, plated steel prop driver is employed. This engages four lands on the prop-shaft length just in front of the main journal. A substantial steel retaining washer and a hexagon nut complete the propshaft assembly.

Performance

One has only to see Fox 35s in the hands of stunt experts to note that generally they are easy starters. Our test model was no exception and responded quickly to the orthodox starting drill of an exhaust prime when cold and a couple of choked preliminary flicks when hot. We were also happy to find that it did not require an unduly lengthy running-in period. We gave our motor eight two-ounce tanks of fuel at a rich four-stroke, before beginning to lean it out. Within an accumulated running time of one hour it would maintain a steady optimum two-stroke setting without slowing down. A further full hour of running time was then logged before performance tests were started.

Essentially simple basic design of the Fox 35 is easy to see in this photograph of the component parts of the engine.



We used both our standard test fuel containing 5 per cent nitromethane and the maker's recommended Fox Superfuel which has a similar or slightly lower nitromethane content. There was little or no difference in the recorded power output on these two mixtures. On the popular 10 × 6 size stunt prop, speeds ranged from 9,700 r.p.m. on a Power-Prop wood to 10,300 r.p.m. on a Tornado nylon. Other prop speeds included 8,000 on an 11 × 6 Top-Flite wood, 9,400 on an 11 × 5 Top-Flite wood, 11,000 on an 11 × 3 Top-Flite wood and 11,400 on a 10 × 4 Tornado nylon.

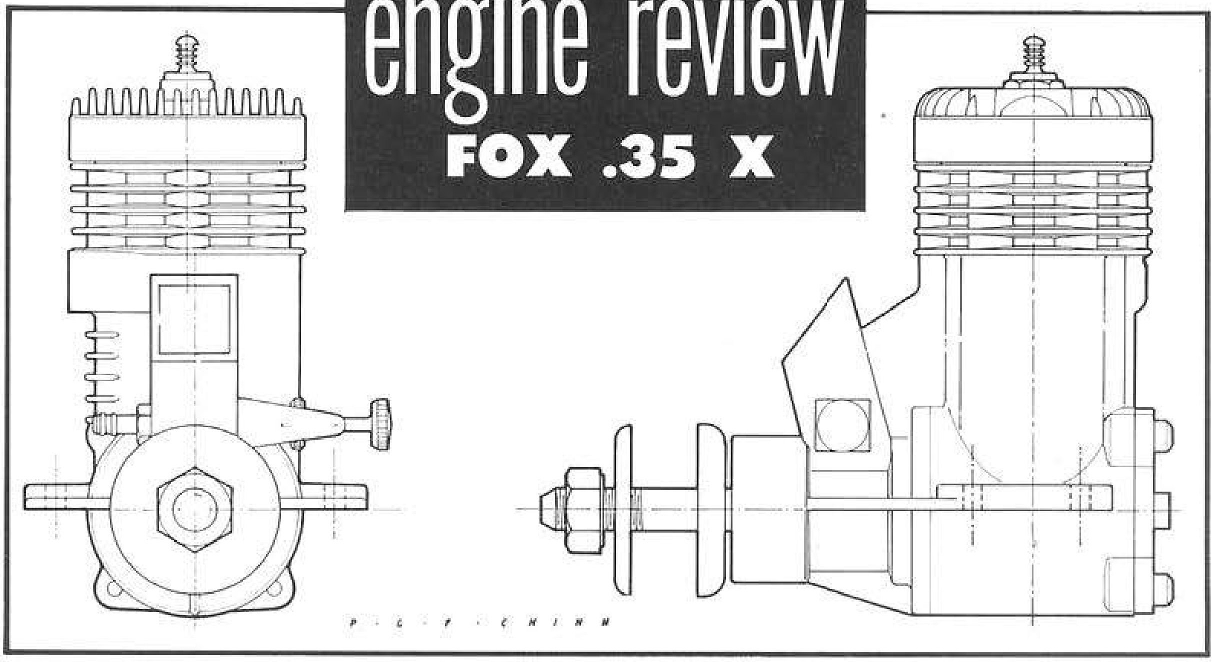
On the cradle dynamometer, maximum torque was realised at 7,000 r.p.m., reaching a figure of 46 oz. in., equivalent to a b.m.e.p. of 52 lb/sq. in. which is reasonable for an engine of this type on a fuel of 5 per cent nitro rating. The torque curve declined at a very steady rate as load was reduced and resulted in a maximum output of 0·45 b.h.p. at between 11,500 and 12,000 r.p.m.

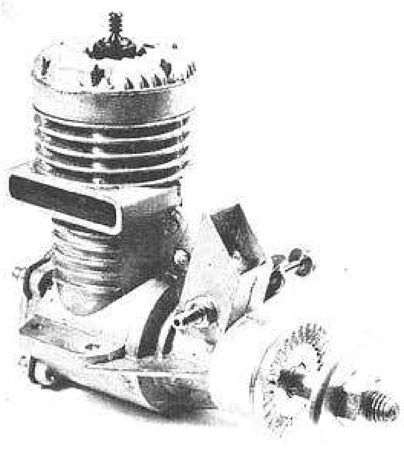
Running was even and fairly smooth except when the Fox was overloaded (i.e. propped for speeds between 7,000 and 9,000 r.p.m.) which produced more vibration. Under normal conditions, with a 10 × 6 or 10 × 5 prop, the engine ran extremely well. The only fault we had to find with our particular motor, in fact, was that the needle-valve was a bit slack in its threads. Since the Fox needle is not actually a needle form, but is a parallel rod with a chisel flat on one side only, this caused slightly erratic response when it was being adjusted, but the engine ran perfectly steadily once the correct adjustment had been established.

Control-line stunt engines are not, of course, rated solely on power output and 0.45 b.h.p. is not exceptional, these days, for a motor of nearly 5.8 cc. However, taking into account the fact that the Fox weighs less than 6½ oz. (no more than some .19 class engines) this b.h.p. is actually very good on a power/weight ratio basis.

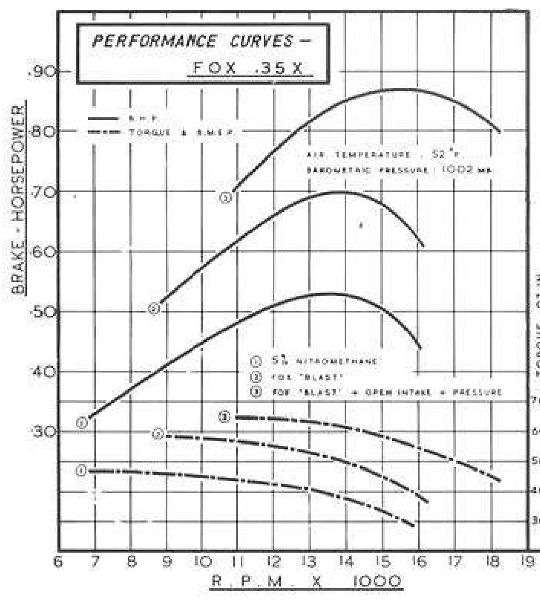
Power/Weight Ratio (as tested): 1.12 b.h.p./lb.
Specific output (as tested): 78 b.h.p./litre.

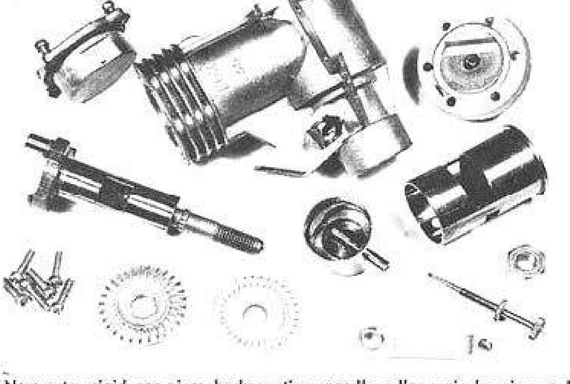
engine review
FOX .35 X





For control-line combat, .35X on Blast fuel and pressure probably delivers more urge per dollar of purchase price than any other .35 engine.





New extra rigid one-piece body casting, needle roller main bearing and many of the proven features distinguish the new multi-purpose Fox .35X.

by P. G. F. CHINN

SIXTH IN A LINE OF .35-40 CU. IN. ENGINES, IT IS THE "BLUE RIBBON" OF A SERIES OF CONTROL LINE CONTEST ENGINES.

► The Fox .35X is the sixth descendant of a line of Fox .35-.40 cu. in. motors that began with the announcement of the original black-head Fox Combat .35 in January 1957. Built around a new body casting, the Combat .35 aimed at achieving the same distinction, in combat and rat-racing circles, as the famous Fox Stunt .35 had done in aerobatics contests. In due course, these two specialized contest .35's were joined by a third engine, the Fox Rocket .35, based on the Combat .35 casting. This was Fox's first low-priced .35 and sold at $11.95.

The next step was the very (*Continued on page* 52)

VTO

(*Continued from page* 50)

ing angles—shift weight accordingly.

4. Check the decalage (the position of the wing in relation to the stab). Wing should be at a greater angle of attack than the stab.
5. Add downthrust to the engine, this will stop a model from looping.

SUGGESTIONS: Never try all or even 2 adjustments at one time—one at time will save the plane for another try. Don't make great changes—a little bit of tab movement will go a long way.

Serious rubber and towline enthusiasts should take note of the existence of Sal Cannizzo's "New England Wakefield Supply" (P. O. Box 4, Staten Island 5, New York) as a source for those often hard to find items such as Glider Winches, Nordic Wing Tongues, Wakefield Front End Assemblies and Pirelli Rubber. Latest addition to his line is a custom made Wakefield Winder featuring a steel 7" cranking arm for durability and easy winding.

Engine Review

(*Continued from page* 26)

hot Combat-Special, with its crankshaft supported in twin needle-roller bearings fitted in a new, separate, front housing with big rectangular intake. It was followed by the rat-racing Fox .40, which utilized a modification of the basic Rocket .35 main casting but had a lengthened stroke, plus a number of improvements. Shortly after this (mid-1961), an improved model Rocket-35 was introduced and, at the same time, the basic casting was given wider mounting lugs.

Early last year, Fox adverts began promising a new motor, then named as the "Blue Ribbon" .35, that would combine the best of many Fox contest motor features (mainly those of the $19.95 Combat Special) in an engine that would be even cheaper than the Rocket .35—only $9.95. This, seemingly, was a pretty tall order, but, in fact, the 35X, as it was subsequently named, turned out to be one of the best .35's that has ever appeared, irrespective of price.

Our test sample .35X came from Duke Fox personally and while it is reasonable to suppose therefore, that it was a "good 'un," it was otherwise an absolutely stock specimen. One of the claims made for the .35X is versatility—the ability of the engine to cope with a variety of model applications, both contest and non-contest, by simple modifications to fuel formulation, compression ratio and venturi size. This claim is most certainly justified. As our tests revealed, the .35X responds remarkably well to such simple performance aids as the substitution of a high nitro fuel and the removal of the venturi insert and addition of a pressurized fuel feed.

Externally, the .35X's family connection with the Combat-Special is immediately suggested by its rectangular section air intake. Inside, the high promise of a Combat-Special standard of refinement is also confirmed in almost identical working components, including a needle-roller main bearing. Such concessions to economic production as can be found, are confined to the use of a single needle-roller bearing, instead of two such bearings, a front housing that is integral with the crankcase and a slightly reduced big-end bearing length (to facilitate assembly in the one-piece case), the actual crankpin being solid instead of tubular. So far as the integral front housing is concerned, this is, in itself, an improvement, since it has allowed the addition of four good stiffening webs and a much stronger and more rigid front end. The other modifications would not appear to indicate any significant effect on performance or durability.

A new feature is the selectively hardened crankshaft. In this, only the actual working surfaces of the shaft journal and crankpin are hardened. The rest of the shaft is copper-plated to protect it during the case-hardening process. The idea is to obtain hard wearing working surfaces, yet preserve the tough non-brittle characteristics of the metal in all other areas subject to fatigue through operational stress or damage from mishandling. This method of achieving selective hardening has, of course, been successfully used in model engine manufacture previously—notably for hardening the piston skirts of engines using swaged socket ball-jointed piston/rod assemblies.

In most other respects, the 35X shaft is identical with that of the Combat Special. It has a full .375 in. bore gas passage and is heavily counterbalanced by means of a machined-in crescent counter weight, plus cutaway web flanks either side of the crankpin. Main journal diameter is ½ in. and crankpin diameter 7/32 in. The needle-roller main-bearing contains 27 needles running in direct contact with the shaft journal and is situated at the inner end. The outer bearing length is not bushed, but is bored in the actual crankcase material (which is of an alloy having good properties as a bearing metal) and has an excellent finish. The carburetor air intake, inclined 15 deg. from the vertical, has a rectangular section, .390 in. square internally and continues straight into the bearing to register with a .360 in. long rectangular shaft port to give quick opening and closing and a rotary-valve duration of approx 190 degrees of crank rotation.

The cylinder follows the now familiar Fox pattern of a "picture window" bypass port and a divided 180 degree exhaust port in a relatively thin-walled (.037 in.) leaded steel liner. Measured port opening periods were: exhaust, 142 degrees; bypass, 134 degrees. The liner is a slip fit in the main casting, flanged at the top where it is clamped between the cylinder block and head .The head is recessed and secured with six Phillips screws and a .010. soft aluminum blowproof gasket is used between the liner flange and head recess. The piston is of Meehanite and is similar to that of the Combat Special except for a slightly lower baffle height. A 5/32 in. dia. wrist-pin is used, hardened to Rockwell C-58/60. The conrod is machined from bar stock.

Submitted with the Fox 35X were a couple of cans of Fox's new racing fuel, "Blast," along with the suggestion that after tests on our standard test fuel, we might check performance on this too. Accordingly, after our regular test routine on 5 percent nitro fuel we ran a repeat series on "Blast." Both these tests were made on normal suction feed with the standard venturi insert in place. This insert is machined from ⅜ square bar aluminum, bored .275 in. A further test on "Blast" was then made with the insert removed and with pressurized fuel feed. The results of all three series of tests are shown in the performance graph.

Initial impressions of the 35X on test were favorable. Using orthodox starting procedure, the motor started, cold, within a few seconds and hot restarts were practically first flip. Running, on our mild 5 percent nitro test fuel, was smooth and consistent. At this stage, however, there was little indication of the 35X's combat potential. Checked on various popular size props, rpm was not very much greater (200-400 rpm up) than had previously been achieved with the 1962 model Rocket 35. This was subsequently confirmed by dynamometer test. A slight improvement (about 10 percent) in low speed torque was revealed but at around 14,000 rpm there was little to choose between the two motors. To us, this at least suggested that our test specimen was by no means an extra hot toolroom special. Peak bhp achieved by the 35X on this test was 0.53 at between 13,500 and 14,000 rpm and 0.48-0.50 bhp was delivered at 11,000-11,500 rpm which are the in-flight rpm that one could expect typical 10x6 stunt props to be turned.

Switching now to "Blast" fuel gave an immediate increase of 1,000 rpm or more on practically any prop. Interestingly, the biggest percentage increase came at the more moderate speeds, 12 percent up at 10,000 rpm load speed but only 7 percent up at 16,000 rpm. This was reflected in much higher maximum torque—maximum 58 oz. in. against 47 oz. in.—and in the fact that the now very solid peak output of .70 bhp was delivered at the still very practical operating speed of 14,000 rpm.

With the venturi insert in place, carburetor throat cross-sectional area, on the 35X, is approximately .059 sq. in., whereas, with the insert removed, the area goes up to .152 sq. in.—an increase of approximately 157 percent. Actually, the percentage increase in effective choke area is much greater than this, because the 9/64 in. dia. spraybar restricts the small bore venturi insert to a far greater extent than it does the wide open carb.

Some change in performance characteristics was, therefore, expected when we removed the venturi insert. In theory, the major improvement should come at the top end of the rpm range and this is exactly what the tests revealed but with a substantially greater increase in torque than had been anticipated. The horsepower peaking speed was now up to around 16,000 where actual bhp rocketed to a highly impressive 0.87. Maximum torque was up to slightly over 64 oz. in., equivalent to the exceptionally good brake mean effective pressure rating of nearly 72 lbs. per sq. in.

Just what all this means in terms of prop speeds can be shown by the following examples. Firstly, on an 11x5 Power-Prop, the 35X recorded 10,100 rpm on mild fuel, 11,300 on Blast and 11,900 on Blast with insert out. Thus, on Blast, rpm went up by 1200 but a wide intake contributed only another 600 rpm. Secondly, on an 11x3 Power-Prop, speeds were 11,700, 12,900 and 14,100. Rpm increases were now in equal steps of 1200 rpm. Thirdly, on an 8x6 Power-Prop, speeds recorded were 14,900, 15,900 and 17,700. The pattern of the 11x5 prop load figures was now reversed, with increases of 1,000 and 1800 rpm.

We have nothing but praise for the way in which the 35X performed on test. If we have to find something to criticize, we will once again voice our own pet complaint which is the needle-valve control—a bit difficult to grasp and too stiff to operate for our tastes. Apparently, most Fox customers are content with it, however, as it has been in use on Fox motors for many years. Incidentally, we should explain that our tests on the 35X with venturi insert removed, were conducted with a crankcase-pressurized tank (a pen bladder tank is an alternative) and for these tests, the regular backplate was replaced with the one from our Combat-Special which has a pressure nipple fitted as standard. The stock backplate can, of course, be drilled and tapped for a pressure fitting—the latter being a stock Fox accessory available at 50 cents.

The 35X, in our opinion, is one of the most outstanding motors to come from the

Fox factory for a very long time. At only $9.95 it looks like phenomonally good value.

Summary of Data

Type: Loop-scavenged two-cycle with shaft rotary valve induction.

Weight: 7.5 oz.

Displacement: 0.3519 cu. in. or 5.767c.c.

Bore: 0.800 in. Stroke: 0.700 in.

Stroke/Bore Ratio: 0.875:1

Specific Output (as tested):

1.51 bhp/cu. in. on 5 percent nitromethane fuel.

2.44 bhp/cu. in. on Fox "Blast" fuel with wide open intake and pressure feed.

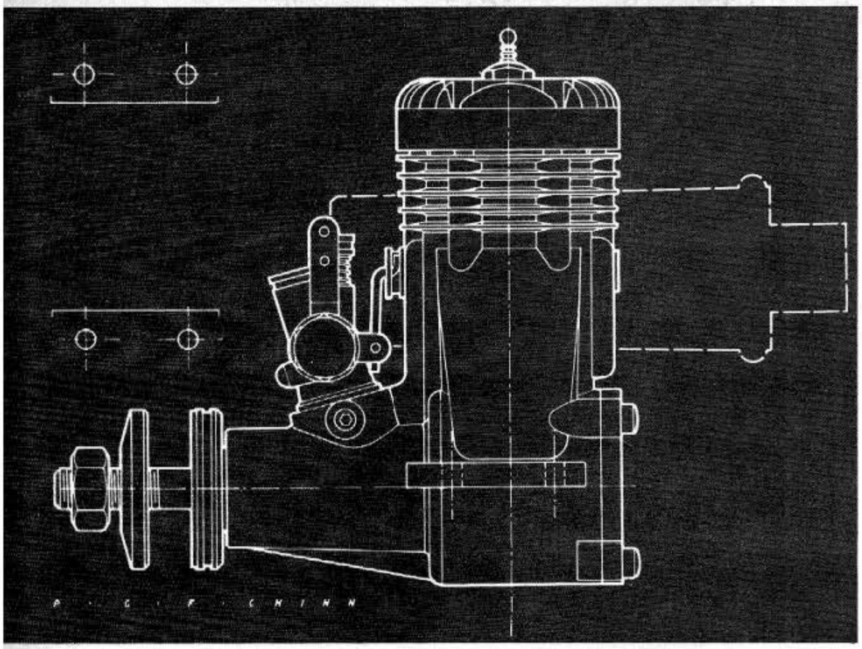
Power/Weight Ratio (as tested):

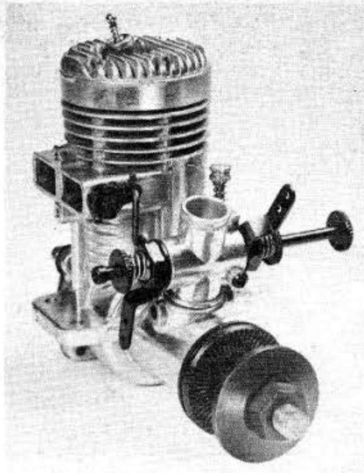
1.13 bhp/lb on 5 percent nitromethane fuel.

1.86 bhp/lb on Fox "Blast" fuel with wide open intake and pressure feed.

Price: $9.95.

Manufacturer: Fox Manufacturing Co., Station A, Fort Smith, Arkansas.





Carburetor has throttle arms on both sides; exhaust restrictor need not be removed to fit Fox muffler.

FOX .36 R C (1973)

ENGINE REVIEW

BY PETER CHINN . . . reviewed this month is new version of Fox's popular .36 R/C Sport motor which continues company's tradition of reliability and performance at moderate cost. Four-model group comprises both standard and throttle-equipped engines.

• At the present time, the all-American Fox engine range comprises 17 different models including nine Radio Control engines. These latter cover just about every significant displacement group from .15 cu.in. to .78 cu.in. Well-placed to attract the attention of those needing a reliable, reasonably priced, medium-sized motor suitable for everyday R/C Sport flying is the latest Fox 36 R/C.

This engine supersedes the 36X R/C model dealt with in this series nearly four years ago. Whereas the earlier engine was a development of the Fox 35X (first introduced in 1962 and outstanding in its day) the current 36 R/C is one of a new Fox medium displacement four-model group comprising both standard and throttle-equipped engines in a choice of .29 or .36 cu.in. displacements.

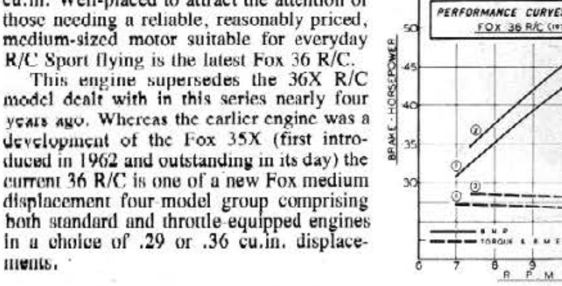
Compared with the 36X R/C, the new 36 R/C replaces the earlier engine's single needle-bearing with a full length bronze bushing, is lighter, has a removable and less

complex carburetor coupled to a semi-rotary exhaust restrictor and has provision for fitting a Fox muffler in either closed or open front form. We found the power output slightly below that of the 36X R/C but nevertheless well up to expected levels.

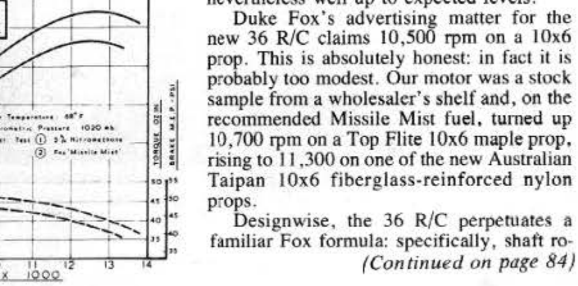
Duke Fox's advertising matter for the new 36 R/C claims 10,500 rpm on a 10x6 prop. This is absolutely honest: in fact it is probably too modest. Our motor was a stock sample from a wholesaler's shelf and, on the recommended Missile Mist fuel, turned up 10,700 rpm on a Top Flite 10x6 maple prop, rising to 11,300 on one of the new Australian Taipan 10x6 fiberglass-reinforced nylon props.

Designwise, the 36 R/C perpetuates a familiar Fox formula: specifically, shaft ro-

(Continued on page 84)



New carburetor parts: Separate high/low speed jets have own adjustment.



Components of 36 R/C indicate construction follows traditional Fox pattern.

Engine Review

(Continued from page 20)

tary valve induction, open-loop or crossflow scavenging, a one-piece body casting, a lightweight lapped cast-iron piston, a substantial counterbalanced crankshaft running in a bronze main bearing and a carburetor of exclusive Fox design.

Let's deal first with the carburetor. There have been many different types of Fox carbs over the years but they have all shown one thing: Duke Fox's determination not to abandon his own ideas on basic carburetor design. As regular readers of this column will know, Fox carbs do not employ the usual type of throttle valve in which the intake air passes through a hole in a semi-rotary barrel, picking up fuel from a co-axial spraybar or jet tube. Instead, Fox throttle valves more closely resemble the butterfly valve used by many automotive carburetors and are used in conjunction with a two or three jet fuel metering system to control mixture strength at varying throttle openings.

In the case of the earlier Fox 36X R/C, three separate jets were used and came into operation successively as the throttle was opened. The amount of fuel released by each jet was adjustable so that exactly the right mixture was supplied for idling, intermediate and high speed operation. As we said in our original report on the 36X R/C, this carburetor worked very well indeed and, in spite of having three needle-valves and a throttle-stop to adjust, was quite easy to set up, *provided that one followed the correct sequence*. This involved setting the idle mix first, followed by the intermediate needle and then the main needle: simple enough although rather different from the customary procedure of first establishing the main needle setting and then adjusting the idle mix. However, it is possible that the three needles may have frightened off some prospective customers and, in subsequent Fox carbs, a simplified arrangement has been used in which the intermediate range jet and its needle valve have been eliminated. Mid-range mixture control is now taken care of automatically.

In the carburetor fitted to the latest Fox 36 R/C, adjustable controls are limited to a main needle-valve and a low-speed mixture adjustment plus, of course, the usual throttle stop screw. It is a lighter and more compact carburetor than the earlier design and is also simpler than the two-needle type used by the .40 and Eagle .60 models already dealt with in the Engine Reviews.

The throttle valve is milled away to form flats front and back to allow intake air to pass either side of it. It is drilled axially and threaded to take, from the left side, a conventional valve needle and, from the opposite side, a threaded tubular fuel inlet fitting. The fuel metered by the needle-valve and released into the interior of the throttle valve is then fed into the intake via two jet holes. One of these (the idling jet) is placed in the front "flat" and the other one (the high speed jet) is located in the bottom of the throttle valve and offset to one side. Below the throttle valve the bore of the carburetor body changes shape, as a result of which the offset high-speed jet is completely masked as the throttle is closed and the engine then runs only on its idling jet. The high speed jet remains closed until the throttle is approximately half-open and then begins to open. Some re-adjustment of the point at which the high-speed jet becomes operative is possible by altering the effective length of the small round-head throttle retaining screw on the front of the carb body, but this is not mentioned in the maker's instruction leaflet and, when testing the 36 R/C, we found no evidence to suggest that such readjustment might be necessary.

The correct mixture strength for full speed running is obtained in the usual way by means of the needle-valve. However, as previously noted, the same needle-valve also feeds the idling jet. Therefore, to control the amount of fuel released by the idling jet, this has its own adjustment via the screw-in inlet fitting in the opposite end of the throttle valve. Externally, this fitting has a small knurled disk and a light compression-spring (like the main needle-valve) and can be screwed in (to weaken the idling mix) or out (to enrich the idling mix) as needed. The inlet fitting is, itself, acting as a needle-valve here, since its tip, in addition to being drilled to accept the needle-valve tip, is externally tapered and projects just beyond the position of the idling jet hole, thereby controlling the amount of fuel fed back to the idling jet.

The rest of the 36 R/C is conventional and, apart from a longer crankcase nose, a differently shaped cylinder-head plus, of course, its carburetor, the engine is similar in appearance and construction to the smaller displacement Fox .29 Control Line/Free Flight motor dealt with in the May 1973 issue.

The body casting is, as usual, of pressure die-cast aluminum alloy. It includes a full length finned cylinder casing well stiffened to resist distortion and an integral front housing with a cast-in

(Continued on page 62)

the best performance under normal conditions with this engine. Our test curves indicate that the peak output (0.52 bhp on Missile Mist) is available at around the 12,500 rpm mark so there is no point in using a small prop that would allow the engine to accelerate up to beyond this speed in the air. On the other hand, the Fox will pull larger sizes quite comfortably should it be required to do so.

General handling qualities of the 36 R/C were good. Our motor started readily from cold when new and only slightly less eagerly when warm. One snag arises when one is using the muffler: it is not then possible to prime directly into the cylinder via the exhaust port. Our personal method of priming the engine for an initial start from cold under these conditions is to remove the glowplug and inject a few drops of fuel through the plug hole. This, we feel, is no handicap since one can, at the same time, check the glowplug and insure that the voltage applied is neither inadequate not excessive—always a good idea as different types of plugs vary quite a bit in their requirements. Naturally some care must be exercised in removing and replacing the plug to avoid damage to the plug hole threads and the ideal tool here is the Fox combination socket wrench, Part No. 90102, which fits both plug and prop nut. An alternative method of priming the cylinder is to prime the crankcase via the carburetor intake and to then rotate the model onto its back while turning the prop to introduce the mixture into the combustion chamber.

Incidentally, as we found with other Fox engines fitted with these mufflers, the Fox B size open-front muffler caused no power loss. Unfortunately, as is inevitably the case with no-loss mufflers, the degree of noise suppression obtained is very limited but the Fox muffler has the merit of being light in weight and very compact.

The throttle worked well and we had no difficulty in setting it up for a safe idle of around 2600 rpm (10x6 prop and Missile Mist fuel) with steady intermediate running and instant recovery to full throttle.

No problems were encountered with the 36 R/C at any time and, stripped down at the conclusion of the tests, all parts were found to be in good condition. The single Fox R/C plug used to obtain all the performance figures remained intact and (checked against two new plugs) had not deteriorated to cause any loss of performance.

Summary of Data

Type: Single-cylinder, two-stroke cycle with bronze bushed main bearing. Throttle type carburetor with coupled exhaust restrictor. Optional muffler.

Checked Weights: 8.35 oz. (less muffler)
9.80 oz. (with Fox Type B open front muffler)
9.87 oz. (with Fox Type B closed front muffler)

Displacement: 0.3594 cu.in. (5.889 c.c.)

Bore: 0.800 in.

Stroke: 0.715 in.

Stroke/Bore Ratio: 0.894:1

Specific Output (as tested): 1.45 bhp/cu.in. (with muffler and Missile Mist fuel)

Power/Weight Ratio (as tested): 0.85 bhp/lb. (with muffler and Missile Mist fuel)

Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901.

List Price: $24.95. ■

Peter Chinn's RADIO MOTOR COMMENTARY

1980 Fox 36RX Tested

This new Fox model, first announced in the U.S. a few months ago and aimed at the R/C sport flyer, has its origins in the rear exhaust Fox 36 that was introduced in 1976.

At that time, the engine was made not only as a throttle-equipped radio-control motor, but also in free-flight and control-line versions and with several choices as to specification. For example, one could choose a ball or plain main bearing, a ringed aluminium or lapped cast-iron piston and a high or low compression cylinder head.

The current version, however, is offered in just one model that has been developed specifically for the R/C sport flyer and includes an additional feature in the shape of a rectangular expansion chamber silencer installed vertically behind the cylinder and crankcase, enabling it to be completely enclosed within the engine cowling.

This silencer fits over the machined o.d. of the integral exhaust stub and is locked in place with an Allen set screw. It is narrow enough to fit between the engine bearers when the motor is mounted upright but can be rotated to any other position if necessary; for example, when the engine is installed horizontally or inverted.

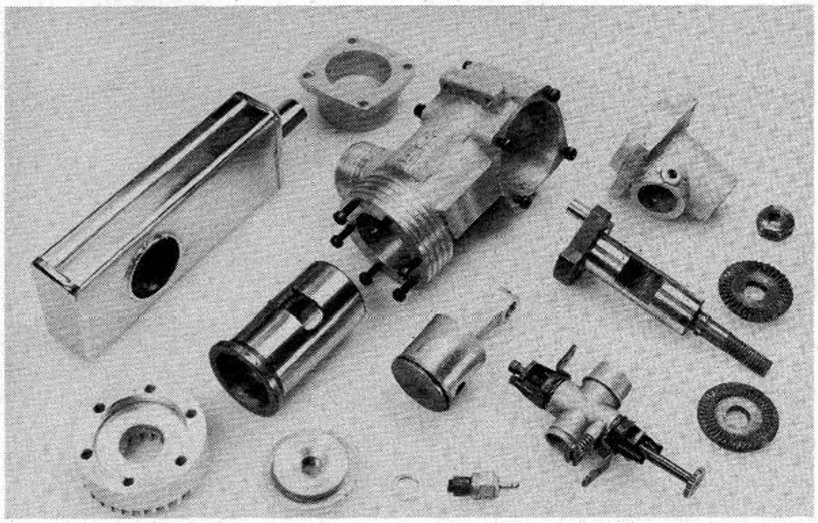
As the Fox 36RX is sold as a complete power package, all our tests were carried out with the silencer in place. During the early stages of running-in, it was detected that the main bearing (a plain phosphor-bronze bush on this engine) tended to run a bit hot and a little of Duke Fox's "Lustrox" running-in compound was used to good advantage. As usual, our standard R/C test fuel containing 5 per cent nitromethane, in a methanol and castor-oil basic blend, was used for the performance tests. The glowplug used was the Fox long-reach 1.5 volt idle-bar type as supplied with the motor.

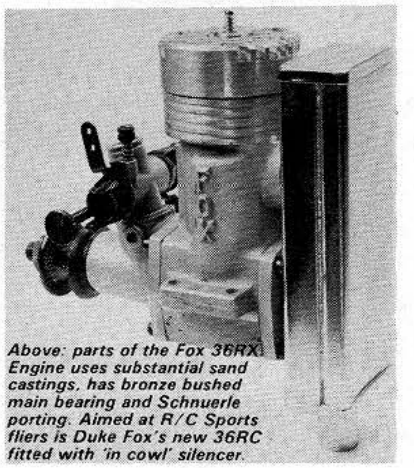
Typical prop rpm recorded under these conditions and after approximately two hours running-in, were as follows:

8,000 rpm on a 12 × 5 Top Flite maple
8,900 rpm on a 12 × 4 Zinger maple
9,500 rpm on a 11 × 6 Power Prop maple
9,700 rpm on a 10 × 7 Zinger maple
10,200 rpm on a 10 × 6 Top Flite maple
11,000 rpm on a 10 × 5 Top Flite maple
12,500 rpm on a 10 × 4 Top Flite maple
11,200 rpm on a 9 × 7 Zinger maple
11,800 rpm on a 9 × 6 Zinger maple
12,400 rpm on a 9 × 5 Zinger maple

The prop size suggested by the manufacturer for the 36RX for use with "average size five-pound radio-control models" is a narrow blade 10 × 6 but (as our figures show) the engine is capable of handling a variety of different sizes suitable for larger and smaller models. There is, however, no point in propping the engine for higher speeds than those achieved on the 10×4 and 9×5 as these are likely, in flight, to take the engine over the rpm at which it delivers its best performance. Also, at these higher speeds, our engine began to enter a vibration period, whereas at normal speeds, it ran smoothly and steadily.

Initially we were unable to persuade the 36RX to throttle down below 3,400 rpm on a 10×6 prop: even with the throttle stop screw slackened off to the point where the throttle valve was completely closed, the engine continued to run and could only be stopped by shutting off the fuel supply. This clearly indicated that air was leaking into the crankcase and subsequent investigation confirmed this. The backplate makes a metal-to-metal contact with the crankcase and, on our engine, this joint was slightly less than perfect. A cure was easily effected by fitting a simple paper gasket.





Above: parts of the Fox 36RX. Engine uses substantial sand castings, has bronze bushed main bearing and Schnuerle porting. Aimed at R/C Sports fliers is Duke Fox's new 36RC fitted with 'in cowl' silencer.

Unlike most modern production engines (and all other Fox models), the 36RX uses sand cast body components. These consist of a substantial main casting comprising barrel type crankcase and full length cylinder block, a separate bolt-on front housing and a conventional backplate. The engine uses the traditional Schnuerle scavenging arrangement of just two angled transfer ports, one each side of the exhaust, without a third port. The exhaust port is centrally divided and has its top edge raised at the centre so that there is a less abrupt release of exhaust gases, which should mean less noise. This seems to be confirmed in practice, the 36RX being quieter that one would normally expect of an engine of this size fitted with a simple expansion chamber silencer having a relatively large outlet area (85 sq.mm.).

Another unusual feature of the 36RX is its two-piece cylinder head. This consists of a flanged insert that drops into the top of the cylinder liner, held in place by a separate finned outer component secured to the main casting with six screws. The gravity-cast piston is conventional, with a flat crown and a single, pegged, compression-ring. It is coupled to an unbushed machined alloy conrod by a tubular gudgeon-pin. The crankshaft has a $\frac{1}{2}$in (12.7mm) main journal and a 0.216 in. dia. solid crankpin. The shaft has a $\frac{3}{8}$in. dia. gas passage and the rectangular valve port is open for 194 degrees of crank angle, closing at 52 deg. ATDC according to our measurements.

The Fox 36RX has a bore and stroke of 0.800in × 0.715in giving a swept volume of 0.3594 cu.in. or just under 5.89cc. It weighs 362 grams or 12.8 oz complete with silencer.

One final point. Any cowling that encloses a silencer, as well as the engine, must be very well ventilated to prevent the engine from becoming overheated. Remember, it is pointless simply to open up the front of the cowling. The essential requirement is that the air should be able to flow freely *from* the cowling, taking heat with it. Therefore, the outlet area should be greater than the inlet area and should be positioned and shaped to promote the maximum possible air flow around the engine and silencer.

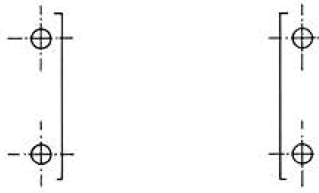
ENGINE REVIEW

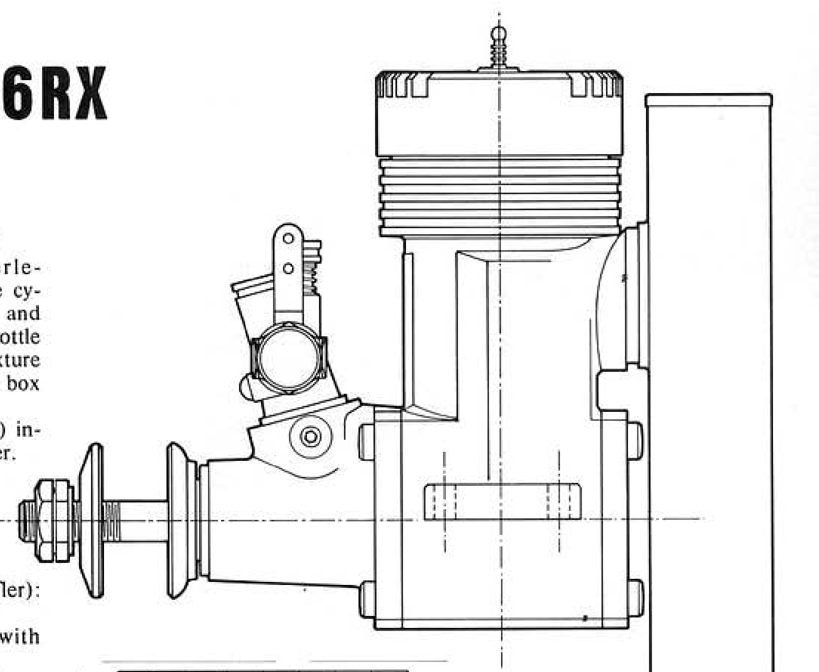
by Peter Chinn

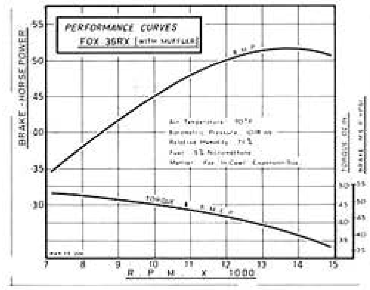
1980 FOX 36RX

SPECIFICATIONS

Type: Single-cylinder, Schnuerle-scavenged, rear-exhaust, two-stroke cycle with crankshaft rotary-valve and bronze bushed main bearing. Throttle type carburetor with automatic mixture control. Special 'in-cowl' expansion box muffler.
Checked Weights: 362 grams (12.8 oz) including 60 grams (2.1 oz) for muffler.
Displacement: 0.3594 cu in. (5.889cc)
Bore: 0.800 in. (20.32 mm)
Stroke: 0.715 in. (18.16 mm)
Stroke / Bore Ratio: 0.894:1
Measured Compression Ratio: 7.7:1
Specific Output (as tested with muffler): 1.44 bhp/cu in.
Power / Weight Ratio (as tested with muffler): 0.65 bhp/lb
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, AR 72901.







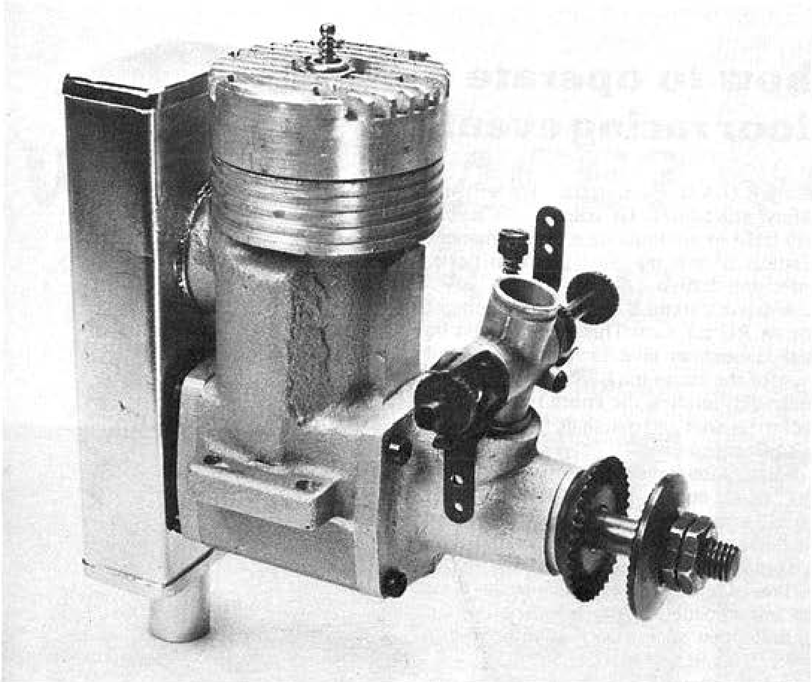
• Although the rear-exhaust Fox 36 was first announced four years ago in a choice of four different models covering CL Stunt, Profile Carrier, Free Flight and RC (see "Engine Review Round-Up," June 1977 *M.A.N.*), the present model is a new version that was introduced in May of this year for the RC sport flier.

With this engine, Duke Fox is probing the market, testing reaction to the idea of a radio-control engine in which the muffler, virtually an integral part of the power package, is installed vertically behind the cylinder and crankcase, fitting between the motor mounts so that it can be fully enclosed within the engine cowl.

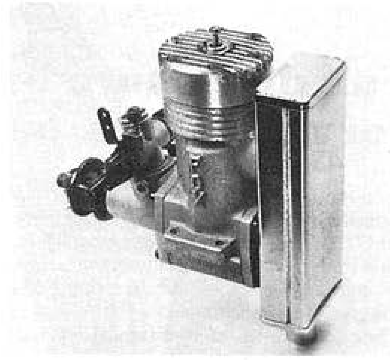
The idea is an attractive one. For years, scale buffs have been in favor of such an arrangement in order to avoid having to spoil the appearance and authenticity of a scale model by using the conventional type of muffler outside the cowl. Until now, in fact, the modeler has been obliged, if he wished to avoid such an unwelcome excrescence, to concoct an in-cowl muffler of his own design and construction. This, particularly with a side-exhaust engine, is not an easy matter.

Before we pursue this subject any further, however, we would like to add a note of warning.

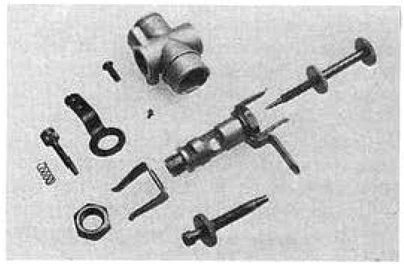
In-cowl mufflers can create problems unless special attention is given to cooling. The important point here is to ensure a generous flow of cooling air *through* the cowl. It is not enough simply to have a large opening in the front through which air can enter. The essential requirement is an even larger exit area to allow the air, now heated and therefore expanded in volume, to escape. Failure to do so will simply mean a progressive increase in the temperature of the air within the cowl, resulting in overheating of the engine and, eventually, damage to it. Even if the engine does not actually seize up, overheating of this nature can have effects which the user may not immediately associate with lack of cooling. For example, it can cause the piston ring to be sealed in its groove with baked castor oil, resulting in a complete loss of compression and a refusal to start when the engine is cold. Similarly, as its higher coefficient of expansion causes the aluminum cylinder casing to pull away from the steel cylinder liner, lubricant is forced between the two where



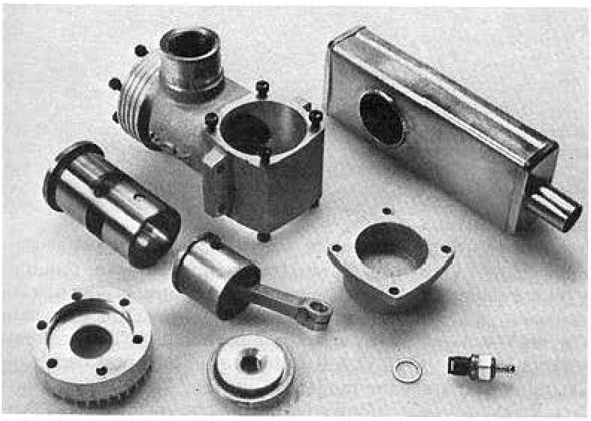
Fox 36RX is a new kind of power package for the sport flier. Muffler is designed to fit between engine bearers and inside cowl; engine uses sand castings.



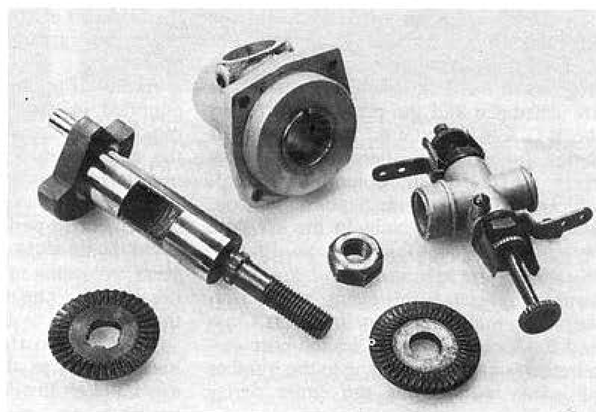
With in-cowl muffler, increased flow of cooling air is needed.



Carb features separate high- and low-speed jets, individually adjustable.



Special two-piece cylinder head and original Schnuerle type porting without third port are used.



Crankshaft runs in a bronze main bearing. Front housing, like main casting and backplate, is a sand casting.

it eventually carbonizes with the excess heat, bonding the liner to the casing and causing cylinder distortion.

So remember, whenever a cowl is used, a constant stream of fresh cool air must be able to pass through it and around the engine. If the cowl also encloses any sort of muffler, provision must be made to increase the volume of air flowing through the cowl.

As already noted, the Fox in-cowl muffler is installed immediately behind the engine. It is of the expansion chamber type: a vertical rectangular box which slips over the 36RX's circular rear exhaust stack and has a downward pointing outlet pipe for convenient discharge beneath the cowl, although it could, if more appropriate to a particular installation, be rotated through 360 degrees to any other position.

Unlike all other Fox engines, the 36RX uses sand castings, rather than die castings, for the crankcase, etc. Naturally, these do not give such a crisp, clean appearance as die castings and it is probable that the latter will be adopted in the future for the 36RX, if the engine's new concept proves acceptable to Fox customers. Meanwhile, owners of the 36RX can content themselves with the thought that the existing components are probably rather stronger than equivalent pressure-cast ones.

Let's have a look at the 36RX's design and construction in more detail.

MAIN CASTING. This comprises the crankcase barrel, open at both ends, and a full-length cylinder casing. It has narrow, but stout, beam mounting lugs and a circular section exhaust stack at the rear, machined to 0.807 in. o.d. There is a cast-in bypass channel on each side, angled to direct gas toward the front of the cylinder, but no third port channel. This arrangement, in fact, follows that of Dr. Schnuerle's original scavenging system.

CYLINDER LINER. The drop-in steel cylinder liner, located in the usual way by a flange at the top, features two very large bypass ports that are open, according to our measurement of the test engine, for a modest 104 degrees of crank angle. The centrally divided exhaust port, which is open for 136 degrees of crank rotation, has less than half the total area of the two bypass ports, but has its upper edge shaped

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ENGINE REVIEW

(Continued from page 49)

to promote an initial release of gases near the center at approximately 6 degrees of crank angle before the exhaust port's full width is uncovered and 16 degrees before the bypass ports are opened. This should have the effect of both reducing charge loss and lowering exhaust noise level.

PISTON AND CONROD ASSEMBLY. The aluminum piston is machined from a permanent mold casting. It has a flat head and is fitted with a single compression ring, radially pinned at the front to prevent rotation of the ring gap into the ports. The machined aluminum connecting-rod has plain unbushed eyes with a lubrication slit at the lower end. The rod is long, 1.42 in. between centers, which has the beneficial effect of reducing rod angularity and, in consequence, piston side thrust is diminished. A long conrod usually means that engine height is increased, but in the 36RX this is partly offset by placing the wristpin higher in the piston. The wristpin itself is tubular, has an o.d. of 0.182 in., and is retained by wire snap rings. Weights are moderate: the piston and ring scale 6.5 grams, or 8.2 grams with wristpin added, and the rod weighs 3.7 grams.

CRANKSHAFT. The one-piece, case-hardened, counterbalanced shaft has a 1/2 in. dia. journal and a 0.216 in. dia. solid crankpin. The gas passage through the shaft is 3/8 in. (9.5 mm) bore and is fed from a 1/2 in. long rectangular valve port that opens at 38 deg. after bottom dead center and closes at 52 deg. after top dead center—according to measurement of our test motor. As on most Fox engines, the drive to the prop is conveyed through a steel thrust washer that is keyed to the shaft by four short splines on the 1/4 in. dia. prop shaft. The shaft end is threaded 1/4-28 UNF and is fitted with a steel hex nut and serrated face prop washer.

FRONT HOUSING & BACKPLATE. The crankshaft runs in a bronze bushing that is fitted into the sand-cast front housing. The housing is secured to the crankcase in the usual way by four screws and incorporates a 1/2 in. i.d. intake boss into which the carburetor is inserted and held by two hex socket headless setscrews.

The backplate is also a sand casting, attached to the crankcase with four screws.

CYLINDER HEAD. This is a Fox machined bar-stock two-component type. It consists of a flanged insert or button that drops into the top of the bore, to form the roof of the combustion chamber, and a finned outer component that clamps the assembly to the cylinder with six screws. The underside of the insert is substantially flat except for a shallow conical depression surrounding the glowplug.

CARBURETOR. The carburetor is an adjustable automatic mixture control type of typical Fox design in which the throttle rotor, instead of having a choke hole, has milled flats, front and back, to form a butterfly type valve. It is drilled axially and threaded to take, from the left side, a conventional valve needle and, from the opposite side, a threaded tubular fuel inlet fitting. The fuel metered by the needle valve and released into the interior of the throttle rotor is then fed into the intake via two jet holes. One of these (the low-speed jet) is located in the front flat and the other, the high-speed jet, is positioned in the bottom of the throttle rotor and offset to one side. Below the rotor, the bore of the carb changes shape, and as a result of this, the offset high-speed jet hole is completely masked as the throttle is closed and the engine then runs on its low-speed jet only.

As in other, more orthodox carburetors, the correct mixture strength for full speed running is obtained by means of the needle valve. However, as already stated, this also feeds the low-speed jet and, to control the amount of fuel released to the low-speed jet, this has its own adjustment via the inlet fitting in the opposite end of the throttle rotor. This screws in to weaken the low-speed mixture and out to enrich it. The fitting itself acts as a needle valve here. Its tip, in addition to being drilled to accept the needle valve tip, is tapered externally and screws into the valve rotor to just beyond the position of the low-speed jet hole, thereby controlling the amount of fuel fed back to the low-speed jet.

The carburetor has the usual throttle stop screw and is provided with adjustable throttle arms on both sides.

MUFFLER. The muffler is a plain expansion box of fabricated construction, and has a volume of approximately 46 milliliters and a short outlet pipe of approximately 85 sq mm area. It fits firmly onto the engine's exhaust stack and is locked with a setscrew that is reached with a long Allen key through the outlet pipe in the bottom.

PERFORMANCE. As the 36RX is sold only as a complete engine/muffler package and is intended to be operated as such, all our tests were carried out with the muffler in place.

The engine is not critical to the type of fuel used: as the instruction leaflet says, any of Fox's own brands works well in the 36RX. However, a nitro blend is not essential and, where minimum operating cost is a factor, the engine can be run quite satisfactorily on a straight mixture of methanol and castor-oil. For our tests we compromised by using our standard RC engine test fuel which contains 5 percent nitromethane in a methanol/castor-oil base mix.

Our 36RX was given approximately two hours' break-in time prior to testing. Initially, the engine showed signs of a tight main bearing and we therefore used a little of Duke Fox's "Lustrox" to hasten the break-in. This worked well: at the end of the break-in, the front end was running noticeably cooler and the engine was holding steady leaned-out rpm.

At this stage, we ran some prop rpm checks. Although an 11x5 is the largest size recommended in the manufacturer's instruction leaflet (rightly so, where one is looking for as much power as possible), we found that it would also cope quite happily with somewhat larger sizes. For example, it turned a 12x4 Zinger maple at 8,900 rpm; a 12x5 Top Flite maple at 8,000 rpm; and, still without any sign of laboring, a 12x6 Zinger maple at 7,700 rpm. Of course, these big sizes would only be required for very large, lightly loaded models. Moving toward more normal sizes, an 11x6 Power-Prop maple was turned at 9,500 rpm and a 10x7 Zinger at 9,700 rpm. Also, 9,750 rpm was recorded on an 11x4 Power-Prop maple; 10,200 on a 10x6 Power-Prop maple; 11,000 on a 10x5 Top Flite maple; and 11,100 on a 10x5 Zinger maple. Other figures included 11,200 on a 9x7 Zinger maple; 11,800 on a 9x6 Zinger maple; 12,400 on a 9x5 Zinger maple; 12,500 on a 10x4 Top Flite maple; 12,700 on a 10x4 Zinger maple; and 13,100 on a 9x5 Top Flite maple.

General running qualities were good.

The engine ran smoothly except when loaded for speeds above 14,000 rpm, where there was some unevenness and an increase in vibration. This, however, is not important because, as the performance graph shows, such speeds are above the revolutions at which the 36RX delivers its maximum power. Allowing for some rpm build-up in the air, as the load on the prop is reduced with forward speed, it is probably best to prop the engine for static rpm of between 11,000 and 12,000. However, as the torque curve indicates, there is also plenty of pulling power at low speeds and consequently (as we have already seen) the 36RX also performs well on larger size props.

The peak power output, determined from our dynamometer tests, of just under 0.52 bhp at around 13,700 rpm is good for a .36 cu in. RC sport engine fitted with a muffler and running on mild fuel. It is also better than we recorded for the standard side-exhaust crossflow scavenged Fox 36RC *without* a muffler. Incidentally, with both engines fitted with the appropriate Fox mufflers, the 36RX is noticeably the quieter of the two and this, it would seem, can be attributed not only to its muffler but also to the shape of its exhaust ports which, by initially releasing the exhaust gases more gradually, give a less explosive crack to the exhaust note.

Handling qualities were generally good. After the break-in, the engine started easily and responded well to the carburetor controls, with a low idle (2,400 on a 10x6) and reliable transition between speeds. One thing to watch is the nearness of the carb controls to the prop. Needle-valve adjustments are best approached from behind the engine with the forefinger and thumb. Also, make sure that the back of the prop does not foul either of the throttle levers at the limits of their travel. This can happen if you are using a prop that has the back of the boss cut away, or if the throttle arm is incorrectly positioned—it can be readjusted by slackening the locknut on the throttle rotor.

Stripped down at the conclusion of testing, our Fox 36RX was found to be in good condition throughout. The original Fox long-reach idle-bar type plug, supplied with the engine, remained intact and, checked against another plug of the same type, had not deteriorated in performance. ■

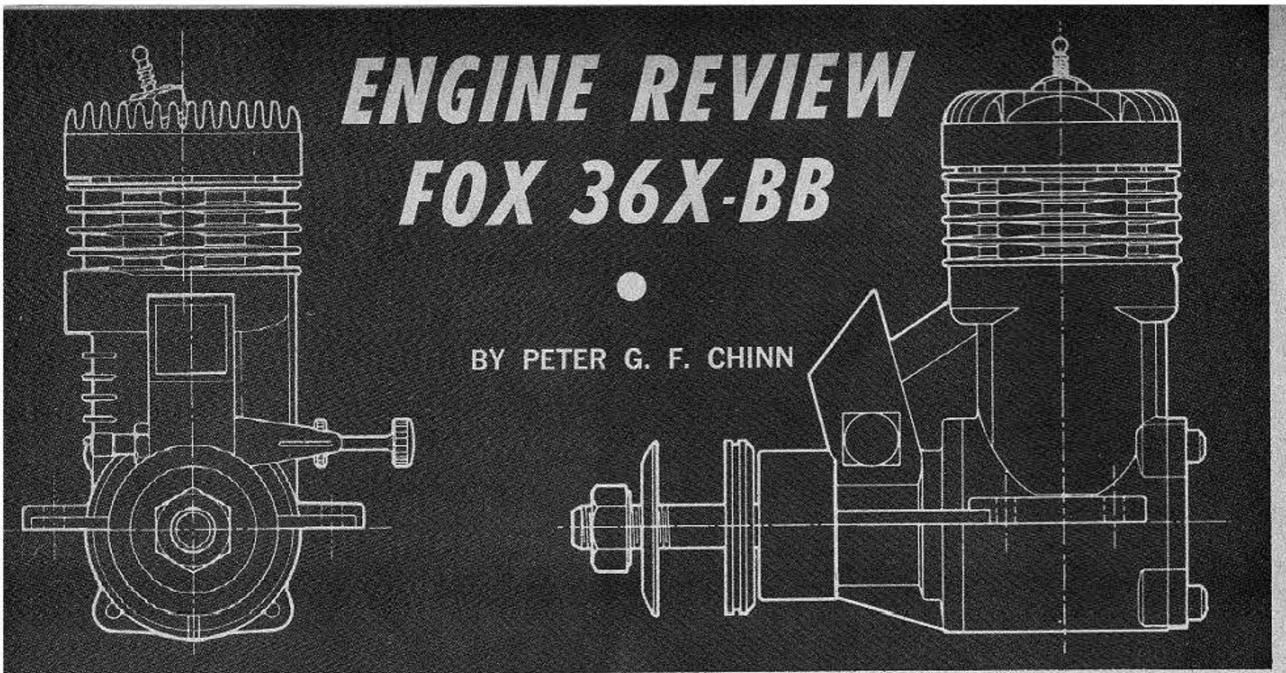
FOR ENGINE LOVERS

(Continued from page 58)

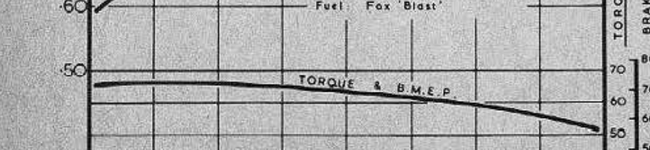
Hilscher, P.O. Box 725, Indianapolis, IN 46206), and also write to Peter Feldman (P.O. Box 591, Times Square Station, New York, NY 10108). Peter specializes in old glow engines and has many parts. In addition, there's the International Model Aero Engine Collectors Society (c/o Peter N. Scott, Sihlwaldstrasse 8, 8135 Langnau-am-

ENGINE REVIEW
FOX 36X-BB

BY PETER G. F. CHINN



Features are heavy-duty ball-bearing, reworked shaft porting, higher compression rating, and polished exterior. Pressure fitting and omission venturi insert.



DEVELOPED FROM A LONG LINE OF NOTED FOX COMBAT MILLS, CUSTOMIZED 36X-BB IS MOST IMPRESSIVE CONTRIBUTION YET.

► In our July 1963 Engine Review, we had the pleasure of dealing with the then new Fox 35X and, purely from a point of personal interest, put it through an extended series of tests that subsequently demonstrated the remarkable potential of this modestly priced motor. Starting with a conservative maximum of .53 bhp at around 13,700 rpm on mild fuel (5 percent nitro) with the stunt size venturi and suction feed, we eventually had the 35X putting out .87 bhp at nearly 16,000 rpm on Fox "Blast" running on pressure feed and with a wide open intake. Not surprisingly the 35X was soon stealing the thunder of its more expensive brother, the Combat Special and to such effect that the latter engine was discontinued and development concentrated on the 35X.

Early in 1964, in response to enthusiastic but heavy demands made on the motor (*Continued on page* 58)

by combat fiends, the 35X was given a new shaft and renamed the 36X. The new shaft was strengthened by means of a slightly thicker crankweb with more meat around the crankpin. At the same time the opportunity was taken to move the crankpin and stroke the engine to .715 in., thereby taking full advantage of the .36 cu. in. displacement limit under combat rules. (This latter move probably caused Duke Fox some soul searching, for the .800 x .700 bore and stroke of Fox stunt and combat engines had virtually become a trade mark.)

Towards the end of 1964, the engine appeared with a remodelled head, still with the familiar Fox wedge-shaped combustion chamber but with the plug now inclined to fit flush with the wedge surface. In addition to eliminating the pocket produced by the old vertical plug location, this had the practical merit of facilitating quick plug changes in sidewinder combat wings when the cylinder was hard up against the leading edge.

In order to accommodate the longer piston stroke, a slightly longer cylinder sleeve was fitted. This extended approximately .025 in. higher, relative to the case and the sleeve ports. Piston height and conrod length were unaltered, so the exhaust and bypass periods were slightly extended. Incidentally, it is possible to fit a 36X shaft to a 35X without replacing the cylinder: a head spacer is available to give the necessary head clearance for the increased stroke.

Still later, a special custom version of the 36X was introduced. This, the 36X-BB, the subject of our present report, embodies a number of further changes, as follows.

Crankshaft. This has the valve port lengthened and widened to give a timing of approximately 40 deg. ABDC to 54 deg. ATDC. The gas passage through the shaft is reamed out from a stock .375 to .390 in.

Main Bearing. The rear needle-bearing of the 35X and stock 36X, is replaced by a Fafnir ball journal bearing at the front end, the half-inch shaft continues to run in the silicon-aluminum crankcase material.

Main casting. In the 35x, the extreme ends of the 180-degree exhaust port in the cylinder sleeve were partially masked by the casting. This is still the case with the 36X, but both the 36X and the 36X-BB now have a modified casting in which the back of the exhaust stack extends around the cylinder to join up with the outside of the bypass. This enables the stack to be milled out on the 36X-BB for more complete scavenging through the full width of the sleeve port.

Cylinder sleeve and head. The "picture window" bypass port of the 35X has been replaced by a port of conventional depth in the 36X and 36X-BB. Ports are otherwise unchanged but, with the revised piston stroke, measured exhaust and bypass periods for both .36 cu.in. models are now 146 deg. and 138 deg., an increase of 4 deg. on each. A slightly higher compression ratio is standard with the 36X-BB. The gasket recess is machined and only one 10 thou. gasket (instead of two) is used.

Piston and connecting rod. The 36X and 36X-BB pistons have slightly taller (.170 in.) baffles than the 35X (.160 in. on our original test engine), but are a trifle lighter. The stiffening web above the wristpin bosses is narrower and the skirt wall slightly thinner. On the 36X-BB the skirt has a cutaway at the front to ensure that it will clear the top edge of the ball-bearing that is exposed at this point. The 36X-BB conrod has the addition of an oil hole at the crankpin end. Both 36's have solid wristpins with domed ends instead of hollow pins with brass pads.

General. The 36X-BB is set up for a pressurized fuel system as received. A venturi insert is not supplied and the backplate has a pressure fitting ready installed. Apart from this, the engine can be distinguished externally from the stock 36X by its polished castings.

Desaxe cylinders. In describing many of the Fox engines dealt with in these Reviews—notably the 35's, 40's and 59—we have often commented that they embody a "desaxe", or offset, cylinder. The 36X and 36X-BB retain this and it is perhaps, about time (for the benefit of readers unfamiliar with this feature), that we explained what a desaxe cylinder is and how it affects the design and operation of the engine.

In a normal symmetrical engine, the cylinder is located so that its axis intersects the crankshaft axis. In a desaxe engine, however, the cylinder is offset in the direction of rotation. In other words, it is displaced to the left side when looking at the front of the engine—assuming normal anti-clockwise rotation.

The obvious mechanical advantage (and this applies to all reciprocating piston engines—two-cycle, four-cycle, gas or steam) is that the side thrust of the piston against the cylinder wall is reduced. Side-thrust causes piston and cylinder wear and reduced performance through frictional loss. Side-thrust is the resultant of the downward force acting in the direction of piston travel and the upward force acting through the angle of the connecting-rod. The greater the angle of the connecting-rod, the greater will be the resultant. One way of reducing side thrust is to use a very long connecting-rod. This, however, is impractical in modern engines since it means increased engine height and weight and, in a two-cycle engine, excessive primary compression chamber volume.

Offsetting the cylinder towards the direction of rotation means that the angularity of the connecting-rod for any piston position between slightly after TDC and slightly before BDC, will be less than for corresponding positions in a symmetrical motor. We can probably understand this better if we envisage an exaggerated example in which the cylinder offset is equal to half the stroke. In this, the connecting-rod will be approximately vertical at a point midway between TDC and BDC (i.e. no side-thrust) whereas, on a symmetrical engine, the conrod angle would be about 15 or 16 degrees at the same point. There is, of course, a corresponding increase in conrod angle and side-thrust on the return stroke between BDC and TDC, but since the pressures are much less than during the power stroke, this is not so important.

Here we must insert a word about the use of the use of the terms "TDC" (top-dead-center) and "BDC" (bottom-dead-center). Strictly speaking, these refer to the uppermost and lowermost positions of the crankpin which, in a symmetrical engine correspond to the uppermost and lowermost positions of the piston also. In a desaxe engine, the top and bottom positions of the piston occur *after* the dead center positions of the crankpin are reached. Therefore, the use of the terms TDC and BDC to describe piston positions in desaxe engines is not strictly correct. However, these terms now seem to be more widely understood to mean the uppermost and lowermost positions of the piston and we do not, therefore, propose to be dogmatic on this point.

A peculiarity of the desaxe arrangement is that the locations of the crankpin at the upper and lower piston positions, are no longer at 180 degrees to each other, due to the fact that the angularity of the conrod at the upper piston position is different from that at the lower piston position. For example, at piston TDC, our exaggerated desaxe engine would have a conrod angle

(Continued on page 62)

of about 12 degrees to the cylinder axis, but at piston BDC the angle will have increased to about 22 degrees.

This has an effect on the velocity of the piston at various stages of crank rotation. In a symmetrical engine, the piston starts from rest at TDC, accelerates rapidly to mid-stroke, takes a little longer to decelerate to BDC and an equal time to accelerate back to mid-stroke, finally decelerating quickly towards TDC. With an offset cylinder, the piston acceleration to mid-stroke is a little slower and the deceleration to BDC takes even longer, but the mid-stroke position is regained much more rapidly and the final stage back to the top of the cylinder is also quicker. This, in turn, influences port timing. When the exhaust port is uncovered, it takes longer to open fully and then closes more quickly. The same, of course, applies to the bypass port.

Theoretically, at least, this offers several advantages. The expanding gas in the combustion chamber has a little more time to do useful work before the exhaust port opens. It may also be argued that, since the ports reach their fully open positions more slowly, there is time for the cylinder to be more completely scavenged and refilled with fresh gas, after which the ports close quicker to avoid charge loss. It has to be admitted, however, that, since the amount of offset used in model two-cycle motors is usally very small (about 7 percent of the stroke on the Fox) these effects may not be significant.

There are other effects of offsetting the cylinder which may or may not be practical considerations in the design of a model engine. Among these is the engine's inability or, at least, unwillingness, to run in the reverse direction, even in the case of sideport or reed-valve induction systems. This is easily understood, but less obvious is the fact that in an offset engine the crank throw (i.e. the radius described by the crankpin center about the shaft axis) is not precisely half the piston stroke but very slightly less. In other words, the desaxe engine will accept a slightly smaller diameter crank chamber than an equivalent displacement symmetrical engine, although the difference is rarely enough to cause any worthwhile reduction in crankcase volume and thus pumping efficiency.

So much for desaxe cylinders.

Performance-wise, the favorable remarks contained in our July 1963 report on the 35X apply equally to the 36X-BB. Tests in this instance were on Blast fuel only, using an orthodox metal pressure-tank coupled to the backplate pressure fitting. The torque and power curves quite closely matched those of the 35X previously tested, with just a slightly higher output indicated on the performance graph. In fact, the difference between typical examples of the 35X and 36X-BB may be a little more than we recorded with our test engines. Our 35X was, undoubtedly, a good one and we believe that the 36X-BB may be capable of even higher performance than the figures we achieved—good as they are.

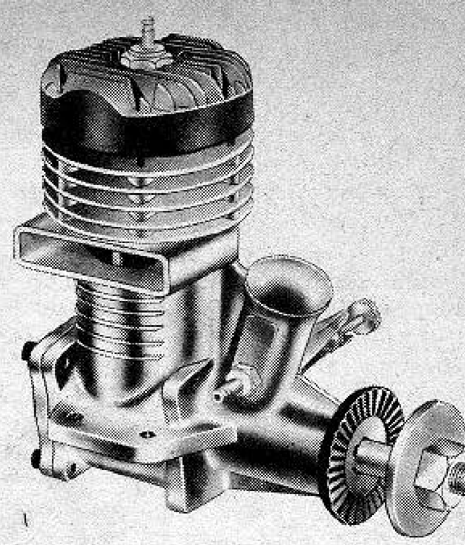
Starting was excellent, hot or cold. Running was smooth and consistent. We blew a couple of plugs during the first hour or so of running, which is no more than we expect in loosening up a hot performer, after which plug life was good. The engine was easy to adjust in that it responded positively to needle-valve adjustments but was never over critical.

This is clearly another exceptionally high performance Fox engine. We think it has just about all the power that combat enthusiasts need—or can use, although combateers themselves are the best judge of this latter point. Other important "combat" features are its moderate weight (to aid acceleration, climb and maneuverability), strong case (for crash resistance) and quick hot-restarting for rapidly getting airborne again.

Summary of Data

Type: Loop-scavenged two-cycle with crankshaft rotary-valve induction and single ball-bearing.
Weight: 7.8 oz.
Displacement: 0.3594 cu.in. or 5.890 cc.
Bore: 0.800 in. Stroke: 0.715 in.
Stroke/Bore Ratio: 0.894 : 1
Specific Output (as tested): 2.48 bhp/cu.in.
Power/Weight Ratio (as tested): 1.83 bhp/lb.
Price: $19.95
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas.

One To Make The Rat Racers Happy . . . Duke's .399 "40"



■ After checking the AMA rule book, that sly ole Fox (widely known as Duke) has again come up with a "special purpose" power plant. This "40" (actually .399 cubic inch displacement) was designed to the limit of Rat Racing regulations.

Several methods of increasing the displacement of a specific engine are available to the designer. Fox chose to lengthen the stroke of their basic 35 from .700 to .790 inches. Excessive vibration, sometimes a result of this practise, is not apparent in Duke's .40. A thinner piston cross section has been employed and no doubt this reduction in weight has much to do with maintaining smoothness.

The 40 R/C and the Rat Racing 40 share almost identical parts. We can't say for sure which was the chicken and which the egg, but we did receive the R/C version first and so figure that the Rat Racer Mill was derived from it. They are practically identical except for those parts necessary for variable speed control and the design of the piston. To further reduce piston weight, the "Rat" mill utilizes an extremely thin straight baffle while the R/C employs the heavier double crescent to aid low speed characteristics.

Mounting dimensions of the Fox 35's and 40's are identical. Weight differential is so slight that the more powerful 40 may be substituted to add more zip to a larger or overweight stunt ship that "squares" poorly or otherwise suffers from "tired blood".

Crankcase of die cast of aluminum embodies the cylinder barrel, main bearing and carburetor intake. The bearing has a cast-in bronze bushing with shallow longitudinal oil groove which extends to within ¼ inch of its front end. The intake tube is sleeved down by means of a removable steel insert retained by the standard Fox brass spray bar assembly.

A hardened one-piece steel crankshaft, heavily counter balanced, features a square rotary valve. Connecting rod of aluminum appears strong enough to withstand the additional strain imposed by the increased displacement. The tubular steel full-floating wrist pin has brass end pads to prevent cylinder scoring.

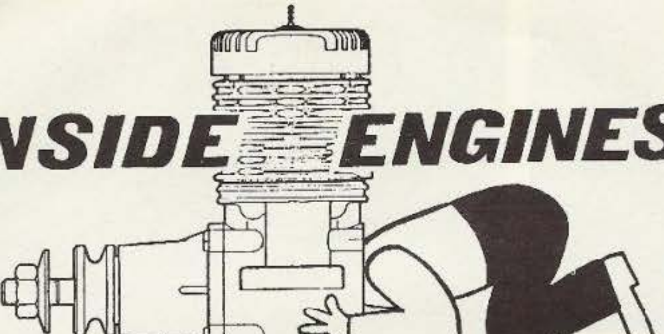
The steel cylinder sleeve, an easy push fit into the main casting, is not keyed. Port dimensions are identical to Duke's Combat 35 and R/C 40. Due to the lengthened stroke, the sleeve extends 5/32 inch above the casting. A die cast aluminum head with recessed aluminum gasket bolts to main casting via six Phillips head machine screws. While the aluminum backplate has no pressure tap, through an integrally cast center stud the do-it-yourselfer should find little difficulty in adapting this stud for tank pressurization.

Although our test engine started easily, initially it ran hot which means a careful break-in period. This is a common trait of any lengthened stroke design. Happily that break-in period was shorter than we had expected. An hour of short, rich (but not lugging) runs was sufficient to bring this test mill to a point where it would run out a 3 ounce tank of Fox fuel at sustained high speed.

Faster starts when cold were made by priming directly into the exhaust port. Hot starts were accomplished readily by intake choking. Needle valve adjustment is non-critical; no "floating" was encountered.

Our engine turned a very respectful 11,500 rpm with either an 11/5 or a 10/6 wood prop. With a Tornado 10/6 nylon rpm was upped to 12,500.

Specifications: Bore .800 inch; Stroke .790 inch; Displacement .399 cu. in.; Weight 7.6 ounces.



INSIDE ENGINES

WITH STU RICHMOND

Fox .40 BBRC

• The true measure of usefulness of a model airplane engine for R/C is its speed range. The *only* exception is if the engine is used for all-out racing, as in R/C pylon.

Speed range is the ratio of high speed to reliable idle speed, and it is easily measurable with modern equipment.

Speed range is the actual value of an R/C engine, not its cost, not its horsepower measurements, not its weight or appearance, not its casting glitter or its instruction manual. If an R/C engine reliably idles at 2,000 rpm and then will speed up from that idle to 8,000 rpm, it has a 4:1 speed range. If that same engine idles reliably at 2,000 rpm and then will speed up from that idle to 12,000 rpm, it has a 6:1 speed range.

A 4:1 speed range is barely acceptable for R/C use. A 6:1 speed range is highly desirable, and R/C models powered by such engines will sit still at idle on a paved runway normally. If the speed range is poorer than 4:1, the model is usually difficult to land due to too much airspeed. A speed range near 6:1 enables easy landing approaches as the engine, at idle speed for the approach, windmills its propeller to form a disc-shaped artificial drag inducer which serves as a brake to airspeed. One can argue that propeller parameters effect this disc-shaped drag. I accept this argument. But the paramount fact is that model engines for normal R/C flying that have the broader speed range performance ratio are those most sought by knowledgeable R/Cers!

Factors that influence the speed range are fuel, glow plug, carburetor throat inside diameter, reciprocating mass, internal shape and metrology (dimensions) of the combustion chamber, exhaust (and other) port timing, inside diameter of the muffler's exhaust exit, and the interplay of each of the above factors with the others. Other less obvious factors also influence speed range of our engines. It's virtually useless to show torque curves; they mean that the faster an engine turns the more the internal frictions develop. Even a horsepower chart for an R/C engine is of doubtful value. The best R/C flight performance comes when (usually by trial and error) a *propeller* is matched to the flight performance characteristics of the individual model and we add an engine to make the prop perform. For that reason Inside Engines will report individual engine speed ranges for a group of props suitable for the reviewed engine. This column will supply enough information on the above listed factors to hopefully be interesting reading and the photos should show you the engine's insides so you don't have to take your pride and joy apart to see what ticks. Comparison reading of Inside Engines columns might guide your future engine purchases. Before we start looking inside this month's engine, please let me present some credentials: an ex-machinist, Georgia Tech graduate, race sport R/C pylon, fly sport R/C scale, usually scratchbuild from my original designs, enjoy R/C assist old-timers, fly R/C sailplanes a bit, and I still enjoy rubber power too.

And now, to this month's engine.

FOX .40BBRC W/ LAPPED IRON PISTON 24096

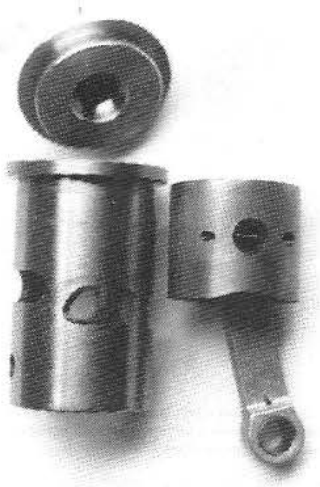
In a recent letter to me, Duke Fox referred to this engine as the "Fox .40 Standard." My quick conclusion after testing this newly introduced engine is that it will become *the standard* of speed range performance that other engine makers will try to match.

When an engine hand starts on the second flip on the test stand, I'm impressed. The engine was choked for five flips, turned over by hand until a "bump" was felt with the glow plug hot, and then it started on the second flip! The tilt-down muffler interfered with the test stand so it was (no-charge) returned for a #90236 tilt-up muffler in less than a week. This engine comes out of the box with the idle and high speed needle valves preset at the factory as a result of actual test running. As the break-in continued, each needle valve was gradually turned in about half a turn over the period. This preset feature is certainly a strong selling point that's sure to attract all R/Cers.

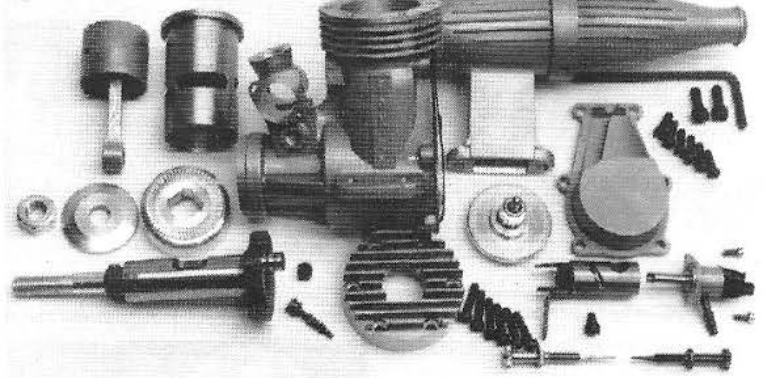
At Toledo one year I asked Duke why he originated the unique rear crankcase cover design that he calls the "high back door." His answer was that it helps in casting, and it facilitates getting tooling inside the casting to perform machining. As you remove the high back door and study the internal intricacies of the crankcase, it is plenty evident that the high back door crankcase cover allows easy internal machining access that translates to lower costs for us, the buyers.

This Fox #24096 has additional manufacturing features. A reverse rotation crankshaft p/n 13928 is made for pusher and twin engine uses. And very unusually available are pistons for this engine that are stepped .0003 inches apart in diameter. So that as normal wear takes place you have the option of replacing a worn piston with a "first-over" or "second-over" sized new piston. With the exception of engines from Taiwan,

Duke Fox calls this engine his "Fox .40 Standard." After testing, the author concludes with the observation that this surely will become the standard of speed range performance that other engine manufacturers will seek to emulate.



Front view of piston/cylinder shows inclined Schnuerle ports through cylinder wall and also the unique method of retaining the wrist pin inside the piston with a tiny steel roll pin.



The Fox features the long-wearing economical match of a Meehanite cast iron piston running in a steel cylinder. High back door has one transfer port cast into it.

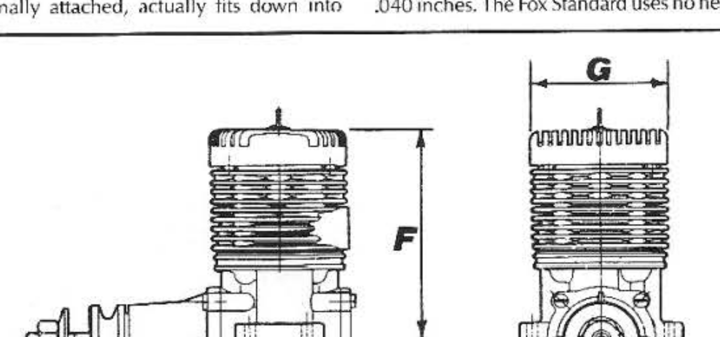
buying replacement parts for overseas-produced engines has gotten so extremely expensive that in many cases it is more cost-effective to simply buy a whole new engine. Not so with Fox. You can call (501)646-1656 direct to the USA factory and order replacement parts for current and many past engines. But please remember the Fox model engines have been produced for 45 years! Please be reasonable and don't expect to find parts available for antiques!

The instruction sheet mentions that one carburetor (like the series 6 with this engine) may not handle all variable conditions and contains data on how to tailor the low speed needle to unique needs. I found no such unique needs. My engine came with the new "Miracle" or four-cycle Fox plug that seems to work better in all engines and has five coils in the element. When a new model engine comes without a glow plug, I liken it to buying a new automobile without spark plugs and then going to my local auto parts store to complete my purchase. This engine's exhaust timing is 145 degrees. Fox is to build a sport pylon engine, and slightly higher exhaust timing would surely respond to a tuned pipe.

The high back door, when removed, shows one transfer port is cast into it. Air-fuel mixture travels up the port and turns horizontally to enter the combustion chamber flowing *away* from the exhaust port. A mirror image transfer port is cast inside the case itself. The cylinder's matching intake windows are taper-machined to further point gas flow away from the exhaust. Modern Schnuerle design. The Series 6 carb is of modern two-needle (Webra calls it TN) design. The idle needle is nickel-plated, is on the engine's exhaust side, and was open eight turns as received. The black needle (the two needle valves are not identical in shape) is the high speed adjustment and was open 4-1/4 turns as received. Inside diameter of the carburetor's throat measures a modest .285 inches; same as the also new Super Tigre G-40 Sport engine from Italy. The Fox muffler outlet inside diameter measure .350 inches. The G-40 Sport measures .295 inches.

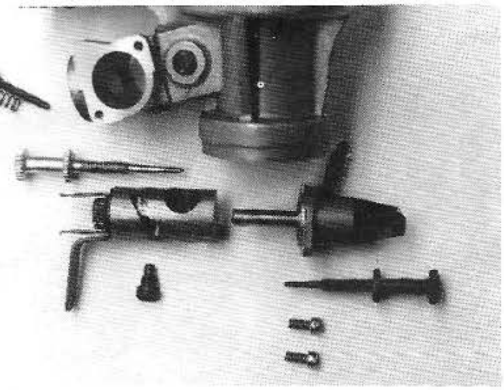
Removing the six-cylinder head bolts released the cylinder head fin section which clamps down the cylinder head button. The fully machined aluminum button holds the glow plug and forms the top of the engine's combustion chamber. The lower side of the button has a .375-inch diameter single bubble bowl that is .125 inches tall. The miracle plug's threads just match the button's internal threads. But this glow plug has a .050-inch snoot or lower non-threaded section which extends *below* the threads. This snoot, with the glow plug wire conventionally attached, actually fits down into the combustion bowl. The net effect is the bottom of the glow plug's catalytic action wire element is almost in the geometric center of the combustion bowl. I usually lower (by bending) the bottom two or three coils of the element of the glow plug for pylon racing. Other bend lower the coils of a Glo Bee. I've seen others race with K&B idle bar plugs and snip off the idle bar to better expose the coils, all in attempts to get better combustion. It seems Fox has, in effect, already done the same by design!

The deck height or distance from the bottom of the squish band down to the top of the piston (at top dead center) measures .040 inches. The Fox Standard uses no head

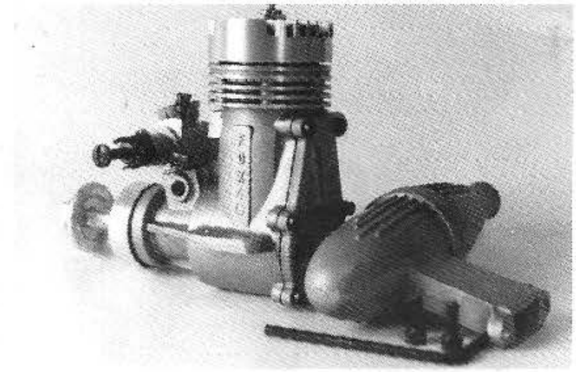


A = 5/8"	F = 2-9/16"	Bore = .835"
B = 1-5/16"	G = 1-7/16"	Stroke = .710"
C = 1-5/8"		Displacement = .389cu. in.
D = 7/16"		Engine weight = 10 oz.
E = 2-3/4"		Muffler weight = 1-3/4 oz.

Measurements of the Fox 40BBRC with lapped iron piston (also called the Fox 40 Standard). Generic engine illustration shown above.



Carburetor's barrel features over 1/8-inch lateral leaning-mixture movement. Carb body is silicone sealed to the crankcase casting.



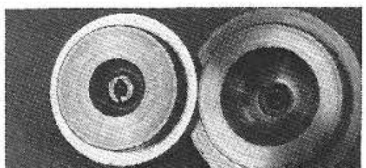
Rear crankcase cover is called the high back door. Text tells manufacturing reasons. Tilt-up and tilt-down mufflers, reverse rotation crankshaft and four stepped diameter pistons are available.

gasket; the aluminum button forms its seal easily to the steel cylinder.

A light upwards push slid out the steel cylinder liner. Its top inside diameter measured .835 inches, and the wall thickness is a modest .035 inches. Fox also makes a .36-size engine in this case with a heavier cylinder wall. The small .150-inch diameter hole under the exhaust port is for jigging/positioning in manufacture and is common with other brands of engines. Slight honing taper exists in the cast iron piston and the steel cylinder. This choice of materials with their hot expansions contribute much to the frequent one-flip and two-flip hot restarts experienced on the test stand.

The reciprocating weight of the piston, connecting rod, wrist pin and roll pin assembly totals 16-1/2 grams, which is just under two-thirds of an ounce in this .40-size engine. This isn't very heavy when you consider the massive strength in the rod and its lower bushing and consider the fact the piston is cast iron. The piston's lower skirt is machined down to only .015-inch thickness. The wrist pin measures a husky .220-inch outside diameter; bigger by .005 inches than the crankpin's diameter. Duke Fox enjoys creative engineering; the wrist pin is held in place uniquely by a tiny steel roll pin that enters the front wall of the piston, passes through the front end of the wrist pin to capture it, and locks in the piston wall. This shows in one of the photos. This is truly foolproof. The upper and lower connecting rod bearings have their lubrication holes in "better" locations. The greatest normal force on the conrod is compression between the bearings caused during the power/combustion stroke. The lube holes introduce flow to these points as seen in the photo(s). Most other engines have lube holes in easier-to-drill locations.

The crankshaft is 8620 steel, rides on two ball bearings with .500-inch inner diameters and the shaft's intake window is .415 inches long and .380 inches wide. The flow passageway down the hollow shaft is .310 inches in diameter. A crash-resistant 1/4 x 28 nickel-plated replaceable prop stud threads into the front of the crankshaft. (Only Fox and K&B use this neat feature.) The shiny aluminum prop driver keys onto eight steel mini-studs machined on the shaft's front end. The prop washer and



Smaller cylinder head button is for the Fox .40 Standard and you can see how the miracle plug fits down into the combustion bubble's dome. The larger button is to a Rossi .65 and has a K&B 11 plug in place.

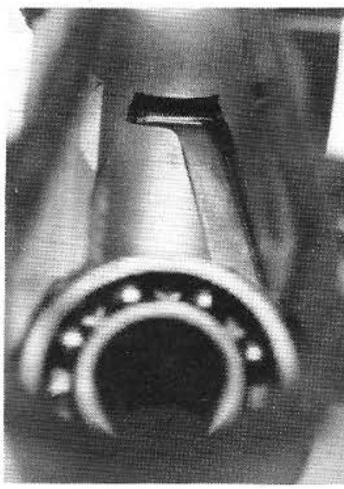
matching nut are also bright nickel-plated.

A source of many idle aggravations on R/C engines is air leakage where carburetors fit into crankcase castings. Other manufacturers use tapered fits, gaskets, or "O" rings to effect seals between carb and case. Fox wisely uses a simple coating of RTV (room temperature vulcanizing) clear silicone to make a permanent trouble-free seal that should not be disturbed. One Allen set screw through the crankcase casting against the carb's neck provides final locking/clamping action.

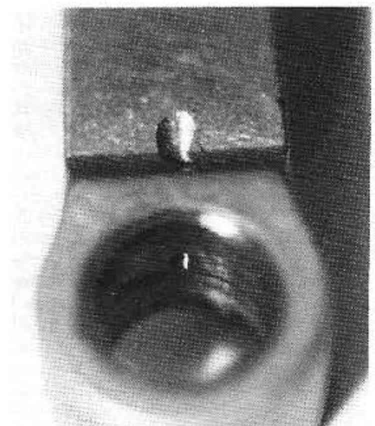
On initial start-up of a brand new Fox engine its not uncommon to observe blackish exhaust. Don't be alarmed, as usually its the last of the lapping compound being washed out of the lapped piston/cylinder. I do all static testing with black nylon Master Air Screw props and use 10-percent nitro hobby shop fuel to which one ounce of castor oil per gallon is added. Fox advocates castor-lubed fuels for long life. I concur. Two tachometers are used. This Fox 40BBRC Standard was so impressive on test that I chose to mount it and fly it for further verification. The speed range of the engine enhanced the PT 40 test model's flying and 12 total flights over four different days have been made. Neither needle valve was changed during flight testing. The four-ounce fuel tank averages seven-minute flights. Vibration level was judged extremely low and throttle response and related speed ranges make this an engine for competitors to copy. I fly with a slightly different fuel, and the five-pound model with a 10-6 is capable of sustained vertical flight! Landings are extremely slow. I found no need for a pressure line from the muffler to the fuel tank's inlet.

The only fault I've been able to find with

Continued on page 72



A look through the high back door shows the front transfer Schnuerle port and how fuel flow is directed away from the exhaust.



Close-up photo shows how lube hole is drilled in a better location at rod's top and bottom bearing. Purpose of careful oil-rich break-in is to seat these bearings as well as to finish forming the piston/cylinder fit.

the test engine is that the two front engine mounting holes are drilled about .020 inches off center, towards the exhaust's side of the engine. It's darn little to be wrong with a top-performance engine.

MEASURED PERFORMANCE

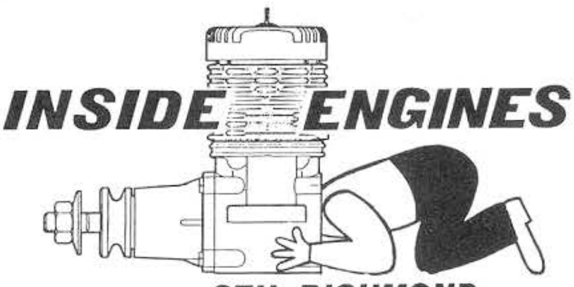
(Readings are after break-in and with Master Air Screw props and 10-percent nitro fuel with one ounce of castor oil added. The supplied muffler is installed for the following readings.)

Prop Size	Low Speed	High Speed	Speed Range
9 - 6	2300	15,300	6.6:1
9-1/2 - 6	2200*	15,200**	6.9:1
10 - 6	1850	14,100	7.6:1
11 - 6	1700	11,900	7.0:1

*without muffler = 2500
**without muffler = 15,500

A speed range below 4:1 is unsatisfactory.
A speed range of 4:1 is barely satisfactory.
A speed range of 5:1 is average.
A speed range of 6:1 is excellent.
A speed range above 6:1 is superb performance.

The Fox 40 Standard #24096 is manufactured by Fox Manufacturing Company, 5305 Towson Ave., Fort Smith, Arkansas 72901; (501)646-1656. The retail price of this engine at time of testing was $79.95. •



INSIDE ENGINES

WITH **STU RICHMOND**

Fox Quickee 500 Sport .40

• Duke Fox introduced this month's engine at the '89 IMS/Atlanta Show. He said to me, "Stu, tell your readers this is a mild-cam street version of my fire-breathing QUICKEE 500 SPECIAL for sport pylon racing." By "mild-cam street version," he was using automotive parlance to indicate this was a mildly detuned performance engine aimed at the R/C sport flier.

The .40 size engine is the most popular size for today's R/C use. This month's engine is Duke's fourth .40 in current availability . . . and a fifth one with an economy sleeve bushing instead of ball bearings should also be soon available. Three of the .40's share the smaller and lighter Fox "C" frame crankcase. They are:

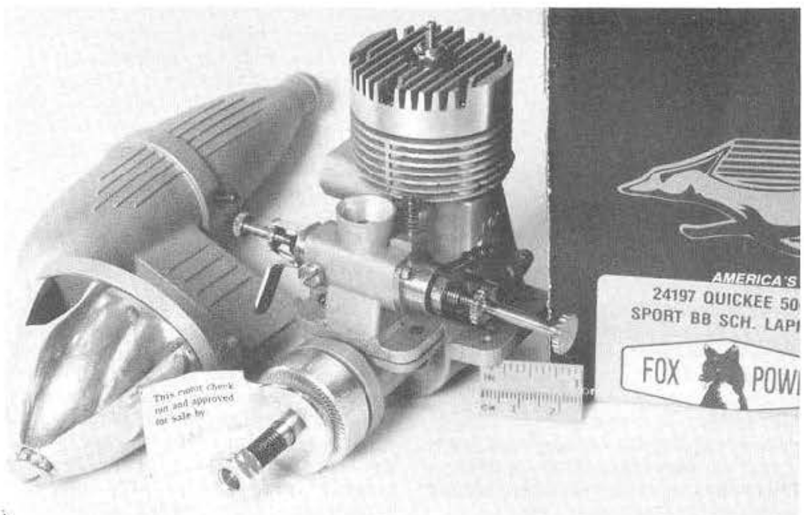
1. The soon-available #24095 without ball bearings and with a cast iron/steel piston/cylinder at an economy price.
2. The #24096 Fox STANDARD with dual ball bearings and cast iron/steel piston/cylinder.
3. The #24098 DELUX with dual ball bearings and an ABC piston/cylinder.

Duke built the #24097 QUICKEE 500 SPECIAL (an all-out pylon racing engine not suitable for sport flying) in the larger and sturdier "B" frame crankcase that his .45s and .50s use. In this month engine, he's fitted an economical steel cylinder and lapped iron piston into the same larger and sturdier "B" frame. Our tests show a power gain over the Fox STANDARD reviewed in our April '88 column.

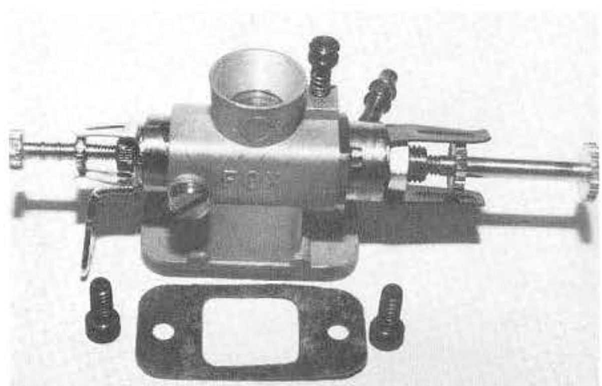
This engine's instructions specify using a fuel with at least 18 percent castor oil, similar to Duke's Fuel (with 10% nitro) which wasn't available here in Central Florida. Cast iron is a very hard, shock-resistant, semi-porous material ideal for our model engines. Castor oil builds a brownish glaze on the working surface of cast iron . . . and this glaze is what allows the iron/steel piston/cylinder to wear so well and to seal so tightly. Please remember, cast iron and castor oil go together. Cox's #551 Super Power Fuel was locally available and it has a very high castor content. I bought a pint for careful break-in.

All Fox engines are now factory test run and come with the new Miracle Plug that extends .050 inches down into the combustion chamber, further than other glow plugs . . . ignition is placed nearer to the

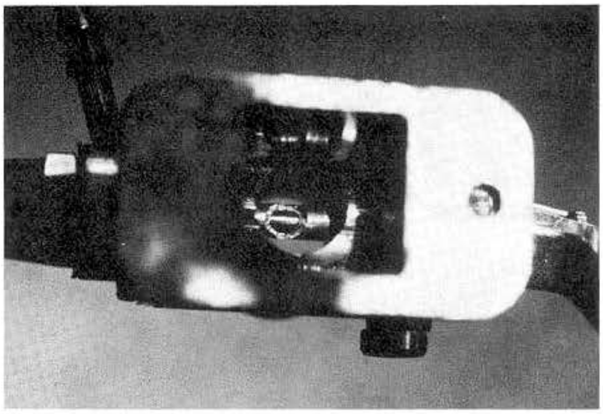
Below: The new #24197 Quickee 500 Sport .40 is a rugged long-stroke R/C engine, using the same massive crankshaft and beefed-up crankcase as the larger Fox .45 and .50. Sturdy construction make this engine a candidate for muffled tuned pipe use, developing still more power than shown in the chart on the facing page. The engine has an exceptional speed range between full and idle rpm.



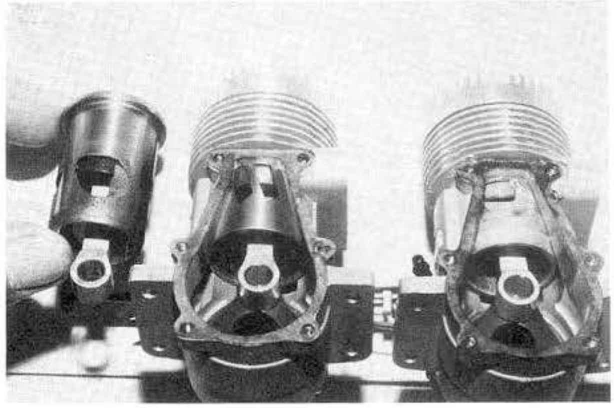
All the parts laid out for inspection. Cylinder's bore is .800 inch rather than .835 like other Fox .40s. Stroke is longer and the engine is comfortable turning 11x6 and 11x7-1/2 .60 size props.



The carburetor's long needle valve is for high speed; short one is for idle mixture. The forward facing screw retains the barrel in the casting, while the one on top acts as the barrel's "stop."



The camera is focused on the bottom of the carb's spray bar and shows the ragged edge hole for entry of fuel. Stu feels the ragged edges probably promote a steadier fuel flow into the airstream.



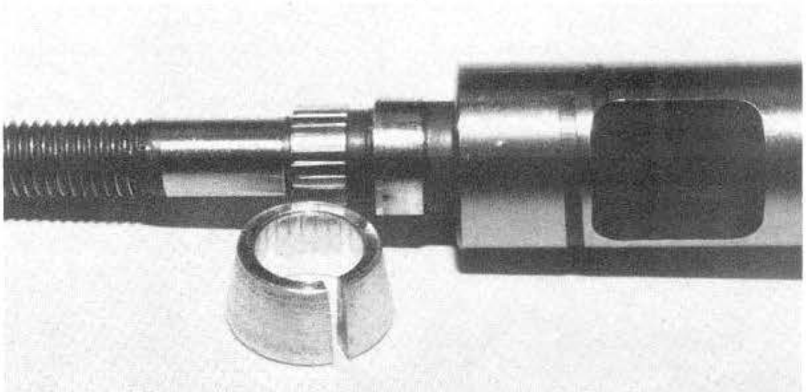
Piston/cylinder comparisons, from left; this month's engine's iron piston in a steel sleeve; the .50's ringed aluminum piston in a steel sleeve; and the "Q" .40 with an aluminum piston in a chromed brass cylinder.

center of the combustion chamber. The high speed needle valve, the big one on the fuel nipple side, was out 1-7/8 turns as received . . . the idle needle, the smaller one on the exhaust side, was out three turns as received. These are slightly rich settings by about one half a turn . . . but were ideal for break-in running. Initial running was with the 9-1/2x6 Master Airscrew. Six chokes at full throttle, glow plug heat added . . . prop grabbed firmly and briskly pulled through compression three turns until I felt an ignition "bump" . . . throttle closed to just above low idle . . . ONE FLIP AND THIS NEW FOX QUICKEE SPORT .40 WAS RUNNING. IMPRESSIVE!!

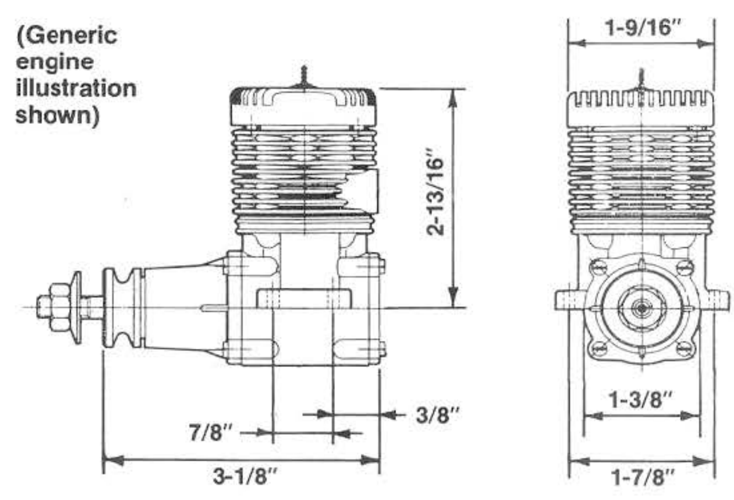
Break-in was a series of 30 second runs at increasingly higher rpm with complete cooling allowed between each 30 second run. Then a series of longer moderately fast runs were made with complete cooling between runs and finally full-throttle slightly rich runs were made with frequent squeezing/pinching of the fuel line to be sure we were still slightly rich. The process takes an afternoon and assures you that maximum performance designed into an engine can be gotten out at the prop. It took the whole pint of Cox #551 fuel. The muffler is left off during break-in to allow maximum escape of heat during this critical time in an engine's life. No attention is paid to idle performance during break-in. Right from the start this crankshaft-to-bearings fit felt perfect . . . there is just the slightest hint of front-to-back freeness (called end-play) as you lightly push and pull the prop's hub backward and forward. The prop readily rocked back and forth off of compression with just a light touch of a finger. Occasionally the engine started backwards, which comes with rather advanced intake timing. Backwards running is easily stopped by just opening the throttle . . . no big deal. All starting was with a "chicken stick" rubber hose rather than my fingers . . . we've yet to use an electric starter on this engine.

The reason Duke specifies as much as 18 percent castor oil initially is simple . . . castor is the world's finest high temperature lubricant for model engines. While metal-to-metal fits are being established

Continued on page 79



The tapered split collet is a common method of holding the drive washer to the crankshaft. First shoulder of the shaft has been splined to keep the drive washer from slipping.



MEASURED PERFORMANCE

PROP SIZE	LOW SPEED	HIGH SPEED	RICHMOND SPEED RATIO
9x6	2,500	15,600	6.24:1
9-1/2x6	2,350*	15,200**	6.47:1
10x6	2,000	14,200	7.10:1
11x6	1,900	12,100	6.37:1
11x7-1/2	1,750	11,050	6.31:1

*Muffler-off speed varied between 2,500 and 2,700 rpm.
**Muffler-off speed varied between 15,500 and 16,250 rpm.

during break-in at the top and bottom rod sockets, between the piston and cylinder (even in the ball bearings!), along the wrist pin and the crankshaft too, there are abnormally high temperatures, and castor oil provides the maximum lubrication as well as absorbing heat and carrying it out the exhaust stack too. Some of the major European fuel blenders use only a total of 10 percent oil in their fuel. But of that minor amount they specify in print that one fifth of the total oil is high quality, first pressing castor oil! Some of the popular Klotz oils also contain castor.

Most cold starts required only four chokes and one flip during testing. The piston/cylinder fit on this engine was superb . . . and this precision seal is what gives the compression of the fuel required for easy starting. All starts were made with the throttle opened just above idle speed. As the engine got into higher speed it was exhibiting more vibration than I was comfortable with . . . much more than on my Fox DELUX that's flown regularly. The spinner was suspect. This engine also came with a regular prop driver . . . off came the spinner and its backplate and on went the prop driver and away went the excessive vibration problems. Be prepared to spend some tedious and careful time with a High Point balancer before you use the shiny spinner.

For actual testing after break-in we used the same props from our Fox April 1988 test . . . and bought a gallon of Red Max 10% nitro fuel to which one ounce (protection) of castor oil was added. At this time the idle was carefully set with both barrel rotation and idle needle adjustments.

The Australian model press has made mention of my work on the ratios of high speed to reliable idle speeds . . . they're calling it something like the "Richmond Ratios" . . . and I'm totally flattered. Simply stated, an engine with poor or low ratios of high speed to idle speed should be passed over in favor of an engine with higher ratios for the sport and competition flyer . . . except in all-out speed cases. Unless an engine idles superbly (and reliably) you *cannot* make slow and easy landings or touch-and-go approaches. If your engine idles *slower* than the model's flying speed, the prop and engine serve as an air brake to safely slow the model as the prop is air-driven against the engine's compression. It's parallel to shifting into 2nd gear as your automobile comes to a red light in traffic. The engine's compression resistance helps slow the car. A stopped or stalled model engine with a non-turning prop is parallel to shifting your car into neutral and using only your footbrake to stop your car. I think we've all felt sorry for the R/C beginner trying to land with his engine idling at 3,000 rpm or so!

There are special points of interest in this month's Fox .40 R/C engine. A .0005 inch oversize piston and rod assembly is available if you wear out the original. The supplied tilt-down silencer can be no-charge exchanged at the factory for a #90246 tilt-up one . . . the tilt-up style fits all my models as the bigger .45s and .50s . . . it's sturdy. This engine's muffler outlet is .375 inches ID . . . the Fox STANDARD and DELUX measure .350. A machined aluminum head button sitting on a soft aluminum .010 inch thick head gasket forms the top of the combustion chamber when mated to the cylinder.

This engine is a .40 built into the case of a .50 . . . as you would expect, the cylinder wall is *extra* thick at .080 inch and weighs 43 grams . . . 28 grams = one ounce. The reciprocating weight of the piston and rod assembly totals 18-1/2 grams. As this is a .40 that uses a .50's crankshaft (AND THE 50's STROKE TOO) the bore is a smallish .800 inches . . . in effect, THIS ENGINE IS AN EXTRA RUGGED *LONG STROKE* sport .40. It shows best speed ratios (Richmond

past . . . *those days are over!* I assure you the indicated speed ratio figures are possible and attained only through modern and excellent design and manufacture . . . and that there are other manufacturers who most probably wish their speed ratios were as good.

MEASURED PERFORMANCE

Readings are after break-in, with black Master Airscrew propellers, and using 10% nitro Red Max fuel with one ounce of castor oil added for new engine protection. The optional tilt-up muffler is installed except as noted.

The original Miracle Plug failed the first time we encountered the spinner-induced vibration mentioned earlier. With the vibration problem solved, the second Miracle Plug looks like new after the testing concluded.

The Fox #24197 OUICKEE SPORT R/C .40 engine is made in America by Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901. Retail price is $129.95. A small initial batch of these engines got out with rear ball bearings that somebody sold to Fox Manufacturing that are of inferior quality. They rust and cause the engine to fail. Please be assured that Fox Manufacturing speedily repairs these engines without charge . . . and is sorry for the inconvenience these few engines may cause modelers. •

PRODUCT REPORT

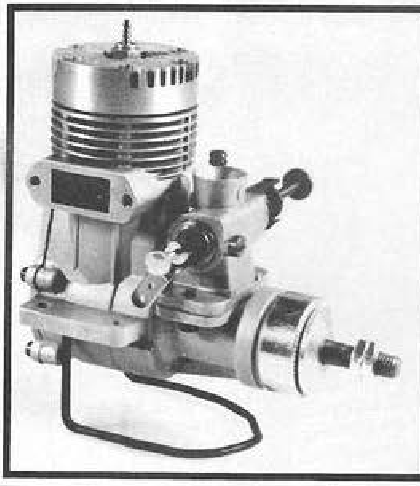
FOX QUICKEE 500 SPECIAL

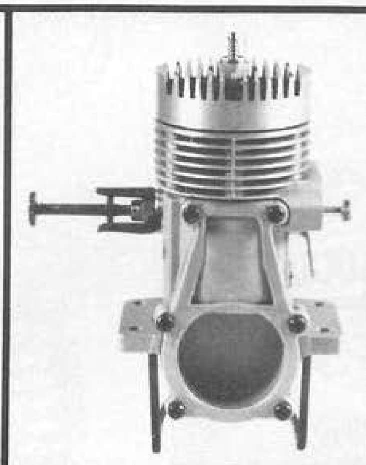
By Clarence Lee

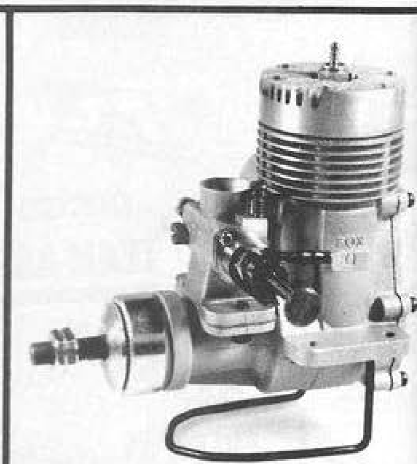
SPECIFICATIONS

Type: Single cylinder, air-cooled, 2-stroke cycle, Schnuerle scavenged, ABC, glow ignition.
Bore: .800"
Stroke: .790"
Displacement: .397 cu. in.
Compression Ratio: 12.54:1
Weight: Bare 13.3 oz.
with muffler 16.9 oz.
Manufacturer: Fox Manufacturing Co., Fort Smith, Arkansas

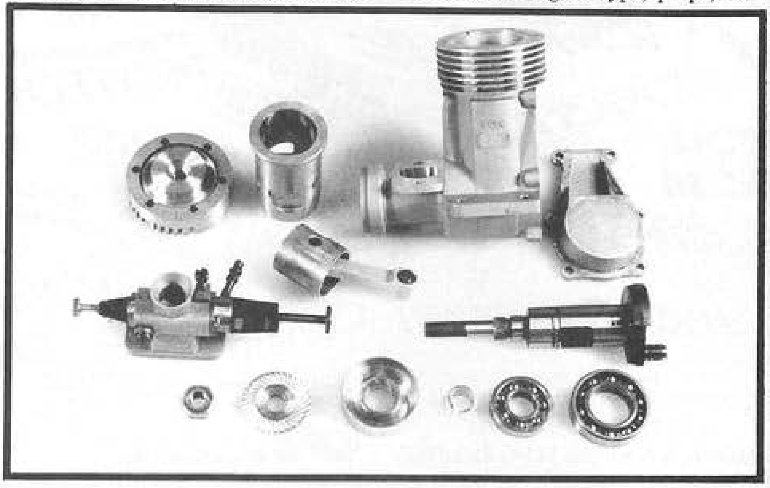
The most popular R/C racing event at the past 1988 Nationals was the Quickie 500 which drew 79 entries. Formula I, the premiere R/C model aircraft racing event, drew 50 entries; Quarter Midget, 42; and FAI, only 18.

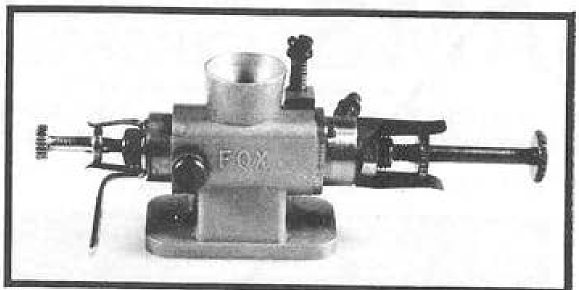




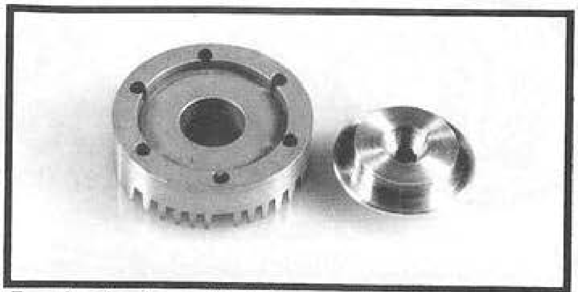


Although an unofficial trial Quickie 500 race was held at the 1987 Nationals, 1988 was the first year that Quickie 500 became a regular sanctioned AMA event. Quickie 500 racing was actually the brainchild of a modeler named Glen Spickler and got its start in the Bakersfield, California area in the early 1970's. A group of modelers in the Bakersfield area had been racing a variety of aircraft and engines in sport pylon type racing and decided that a standard aircraft design that was easy to build, fast, super stable, and did not require a lot of time or money invested if involved in a crash, was needed. Glen Spickler, noted for his aircraft design ability, was approached to design such an aircraft and the Spickler Quickie 500 racing aircraft was the result. Initially, Glen just drew up a set of plans and made airfoil and fuselage templates available through a local Bakersfield hobby shop so that fellows could more or less make up their own kits. To further standardize the event, the K & B front rotor 40 was designated as engine power. The thinking here was that Quickie 500 could also serve as an entry/training level for Formula I racing. The first Quickie 500 race using Spickler Quickie 500 aircraft was held at the Bakersfield, Famosa flying site in about 1971. The Famosa flying site is famous for the large pattern contests held there back in the early days of R/C, and then later for the annual Formula I contests which often drew in excess of 100 entrants. Interest in Quickie 500 racing gained rapidly and plans for Glen's Quickie 500 aircraft were published in the December 1972 issue of American Aircraft Modeler. Shortly after this, due to the interest created, Glen went into the kit manufacturing business turning out Spickler Quickie 500 kits, something he had no intention of doing initially. Quickie 500 racing caught on rapidly all over the country but with different clubs and areas making up their own rules as to engine type, props, etc.





Fox MK X-B 2-needle mixture control carburetor has .360" throat diameter.



Two piece head assembly. Wide squish band and small center bowl result in an exceptionally high compression ratio of 12.54:1.

Crankshaft and bearings. One side of counterbalance has been milled away for better dynamic balance and smoother operation. Spiral groove in nose of crankshaft reduces fuel leakage out front bearing. This mod can be performed on any make of engine.

Here in Southern California, the original Spickler concept ended up as Formula 500 still using the Spickler type aircraft but allowing the use of any front intake .40 cubic inch displacement size engine — Schnuerle ported, rear exhaust, and also the use of tuned pipes.

The AMA, recognizing the popularity of the event, decided it should become a standard AMA racing event. However, different parts of the country had their own ideas on how the event should be held with no countrywide standardized event. So, a committee, headed by Cliff Telford, was appointed to come up with a standardized set of rules for the Quickie 500 event that could become part of the AMA program. This resulted in Quickie 500 racing being held at the 1988 Nationals officially for the first time.

The present rules call for an unmodified front intake, side exhaust, .40 cubic inch displacement size engine equipped with the manufacturer's supplied muffler and carburetor. The fuel, 15 percent nitromethane (supplied by the contest organizers), and the propeller to be a commercially available two-blade wooden type with balancing being the only modification allowed. A specific prop size is not specified. The aircraft is still basically the original Spickler type.

Up to now, the Rossi 40 has proven to be the dominant engine in the AMA Quickie 500 event with the only close contender being the Webra Speed 40. However, a new challenger has now entered the picture in the form of the Fox Quickee 500 Special — the double "e" in Quickee being Duke Fox's way of spelling the word and not a typographical error. Until now, the Rossi 40 has been head and shoulders above all of the other front intake, side exhaust 40's tested, so I was really amazed when checking out the Fox 40 Quickee Special to have it out-turn the Rossi by 200 rpm with the 9 x 6 and 9 x 7, and 500 rpm with the larger 10 x 7 and 11 x 6, making it the most powerful .40 displacement size front intake, side exhaust 40 on the market. It should be pointed out, however, that the AMA rules do not specify a carburetor throat size, and Duke, sly old Fox that he is, has taken advantage of this by using a carburetor throat size of .360". As a comparison, the Rossi 40 has a carburetor throat diameter of .302" and our California Formula 500 rules limit the carburetor throat size to 8mm (.315"). I don't imagine that Rossi will let this go unnoticed. Although the Rossi was intended for sport type flying and not designed specifically for the Quickie 500 event (as was the Fox Quickee Special), the Rossi, until now, has proven to be the number one choice of engine power for the event. I do believe that the AMA rules should specify a carburetor throat diameter. Since the biggest spread in power between the Fox and Rossi is with the larger prop sizes,

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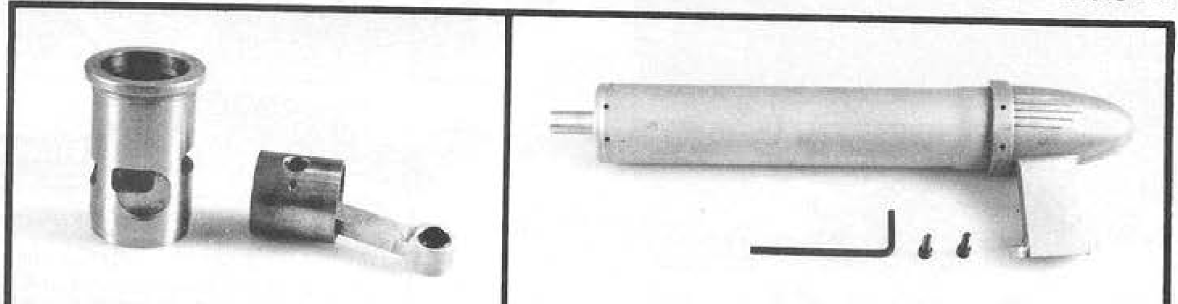


LEFT: Piston/sleeve/rod assembly. Note novel spot face treatment given to transfer ports. Wrist pin retained by roll pin pressed through piston wall. A Fox exclusive. RIGHT: Fox Quickee expansion chamber muffler. Has slight tuning effect.

continued from page 86/84

then it becomes only logical to use more prop on the Fox either in the form of larger diameter, higher pitch, or a combination of both. So let's take a look at the Fox 40 Quickee Special and see what Duke has done to get all this horsepower.

The Quickee Special uses the same crankcase casting as that used for the Fox 45 and 50 but with machining modifications to improve the high speed breathing. The crankshaft is also the same as that used in the 45 and 50 but with a modification to the counterbalance to promote smoother running at high speeds, and the engine was very smooth (see photograph). The 45, 50, and Quickee Special all share the same .790" stroke with the measured stroke in our test engine actually being .793". With a bore of .800" and stroke of .790" the engine is just slightly over-bore in design which is one of the contributing factors to its high torque and ability to turn the larger prop sizes. Rather conventional crankshaft intake timing is used, opening 45° after BDC and closing 60° after TDC. The bearing sizes are also the same as those used in the 45 and 50 with the rear bearing having an o.d. of 1.102" (28mm) and i.d. of .590" (15mm), and the front bearing an o.d. of .875" and i.d. of .375" (non-metric). These are the same bearing sizes as used on many .60 displacement size engines which, in turn, allows the use of a larger gas passage through the crankshaft and, in the case of the Quickee Special, is .406".

The engine is of ABC design technology utilizing a very heavy walled .083" thick brass sleeve that has been hard chrome plated and a high silicon, cast aluminum piston. The sleeve bore has a .003" taper measuring .800" at the top and .803" at the bottom. Most of your high performance racing type engines now utilize high sleeve tapers with as much as .008" used in some applications. Schnuerle scavenging is used with a single transfer port on either side of the exhaust port and a large boost port directly opposite the exhaust. An unusual modification has been made to the transfer ports in the form of a spot face done with a 1/2" end mill cutter (see photograph). This would appear to be a production method of thinning the lower port edge, in turn, allowing easier fuel passage through the port and into the combustion chamber. The more air/fuel mixture you can get into the combustion chamber, the more power the engine will develop. This is the route Duke has taken with the Quickee Special to help reach its high power level. Although I have seen many modifications to the intake port(s) used, this is the first time I have ever seen an end mill spot face used. Duke Fox has always been an innovator and not one to follow conventional practices. The port timing, like the crankshaft timing, is quite conventional with an exhaust duration of 150°, transfer port duration of 130°, and boost port duration of 134°. Note, however, that the boost port opens 4° ahead of the transfer ports — just the opposite of standard practice.

The connecting rod has been machined from 2024 aluminum alloy and is bronze bushed at both the crank pin and wrist pin ends. A .218" dia. hardened steel, tubular wrist pin is used and retained in the piston by a 1/16" dia. roll pin with the roll pin hole being drilled through the side of the piston 90° to the wrist pin axis. This is another Fox innovation (see photograph).

And now we get to one of the major contributing factors to the Fox Quickee Special's high power level — the compression ratio and combustion chamber shape. The measured combustion chamber volume was exactly .4ccs which computes to a compression ratio of 12.54:1 figured from the closing of the exhaust port — an exceptionally high compression ratio. The combustion chamber shape is that of a very small bowl surrounded by a very wide .210", flat, squish band area. The clearance between the top of the piston and squish band was measured at .010". Although no preignition sound could be detected with the engine running, the standard Fox glow plug blew on the first run. This often happens on a first run due to minute particles of metal from the break-in process. Our test engine had been factory run, however. A second Fox standard long reach plug was tried with the same result. The Fox Miracle plug was tried next and held up throughout the balance of the testing. I should imagine that a Rossi #4 plug that many of the Quickie and Formula 500 racers are using would work well also but I happened to be out of these at the time of the Fox testing.

The same MK X-B 2-needle, rotating barrel type carburetor that is used on the Fox 45 and 50 is also used on the Quickee Special but with the intake opened up to .360" and the spray bar tube shortened to extend only halfway across the intake. The designation for the Quickee carburetor is now MK X-D. Although this large intake size does improve an engine's breathing ability at higher rpm with the smaller diameter prop sizes, it is less of a contributing factor with the larger prop sizes.

The muffler that is supplied with

the engine is a bit unusual in appearance due to its length. Internally, it is strictly an expansion chamber with no inner mini-pipe as is used in the Rossi 40 muffler. Duke found it necessary to use a muffler this long in order to get sufficient volume to both hold the noise level down and not create excessive back pressure and power loss. Duke claims that the muffler has some of the characteristics of a tuned pipe and works best if the engine is propped to run between 17,000 and 19,000 rpm. Our own tests with the 9 x 6 prop showed the engine to turn 17,600 with the muffler installed and 18,000 with open exhaust. However, even the 400 rpm difference is not significant when you consider the rpm the engine is turning and the power that is being developed. With the small diameter tail pipe used on the muffler you would expect a considerably higher rpm loss, so evidently some resonant tuning is taking place.

Okay, so just how much power does the engine develop? Although the engine, like all Fox engines, had been previously run at the factory, it was given an additional 30 minutes of break-in time. Although the AMA Quickie 500 rules call for 15% nitro fuel, we used only 10% as this has been the fuel we have used when testing other engine makes in the past and did not want to give the Fox an edge by using 15%, when the Rossi, for example, had been tested with 10%.

The test fuel consisted of 10% nitromethane, 19% Klotz KL-200, 3% castor oil, and the balance methanol. Under the following weather conditions, the following power figures were recorded. Note that although the temperature was ideal, the humidity was on the high side at 55% and the barometric pressure below normal. A higher barometer and lower humidity would have shown even higher readings.

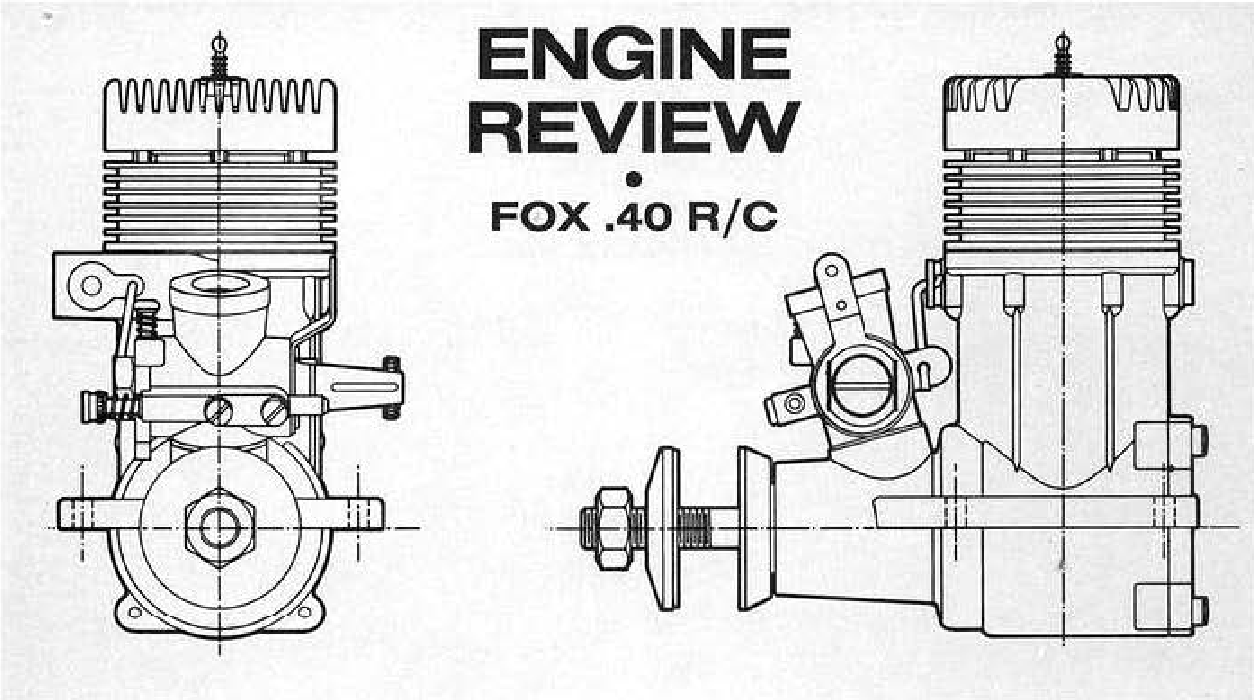
Temperature 70°F — Relative humidity 55% — Barometric pressure 29.85" Hg.

9 x 6 Rev-Up	17,600 rpm
9 x 7 Rev-Up	17,200 rpm
10 x 6 Rev-Up	15,850 rpm
10 x 7 Rev-Up	13,750 rpm
11 x 6 Rev-Up	12,900 rpm

As can be seen by the preceding figures, the Fox 40 Quickee 500 Special is a real stump puller, developing more power than most 45-50 displacement size engines and approaching what some of the 60's were developing just a few years ago. However, all this power does not come without a few sacrifices. Although the engine could be hand started when cold, it did have a pretty good kicking tendency due to the extremely high compression ratio. Hand restarts when hot were a completely futile attempt and an electric starter was definitely required. The exact reason for this is a little hard to determine as the engine had good hot compression, the timing is not that wild, etc. However, the engine just did not want to take off running by hand flipping when hot; forward or backward made no difference. This should not pose any particular problem as the majority of fellows racing Quickie 500 already use electric starters.

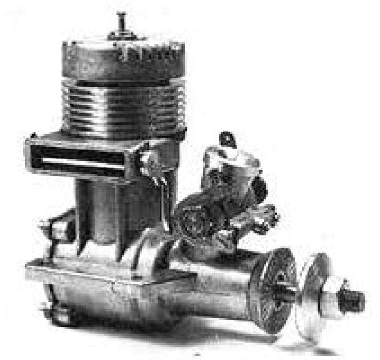
The engine also exhibited a rather high idle speed with 3,600 rpm being just about as low as the engine could be idled reliably. Again, however, the AMA Quickie 500 rules do not call for the engine to idle and the only function of the carburetor is to serve as a fuel shut-off. Bear in mind that this engine was designed to develop a lot of horsepower for a specific event and not to display an impressive tick-over idle --- a characteristic of most high performance racing engines, either full scale or model. I should imagine that if someone had reason to use the engine for purposes other than Quickie 500 racing, that raising the head clearance with a .020" (approximate) spacer and installing the 45/50 carburetor would tame the beast. In its present form the Quickee Special is far from the docile engine that the Fox 45 and 50 are. It was not intended to be.

The Fox 40 Quickee Special has all the indications of being a real winner and should give the Rossi 40 some serious competition. This is something that is really needed to keep AMA Quickie racing from becoming a one engine event --- something it has more or less become. □

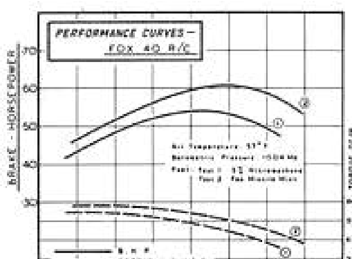


ENGINE REVIEW

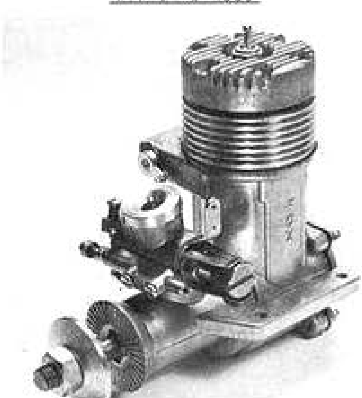
FOX .40 R/C



New style porting, separate cylinder jacket and a massive shaft are features of the new Fox.



Like all Fox motors, 40 is easy to take apart for do-it-yourself servicing and examination.



Two-needle carburetor is simple to adjust. Engine's long mounting lugs for firm support.

BY PETER G. F. CHINN

Entirely new model from one of America's oldest established engine manufacturers. Design marks a breakaway from many earlier Fox traditions—watch for it on the field.

• This .40 cu. in. engine from the Fox Manufacturing Company is a completely fresh design owing little or nothing to previous medium size Fox motors.

Duke Fox's first 40 appeared 11 years ago, based on a stroked version of the 1960 Fox Rocket 35 which, itself, was designed around the 1957 Fox Combat-35 body casting. In 1962 a throttle-equipped version was introduced but was made for only a short time. Subsequent Fox 40's were mostly high-performance ball-bearing/needle-bearing engines aimed at the Control Line Rat Racing field —where they were highly successful.

All these earlier medium displacement Fox motors had (and still have, in the .29, .35 and .36 models) certain features in common—to wit, a single casting embracing the crankcase and cylinder casing, offset cylinder with conventional open-loop or crossflow scavenging, deflector type piston and wedge pattern combustion chamber.

It is quite surprising to find that the new 40 breaks with what one had come to regard as a Fox tradition by having none of these features. In overall dimensions it is also a somewhat larger engine; taller, heavier and requiring wider bearer and bolt hole spacing.

Starting with the pressure-cast aluminum main casting, this includes the crankcase and cast-in bronze main bearing bush but extends upward only so far as to include the exhaust stack. It has very long beam mounting lugs that assist in bracing the front end and extend rearward to include the thickness of the

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Engine Review

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backplate, thereby providing very firm support for the engine at all times. The bypass passage is divided into three parallel channels that extend almost completely around the bypass side of the cylinder sleeve. They are separated by two vertical ribs that help to align the sleeve and accommodate two of the six long 4-40 screws which, spaced at 60 degree intervals, tie the complete cylinder assembly to the case.

Fox engines seldom show any sort of outside influence, tending, rather, to reflect Duke Fox's own individual ideas of design, so it is interesting to note that the sleeve ports on the new 40 are just a wee bit "Garofali." The exhaust port takes the regular rectangular form but the bypass porting, consisting of two deep ports, steeply inclined through the cylinder wall and used in conjunction with a flat crown deflectorless piston, are decidedly reminiscent of the system used by many of the high-performance Super Tigre motors. The Fox ports are, however, modified at the top outer corners, presumably to promote a cleansing gas flow fore and aft across the piston as the port opens. Also, unlike the original non-pipe timed ST porting, there is still a blow-down period, the exhaust remaining open for 128 degrees of crank angle against a 120 degree bypass period.

Except for the absence of a baffle, the lapped piston is of orthodox Fox design, machined from Meehanite bar with an annular rib above the wrist-pin bosses to help maintain roundness. Piston weight is 10.2 grams bare of 12.9 grams complete with .182 in. dia. full-floating hardened tubular wrist-pin. The latter is retained by wire snap rings in the piston. Incidentally, although the maker's instruction leaflet calls for extracting the wristpin if the piston and rod assembly needs to be removed from the engine, we found this unnecessary. If the rod is drawn back on the wristpin as far as it will go, it can be lifted off the crankpin and withdrawn complete with piston.

Above the exhaust stack, the cylinder is encased in a close-fitting machined aluminum finned jacket. This, aided by a gasket, seals the tops of the bypass channels and exhaust duct. The cylinder sleeve is located by the usual upper flange, on top of which the head is seated complete with 10 thou. soft aluminum gasket. The head is unusual among present-day two-cycle motors in that the combustion chamber roof is perfectly flat except for a small rim surrounding the central glow-plug hole. The plug fitted is Fox's highly regarded long-reach R/C type with integral idle-bar.

The new 40 crankshaft, very large for an engine of this displacement, has a 9/16 in. diameter journal and an enormous (.410 bore) gas passage. The valve port, on the other hand, is of much more modest proportions and it therefore seems reasonable to suppose that the object of using a shaft of such generous dimensions is to leave plenty of scope for future development—perhaps an ultra high-performance version for Pylon and Rat Racing. Measured valve timing on our engine was 48 deg. ABDC to 45 deg. ATDC.

The Fox 5-A carburetor fitted to the Fox 40 R/C is outwardly similar to the Model 4-A unit first used on the Fox 36X R/C but has been completely redesigned to simplify the process of adjustment. As we remarked in our test report on the 36X R/C two years ago, the 4-A was *not* difficult to set-up if one followed the correct sequence of adjustments but, apparently, the idea of having to tackle three needle-valves was just too much for some modelers.

In the new carb, Duke Fox has therefore eliminated the separate needle-valve for adjusting mixture strength at intermediate speeds. This is now taken care of automatically. The system of operation is as follows.

1. Fuel is fed to the engine via an inlet nipple cast into the front of the carburetor body. From here it takes two routes:

(a) Fuel for the low-speed mixture is conveyed to an idling jet drilled directly into the carburetor throat and the amount metered through this is controlled by a small needle screw at the front on the right hand side of the carb.

(b) Fuel for the main jet flows through a delivery hole in the carburetor body, well over to the left side, where it is picked up by a hole in the surface of the throttle rotor and conveyed into the interior of the rotor. From here it is discharged through the main jet located in the bottom of the rotor. The amount of fuel metered to this jet at full-throttle is controlled in the usual way by a needle-valve, the needle screw being fitted in the left-hand end of the throttle barrel.

2. (a) When the throttle is partly closed, the hole in the throttle rotor is no longer exactly aligned with the delivery passage. However, a thin slot in the surface of the rotor, extending from the hole, allows a reduced quantity of fuel to be admitted into the rotor, thereby automatically adjusting the fuel strength to intermediate throttle openings.

(b) Further rotation of the throttle rotor toward the closed position cuts off the fuel to the main jet entirely so that the engine now runs on its idling jet only.

For a standard, non-racing type 40, the Fox has an unusually large choke area. The throat bore is 9.8 mm. which, after allowing for the 4.8 mm. wide flat center section of the throttle rotor, gives an effective choke area of approximately 30 sq. mm. However, the actual intake area is smaller than this as the mouth of the carb is fitted with an aluminum cap having a 5.6 mm. dia. hole—i.e., 24.6 sq. mm. cross-sectional area.

The carburetor body is of pressure diecast aluminum alloy and is sealed into the engine crankcase with aluminum-filled epoxy adhesive. The throttle rotor is of steel, finely finished and closely fitted to the carb body to ensure leak-free operation of fuel transfer between the two components.

The carburetor throttle is linked to an exhaust restrictor valve. Unlike previous Fox R/C engines, the valve is of the semi-rotary type, machined from aluminum bar stock and installed within the exhaust stack which is extended for this purpose. A short wire link connects the exhaust valve to a diecast aluminum arm secured to the solid end of the throttle rotor by means of a 1/4 in. hex nut. This arm has two short additional arms that set the limits of throttle travel, full-throttle and idle, the latter being equipped with a screw adjustment.

According to Fox literature, the 40, having a lapped piston and bronze bushing, may require a considerable amount of running to bring it up to peak performance. On our sample, the bearing was quite free but, having noted that the piston did not have the top relief of the 36 and was fairly tight at the top of the stroke we suspected that a long and tedious break-in might be necessary before the engine could be fully leaned out. In fact, by using a straight three-to-one methanol and castor oil fuel mix without nitro, our engine took less than 30 minutes (in two-minute runs) of slightly rich operation on a 10x6 prop to reach the point where it would stand a fully leaned-out continuous run on a 5 percent nitro fuel. However, to further free the engine, we then ran about 20 tanks of fuel through it.

The engine was now holding steady on a 25 percent nitrol fuel and was judged to be sufficiently broken-in for test purposes. At this point on Fox Missile-Mist fuel, it was turning 10,800 rpm on an 11x6 Power-Prop Super-M, 11,300 on an 11x5 Power-Prop, 11,900 on an 11x4 Top-Flite, 11,500 on a 10x6 Top-Flite Super-M and 12,600 rpm on a 9x6 Top-Flite Super-M.

A series of torque and rpm readings were then taken on our standard 5 percent nitro test fuel, followed by a second series using Missile-Mist. These indicated that (so far as our test sample was concerned) there was nothing to be gained by propping the 40 for speeds above about 12,000 rpm. Maximum torque was recorded at 8,000-9,000 rpm and the engine delivered its most useful power output when loaded for speeds between 10,000 and 12,000 rpm. The manufacturer's instruction leaflet suggests a 10x6 prop and our findings indicate that this is just about right for releasing the engine's maximum performance on either fuel. In other words, we would expect that, in a model, the 40 would pick up to rpm figures, in level flight, that are close to its peaking speed—making due allowance, of course, for the fact that different 10x6's may vary up to 500 rpm or even more, in power absorption.

The Fox was not at all critical to fuel mixture. As already stated, it was broken-in, initially, on a straight methanol-castor mix and was subsequently tested on 5% and 20-25% nitro fuels. It ran well on all of them. Naturally, it was most powerful on the higher nitro percentages and, as the graph shows, Missile-Mist added 12-15% more power. As regards handling, the 40 did not re-start hot so rapidly as some Foxes we have tested but always started easily enough from cold—which, after all, is what matters most. The needle-valve, being close to the prop, needs careful handling if one is to avoid getting one's knuckles rapped.

We have no complaints about the throttle. We do not know whether these engines have the idle needle specially adjusted to an estimated setting before they leave the factory but it so happened that on our example, the setting as received (one turn open) was just about right. In any case, the optimum setting was not critical. Only the idle stop screw required adjustment. As delivered, the engine was idling at about 4,000 rpm on a 10x6. Slackening off the idle stop screw brought this down to 2,500 rpm without need of readjustment to the idle mixture. Mid-range throttle response was equally good and the mixture strength appeared to be quite well-matched to the whole range of throttle movements between idle and full speed.

In marked contrast to many manufacturers, whose policy is to discourage the purchaser from attempting to service his own engine, Fox approves the idea of the user undertaking his own repairs and will not penalize him in any way if he is unsuccessful and eventually has to send his motor back to the factory.

Helpful here is the fact that Fox engines can be taken apart and reassembled with ordinary tools. We have mixed feelings though, about the suggestion, also contained in the instruction leaflet, that the user may hand-lap the piston and cylinder or hone the bearing of a tight motor or make minor modifications to the throttle if the intermediate mixture is either too rich or too lean. As the manufacturer rightly points out, such alterations should be carried out with extreme caution. We would go further and recommend that if the owner has a limited knowledge of model engines and has never previously tackled anything of this nature, he should first seek advice as to the precise implications of the work intended and the best way of going about it, from a friend known to be experienced in such matters.

To sum up our findings, the new Fox 40 R/C is a sturdily made engine of good all-round performance. The throttle is effective and easy to adjust and the engine's construction makes do-it-yourself replacement of parts a simple matter. The engine's basic design and construction would also appear to have distinct possibilities for future development (for example, a more fancy combustion chamber shape and a bigger rotary-valve port) for more power.

Summary of Data

Type: Single-cylinder two-stroke cycle with crankshaft rotary-valve and bronze bushed main bearing. Throttle type carburator with coupled exhaust restrictor.

Checked Weight: 10.37 oz.

Displacement: 0.3971 cu. in. (6.507 c.c.)

Bore: 0.800 in. *Stroke:* 0.790 in.

Stroke/Bore Ratio: 0.9875 : 1.

Specific Output (as tested without muffler):

1.36 bhp/cu. in. (5% nitromethane fuel).

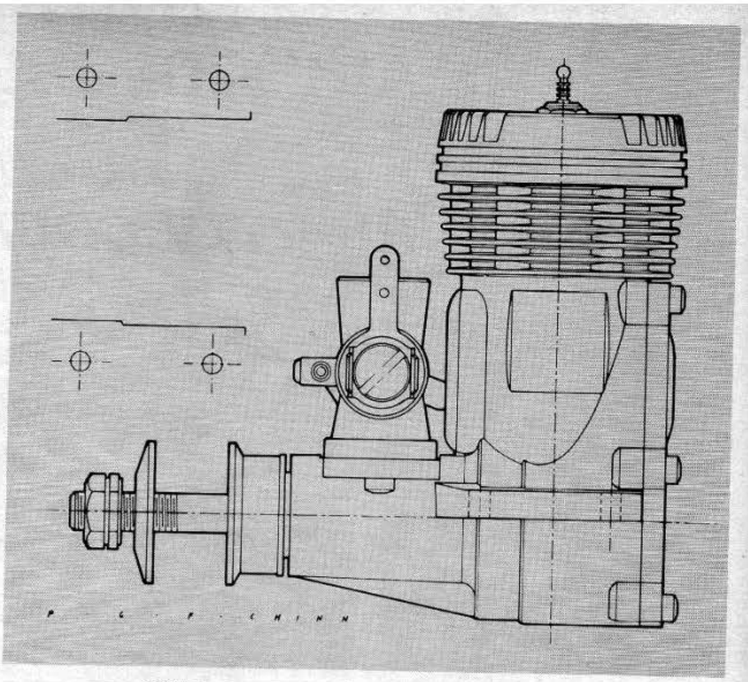
1.53 bhp/cu. in. (Fox Missile-Mist fuel).

ENGINE REVIEW

BY PETER G.F. CHINN

FOX .40 R/C

Latest Fox is entirely new model. Has some unusual features. Most powerful, throttle-equipped Fox 40 we've tested.

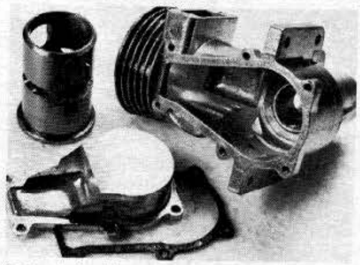


• Unlike automobiles, model engines are not generally identified by the year they were manufactured, but perhaps we can be excused for referring to certain Fox models this way. For how else do you prevent modelers from confusing the latest Fox 40 with the previous model which was also known simply as the "Fox 40"?

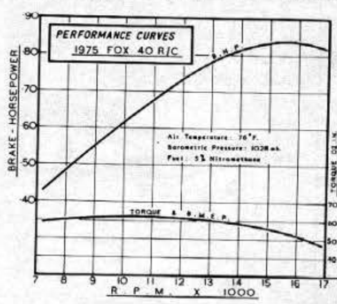
If a manufacturer makes no alteration in a new season's offering, other than to change the color of the cylinder head, there is obviously no justification in presenting it as a new model, but this certainly does not apply in the case of Fox engines. The current Fox 40, in particular, demands that we draw attention to the fact that it is a *completely new model*, quite different from the previous Fox 40 (featured in our March, 1972, "Engine Review", which was, itself, entirely different from all other Fox 40 models made over the past 14 years or so.

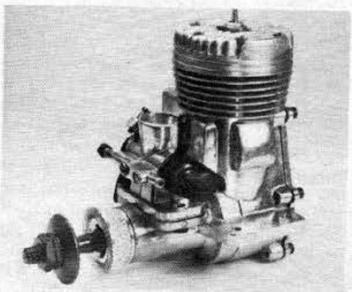
Now you may say, "So it's new and it's different. Is it better?" We think it is. Its performance shows an immense improvement. So far as our respective test samples are concerned (both were the standard R/C versions), the new model, running on a mild fuel (5% nitro), developed a 55% higher peak power output than the 1972 engine, and even when the older motor was fueled with Fox Missile-Mist, the 1975 engine, again running on 5% nitro, was still nearly 38% more powerful.

One thing that the 1975 Fox 40 shares with the previous model is its use of a plain bushed main bearing and a lapped cast-iron piston. In this respect it differs from all other .40 cu.in. R/C engines of comparable power output, most of which use ball-bearing shafts and ringed pistons. A ball bearing 40-BB version, with the option of a ringed aluminum piston or an ABC type piston/cylinder set-up, is also to be offered. Meanwhile, let's see what makes the standard 1975 40 R/C such a marked improvement over its predecessor.

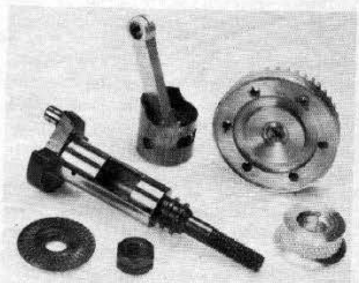


An exclusive Fox construction feature is 40's unique body casting with special backplate.





New 40 is ruggedly built and fairly heavy. Carb is Fox 60 type. Runs well on low nitro.



Large diameter crankshaft journal—note oil hole behind valve port, unusual piston design.

MAIN CASTING. The only thing that this has in common with the earlier type is its use of a cast in bronze main bearing bush. Whereas the older unit extended upward only to include the exhaust stack, the 1975 casting includes the finned cylinder casing, like most other current Fox motors. It also has the now familiar Fox rectangular flange mount for the carburetor.

Where it really differs from all other current designs is in its highly unorthodox "back door." Instead of having a conventional back-plate covering the crankcase portion only, the casting has a very much larger opening that exposes the back of the cylinder, including the rear bypass port as well as the actual crank chamber. This form of construction has been adopted to facilitate coring for the Schnuerle type bypass passages used by the new 40. The front bypass and the (side) third-port bulge are formed in the main casting itself, and the rear bypass is incorporated in the ex-

(Continued on page 85)

tended backplate which is attached with six screws. This unusual form of construction is the subject of a patent application by the Fox Company.

The crankcase is wider than before and calls for 1⅞" lateral bolt hole spacing. The exhaust stack is much narrower but deeper and has tapped holes fore and aft for an optional 1" long pressure cast stub pipe. This has an i.d. of 0.61" and an o.d. of 0.72", and it is anticipated that it may, in due course, be used in conjunction with a separate Fox muffler.

CRANKSHAFT. A feature of the previous 40—not fully exploited at the time in terms of valve port dimensions—was its very large diameter shaft journal. This size, at 9/16" o.d. (14.3 mm.), was the largest then used by any .40 engine and continued in the current model, is still one of the largest in use in this displacement group. However, the 1975 engine makes much better use of the shaft's 0.410" i.d. gas passage with an 0.510" long, rectangular valve port. This port, aided by a parallel-sided intake aperture through the bearing, gives an extended, rapid-opening, rapid-closing intake period of 185° of crank angle, timed (our measurements) from 45° after bottom dead center to 50° after top dead center.

The new shaft has an appreciably thicker crankweb and a heavier counterbalance, while the crankpin o.d. is unchanged at a nominal 7/32" and is much shorter. There is now a small oil hole at the rear of the journal, strategically placed so that crankcase compression is utilized to force lubricant into the vicinity where it is most needed, i.e. between the journal and the lower inner area of the main bearing where maximum loading occurs during the power stroke.

At the front end, the shaft has the familiar Fox short spline method of keying the prop driver, but has the shaft diameter increased at this point, compared with earlier models, in order to accommodate the separate, screw-in prop stud. The prop driver itself is of aluminum, although a steel one is available as an option. The prop stud thread is the usual ¼ UNF size.

CYLINDER & PISTON ASSEMBLY. The slip-fit, leaded-steel cylinder sleeve has a considerably thicker wall than has been customary with the Fox medium displacement motors. Actual wall thickness is .084" (compared with .050" for the previous 40) which, obviously, is helpful in maintaining effective port angles. The Schnuerle type scavenging system featured by the new Fox 40 consists of a fairly large unbridged exhaust port that is uncovered for a lengthy 150° of crank angle, a pair of angled main bypass ports, open for 122° and, diametrically opposite the exhaust, a very large third port that begins to open approximately 6° later than the main bypass ports for a total of 110° of crank angle.

The lapped, ringless piston is machined from Meehanite cast iron and is a flat-topped, deflectorless design with a third-port window and a skirt cutaway on the bypass side. The wristpin is located high in the piston, and this has enabled a longer connecting rod to be used without increasing overall engine height. The longer conrod, 1.5" between centers, has the advantage of reducing rod angle and, in turn, piston side-thrust.

Mainly due to thicker bosses, the piston is somewhat heavier than the earlier 40 piston and weights 13.2 gm. or just under 15 gm. with wrist-pin. The machined aluminum conrod adds a further 4 gm. It has a narrower lower-end eye than the previous model, but this is now bronze-bushed instead of plain.

CYLINDER-HEAD. Although the large, external diameter of the new 40 cylinder-head gives the impression that the engine has a larger bore than previous Fox 40's, this is unaltered. In fact, all Fox 40's produced to date have had the same bore and stroke (.800" x .790"); just as all Fox 35's and 36's have been .800" x .700" and .800" x .715" respectively.

The head is of pressure diecast aluminum with tapered cooling fins and is recessed to fit over the cylinder sleeve flange without a gasket. The head shape is a shallow cone with a small central depression surrounding the glow plug. Six Phillips screws tie the head to the main casting. The measured geometric compression ratio of the test motor was approximately 9:1.

CARBURETOR. The Fox carburetor fitted to the 1975 Fox 40 R/C is identical to that used by the Fox Eagle 60 and carries the same part number. It features a pressure diecast body; a machined steel, butterfly type throttle rotor; two needle-valves and an automatic fuel metering device to maintain correct mixture strength at all throttle settings. It works like this: Fuel is fed into the carburetor through an inlet nipple at the front on the left side. From here it takes two routes: First, fuel for the low-speed mixture is conveyed to an idling jet drilled directly into the carburetor throat, and the amount released through this is adjusted independently from the main needle-valve by means of a small needle screw at the front on the right-hand side.

Secondly, fuel for the main jet flows through a delivery hole in the carb body, well over to the left side, where it is picked up by a hole in the surface of the throttle rotor and conveyed to the interior of the rotor. From here it is discharged through the main jet located in the middle of the flat, center section of the rotor. The amount of fuel metered to this jet is controlled by the main needle-valve which is a large screw installed in the left-hand end of the throttle rotor.

When the throttle is partly closed, the pick-up hole in the throttle rotor is no longer exactly aligned with the delivery passage in the carb body. However, a tapered groove in the surface of the rotor, extending from the hole, allows a reduced quantity of fuel to be admitted into the rotor, and this automatically maintains a correct fuel/air mixture strength ratio in accordance with the throttle opening.

Further rotation of the throttle rotor towards the closed position eventually seals off the fuel supply to the rotor so that the engine now runs on its idling jet only.

In the previous model Fox 40 R/C, the carburetor was sealed into the crankcase intake boss with epoxy adhesive, and the throttle was linked to a semi-rotary exhaust restrictor valve. The current model has the carburetor flange mounted with two screws, and no exhaust restrictor is fitted.

PERFORMANCE. Each Fox 40 is supplied with an instruction and spare parts sheet that contains some good commonsense advice for the purchaser.

In the past, medium- and large-sized lapped-piston engines often took a tediously long time to break in, and when more ringed piston motors began to appear, many of us breathed a sigh of relief. However, lapped piston motors have improved a lot during the last ten years, and although the Fox instruction leaflet cautions new owners to take care to throttle back immediately if the engine shows any sign of sagging, we found the new Fox 40 to be commendably trouble free. We used a straight three-to-one mixture of methanol and castor oil during the break-in period, following our usual procedure of building up break-in time in a series of short rich-mixture runs, and within a very short period the 40 was holding peaked-out runs without the slightest sign of overheating or loss of power.

One thing that will please Fox's export customers is the 40's willingness to run perfectly on mild fuels. As the instructions point out, it will work quite well on fuel with no nitromethane. Our tests were carried out on our standard R/C engine test fuel which contains 5% pure nitromethane. Fox Superfuel can be expected to give much the same performance, while "Duke's Fuel," containing 10% nitro, should add another couple of hundred rpm to the top end.

Initial testing quickly showed the 1975 Fox 40 to have considerably greater torque than our 1972 model in the normally used rpm range. Maximum torque was indicated at between 10,000 and 11,000 rpm and was well maintained as load was reduced, resulting in a peak horsepower output of nearly 0.84 at between 15,000 and 16,000 rpm.

This is the highest figure we have recorded to date for a lapped piston, plain bearing, throttle-equipped 40 and (excluding Pylon racing types) has been bettered only slightly by a select few of the more expensive, twin ball-bearing ringed-piston R/C 40's.

Manufacturer's recommended prop sizes for the 1975 Fox 40 R/C are 10x6 (or 10x7 narrow blade) for average size 5-lb. R/C models. Checked on a Top Flite maple 10x6, our test motor indicated 12,600 rpm which was 1,400 rpm faster than was obtained on a similar prop and fuel with the earlier 40 R/C and still over 1,000 rpm faster, even when the latter had the advantage of Fox Missile Mist fuel.

Other prop rpm figures returned by the new 40 R/C included 10,000 rpm on a 12x4 Top Flite, 11,-500 rpm on an 11x5 Top Flite, 12,300 on an 11x5 Power Prop, 13,200 on a 10x6 Taipan fiberglass-nylon and 14,200 on a 9x6 Top Flite maple.

As regards running qualities, the 40 did not show quite such low vibration levels as have been indicated with the smoothest aluminum-piston 40's we have tested (not surprising, since an aluminum piston can be only about half the weight of an equivalent cast-iron one), but, as we have previously remarked, it ran very steadily, and this applied to a wide variety of prop sizes. Handling qualities were good, and starting, whether by hand or with an electric starter, presented no problems. For use with an electric starter, the manufacturer recommends the optional, steel prop driver in place of the standard, aluminum one.

Throttle response was very good. The engine idled happily at 2,600 rpm on a 10x6 prop with reliable recovery and good mid-range control. We also found the throttle control very easy to set up.

On all counts, we think that this is the best throttle-equipped Fox 40 yet produced—which is not to say, of course, that the 40-BB ringed-piston version will not be even better.

SUMMARY OF DATA.

Type: Single cylinder, Schnuerle loop-scavenged, two-stroke cycle with crankshaft rotary-valve and bronze-bushed main bearing. Throttle type carburetor with automatic mixture control.

Checked Weights: 11.5 oz. less exhaust stub.
11.8 oz. with exhaust stub

Displacement: 0.3971 cu.in. (6.507 c.c.)

Bore: 0.800". *Stroke:* 0.790"

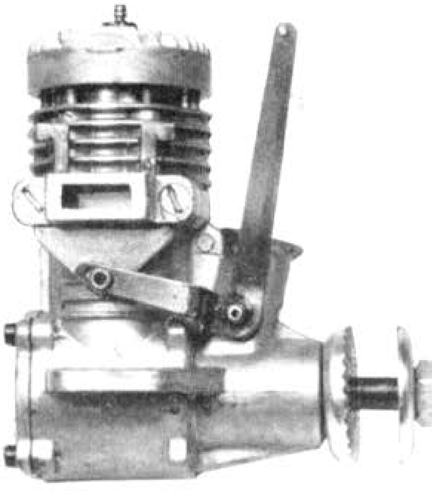
Stroke/Bore Ratio: 0.9875 : 1

Measured Nominal Compression Ratio: 9 : 1

Specific Output (as tested): 2.11 bhp/cu.in.

Power/Weight Ratio (as tested): 1.17 bhp/lb.

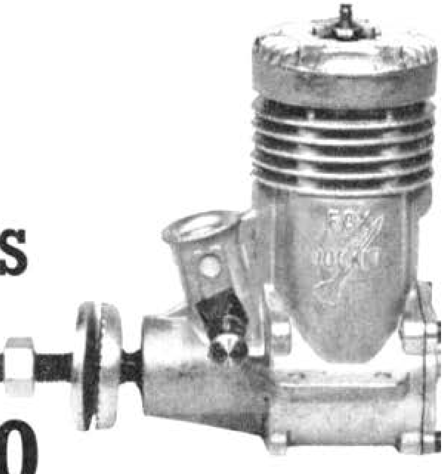
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901. ■



ENGINE ANALYSIS

Number 90

by R. H. Warring



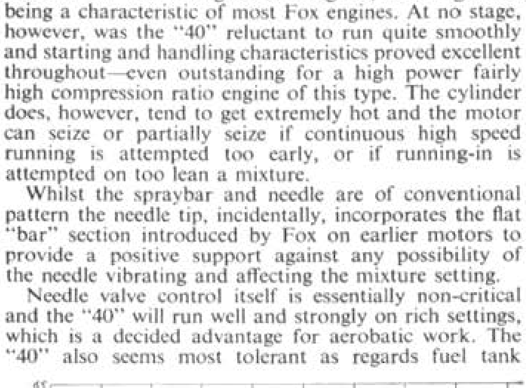
FOX 40

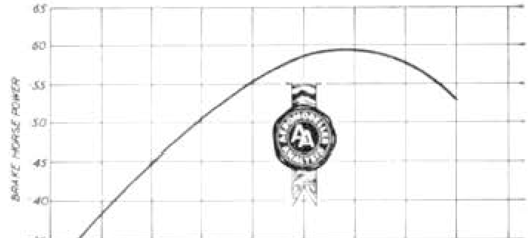
DUKE FOX HAS, from time to time, produced engines which have not necessarily been glowing with external glamour despite their obvious potential, but throughout has always maintained standards of workmanship in the best American tradition employing modern machines and techniques and paying particular attention to the internal parts and fits which really matter. The Fox 40 is a specially enlarged engine for control lino Rat Racing stunt and combat, of conventional design throughout, well planned and built, rugged and easy to handle. It utilises the same bore as the Fox "35" but with an increased stroke, resulting in an almost square engine.

Considerable running in time was found necessary to ease the "40" down to good running fits, initial tightness being a characteristic of most Fox engines. At no stage, however, was the "40" reluctant to run quite smoothly and starting and handling characteristics proved excellent throughout—even outstanding for a high power fairly high compression ratio engine of this type. The cylinder does, however, tend to get extremely hot and the motor can seize or partially seize if continuous high speed running is attempted too early, or if running-in is attempted on too lean a mixture.

Whilst the spraybar and needle are of conventional pattern the needle tip, incidentally, incorporates the flat "bar" section introduced by Fox on earlier motors to provide a positive support against any possibility of the needle vibrating and affecting the mixture setting.

Needle valve control itself is essentially non-critical and the "40" will run well and strongly on rich settings, which is a decided advantage for aerobatic work. The "40" also seems most tolerant as regards fuel tank





position, a change in vertical height of the tank position of several inches when bench running having no effect at all on mixture at speeds of 12,000 to 14,000 r.p.m. (Frank Warburton, has been first to recognise these qualities, and speaks highly of its potential for stunt.)

The torque curve as plotted on test showed a more rounded form than usual with very high torque developed in the 11-13,000 r.p.m. range, falling off markedly at lower speeds but being well sustained at the higher speeds. The "40" was not too happy running very slow—*i.e.* with 11 and 12 inch diameter propellers, but extremely consistent in performance at all higher speeds. Peak power as measured on test was just below .6 B.H.P. at 14,000 r.p.m., with maximum torque developed at 12,000 r.p.m. It thus appears well able to handle higher pitch propellers which glow motors—even large glow motors—do not always like, especially for static running.

Design and construction is fairly conventional, about the only outstanding features being the large diameter crankshaft and the quite thin cylinder liner employed—the former usual, and the latter unusual these days. Crankshaft diameter is a full ½ in., stepping down to a ⅜ in. diameter threaded length. Actual journal length is only one inch which does tend to exaggerate the appearance of the large diameter. The intake port in the shaft is rectangular—⅜ in. by 5/16 in., opening into a 11/32 in. diameter hole down the centre of the shaft. These dimensions are more or less consistent with what is becoming standard practice on engines of this size.

The crankweb is cut away and very heavily over-balanced, while the 7/32 in. diameter crankpin is long and stepped back so that it can be ground to finish, the shaft also being ground over the bearing length. Fit is quite close and very good in the bronze sleeve in the crankcase casting, forming the main bearing. A hardened steel propeller driver keys onto lugs formed on the shaft. The shaft itself is hardened and then relieved to some considerable degree. We are not entirely happy that the fairly abrupt step-down from the ½ in. major diameter to ⅜ in. propeller shaft diameter gives the strongest posssible insurance against crash damage, but lacking actual experience as to how the "40" stands up under really rough treatment we can hardly comment further on this point. Certainly the rest of the engine is really rugged and strong—without being excessively heavy—and seemingly capable of outlasting several airframes.

The crankcase unit is the "Rocket 35" silicon-aluminium die casting in light alloy with the crankcase and bore machined out. Transfer passage is cast in. Duplicated lugs on the front face of the crankcase emphasise that this design of casting is also utilised in further designs with detachable front unit, as for example the square intake, needle bearing Combat Specials.

The cylinder liner is of leaded steel, unhardened, and conventional in form. Exhaust ports are cut through the walls over a full 180 degrees, with a small bar providing support at mid length—*i.e.* two separate ports are cut leaving this supporting piece in the liner wall. Depth of these ports is 3/16 in. The single transfer port, whilst not so wide, looks enormous by comparison, having a depth of 5/16 in. The top of the transfer almost completely overlaps the exhaust.

Liner overall diameter is only .874 in. for a bore diameter of .800 in., which means that the walls are very thin. However, the fit in the crankcase unit is quite tight, so presumably it is reasonably well supported by the casting. It is located on a flange on top of the liner, clamped in position by six screws through the head. The head is a rather heavy die casting in aluminium alloy. Presumably the large volume of metal in the head and the small effective area of finning on the crankcase unit—rather more decorative than effective as cooling fins—contribute to the high cylinder temperature achieved when running.

Piston is of meehanite, machined to quite a thin walled section and is light for size. A flat plate deflector is formed on the top. Gudgeon pin is small—.155 in. diameter—is a floating fit and is hollow with brass eyelet type end pads. To remove the piston it is necessary to withdraw the gudgeon pin through a hole in the back of the cylinder jacket casting as it cannot be reached in any other way. A tight fitting liner is thus necessary in order to ensure that there is no gas leakage through this hole.

Connecting rod is machined from 24 ST aluminium alloy and then tumbled to finish, giving a matt appearance. Big end diameter is .2165 in., both big and little end bearings being plain. The bottom of the connecting rod only just has clearance in the bottom of the crankcase and had, in fact, been reworked to achieve clearance.

Unusual for an American engine, the cylinder liner appeared to have been finished by internal grinding. Certainly the chamfer relief at the bottom of the cylinder had been ground and with a set-up to do this it would appear only logical to grind the bore as well. The appearance of the bore after running was too rough to determine the original finish. Normal practice with Fox engines is to employ cross-hatch honing which does give a roughish appearance—an optical illusion, in fact, as far as judging the actual surface finish because of the nature of the marks made by the stones. In this case, however, we would not class the fit or finish as good, even after considerable running time, mainly because there appeared to be non-circularity either on the piston or liner bore. Possibly the liner is a little on the thin side and does warp or distort. Nevertheless the power output of the "40" was too high to suspect much loss through excessive friction in the piston-cylinder assembly, nor were there any signs of undue wear which would shorten the life of the motor.

The back cover is a light alloy pressure die casting, attaching with four screws in the conventional manner and sealing on a gasket. The centre of the cover has a stud extension which could be drilled and tapped if required, to form a pressure feed port.

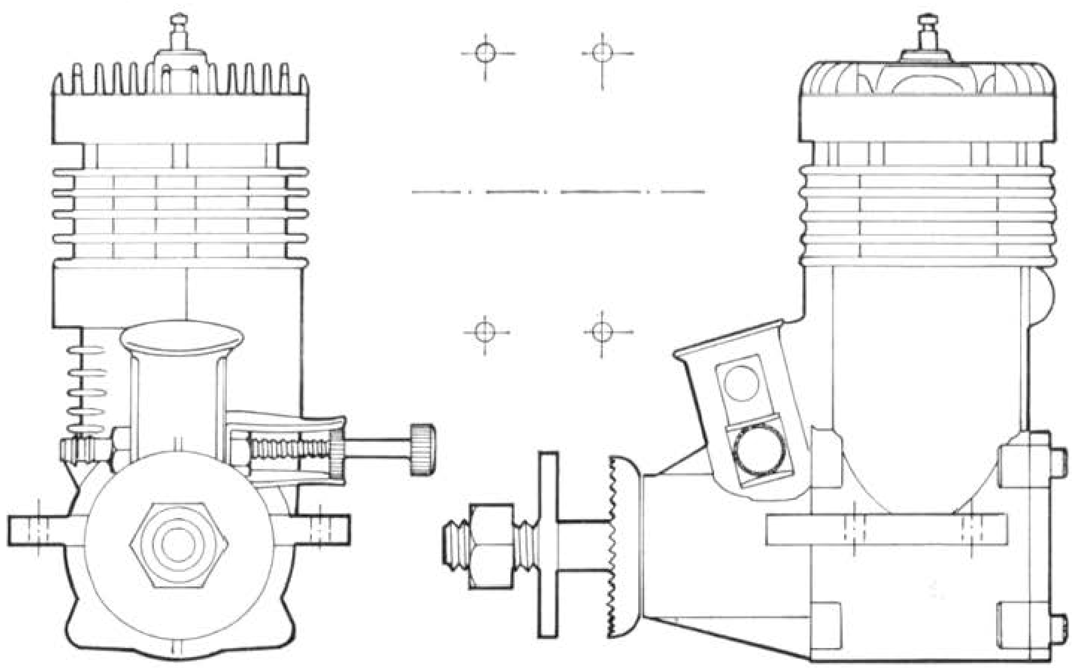
A turned venturi insert is fitted as standard in the choke tube, located by the spraybar. The spraybar is of brass with a steel needle, externally threaded.

Summarising, a sound, rugged engine with excellent starting and handling characteristics. Torque is well maintained up to 14,000 r.p.m., giving the "40" exceptional pulling power for a glow motor with peak power realised at 14,000 r.p.m. It should be an excellent choice for control line stunt and combat work with the larger sizes of models. The Fox R/C 40 (*illustrated opposite*) has a combined throttle and spraybar plus exhaust slide valve. Bradshaw Model Products loaned us this example from their new stock and it exhibits several minor changes.

PROPELLER—R.P.M. FIGURES

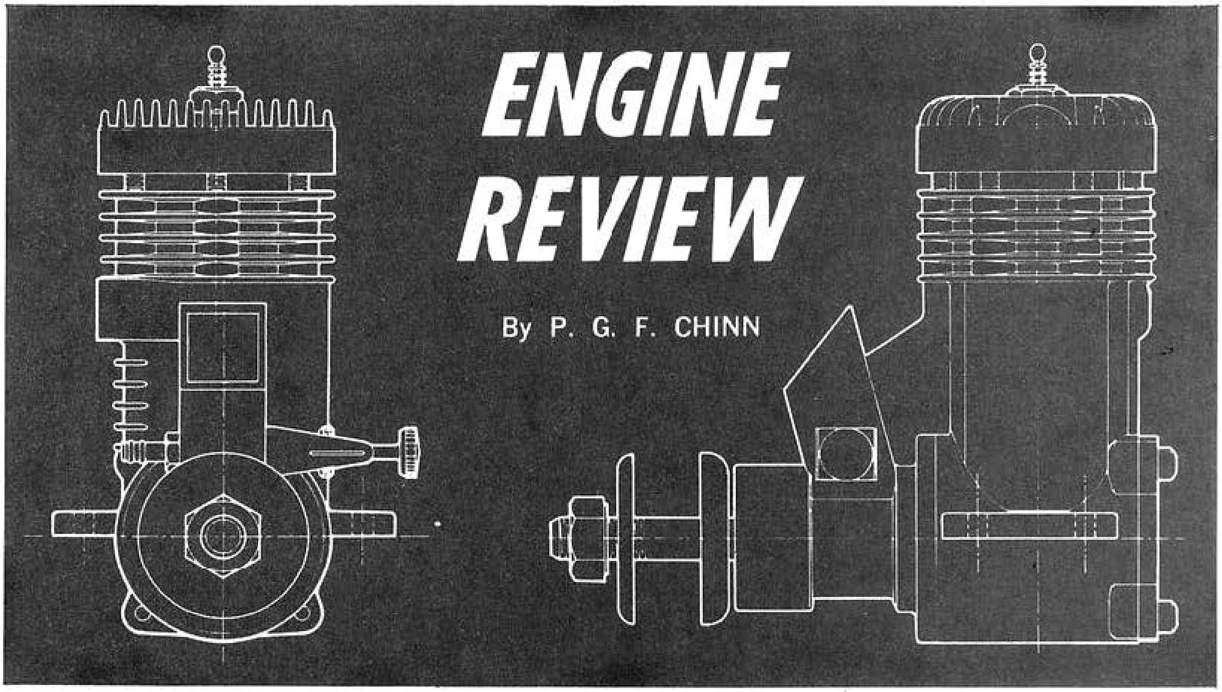
dia x pitch	*r.p.m.*
11 x 4 Top Flite	10,500
10 x 6 Top Flite	11,900
10 x 3½ Top Flite	13,400
9 x 7 Top Flite	11,800
9 x 6 Top Flite	12,800
9 x 7 Keilkraft nylon	11,800
9 x 6 Keilkraft nylon	12,000
9 x 4 Keilkraft nylon	15,800
9 x 6 Frog nylon	14,000
10 x 6 Frog nylon	11,700
11 x 4 Tornado nylon	11,200
11 x 6 Tornado nylon	9,000

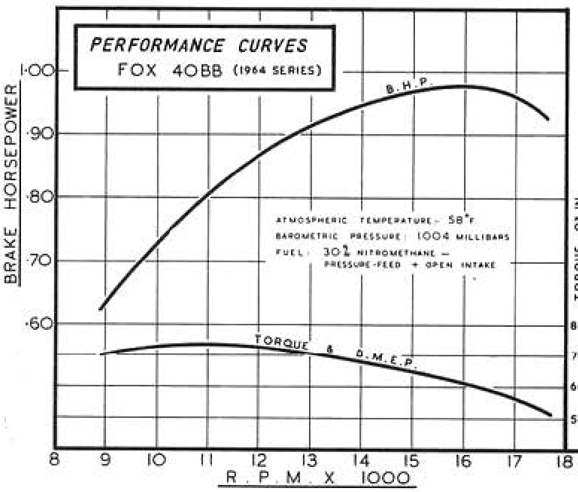
Displacement: 6·495 c.c. (·3961 cu.in)
Bore: ·800 in.
Stroke: ·788 in.
Bore/stroke ratio: 1·015
Bare weight: 7¾ ozs.
Max. Power: ·595 B.H.P. at 14,000 r.p.m.
Max. torque: 47 ozs.—inches at 11,500 r.p.m.
Power rating ·0915 B.H.P. per c.c.
Power/weight ratio: ·078 B.H.P. per oz.

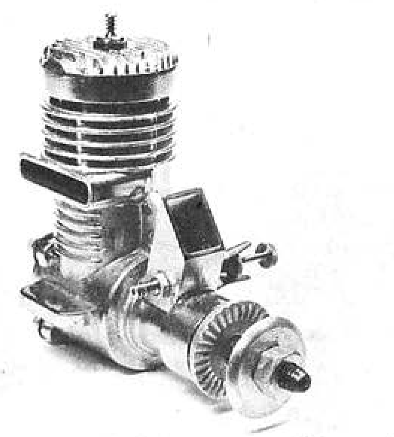


ENGINE REVIEW

By P. G. F. CHINN

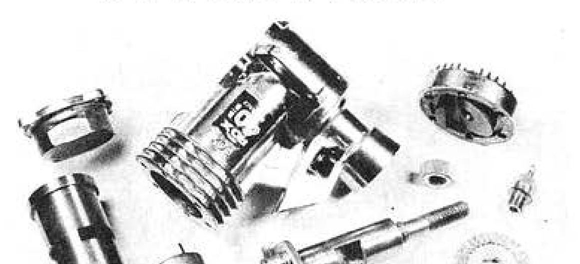






Easily distinguished by its gold-finished castings, Fox 40BB sports ball and needle bearings and has been evolved specially for rat-racing.

'64 FOX .40BB



Parts of latest 1964 Fox 40BB include new and stronger shaft, wrist pin.

OUR REVIEWER CLAIMS THE HIGHEST POWER/WEIGHT RATIO OF ANY ENGINE TESTED TO DATE FOR FOX'S LATEST POWERPLANT.

► Our test model of the "Golden" Fox 40BB was submitted direct by Duke Fox and was one of the improved 1964 models. Compared with the 1963 40BB, this has a number of changes, most of which are not externally visible.

Firstly, a new and stronger crankshaft is used. The intake hole through the shaft is now 0.340 in. bore instead of 0.375 in. and the crankweb, not quite so heavily cut away each side of the crankpin, is wider. The working length of the crankpin is now 0.300 in., instead of 0.250 in. to accommodate a wider conrod big end. A stronger wrist-pin is fitted, which has the same diameter as before, but solid, instead of hollow with brass endpads.

Modifications have also been made to the cylinder liner. The "picture-window" bypass port (*Continued on page 52*)

Round & Round

(*Continued from page 48*)

and after landing start the engines individually to determine which one has the bug. I never reach the point when an engine won't start. I throw away a lot of half-used plugs and replace a lot of reed valves but, boy oh boy, it is worth it."

Tony admits the twin is not a stunt plane, but it does steep climbs. He uses 25 feet of line on windy days. He has flown the little ship for nine months, and finds that it does not make any difference which engine cuts first.

"I've said a lot about my brainchild," Tony says, "but the most important thing is, she is reliable, consistent and a beginner can build her."

He thinks beginners will flip when they hear that twin-engine song, wants Sterling to make a twin-Ringmaster (Jr.) with a Dornier Do.217 or Messerschmitt Me.110 profile, with one piece gear on the wing. For a beginner he rambles on at freight-train length about such things as loving Cox .049's but not the "muffler" (we have an .09 throttle which is just fine), the Cox PT-19 which he rates tops for learning to fly on plastic models and he thinks some jobs could not be landed in one piece by a world champion. The guy is frank and we ain't no censor—if you'll pardon the vernacular.

Engine Review

(*Continued from page 20*)

has been abandoned and replaced by a new, shallower (0.184 in. instead of 0.312 in.) but slightly wider port. Exhaust port depth is very slightly increased. Exhaust timing is unaltered but the bypass period has been extended slightly.

As received, our 40BB was nicely loosened up and bore evidence of having been broken-in with the aid of a running-in compound. In reply to our enquiry as to whether this was normal practice, Duke Fox stated that, with 40BB's currently selling at $24.95, the factory can afford to take a great deal of care and attention in fitting and running them in and assured us that our test sample was typical of 40BB's presently leaving the factory. "All these motors have been carefully fitted and run until they come up to full power, stopped and hand-started several times," said Duke. "If they seem slow coming up to full power, we bring them back in and re-fit the cylinder and piston. Unfortunately, this amount of attention we cannot afford to give our lower priced motors." As part of the regular initial run routine, a little Lustrox polishing compound, mixed with oil, is introduced via the intake, the object being to smooth the working surface which should extend the life of the engine as well as bring it up to full performance more quickly.

Judging by the terrific performance of our 40BB (of which more anon) this extra attention has certainly paid off.

The 40BB is, of course, the successor to the original plain-bearing Fox 40 which first appeared in 1961 and was dealt with exactly three years ago in our October 1961 Engine Review. Apart from having the same bore and stroke and a general family resemblance to it, however, little of the original 40 is to be found in the 40BB.

The most obvious external change is in the adoption of a new crankcase and body casting, with a bigger front housing and cavernous rectangular air intake. The new casting is basically similar to that of the current Fox 36X and 35X models but has the lower and side webs on the crankcase nose omitted. Internally, the differences between the earlier 40 and the latest variant are more marked. In overall dimensions the new model is the same height, but is ¼-in. longer and 3/16 in. wider across the beam mounts, which also have wider bolt hole spacing. Weight has gone up by 8 percent to 8.2 oz, but this is more than compensated by the increased performance. The 40BB has, in fact, one of the highest power/weight ratios of any engine tested to date.

The 40BB has no startling new innovations. Obviously, the Fox recipe for success is continual experiment with, and development of, basic design concepts. The lineage of the present 40BB can be traced back through at least six .35-.40 cu. in. models over the past seven years. New variations on well-known Fox themes appear pretty frequently, and every so often one of them hits a really winning combination right on the button. If this sounds like a fearfully rule-of-thumb way of finding the ultimate engine design, let us say, right away, that nobody ever designed an internal combustion engine, model or full size, that was 100 percent right when it was built and couldn't be improved with further development. There have been plenty of expertly designed engines that, on paper, had everything, and, the more clever they were, the longer it took to get them to perform and keep on performing.

After this little disgression, let's have a quick look at the parts of the 1964 Fox 40BB.

If memory serves us correctly, the 40BB is the first regular production model Fox to have a ball-bearing since the 29R of 1956. (The Combat-Special and 35X dealt with previously in this series were, of course, needle-bearing engines). The 40BB has a ½-in. i.d. x 1⅛ in. o.d. 9-ball journal bearing supporting the rear end of the shaft. This is supplemented by ½ in. i.d. needle-roller bearing at the front end, having 27 needles running in direct contact with the hardened shaft journal. The shaft, incidentally, is now hardened all over, including the parts previously masked. Between the bearings, the shaft is an easy fit in the crankcase material and is extremely free running in the bearings. The shaft has a ⅜ in. square valve port which registers with a rectangular intake aperture in the main bearing to give quick opening and closing for the 200 degree intake period. Measured intake timing on our test engine was: intake opens 30 degrees after piston reaches BDC, closes 50 degrees after piston reaches TDC.

As we mentioned at the beginning, the "picture window" bypass port, which has been a feature of previous models, has been dropped and, by raising the top edge of the bypass port, exhaust lead has been cut in this latest 40BB to a mere 3 degrees —which is very short indeed. Actual measured periods of port opening on our test engine were: exhaust, 140 degrees; bypass, 134 degrees. The leaded steel cylinder sleeve is otherwise of typical Fox design and wall thickness is unaltered at .037 in. The Mechanite, lapped piston has a straight baffle, an internal annular stiffening web above the wristpin bosses and couples to the machined dural connecting-rod via the now solid 5/32 in. dia. full-floating wristpin.

The cylinder-head is identical with that of the previous 40 and 35X, deeply finned and featuring a wedge pattern combustion chamber. A glowplug of Fox manufacture is now fitted. Two .010 in. soft aluminum gaskets make the joint between the top of the cylinder liner and the cylinder head. Six screws secure the head. The backplate is fitted as standard equipment with a screw-in brass pressure fitted for connecting to a sealed, pressurized fuel tank. No venturi insert is fitted, although anyone wishing to convert the 40BB to suction feed could do so quite easily by fitting a 35X venturi insert and replacing the backplate nipple with a 3/16 in. 4-40 screw and fiber washer.

Although our 40BB was, for all practical purposes, ready broken-in as received, we added, in a series of 1 to 3 minute runs, a further one hour of running time to the engine prior to dynamometer testing. Starting was excellent at all times and the engine ran evenly and smoothly. One of the nicer features of modern high performance engines is that they are often just as easy to handle as a beginner's motor and the 40BB is a good example of this. Gone are the days when hard starting and vicious handling characterized the "hot" engine.

For our tests, we used the standard 30 percent nitro test fuel which we usually employ for tests on rat-racing and combat motors. The engine was hooked up to a Veco Series 31 pressure tank.

We started by loading the 40BB for a speed of just under 9000 rpm and an indication of the performance to come was immediately apparent in the high torque developed, at this speed, of nearly 70 oz. in. As load was reduced and speeds pushed up, torque rose to just on 74 oz. in. at 11,000 rpm before beginning to decline. At this speed the engine was already topping 0.80 bhp. It reached 0.90 bhp at 12,600 rpm and finally levelled off at nearly 0.98 bhp at 16,000. This, of course, is really excellent, especially as, so far as this particular motor is concerned, there would obviously be no difficulty in pushing power up above the magic 1-hp mark with a still hotter fuel.

Incidentally, we have heard of some rat-racing fiends propping their 40BB's for speeds of around 20,000 rpm on 50-50 percent nitro fuel, although, on the strength of our tests, it would seem that, even allowing for, say, a 1,000 rpm higher peaking speed plus another 1,000 rpm for better acceleration, 18,000 would be a more realistic in-flight maximum. However, the final proof of the pudding is in the flying, and, if modelers get more speed by using smaller props than the recommended ones (which hold rpm nearer to our test curve peak), we are not arguing. . . We'll merely say; please avoid weak props and don't be in the line of fire when an overstressed prop throws a blade!

Rat-racing apart, with nearly 2 horsepower per pound weight, the 40BB ought to make quite a potent piece of Class C free-flight machinery. We checked it out on one of two free-flight props and recorded 12,500 on an 11x5 Top-Flite wood, 14,700 on an 11x3 Top-Flite wood and 16,100 on a 10x3½ Top-Flite wood.

Summary of Data

Type: Loop-scavenged two-cycle with shaft rotary-valve induction.
Weight: 8.2 oz.
Displacement: 0.3971 cu. in. or 6.507 c.c.
Bore: 0.800 in. Stroke: 0.790 in.
Stroke/Bore Ratio: 0.9875 : 1
Specific Output (as tested): 2.46 bhp/cu. in.
Power/Weight Ratio (as tested): 1.91 bhp/lb.
Price: $24.95.
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas.

The "Show-biz" Club

(*Continued from page* 15)

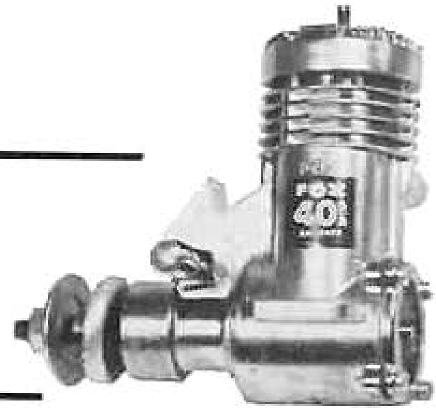
worth it. Last year demonstrations were arranged by the Rib Crackers own promotion. This year they are invited to put on their shows!

Such was last year's flying show at the Michigan State Exchange Club Contest held at the Ford Motor Company Test Track in Dearborn. The boys then flew Ringmasters, Busters, etc.—now there's special air show jobs like the Foxy bipes.

This year 9,000 attended the Michigan State Model meet. The Rib Crackers put on two 1-hour shows. Some 1,000 people took in that demonstration. Other demonstrations were slated, as this is written, for the Grosse Isle U-Control contest in August, and the Livonia Municipal Exposition, Showtrain. The list of dates undoubtedly will grow. Spectator comments center upon the fancy footwork of the six-man combat team, and on the grim faces!

"This club is an outstanding example of what interested modelers are capable of doing if they are given the chance to do it," says club president Joe Ziomek. What the Rib Crackers are capable of makes quite a list of solid achievements, from which the air show demonstration naturally has stolen the spotlight.

The Second Annual Greater Detroit Model Cavalcade, a sort of General Model Conference along the lines of RC's Toledo Conference, holds great future promise. The first Cavalcade, March 3, 1963, in-



Data	
SPECIFICATION Displacement: 6.49 c.c. (.394 cu. in). Bore: .800 in. Stroke: .790 in. Weight: 8 ounces. Max. power: 76 B.H.P. at 15,600. Max. torque: 55 ounce-inches at 12,000 r.p.m. Power rating: .117 B.H.P. per c.c. Power/weight ratio: .095 B.H.P. per ounce.	PROPELLER—r.p.m. figures *Propeller* — *R.P.M.* Top Flite: 9 x 6 — 14,200 (15,300 on Fox *Blast*) 10 x 6 — 12,400 (13,200 on Fox *Blast*) 9 x 7 — 13,300 Keilkraft: 8 x 6 — 16,800 9 x 6 — 13,300 9 x 7 — 13,600 Frog nylon: 9 x 6 — 15,300 *Fuel:* 30 per cent nitromethane *All B.H.P. curve figures extracted on Fox* Blast *fuel* (30% *nitro*)

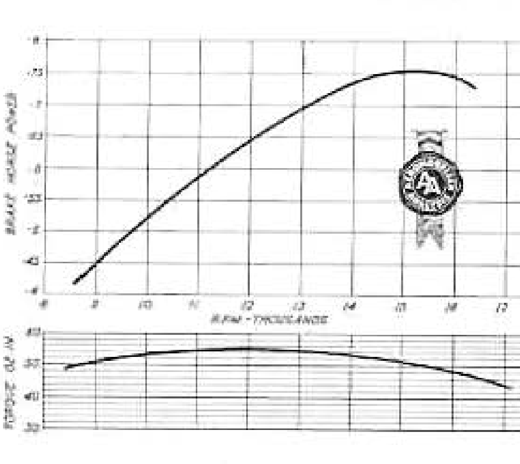
ENGINE ANALYSIS No 116 by R. H. Warring FOX 40 BB

THE Fox 49 BB is a real "man's" engine specifically developed for rat racing and to the maximum displacement permitted by the AMA Rat Race Rules. Like all Fox engines it has a general look of ruggedness and honest model engineering, despite an overall "gold plating" externally applied as a further distinguishing feature. This, in fact, only serves to emphasise rather than mask the "engineering" finish of the castings on what is essentially a "workhorse" of a power unit rather than a sleek production for mass appeal. Performance-wise the Fox 40 BB is quite capable of speaking for itself, almost literally by its noise level, and by power output.

Although essentially a specialist engine for the more enthusiastic modeller the Fox 40 BB is by no means difficult to handle. The fantastically large induction port coupled with complete absence of effective suction demands a pressure fuel feed (or gravity feed for bench running), but starting characteristics are very good. With a pressure tank, starting from cold can usually be accomplished in two or three flicks at the most, following a generous prime. Re-starting with the engine hot is almost immediate without priming.

With a gravity feed set-up for bench running flooding is a distinct possibility unless provision is made to shut off the fuel supply until a moment or two before starting (and immediately on stopping again). The most satisfactory answer in this case is a tap in the fuel line or a pinch-type clip used on flexible (neoprene) fuel tubing and a similar device is, in fact, recommended by Fox for inserting between the pressure tank and the spraybar in a typical model installation. Closing the fuel line then prevents any possibility of flooding the engine when refilling the tank at pit stops.

Like a good many "racing" glow motors designed to run on high-nitro fuels the Fox 40 BB is pretty hard on plugs. Long reach plugs are specified and it is very much a matter of finding which particular plugs will stand up best to the fuel being used. On low-nitro fuels plug life is fairly reasonable but with high nitro fuels a plug blown per run is not unusual, although having found a plug which will stand up to a run or two it will usually last for some time. The surest way of blowing a plug seems to be leaning the mixture right out for absolute peak performance. The power loss adjusted for a slightly richer setting is negligible—and certainly less expensive.



Two handling features we did not particularly like, both relating to matters of detail design. The propeller driver, we feel, is too coarsely knurled and it is difficult to get a tight enough grip on the prop. hub. As a consequence we found prop slipping relatively common when starting. The other "fault" lies in the needle valve which is somewhat difficult and almost painful to adjust (with adequate spring locking tension) due to the small knob.

Another limitation from the handling point of view is that with the very high power output and almost "explosive" starting certain types and sizes of propellers can only be regarded as unsafe to use with the Fox 40 BB. This, in particular, limited the number of test propellers we felt it safe to use, especially as many have by now been subjected to considerable hard wear. Duke Fox also mentions that certain propellers (e.g. the Tornado 8 x 8) have a habit of shedding blades.

Logical prop sizes for rat racing are 8 x 8 or 8 x 9, which should allow the Fox to turn some 13,000 plus r.p.m. on the ground and reach peak r.p.m. (about 15,500) in the air. Fuel makes quite a difference to performance, the design being more or less "balanced" to a 50 per cent nitro content (e.g. Fox *Blast*), giving some 1,000 r.p.m. up to a 30 per cent nitro mixture on an 8 x 8 or 9 x 6 prop. The Fox 40 BB, rather surprisingly, starts and runs quite well on a straight methanol:castor mixture, although holding nothing like the same peak.

Design-wise the 40 BB follows very much the layout of the earlier Combat Special, and is largely conventional except for the very large square intake with parallel section. The crankcase unit is a single, substantial pressure die casting incorporating the induction tube, cylinder and race housing. Porting is conventional, with a single transfer passage on the left side and a diametrically opposite exhaust opening nearly 180 degrees.

The cylinder liner is of soft steel, extremely thin walled for an engine of this size and with enormous rectangular port openings. Transfer opening almost completely overlaps the exhaust. Both ports are approximately 170 degrees wide and the transfer port is 5/16 in. deep, leaving very little metal carrying the upper part of the liner. The liner is, however, very well supported in the crankcase unit. The liner is held down by six screws through the finned (die cast) head of substantial mass for heat retention, the combustion chamber being contoured in "racing" fashion for most efficient gas flow—at some

expense, we feel, to increasing the mechanical loading on the glow plug element.

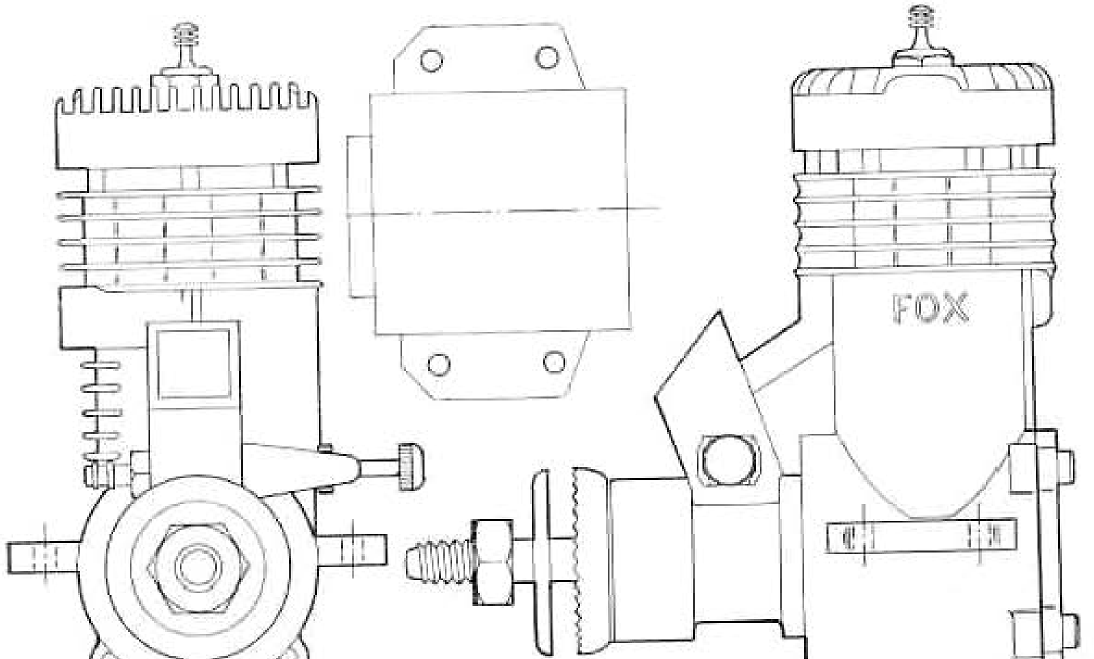
The piston is of cast iron machined away to very thin walls as well as being scalloped on the skirt. Top is flat but with a high, narrow deflector, slightly chamfered to the edges. The fully floating gudgeon pin is hollow, of hardened steel, with brass end pads. Certainly liner and piston appear to have been taken down to limits of material thickness for lightness and with particular attention given to port development and gas flow.

The ½ in. diameter crankshaft is of steel, hardened over the journal length and crankpin but soft over the forward ¼ in. diameter threaded length and crank web. It is carried on a ½ in. ball race at the rear and a ½ in. roller race at the front, the latter being of the cageless type with the rollers simply retained by end flanges. This permits a minimum diameter housing. The main rear race is also unusual in having rather wide ball spacing. The plain length between the races is only lightly rubbed by the shaft and provides an oil seal.

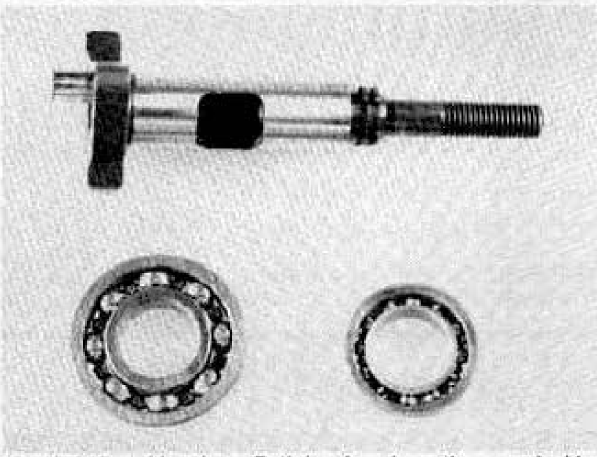
Shaft port opening is ⅜ in. square, entering a ⅜ in. diameter shaft hole—an effective entry area of 0.11 sq. in. Finish over the journal length is ground but showing some evidence of fretting at the race positions after about three hours running. Immediately in front of the journal length the shaft steps down abruptly to ¼ in. diameter on which is formed the castellated key for the prop driver and then the standard thread for the prop nut. Relief of hardness is taken right back to the square front of the ¼ in. diameter length so that in a bad crash the front shaft could, presumably, bend instead of break. The crank web is quite thick, but heavily chamfered and cut away for counterbalance. Sharp edges are also taken off on the rear face. Crankpin is 0.215 in. diameter. The connecting rod appears to be a light allow die casting, machined around the big end to reduce to a satisfactory clearance size.

The crankcase rear cover is a light alloy pressure die casting attached by four Phillips head screws and sealing on a gasket. The centre is drilled and tapped for a brass pressure nipple fitting. The spraybar is of brass with a steel needle and integral thimble, the whole unit being a little on the flimsy side for an engine of this size and duty (it is difficult to tighten it up properly without fear of stripping the threads holding the retaining nut, for example). The needle end features the Fox-originated spade protrusion to centre the taper needle against vibration. The propeller driver is of steel, with a shaped hole to lock on the shaft. A standard nut and washer complete the assembly.

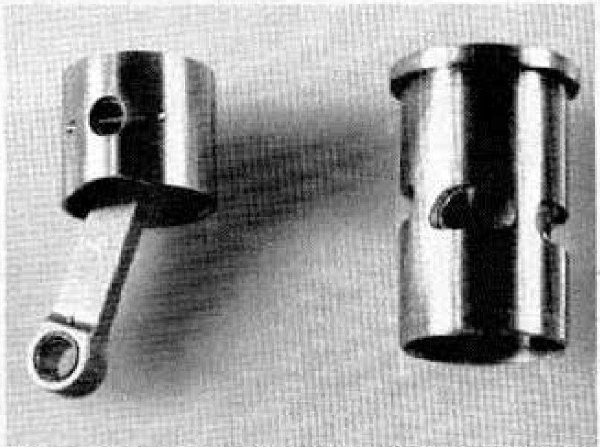
Altogether, the Fox 40 BB is a more or less orthodox design of engine with somewhat exaggerated porting, especially on the induction side, demanding that fuel be fed to the engine rather than be sucked in by it. It relies for its performance on inducting and consuming a vast quantity of fuel, and using it efficiently—which is where Fox "know how" comes into play with regard to details that make all the difference. The 40 BB, in fact, exemplifies just what can be done through years of experience and development in the matter of extracting more B.H.P. per c.c. from a basic engine layout and tailoring an engine to a particular requirement; and whilst we may disagree with certain details, results speak for themselves. Relatively few designers other than Duke Fox would have got anywhere near the same figures.



Engine Clinic CLARENCE LEE



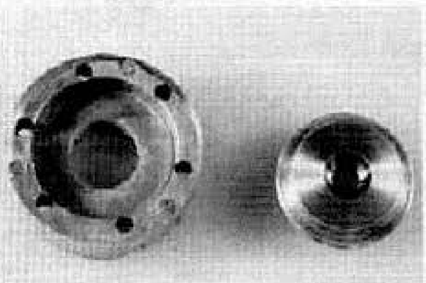
Crankshaft and bearings. Both bearings have the same inside diameter, but note difference in outside diameter.



Piston and sleeve assembly. Note hole in side of piston near wrist pin for roll pin to retain the wrist pin.

Fox 40 BBRC
Delux Specifications
Type: Single cylinder, 2-stroke cycle, Schnuerle ported, glow ignition.
Bore: .840"
Stroke: .715"
Displacement: .3962 cu. in.
Compression ratio: 7.62:1
Weight: Bare 9.6 oz. — with spinner 11.1 oz. — with spinner and muffler 12.2 oz.
Manufacturer: Fox Manufacturing Co., Fort Smith, Arkansas

According to the hobby dealers, the .40 cubic inch displacement size 2-stroke engine is the most popular selling R/C engine. Not too well-known is the fact that Duke Fox was the first model engine manufacturer to market a .40 size U-control engine in 1961, following a year later with an R/C version. The .40 size engine actually evolved from an earlier .35 size engine with Duke Fox again being the first model engine manufacturer to market an engine in this displacement size. The first Fox .35 appeared on the model market in 1949. Over the years, Duke Fox has manufactured a large variety of .40 size engines, always gaining knowledge and making improvements along the way. Earlier this spring Duke introduced his latest .40 size R/C engine which, according to Duke, is the product of 10 years of refinement of this particular .40 design concept, i.e., a Schnuerle ported engine. This latest .40 size engine is also Duke's first ABC piston/liner engine. Prior .40 size engines have been of lapped iron piston and steel sleeve construction. Although the present engine is of true ABC construction, i.e., a high silicon aluminum piston running in a chrome plated brass liner, those reading the Fox advertisements for the engine will have noted that the engine is listed as having a composite piston design utilizing an oil absorbing iron band to aid upper cylinder lubrication. However, early release U-control engines exhibited some problems with the iron band sticking up on extremely lean runs and pulling off of the aluminum piston, so this feature was discontinued and all engines with the composite pistons were recalled. Fortunately only a couple of hundred engines had been released before this problem was discovered and corrected. No matter how hard an engine manufacturer tries to outguess any anticipated problem areas in a new engine design before release of the engine, the final proof is when the engine gets into the hands of the modelers who can usually figure out some way of coming up with a weak point in an engine design. However, Duke Fox has always stood 100% behind his product and if a problem area does show up, he is quick to make changes including no charge modifications to those engines already sold. This is something that cannot always be said of some of the foreign imports as many fellows are finding out the hard way when trying to get warranty service on their engines.

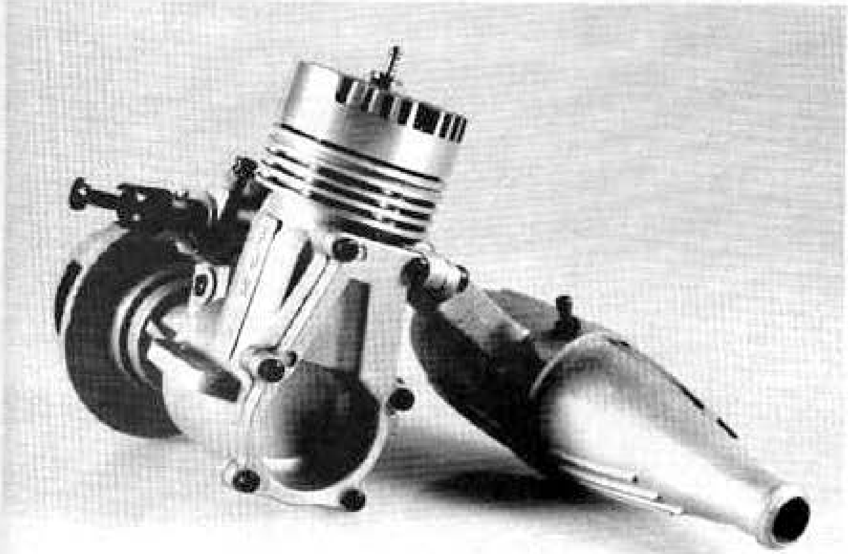


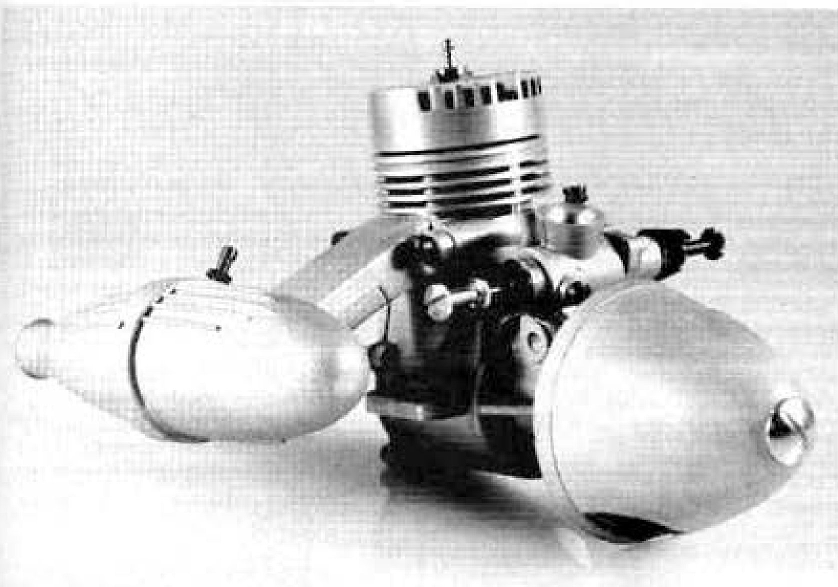
Two piece head assembly. Head button very wide squish area surrounding small combustion chamber bowl.

This past month I received one of Duke's new Fox .40 BBRC Delux engines for evaluation and, in Duke's own words, ". . . observation, testing, use, destruction, or whatever else may please you." I am quite happy to say that the engine performed beautifully in all performance areas with no problems whatsoever encountered.

The first thing that one will notice about the new Fox .40 Delux, besides the very light weight (only 12.2 ounces complete with spinner and muffler), is the unusual back cover design. Rather than a conventional back cover that most modelers are familiar with, the Fox .40 back cover extends all the way up to the bottom of the cooling fins. Duke feels that this type of block shape crankcase design has the advantage of lessening the stretching stresses imposed by the combustion process from the mounting lugs up to the top of the case, resulting in an

more accurate bearing concentricity is maintained. This is sometimes a problem when centerless grinding crankshafts follow the heat treating process. Even though both bearings have the same i.d. dimension (.500), the rear bearing is of considerably heavier construction with an o.d. of 1.125" whereas the front bearing has an o.d. of .875" and was specifically made for the Fox application. Another nice feature of the .40 Delux





Fox .40 BBRC Delux.

overall stronger crankcase.

Unlike the Fox .40 BB Compact that uses a single rear ball bearing for crankshaft support, the new .40 BB Delux utilizes both a front and rear ball bearing. However, rather than the front of the crankshaft stepping down for a smaller inside diameter ball bearing, both the front and rear bearings have the same i.d. By eliminating the front bearing step,

crankshaft is a removable prop stud so that in the advent of a crash and possible bending of the crankshaft, only the removable stud need be replaced rather than the whole crankshaft.

The Fox .40 Delux is of Schnuerle port design with single transfer ports on either side of the exhaust port, but utilizes an extremely large boost port opposite the exhaust port. The single boost port actually has the same width as the single exhaust port but is angled upward to direct the incoming air/fuel mixture into the combustion chamber. Something not previously seen before in a model engine is the method of retaining the tubular steel wrist pin in the aluminum piston. A small hole has been drilled through the side of the piston wall and the wrist pin boss 90° to the wrist pin axis, and a 1/16" roll pin is pressed in, locking the wrist pin into place. Needless to say, if it should be necessary to replace the connecting rod it would be best to return the engine to the Fox factory rather than attempting removal of the roll pin on one's own. However, since the rod is fabricated from 2024 bar stock aluminum and bronze bushed at the crank pin end, it is very unlikely that it would need replacing very often due to wear. A bad crash would more likely be the reason for replacement, in which case the engine should be returned to the Fox factory for service.

The engine uses a two piece head assembly consisting of the finned section and separate combustion chamber button. The combustion chamber shape is a bit different in that it is completely flat bottomed with a small hemi shaped dome in the center where the glow plug screws in. This would appear to be an extremely wide squish band; however, the distance from the top of the piston to the head is such that little or no squish action would be taking place. This combustion chamber shape, in conjunction with other design features, did make for a nice broad high speed mixture adjustment range, easy starting, and excellent idle.

For carburetion, the Fox .40 Delux uses a rotating barrel, two-needle type design which is the same basic design as the well-proven Mark X carburetors used on the large displacement Fox engines. The rotating barrel features a high spiral action wich means that it has considerable in and out action as it is rotated. This helps to make the carburetor self cleaning and foreign matter that might clog up other types of carburetors can be passed right through.

The Fox .40 BBRC Delux comes equipped with both a muffler and spinner. The muffler is of the tilt-down design as most modelers seem to prefer this type. However, if your particular installation would work better with a tilt-up style, the mufflers can be exchanged by mailing the original back to the Fox factory. The spinner supplied with the engine has the nice feature of the spinner backplate being broached to match drive splines on the crankshaft, i.e., the spinner backplate also serves as what would normally be the prop drive washer with no separate drive washer being used. This completely eliminates any spinner backplate slip. If you choose to operate the engine without the spinner, a standard prop drive washer is also available.

With the basic technicalities out of the way, let's get to the engine's performance. One very nice advantage of all Fox engines is that they are all factory run and the carburetor adjustments made before shipment. Fox has even designed their display box so that the engine can be boxed with the needle valves in place and adjusted so that the modeler need only install the engine in his aircraft and fly without ever touching the mixture needles. This is a great help for the beginning modeler who many times has a difficult time finding the initial needle valve setting for starting, etc. So, without touching the needle valve settings, the engine was installed on our test stand and using a fuel consisting of 10% nitromethane, 19% Klotz KL-200, 3% castor oil, and balance methanol, was started.

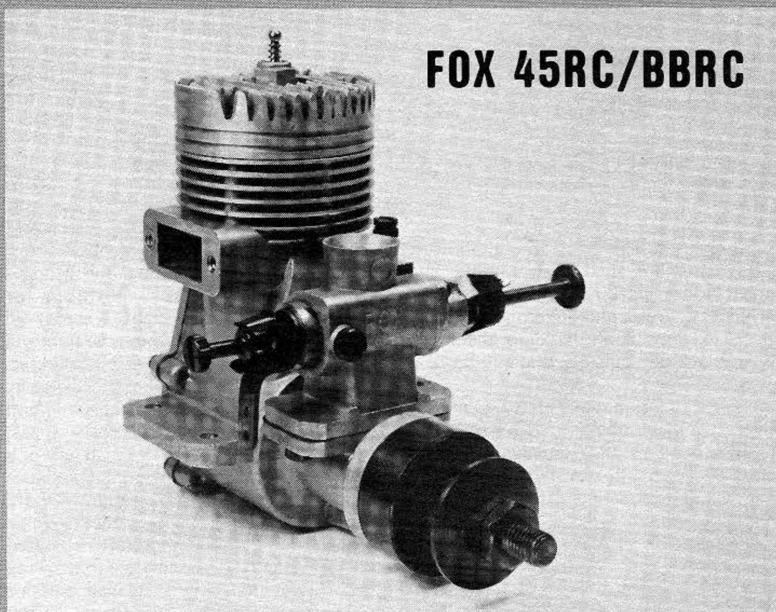
The engine fired first flip after choking and connecting the starting battery which always wins points with me. The factory adjustments did prove to be somewhat on the rich side which would certainly be desirable for a new engine and a setting that would easily give the engine enough power to fly a sport/trainer type aircraft. Even though previously run by the factory, the engine was given an additional 30 minutes of break-in time varying the mixture between rich and lean with several cooling off periods between runs. Following the loosening up period, we were able to record 14,700 with a 9 x 6 Rev-Up, 14,500 with a 9 x 7 Rev-Up, 13,400 with a 10 x 6 Rev-Up, and 10,900 with an 11 x 6 Rev-Up. These are all very respectable figures, especially when the temperature was 78° and relative humidity 60% on the day we ran the engine. Hot, humid days are not ideal conditions for engine testing, but this time of year here in California (early May), we do not have too much choice.

The engine would hold a reliable 2,250 idle with the 10 x 6 prop and 2,150 with the 11 x 6 with excellent recovery and the engine was very smooth vibration-wise. It is one of, if not the, smoothest running .40 size engines I have ever run. Duke Fox terms his new engine "user friendly" and we would have to agree. It is a neat running and handling engine. Duke is quite proud of his new engine and justifiably so.

★

ROUND-UP

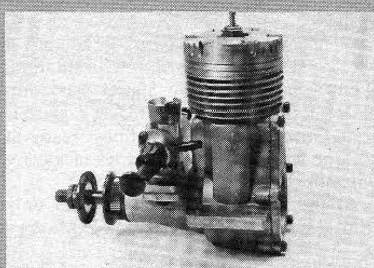
by Peter Chinn



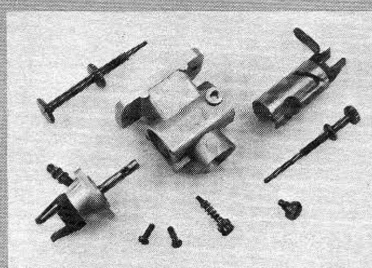
Fox's distinctive looking twin ball-bearing 45BBRC has been modified and improved.

SPECIFICATIONS

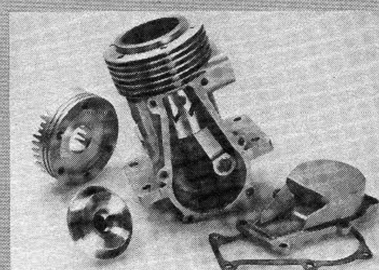
Type: Air-cooled, single-cylinder, side-exhaust, two-stroke-cycle with crankshaft rotary-valve and Schnuerle scavenging.
Bore: 0.850 in. (21.59 mm)
Stroke: 0.790 in. (20.07 mm)
Displacement: 0.4483 cu in. (7.346cc)
Measured Compression Ratios: 11.5:1 (45RC); 12.0:1 (45BBRC).
Speed Control: Fox Mk. 10-A carburetor
Checked Weights: 338 grams—11.9 oz (45RC); 357 grams—12.6 oz (45BBRC).
Manufacturer's claimed power output: Not stated. See text.
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, AR 72901.



Fox can also be obtained in bushed bearing 45RC model as shown here.



45RC and 45BBRC are both fitted with new Fox Mk10-A automatic mixture carb.



Fox's unusual backplate is retained. Two-part head is new, as is the bushed rod.

• The Fox 45 was introduced in 1975 in both plain (bronze bushed) and twin ball bearing models, and the latter was the subject of a full test report in the March 1976 issue of *M.A.N.*

A few months ago (May 1980), upgraded versions of the 45 and 45BB (together with the smaller bore 40 and 40BB models) were announced and, although model numbers (24500 for the 45RC and 24600 for the 45BBRC) are unchanged, the 1980 motors differ considerably from the earlier engines.

The first thing that Fox enthusiasts will notice will be the modified external appearance. There are changes to the main castings, a new cylinder head and a new carburetor.

Main castings. These continue the unconventional "back door" of the original design, but the dies have been modified to provide a full-length third port channel instead of the short chamber of the earlier model, and both the plain and BB versions have lengthened crankcase noses. The new units also have the edges of all but the bottom two cooling fins machine finished, reducing fin diameter from 1.67 in. to 1.55 in., and the casting finish is now matt instead of tumble polished.

Cylinder-liner and piston assembly. The cylinder liner, with its unusual Schnuerle porting system featuring four long angled bypass ports and twin "third" ports, has undergone some modification. Whereas our original test engine had a 120-degree main bypass period with the third ports opening for only 104 degrees, the new model has all six ports opening for 112 degrees of crank angle. The exhaust period is unchanged at 150 degrees.

The ringed aluminum piston no longer has a skirt port since the full-length third port channel makes this unnecessary. The connecting rod, which formerly had plain eyes, is now bronze bushed at both ends and the lower end bearing width is in-

(Continued on page 90)

creased from 0.282 in. to 0.320 in. The rod also has an angled oil hole at each end to feed lubricant to the loaded side of the bearings, instead of outer oil slits.

Cylinder-head. Whereas the original engine had a conventional one-piece head with a shallow conical combustion chamber, the new motor has a two-part head, consisting of a machined bar stock central insert, or "button," held in place by a finned outer component secured to the main casting with six screws. The insert has a sloped squishband that merges into a deep trumpet-shaped combustion chamber. Measured combustion chamber volumes for the 45BBRC and 45RC checked out at 0.67cc and 0.70cc respectively, giving nominal geometric compression ratios of approximately 11.5 and 12.0 to 1, compared with only 8 to 1 for our earlier test motor.

Crankshafts. To match the longer crankcases, both the 45 and 45BB have lengthened crankshafts. The shafts also have longer crankpins to match the wider conrod.

Carburetor. In addition to their new crankcases and cylinder head, one other feature clearly sets both models of the new Fox 45 apart from their predecessors: the Fox Mark X carburetor. This new carb, as was explained in our write-up on the Fox Twin in the July issue, breaks with a Fox tradition. It uses a barrel throttle rotating in a helical movement around a fixed spraybar in which a secondary needle moves to control mixture strength at various throttle settings. In other words, it works like a number of other adjustable automatic mixture control carburetors, thereby making it easier for the average modeler to adjust, even though its construction is a little different and it still uses Fox's unusual flange mount type installation. These carbs are made in different choke sizes, and the Fox 40 and 45 engines are fitted with the Mk.X "A" size having a 0.290 in. diameter throat.

When we tested the original Fox 45BBRC for *M.A.N.,* a peak output of just over 1.00 bhp was obtained at 15,500 rpm on 15 percent nitro fuel. Using our standard 5 percent nitro test fuel caused the power curve to flatten out much earlier and a consequent reduction in peak output of about 10 percent. We attributed this to the original engine's low compression ratio at a time of testing when air temperature was relatively low. The much higher compression of the new engine and its better combustion chamber shape should mean that it will run well on 5 percent or even on no nitro at all, although, naturally, one of Duke Fox's own nitro fuels can be expected to give a worthwhile increase in performance.

These engines are just a trifle heavier than the models that they replace but, as the foregoing notes have indicated, they should be both more powerful and more durable. They are also better finished and better looking.

Will it fit?

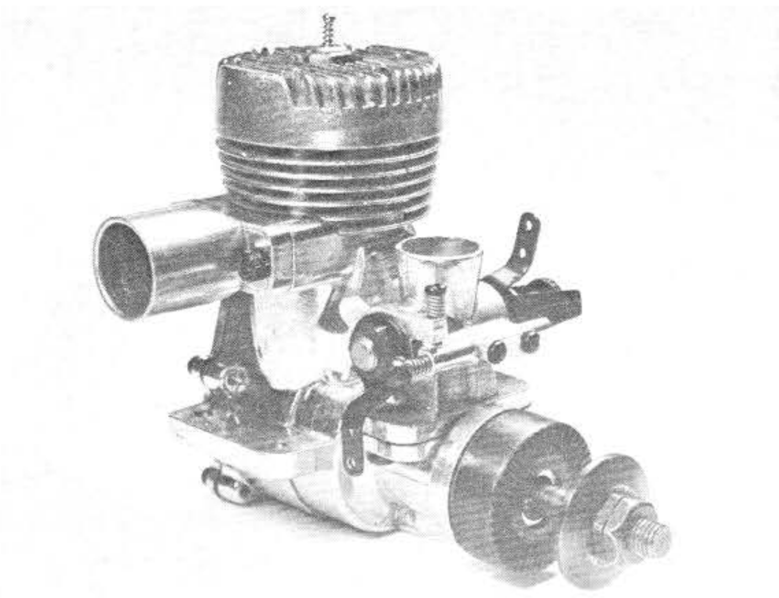
Fox 45RC and 45BBRC mounting dimensions, less muffler:

Crankcase width: 1.375"

Length (from prop-driver face): 3.10" (45RC); 3.14" (45BBRC)

Height above C/L (less glowplug): 2.76"

Bolt-hole spacing: 1.875" x 0.875". ■



Peter Chinn tests the FOX 45BB

THE FOX 45BB is the top model in a group of four Fox engines in the .40-.45 cu.in. class. The other models consist of a smaller bore, .40 cu.in. version of the 45BB, plus .40 and .45 cu.in. versions of a simplified model having a bronze bushed main bearing instead of ball bearings, different cylinder porting and a lapped cast-iron piston in place of the BB model's ringed aluminium piston.

Our test model came direct from the U.S.A. without silencer, but a British-made expansion chamber type silencer, previously used for tests on a plain bearing .40 was used, supplied by John D. Haytree, the Fox importer for the U.K.

Design and construction summary

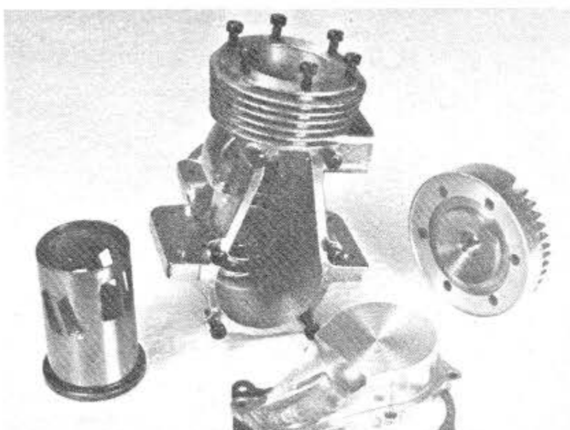
Main casting and backplate. The main casting consists of the crankcase, most of the cylinder casing and the entire front housing in pressure die cast aluminium alloy. It has a highly unorthodox rear end in which the backplate, instead of merely uncovering the crankcase barrel, also incorporates the lower rear part of the cylinder casing, so that its removal exposes not only the crank chamber but also the rear of the cylinder liner up to and including the rear transfer port. It was, in fact, to simplify the problem of coring the casting for the three transfer channels required by the engine's Schneurle scavenging system, that this form of construction was chosen: the front and side channels are incorporated in the main casting, while the rear one is formed in the tall backplate. A thick gasket and six screws are used to ensure a gas tight joint.

Cylinder-liner. Drop-in steel cylinder liner with .059 in. wall thickness and incorporating unconventional unconventional multiple ports. Exhaust port divided into three, timed to open and close at 75 deg. each side of BDC and flanked on each side by a pair of long transfer ports milled through liner at an angle of approximately 16 deg. to cylinder axis to direct gas flow away from exhaust port. These ports are timed to open and close at 60 deg. each side of BDC and are supplemented by a long centrally divided third port which opens and closes at approximately 52 deg. each side of BDC.

Piston and connecting-rod assembly. Cast aluminium alloy piston with flat crown, port window on bypass side and single orthodox compression ring. Machined aluminium alloy connecting-rod, unbushed, with oil slits at both ends. Solid 0.182 in.dia. gudgeon pin retained by wire circlips.

Cylinder-head. Pressure diecast aluminium alloy with machined combustion chamber. Combustion chamber shape is a shallow cone with a small central depression surrounding the glowplug. The head is secured with six Phillips screws and is installed without a gasket. The measured nominal geometric compression ratio of our test engine was 8.0:1.

Crankshaft and bearings. Large diameter (15 mm. o.d., 10.8 mm i.d.) counterbalanced, hardened steel crankshaft with 7/32 in. o.d. solid crankpin. Rectangular 13 mm. long



valve port timed to remain open from 40 deg. ABDC to 52 deg. ATDC. Shaft supported in one 15 x 28 mm. 10-ball steel-caged ball journal bearing at rear and one ⅜ x ⅞ in. 7-ball steel-caged ball journal bearing at front. At the front end the shaft has a ¼-28 UNF thread for the prop nut and a short knurled length on which an aluminium split taper collet is fitted for the blued steel cup-type prop driver, partially enclosing the front bearing.

Carburettor. The special Fox carburettor is flanged-mounted, with two screws, to a saddle on top of the crankcase front housing and is the same as that fitted to the Fox Eagle 60 model. It incorporates separate idling and high-speed jets, each with its own mixture adjustment. Part-throttle mixture controlled automatically by movement of throttle valve. Carburettor body of pressure die cast aluminium alloy. Steel throttle valve, taper ground for close fit within carburettor body. High speed needle-valve installed in left side of carb. Idle mixture needle located forward in right side of carb body. Throttle actuating arms on both sides of carburettor.

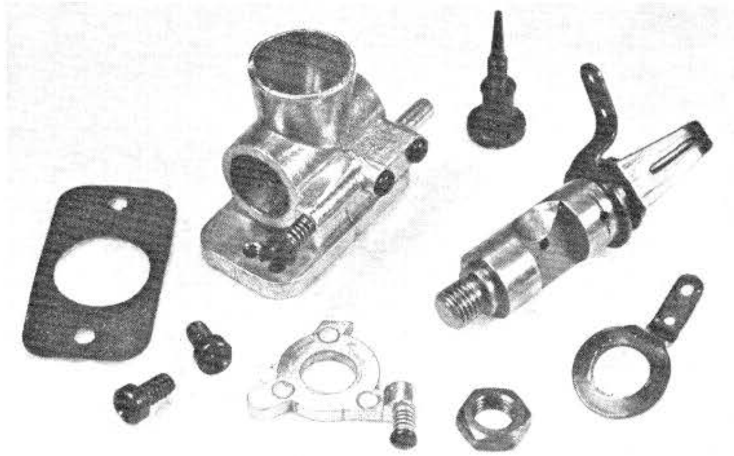
Silencer. The Fox-U.K. silencer is a fabricated cylindrical expansion box designed for use with the optional round-outlet exhaust stub supplied for the 40/45 engines. (The outlet stub itself is attached to the engine with two screws). The silencer may be fitted to the outlet stub with self-tapping screws, or the joint may be made with epoxy resin. Our silencer was an early sample in which the inlet tube had become loose in the silencer casing and we therefore resorted to liberal use of epoxy for sealing both joints, as may be seen in the photos.

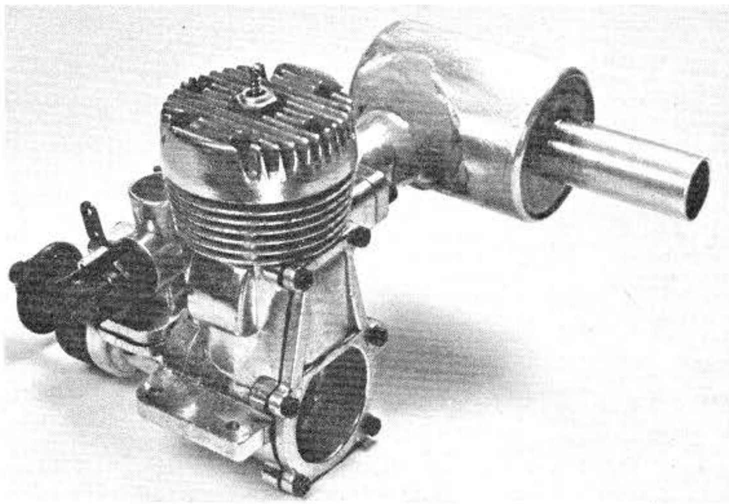
Test performance

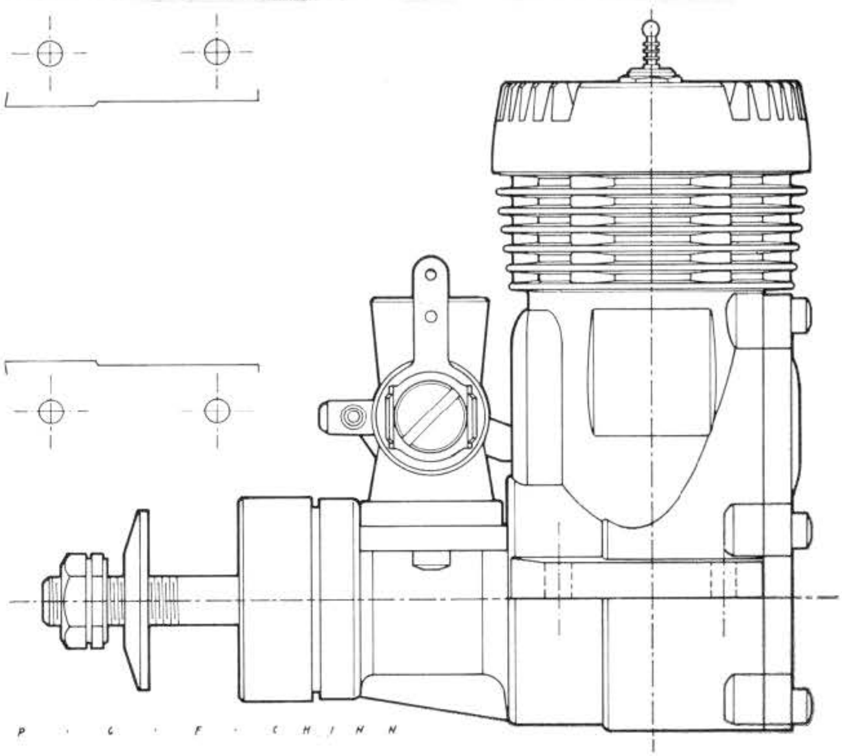
Our test sample was run in on a straight 3-to-1 mixture of methanol

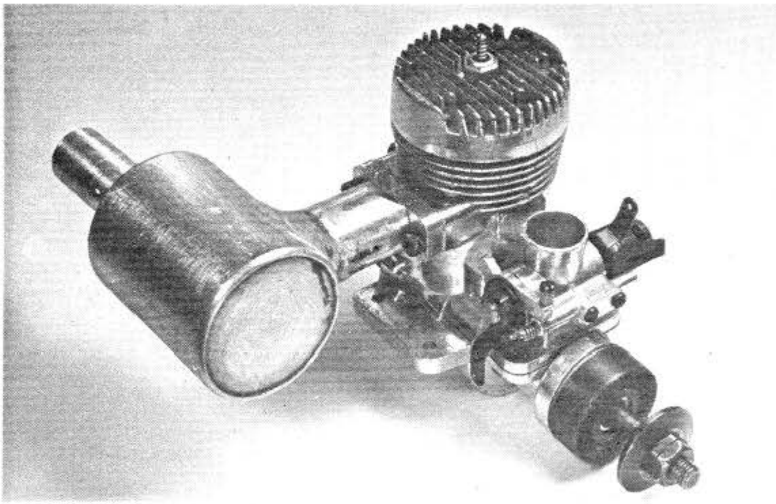
GENERAL INFORMATION

Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901, U.S.A.
U.K. Importer: John D. Haytree, Shutterton Industrial Estate, Dawlish, Devon EX7 0NH.
U.K. Distribution:
(i) Irvine Engines, Unit 8, Alston Works, Alston Road, High Barnet, Herts.
(ii) Model Aircraft (Bournemouth) Ltd., Norwood Place, Bournemouth, Dorset.
(iii) Ripmax Ltd., Ripmax Corner, Green Street, Enfield, Middlesex.
Type: Shaft rotary-valve, throttle-equipped glowplug engine with Schnuerle scavenging two ball-bearings and ringed aluminium piston.
Bore and Stroke: 0.850 in. x 0.790 in.
Stroke/Bore Ratio: 0.929:1
Displacement: 0.4483 cu.in.—7.346 cc.
Measured Nominal Compression Ratio: 8.0:1
Checked Weights:
(i) 335 grammes—11.8 oz. (less silencer)
(ii) 380 grammes—13.4 oz. (with silencer).









and castor-oil and was found to be quite free-running from the outset. Initial tests were carried out on our standard 5 per cent nitromethane R/C test fuel but this was found to be too "cool" under light loads and the relatively cold weather conditions prevailing at the time of testing and a recheck was therefore made on 15 per cent nitro. Glowplugs used were Fox idle-bar 1.5 volt long-reach with platinum-rhodium element as supplied with the engine. Atmospheric temperatures at the time of testing were 10-11°C (50-52°F) and barometric pressure was 1024 mb (30.24 in.Hg.)

Starting and running

The starting and handling qualities of the 45BB were very good. The engine had good piston seal as delivered and started readily both hot and cold. It was quite docile and showed no viciousness when hand-started on a variety of props.

Running qualities were also good. Vibration was at a low level and noticeably less than with the plain bearing Fox 40 previously tested: the lower weight of the 45BB's aluminium piston and, to a lesser extent, its lower compression-ratio, being contributing factors here.

Power—with silencer. A check on prop speeds recorded with the silencer installed indicated a willingness on the part of the 45BB to swing quite large props without loss of power or any sign of stress. We obtained 9,100 rpm on a 13x5½ Top Flite standard, 9,800 on a 12x6 Top Flight maple, 11,000 on a 12 x5 Top Flight standard and 11,250 rpm on an 11x8 Robbe glassfibre-nylon. On the 11x6 sizes, 11,700 were recorded on a Top-Flight maple and 12,200 on a Power-Prop maple. On the 10x6 sizes, a Top Flight maple was turned at 13,300 and a Taipan glassfibre nylon at 13,600 rpm. These later are about the smallest sizes that one would normally need to use but, just for the record, we also checked a pair of 9x6s—Top Flight maple and Taipan glassfibre-nylon—and obtained 14,300 and 14,800 respectively.

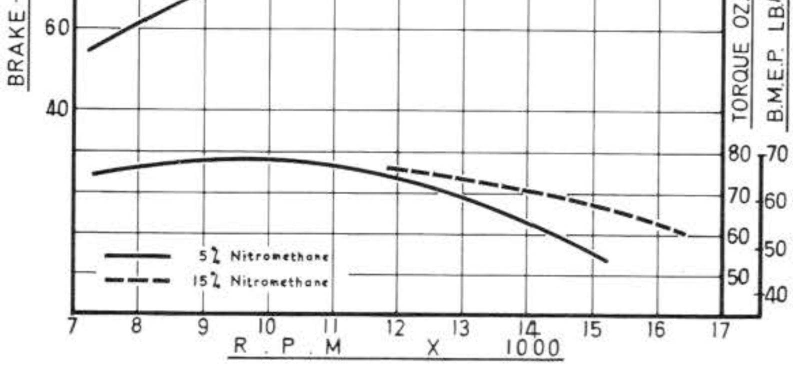
Torque tests indicated a maximum torque of 78 oz.in. at between 9,500 and 10,000 rpm and a peak power output of just on 0.90 bhp at 13,000 rpm.

Power—less silencer. The small lightweight silencer with its very large tailpipe (13.5 mm. i.d.= 143 sq.mm.) does not markedly affect power output (it does not "silence" very much either) and it was no surprise to find that removing it added only about 100 rpm to the engine's speed at the peak of the power curve, rising to a maximum of 200-300 when the engine was propped for speeds a couple of thousand revs beyond its peaking speed.

Removal of the silencer did, however, serve to confirm a suspicion that a combination of the engine's low compression-ratio (it is actually slightly less than 6-1 if one takes into account the late closure (75 deg. ABDC) of the exhaust port), mild fuel and cool weather conditions, were resulting in late ignition and loss of power under light loads and high rpm. Since the 45BB is not fitted with a head gasket, it was not possible to check the effect of raising compression ratio by fitting a thinner gasket. It was therefore decided to run a repeat series of tests using a fuel of higher (15 per cent) nitromethane content.

The results of this can be seen in the second set of curves. Although the higher nitro content had virtually no effect when the engine was loaded for speeds below 12,000 rpm, there was a marked improvement under lighter loads, resulting in a very much flatter torque curve and the extension of the bhp curve to a peak approximately 2,500 rpm higher at around 15,500, where the engine just topped 1.0 bhp.

Throttling. Bench idling at around 2,500 rpm on an 11x6 Power Prop was obtained. (To achieve this safely in the air, it might be as well to use an exhaust-pressurised fuel system). As we have found before, the Fox 2-needle carburettor is easy to adjust. Always remember: these carbs require the idle mixture to be adjusted first—*not* the high-speed needle.



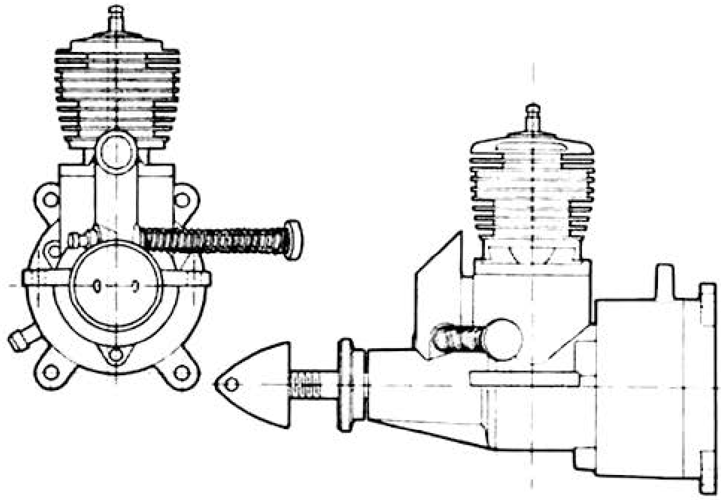
Comment

A robustly constructed engine of good all-round performance. Some examples (like our test motor) may require medium nitro fuel to avoid early falling-off of power under light loads. Otherwise, easy handling, powerful and smooth running.

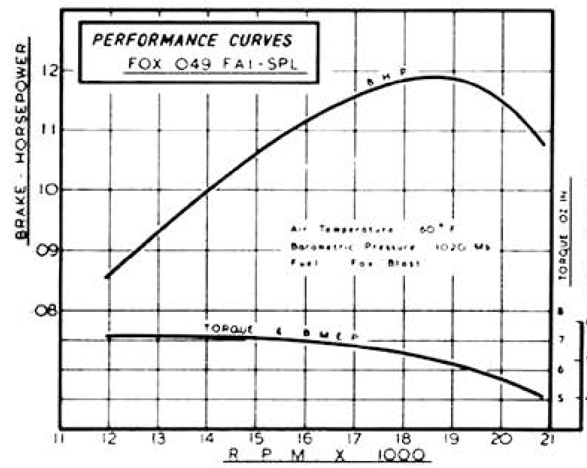
Engine Review

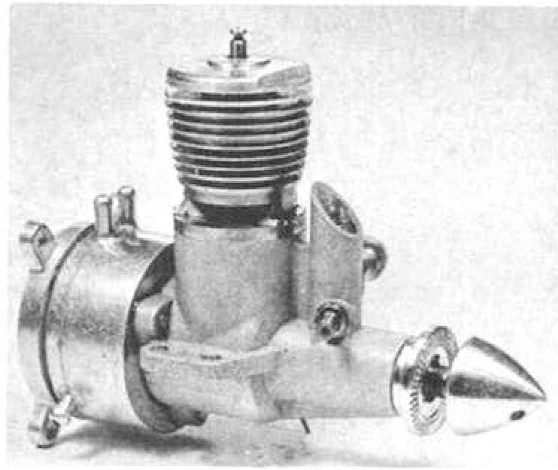
Fox .049 FAI Special

By P. G. F. CHINN

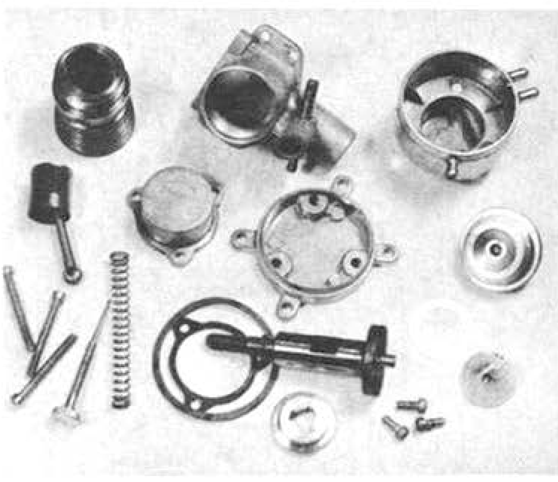


MUCH MODIFIED CONTEST VERSION OF POPULAR FOX .049 FAI-SPECIAL REVEALS IMPRESSIVELY BOOSTED PERFORMANCE AND EXTREMELY INTERESTING PORTING CHANGES.





Shown here with optional tank mount, FAI Special is easily identified by larger bearing housing and intake, also new tapered exhaust ports.



Parts of FAI Special. Engine features new crankcase, large diameter shaft, optional tank mount, also new cylinder with special dual bypass.

► We have remarked before that, in the ½ A class, American motors lead the world in performance. This is underlined by the new Fox 049 "FAI-Special" which, by our rating, qualifies among the top two or three contest 049's, on a power output basis.

Outwardly, the FAI-Special version does not, at first sight, look very much different from the standard Fox 049. A machined aluminum spinner-nut decorates the front end and the casting has a matt, instead of polished, finish. However, a closer look reveals a larger diameter intake tube, differently shaped exhaust ports and a much bigger main bearing housing with side webs omitted. The modifications do not stop here either. Dismantling the FAI-Special and comparing it with previous models, we find that it has a new crankshaft, new cylinder and revised porting throughout. In fact, the really significant changes are, in our view, in the porting. Here, by way of explanation, we would like to digress for a moment.

We were asked recently why we do not regularly quote compression-ratios in these Engine Reviews. There are a number of reasons for this. Firstly, to calculate compression-ratio, one must measure the volume of the combustion space at top-dead-center. This can rarely be done accurately in a small engine by geometrical calculations derived from actual physical measurements and the more common method is to determine the volume of the combustion chamber with the aid of a burette or pipette and a suitable fluid. However, even this becomes tricky when one gets down to ½A sizes, especially as with the wide use of one-piece glowheads in such engines, an alternative must be found to the usual practice of introducing the fluid via the plug hole. Secondly, even assuming that one evolves a practical method, standard to all engines, of accurately determining combustion chamber volume, the nominal compression-ratio, based on the relationship of the total volume of the cylinder (as swept by the piston) plus the (unswept) combustion space volume and divided by the combustion chamber volume, does *not*, in fact, give us a true picture.

The fly in the ointment—and this applies to all two-cycle engines with piston controlled ports—is that, since compression can only begin when the cylinder is sealed, *effective* compression-ratio is related only to the actual swept volume of the cylinder *above the top of the exhaust port*. Moreover, since the swept volume above the exhaust port, relative to the nominal swept volume, varies according to the location of the exhaust port between TDC and BDC, it follows that the effective compression ratio is also influenced by exhaust port timing.

On the new Fox 049 FAI-Special, the exhaust port closes early: only 58 degrees after bottom-dead-center. This is 12 degrees earlier than on the stock 1964 049 and 18 degrees earlier than on the original Fox 049 of 1962 and means that the effective compression ratio is appreciably higher.

In theory, this also means that there is less loss of fresh mixture through the exhaust port immediately before it is closed by the raising piston and that, during the power stroke, more energy is extracted from the expanding gases by delaying their release. On the other hand, these latter two advantages are, to some extent, nullified by the reduced time available for scavenging the cylinder of burnt gas, which may mean that the incoming charge is more heavily adulterated with residual exhaust gas.

These conflicting factors are, of course, old stuff and as is so often the case, an engine designer has to aim for an exhaust timing that will strike the best balance. However, it is equally true that, as i.c. engine design develops, emphasis tends to shift from one part of the engine to another and, as a result, it may be found that rules which have held good in the solution of one particular problem, may, with advantage, be modified later, to blend in with a development in some other part of the engine.

There has been just such a shift of emphasis in regard to exhaust port areas and timing. During the early development of high performance model engines, much was made of the need for free and unrestricted discharge of exhaust gases and designers struggled to accommodate the biggest possible exhaust port area along with generous timing. Many engines were grossly over-ported on the exhaust side and, in due course, it became abundantly clear that filling the cylinder was far more important than emptying it. Intake valves and passages and ports have, as a result, became highly developed during recent years.

As we remarked earlier, the significant changes made to the Fox FAI are in these departments. Firstly, gas enters the engine via an appreciably larger carburetor intake tube (its actual cross-sectional area being approximately 60 percent bigger than that of the standard 049) and through a very much larger crankshaft. This latter has a 5/16 in.dia. journal (instead of ¼ in. dia.) which accommodates a large rectangular valve port (approximately 100 percent greater area) and a 13/64 in. bore intake passage (69 percent more cross-sectional area). Rotary-valve timing (measured) is 54 deg. ABDC to 41 deg. ATDC.

From the crankcase, gas reaches the cylinder through two internal bypass flutes which total about three times the cross-sectional area of the standard engine's single bypass. These flutes extend well up between the exhaust ports to give a bypass period of 108 degrees which, although less than the bypass duration of the stock engine, reduces exhaust lead when the ports open, to only 4 degrees. To accommodate these wider bypass flutes, between the two opposed exhaust ports, the latter are now tapered in width from top to bottom. The lower one-third of the port height is ineffective as exhaust area, serving instead as a sub-piston supplementary air intake port, when the piston skirt clears the bottom edge of the port, for 28 degrees of crank rotation each side of TDC.

Structurally, the FAI-Special follows the basic specification of the standard Fox 049. The crankshaft has a crescent counterbalance, is hardened and runs direct in the pressure-cast aluminum crankcase. The piston is hardened, with a ball joint hardened steel rod and runs in a leaded steel cylinder which screws into the crankcase. The head is the stock Fox 049 type with integral glow filament. The engine has drilled beam mounting lugs but is supplied complete with an optional radial tank-mount of substantial diecast aluminum construction.

Two FAI Specials were received for test. As is our usual practice, both engines were checked out after break-in and the best of the two was used for subsequent tests. These engines were stock specimens and had not been specially selected: there was, in fact, an appreciable difference in the performance of the two examples still amounting to over 1000 r.p.m. on a 5x4 prop at the conclusion of the initial break-in period (15 minutes intermittent running) although the slower engine began to pick up with further running. Of course, the Fox 049 does not, in any case, call for the type of break-in that we normally associate with larger lapped-piston motors. A few runs with the needle set slightly rich will normally be sufficient to enable the 049 to be given its head, straight off, without risk.

We tried the FAI-Special on various fuels. It ran well on all of them, ranging from a straight 3 to 1 methanol-castor mix, to Fox "Blast." On a 6 x 3 Tornado, it was 1500 rpm faster using "Blast" than on straight methanol-castor. Nevertheless, the FAI-Special was more powerful on straight fuel than the standard 1964 model Fox 049 had been on "Missile-Mist"—which is pretty good. For our dynamometer tests on the FAI-Special, we chose "Blast."

Immediately noticeable was the substantially improved torque developed by the FAI-Special—about 15 percent higher than the stock 049. About one-third of this gain can be attributed to the greater power liberated by the use of high-nitro "Blast" as opposed to medium nitro "Missile Mist", but it is clear that the improvement in aspiration gained from the use of bigger intake and bypass passages has been responsible for the major part of the FAI-Special's greater performance.

By contrast, the bhp peaking speed (in the 18,500/19000 rpm bracket, where the excellent output of nearly 0.12 bhp was developed) was no higher than before and it seems reasonable to suppose that this is a product of the more conservative timing of the new engine. It means that, while the FAI Special will turn any size prop faster than the standard 049, it may be advantageous to use a slightly bigger size. This much is, in fact, suggested in the instruction leaflet issued with the engine. On our tests, the FAI Special was 27 percent more powerful than the standard 049 at 18,000 rpm and 26 percent better at 16,000 rpm. However, at 20,000 the improvement had dropped to 23.5 percent and at 21,000 to 19 percent.

For ultimate contest performance, therefore, it seems logical to aim for an in-flight maximum rpm of 19,000, or just over, which will allow the engine to accelerate rapidly up to its peak, but not too far beyond. A 6x3 Top-Flite nylon (17,400—18,300 rpm according to age, etc of the prop) would seem to be the smallest practical free-flight size. A 6x3½ (if available) or a fast 6x4 may be preferable with some models.

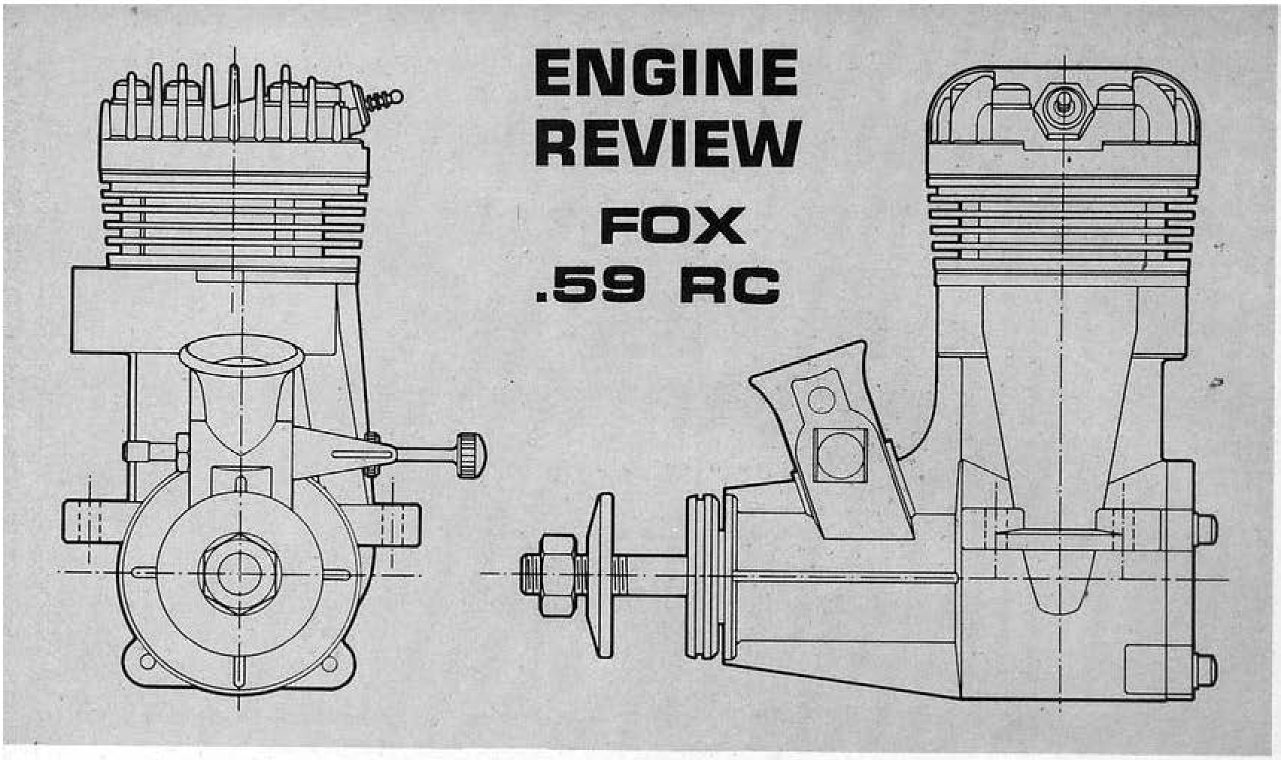
We encountered one slight spot of starting bother with both test model FAI-Specials during break-in. This was a tendency for the engine to oscillate, i.e. for it to fire too far advanced, causing the prop merely to flip back and forth as the piston was arrested just short of TDC. This is a phenomenon sometimes encountered when starting diesels if there is an excess of fuel in the combustion chamber combined with too much compression. On the FAI-Special, the nominal compression ratio is higher than on the standard 049; it has only one head gasket instead of two and, as we discussed earlier, its effective compression ratio is also higher. This probably accounts for the tendency to oscillate if one is a bit too liberal when priming for a start.

Any user who encounters this problem and who finds he cannot adjust himself to the required starting techniques, can effect a quick remedy by adding an extra head gasket (or even two gaskets if necessary) and/or using a mild fuel, such as straight 3/1 methanol/castor without additives. An extra head gasket will cost 300-400 rpm; straight fuel and extra gasket 1800-2000 rpm. After becoming used to handling the engine in this "de-tuned" state, a return can usually be made to stock "contest" condition without further trouble.

For many years, Fox engines have enjoyed a well-deserved following among contest flyers, especially in the C/L stunt, combat and rat-racing fields. With the FAI-Special, Fox now makes a strong bid to extend this appeal to ½A contest flyers.

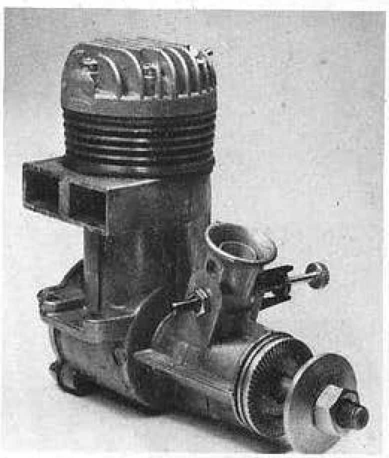
Summary of Data

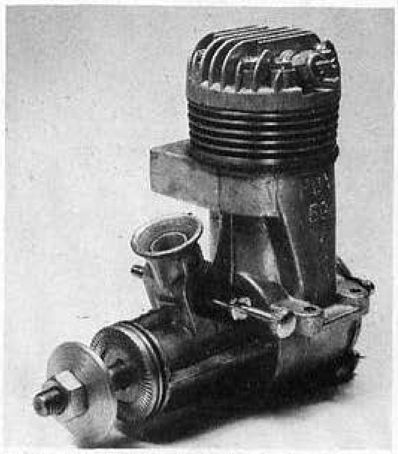
Type: Two-port, two-cycle with opposed exhaust ports and dual bypass. Shaft type rotary-valve intake.
Weight: 1.7 oz. (1.9 oz including tank)
Displacement: 0.04993 cu. in. or 0.818 c.c.
Bore: 0.390 in. Stroke: 0.418 in.
Stroke/Bore Ratio: 1.072:1
Specific Output (as tested on "Blast" fuel): 2.36 bhp/cu. in.
Power/Weight Ratio (as tested on "Blast" fuel). 1.11 bhp/lb.
Price: $9.95
Manufacturing: Fox Manufacturing Company, Station A, Fort Smith, Arkansas.



ENGINE REVIEW

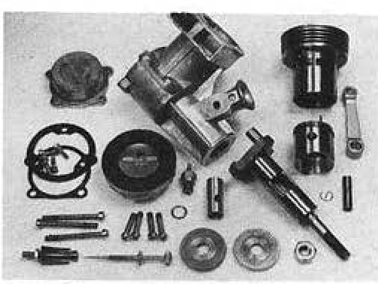
FOX .59 RC



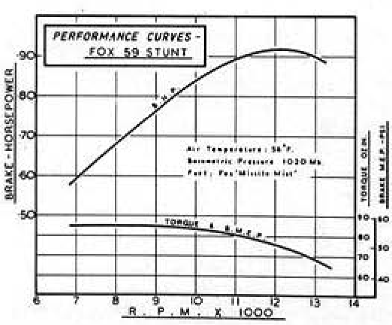


There's no mistaking that very distinctive crankcase and deep-finned cylinder-head with side plug. Blank off the front end and it could belong to the original Fox 59 of 1947!

Latest version of old respected favorite, Fox 59 Stunt, still highly competitive both performance-wise and without doubt price-wise.



Examination reveals improvements, including modifications to case, shaft and piston rod.



By PETER G. F. CHINN

Dear Reader, if you are of the post-WW II generation, kindly stand up and respectfully remove your hat, for we are about to usher into your presence a venerable old gentleman: the Fox 59. The Fox is the oldest American engine still in production. Almost a quarter of a century has now passed since it first saw the light of day.

It might be supposed, from this, that the 59 is an out-moded design. Not so. Over the years it has undergone many modifications and improvements. To be quite truthful, the Fox 59 is now a good deal different from that first production model of 1947. Nevertheless, by virtue of its highly distinctive appearance, there can be no doubt as to the identity of even the very latest model.

The original Fox 59 was a twin ball-bearing, rear rotary valve motor with spark ignition. The present model is a bronze bearing, front rotary valve engine with glow ignition. But the basic crankcase design with its high mounting lugs, big rectangular exhaust stack and narrow tapered bypass, the Desaxe (offset) cylinder with its integral cooling fins and the highly individual deeply-finned head and side-mounted ignition plug are all still there and stamp the engine unmistakably as a Fox 59.

Two major changes have been made to the Fox 59 since it was first put on the market. The first one came in 1951, following the switch from spark ignition to glow. The original backplate unit,

Continued on page 62)

Engine Review

(Continued from page 20)

with its timer assembly and disk type rotary intake valve, was discarded and was replaced by a new backplate with vertical intake and 5/8 in. dia. drum type rotary valve. At the same time, the engine's original bore and stroke of 0.937 x 0.860 in. were changed to 0.920 x 0.906 in. The second major alteration came in 1954 when the design was converted to front rotary induction via a new, larger diameter crankshaft, running in a bronze bushing. In this form, the engine was aimed at the control-line stunt fraternity but the immense success of the smaller Fox 35 for stunt use eventually resulted in the 59 being temporarily withdrawn from production while the factory concentrated on meeting the demand for the 35 and the many other Fox motors that followed.

In 1962-3, the 59 was given a new lease of life as a result of renewed demand, particularly from multi-channel R/C flyers, for larger engines. Duke Fox took the 59 out of cold storage, fitted it with a new ringed aluminum piston in place of the earlier lapped cast-iron type, modified the cylinder ports to suit and reduced the bore to 0.907 in. In this form, with other minor improvements, the 59 has continued in production, both as a C/L stunt motor and with a throttle type carburetor for R/C, ever since.

We ran tests on the 59 R/C back in 1963. Having regard to the fact that at the present time there appears to be an upsurge of interest among C/L aerobatics enthusiasts in motors larger than the popular 35, the report that follows therefore deals with the current stunt version of the Fox 59.

This latest model Fox 59 Stunt first appeared on the market in the summer of 1970. Comparing it side by side with the 1963 type, several significant modifications are soon apparent.

First of all there are a couple of small changes to the light-weight pressure-cast crankcase. A vertical rib has been added between the exhaust stack and right beam mounting lug to increase strength and rigidity and the top o.d. of the case, on which the cylinder base flange is seated, has been widened. As before, the mounting lugs are located 3/16 in. above the engine's crankshaft axis and a cast-in bronze main bearing with longitudinal oil groove is used.

The hardened steel crankshaft no longer has a full disk crankweb with counterbalancing provided solely by a crescent counterweight. Instead there are cutaways each side of the crankpin, the web being thicker. The crankpin is increased from 7/32 in. to 1/4 in.dia. and is also longer, providing appreciably greater area for improved bearing life. The rectangular rotary-valve port is slightly shorter but the gas passage through the shaft remains unaltered at 13/32 in. bore.

The aluminum piston, originally turned from a pressure casting and subsequently a permanent mold casting, is now machined from bar stock. As before, it has a flat head and a straight baffle, but baffle height has been slightly increased. New, somewhat deeper (3/64 in. instead of 1/32 in.) compression rings are fitted, but the weight of the piston complete with rings is slightly less at 9.3 grams or 0.33 oz. The 7/32 in.dia. wrist-pin is now located by wire snap rings in the piston.

Early versions of the Fox 59 Stunt had diecast conrods but these were replaced in 1963 by a machined 24ST aluminum rod. The present rod has been further improved. It has a thinner, wider shank with much bigger bearing areas top and bottom. At the wrist-pin end, bearing length has been increased 25 percent from 1/4 in. to 5/16 in. At the lower end, length has been similarly increased so that, with the larger crankpin diameter already mentioned, bearing area here has been enlarged by some 42 percent.

The hardened steel cylinder with its integral fins, six exhaust ports and three bypass ports, remains essentially the same as before. However, the measured port timing is somewhat different (due mainly to the wrist-pin being located lower in the new piston) the bypass period being reduced by approximately 10 degrees to 108 degrees of crank angle and the exhaust period to 121 degrees.

The cylinder head has been made slightly thicker but is otherwise unchanged. It is fitted with a Fox long-reach plug set almost horizontally in the bypass side. There are seven cylinder screws, four of which serve to secure the head to the cylinder, while the other three pass through the cylinder fins to tie the complete assembly to the crankcase. Composition gaskets are used under the head and cylinder base flange. The cylinder is, as with many Fox engines, of the Desaxe type, i.e. its center-line is offset, relative to the crankshaft axis, in the direction of rotation, thereby reducing piston side-thrust during the power stroke.

The rotary-valve remains open for 180 degrees of crank rotation closing at approximately 55 degrees after the piston reaches the top of its stroke. Fuel is supplied via a standard Fox type needle-valve assembly and the 3/8 in.dia. intake is fitted with an aluminum tube venturi which reduces choke diameter to 8.5 mm. Effective choke area is approximately 27 sq.mm.

For the Fox 59 Stunt, Duke Fox recommends the use of Fox "Missile Mist" fuel rather than the milder Fox "Superfuel" which, for many years, has been the standard Fox stunt blend. According to Fox literature, Missile Mist contains 25 percent nitro against Superfuel's five percent and, as one would expect, it gives a higher power output. However, for breaking-in we elected to use a five percent blend as, until the 59 had accumulated about 1½ hours of running time, it tended to overheat and tighten up whenever the needle-valve was leaned out to a fast two-cycle. We also tried a straight 75/25 methanol/castor-oil mixture during break-in for even cooler running, but it was noticeable that, on this fuel, power dropped off when the starting battery was disconnected.

This tendency to lose power when the plug lead was removed was also evident with five percent nitro. fuel, after breaking-in, when running on lighter loads (i.e. 11x6 and smaller props). Here, the 59 would eventually regain power after warming up for 30 to 60 seconds, but it is doubtful whether this would be satisfactory under those C/L stunt flying conditions where an engine is adjusted to switch from two-cycle (hot) to four-cycle (cool) running conditions as it goes through an aerobatic pattern. Admittedly, at the time of testing, the weather was cool and under warm summertime conditions this problem might not be encountered, but the short answer, obviously, is to use Missile Mist or an equivalent fuel.

We found the Fox quite pleasant to handle. It was not at all vicious and could be hand started on any suitably sized prop without risk to one's fingers. It responded to the usual starting preliminaries of an exhaust port prime when cold and just a single choked flip when warm. As one might expect, starting gradually improved as the engine accumulated more running time and the piston rings became mated to the cylinder bore to give better piston seal. The rings, we might add, were a very good fit in their grooves.

Response to the engine's single control, the needle-valve, was satisfactory. It was non-critical, easy to adjust and held settings firmly. The needle, incidentally, is of the spade tip design long favored by Duke Fox.

Torque tests of the 59 Stunt (on Missile Mist) indicated a maximum torque of 85 oz.in. at between 7000 and 8000 rpm and a peak power output in excess of 0.90 bhp at just over 12,000 rpm. Some readers may notice that this is not quite so high as the performance we recorded earlier for the R/C model on the same fuel, so a word of explanation is necessary. Firstly, Duke Fox admits that a small sacrifice in power has been made in the interests of smoother running. It is reasonable to assume that the slightly smaller choke area and the detuned exhaust and bypass timing are factors. Finally, even in identical engines, a few percent variation in performance is to be expected. Our original 59 R/C was probably a good one. We won't suggest that our test model 59 Stunt was below par because a specific output of nearly 1.6 bhp/cu.in. for a C/L stunt motor is good by any standards.

The most suitable props for C/L stunt jobs using the Fox 59 will probably be between 11x7 and 11x8. Some static prop speeds recorded by our test motor included 9,500 on an 11x8 Rev-Up, 9,900 on an 11x8 Top Flite Super-M, 10,100 on an 11x8 Power Prop Super-M, 10,700 on an 11x8 Power Prop standard, 10,400 on an 11x7½ Rev-Up, 11,100 on an 11x7½ Power Prop Super-M, 10,600 on an 11x7 Top Flite Super-M, 10,700 on an 11x7 Power-Prop Super-M and 11,600 on an 11x6 Top Flite Super-M.

No troubles of any kind were experienced with the Fox 59 Stunt through several hours testing and the original Fox glowplug survived the full series of tests.

A notable feature of the 59 is its modest weight which, at 11.8 oz., is appreciably less than most other current motors of similar displacement and results in a very good power/weight ratio. Lower priced than most of the imports of similar displacement, the Fox 59 Stunt also represents, in our opinion, outstandingly good value. One other point that should not be overlooked is that this is the sort of motor that you can easily service youself. It is simple to dismantle and reassemble without special tools and unlike the situation sometimes encountered with foreign products, replacement parts, if needed, are readily obtainable.

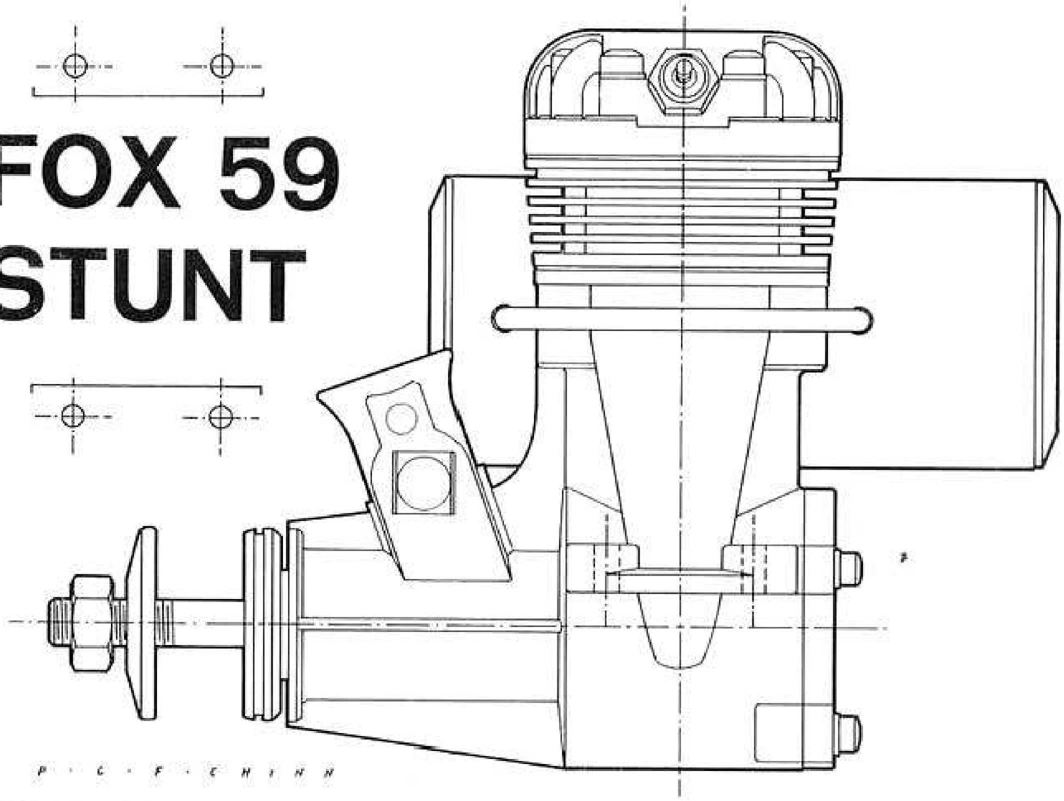
All this, no doubt, accounts for the fact that there is still a market for the Fox 59 twenty-four years after its introduction. It probably has many more years yet to run.

Summary of Data
Type: Single-cylinder two-stroke cycle with crankshaft rotary-valve and bronze bushed main bearing.
Weight: 11.82 oz.
Displacement: 0.5852 cu.in. or 9.590 c.c.
Bore: 0.907 in.
Stroke: 0.906 in.
Stroke/Bore Ratio: 0.999:1
Specific Output (as tested on Missile Mist fuel): 1.57 bhp/cu.in.
Power/Weight Ratio (as tested on Missile Mist fuel): 1.24 bhp/lb.
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901.

Footnote

Just after our tests on the Fox 59 Stunt had been concluded, we were advised by Duke Fox that a modification has been made to the port timing on current production models which results in a slightly higher top end output. Duke also tells us that he has experimented with raising the engine's compression ratio (previously reduced in the interests of smooth running although a high compression head is not being incorporated at the present time. However, for the benefit of those who are always looking for more and more power and have access to a lathe, Duke mentions that turning about .080 in. off the gasket area of the head will produce a very substantial gain in power. This, we would guess, will appeal rather more to those using the R/C version of the Fox 59. ■

FOX 59 STUNT



ENGINE TEST by Peter Chinn

of one of the largest control-line aerobatic motors

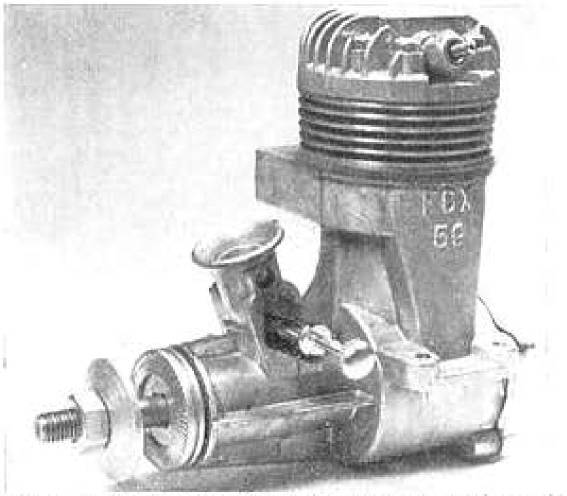
BACK IN THE LATE NINETEEN-FORTIES when control-line stunt flying was at the peak of its popularity, the favoured power unit for top-class competition work was a large engine of around .60 cu. in. capacity, with the American Super-Cyclone and Atwood Champion (or Glo-Devil) proving particularly successful – especially in the U.S. Then came the slower flying, large-area model, with coupled flaps, that flew on its wing rather than its prop, and the engine that dropped neatly into this new formula and set a standard for the best part of two decades afterwards, was the Fox 35.

For the past two or three seasons, however, it has been apparent that there is now a trend towards larger models and a swing back to more powerful engines for international contest work. This was clearly confirmed at this year's Criterium of Europe meeting where nearly two-thirds of the models entered were powered by engines in the .40-.50 cu. in. group.

In the January issue *Engine Test* we featured one of the recent additions to this new generation of C/L stunt engines in the shape of the O.S. Max-H. 40-S. This month we are dealing with a much larger engine of considerably older lineage, the Fox 59 Stunt.

The present stunt type Fox 59 actually dates back to 1954 when the factory brought out the first front rotary-valve plain bearing model. Prior to this, the Fox 59 had been a rear induction twin ballbearing engine: originally (in 1947) with a disc valve and spark ignition and then (in 1951) with a drum valve and glow ignition. Since 1954, numerous modifications have been made to the 59 Stunt, including a switch from lapped cast-iron pistons to ringed alumin-

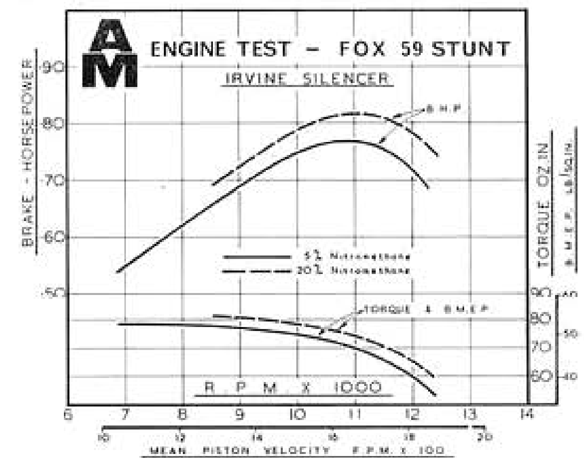
Fox 59 Stunt as tested with Irvine silencer. Discoloured cylinder head (fried castor-oil) is characteristic of this model.



The highly individual Fox 59 cylinder shape – the engine could never be mistaken for any other make. Uses Desaxe cylinder arrangement, very wide exhaust ports, narrow transfer, and an unusual combustion chamber shape – as seen in photo below.

ium ones (originally pressure diecast, then gravity cast and now machined from bar stock) and changes to crankcase, crankshaft and connecting-rod design and to port timing and compression ratio. Despite all these changes, the present Fox 59 still bears a strong family resemblance to the first Fox 59 marketed nearly twenty-five years ago. This is entirely due to the engine's distinctive crankcase and cylinder styling, including the very deeply finned cylinder head with ignition plug installed in its side, the big rectangular exhaust duct, narrow tapered transfer passage and high placed beam mounting lugs.

Other out-of-the-rut features of the Fox 59 are its cylinder porting (exhaust port area twice that of the transfer ports and extending well over half way around the cylinder bore) its Desaxe cylinder arrangement and its asymmetric domed seven-screw cylinder head. Cylinder port timings are conservative (exhaust period 121 degrees of crank angle, transfer 108 degree) contrasting with a 55 deg. ABDC – 55 deg. ATDC rotary valve timing and a fairly generous (for a stunt engine) carburettor effective choke area of approximately 27 sq. mm.



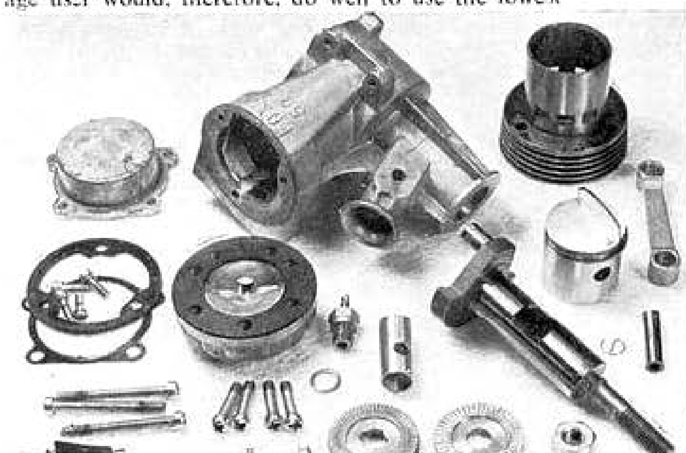
Performance

For the initial running-in period we used, in the interests of cool running and good lubrication (and economy), a plain 3-to-1 mixture of methanol and castor-oil, without nitromethane. It was soon evident, however, that a straight mix would not suit this engine too well for regular use. With (after adequate running in) the engine leaned out to maximum r.p.m., there was, on straight fuel, a marked loss of power when the plug lead was removed and, using a Top-Flite Power-Prop of the recommended size (11 x 8), the 59 was hard-pressed to struggle up to 9,400 r.p.m.

The Fox company does, in fact, recommend the use of a fuel of medium nitromethane content (specifically Fox Missile Mist) for the 59. 'Missile-Mist' is not available in the U.K. and the equivalent would be a blend having a nitro content of around 20-25 per cent. Such a fuel is apt to be rather expensive outside the U.S.A., so we tried a compromise in the shape of the 5 per cent pure nitromethane (equivalent to 7-8 per cent commercial denatured nitro) blend normally used for our tests of stunt engines. This helped matters considerably, adding 300-400 revs. There was still a slight drop when the battery lead was removed but the engine regained power as it warmed up. Nevertheless one is bound to have some doubts as to whether 5 per cent nitro would be adequate under C/L stunt flying conditions where the engine is set up to suddenly switch from a rich, cool, reduced power setting for level flight to a leaned-out full power two-stroke through manoeuvres.

Here we must mention that the engine under review has a lower compression ratio than some earlier models, which would almost certainly have some effect on the engine's fuel requirements. The best advice that one can offer, therefore, is that the Fox 59 owner should try fuels of varying nitro rating in order to establish the mixture best suited to his particular engine and operating conditions.

As the performance curves show, although more power was available when using a fuel containing 20 per cent nitromethane compared with one of only 5 per cent nitro rating, the increase was not such as to make 20 per cent nitro necessary solely in the interests of power. The improvement when using 5 per cent as opposed to no nitro at all was just as good and, from the economy standpoint, the average user would, therefore, do well to use the lowest



nitro percentage consistent with his particular engine's ability to function satisfactorily through manoeuvres.

All our tests were carried out with an Irvine silencer fitted. This has a generous outlet area (almost 100 sq. mm.) and does not absorb too much power. On props matched to the engine's b.h.p. peaking speed, r.p.m. loss was in the region of 300-400.

The handling characteristics of the Fox 59 Stunt were fairly orthodox. Starting was straightforward once the engine was sufficiently run in. It responded best to a fairly generous prime when cold and to just choking the intake for one flick of the prop when restarting warm. Hot restarts, as with many new engines, were a little slow at first, but were quite O.K. once the piston rings had bedded in sufficiently to improve hot compression.

Prop revs recorded by the Fox 59 Stunt, using 5 per cent nitro fuel and the Irvine silencer, included 9,200 r.p.m. on an 11 x 8 Rev-Up, 9,500 on an 11 x 8 Top-Flite maple, 9,700 r.p.m. on an 11 x 8 Power-Prop maple, 10,300 r.p.m. on an 11 x 8 Power-Prop standard, 9,500 r.p.m. on an 11 x 7¾ Bartels fibre-glass, 10,000 on an 11 x 7½ Rev-Up, 10,700 on an 11 x 7½ Power-Prop maple, 10,250 on an 11 x 7 Top-Flite maple, 10,300 on an 11 x 7 Power-Prop maple, 10,500 on an 11 x 6 P.A.W. Trucut and 11,100 on an 11 x 6 Tope-Flite maple.

The Fox 59 Stunt is one of the very few large engines still manufactured that was designed and developed specifically for C/L aerobatics and, as such, is lighter (only 11.8 oz.) than more recently designed 10 c.c. class motors intended primarily for R/C work. It offers a good power/weight ratio and is reasonably priced.

Power/Weight Ratio (as tested with Irvine silencer):
0.86 b.h.p./lb. on 5 per cent nitromethane fuel.
0.91 b.h.p./lb. on 20 per cent nitromethane fuel.

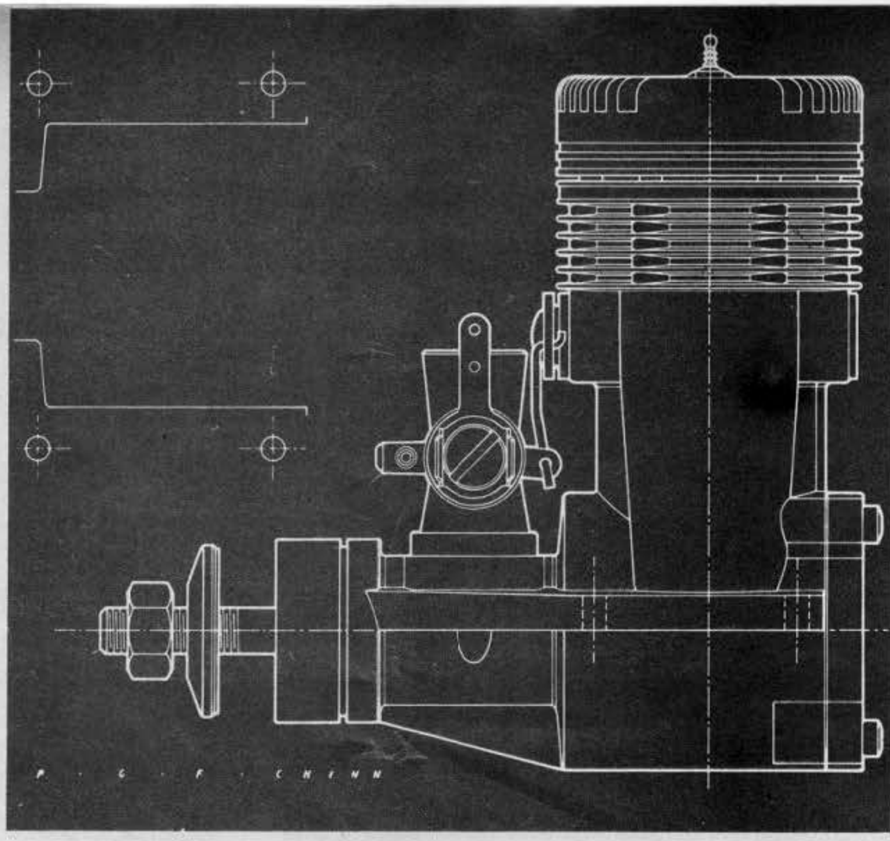
Specific Output (as tested with Irvine silencer):
80 b.h.p./litre on 5 per cent nitromethane fuel.
85 b.h.p./litre on 20 per cent nitromethane fuel.

SPECIFICATION
Type: Single cylinder, air-cooled glowplug ignition two-stroke. Shaft type rotary-valve induction and bronze bushed main bearing.
Bore: 0.907 in.
Stroke: 0.906 in.
Swept Volume: 0.5852 cu. in. (9.590 c.c.)
Stroke/Bore Ratio: 0.999:1
Checked Weights: 335 grammes – 11.82 oz. (less silencer)
408 grammes – 14.40 oz. (with Irivine silencer)

General Structural Data
Pressure diecast aluminium alloy *crankcase/main bearing unit* with cast-in bronze main bearing bush. Detachable rear *crankcase cover* secured with four screws. Hardened steel counterbalanced *crankshaft* with 0.562 in. dia. journal, 0.406 in. bore gas passage and 0.250 in. dia. solid crankpin. Machined aluminium alloy *piston* with baffle and two *compression rings*. Hardened steel 0.219 in. dia. tubular *gudgeon-pin* retained by wire circlips in piston. Machined aluminium alloy *connecting-rod* with plain eyes. Hardened steel *cylinder* with integral cooling fins. Pressure diecast aluminium alloy cylinder head with deep cooling fins, inclined side-mounted, glowplug and secured with seven head screws three of which pass through cylinder fins to tie complete cylinder assembly to crankcase. Aluminium alloy carburettor *choke restrictor* retained by spraybar assembly. Steel *prop driver*. Beam mounting lugs.

OPTIONAL EXTRA
Irvine machined aluminium alloy expansion chamber type silencer with side outlet available from U.K. distributor.

TEST CONDITIONS
Running time prior to test: Approx. 2 hours.
Fuels used: (i) 5 per cent pure nitromethane 25 per cent Duckhams Racing Castor-oil 70 per cent methanol.
(ii) 20 per cent pure nitromethane, 25 per cent Duckhams Racing Castor-oil, 55 per cent methanol.
Glowplugs used: Fox standard long-reach as supplied.
Air temperature: 13 deg. C.
Barometric Pressure: 30.10 in. Hg.
Silencer: Irvine Mk. I as recommended.



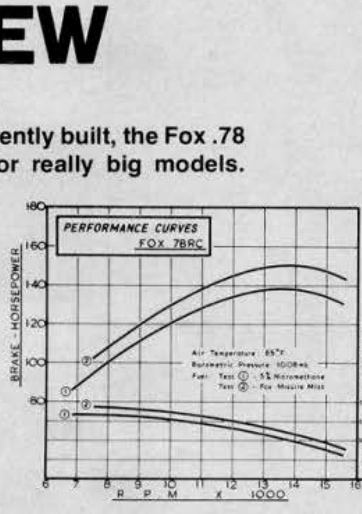
ENGINE REVIEW

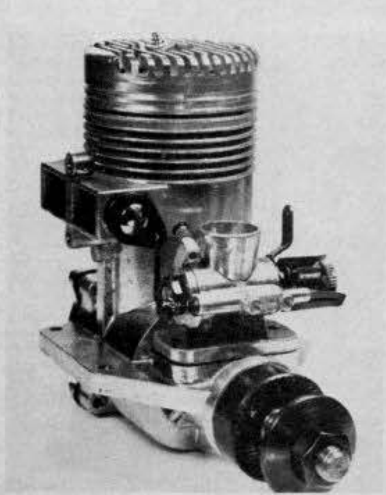
BY PETER G.F. CHINN

One of the largest single cylinder, American engines currently built, the Fox .78 has the torque that is necessary to turn big props for really big models.

• The Fox 78 is the largest, American built, single cylinder, model aircraft engine in current production. With a displacement of 0.7854 cu.in. or 12.87 c.c., it is outside the statutory FAI 10 c.c. limit for international class contest work; however, it has an important role to play in powering extra large or heavy models where the ability to turn larger

Enlarged bypass, new carburetor, new head and various internal improvements are features of the .78.





Fox .78 is strongly built. Note hefty front end plus the big mounting lugs to give really solid support.

diameter props is of paramount importance, e.g., for the heavier types of scale models or for big load carriers used for such purposes as aerial photography

Basically, the 1974 model Fox 78 is a development of a design that goes back about six years to the original Fox 60 and Fox 74 but we want to say, immediately, that the latest 78 is a far better motor Re-design has eliminated some of the more complex (some would say controversial) features of the early models, including their fabricated, selectively hardened steel connecting rods with caged needle bearings at both ends, their complicated triple-jet, three needle-valve carburetors and their unusual cylinder-heads with two glow plugs, each of a different

(Continued on page 83)

Engine is a development of earlier Fox 60/74 design but is much improved and has better performance.

type. However, certain distinctive Fox features are perpetuated in, for instance, the cylinder porting, piston, combustion chamber and throttle system and all this, combined with some more subtle changes, has resulted in an engine that is lighter, easier to handle and considerably more powerful.

A criticism that one could level against the early models was that they were rather heavy. Examples of the 74 and 60 that we checked in 1969-70 scaled 19.2 oz. and 19.75 oz., respectively. Fox advertising lists the 78 at 19 oz., but, in fact, it checks out at only 18.1 oz. which is modest for an engine that is nearly 30% larger in displacement than the average 60. It also means that the 78 offers a substantially higher power/weight ratio than the earlier large Fox motors.

DESIGN AND CONSTRUCTION

Body Casting. The 78 has a very solidly proportioned pressure casting that incorporates the crankcase, main bearing housings and full-length cylinder-block in a single unit, with massive beam mounting lugs that provide wide-based support and also serve to brace the engine's front end. It has a deeper bypass passage than earlier models and incorporates mounting lugs for a muffler but continues the earlier feature (now also found on the Eagle and the Fox 19 and 25) of a rectangular base on which the flange fitting carburetor is mounted.

Crankshaft and Bearings. The hardened steel crankshaft has a 15 mm. main journal and a ⅜" front journal and runs in steel-caged ball journal bearings, front and rear. The shaft has an intergral ¼" dia. solid crankpin and a 10.5 mm. i.d. gas passage fed from a rectangular valve port that is timed to remain open for some 205° of crank angle, closing quite late at 57° after top dead center. The shaft end terminates in a 5/16" UNF thread. The prop driver is of steel, mounted on an aluminum split taper collet and is recessed to fit over the crankcase nose and protect the front bearing.

Cylinder-Sleeve and Head. The hardened drop-in cylinder-sleeve has six exhaust ports, timed to open and close at 70° each side of BDC and four bypass ports timed to open and close at 60° each side of BDC. The sleeve has a 1/16" wall thickness and, typically Fox, port areas are large, the exhaust ports extending around the bore well beyond the usual 180° limit to almost meet the bypass ports.

The sleeve is located vertically in the cylinder casting by the usual top flange and the cylinder head is channeled to fit over this and make the head joint via a .010" aluminum gasket. The head is produced from a permanent mold casting but is extensively machined, including the fins; only the modified wedge pattern combustion chamber surface is left as cast. The long-reach Fox bar type glow plug is inclined at 15° to emerge flush with the surface of the wedge and the head is secured with six Phillips screws.

Piston and Connecting Rod Assembly. Like the Fox Eagle 60, the 78 continues to employ two compression rings, rather than the single ring now widely used by other makes. As we remarked in our report on the Eagle, there are arguments for and against both types: the single ring can claim lower frictional losses; while two rings have the advantage of better thermal bridging to carry away piston heat. Duke Fox also considers that two rings hold compression better, particularly for hot starts.

The piston is of conventional design with a straight baffle on a flat head and a plain skirt with just a shallow cutaway in the forward edge to enable it to clear the shaft counterbalance at bottom dead center. The ¼" o.d. wristpin is tubular, very light and is located by snap-rings in the piston. The conrod is bronze bushed at the crankpin end, has an oil hole at the top and a slit at the bottom and is 1-11/16" between centers.

Carburetor and Exhaust Valve. The carburetor looks identical with that of the Eagle 60 but closer examination reveals that the choke has been opened up from 0.375" to 0.400" and the throttle valve slimmed down approximately .025", in order to increase the effective choke area in accordance with the 78's larger displacement. All other parts (i.e., needles, screws and arms) are interchangeable with those of the Eagle.

The carburetor is of the automatic fuel metering type. That is to say, once it has been correctly adjusted, the amount of fuel released by the carburetor into the engine is automatically varied in accordance with the throttle opening, so that an approximately constant and correct air/fuel mixture strength is maintained at all times. Maintaining mixture strength within narrow limits is vitally important as, outside a certain ratio of air and fuel, the mixture will not fire properly and the engine will cease to run.

Automatic fuel metering is now a common feature of the larger R/C engines but Duke Fox, never content to merely copy the ideas of others, has his own opinions as to how this should be done. The Eagle 78 carburetor incorporates two jets and two needle-valves, and fuel is delivered to the carburetor through an inlet on the left side of the body at the front. It then takes separate routes to the idling jet and main jet.

First, fuel for the idling mixture flows to a jet drilled directly into the carburetor throat and the actual amount released is adjusted by means of a small needle screw on the right side.

Secondly, fuel for the high speed mixture is conveyed through a feed hole drilled through the carb body well over to the left side where, instead of being released, it is picked up by a hole in the cylindrical surface of the throttle rotor valve and directed into the interior of the rotor. From here, it is discharged through the main jet located in the center of the flat section of the rotor. The actual amount of fuel passing through the main jet at full throttle is controlled by the large needle screw installed in the left-hand end of the throttle barrel.

Setting up this Fox carburetor is quite simple. The idea is to set the idle mix first, since only this jet is in operation when the engine is idling, and to then open the throttle and readjust the main jet for the required high speed mix.

Mixture strength at intermediate speeds is taken care of automatically by a fine tapered groove which extends from the pick-up hole in the surface of the throttle rotor valve. As the throttle valve is rotated and the main feed and pick-up holes are no longer aligned, a progressively reduced quantity of fuel is metered, via the tapered groove, to the main jet to match the reduced volume of air drawn in.

To help maintain reliable idling, especially in the absence of a muffler, the 78 includes a coupled exhaust valve system. This consists of a steel semi-rotary baffle enclosed within the large rectangular exhaust stack and coupled to an arm on the right side of the carburetor throttle.

The Fox 'D' size muffler fits the 78, but our review samples were supplied without a muffler. We understand that in order to reduce the risk of damage to the engine casting in a crash, an improved muffler and/or fixing method will be devised, but this was not available at the time of testing. Our tests were therefore carried out with the engine in standard open-exhaust form.

PERFORMANCE

Few engines, nowadays, are test run by manufacturers before being shipped out to distributors and dealers, so it is both surprising and reassuring to learn that *every* Fox 78 is run up to full power before it leaves the factory. The instruction leaflet states that prolonged bench running is unnecessary and merely advises the new owner to make his first few flights on a rich mixture setting.

We began by giving the 78 a series of short rich runs using a mild 3 to 1 break-in mix of methanol and castor oil totalling about sixty minutes to insure that it was reasonably well loosened up. We then switched to our standard R/C test fuel containing 5% nitromethane and ran an initial series of torque tests before substituting the recommended Fox Missile Mist fuel which has a substantially higher nitro content.

As expected, Missile Mist gave the best performance, both as regards general handling and running qualities and power, comfortably reaching 1.5 bhp at just short of 14,000 rpm, but, even on 5% nitro, the maximum output was almost 1.4 at a very slightly lower peak.

Where the 78 really scores, however, is in the high torque that comes from its bigger displacement. This reached a maximum of 134 oz.in. at around 7,500 rpm on Missile Mist and was still showing 120 oz. in. at 12,000 rpm. In terms of aircraft performance, this means that the 78 has the ability to pull big diameter props and thereby develop the sort of thrust needed to get a heavy model off the ground.

For example, we had it turning a 14×6 Top Flite maple on Missile Mist at an impressive 10,200 rpm, a 14×4 Top Flite at 12,200 and a 12×6 Top Flite maple at 12,400 rpm. Bigger sizes than 14×6 are not too easy to find, but the 78 is quite capable of turning them if need be. For instance, we also checked it on 15 and 16" diameter

British-made Punctilio props. It showed no distress at being loaded down to speeds of 8,500 to 9,000 on these props but is, perhaps, at its most useful on something like a 14×6 which, even on 5% nitro, it turned faster than any engine previously tested with the exception of the Ross four-cylinder.

If you want to fly the 78 in a pattern model, there is nothing to stop your doing so, provided that you can accommodate a larger fuel tank. The minimum prop size we would suggest here would be an 11×8. Here, on equivalent fuel, the 78 was still just a bit faster than the best of the high-performance Schnuerle-scavenged R/C 60's tested to date. On anything smaller, its advantage, as expected, disappeared.

Handling and running qualities of the 78 were good. From the very first, we found it easy to start (by which we mean *hand* start—it goes without saying that it starts well enough with an electric starter) on all usable props. The carburetor was easy to adjust and, as we found earlier with the Eagle, gave a steady idle and good midrange response. In our report on the Eagle, we criticized the carb's plain fuel inlet nipple as having a tendency to allow the delivery tube to slip off. Duke Fox recommends the use of a rubber or neoprene fuel line to prevent this from happening and we found that this does help, especially if the tube is mounted dry.

In many ways, the Fox 78 is unique. The O.S.80 is comparable but has a rear intake so, for anyone wanting a front rotary-valve motor capable of developing high power, especially on props of 14" to 16" diameter, the 78 is the *only* solution at the present time. We think it is an eminently satisfactory one all the same.

SUMMARY OF DATA

Type: Single-cylinder two-stroke cycle with crankshaft rotary valve and twin ball bearings. Throttle type carburetor with coupled exhaust restrictor.

Weight: 18.1 oz. (less muffler)

Displacement: 0.7854 cu.in. or 12.87 c.c.

Bore: 1.000"

Stroke: 1.000"

Stroke/Bore Ratio: 1.00:1

Specific Output (as tested, less muffler):
1.76 bhp/cu.in. on 5% nitromethane fuel
1.91 bhp/cu.in. on Fox Missile Mist fuel

Power Weight Ratio (as tested, less muffler):
1.22 bhp/lb. on 5% nitromethane fuel
1.33 bhp/lb. on Fox Missile Mist fuel

List Price: $84.95

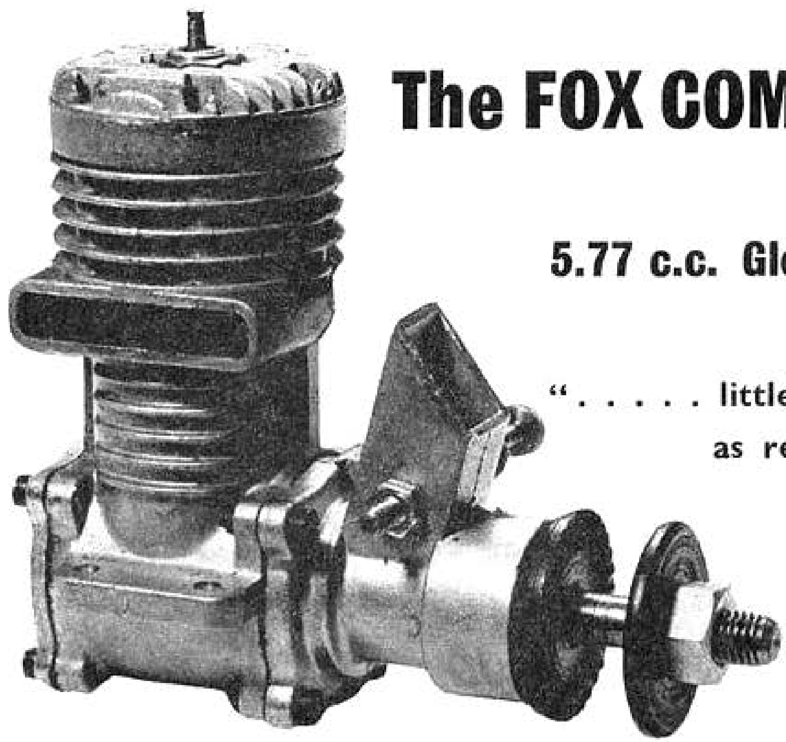
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, AR 72901. ■

engine made adjustment quite safe.

Maximum torque reached by the Viper was just over 13 oz. in. (0.068 lb. ft.) at between 9,000 and 10,000 r.p.m. The torque curve declined evenly and gave rise to a maximum horsepower of 0.162 b.h.p. at between 15,500 and 16,000 r.p.m. This, needless to say, is exceptionally good for a 1.5 c.c. motor. Prop speeds included 9,200 on a KK nylon 9 × 4, 10,950 on a KK nylon 8 × 4, 12,000 on a Top-Flite 8 × 3½, 14,100 on a 7 × 4 Power Prop and 17,900 on a Frog 6 × 4.

Power/Weight Ratio (as tested): 0.63 b.h.p./lb.

Specific Output (as tested): 109.5 b.h.p./litre.



The FOX COMBAT SPECIAL

5.77 c.c. Glo-plug motor

". . . . . little short of phenomenal as regards power output."

IN the U.K., C/L combat models are limited to engines of 3.5 c.c. maximum and the usual choice is a 2.5 or 3.5 c.c. diesel, for which peak outputs range between 0.28 and 0.40 b.h.p. In contrast, American rules permit 0.35 cu. in. (5.8 c.c.) motors and the popularity of combat events has led to the development of special "combat" versions of 0.35 stunt glowplug engines in which power outputs on suitable "hot" fuels have been raised to the 0.65-0.75 b.h.p. bracket.

In general, the main differences between the "stunt" and "combat" 35's, are to be found in the latter's opened up intake system. Carburettor venturi inserts are enlarged or discarded entirely, valve apertures and crank shaft ports are enlarged and/or altered in shape and the gas passage through the shaft is usually enlarged also. To compensate for the loss of fuel suction resulting from large carburettor choke areas, it is usual to employ a pressurised fuel system. The most common solution here is to utilise the positive pressure differential within the crankcase by means of a small nipple in the backplate, conducting the low pressure so obtained to a sealed fuel tank via fuel tubing.

The Fox Manufacturing Company Inc., of Fort Smith, Arkansas, have, of course, been well known for their 0.35 class stunt engines for many years and they were among the first to introduce a combat version with their original black-head Combat 35. More recently, however, they have designed and put into production a completely new engine designated the Fox "Combat Special" which moves further away from the basic 35 stunt layout retained by all previous combat engines and, in so doing, presents an entirely new standard of 0.35 cu. in. performance.

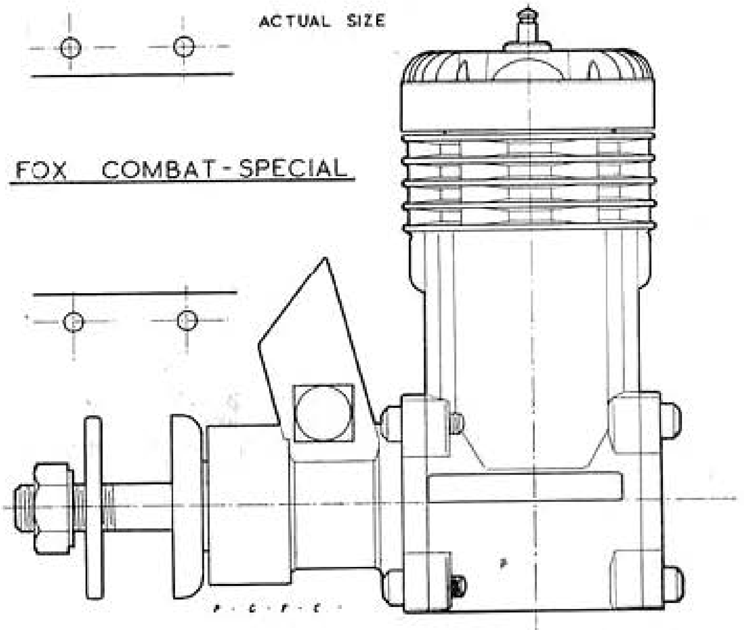
The Combat Special, the subject of this test report, is, in fact, little short of phenomenal as regards power output. Our test sample, which we ran in from new and which was absolutely standard in all respects, reached 0.87 b.h.p. on 30 per cent. nitromethane. This, equal to a specific output of over 150 b.h.p./litre, is comparable with the highest levels yet reached with model i.c. engines, irrespective of type.

The most original and interesting feature of the Combat Special is its use of needle bearings to support the crankshaft. Unlike previous Fox 35's, the main bearing housing is not an integral part of the main casting. The main casting, comprising crankcase and cylinder block only, is basically the same as that used for the black-head Combat 35 and the cheaper red-head Rocket 35 models, but is modified with four-point lug and flange mounting for the new bearing housing. Each bearing consists of 27 needle rollers in a steel race, the needles running in contact with each other and with the shaft journal which is surface hardened to Rockwell C-62 for satisfactory operation with these bearings.

As one would expect, porting is generous and in accordance with the latest developments. The square-sectioned carburettor has internal dimensions of ⅜ in. × ⅜ in. and opens into a rectangular valve aperture which registers with a rectangular valve port in the shaft. This gives rapid opening and closing of the rotary valve to make full use of the 180 deg. induction period and large bore (¼ in.) gas passage. The exhaust port occupies 180 deg. of the cylinder circumference and is 3/16 in. deep. The very deep transfer port (5/16 in.) overlaps approximately five-sixths of the exhaust port depth to give very advanced transfer opening.

The cylinder liner is of leaded steel and, in contrast to a trend in European diesel design, wall thickness is quite modest—only 0.037 in. It is an easy push fit in the main casting, being located at the top by a flange which also makes the head joint, via a 10 thou. aluminium gasket recessed into the diecast and machined cylinder head. Internal head shape has been modified by comparison with previous Fox 35's. Compression ratio is high at 12 : 1. The piston, with 5/32 in. dia. tubular gudgeon pin, is notably light in weight.

In accordance with usual Fox practice, a Desaxé cylinder arrangement is used—i.e. the cylinder is offset to the exhaust side relative to the crankshaft.



Specification

Type: Single-cylinder, air-cooled, loop scavenged two-stroke cycle, glow-plug ignition. Crankshaft rotary valve induction. Baffle piston. Central ignition plug.

Bore: 0.800 in. Stroke: 0.700 in.

Swept Volume: 0.3519 cu. in. = 5.767 c.c.

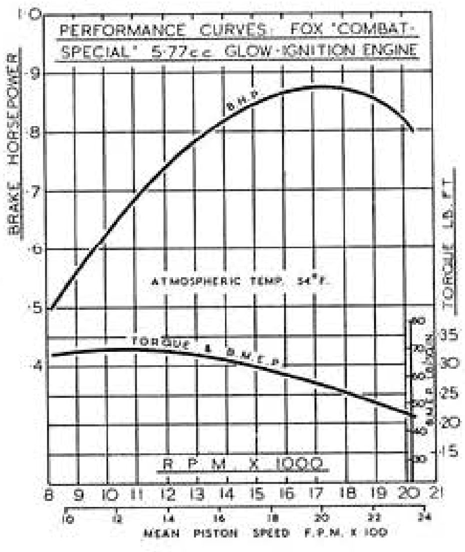
Stroke/Bore Ratio: 0.875 : 1.

Compression Ratio: 12 : 1.

Weight: 7.5 oz.

General Structural Data

Pressure diecast, silicon aluminium alloy crankcase and cylinder unit with leaded steel cylinder liner. P.d.c. silicon aluminium alloy front bearing housing containing two ½ in. i.d. needle-bearings and attached to main casting with four Phillips screws. Counter-balanced ½ in. journal alloy steel crankshaft with 7/32 in. dia. hollow crankpin and case hardened to Rockwell C-62. Lightweight Meehanite piston with fully-floating tubular 5/32 in. dia. gudgeon-pin, case hardened and fitted with brass eyelet end pads. Connecting rod of 24ST alloy with plain unbushed eyes. P.d.c. silicon aluminium alloy finned cylinder head with recessed 0.010 in. soft aluminium gasket and secured to cylinder with six Phillips screws. Pressure diecast silicon aluminium alloy crankcase backplate with central brass nipple for fuel tank pressurisation and attached with four Phillips screws. Steel drive washer splined to crankshaft. Brass spraybar with one-piece steel needle and double spring ratchet device. Beam mounting lugs.



Test Engine Data

Running time prior to test: 4 hours.

Fuel used: KK Record Super-Nitrex (30 per cent. nitromethane).

Ignition plug used: Maker's 1.5 volt as supplied.

Performance

One of the most pleasing characteristics of the Combat Special is its remarkably easy handling qualities. Starting was as straightforward and trouble-free as anything yet encountered in the .35 class. When starting from cold, an exhaust prime invariably gave a quick start and, with the engine hot, two or three flicks were usually the only preliminary to a rapid restart. With pressure feed, intake choking is, of course, ineffective, and the preliminary flicks serve to pump the fuel through from tank to carburettor. If the engine is stopped with a partly filled tank, however, it is necessary to remember that residual pressure in the tank may tend to flood the carburettor unless the needle valve is closed. The best way to stop the engine and, at the same time, avoid this risk is to release the tank pressure.

The ultimate performance that can be realised with the Combat Special is largely dependent on the fuel used. For normal use, Fox recommend a blend containing 20 per cent. nitromethane but state that the engine's construction is such that there is practically no limit to the amount of nitromethane that it will take under suitable conditions and when really well run in. In other words, given ideal climatic conditions, one might use 50 or 60 per cent. nitro to gain absolute maximum power output. For our tests, a 30 per cent. nitromethane mixture was chosen.

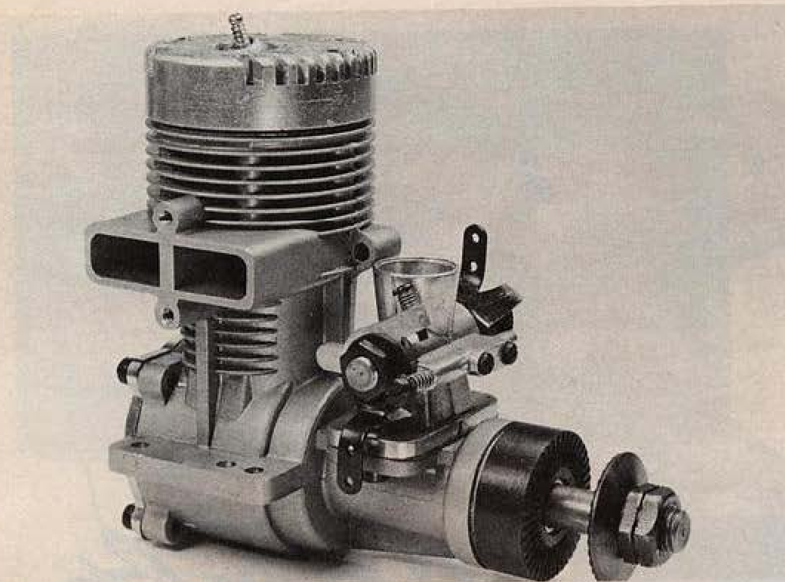
Under these conditions, the Combat Special developed a maximum torque of 0.33 lb. ft. at 11,000 r.p.m. which, equivalent to a brake mean effective pressure of just over 70 lb./sq. in., is unsurpassed by any engine yet tested in this series and gives a clear indication of the very high power available even at speeds well below the peak. Actual maximum horsepower reached was, as already mentioned, some 0.87 b.h.p., this occurring at between 17,000 and 18,000 r.p.m.

The ability of the Combat Special to run happily at speeds well in excess of this already high peaking speed is quite remarkable. We had our test motor up to 20,000 r.p.m. At this speed it was smooth and absolutely steady. As a matter of interest, the Combat Special turned a PAW 9 × 4 prop at 16,900 r.p.m., a 9 × 6 at 13,300 and a 10 × 6 at 12,500.

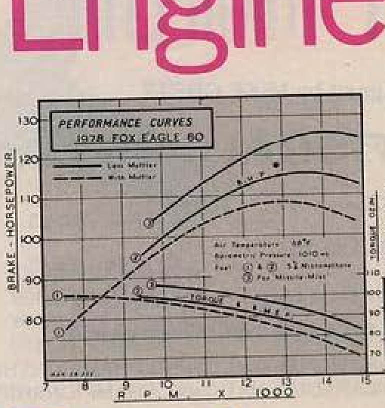
Power/Weight Ratio (as tested): 1.86 b.h.p./lb.

Specific Output (as tested): 151 b.h.p./litre.

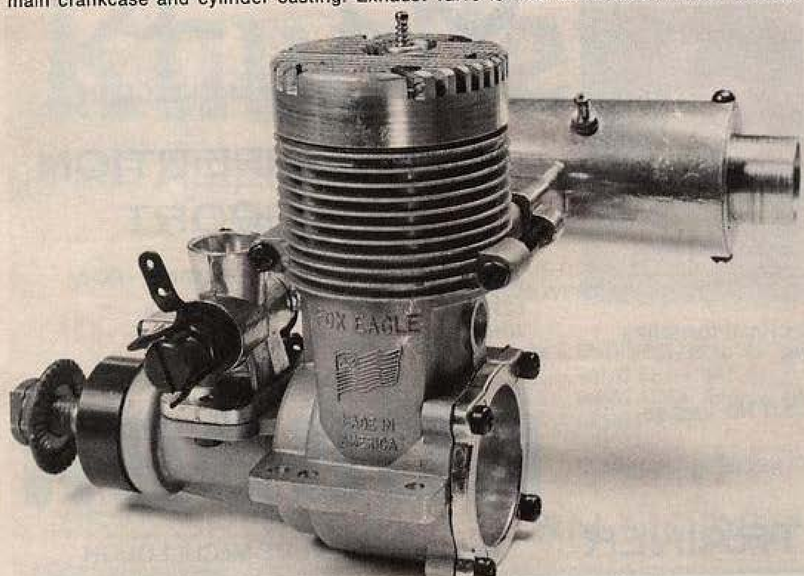
Engine Review



In place of tumble-polished finish of earlier Eagles, new model has neat bead-blasted main crankcase and cylinder casting. Exhaust valve is also eliminated on new version.



BY PETER G. F. CHINN



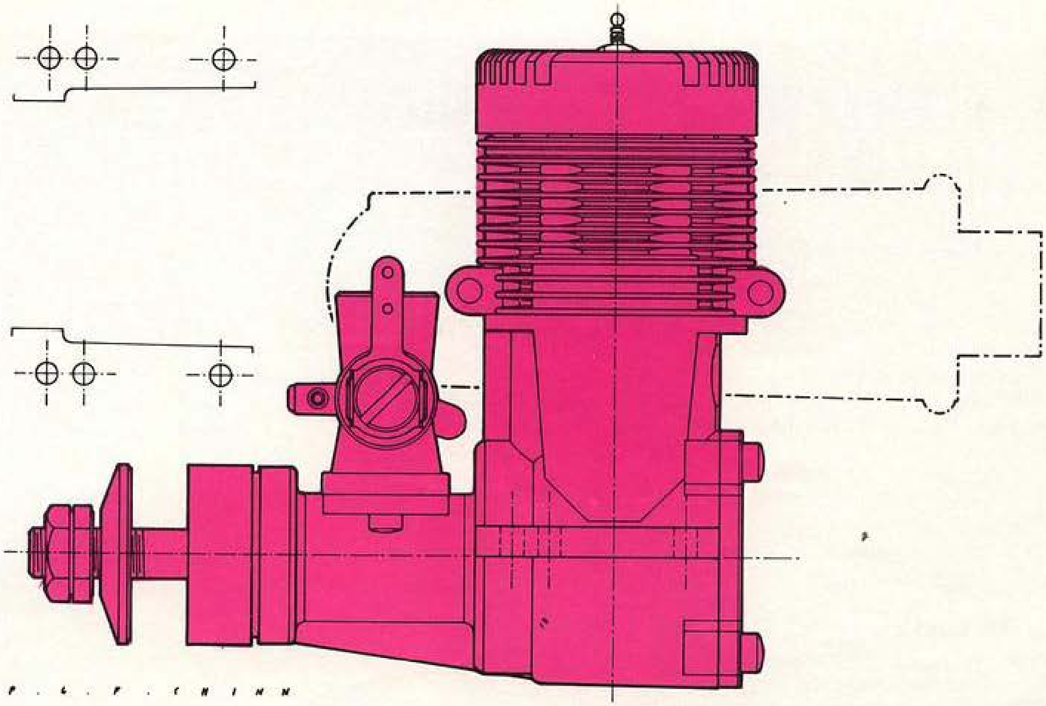
Export version of new Eagle has a modified cylinder head, with the glow plug installed vertically and very close to the exhaust side of the cylinder—note the new muffler.

• Not everyone who buys a .60 cu. in. R/C engine needs upwards of 1.5 HP. The average Sunday flier who uses a .60 generally does so because that is the displacement required to turn the size of prop specified for the model in question—for example, an 11 x 7½ for an aerobatic model or a 12 x 6 or 13 x 5 for a scale job. Unless the model is excessively overweight, it will perform adequately on any of the .60 cu. in. motors on the market, and the only advantage—if it is an advantage—of using a more powerful engine is that the model will fly faster and climb quicker.

Obviously, the more expensive Schnuerle-scavenged engines have their uses, and we are not about to suggest that the Hanno Prettners and Dave Browns of this world should discard their Webra Speed 61's and O.S. 60 FSR's. What we are saying is that the ordinary modeler can get

New, stronger main casting features larger diameter crankcase to provide clearance for new connecting rod. Backplate is also new.

New, sturdier conrod has bronze bushed lower end. Piston is unusual in continued use of two rings. Standard head is shown here.



New, improved version of Duke Fox's popular Eagle costs only half as much as some .60 engines. Now also obtainable in Export version, for operation on straight fuel.

by very nicely with a motor costing a whole lot less—50 percent less, in fact.

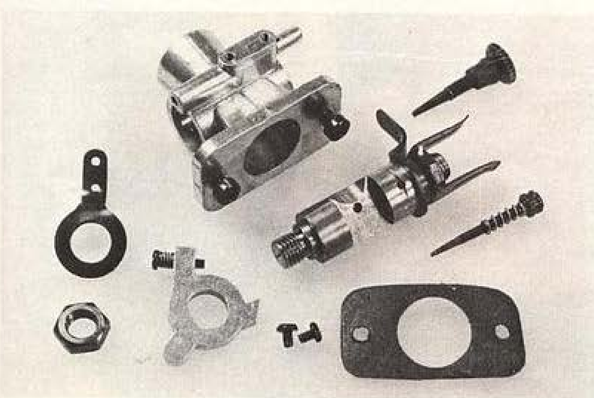
Engine prices vary a good deal these days, with list prices running up to $120 or so but, generally speaking, even at a substantial discount, you will have to pay around $90 for one of the favored Schnuerle-scavenged 60's. In contrast, the subject of our report this month, the latest Fox Eagle 60, is listed at $64.95 and can be found for as low as $42 to $44. This, it would seem, makes the Eagle just about the lowest priced .60 on the United States market at the present time.

The Eagle is not a new engine. In its original production version, it first appeared more than six years ago, and this is one of the reasons why its price remains so competitive. Tooling for a new engine now costs a great deal more than it did in 1971-72. Add to this the fact that the manufacturing costs of a conventional crossflow scavenged engine, like the Eagle, are less than for a Schnuerle-scavenged motor, and you see why Fox can offer the Eagle at such a modest price without cutting corners on quality. Quality has, in fact, been improved, compared with the 1972 model featured in the *M.A.N.* "Engine Review" series in that year. The current model has, for example, a modified crankcase, a modified muffler, a new backplate, a new conrod and a number of subtle internal modifications. Its appearance is also improved with the adoption of a bead blasted main casting finish and a new head.

For 1978, purchasers also have the option of an export model. This had a modified cylinder head, aimed at making the engine more suitable for operation on the straight methanol/castor oil fuels in use in some overseas markets.

As with most, if not all, Fox motors, there is little risk of the Eagle's being accidentally mistaken for another make. In our earlier article, we mentioned that, in the course of a conversation some years ago, Duke Fox told us that he disapproves of copying the ideas of other engine designers and therefore tries to find a differ-

(Continued on page 101)



Carburetor. Tapered groove on throttle barrel meters fuel to main jet in center, according to throttle position. Separate idle jet.

Fox "C" type muffler improves moderate degree of noise attenuation, can be improved by adding fuselage mounted Fox Aftermuffler.

Engine Review

(Continued from page 61)

ent way of doing things whenever this is feasible. Although the Eagle is less unconventional than some other Fox designs, it still has certain features that set it apart from its competitors, such as its longer stroke, its very wide exhaust porting, its continued use of two piston rings and its distinctive carburetor design and method of installation.

Design and structural features of the 1978 Fox Eagle and Export Eagle models are as follows:

MAIN CASTING. The Eagle uses a one piece body unit, comprising the crankcase, front housing and full length finned cylinder jacket in pressure die-cast aluminum alloy. It has the usual beam mounting lugs, an exhaust stack on the right side with muffler fixing lugs and a saddle on the crankcase nose to which the flange fitting carburetor is attached.

The main differences between the crankcase of the original production model Eagle and the current version are as follows: First, the crankcase's outside diameter has been increased from 1.45" to 1.55", enabling its inside diameter to be enlarged from 1.30" to 1.37" for added conrod clearance while, at the same time, increasing crankcase wall thickness. Second (although this was actually first incorporated in the 1974 models), there are two muffler mounting lugs, fore and aft, in addition to the two above and below the exhaust stack. The case has also been beefed up in the region of the extra lugs and between the top two fins. Except for needing added clearance between the motor bearers to accommodate the wider crankcase, the mounting dimensions are unchanged and the six bolt hole locations remain the same.

CRANKSHAFT AND BEARINGS. The hardened steel crankshaft has a 15 mm o.d. main journal, a 3/8" dia. front journal and an integral 1/4" dia. solid crankpin. Counterbalancing is by means of web cutaways, each side of the crankpin, supplemented by a crescent counterweight. The shaft is bored 10.8 mm i.d. and has a rectangular valve port, 13 mm long, that is timed to remain open for 180 degrees of crank angle, closing at 45 degrees after top dead center. The shaft is supported in a 15 x 28 x 7 mm 9-ball steel-caged ball journal bearing at the rear and a 3/8 x 7/8 x 7/32 in., 7-ball steel-caged bearing at the front. Ahead of this and cupped to fit over the crankcase nose is a steel prop driver on an aluminum split taper collet. The shaft terminates in a 5/16-UNF thread.

CYLINDER AND PISTON ASSEMBLY. The most commonly used cylinder bore size with engines designed to come within the FAI 10cc (0.6102 cu. in.) displacement limit is 24 mm (0.950") which, when combined with a 22 mm (0.866") stroke, gives a stroke/bore ratio of 0.917. Variations of this are to be found in some American and British engines using 0.940" bore sizes (K&B, Kraft, Merco, Meteor) which, if combined with a 0.875" stroke, results in an S/B ratio of 0.931. Using a somewhat shorter stroke layout is the Hirtenberger HP 61, which combines a 24.5 mm (0.965") bore with a 21 mm (0.827") stroke for an S/B ratio of only 0.857, but the Eagle, like the later and more powerful Fox Hawk 60, continues to be successfully, if unfashionably, different by using a high stroke/bore ratio of 1.033, derived from a bore of only 0.907" and a stroke of 0.937".

Also unusual is the Eagle's cylinder porting. This, as already mentioned, is of the orthodox open-loop or crossflow scavenged pattern but, instead of the usual layout where the exhaust ports occupy rather less than half the cylinder circumference, the Eagle's ports, six in number, cover a total of approximately 205 degrees of the cylinder bore, extending well to the bypass side but separated from the four bypass ports by the piston baffle. Measurements of the test engine indicated a bypass period of 110 degrees of crank angle, with an exhaust period (slightly shorter than on the earlier Eagle) of 135 degress.

The piston, machined from an aluminum alloy casting, has a straight baffle on a flat head and is fitted with two conventional compression rings. The hardened tubular wristpin, located in piston bosses hung from the underside of the head, has an o.d. of 1/4" and is retained by internal snap rings in the piston.

A significant improvement made possible by the new crankcase casting is the sturdier connecting rod. The added clearance given by the larger crankcase i.d. has permitted the o.d. of the lower eye of the rod to be enlarged from 0.340" to 0.400", increasing its wall thickness by approximately 66 percent and enabling a bronze bush to be inserted.

CYLINDER HEADS. The machine-finished, pressure-cast cylinder head continues to use a curved, wedge shaped combustion chamber but now has fewer and deeper cooling fins. The standard head had the glow plug hole inclined so that the plug element is located approximately centrally, but close to the piston baffle slot. For the export model, the plug hole is repositioned upright and well over to the right, so that the element is as close as possible to the exhaust side of the cylinder. Both heads are fitted with recessed 0.014" soft aluminum gaskets and are secured with six Phillips screws.

BACKPLATE. The pressure-cast backplate has been enlarged to fit the new crankcase casting but is still embossed with the distinctive eagle emblem.

CARBURETOR. The special Fox carburetor is essentially the same as that fitted to a number of other current Fox motors in the .40 to .78 cu. in. group and, as its design has been dealt with in some detail on several previous occasions in these reports, it will be sufficient to remind readers that it incorporates a butterfly valve type throttle rotor, separate main and idling jets and an automatic fuel-metering device to ensure that an air/fuel ratio within the combustible mixture strength range of the fuel is maintained at all throttle settings. It has an effective choke area at full throttle of approximately 30 sq. mm.

MUFFLER. Early models of the Eagle had a semirotary exhaust restrictor valve linked to the carburetor throttle but, since it has become standard practice to use a muffler, an exhaust valve is no longer fitted. This, along with the two extra lugs mentioned earlier, enables the Eagle to be equipped with the later type Fox "C"-size muffler having a box extension that fits around the exhaust stack. The muffler consists of a pressure-cast outer chamber and a machined bar-stock baffle tube having nine entry slits totaling an area of approximately 216 sq. mm. on the side opposite the exhaust stack. The tube has an i.d. of ⅝", giving an outlet area of 198 sq. mm., and the total volume of the muffler is approximately 45cc.

PERFORMANCE. Our test motors, a standard domestic Eagle and an Export model, came direct from the Fox factory, were 100 percent stock and had not been broken in. They both needed about two hours' break-in time to loosen up sufficiently for testing to begin. We had already decided to use just one engine for all the tests, simply switching heads in order to determine the precise effect of the Export model's head. In fact, both engines were fairly evenly matched when running on the same heads.

The stock domestic head was used for most of the tests and some prop rpm figures were checked on 5 percent nitro fuel with this, and the muffler fitted. Figures recorded included 8,600 rpm on a 14 x 6 Top Flite Super-M, 10,600 on a 14 x 4 Top Flite standard, 10,800 on a 12 x 6 Top Flite Super-M, 11,800 on a 12 x 5 Power-Prop standard, 11,400 on an 11 x 7½ Zinger, 11,600 on an 11 x 7½ Power-Prop Super-M, 10,700 on an 11 x 7 Rev-Up wide blade and 12,800 on an 11 x 6 Power-Prop Super-M.

When we tested the earlier model Eagle, removing the original muffler added only a hundred or so rpm to the engine's speed on the lighter loads. Although the current muffler is basically the same, we now found that the Eagle gained an extra 200 rpm when loaded for speeds around 11,000 rpm, rising to an extra 300 rpm when the engine was loaded for speeds around the bhp peak. Just what this means in terms of torque and power output is indicated by the performance curves. A figure of 1.08 bhp at 13,000 rpm was recorded with the muffler, rising to over 1.15 bhp at 13,500 with the muffler removed.

These figures, as already stated, relate to the performance obtained on our standard 5 percent nitromethane test fuel. However, the manufacturer's instruction leaflet states that the Eagle was designed to operate on Fox Missile Mist fuel containing 25 percent nitromethane. The maximum bhp of the earlier Eagle was improved by approximately 10 percent when run on Missile Mist and a similar improvement was recorded with the 1978 model, raising the peak output to 1.26 bhp at around 14,000 rpm.

Switching to the Export model head, we discovered, resulted in a very slight reduction in power, and there would be little point in a domestic user opting for the Export-Eagle unless he wished to run the motor on straight fuel. The idea behind the Export-Eagle head is that it should keep the plug warm at idling speeds on straight fuel, without having to run the engine too lean. Some tests were run on a straight methanol/castor oil blend. The Export-Eagle ran well and idled satisfactorily. Revs under load were reduced by between 200 and 300 over the 11,000-14,000 rpm range: a very modest loss.

Handling and running qualities of the two Eagles were generally good. Until they were adequately broken in, they ran quite hot, and it was important to maintain a rich setting on the needle valve. We would suggest that, if owners wish to break in their Eagles in the air, the main needle should be set, initially, as rich as is consistent with the power required to get the model airborne and that, during the first two hours of running time, the throttle should be used freely to allow cooling down periods between the bouts of full-throttle operation.

The carburetor itself is easy to set up and, once this was done, throttle response was found to be excellent. The thing to bear in mind when adjusting the Fox two-jet carburetor is that, unlike nearly all other model carbs, it is necessary, when finalizing adjustments, to set the idle first (since the main jet is shut off when the throttle is rotated to the idle position) and to then adjust the main needle for maximum power with the throttle wide open. Obviously, adjustments can be finalized only after the engine has been fully broken in. The engine should then idle safely in the 2,400 to 2,600 rpm bracket on 11" and 12" props, with instant pick-up and good mid-range operation. Incidentally, there are throttle arms on both sides of the carb, and these can be adjusted to respond to either a push-to-open or pull-to-open servo setup.

One small criticism concerning the carburetor, and one that we have mentioned before, is that the plain fuel inlet nipple has a tendency to allow the fuel line to slip off. To reduce the risk of this happening, the use of neoprene-type fuel tubing (mounted dry), rather than the now more widely used silicone type, has been suggested. However, we have found a better solution. This is to fit an ⅛" i.d. x 3/16" o.d. spring washer over the nipple (a very fine groove can be filed around the nipple to locate it), about 1/16" from its end. Silicone tube can be pushed over this and will close up again on the other side, making a secure airtight joint.

At the conclusion of our report on the original Eagle, back in 1972, having detected some liberty in the rod bearings at the end of the tests, we voiced the thought that it might have been better to use bronze bushings, but recognized that such a modification was difficult in view of the limited clearance within the crankcase. We now have our answer. The new Eagle has a bronze-bushed rod bearing at the crankpin end, the crankcase having been enlarged to accommodate it. This time, our concluding examination revealed an engine in perfect condition. All bearing surfaces were excellent, as were the piston, rings and cylinder bore.

At today's prices, both the Eagle and its stablemate, the more powerful Fox Hawk 60 (*M.A.N.*, March 1975), are, we think, very good value.

SUMMARY OF DATA

Type: Single-cylinder, crossflow scavenged, two-stroke cycle, with crankshaft rotary valve and twin ball bearings. Fox throttle type carburetor with automatic mixture control. Muffler optional.

Checked Weights: 14.2 oz. (less muffler)
17.1 oz. (with muffler)

Displacement: 0.6054 cu. in. or 9.921 cc

Bore: 0.907 in. (23.04 mm)

Stroke: 0.937 in. (23.80 mm)

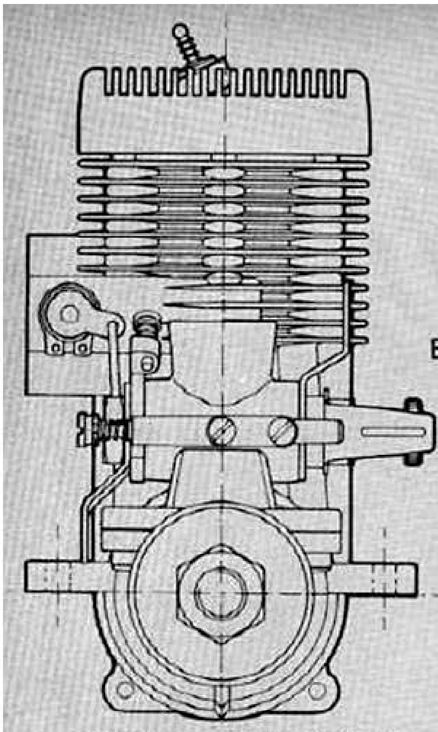
Stroke/Bore Ratio: 1.03:1

Measured Nominal Compression Ratio: 10.5:1

Specific Output (as tested):
1.78 bhp/cu. in. on 5 percent nitromethane, with muffler
1.91 bhp/cu. in. on 5 percent nitromethane, less muffler
2.08 bhp/cu. in. on Fox Missile Mist, less muffler

Power/Weight ratio (as tested):
1.01 bhp/lb. on 5 percent nitromethane, with muffler
1.30 bhp/lb. on 5 percent nitromethane, less muffler
1.42 bhp/lb. on Fox Missile Mist, less muffler

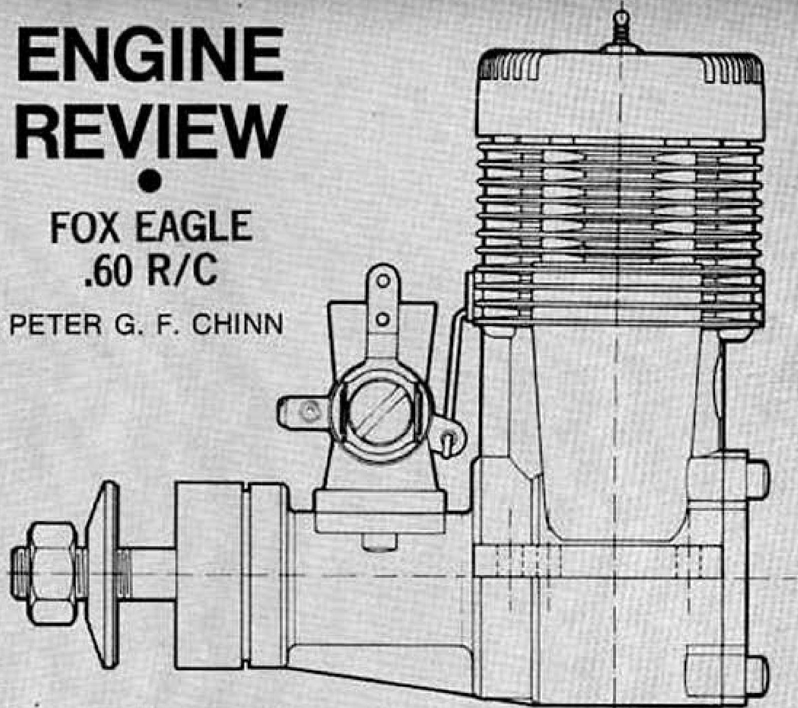
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Ark. 72901. ■



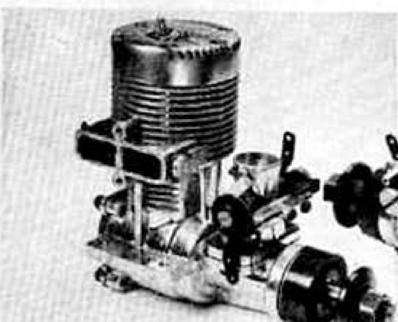
ENGINE REVIEW

FOX EAGLE .60 R/C

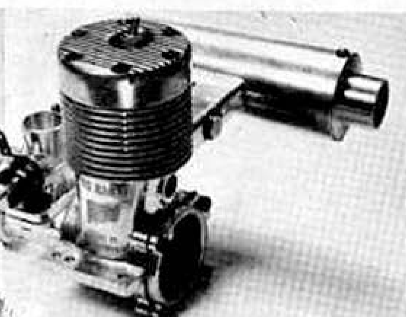
BY PETER G. F. CHINN



Duke's new R/C 60 offers strong challenge to imports in both price and performance. Excellent throttle with good range, good price, with an optional muffler.



Fox carburetor gave excellent results on test. Has two needle valves but is easy to adjust.



Fox muffler causes negligible power loss and enables coupled exhaust valve to be retained.

• Over the past few years, the majority of .60 class R/C engines sold in the United States have been of foreign manufacture. The reasons for this state of affairs are several. Firstly, these products come from half-a-dozen countries and there are many more of them, thereby offering the prospective purchaser a wider choice. Secondly, many of them have been cheaper than an American equivalent. Thirdly, in some instances, an imported engine has been able to offer an edge in performance.

The new Fox Eagle 60 should do much to redress this imbalance.

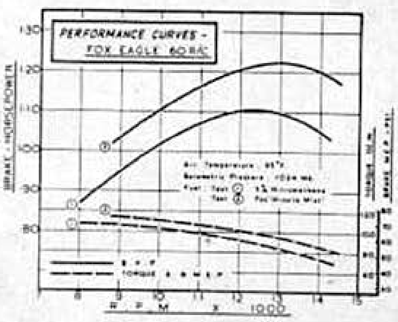
For a start, the Eagle, listed at $49.95, is priced lower than almost any of the imports. At the same time, if our example is typical, it achieves a level of performance which puts it on a par with most of the more costly foreign 60's. Add to this the advantage of owning a domestically-produced engine (for which continuity of spare parts supply and servicing should be better) and you have some excellent reasons for giving the Eagle serious consideration if you are in the market for a new 60.

The Eagle is a totally new Fox model. Admittedly, it bears certain family resemblance to the previous Fox 60 R/C introduced some four years ago that was also offered in a .74 cu. in. size (and was later to form the basis of the now current Fox 78) but the new Eagle is unquestionably a far better motor. The older model, by reason of the necessity to use basic parts common to a substantially larger displacement option, was both heavy and bulky for a 60. The Eagle is much more compact and is *five ounces lighter*, yet has more power and better handling qualities.

Duke Fox, designer/manufacturer of Fox motors, has never been content to slavishly follow established design trends. In conversation, he once admitted to us that, wherever possible, he tries to be different and disapproves of

(Continued on page 72)

Disassembled, Eagle shows interesting blend of contemporary and traditional, Fox originality.



copying the good ideas of others. A worthy approach and one that, from time to time, pays off with a highly successful new engine. In some respects, the Eagle 60, following on the long-established Fox 59 and the previous Fox 60 R/C, moves a little closer to contemporary practice, but it still has many features that set it apart from most other current R/C 60's. These are externally visible in the design of the main casting with its unusual method of carburetor installation and in the design of the carburetor itself. Inside, there are many other features which go against current trends, as we shall see from the following description.

Practically all the 10 c.c. (.60-.61 cu. in.) R/C engines produced throughout the world at the present time have "over-square" cylinders—i.e. a cylinder bore that is larger than the piston stroke measurement. The most widely used combination is a 24 mm. bore with a 22 mm. stroke or 0.945 x 0.866 in. British and American 60's built to English measurement usually have a nominal 15/16 in. x 7/8 in. or 0.940 in. x 0.875 in. measurement. One or two foreign engines have a still shorter stroke: the HP 61, for example, using a 24.5 x 21 mm. (0.965 x 0.827 in.) combination. By contrast, the Fox Eagle has an "undersquare" or long-stroke set-up, the bore being only 0.906 in. and the stroke 0.937 in.

There are many points in favor of both short-stroke and long-stroke configurations in internal-combustion engine design, depending very much on the type, size and duty for which the engine is intended but, so far as model engines of the type presently under consideration are concerned, it is doubtful whether the arguments, pro and con, have any great significance and this seems to be borne out by the fact that the performance characteristics of the Eagle (stroke/bore ratio 1.034) are not demonstrably different from those of a typical European high performance 61 having an S/B ratio of 0.917. It would seem that the 12.7 percent higher S/B ratio of the Fox is not a sufficiently large departure from normal practice as to suggest any marked advantage or disadvantage.

Cylinder porting on the Eagle is of the open loop type but, in contrast to the usual crossflow scavenged arrangement where the exhaust ports occupy rather less than 180 degrees of cylinder circumference, the Eagle's ports follow the tradition of the Fox 59 by extending well to the bypass side and they actually cover some 205 degrees of the bore. The exhaust port area is 50 percent greater than the bypass area. There are six exhaust and four bypass ports, all 0.190 in. wide by 0.220 in. deep. As regards timing, there is a somewhat longer blow-down period than one finds with most non-piped two-cycle model motors, the exhaust remaining open for 140 deg. of crank angle against only 110 deg. for the bypass period. The cylinder-head, machined from a pressure casting, has a modified wedge pattern combustion chamber with an inclined ignition plug. A recessed 15 thou. aluminum gasket is used and the head is secured to the main casting with six screws.

Whereas most other recently produced ringed engines now use a single piston ring (sometimes of the low-pressure Dykes type), the Eagle employs two conventional rings. The argument against such an arrangement is that it causes greater frictional losses. In its favor is better piston cooling because of improved thermal bridging between piston and cylinder wall. The piston itself, being of smaller diameter than most, remains quite light. Complete with rings, it weighs 0.40 oz. or 0.48 oz. complete with its 0.250 in. o.d. lightweight tubular wristpin. The pin is retained by snap rings in the piston. The machined conrod, which has plain unbushed eyes and an oil-slit at the lower end, is also very light: only 0.15 oz.

One thing that the Eagle shares with most other front rotary-valve 60's is its use of a 15 mm. dia. crankshaft main journal. The shaft is supported in an American Fafnir 15 x 28 x 7 mm. 10-ball steel-caged ball journal bearing at the rear, supplemented by a ⅜ x ⅞ x 7/32 in. 7-ball steel-caged bearing at the front. The gas passage through the shaft is 10.7 mm. (27/64 in.) bore and is fed from a rectangular valve port. This registers with a rectangular induction port and is timed to open at 42½ deg. ABDC, closing at 45 deg. ATDC (our measurements). Ahead of the crankcase nose and cupped to fit over it and protect the front bearing is a steel prop driver. This is mounted on an aluminum split taper collet which, in contrast to the usual arrangement, is slipped over a short knurled (instead of plain) shaft section. The propshaft length is 5/16 in. dia.

As first featured on the Fox 60/74/78 series and, more recently, on the Fox 25, carburetor mounting is via a wide rectangular saddle formed on the crankcase nose. The carburetor has a base flange of the same size and shape and is secured with two screws. Apart from this unusual method of installation, the carburetor is similar in design to the Fox 5-A type fitted to the Fox 40 R/C dealt with in the March 1972 issue and works in exactly the same way. Of exclusive Fox design, it incorporates two needle-valves and an automatic fuel metering system to insure correct mixture strength throughout the throttle range. Its operation is as follows:

1. Fuel is fed to the engine through an inlet nipple cast into the front of the carburetor on the left side and, from here, takes two routes:

(a) Fuel for the low-speed mixture is conveyed to an idling jet drilled directly into the carburetor throat and the amount released through this is adjusted by means of a small needle screw at the front on the right hand side.

(b) Fuel for the main jet flows through a delivery hole in the carb body, well over to the left side, where it is picked up by a hole in the surface of the throttle rotor and conveyed into the interior of the rotor. From here it is discharged through the main jet located in the middle of the flat center section of the rotor. The amount of fuel metered to this jet is controlled by a large needle screw installed in the left-hand end of the throttle barrel.

2 (a) When the throttle is partly closed the pick-up hole in the throttle is no longer exactly aligned with the delivery passage. However, a fine groove in the surface of the rotor, extending from the hole, allows a reduced quantity of fuel to be admitted into the rotor and this automatically adjusts the fuel strength to intermediate throttle openings.

(b) Further rotation of the throttle rotor cuts off the fuel to the main jet entirely so that the engine now runs on its idling jet only.

The Eagle carburetor is equipped with two throttle arms, one each side, and is linked to a semi-rotary exhaust restrictor valve. This latter, enclosed within the exhaust stack, does not interfere with the fitting of the optional Fox muffler. Tapped lugs are incorporated above and below the stack for muffler attachment.

A Fox "C" size muffler with closed front was supplied for test with our Eagle. The outside dimensions of this muffler are quite small for a 60 size engine and it has a vast 5/8 in. i.d. outlet but is not as noisy as one might suppose. This is because it uses an inner perforated tube with entry slits on the side opposite the entry duct. The slits, nine in number, total an area of approximately 168 sq. mm., less than the outlet area (198 sq. mm.) but still very large — as large as the total outlet area of many open-front extractor type mufflers.

Our test model Eagle came direct from the Fox factory. It was given a two-hour break-in on straight methanol/castor-oil fuel before test figures were taken.

The first series of tests was conducted on our standard R/C test fuel containing 5 percent pure nitromethane. This added 200 revs to the static rpm on an 11x8 prop and resulted in a maximum torque of 104 oz. in. at 8,000 rpm and a peak output of just over 1.10 bhp at approximately 12,500 rpm. The Eagle has, however, been set up to perform best on a somewhat higher nitro content fuel, Fox Missle-Mist being the recommended mixture and a repeat series of tests was therefore undertaken on this fuel. The manufacturer states that, on Missle Mist, the Eagle produces approximately 1¼ horsepower. Our results were in close agreement with this estimate, a figure of approximately 1.22 bhp being determined at 13,000 rpm.

In terms of propeller speeds, the following figures were obtained on typical props: 9,300 on a 14x6 Top-Flite Super-M, 11,500 on a 14x4 Top-Flite standard wood, 11,600 on a 12x6 Top-Flite Super-M, 11,300 on an 11x8 Top-Flite Super-M, 12,200 on an 11x7 Top-Flite Super-M, 13,000 on an 11x6 Top-Flite Super M and 13,600 on an 11x6 Power-Prop Super-M. These figures were recorded with the Fox muffler fitted. Removing it had no effect on speed at the lower end and added only 100 rpm to the top end. This is better than Fox's claims. The overall performance indicated by the test figures is excellent and is particularly impressive in regard to the power available on the 12 to 14 in. dia. prop such as might be used for heavy scale-type models.

Overall handling and running qualities were good. Starting presented no problems even from new (thanks to well-fitting ground-finish piston-rings) and the throttle worked excellently with steady idling down to as low as 2,000 rpm on a 14x6 and with instant recovery. Adjusting the carburetor was found to be quite easy. Remember that, with the Fox two-jet system, it is necessary to adjust the idle first (since the main jet is shut off with the throttle valve in the idle position) and to then adjust the main needle with the throttle wide open. We have but one criticism of the carburetor. Since the fuel inlet nipple is parallel and has no pressure ring, there is a tendency for the fuel delivery tube to slip off, especially when wet with fuel. Helpful here is to wire the tube to the inlet after thoroughly drying both items. (This, of course, will necessitate using a tank with a separate filler tube as well as a vent tube.)

At the conclusion of the tests we stripped the Eagle to examine it for any signs of undue stress or wear and detected a slight amount of liberty in the conrod bearings. This was not excessive but was enough, perhaps, to make one wonder whether the use of bronze bushed, rather than plain, bearings might be preferable. It has to be realized, however, that the Eagle's longer stroke and consequently, restricted clearance within a normal crankcase diameter, does limit the dimensions of the conrod lower end, making it difficult to accommodate a bronze bushing. Apart from this, the engine was in faultless condition and the piston and cylinder-sleeve were very clean and virtually unmarked.

Unlike the previous Fox 60, the Eagle will fit the bearers of any model intended for any of the popular R/C .60 cu. in. engines on the market. At only 14.3 oz. (or under 16.9 oz. with muffler), the Eagle is also below average weight for a high performance 60 and consequently offers an excellent power/weight ratio.

Summary of Data

Type: Single-cylinder two-stroke cycle with crankshaft rotary-valve and twin ball-bearings. Throttle type carburetor with coupled exhaust restrictor. Muffler optional.

Weight: 14.3 oz. (16.9 oz. with Fox muffler.)

Displacement: 0.6041 cu. in. or 9.900 c.c.

Bore: 0.906 in.

Stroke: 0.937 in.

Stroke/Bore Ratio: 1.03:1

Specific Output (as tested):

1.82 bhp/cu. in. on 5% nitromethane fuel.

2.02 bhp/cu.in. on Fox Missile-Mist fuel.

Power/Weight Ratio (as tested):

1.23 bhp/lb. on 5% nitromethane fuel, less muffler.

1.36 bhp/lb. on Fox Missile-Mist fuel, less muffler.

1.04 bhp/lb. on 5% nitromethane fuel, with muffler.

1.16 bhp/lb. on Fox Missile-Mist fuel, with muffler.

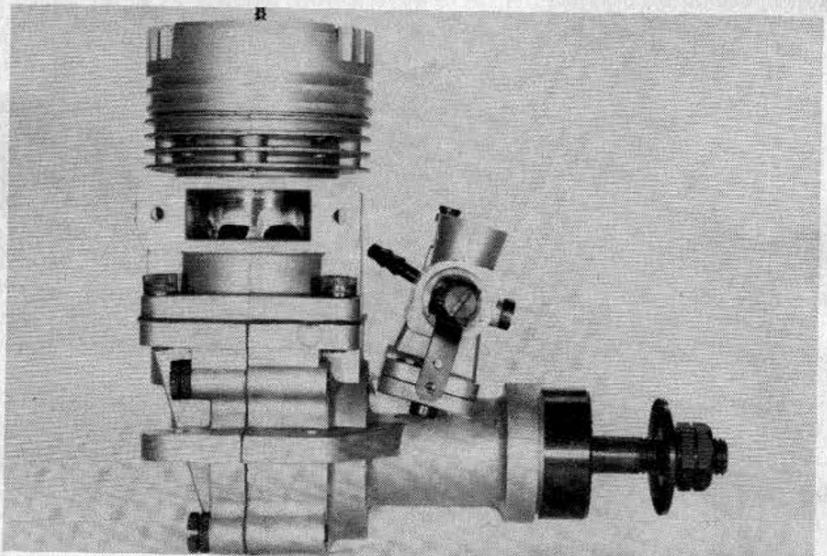
List Price: $49.95 ($58.90 including muffler).

The engine tests in this series have to date taken a look at products which could be considered in the outer fringes of the huge range of model engine sizes and performances. The time seems right (your editorial staff sacrifically offered an engine for the purpose) to undertake a formal test of a more "normal" engine.

However, the engine they sent turned out to be the latest Fox 10cc R/C motor, and there seemed to be no way that the engine from the prolific (seemily tireless) Duke could ever be "in the common mold". Characterized as they are by that huge individuality, has made them an apt expression of the American scene.

In this latest case, the unit looks more aggressively "motor" than many other more sleekly, manufactured affairs.

In addition to providing more substance to this report, both the side exhaust unit and the rear exhaust unit were jointly tested, with the findings shown on the graph. The first impression is that these most recent Fox products show evidence of those engineered requirements for ruggedness accumulatively tested over many years.



PHOTOGRAPHY: MIKE BILLINTON

An FM Engine Review:

Fox's Eagle II

Our engine expert reviews both side and rear exhaust types/**Mike Billinton**

Mechanicals

The three-part diecast alloy cylinder/crankcase (reminiscent of the 1940's Hornet and others of that period) atavistically signals a return to the tuned pipe era. Mechanical splitting allows the rear of side exhaust mode (used by appropriate machining of the bottom part) to be correctly aligned with the usual Schnuerle transfer passages. The built-up construction has also worked nicely with the structural layout of "big brother", the Fox 20cc horizontally opposed twin. The three pieces form a well fitted unit an the firm base and bottom two parts are attached accurately by four bolts in closely fitting holes. The top alloy cylinder section, in turn, is then held down to the solid base by four substantial allen bolts.

Although the Transfer passages in the upper cylinder unit are cast-in, their continuations down into the bottom end are milled out individually. So once committed in this way to either the side or rear exhaust styles, the motor should remain so. The resultant two main jointing faces are separated by gasket material and it seems adviseable when bolting the three-part unit together to do so gradually using all eight bolts sequentially. Even though there really should be none in the bottom half, this is to avert any possibility of slight misalignments. The liner (mild steel carbon-nitrided and .078" thick) is quite long and substantial consequently it plays its part in firming up the whole multi-part engine assembly. Honing is undertaken to give a "waisted" effect in the port belt area (a truncated hour-glass in Duke's words).

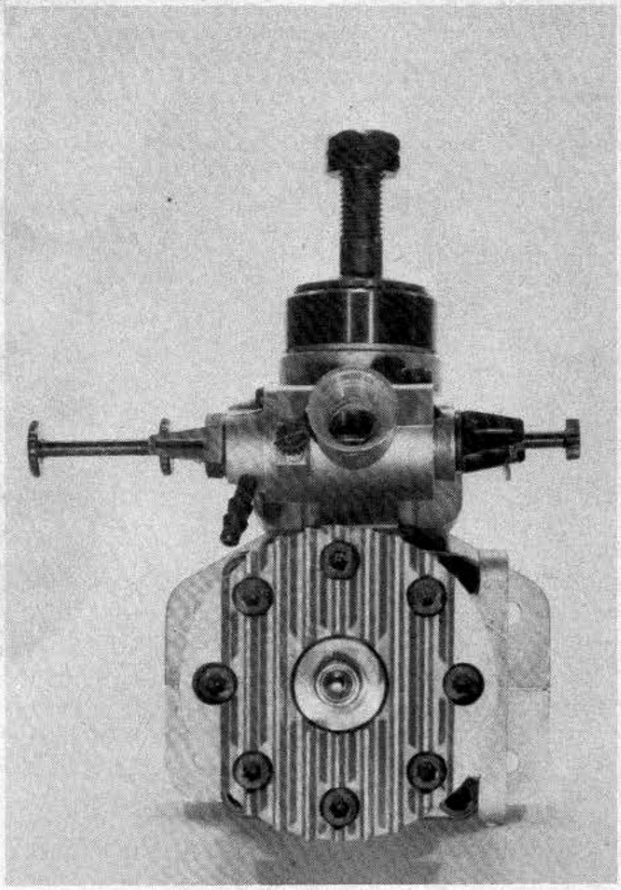
The boost ports are effectively larger in area than the transfers due to the shrouding effect the transfer passages have on the two side ports. Externally, the cylinder gives the impression of having massive side transfer passages, when in fact, their combined widths are just equal to the one boost passage. In the side exhaust motor, this relative bias of the boost side together with the unusual shape and high angle (30°) of the combustion chamber (virtually no flat squish either) results in a somewhat different look to the whole transfer and combustion set-up. It looks like another area in which the Duke would not follow the fairly tedious (but effective) norm. Oddly then, the rear exhaust motor uses a fairly normal flat squish of .15" width with a hemi bowl, but (unbowed). Fox then gives it an unusually large squish clearance of 40 thousandths.

The side exhaust timing is 142° which in standard form is more suited to open exhaust or normal silencer operation. For more effective results on tuned pipes the rear exhaust motor with its higher standard timing of 150° is more appropriate and factory recommended. The timings are advanced for the transfer and boost with the latter given 28° extra compared with the side exhaust motor. As photos show, the cylinder head is the two-piece variety with the turned aluminum alloy "button" being held down onto the liner tip flange (a thick ⅛") by a large, strong, upper head casting having deep widely spaced fins. The X-section of these is tapered in the classically correct manner.

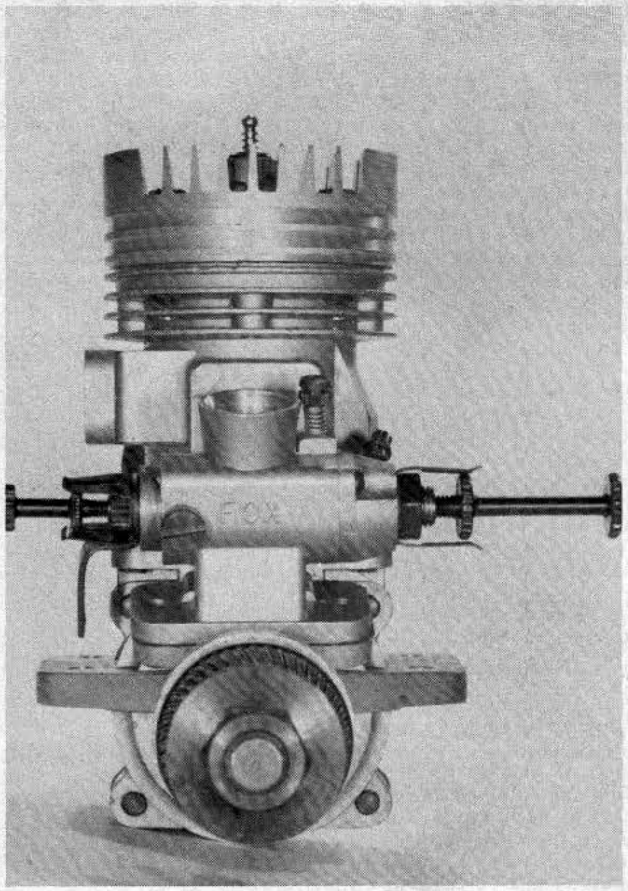
The long piston (resulting mainly from the undersquare bore/stroke ratio of 1:03) provides a larger than average bearing area and is made of a high 22 percent silicon aluminum casting. Because of the aluminum's low heat expansion rate, it makes a more sensible route to go when associated with a ferrous liner. The older method of using hi-temp, hi-strength (but high expansion) alloys is increasingly being abandoned in model engines because of the adversely larger piston/liner clearances necessary and with consequent rocking pistons, lesser heat transfer, and pumping losses on the debit side. (Hot fuels and tuned pipes have been two of the spurs to action here). It happens that the high-silicone alloys provide more realiable bearing surfaces in any case. So fortunately, the problems of producing this allow, (even at higher percent of silicon) and the subsequent difficult machining problems have been overcome. As recognized in the full-size work of racing motorcycle two-strokes, the combination of close-fitting, high silicon piston/piston ring/steel liner is gaining acceptance in the model world as one of the more superior combos possible. However, it still takes a backseat to the non-ringed ABC style on the grounds of performance, and is also likely to maintain a longer useful life than the ABC by virtue of the single (non-Dykes) hi-compression pinned ring.

The very solid 2024 aluminum con-rod (typically lengthy at 1.75" centres) features thin wall bronze bushings (giving consequently greater strength to the big and little ends) and an interesting, small 44 thousandths lubrication hole drilled to the high pressure zones of each end. Traditional practice often places such holes/slots at the opposite low-pressure side. The thinking is that oil is ingested more easily there because the larger clearances and lower pressures on each revolution drags oil around to the high-pressure zone where it's required. It looks like Fox doesn't believe this happens adequately; so they're drilling straight to the source of greatest need.

An interesting sidelight, during one tuned-pipe run a propeller became detached due to sudden reversals of rotation. The



This is a top view of the side exhaust version of the Fox Eagle II .60 engine. A side view shows the three-way split case (**opposite page**).



This is a front view of the side exhaust Eagle II. Both the side and rear exhaust models of the Eagle II are reviewed here. An angular look.

subsequent high speed shaft run for several seconds resulted in no failure of any sort under conditions where other con-rod layouts might well have been less forgiving. Following these occasional reversals on tuned pipe, securing the propeller more firmly was advisable and eventually the writer opted for a very small touch of Loctite on the shaft threads to prevent the nut from free-running backwards and jumping off. Thereafter I had no problems.

The piston pin is drilled almost through and is held floating in the piston by flat snap rings (not the usual wire circlips). The massive twin ball bearing crank at 15mm shaft diameter and 10.3mm bore is of 8620 hardened carburising steel and looks to last for ever. The inner bearing is one of those small ball/slender track jobs.

The final angular appearance of the motor has certain distinct architectural overtones and is so individual that no imitations seem likely to follow.

Tuned-pipe points

Since there wasn't much information on the formal testing of tuned-pipe motors, some anguish seemed in order if the results were to have any significance. After much discussion with interested parties, it seemed clear that the earlier idea of optimising the pipe's many parameters for each r.p.m. point (the hoped for torque curve was neither sensible nor relevant) would be a hopelessly long-winded affair with the likely misleading result of a very flat curve. We didn't adjust our port timings in this way, nor the other myriad built-in features that can affect power at differing r.p.m.'s. Again, to do so would have resulted in a recognizably "manipulated" torque curve.

The argument then really boiled down to, how simple and easy to adjust was the particular variable provided by the manufacturer? Traditionally only fuel/air mixtures, compression ratios in diesels and variable ignition timing (where provided) were optimised during power tests, virtually all other parameters were taken "as is". The manufacturers tests determined the whole r.p.m. range by using the above adjustments. The tuned-pipe fell awkwardly between the two stools—we could adjust it—but not that conveniently. (In the air it would be even more of a task).

It seemed to the writer very difficult to attempt to escape the inevitable sharp peaks, even multi-peaks, which the likely alternate outcome of full r.p.m. range testing of a tuned-pipe motor with a fixed pipe length. The method revealed any advances being made in flexibility resulting from new pipe designs. Continual adjustment of the pipe's parameters during tests largely obscure this point.

Moving forward is now a matter simply of optimising the pipe's length (the most normally used and major variable) using the maximum diameter to the piston face (L) as our measurement. The optimising means getting the maximum. r.p.m. gain at a previously determined r.p.m. area. This area could be that based on a desire to operate the motor (albeit less efficiently) at a low quiet r.p.m. or at the motors known maximum BHP peak. Where the pipe wants to be the motor will surely follow.

Power Tests

Having arrived at a fixed length, full power tests were conducted as normal over as wide a range of r.p.m. which seemed sensible (results are shown in the graph). In reality though, (because some users may well operate motor, manifold and pipe in their unadjusted state) one of the curves relates to the over-length situation of L and equals 13½" approximately. This refers to the side exhaust motor with Mac's quiet tuned-pipe 60 size. A further set of figures was obtained for the rear exhaust unit (using again this over-length pipe). We omitted this information, since the curve was similar to the "pipe optimised at 11", but it displaced about three thousand r.p.m. lower.

The width of operable r.p.m. is an important factor for many users. If you want r.p.m. band-width you have to sacrifice maximum power. The Mac's quiet pipe seems a good compromise and the revealed width of around three to four thousand r.p.m. band should be sufficient for most users.

In all runs on the pipe a pressure tapping from the manifold to the fuel tank was used. This made pipe response less extreme and allowed for forcing more fuel into the engine. The immediate pressure rise inside the pipe was transferred directly to the fuel tank.

There were power output differences between the rear and the side exhaust units. The 90° rotation of the upper cylinder changed gas flow internally. The rear exhaust had a longer cylinder port timing. Also, the rear had a compression ratio of 6:8 and the side exhaust ration was 9:6. The torque curve of the rear exhaust unit (when on open exhaust) showed a steeper decline than did the side exhaust engine.

The side exhaust unit experienced a power loss (due to an 80 square mm outlet area) past 14 thousand with a standard muffler. Using the Windsor Master 11X7 (quiet pipe L equals 11") the 25 percent nitro gave 14,400 r.p.m. and peaked at 16 thousand.

Final reservations

With a tuned-pipe of fixed length r.p.m.'s rise with progressive load reductions. Plus temperatures increase to sometimes destablise the tune of the pipe.

The Mac's Quiet pipe set-up was fairly predictable over much of the r.p.m. range, and only infrequently did anomalous results appear. By comparison, the open exhaust motor was far easier to deal with. Adjustments in pipe length to within ¼" were usually precise.

Tuned pipe response (as some readers may already know) can be more weather dependent with open exhaust motors. Hence, the results obtained here are unlikely to represent the very best figures possible. It is better to obtain good results, than work away for final optimum weather/equipment combinations which may return infrequently in the engine's life.

The manufacturer's figure of 1.9 bhp was not quite realized but almost certainly would be closely approached given enough time to get the right conditions.

The Fox/Mac's pipe combination showed resilency and consistency in the results obtained. As an indication only two glow plugs (Fox R/C idle bar long reach 1½ volt) were consumed during the 120 separate runs necessary to establish the various torque curves (virtually all flat out at maximum power-on nitro).

Mark X Carburetor

Even with the profusion of jets, needles, passages and linkages, the new Fox carburetor impresses the writer as simple to understand. There are two separately operable needles working withon one spray-bar, plus, the rotating air control barrel attached to the slow running needle and that's all. The combination of fuel/air mixture strength in R/C motors is an area in which simplicity in the adjustment is a shining virtue. This new carburetor is soundly constructed, smooth and foolproof in operation. Idling and pick-up is adequately reliable on open, silence or tuned-pipe operation. On all these types of operation long-term idle is only possible above 2,800 r.p.m. when using an 11X7 propellor. Lower idle is achieved with a larger kinetic energy propeller of say 14" in diameter. On the tuned-pipe the dynamic difference between this slowest idle and the maximum "on pipe" setting is very large. The carburetor however, remains capable of handling this differential.

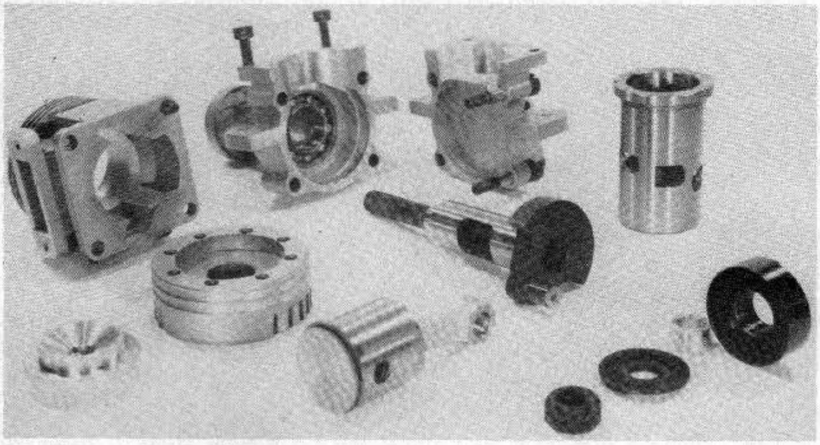
The existance of two needles on each side of the carburetor makes any question about rotation irrelevet. The small carburetor throat area of 57 square mm contrasts well with the authors severely opened out OS-61VRM at 180 square mm which assisted it to 2.9 bhp. This proves that induction restrictions do force reductions in power. One wonders whether correction factors should be applied to all H.P. figures to account for the variations in induction area between motors and power. Generally though, there seems scope throughout both these motors for increase of power with extra breathing.

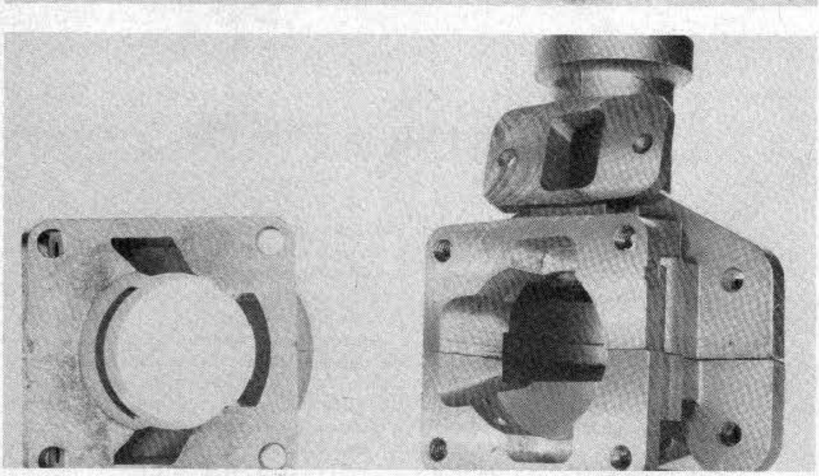
Summary

The various curves arrived at are an attempt to give a broad span of information and shouldn't be read as a means of comparing one motor against another. With existing model layouts in mind, one should procede with personal preference as a guide for engine selection.

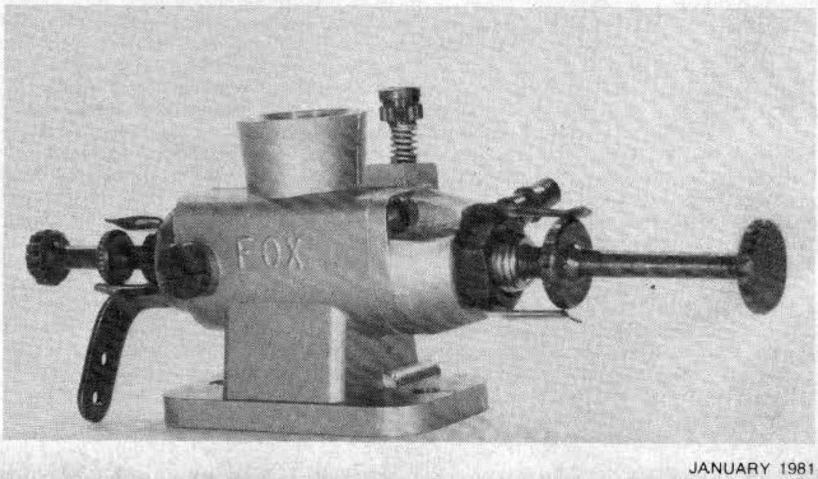
The Mac's Quiet pipe forms a strong flexible combination which will stand up to rugged conditions. The shaft and liner in particular appear extremely durable.

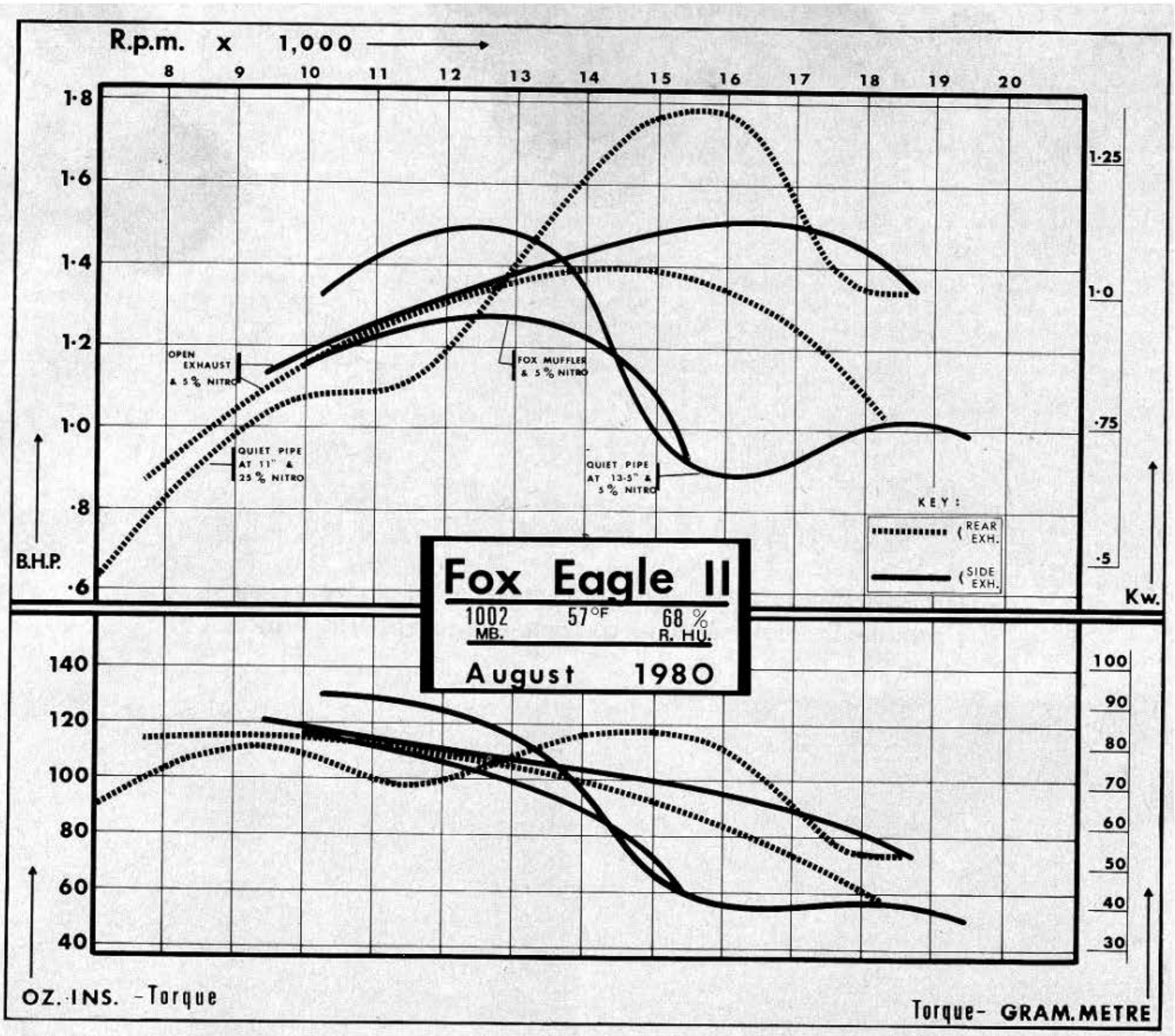
Finally, the writer must admit to a sneaking regard for the apparent determination Fox Manufacturing has not to follow prevailing trends too closely. There is much virtue in the variety such attitudes encompass.





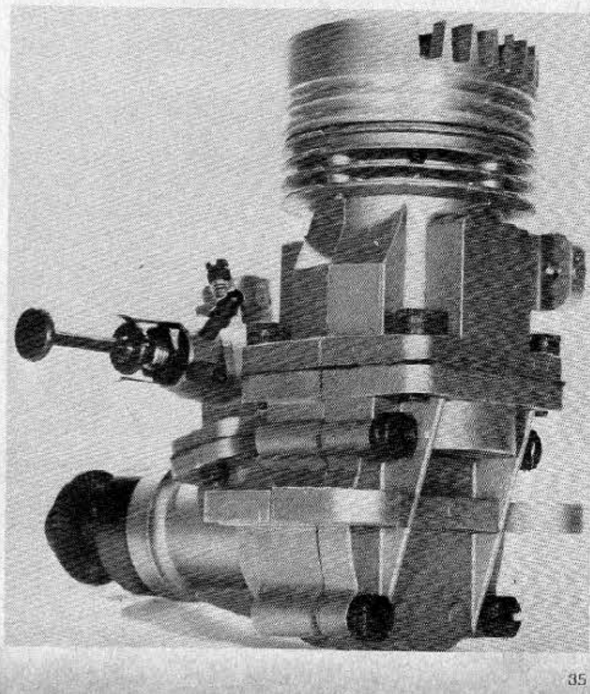
Three pieces together form the crankcase of the side exhaust motor. The side exhaust breakdown shows the straight taper combustion chamber at bottom left in the photo (**top**). The MK X carb (**below**).

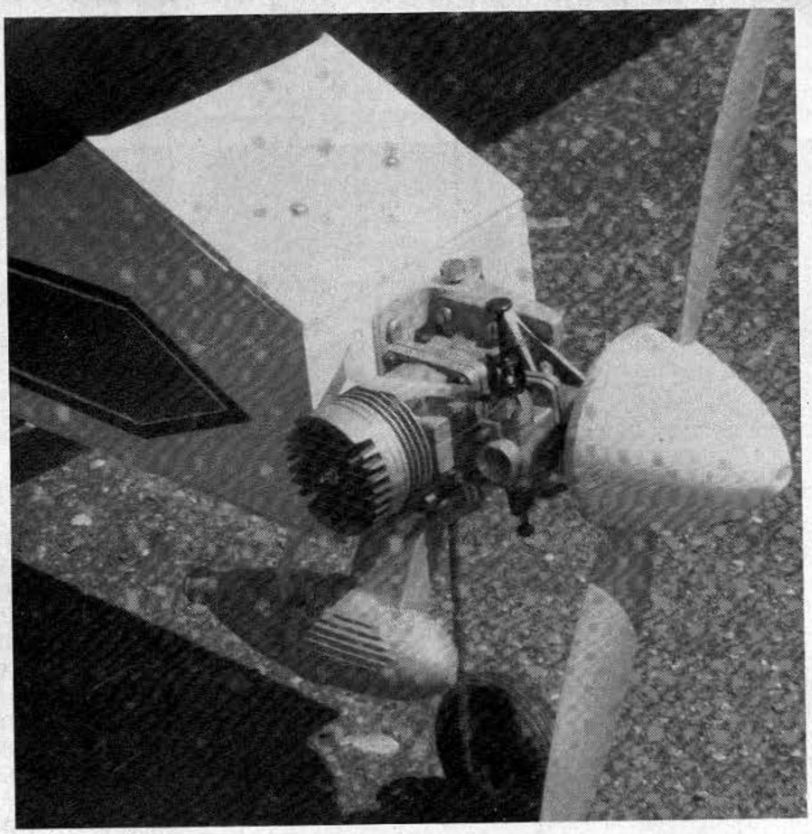




Fox Eagle II: Side and Rear Exhaust Models

SPECIFICATION	FOX EAGLE II SIDE EXHAUST	FOX EAGLE II REAR EXHAUST
Capacity	.6047 cu. in.	same
Bore	.907"	same
Stroke	.936"	same
Timing periods		
Exhaust	142°	150°
Transfer	114°	124°
Boost	100°	128°
Induction opens	40° ABDC	same
Induction closes	52° ATDC	same
Exhaust port heights	.247"	.255"
Combustion volumes	.84cc	1.10cc
Compression ratios		
Theoretical	12.8	10.0
Effective	9.6	6.87
Cylinder head squish	.013"	.040"
Squish band width	.040"	.15"
Squish angle	30°	0°
Height	4⅛"	same
Length	3.45"	same
Width	2⅝"	same
Frontal area	7¼"	same
Carb. bore	.335	same
Weights		
Bare	19¼ oz.	same
With muffler	22 oz.	same
With quiet pipe and muffler	25½ oz.	same
Crankpin dia.	.2805"	same
Mainshaft	.5902"	same
Piston pin	.25"	same
Rod shank	.187" thick x .30" wide	same
Shaft thread	5/16" UNF	same





PHOTOGRAPHY: D.B. MATHEWS

Fox Eagle III mounted in the business end of one of the author's R/C ships. The Eagle III is an economical .60 size engine which runs well on low or no nitro fuel. In fact it outperforms many hot, foreign engines.

An FM Product Review:

Fox's Eagle III

By D.B. Mathews

An American made 60 powerhouse which performs well on low or no nitro fuels. Duke's latest!

This is an engine review written by someone who doesn't even own a micrometer! Frankly, such things as wall thicknesses and degrees of porting are of only passing interest to many of us. Those who enjoy the technical data associated with model engine design are referred to a superb article of that type by Peter Chinn in the Oct. 1981 issue of M.A.N. (F.M. features Mike Billinton's engine reviews on a regular basis.—Ed) This will be an engine review for those who like to strap an engine onto a model airplane and fly it.

In 35 years of operating model aircraft power plants, my primary interest has always been "how does it start, how does it run, and will it last?". I presume such pragmatic concerns also apply to you the reader.

First and foremost, the Fox Eagle III is an incredibly powerful 10 c.c. power plant! The model shown is a 9 pound, 850 in^2 goat with lots of built in drag. The Eagle III will pull it straight up!

Designed to allow quick engine changes, the model is ideal for making comparisons between engines. The Fox pulls this model with as much authority as my Japanese 60. The truely amazing point is that the Fox Eagle III does its thing on *non-nitro* fuel! Yep, the Eagle III will run right in there with the best of the foreign 60's, but on economical FAI type fuel!

The 10% nitro fuel my Japanese engine requires costs seven dollars per gallon more than the 4 to 1 methanol-oil mixture for the Fox. Certainly, this factor of economy is not easily ignored. The Eagle is specifically designed for non-nitrated fuels utilizing a specially shaped head and high compression piston top. I found no appreciable difference in performance or handling when switching from fuel to fuel.

The Eagle III is *not* just the "north" side of Fox's twin! Although appearing much like the Eagle II, this a completely different engine with specific parts numbers. It has been designed for a special purpose and meets those requirements amazingly well. The test unit turns an 11X8 Rev-up at 13,000 rpm, yet idles beautifully at 2500. Transition is rock steady at all speed ranges up and down the throttle range, and the throttle is quite simple to adjust.

The Eagle III also will turn a 16X4 prop at a very respectable 8500 rpm, good numbers for many .90 size engines. Although I have not as yet tried it, I suspect that the engine would be more than suitable on Sig's ¼ scale Cub and many of the Nosen kits.

My Eagle III is an easy starter, even by hand, exhibiting none of the "nastiness" often associated with high compression engines. This is a docile, well behaved, loveable brute of an engine. Its oversized shaft, bolts, mounting lugs and general appearance of strength, sort of grow on one after a while. Certainly not a thing of "sleekness", the Eagle III is more akin to the stationary engines used on oil rigs and irrigation pumps. That is, "heck for stout"!

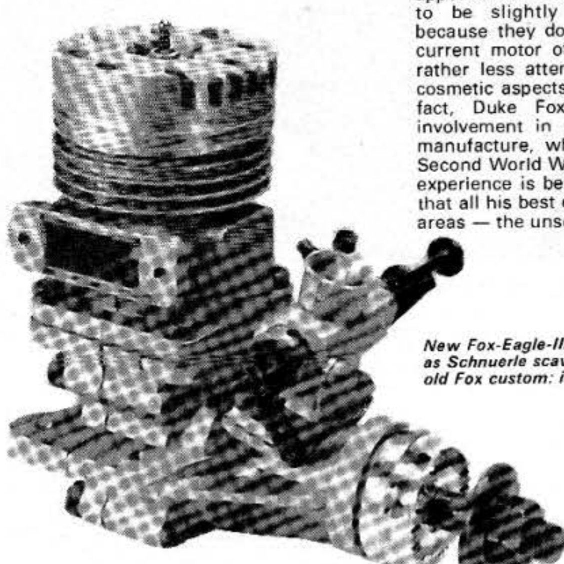
At this writing I have run over three gallons of 75% methanol and 25% Klotz through the engine without blowing a plug or any sign of wear. I anticipate many, many years of yeoman service from this brute.

Two muffler designs are available for the Eagle III (actually the right and left units from the twin). These provide some much needed relief from the frequent "how the heck do I mount a muffler" problem. I use the upward pointed unit on side winders and the downward one inside a radial cowl. Neat!

Parts and helpful advice are easily obtained by calling (501) 646-1656 in Fort Smith, AR. I can almost always anticipate arrival of parts by Friday when I call for them on Monday. In other words, last weekend's broken needle valve can be replaced in time for next weekend's flying.

All in all, the Fox Eagle III is a docile, well behaved, easy to start and adjust, powerful brute of a 60. I find a certain national pride in a domestic product that will outperform the world's best on economical fuel. This incredible power plant may well lay to rest much of the imported model engine "mystique".

PETER CHINN'S RADIO MOTOR COMMENTARY



New Fox-Eagle-III has modern features such as Schnuerle scavenging but perpetuates an old Fox custom: it looks, and is, different.

Fox Eagle-III Tested

This is an entirely different engine from the crossflow-scavenged Fox Eagle first introduced in 1972 and also from the more powerful Hawk model which was the Fox company's first Schnuerle-scavenged 10cc engine. As those readers familiar with the Fox range will see from its appearance, if it owes anything to any other Fox motor, it is to the 20cc Fox Twin.

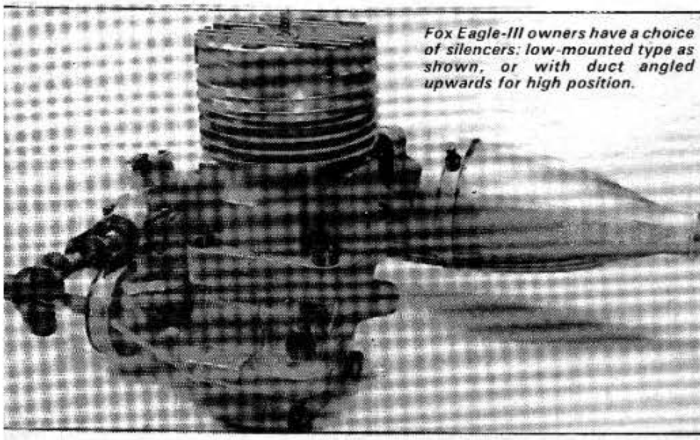
The Fox Manufacturing Company is one of the two oldest surviving American model engine producers and one thing for which Fox designs have always been noted is their tendency to be different from the products of other manufacturers. Duke Fox quite obviously prefers to try to take an original approach, studiously avoiding the practice (common enough among some other producers) of 'borrowing' features from rival designs. One result of all this is that Fox engines sometimes have an outward appearance that some modellers might take to be slightly 'unfashionable', simply because they do not look like every other current motor of a similar type and have rather less attention devoted to the more cosmetic aspects of outside appearance. In fact, Duke Fox's long and continuous involvement in model engine design and manufacture, which began soon after the Second World War, means that a wealth of experience is behind every Fox engine and that all his best efforts are devoted to those areas — the unseen ones, inside — that are the most important insofar as performance and durability are concerned.

The most unusual feature of the Eagle-III is its use of a crankcase that is split vertically, in line with the cylinder axis, into separate front and rear components, topped by a separate bolt-on cylinder block. This arrangement, not uncommon in full-size single cylinder engines, is unique among current commercial model engines. The two crankcase halves are bolted together with four specially machined screws which also act as alignment dowels. The crankcase incorporates generous mounting lugs and webs which extend forward to brace the front end. Another distinctive Fox features here is the unusual intake assembly which, instead of using a round boss into which the carburettor is plugged, takes the form of a flat, angled saddle, with Fox Mk. 10-D flange mounted carburettor.

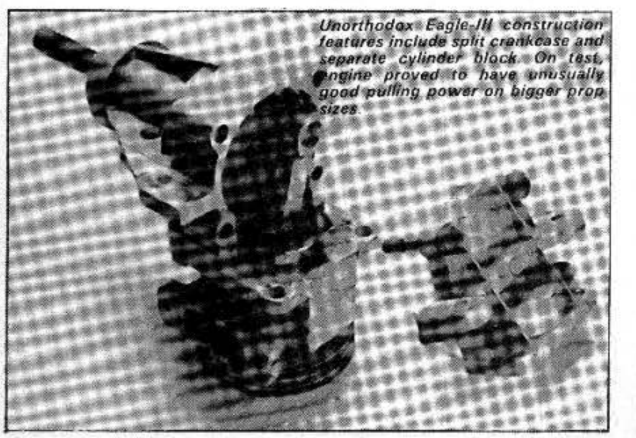
Nearly all 10cc engines have an 'over-square' cylinder — i.e. the bore is larger than the stroke measurement. Almost universal among engines built to metric measurement (e.g. Continental European and Japanese) is the 24mm bore by 22mm stroke combination, while, among those made to Imperial measurement (e.g. British and American), a 0.937 or 0.940 in. bore has usually been combined with a stroke of around 0.875. Again the Fox is different; it has an 'under-square' combination of a 0.907in. bore and a 0.937in. stroke. A long stroke equates with improved torque, theoretically, and, although, because of the many other factors involved, few long-stroke engines, on which we have conducted tests, have ever demonstrated this very convincingly in practice, it is interesting to note that the Eagle-III did, on test, produce well above average maximum torque for a 10cc R/C engine. One of the snags of a long stroke is the greater angularity of the conrod and the increased piston side-thrust that is thereby exerted on the cylinder wall. This can be reduced by lengthening the conrod and the Eagle-III's rod is just about the longest we have encountered in a modern .60 engine. It is 42.9mm between centres, a figure which restores the rod-length/stroke ratio to an acceptable 1.8:1. The increased overall height and greater primary compression chamber volume (and thus reduced pumping efficiency), that a long conrod normally produces, has been kept within bounds by placing the gudgeon-pin as high as possible in the piston.

The conrod itself is machined from high-duty aluminium alloy bar, phosphor-bronze bushed at both ends. There are oil holes at both ends but these are drilled through the conrod eyes at an angle from the *shank* side, presumably with the object of persuading the lubricant to enter those areas of the bearing surfaces that are always under compression when the engine is running. The piston is produced from a gravity casting in a low-expansion piston alloy containing a high proportion (28 per cent) of silicon. The orthodox high-pressure single compression ring is pinned against rotation and the lightweight fully-floating ¼in. o.d. tubular gudgeon-pin is retained by circlips. The piston, complete with ring and gudgeon-pin, tipped our scales at 14.3gms. The conrod weighed 6gms.

In the past, Duke Fox has always favoured the use of fairly liberal quantities of nitromethane in the fuels recommended for his motors. The fuel most commonly specified was Fox's own 'Missile Mist' blend which was a 25 per cent nitromethane/nitroethane blend, while, for extra performance, one could resort, until recently, to more exotic mixtures such as Fox 40-40 (40 per cent nitromethane) and, going back to the 1960s, to Fox 'Blast' which was a 50 per cent nitro



Fox Eagle-III owners have a choice of silencers: low-mounted type as shown, or with duct angled upwards for high position.



Unorthodox Eagle-III construction features include split crankcase and separate cylinder block. On test, engine proved to have unusually good pulling power on bigger prop sizes.

blend. However, nitromethane, at one time very cheap in the United States (the only country which produces nitromethane industrially), has been getting more and more expensive and, of late, its cost has become so high that American R/C flyers are, at least, placed in a position long familiar to modellers in other parts of the world and are seeking to run their engines on very much cheaper fuels — notably ones containing modest quantities of nitromethane (5-10 per cent) or no nitromethane at all.

The various imported motors available in the US have clearly demonstrated that large quantities of nitro are quite unnecessary for good performance with modern engines, provided that they are designed or modified to suit such fuels. Accordingly, recent Fox engine developments have been aimed at making Fox engines compatible with straight fuel and this was on of the first objectives with the Series III Fox Eagle.

Considerable experiment went into the development of the cylinder head. This uses a separate combustion chamber insert, or 'head button' as Fox calls it, and its present dimensions and shape are the result of endless cut-and-try experiments to achieve the best combination of performance, ease of handling and plug life, with straight fuel. It features a flat, very wide (nearly 5.2mm) squish-band, surrounding a deep, almost truly hemispherical 12.7mm dia. central chamber. The actual combustion chamber volume is quite small (0.76ml according to our measurement of the test motor) which gives a full-stroke compression ratio of 14 to 1. This, when re-calculated against the effective compression stroke (i.e. after the exhaust port has closed), is still quite high at 10.2:1. The machined combustion chamber insert, flanged to seat on the cylinder liner flange, is topped by a pressure diecast finned head secured to the cylinder casting with eight screws.

Yet another out-of-the-rut feature is the new silencer that has been adopted for the Eagle-III. This, a simple unbaffled expansion chamber, has its entry duct at a 30-degree angle. It is available in a choice of two models so that, when fitted to the engine, the duct is tilted either upward or downward, giving a choice of a high or low silencer position. These silencers, incidentally, also serve the Fox Twin, one for each cylinder. Each silencer has a volume of 94ml and an outlet area of 82sq. mm.

The performance obtained with the Eagle-III is summarised in the accompanying table. The engine, received direct from the Fox factory just prior to its general release, was run-in on a straight 75/25 mix of methanol castor-oil and nitromethane (our standard test fuel for two-stroke R/C engines), then castor-oil and nitromethane (our stndard test fuel for two-stroke R/C engines), then conducted a full test on 80/20. The difference in power was negligible and the Eagle-III ran extremely well on the straight mix, very steady with safe idling at around 2,500rpm on 12×6 and 11×7 props and a good mid-range.

After dynamometer testing hundreds of different engines over a period of more than thirty years, one is bound to have a pretty good idea of what to expect in terms of performance of almost any new motor, but there are still surprises and the surprise with the Eagle-III was its uncommonly good low-speed torque. This was sufficiently above the norm for .60 R/C engines, running on straight fuel, as to rule out any thought that it could be entirely due to our test motor being a particularly good example of the Eagle-III. Even allowing for such variations as one can expect between individual examples of the same production engine, we would still expect it to be above average.

So far as maximum power output is concerned, a figure of 1.38bhp at 15,000 with the standard silencer fitted puts the Eagle-III up among the market leaders, as does the open exhaust figure of nearly 1.60 at 16,600rpm. Our tests, incidentally, also included checks on 10 per cent nitro fuel and on 25 per cent nitro (to simulate Fox Missile Mist). The latter resulted in the gross bhp being raised to 1.71 at approximately the same peaking speed. This is equivalent to an increase in prop rpm of about 2½ per cent — say 400 rpm. Most users would feel that the Eagle-III is quite powerful enough without the extra cost of nitro fuel but, as the figures show, a small power boost is still there if the user wishes, on occasions, to take advantage of it.

Specifications and Test Data for FOX EAGLE III

General Data

Type: Single-cylinder, front rotary-valve, side-exhaust, glowplug ignition, Schnuerle-scavenged two-stroke, with twin ball-bearing crankshaft.
Bore and stroke: 0.907in. × 0.937in. (23.04 × 23.80 mm)
Swept volume: 0.6054cu. in. (0.921cc)
Stroke/bore ratio: 1.033:1
Measured combustion chamber volume: 0.76ml
Measured compression ratio (full stroke): 14:1
Measured compression ratio (exhaust closed): 10.2:1
Measured port timings:
Exhaust period: 146°
Transfer period: 120°
Third port period: 122°
Rotary-valve opens: 40° ABDC
Rotary-valve closes: 50° ATDC
Carburettor: Fox Mk. 10-D adjustable automatic mixture control type. 37sq. mm effective choke area.
Silencer: Fox expansion chamber type (extra) with choice of upward or downward angled entry duct. Volume 94ml. Outlet area 82sq. mm.
Weights: 548gms (19.3oz.) less silencer
624gms (22.0oz.) with silencer
Required bearer spacing: 44mm

Manufacturer

Fox Manufacturing Company, Fort Smith, Arkansas, USA. **UK Sales and Service:** (i) Model Aircraft (Bournemouth) Ltd., Norwood Place, Bournemouth, Dorset. (ii) Fox Mfg. Co. (UK), The Haven, Rixey Park, Chudleigh, Newton Abbot, Devon.

Performance Tests

Power output, gross (less silencer): * 1.59bhp at 16,500rpm
Power output, net (with silencer): 1.38bhp at 15,000rpm
Torque, gross (less silencer): 128oz. in. at 9,000rpm
Torque, net (with silencer): 119oz. in. at 8,500rpm
Equivalent gross b.m.e.p.: 83lb/sq. in. at 9,000rpm
Specific output, gross: 160bhp/litre
Specific output, net: 139bhp/litre
Power/weight ratio, gross: 1.32bhp/lb.
Power/weight ratio, net: 1.01bhp/lb.
* Output was raised to 1.71bhp at 16,500rpm with the use of 25 per cent nitromethane fuel.

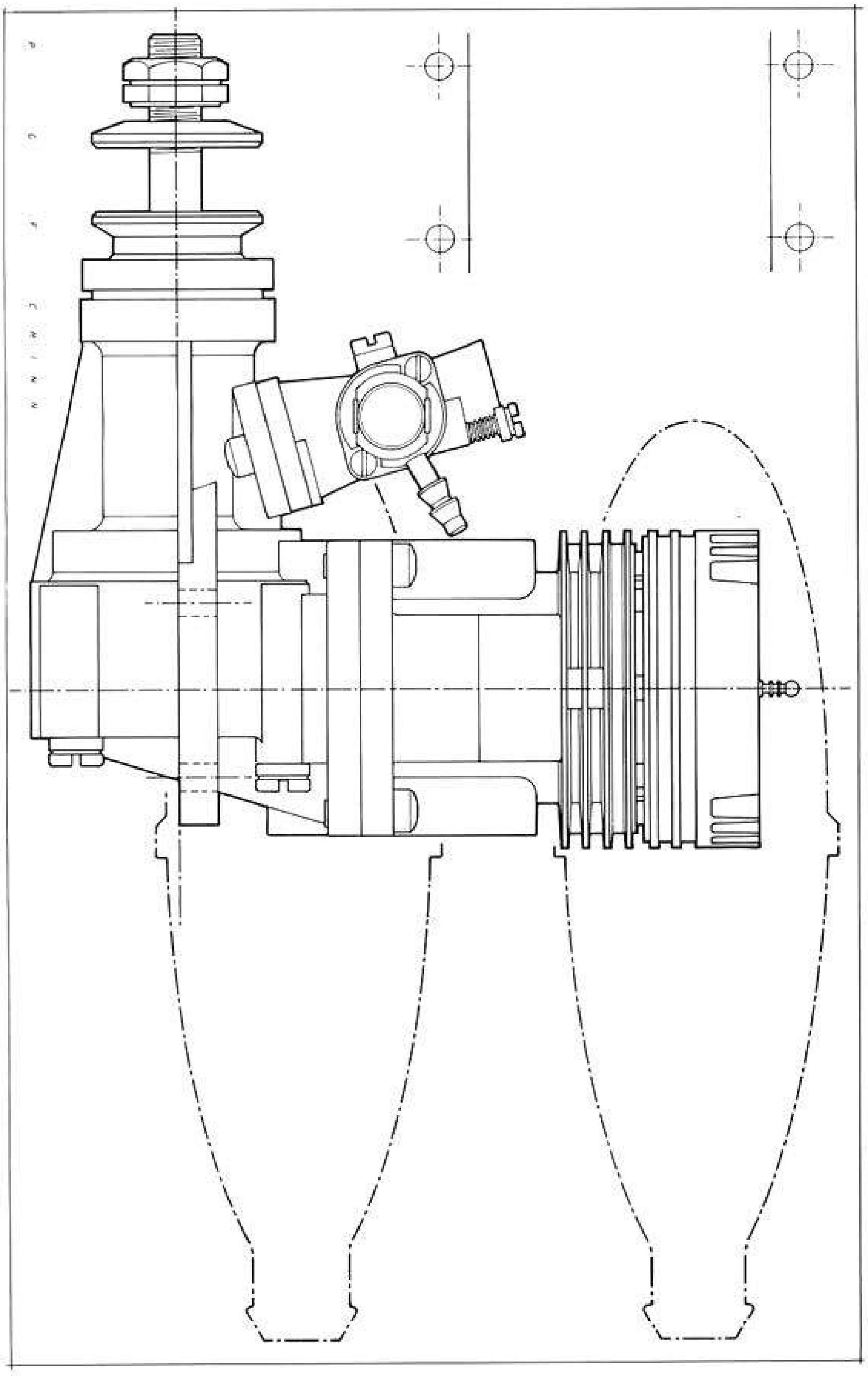
Typical prop rpm (with silencer):
9,700rpm on a 14×6 Top Flite maple
10,100rpm on a 14×4 Top Flite maple
11,400rpm on a 12×6 Zinger maple
11,800rpm on a 12×5 Top Flite maple
12,500rpm on an 11×7½ Power Prop maple
13,200 rpm on an 11× 6 Top Flite maple
13,800rpm on an 11×6 Power Prop maple

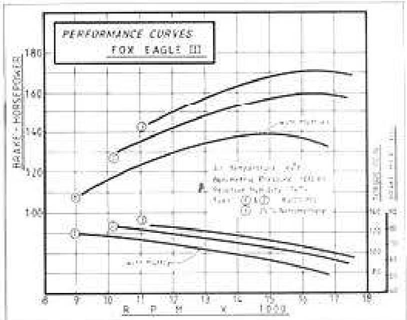
Test conditions: 80/20 methanol/castor-oil fuel; air temperature 18°C; pressure 762mm Hg; relative humidity 74%; Fox 1.5V long-reach idle-bar glowplugs.

ENGINE REVIEW

by Peter Chinn

FOX EAGLE III





SPECIFICATIONS

Type: Single-cylinder, Schnuerle-scavenged, side-exhaust, two-stroke-cycle with crankshaft rotary-valve and twin ball-bearings. Throttle type carburetor with automatic mixture control.

Checked Weights: 548 grams (19.3 oz) less muffler; 624 grams (22.0 oz) with Fox muffler.

Displacement: 0.6054 cu in. (9.921cc)

Bore: 0.907 in. (23.04 mm)

Stroke: 0.937 in. (23.80 mm)

Stroke / Bore Ratio: 1.033:1

Measured Compression Ratio (full stroke): 14.0:1

Measured Compression Ratio (effective): 10.2:1

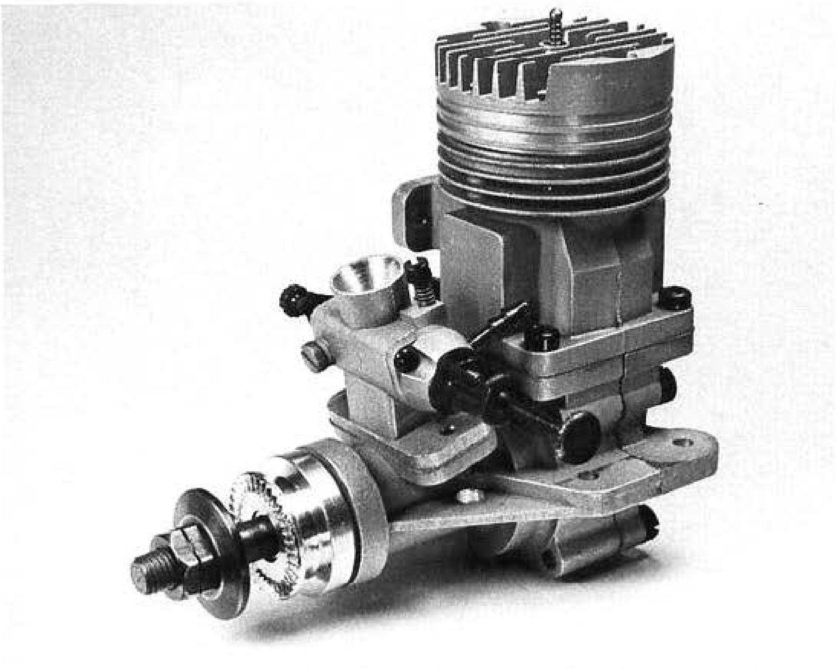
Power Output, Gross: 1.71 bhp at 16,500 rpm (Test 3); 1.59 bhp at 16,500 rpm (Test 2).

Specific Output (as tested): 2.82 bhp/cu in. (Test 3); 2.63 bhp/cu in. (Test 2); 2.28 bhp/cu in. (Test 1).

Power / Weight Ratio (as tested): 1.42 bhp/lb (Test 3); 1.32 bhp/lb (Test 2); 1.00 bhp/lb (Test 1).

Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, AR 72901.

• It was in the late 1940s that a certain monopropellant for liquid-fueled rocket engines, known as nitromethane, was first used as a power-boosting additive for model internal combustion engine fuels. Here, American modelers were extremely fortunate, for the United States was the world's only source of "cheap" nitromethane. At a time when American commercial nitromethane could be bought for about 25 cents per pound, the laboratory grades available from European chemi-



Eagle III looks similar to Eagle II but is virtually a new engine of superior performance and durability. The engine is specifically designed to run well without nitro.

cal manufacturers cost up to twenty times as much.

In due course, American nitromethane, produced by the Commercial Solvents Corporation, was exported to other countries. However, because of the hazardous nature of the material and the special regulations governing its shipment, its landed cost tended to be high and, as a result, nitro was never used so lavishly, in other countries, as in the U.S. Moreover, due to a long period in the 1960s when (following two railyard explosions in 1958, each involving a tank car of nitromethane) overseas shipments were halted, locally produced commercial fuels containing nitromethane virtually disappeared from foreign markets for several years.

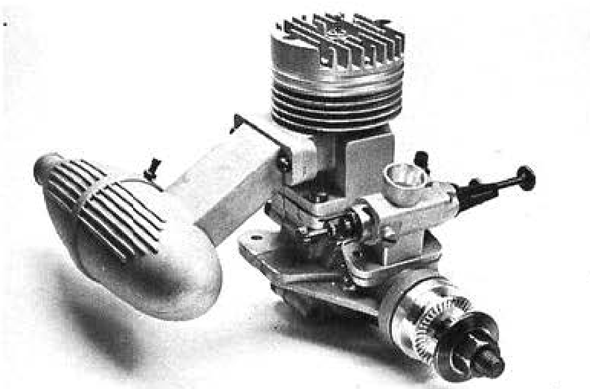
The result of all this was that, while American engine manufacturers designed their motors for use on fuels containing anything between 5 and 50 percent nitromethane, foreign manufacturers were obliged, in most cases, to set up their engines to operate on little or no nitromethane. It was during this period, also, that the FAI introduced the "straight fuel" regulation, limiting contestants in world championship CL speed and FF power events to a simple two-part mixture of methanol and castor-oil.

We said in our opening remarks that commercial nitromethane was cheap. "Was" is the operative word. American nitro is no longer cheap: not even in America. Its cost has been going up and up and by ever increasing amounts and, to quote the model industry, prices are now through-the-roof, sky-high, or out-of-sight... Not surprisingly, some people are beginning to take a leaf from the book of overseas users and to cut down on the nitro content of their fuels.

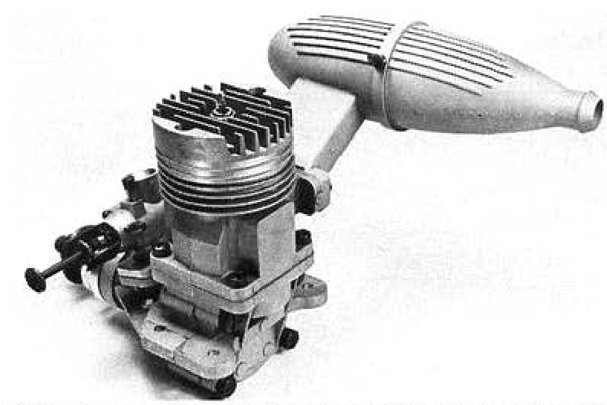
Nowhere do the costs of high-nitro fuels make themselves felt so severely as in the operation of big high-performance R/C engines. It would seem to be important, therefore, that, from now on, engine manufacturers should develop motors of the type that will run well on little or no nitro.

This is precisely what Duke Fox set out to do with his Series III Fox Eagle. And, as we shall show in a moment in our report on the performance of this engine, he seems to have succeeded quite admirably.

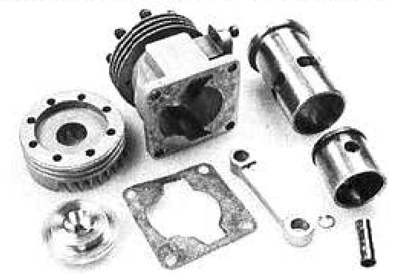
(Continued on page 103)



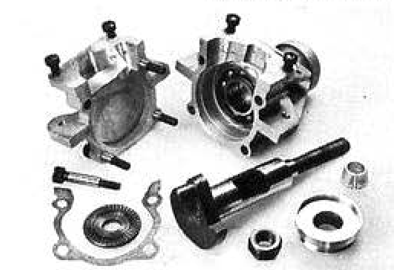
Tradition demands that a Fox should look different from its rivals. The new Eagle III is no exception.



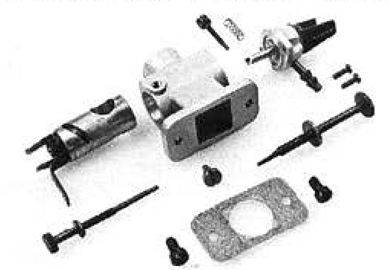
Owners have a choice of high or low muffler position. Duct to the expansion chamber is angled at approximately 30 degrees.



Unusual long-stroke cylinder assembly has separate bolt-on block, 2-part head.



Eagle's unique vertically split crankcase. Two-part crankshaft is furnace brazed.



Fox Mk. 10-D carb design is conventional with automatic mixture control.

ENGINE REVIEW

(Continued from page 39)

Externally, this new engine (the first examples of which started coming off the production line only in May this year) looks very similar to the Eagle-II that it replaces, but Duke Fox is anxious that prospective purchasers should not confuse the two. The new engine is a complete redesign, resulting from extensive development work on the Eagle-II, and practically every part has been changed or modified to produce a more powerful, more durable motor.

Typical of Duke Fox's philosophy, the Eagle does not simply follow the trends set by other current .60 R/C engines. Its design and construction are, in many ways, unusual, if not unique. Let us take a closer look at its component parts.

CRANKCASE. The Eagle has a three-piece body in which the crankcase is split vertically, in line with the cylinder axis, into separate front and rear components, topped by a separate, bolt-on cylinder block. This arrangement is unique among current commercial model engines. It is not uncommon in full-size single-cylinder (e.g., motorcycle) engines, although, in such cases, the rear component frequently incorporates a second main bearing.

The two crankcase components are bolted together with four specially machined cap screws. These have a short, reduced diameter neck, below which they are increased to a 3/16 in. diameter plain machined length before reducing back to an 8-32 thread. The 3/16 in. diameter is

(Continued on page 104)

(Continued from page 103)

closely fitted to the holes through the crankcase rear component and to counter-bored holes in the threaded front part so that the screws also perform the function of dowel pins to properly align the two components. A gasket is used to seal the joint between the two parts.

The crankcase incorporates sizable mounting lugs which extend forward to blend in with large side webs bracing the front end. There is also a full-depth vertical web below the crankcase nose and an angled plate above it for the flange-fitting carburetor.

CRANKSHAFT AND BEARINGS. The crankshaft is made in two pieces, furnace brazed together. Both parts are made from 8620 steel and gas carburized for a hard skin. In contrast to some other manufacturers, who have gone over to 17 mm shafts in the interests of increased rotary-valve areas, Duke Fox has stayed with a 15 mm shaft as no substantial power increase was detected with the larger size and the 15 mm journal enabled a 15 x 32 mm 9-ball steel-caged rear bearing to be used. This size was preferred to the 17 x 32 mm size as, having a higher load rating, it is expected to eliminate, or, at least, reduce, the main bearing problems that have been encountered with some current .60 size engines. At the front end, the shaft is supported in a 3/8 x 7/8 in. 7-ball steel-caged bearing, beyond which it terminates in a 5/16-24 UNF propshaft thread.

A very hefty solid crankpin is used. It has a diameter of 7.13 mm (nominally 9/32 in.) and is integral with the crankweb which has cutaway flanks for counter-balancing. The shaft has a 10.3 mm (13/32 in.) bore gas passage and a 15.8 mm long valve port that is timed to open at 40 deg. ABDC and close at 50 deg. ATDC.

CYLINDER ASSEMBLY. This consists of a pressure cast aluminum block with drop-in nitrided steel liner. The Schnuerle scavenging system has been modified from that used in the Eagle-II. An extra bridge has been added to divide the exhaust into three, rather than two, liner ports. The fore and aft bypass ports are fed from sharply angled channels in the cylinder casting and these have been reshaped and radiussed at the top to provide a smoother flow. A further improvement in the engine's running qualities was found by slightly narrowing the split third port, opposite the exhaust.

According to measurements of our test motor, the exhaust ports are open for 146 deg. of crank angle, the main bypass ports for 120 deg., and the third ports for 122 deg.

The cylinder liner is located in the casting by a thick flange at the top. The liner has an o.d. of 1.062 in. and a wall thickness of 0.077 in. or just under 2 mm. The block is tied to the crankcase with four Phillips 8-32 screws and a 0.012 in. gasket is used between the two. Incidentally, although it is possible to rotate the complete cylinder assembly on the crankcase to bring the exhaust to the rear, this is not recommended as it will result in the almost total masking of one of the bypass channels.

PISTON AND CONROD ASSEMBLY. The flat-headed, plain skirted piston is produced from a permanent mold casting in high (28 percent) silicon content aluminum alloy for reduced expansion and improved resistance to distortion. A conventional high-tension piston ring is used. Duke Fox prefers this type of ring for its better cranking compression. The ring gap is pegged against rotation.

A 1/4 in. (6.35 mm) dia. full-floating tubular wristpin is fitted. It is placed high in the piston and is retained by circlips. The connecting-rod is machined from 2024 aluminum alloy bar and is fitted with phosphor-bronze bushes at both ends. Oil holes are drilled in each end of the rod but on the shank (compression) side of the eye. The rod has a sturdy shank, 19/64 in. wide by 3/16 in. thick, and is a lengthy 1 11/16 in. (42.9 mm) between centers—which, to the best of our recollection, is just about the longest rod of any current .60. A long rod was made necessary by the Eagle's uncommonly long stroke (0.937 in. compared with the 0.866-.875 in. of most other .60s) which, with a shorter rod, would have meant increased rod angularity and piston side thrust. Excessive cylinder height is avoided by the high placing of the wristpin in the piston.

The piston and ring checked out at 11.5 grams (0.41 oz), and at 14.3 grams (0.50 oz) with the wristpin added. The rod weighed 6.0 grams (0.21 oz).

CYLINDER HEAD. A two-part head is featured, consisting of a machined bar stock combustion chamber insert and a pressure cast finned outer component. The latter has deep, tapered fins and is secured with eight 6-32 Phillips head cap screws. The shape of the head insert, or "button," as Fox calls it, is the result of over one hundred cut-and-try experiments to find the one that gave the best combination of plug life, ease of starting, and power output. It features a very wide (13/64 in. or 5.16 mm) flat squishband surrounding a deep, almost perfectly hemispherical, 1/2 in. dia. combustion chamber.

The measured combustion chamber volume of our test engine was 0.76 ml, which gives a nominal (full stroke) compression ratio of 14.0:1 or, when calculated against the effective compression stroke (i.e., after the exhaust port has closed), of 10.2:1.

CARBURETOR. This is a Fox Mark 10-D adjustable automatic mixture control type. The Mk. 10 series carburetor was briefly described in our condensed reports on the Fox Twin in the July 1980 *M.A.N.* and on the latest Fox 40 and 45 engines in the January 1981 issue. The Mk. 10-D fitted to the Eagle-III has a 0.330 in. choke and an effective choke area of approximately 37 sq mm.

MUFFLER. The user has a choice of mufflers for the Eagle. A new design of expansion chamber muffler has been introduced in which the duct to the expansion chamber is angled at approximately 30 degrees and this is made in two models: one with the duct tilted upward from the exhaust and the other with the duct angled down. The user may choose whichever type best suits his model. (These same mufflers, incidentally, also fit the Fox Twin, one for each cylinder, when the angled ducts enable each muffler to be angled outward from the engine cowl.)

Each muffler has a volume of approximately 94 ml, an outlet area of 82 sq mm,

(Continued on page 106)

(Continued from page 104)

and a weight of 2.7 oz.

For those who wish to combine reasonable muffling with the maximum possible power output and can accept its weight and bulk, the Fox company is also offering a tuned muffler system. This consists of a double-cone tuned pipe with integral cylindrical muffler chamber having a 3/8 in. i.d. outlet; plus a chromium plated fabricated adaptor with silicone-rubber tube connector. The complete installation, less supporting bracket(s), weighs 7.3 oz and is approximately 22½ in. long measured from the center of the exhaust port.

For use with the tuned pipe muffler, the manufacturer will supply a special cylinder liner. This has the top edge of the exhaust port raised about 0.020 in. in order to extend the exhaust period to a timing more in line with pipe requirements.

PERFORMANCE. As explained in our introductory remarks, the Eagle-III was developed for use on low-cost fuels containing little or no nitromethane. The engine's high compression ratio and combustion chamber shape are certainly compatible with these requirements.

In our tests, therefore, we decided to extend our normal coverage, which is to test R/C engines on a standard 5 percent nitro mix, and to try the engine on a straight 4-to-1 methanol/castor-oil fuel and on a 10 percent mix, and also to investigate the benefit of using a 25 percent nitro content—i.e., a fuel like Fox Missile Mist; a mixture recommended for substantially improved performance with most other Fox motors.

Our test motor was one of the very first Eagle-IIIs off the production line and came direct from the Fox factory to enable this report to be prepared for publication as soon as possible. It had been run, but was, nevertheless, given a further hour of break-in time before any test readings were taken.

The engine was broken in on a straight 75/25 methanol/castor-oil mixture, after which a comparison was made between prop rpm figures on straight fuel and on our standard 5 percent nitro mixture. The difference, power-wise, was negligible and the Eagle ran every bit as well on the straight mix.

The first thing we noticed about the Eagle-III was its high maximum torque. This was well above average for 10cc R/C engines, highly regarded imports included. For example, on a simple 80/20 methanol/castor-oil mix, it happily pulled a 16x4 Top Flite maple (a prop that would overload a lot of its rivals) at a steady 8,800 rpm. The engine's under-square stroke/bore ratio may have something to do with this. On a 14x6 Top Flite maple (normally the largest size we would use on a .60), it just topped 10,000 rpm, which is very good; and similarly impressive figures of 12,000 on a 12x6 Top Flite maple and 13,100 on an 11x7½ Power-Prop maple were obtained.

In terms of gross horsepower (i.e., less muffler), a peak output figure of nearly 1.6 bhp at just short of 16,500 rpm was determined from our test figures. This compares favorably with similar output figures obtained with other leading .60 class R/C engines, all of which, however, have been tested on 5 percent nitro fuel.

The power absorbed by the Fox muffler is not excessive. In terms of prop rpm it ranges from about 300 to 500/600 rpm on the prop sizes most likely to be used, rising to 700 rpm at peak revs. A dynamometer check on the Eagle-III, running on straight fuel and fitted with the downward pointing muffler, indicated a peak bhp of 1.38 at just on 15,000 rpm. The muffler, while not necessarily the quietest on the market, is rather more effective than the small volume, large outlet area Fox C type muffler used on earlier Fox .60 engines.

As previously remarked, the effect of using 5 percent nitro instead of straight fuel, in the Eagle-III, was negligible. Following the tests on 80/20 fuel and with the muffler fitted, we then tried the effect of using 10 percent nitro. This gave a just measurable increase in power, amounting to 100 to 200 rpm on most props but, contrary to expectations, the engine actually seemed to be slightly less happy when lightly loaded (i.e., when running at around 16,000 rpm) than it had been on the 80/20 methanol/castor mix. Running qualities on straight fuel were, in fact, excellent: the Eagle-III ran very steadily and evenly on this and there was never any loss of revs when the plug lead was disconnected. All of which serves to confirm that Duke Fox seems to have been entirely successful in his efforts to produce an engine that does not really need nitro.

However, there will probably be users who will want to try to get more power by using the medium- to high-nitro fuels to which they may be accustomed. Our final check, therefore, was to run the Eagle-III on 25 percent nitromethane fuel and without the muffler. The result of this was to raise peak power output to 1.71 bhp. This is equivalent to another 400 rpm in prop speed, and it is up to the user whether he considers this relatively moderate increase worth the expense of using considerably more expensive fuel.

There may, of course, be times when a nitro fuel may be preferable—under very cold weather conditions, for example. Also, allowing for the fact that acceptable manufacturing tolerances can cause slight variations in compression ratios, etc., between individual examples of any engine, some Eagle-III owners may find that their engines are more responsive to nitro than was our test sample.

Handling qualities of the Eagle-III were good and the throttle worked well. Using 80/20 methanol/castor-oil fuel, the idle needle setting was exactly correct as specified in the maker's instruction leaflet,

(Continued on page 108)

(Continued from page 107)

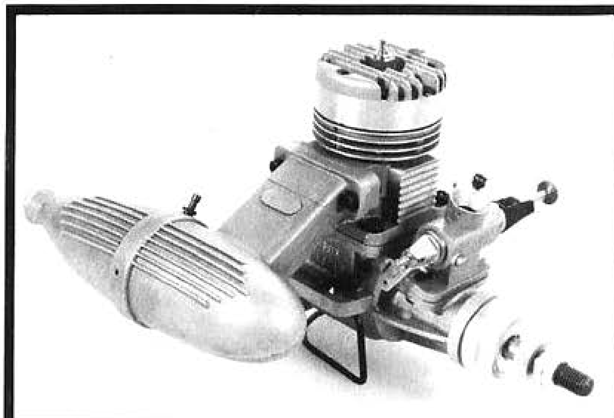
i.e., 1½ turns open when the throttle is closed. Safe idling on 12x6 and 11x7 props was around 2,500 rpm and the throttle was quite linear, with a pleasingly smooth transition from two-cycling to four-cycling at between 6,000 and 6,500 rpm.

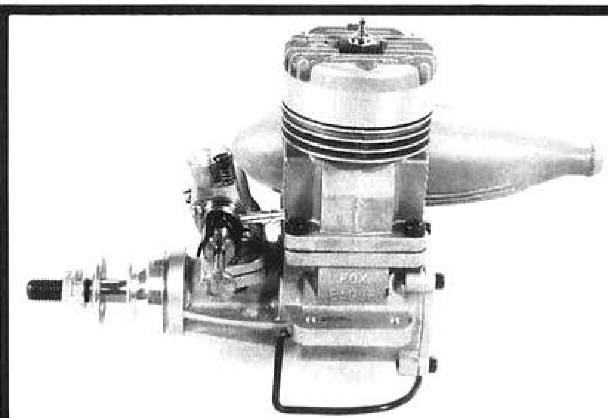
No problems were encountered with the Eagle-III on test. The engine blew a glowplug on its very first run, but thereafter ran through the entire break-in and test program without any further plug failures. We checked out both 2V and 1.5V Fox plugs and finally settled for the recommended 1.5 volt long-reach idle-bar plug that has served us so well in many tests in the past. ■

Fox Eagle 60 or 74? Both engines have an identical exterior. You have to look in the exhaust to tell. See text. Fox Eagle 60/74 shown with tilt down muffler. A tilt up version also available on exchange basis when new.

FOX EAGLE IV 60 and 74

By Clarence Lee

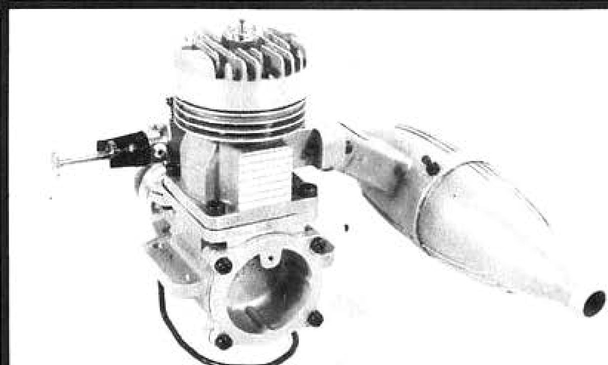




SPECIFICATIONS

Type: Single cylinder, 2-stroke cycle, Schnuerle scavenged, ringed, glow ignition.

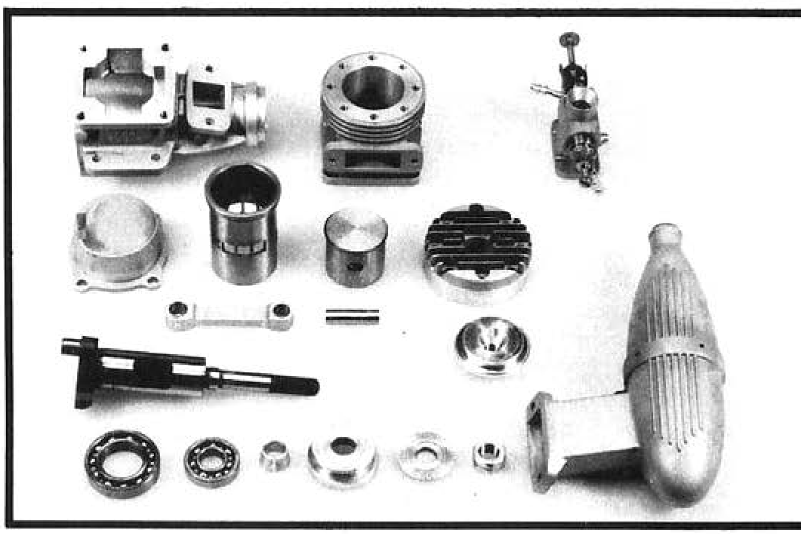
	60	74
Bore:	.907"	1.000"
Stroke:	.937"	.937"
Displacement:	.605 c.i.	.736 c.i.
Comp. ratio:	9.4:1	10.7:1
Bare Weight:	19.6 oz.	19.0 oz.
Muffler wt:	3.1 oz.	3.1 oz.
Manufacturer:	Fox Manufacturing Co. Fort Smith, Arkansas	

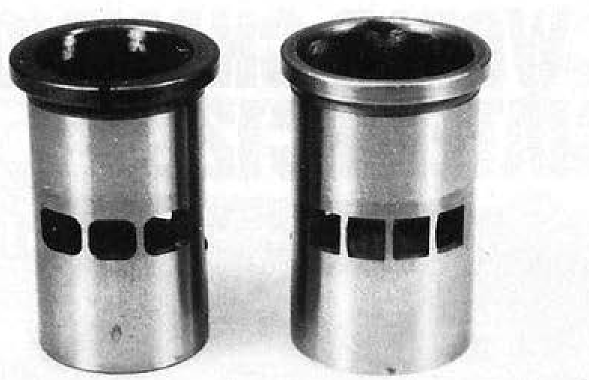


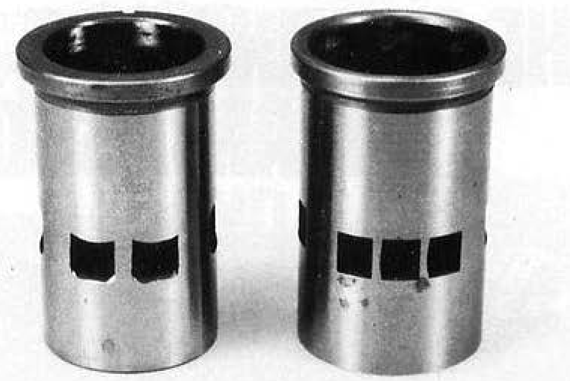
RCM PRODUCT REVIEW

This past summer Duke Fox released the latest versions of his Fox Eagle series engines, the Eagle IV 60 and 74. Although we had received samples of both engines shortly after their release, it wasn't until this past October that we were able to get to the testing of the engines due to a considerable backlog of previously received engines for testing. With the time it takes to put the article together and the magazine lead time, it will be early 1991 by the time this review appears in print. We always like to get new engine releases reviewed and into print as soon as possible after their release, but this is not always possible when you have six or seven engines on the shelf waiting for review. This month, our review will actually be a double header in that we will be covering both the Fox Eagle IV, 60 and 74. The 74 is essentially — an enlarged bore version of the 60 using the same lower crankcase, crankshaft, bearings, etc.

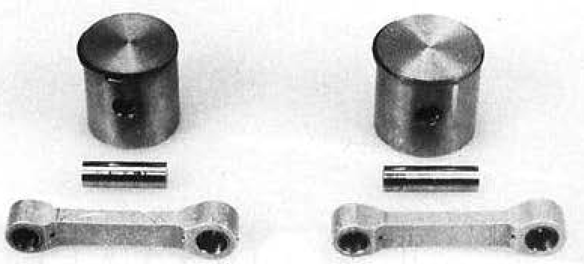
The trend of late has been to long stroke engines to increase the engine's low end torque and ability to swing larger diameter or higher pitch propellers. When the .60 displacement size engines first started becoming popular, the 11 x 8 was generally the accepted propeller size for a sport or pattern type aircraft. As time progressed,

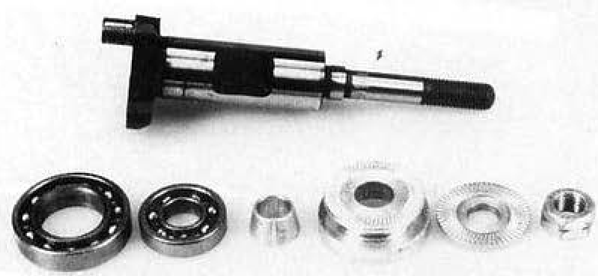






LEFT: Fox 60 sleeve on left has three exhaust port windows and 74 sleeve on right four. Two outer ports of 60 sleeve are larger than the center port. RIGHT: Fox 60 sleeve on left has two boost port windows and 74 on right three. 60 ports have been cut at an upward angle, whereas the 74 ports have not.

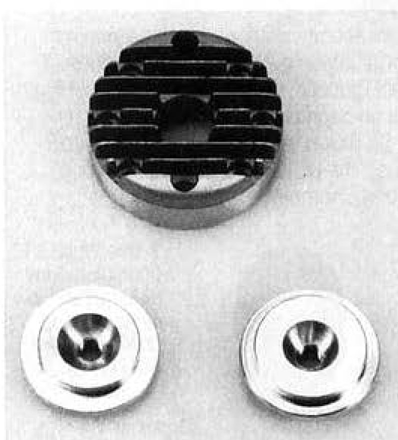




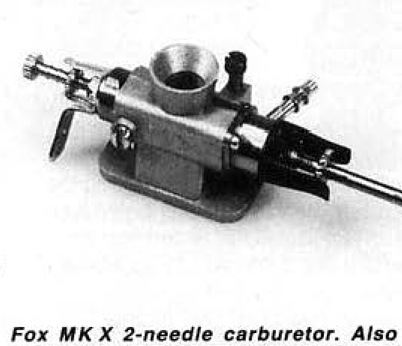
LEFT: Piston, wristpin and rod assemblies. 60 on left and 74 on right. Note size difference. Both engines share the same rod. RIGHT: Crankshaft, bearings, and prop drive assembly. Split collet type prop drive washer used. Both prop drive washer and front prop washer are knurled to prevent prop slippage. A minor detail exclusive to Fox engines.

fellows started using lower pitches and running their engines faster with the 11 x 7½ and 11 x 7 propellers eventually becoming the standard size. Presently, with more emphasis being placed on lower noise requirements, the trend is back to higher pitch props in order to slow the tip speed and reduce the noise level. This led to 11" and 12" pitches being used and, to many of the model engine manufacturers producing long stroke engines to handle the heavier prop loads --- engines that the scale modelers had been asking for for years to handle larger prop diameters necessary for radial cowled installations, etc. Most modelers think of the long stroke engines as being something new on the model engine market and, for the majority of the model engine manufacturers, they are. But how many modelers are aware of the fact that the Fox Eagle 60s have always been long stroke engines? The Fox Eagle 60s have a listed bore of .906" although our review engine had an actual bore diameter of .907", and stroke of .937". Any time the length of the stroke is larger than the bore diameter, you have a "stroker." Duke's Eagle series 60s have always been noted for their larger prop swinging ability but not recognized by many fellows during the period where turning your engine 14,000 to 15,000 rpm with an 11 x 7 was considered the way to go. Now that the trend has gone the other way, many fellows will be discovering the Fox Eagle IV's power potential — something that has been available all along with the previous Eagle series 60 engines. The Eagle 74, on the other hand, with a bore diameter of 1.000" and stroke of .937" (the same stroke as the 60) is of over-bore design but still handles the larger prop sizes with real authority. After all, as the saying goes —

Unusual treatment given to crankshaft counterbalance results in better dynamic balancing and smoother running engine.



60 combustion chamber on left has a larger bowl and narrower squish band than 74 combustion chamber on right. Head retained with eight screws rather than usual six.



Fox MK X 2-needle carburetor. Also available with larger intake for pump operation. Utilizes flat mounting flange that bolts directly to the engine crankcase rather than usual set screws or draw bar.

there is no substitute for cubic inches! So let's take a look at the design and construction features of Duke's latest Eagle IV 60 and 74.

Crankcase: Both engines share the same two-piece pressure die cast aluminum castings comprised of a lower crankcase and bolt-on upper cylinder which is attached to the crankcase with four 8-32 Phillips, Fillister head screws. Although the bolt-on upper cylinder crankcase design is used by several of the 4-stroke engine manufacturers, the Fox Eagle IV 60 and 74 are the only modern day 2-stroke engines utilizing this type of construction. Some of the old spark ignition engines of years past such as the Super Cyclone, Anderson Spitfire and Hornet 60 racing engine (made shortly before and after WW II) utilized the two piece crankcase design. In fact, there is something about the square, rugged appearance of the Fox Eagle IV engines that reminds one of the old Hornet 60. The Eagle IV 60 and 74 share the same lower crankcase but the bolt-on upper cylinder casting has been bored to a larger inside diameter to accommodate the 74's increase in bore diameter. An unusual feature here is the ability to position the bolt-on cylinder so that the exhaust can exit from either the left or right side or to the rear with no other part changes being required.

Crankshaft and Bearings: The crankshaft has been machined in one piece from bar stock steel, hardened and finish ground on all bearing surfaces, with the exception of the crankpin which has a lathe turned finish. One nice feature here is finish grinding of the shank portion of the prop threads which makes for perfect concentricity between the bearing surfaces and prop thread portion of the crank. Quite often this portion of the crankshaft warps during the heat treating process resulting in a brand-new crankshaft having a slight "bend," so to speak. The crankshaft has a massive 17mm (.669") diameter main journal which, in turn, allows the use of a larger diameter fuel passage through the crank. A two diameter fuel passage is used and is drilled to a .460" inside diameter through the main portion and opening up to .475" the last .350" before exiting into the crankcase. The intake port was timed to open 52° after BDC and close 48° after TDC for a total open duration of 176°. Although the closing timing is quite conventional for the operating range of the engine, the 52° opening timing is considerably later than what is customarily used, with 40°-45° being more the norm. I'm sure Duke Fox has a specific reason for using the late opening timing but if I were to personally use the engine in an aircraft, I would go to work with the Dremel Tool and start the crank opening in the 40°-45° range which would, in turn extend the total open duration. Bear in mind, however, that any engine modification of this type would void the manufacturer's warranty.

The counterbalance is of the constant thickness design milled away on either side of the crankpin for counterbalancing action. Something not normally seen is more of the counterbalance milled off on the left side than the right (see photograph). This is done to compensate for the port cutout in the crank and has been found to provide better static balancing of the crank when it is spun up to rpm on a balancing machine. The counterbalance would balance out only the full weight of the rod and no part of the wristpin or piston. Although this would seem a little on the light side, both the 60 and 74 were as smooth in operation as any of the similar displacement size engines we have tested, so evidently the lopsided counterbalance is playing a part here.

In keeping with the large diameter crankshaft, a massive 30mm (1.181") o.d. x 17mm (.669") i.d. rear bearing is used which is, incidentally, the same size rear bearing as used in the O.S. BGX-1 2.1 cubic inch engine reviewed last month. The front bearing is of more conventional size with a .875" o.d. x .375" i.d. (non metric).

Piston, Sleeve, and Rod: Both of our review engines were of the ringed piston design utilizing a single .0475" wide expansion ring running in a hardened steel sleeve. Both engines are also available in ABC versions (aluminum piston and chrome plated brass sleeve) and the 60 is available with an ABC pipe timed piston/sleeve assembly. Fox ringed engines have always been noted for their excellent compression seal hot or cold which is due to the extra finishing steps taken by Fox during the ring manufacture. Rather than using a ring as produced by the ring manufacturer, Fox buys unfinished rings from a major ring manufacturer and finishes them to final diameter using his own patented process. This assures a dead round ring when compressed to the bore size. Not all rings produced by the piston ring manufacturers end up dead round when compressed to the bore size diameter.

The aluminum pistons have been machined from a casting and, due to the high silicon content, no bronze bushings are used for the wristpin holes. The .250" diameter, hardened steel, tubular wristpin is retained in the piston by small stamped steel retaining rings and the connecting rod has been machined from aluminum bar stock and bronze bushed at both the crankpin and wristpin ends. The Fox rod is of rugged proportions, beefier than those used in the majority of the .60 displacement size engines.

Modified Schnuerle porting is used with the 60 utilizing three exhaust port windows flanked by single transfer ports on either side and two boost port windows directly opposite the exhaust. The 74 utilizes four exhaust port windows flanked by single transfer ports on either side and three boost port windows. The only way to actually tell the two engines apart is by looking in the exhaust and noting the number of exhaust windows showing. The engines carry no size designation on the cases. The 60 sleeve is timed for an exhaust duration of 140°, transfer port duration of 116°, and boost port duration of 126°. Note here that the boost ports actually open 5° ahead of the side transfer ports. The 74 has an exhaust duration of 140° also, but the transfer ports have an open duration of 122° and the boost ports 112°. In the 74, the transfer ports open 5° ahead of the boost ports which is more conventional practice.

Cylinder Heads: The heads are of two piece construction using a cast aluminum, finned upper piece in conjunction with a separate combustion chamber machined from bar stock aluminum. If you strip out the glow plug threads using too much muscle, only the combustion chamber need be replaced at considerably less expense. The 60 utilizes a .560'' wide by .200'' deep, bowl shaped combustion chamber surrounded by a .180'' wide, flat squishband with the squishband to piston clearance set at .021''. The 74 on the other hand used a .490'' wide by .250'' deep tea cup shaped combustion chamber surrounded by a very wide .250'' squishband with an approximate 2° taper and the squishband to piston clearance set at .031''. The measured combustion chamber volume of the 60 was .85 cc which computes to a compression ratio of 9.44:1 figured with the closing of the .260'' high exhaust. The 74 has a measured combustion chamber volume of .90 cc which computes to a compression ratio of 10.69:1, again, figured with the closing of the .260'' high exhaust. Both engines having higher than what might be considered standard compression ratios, the 74 in particular. However, neither engine shows signs of preignition even when loaded down with the larger prop sizes and purposely leaned past their peak rpm setting.

Carburetor: Both engines use the same MK X two-needle, rotating barrel carburetor with a .330'' throat diameter. This type of carburetor has proven to work very well and is being used in one variation or another by the majority of the model engine manufacturers. If you are looking for absolute maximum power, Fox has an F size carburetor available which has a .350'' throat diameter. This carburetor, however, requires the use of one of the after market pumps that are available. To facilitate the use of a pump system, smoke system, etc., the backplate has been drilled and tapped for a 4-40 pressure fitting. The pressure fitting hole has not been drilled all the way through, so, in order to make it functional, you just remove the backplate and run a 1/16" drill all the way through. Some of the pump systems such as the Perry do use a larger thread size, however, with the Perry requiring a 6-40 thread size. Do not try to operate the Perry pump with the 4-40 size fitting or the pump will not perform properly. (Perry pumps available from Varsane Products, 546 South Pacific Street, Suite C-101, San Marcos, California 92069, [619] 591-4228.) Drilling and tapping for the larger thread size is no big problem as there is plenty of material in the Fox backplate boss.

Performance: Duke Fox specifies that only fuel containing castor oil for lubrication be used in Fox engines. Duke has a very dim regard for the lubrication ability of the synthetic oils. For the purpose of our testing, Duke's Power Plus fuel was used which consists of 8% nitromethane, 4% nitroethane, 17% castor oil, and balance methanol. Duke makes no secret of the ingredients used in his fuels, which is something that many of the other model fuel manufacturers are reluctant to divulge. Although all Fox engines are test run prior to shipping, both engines were given an additional 30 minutes of break-in/loosening-up time. The factory supplied mufflers were installed and the engines came equipped with the Fox Miracle Plug that still looked as good as new at the completion of the testing. All propellers were Zingers.

	60	**74**
11 x 8	11,800	12,200
11 x 10	10,600	10,900
12 x 6	11,750	12,100
12 x 8	10,700	11,000
12 x 10	8,400	9,000
13 x 6	11,100	12,450
14 x 6	9,450	10,150

Temperature 68°F - Relative humidity 60% - Barometric pressure 29.92" Hg.

As can be seen by the preceding rpm figures, the Fox Eagle IV, 60 and 74 are both strong running engines with the 60 being the strongest running muffler equipped .60 displacement size engine we have tested to date, especially with the larger prop sizes. Only pipe equipped engines have exceeded these power figures. A tuned pipe such as the Mac's Products, Hatori, Rossi, etc., would give an estimated additional 600-800 rpm with no other changes. With the pipe timed sleeve you could expect at least an additional 1,000 rpm increase putting the Fox Eagle 60 right up there with the more powerful of the pipe equipped 60s. The 74, due to the larger displacement, turned 300-400 stronger with most of the props except when loaded down with the 12 x 10 and 14 x 6. Here the spread was 600-700. This is due to the fact that although the 60 would initially reach a slightly higher rpm reading, it would drop back a few hundred rpm indicating that it still needed a little more running time. The 74, on the other hand, would hold the fully peaked setting. Both engines were very "user friendly" as far as starting ability, mixture adjustment, and overall handling characteristics with no problems encountered with either engine. Both engines would hold a steady, reliable 2,500 rpm idle with the 11 x 8; 2,350 with the 12 x 8; and a remarkable 1,750-1,800 with the 14 x 6, with good recovery following a prolonged idle period.

The Eagle 60 lists for $169.95 and the 74 for $179.95; however, if you shop around, you will find the 60 selling in the $100.00 price range and the 74 for about $5.00 more. When you consider the sticker price on some of the competitive foreign imports, the Fox engines are exceptional bargains. Also bear in mind that replacement parts and service are readily available and the engines are made in the U.S.A.! □

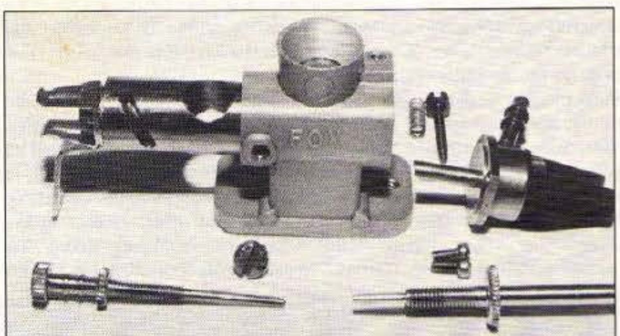
INSIDE ENGINES

BY STU RICHMOND

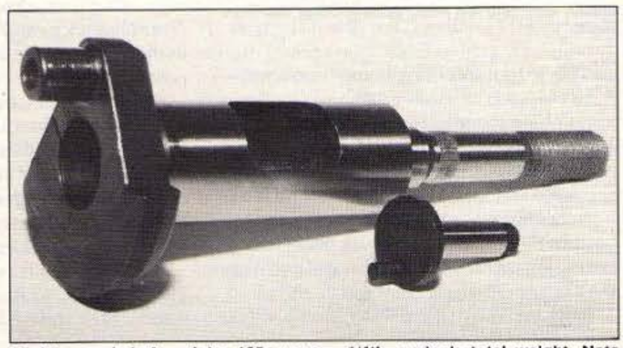
FOX EAGLE IV .74

My American national pride has been pin-pricked and deflated! They've just announced the best selling car in the USA is... the HONDA ACCORD... of Japanese origin!

So it's with great personal pleasure and matching pride that I lead you to this review of an ALL-AMERICAN new model engine that's sure to become a world-respected powerplant... one that the Japanese R/Cer cannot now buy due to their one-way trade barriers! Unless Japan, Brazil, and India quickly decide to dismantle their trade barriers like the Berlin Wall fell, the provisions of the Omnibus Trade Act of 1988 requires the USA to drop the equivalency of a third atomic bomb on these countries' economies by starting retaliatory trade barriers with them June 16, 1990. The "TM" model engine I have from Brazil is total trash; Indian production is little better. Unless trade walls fall, Honda's dominance will falter, along with the Japanese model industry.

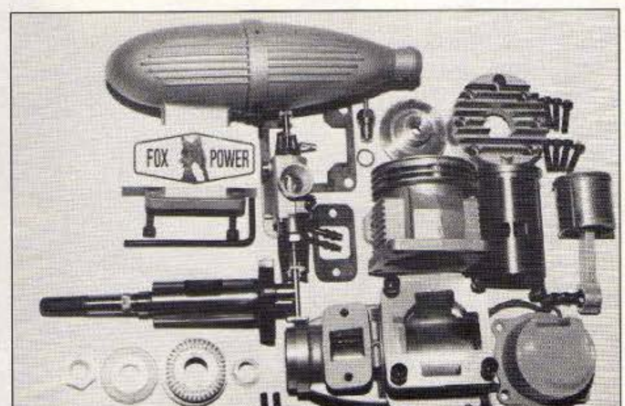


Text tells, in easy-to-understand language, how this carburetor works and how to clean it.

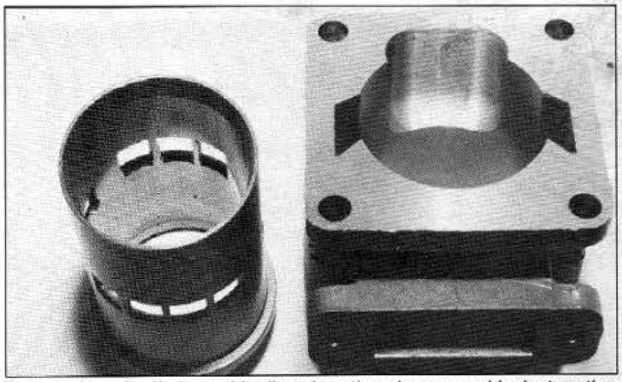


Eagle's crankshaft weighs 105 grams... 1/4th engine's total weight. Note splines on front end. Small 5-gram splined shaft from Cox .049.

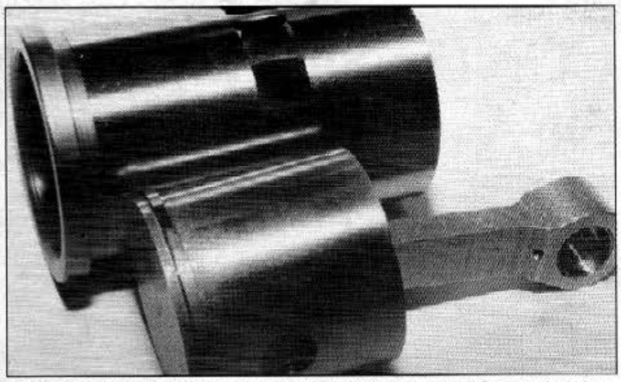
The glow plug threads into the machined button head (left)... casting on right clamps the button head in position.



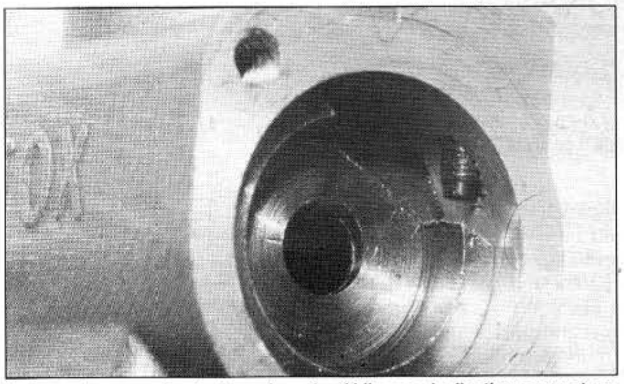
Teardown shows three paper gaskets. Text tells about bolt "snugging" when machine screws pass through paper gaskets.



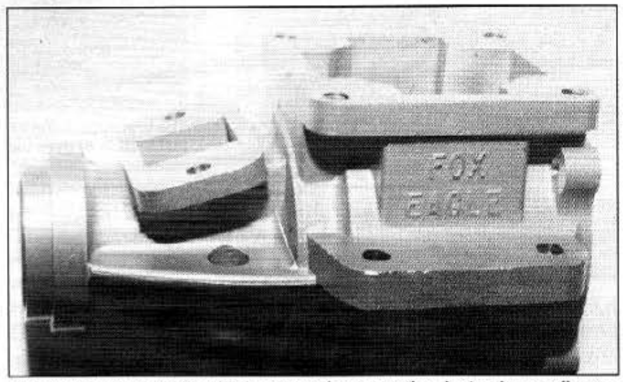
Bottom view of cylinder and its finned casting gives a good look at porting intricacies for modern Schnuerle engines.



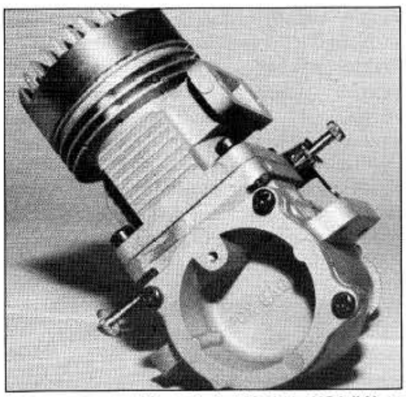
Stu tells us the benefits of buying ringed engines versus ABC types. Lubrication holes on both ends of connecting rod tough to drill.



Extreme close-up of carb shows how tip of idle speed adjusting screw stops barrel rotation for precise low speed adjustment.



Parts for Fox engines, like this lower crankcase section, just a phone call away. Flange mounting of carb being copied by "Fangine 100."



New Fox Eagle IV is entirely "Made in USA." Note threaded access hole for crankcase pressure take-off.

Table 1

PROP SIZE	LOW SPEED	HIGH SPEED	RICHMOND SPEED RATIO
11-7	2,800	12,700	4.54:1
11-7/2	2,550	12,550	4.92:1
12-6	2,050	12,200*	5.95:1
12-8	2,000	11,500	5.75:1
13-6	1,900	10,500	5.53:1
13-8	1,800	9,400	5.22:1

*The 12-6 with the muffler removed, turned 12,800 rpms.

Of the new EAGLE IV, Duke Fox says it "pulls like gangbusters"... and it sure does as you'll see in the performance figures. Model builders in Japan, Brazil, and India (as well as around the world), know well of the Cox, Fox and K&B American engines. Duke has been building big model engines for 45 years and this new EAGLE IV series represents his finest engineering to date. This month's review engine is the .74 size which started shipping in December '89... the .60 size should be shipping February 1, 1990, and these will probably be followed by upscale true ABC versions unless the trade walls fall... in which case Fox Manufacturing will have its hands full trying to meet demand for these two single-ringed engines worldwide.

The .74 has only been to the field twice, and each time modelers have said "Is that the new Fitzpatrick engine?... It sure is pretty!" Duke has done some nice exterior surface machining that doesn't affect performance one bit... but we model builders seem to all want prettiness and shine. If the internal visible surface of the carburetor casting's intake throat were to be highly buffed, the illusion would be complete.

The Fox engines seem to consistently have the best ratios of high speed to reliable idle speed (the Richmond Ratios) so let's first review how the Fox carburetor works. The high speed needle valve (the big one) has a taper from .070-inch diameter at its big shank diameter down to .050-inch diameter at its tip. The tapered distance between the big diameter and small diameter is only 3/16 of an inch, or about seven full turns of the high speed needle valve. Fuel metering actually takes place at the forward threaded end of the black double-ribbed fitting on which your fuel line fits. As you screw in the big high speed needle it increases the resistance to fuel flow at the orifice for a leaner setting. As you screw out the needle it offers less restriction for a richer setting by allowing more fuel to flow. After the fuel is metered by the big needle... it simply flows into the spray bar whose end extends only half way into the carb's throat. The lower tip of the spray bar is beveled off (not seen without disassembly) at a forty five degree angle... the Perry carb's spray bar is similar. Low, or negative atmospheric pressure on the downstream or bottom of the spray bar's beveled tip is what causes the fuel to flow to the engine. The fuel is pushed by the normal atmospheric pressure in the fuel tank which may have a slight internal positive pressure boost if the tank's vent line is attached to the muffler's pressure tap. To slow the engine down, the throttle servo retards or pulls back the throttle arm which is bolted to the steel throttle barrel. As the arm pulls back and rotates the barrel, the air inlet hole in the carb's barrel is turned out of alignment with

continued on page 80

the air inlet hole in the carb's casting. The engine begins to slow down. As the two holes further mis-align at still lower throttle settings the incoming volume of combustion air is still further restricted and speed is further reduced. As model engines slow down, the ratio of fuel to combustion air is too high (the mixture is too rich) for reliable idle performance. Now the idle speed needle valve (the smaller one on the engine's exhaust side) enters the picture. This smaller needle valve is threaded into the exact center axis of the steel throttle barrel. Also, the front surface of the barrel has a diagonal surface groove cut into it... the single screw on the front of the carb casting has its rounded tip precisely fit into the barrel's diagonal groove. As the barrel rotates, the "screw-in-the-groove" causes the barrel to move laterally or sideways... and as it moves inward toward the high speed needle side, it carries the idle speed needle with it. This smaller idle speed needle valve's tip then starts to stick into the beveled end of the spray bar as lower rpms are called for. The further the tip sticks into the spray bar, the more its increasing outside diameter restricts the fuel flow into the engine. By carefully adjusting the idle speed needle valve, you set the proper mixture at idle speed so the engine will have a lean mixture and readily accelerate from idle speed without hesitation. The carburetor is easily cleaned... simply loosen the two tiny 2-56 x 3/16 inch Phillips machine screws that hold the spray bar (and the big needle valve) onto the side of the carb's casting and remove. Remove both needle valves and flush all openings and surfaces with a can of WD-4O.

Most R/C carbs work in a somewhat similar manner to Fox's... it just seems Duke's mixture of inside and outside diameters, needle tapers, lateral movement, bevel angle and internal smoothness and roughness of machined surfaces... along with many other design/engineering factors... results in model engines that consistently have better ratios of high speed to reliable idle speed... better Richmond Ratios.

This Eagle IV .74 has a 1.000-inch bore. The Eagle IV .60 is in the same castings, uses the same stronger crankshaft and its bore (inside cylinder diameter) will be reduced to yield the .60 cubic inch size that's only required for AMA pattern flying competition. The Eagle IVs fit the mounting holes of the earlier (1981) series of Eagle engines. The best and most economical way to increase horsepower in a model engine is to increase displacement... that's what the .74 offers over the 60 size... about 350 to 400 more rpms on a given size prop... a lot of increase at the top ranges of rpms.

There's been a major design change in the Eagle IV's combustion chamber (if you have a mechanically good Eagle III that you don't think runs quite right, send me a SASE c/o *Model Builder* and I'll detail to you the simple changes I've made in mine that you can easily duplicate). The squish band is .250 inches wide and the combustion dome is an exact .500 inch hemisphere that has the supplied Miracle plug protrude down inside about .050 inch. The new glow plug's bottom coil extends down about one coil, as I do on my Quickie pylon racing plugs. The combustion chamber measured exactly two cubic centimeters at top dead center and this gives a nice gentle 7:1 compression ratio, although the ring seals so well after break-in that you'd swear the compression ratio was much higher! The head fin casting is held on with eight 6-32x1/2 inch Phillips screws; the rear crankcase cover is held on with four 6-32x3/8 inch Phillips screws and uses a thin paper gasket for sealing. The head fin casting clamps the turned aluminum button head directly in and on top of the cylinder with no gasket present or needed. It's interesting that Soviet glow engines come with a variety of thin soft aluminum head gaskets, or shims, so their compression ratios can be adjusted to match local humidity and fuel in use. My old (1981) Fox Eagle III .60 ran best in Central Florida's 90%-plus summer humidity with the bottom of the button shimmed to be .035 inches above the top of the piston's upper travel... this dimension is called "deck height"... and this month's review engine exactly matches the .035 inch figure! Anyone who flies in an extremely humid summer-like climate (above about 60%) may find that adding a .010 to .025 inch head gasket under the cylinder head may make any engine "less cranky," easier to needle, and easier on glow plug elements too. Most of us select fuel with nitromethane contents of 10% to 15%... if your engine seems too cranky and you don't want to add a shim, try fuel with a lower nitro content but then don't expect a superb idle. The new Eagle castings have a threaded hole that doesn't quite go through the thickness of the rear crankcase cover. If you drill a 1/16-inch hole through the wall and put the muffler's pressure tap in the threads, you'll have access to untimed crankcase pressure that's far higher than muffler pressure (remove the cover before drilling), and this can be used possibly for an airborne smoke feed system. I've never found muffler pressure to be effective in remedying a mispositioned fuel tank and I seldom use it in acrobatic models. This Eagle IV runs fine without muffler pressure on a 10-ounce tank that's centered up/down on the carb's spray bar. There's an optional "F" size carburetor with a larger .350-inch throat diameter available for still more power, but it'll require an aftermarket fuel pump for good fuel draw... I'm flying this 74 "as is"... and enjoying it on a 12-6 in the 7-1/2 pound test model.

The Eagle IV's carb is held on with two 6-32x5/16 inch Phillips screws and sealing is by a thin paper gasket. All screws that pass through paper gaskets should be lightly snugged before running any new engine... the gaskets tend to compress while the engine waits to be bought. The carb feeds fuel and combustion air through the crankshaft intake window where it then enters the crankcase through a .470-inch inside diameter passageway inside the crank's journal. The journal's outside diameter is a massive .665-inch... the crank's web is .275-inch thick front-to-back... the crankpin is .280-inch outside diameter and is hollow bored to aid balancing. The crankshaft has been lightly splined where the split collet fits to further prevent prop slippage... it's an extra manufacturing step. The prop threads are 5/16x24. The entire crankshaft is hardened and then ground to finish dimensions. The crankshaft's web, as viewed from the rear, is non-symmetrical... it's Duke's creative engineering at work. The crankshaft is so sturdy that it represents ONE FOURTH of the engine's total weight. The shaft runs in a pair of Fafnir (made in Connecticut, USA) ball bearings.

I don't believe in removing ball bearings unless they're going to be replaced. In the same manner, I don't believe most readers buy a new R/C system, take it home, open the receiver, battery pack, and the four servos looking for conductive metal "freebies." Similarly then, I don't think readers should buy a new engine, take it home, tear it all apart and go looking inside for destructive metal "freebies." If you feel you have to absolutely get inside a new engine... I recommend nothing more than removing the glow plug and removing the rear crankcase cover (scratch an "X" on its top first), and flushing through with a can of WD-4O. It's best to recognize that today's engines have very liberal and very valid warranties that protect our purchase. It's also best, I feel, to carefully study the photos with these columns... their focus or aim is to show you what's inside without you having to take things apart yourself! The piston, ring, connecting rod, wrist pin, and circlips assembly weighs only 22.5 grams... light for a .74 size. Fox makes its own piston rings... as I recall they even hold patents on the process of ring making. The single ring exerts above average outward force inside the cylinder walls, but performance sure doesn't suffer.

The two lubrication holes of the connecting rod face forward... and are drilled, through creative engineering, where many people feel is the "right" location... it's a tough spot to drill them. The rod is bronze bushed at both ends, and its cross section is a beefy .300 x .175 inch. If you ever want to remove the wrist pin (like for a rod replacement) you'll need a tool similar to Sears Craftsman #9-45358 to remove one of the circlips that retain the wrist pin. It's best to not reuse the old circlip.

The steel cylinder has three square intake ports as well as a forward and rearward boost port. Even though the cylinder wall is only .060-inch thick, the two boost ports are angled upwards and away from the exhaust ports. The cylinder itself weighs a light 48 grams (28 grams = 1 ounce) and it's an easy no-heat slip fit into its finned casting. The cylinder is clamped in place by a heavy .125-inch thick lip at its top. I'd say the easy slip fit is Duke's way of omitting cylinder distortion problems in a bigger engine with a thin-walled, light weight cylinder. Smart!

This Eagle IV .74 review engine is Fox #27400. It is also available as you read this in the .60 size as #26600 which is also ringed. ABC versions are planned in both sizes as well as a pipe-timed .60 ABC version for contest pattern flying. This engine has conservative exhaust timing of 142 measured degrees... there's lots of time to burn the fuel on each power stroke and the fuel economy is therefore quite good, although none of us buy engines on that basis.

I always choose ringed or non-ABC engines for sport flying and an ABC for pylon racing. Ringed engines take more abuse than ABCs that use an aluminum piston. A tiny hunk of grit can get crushed between an iron piston ring and the steel cylinder and the engine will normally keep on going... with usually only minor vertical scratches. The same piece of grit will often totally destroy an aluminum piston. Many modelers buy ABC or ABN engines for sport flying and think they're better because they cost more. False! A worn-ringed or iron piston engine is much less costly to rebuild. A worn or damaged ABC/ABN piston and cylinder may shock you with replacement costs. The cheapest way to increase power is to increase displacement. For those R/Cers who want a little more power for their .60 size models, this new Fox Eagle IV .74 is a great way to go. This is a time-proven, rugged design engine... built into a new set of castings... with a still sturdier crankshaft... with a new and vastly improved combustion chamber design... with everything made in the USA... and with all replacement parts just a phone call away.

The engine was carefully broken in with POWERMASTER's new Golden Break-in Fuel that comes in a half-gallon jug. The break-in directions come with the jug and are very easy to follow... we used a Master Air Screw 11-7 for break-in and the last of the fuel was used for the first test flights too. The original Miracle plug quit the first time the engine fired... a fluke... the second Miracle plug ran over 30 cold starts, hot restarts, high rpms for test data taching, has been flown over two air-hours, and looks like new.

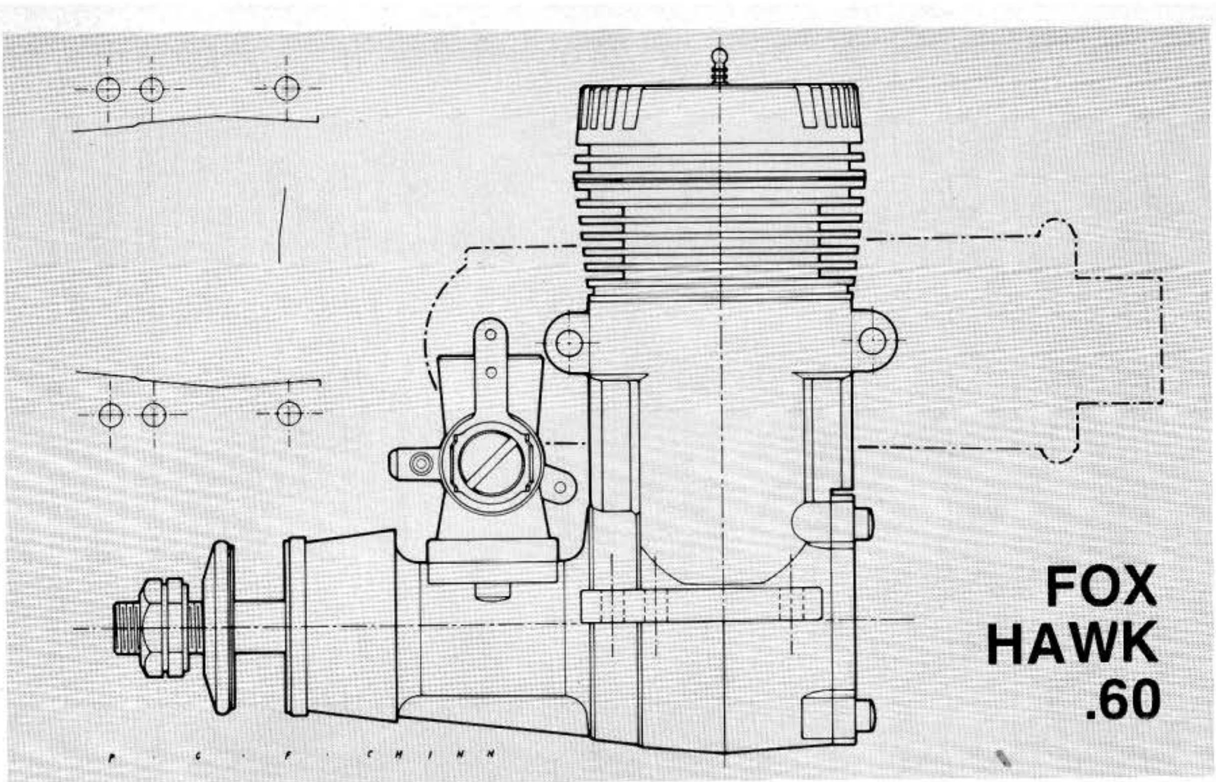
Please be reminded that the ratios of high speed to reliable idle performance (the Richmond Speed Ratios) on a given prop appears to be totally non-related to temperature, humidity and barometric pressure. No matter where you live your Fox .74 should exactly parallel these performance figures. (See Table 1)

The Eagle IV .74 seemed most comfortable running with the 12-6 and is now being regularly flown with that size on the test model.

A speed ratio below 4:1 is unsatisfactory.
A speed ratio of 4:1 is barely satisfactory.
A speed ratio of 5:1 is average.
A speed ratio of 6:1 is excellent.

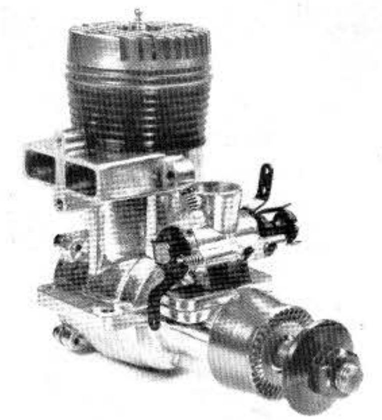
Bore is 1.000 inch, stroke is .938 inch, displacement computes to .736 cubic inch, deck height is .035 inch, carburetor intake diameter is .325 inch, muffler outlet diameter is .395 inch, exhaust timing measures 142 degrees (too low for a tuned pipe to be very effective, but helps fuel economy). The engine weighs 19 ounces and the muffler weighs an additional 3.2 ounces.

Made by Fox Manufacturing Company, 5305 Towson Ave., Fort Smith, AK 72901,



ENGINE REVIEW

By Peter G. F. Chinn. . .Fox Hawk 60 is latest American challenge to high performance imports. Design and construction show Fox individuality, including variation in Schnuerle system.



• Although its shiny crankcase and vertical, flange-mount carburetor are unmistakably Fox, the Hawk 60 is an entirely new motor and is not, repeat not, simply a souped-up version of the existing Eagle 60.

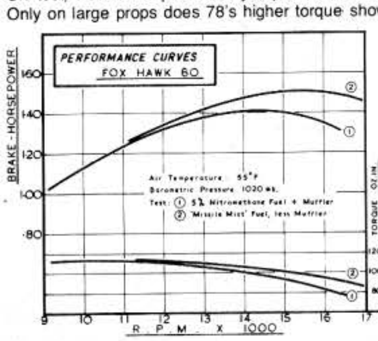
Whereas the Eagle was introduced three years ago to compete with imported 60's mainly on price, Fox has now, with the new and more expensive Hawk, opted to tackle the opposition strictly on performance. To do this, Duke Fox has followed the European trend by going over to a Schnuerle type scavenging system although, typical of Duke's determination to do things differently, the porting is not quite the same as the layouts used by, for example, OPS, HP and Enzesfeld-Webra. There are several other features which demonstrate Fox's continuing policy of individuality in design and construction.

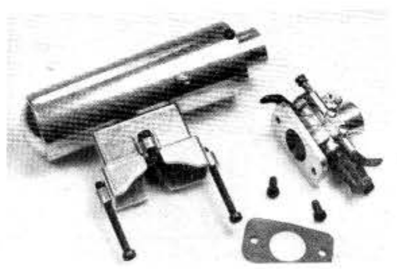
MAIN CASTING. This includes the crankcase and front housing, but unlike the Eagle casting, which also embodies a full length finned cylinder casing, the Hawk casting terminates just above the exhaust stack. It incorporates a conventional, wide bypass passage on the left side as a crossflow motor, with the addition of Schnuerle type channels fore and aft. These latter extend right to the top of the case, where they are sealed off by the gasket between the case and the base flange of the cylinder.

As on the Eagle, the mounting lugs have 6 bolt-holes and provide a choice of 25/32" or 1-1/32" longitudinal spacing. Lateral spacing is the same as on the Eagle and the engine will fit the same bearers but will require slight paring of the inside edges of the bearers to clear the new shape of the crankcase.

(Continued on page 74)

On test, Hawk's output actually equalled Fox .78. Only on large props does 78's higher torque show.





Carburetor is flange mount type, familiar on .78 and Eagle models. New muffler has better mounting.

Modified Schnuerle system features extra large, dual third-port windows. Also note unusual head shape.

Engine Review

(Continued from page 53)

Instead of being cylindrical, the Hawk crankcase is barrel shaped externally, in order to accommodate an internal channel deep enough to provide clearance for the Hawk's larger conrod.

CYLINDER. This is one piece with integral cooling fins and is machined from alloy steel which is then case-hardened by nitriding. It has a pair of exhaust ports on the right side; the fore and aft bypass ports being angled, in the approved Schnuerle scavenge manner, to direct the incoming charge to the left side, where there are two very large "third" ports, chamfered on their top edges to direct gas upward. The exhaust ports are very deep (0.275"), partly because the Fox has a considerably longer stroke (0.9375") than its contemporaries (mostly 0.866"-0.876") and partly because it has an unusually lengthy exhaust period (150° of crank angle). Again, unlike most other Schnuerle scavenged motors, the two fore and aft bypass ports open slightly later than the third-port windows. Cylinder induction periods (according to measurement of our test motor) are, respectively, 124° and 128° of crank angle.

PISTON AND CONROD ASSEMBLY. The piston is machined from a low expansion, high silicon content aluminum alloy casting. Unlike the Eagle piston, it has a flat, deflectorless head, a single compression-ring, pinned to prevent rotation, and skirt cutaways to avoid masking the front and rear bypass channels. It is quite light and weighs only 9.3 gm., or 11.6 gm. with its lightweight 1/4" i.d. tubular wristpin The wristpin is retained in the piston by snap-rings. The connecting rod is machined from aluminum alloy bar stock and, unlike the Eagle rod, is bronze-bushed at the lower end. The top end remains unbushed but now has an oil slit like the lower end. The rod is also 1/32" longer at 1-9/16" between centers and is somewhat sturdier than the Eagle conrod with a heavier shank and bigger o.d. eyes. The rod weighs 5.2 gm.

CRANKSHAFT AND BEARINGS. In common with the Eagle and the majority of other shaft-valve .60 engines, the Hawk has a 15 mm.dia. crankshaft main journal. The gas passage through the shaft is just a trifle bigger than the Eagle's at 10.9 mm. and is fed from a larger, rectangular valve port which opens earlier and closes later. According to our measurements, the rotary-valve is timed 38° ABDC to 50° ATDC. Like the Eagle, the Hawk uses a 1/4" o.d. crankpin, with counterbalancing by cutaway web flanks and a 5/16" UNF thread for the prop nut. Unlike the Eagle, it has a hollowed crankpin and a spiral oilway in the surface of the main journal just ahead of the rotary-valve port. It also has a stronger crankweb and a bigger counterweight.

The shaft is carried in a 15 x 28 x 7 mm. 10-ball steel caged ball-journal bearing at the rear and a 3/8 x 7/8 x 7/32" 7-ball steel caged bearing at the front. The prop driver, anodized red, is mounted on an aluminum split taper collet and is cupped to fit over the crankcase nose.

CYLINDER HEAD. Contrasting with the wedge head of the Eagle and the bowl and squish band combustion chamber shape of most of its competitors, the Hawk features a shallow, cone-shaped head with a shallow 3/8" dia. central depression surrounding the plug. Six 1-1/4" long 6-32 screws tie the head and cylinder to the crankcase.

There is a gasket between the crankcase and cylinder base flange, but no head gasket is used.

The measured combustion chamber volume of our test motor was approximately 0.88 milliliters, which gives a nominal compression-ratio of 12.2:1. This is somewhat higher than average for a .60 pattern engine, but it has to be remembered that the engine's true sweep volume is lowered rather more than usual by the Hawk's lengthy exhaust period which, in turn, reduces the effective compression-ratio to a greater extent than normal.

CARBURETOR. Except for a very slightly larger i.d. choke, the carburetor is the same as the Eagle carb, which is to say that it is of original Fox design, incorporating a butterfly-valve type throttle rotor, two needle-valves and an automatic fuel metering device to ensure correct mixture strength at all throttle settings.

The main needle-valve is located in the throttle rotor on the left side and is used to set the required mixture strength at full throttle, the main jet being in the center of the rotor itself. The idle needle-valve is a smaller screw on the right side of the carburetor body at the front and meters the amount of fuel released by the idling jet. Both jets are fed from an inlet nipple cast into the front of the carburetor, and fuel to the main jet is conveyed, through a delivery hole in the carb body, to an inlet hole in the surface of the throttle rotor. These holes are in line when the throttle is in the fully open position only: a groove in the surface of the rotor, extending from the rotor inlet hole, allows a reduced amount of fuel to be admitted at part-throttle settings, and the groove is tapered to automatically meter the fuel in accordance with the throttle opening. At the closed-throttle (idling) position, the flow to the main jet is completely cut off so that the engine runs on the idling jet only.

Adjustment procedure is quite simple. After the engine has been broken-in, the throttle should be closed and the small needle set for the required idle, following which the main needle is then rechecked for full throttle performance.

Throttle arms are fitted on both sides of the carburetor and can be adjusted to respond to either a push-to-open or a pull-to-open servo setup.

MUFFLER. No exhaust throttle-valve is fitted to the Hawk, and this has enabled an improved method of attaching the appropriate Fox muffler to be adopted. Instead of having the muffler duct merely butt against the exhaust stack and fixed with screws above and below (an arrangement somewhat prone to costly damage in a crash), the muffler now has a box extension which surrounds the engine's exhaust stack, plus a threaded lug at each end to provide four-screw, instead of two-screw, attachment.

The rest of the muffler is basically the same as the closed-front Fox "C" size unit. It is compact in overall dimensions with a 5/8" i.d., full length, inner-perforated tube having nine entry slits on the side opposite the exhaust stack. The slits, however, are longer than those of the muffler originally supplied with the Eagle and have a total area of approximately 216 sq.mm. The outlet area remains at a generous 198 sq.mm. The muffler is now fitted with a brass nipple for a fuel tank pressurization system.

PERFORMANCE

Our test motor came direct from the Fox factory. It had been checked out before dispatch but had not been broken in and was still a little on the tight side after half-a-gallon of fuel had been run through it. The piston is fitted with a somewhat smaller clearance than is usual, and, with the low-expansion alloy used, this is perfectly okay provided that the Hawk is adequately broken in before being leaned out to peak performance. Failure to do so may result in the engine tightening up quickly when run at speeds approaching the peak of the power curve.

We mention this in order to emphasize the necessity of not sending a model off with the needle too near the peak setting during the early stages of the engine's life. This is something that applies to any new motor, of course, but on the basis of our experience with the test sample, it may be that

Engine Review

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the Hawk might require a little longer break-in than some of its competitors. On the other hand, it needs to be said that our motor was an early production model, and it is possible that it is not typical, and that current models are being set up with slightly greater top clearance.

Unlike many American engines, the Hawk was designed to operate on straight FAI fuel as well as regular nitromethane blends. This should give it added attraction in export markets. We found that, when running on any of the usual prop sizes, only about 300-400 revs separated the performance on straight methanol/castor oil from that achieved on fox Missile Mist. Our regular 5% nitro test blend fell midway between the two.

Comparing prop rpm with figures recorded for the Eagle showed a substantial difference in the Hawk's favor. On 5% nitro, with mufflers fitted, the following figures were determined (Eagle equivalents in parenthesis): 11,700 (11,200) on a 12x6 Top Flite maple; 12,800 on an 11x7½ Power-Prop maple; 13,600 (12,600) on an 11x6 Top Flite maple; and 14,200 (13,100) on an 11x6 Power-Prop maple.

Our first series of torque tests were carried out on 5% nitro fuel, with open exhaust, followed by a recheck on the same fuel to determine the power absorption of the muffler. In fact, the muffler caused virtually no power loss up to 14,000 rpm: a just measurable loss at 15,000, rising to about 7% when the engine was taken well beyond its peak to 17,000 rpm. In other words, on all normally used prop sizes, the effect of the muffler on power can be ignored. As the performance curves indicate, the power output determined under these conditions just topped 1.40 bhp at about 14,300 rpm.

Switching to Missile Mist had very little effect on the maximum torque developed but raised the peak power to approximately 1.51 bhp at 15,500, *less* muffler.

Shortly after we had completed our tests, a Fox advertisement appeared for the Hawk 60 in which the engine was claimed to deliver 1.50 horsepower on Missile Mist fuel. Manufacturers' claims often tend to be a little above the levels that we are able to obtain on test, but, as can be seen, the factory claim here appears to be fully justified. The same advertisement also rated the Eagle at 1.25 bhp on FAI fuel. We did not run a full test on such fuel but on the basis of initial checks made, would have expected our Hawk to reach around 1.30 bhp.

Power output levels, irrespective of fuel used, are outstandingly good and put the Hawk squarely in the upper performance bracket. Nor was this high performance obtained at the expense of handling qualities. The throttle worked well, and we had no difficulty in obtaining reliable idling speeds in the 2,200-2,400 rpm bracket with instant pick-up and good transition through intermediate speeds.

SUMMARY OF DATA

Type: Single cylinder, Schnuerle loop-scavenged two-stroke cycle with crankshaft rotary-valve and twin ball bearings. Throttle type carburetor with automatic mixture control. Fox muffler optional.

Checked Weights: 15.1 oz. (less muffler)
18.0 oz. (with Fox muffler)

Displacement: 0.6057 cu.in. = 9.926 c.c.

Bore: 0.907" (23.04 mm.)

Stroke: 0.9375" (23.81 mm.)

Stroke/Bore Ratio: 1.034 : 1

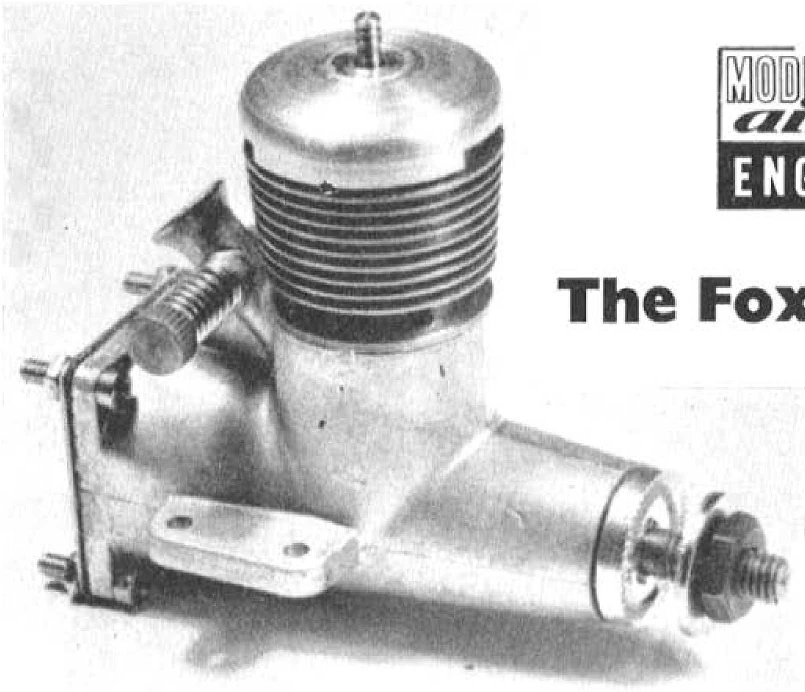
Measured Nominal Compression Ratio: 12.2 : 1

Specific Output (as tested):
2.33 bhp/cu.in. on 5% nitromethane fuel, with muffler.
2.49 bhp/cu.in. on Fox Missile-Mist fuel, less muffler.

Power/Weight Ratio (as tested):
1.25 bhp/lb. on 5% nitromethane fuel, with muffler.
1.60 bhp/lb. on Fox Missile-Mist fuel, less muffler.

Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, Arkansas 72901. ■

MODEL aircraft
ENGINE TESTS



The Fox ROCKET 09

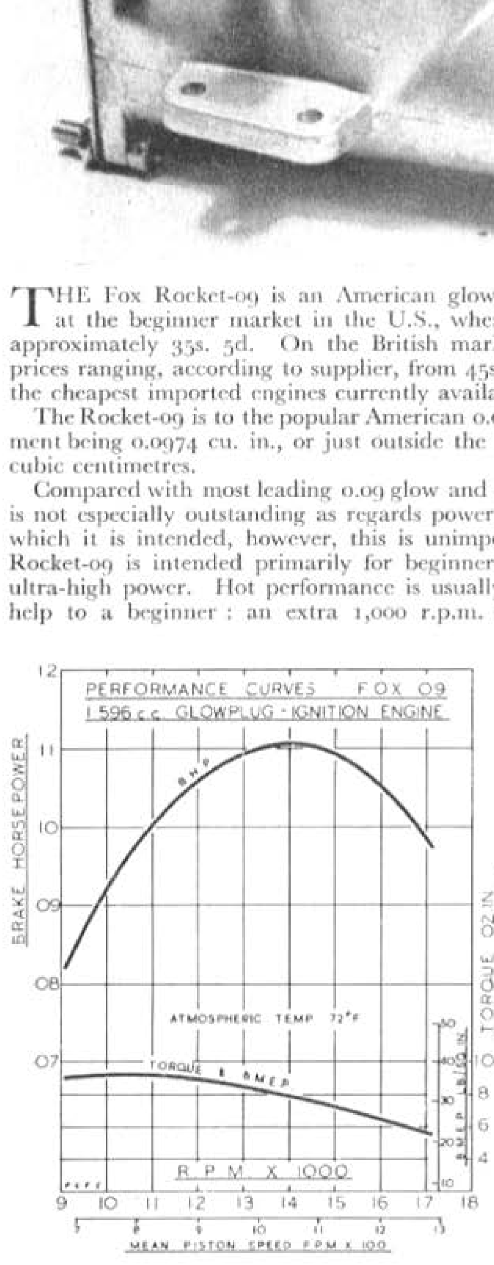
1·6 c.c. Glowplug Engine

". . . excellent starting through a wide variety of props, with no tendency to 'bite.'"

THE Fox Rocket-09 is an American glowplug motor aimed specifically at the beginner market in the U.S., where it costs a modest $4.95—or approximately 35s. 5d. On the British market, it has been advertised at prices ranging, according to supplier, from 45s. 6d. to 60s., but is still one of the cheapest imported engines currently available.

The Rocket-09 is to the popular American 0.099 cu. in. size, actual displacement being 0.0974 cu. in., or just outside the British 1½ c.c. group, at 1.596 cubic centimetres.

Compared with most leading 0.09 glow and 1.5 c.c. diesel motors, the Fox is not especially outstanding as regards power output. For the purposes for which it is intended, however, this is unimportant. As we have said, the Rocket-09 is intended primarily for beginners. As such, it does not need ultra-high power. Hot performance is usually more of a hindrance than a help to a beginner: an extra 1,000 r.p.m. with an imperfectly trimmed F/F model can spell disaster. On the other hand, costing, in its country of origin, no more than the average "Half-A" (0.049 cu. in.) motor, the Fox does offer, over these baby motors, the extra power generally desirable for C/L models. In other words, the Rocket-09 rates favourably on the basis of "power-per-dollar"—as distinct from power/displacement, which, after all, is mainly of interest only to the contest enthusiast.



We have emphasised this approach to assessing the Rocket-09 because we feel that there is often a tendency for modellers to place undue importance on high specific performance figures, irrespective of engine types. This was brought home to us rather forcibly in the case of the Fox, which one experienced and noted modeller dismissed as "disappointing"—mainly because its power fell somewhat short of another engine of equal capacity but costing twice as much.

A quality which is of greater importance to the beginner than sheer power is, of course, easy starting, and, in this respect, the Fox excels. Other desirable characteristics, in a beginner's engine, are that the controls should be placed at a safe distance from the prop, that the engine should be as self-contained as possible—preferably with an integral fuel tank—and that it should be easy to instal in a wide variety of model designs, i.e. with provision for bulkhead or beam type mounting. All these are features of the Fox Rocket-09.

The design of the Rocket-09 is somewhat off the beaten track. With its one-piece crankcase, front housing and fuel tank casting and inclined rear intake, its appearance is quite unlike that of any other engine at present on the market.

The most unexpected feature of the Rocket-09 is in its revival of the 3-port type layout—i.e. piston controlled induction instead of the rotary-valve or reed-valve system that has become standard practice nowadays. Instead of the usual single induction port of the old-type 3-port engine, however, Fox has brought things up to date by using twin opposed induction ports, of generous area, fed from an annular chamber, into which mixture is drawn from an inclined rear-positioned carburettor. This has also facilitated the use of an efficient reverse-flow scavenged cylinder, having twin internal transfer flutes and twin opposed exhaust ports. Other modern features include the use of a ball-joint small-end and a built-in glow filament in a hemispherical pattern cylinder head. Standard beam mounting lugs are disposed symmetrically on the horizontal centre-line of the engine and aft of the cylinder axis. Frontal overhang, however, is kept at a minimum by the short main bearing—made possible by the rear carburettor location. Alternative, four-point, radial mounting is provided for by means of a rectangular flange which normally serves to secure the tank backplate. The engine can be used with or without the integral tank, beam or bulkhead mounted.

Specification

Type : Single-cylinder, air-cooled, reverse-flow-scavenged 3-port 2-stroke cycle.

Bore : 0.527 in. Stroke : 0.450 in.

Swept Volume : 0.0974 cu. in. = 1.596 c.c.

Stroke/Bore Ratio : 0.854 : 1.

Weight : 3.1 oz.

General Structural Data

Pressure die-cast aluminium alloy crankcase and unbushed main bearing unit with integral fuel tank. Tank section separated from crank chamber by screw-in backplate. Rear of tank sealed by stamped aluminium plate, with cork insertion gasket, retained by four screws and nuts. Counterbalanced, hardened crankshaft with $\frac{1}{4}$ in. dia. journal and $\frac{1}{8}$ in. dia. crankpin. A $\frac{1}{8}$ in. dia. oil hole leads into the main bearing from below the cylinder skirt. Machined leaded-steel cylinder with integral fins, screwed into crankcase and seating on soft aluminium gasket. Lightweight, flat crown, steel piston, hardened on outer skirt surface and with swaged socket to ball-joint steel connecting-rod. Screw-in aluminium cylinder head with integral glow element. Soft aluminium head gasket. Alloy prop driver, keyed to shaft by three short lands on latter. Pressed-in brass spraybar, with one-piece steel valve needle and control knob.

Test Engine Data

Running time prior to test: 1 hour. Fuel used: mixture of two parts Record Nitrex-15 and one part Record Super-Nitrex.

Performance

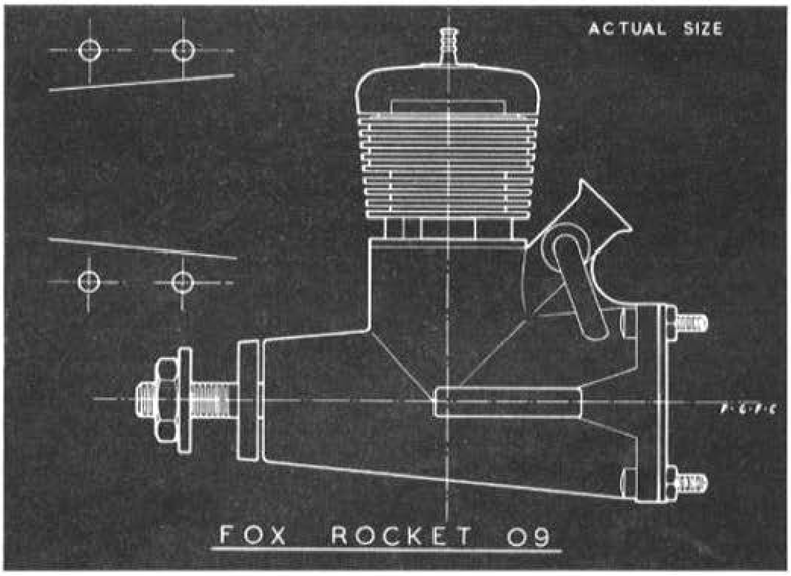
The maker's recommended fuel for the Fox Rocket-09 is Fox "Missile Mist." This is a fuel containing approximately 20 per cent. nitromethane but is unobtainable in the U.K. An equivalent was therefore blended by adding one part Record Super-Nitrex (30 per cent. nitro) to two parts Nitro-15 (15 per cent. nitro).

The first clue to the excellent handling of our test sample came with the initial start from cold. The maker's instruction leaflet is clearly worded and was followed exactly. It calls for a port prime for cold starting. The result was a genuine first flick start, the motor cutting out after a few seconds. A further half-turn of the needle-valve was then sufficient to keep the 09 running continuously and evenly.

With the motor warmed up, restarts were virtually instantaneous after a single, choked, preliminary flick of the prop. This excellent starting continued through a wide variety of props and the engine proved remarkably docile with no tendency to "bite" on props down to 6 × 3 size—allowing r.p.m. well above the peaking speed. On the smaller and lighter props there was a tendency (as with other non-rotary valve type engines) to start in the reverse direction. This, however, was easily dealt with by flicking the prop backwards.

The needle-valve was positive and progressive in operation. Fairly accurate adjustment was necessary to extract the last hundred or so r.p.m., but the 09 would continue to run on an excessively rich mixture, allowing plenty of time to make such adjustment. This latter is particularly welcome in view of the fact that the position of the needle-control, while at a safe distance from the prop, is rather close to exhaust heat.

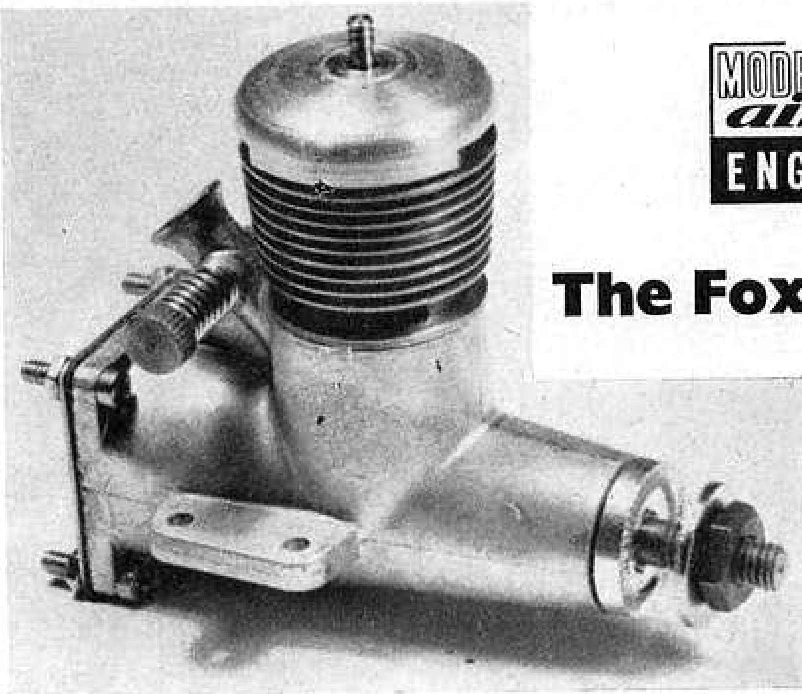
Torque tests revealed a maximum of 9.2 oz. in., equivalent to a b.m.e.p. of 37 lb./sq. in. For a 3-port type motor, the b.h.p. peaking speed was unusually high—14,000 r.p.m.—where an output of just over 0.11 b.h.p. was realised. The Rocket-09 will, however, rev happily well beyond the peak. The maker's recommended props are 7/3 and 6/4, wood or nylon. With a 7/3 wood, the test engine reached 13,000 r.p.m. static, and, on a 6/4 nylon, exceeded 15,500 r.p.m. At these higher speeds, the engine is particularly smooth running.



In all, a likeable motor and one that was a pleasure to test.

Power/Weight Ratio (as tested) : 0.57 b.h.p./lb.

Specific Output (as tested) : 69 b.h.p./litre.



MODEL aircraft ENGINE TESTS

The Fox ROCKET 09

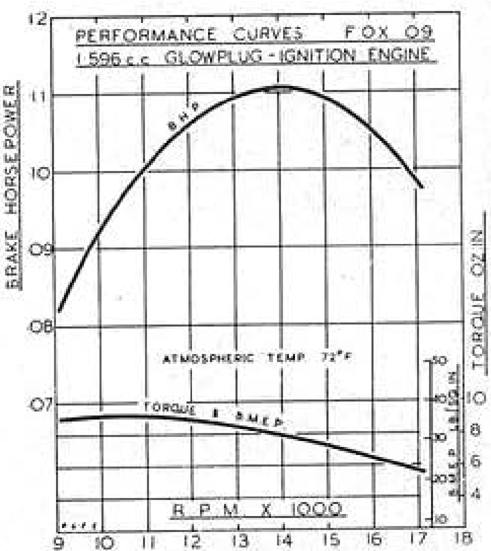
1·6 c.c. Glowplug Engine

" . . . excellent starting through a wide variety of props, with no tendency to 'bite.'"

THE Fox Rocket-09 is an American glowplug motor aimed specifically at the beginner market in the U.S., where it costs a modest $4.95—or approximately 35s. 5d. On the British market, it has been advertised at prices ranging, according to supplier, from 45s. 6d. to 60s., but is still one of the cheapest imported engines currently available.

The Rocket-09 is to the popular American 0.099 cu. in. size, actual displacement being 0.0974 cu. in., or just outside the British 1½ c.c. group, at 1.596 cubic centimetres.

Compared with most leading 0.09 glow and 1.5 c.c. diesel motors, the Fox is not especially outstanding as regards power output. For the purposes for which it is intended, however, this is unimportant. As we have said, the Rocket-09 is intended primarily for beginners. As such, it does not need ultra-high power. Hot performance is usually more of a hindrance than a help to a beginner : an extra 1,000 r.p.m. with an imperfectly trimmed F/F model can spell disaster. On the other hand, costing, in its country of origin, no more than the average " Half-A " (0.049 cu. in.) motor, the Fox does offer, over these baby motors, the extra power generally desirable for C/L models. In other words, the Rocket-09 rates favourably on the basis of " power-per-dollar "—as distinct from power/displacement, which, after all, is mainly of interest only to the contest enthusiast.



We have emphasised this approach to assessing the Rocket-09 because we feel that there is often a tendency for modellers to place undue importance on high specific performance figures, irrespective of engine types. This was brought home to us rather forcibly in the case of the Fox, which one experienced and noted modeller dismissed as " disappointing "—mainly because its power fell somewhat short of another engine of equal capacity but costing twice as much.

A quality which is of greater importance to the beginner than sheer power is, of course, easy starting, and, in this respect, the Fox excels. Other desirable characteristics, in a beginner's engine, are that the controls should be placed at a safe distance from the prop, that the engine should be as self-contained as possible—preferably with an integral fuel tank—and that it should be easy to instal in a wide variety of model designs, i.e. with provision for bulkhead or beam type mounting. All these are features of the Fox Rocket-09.

The design of the Rocket-09 is somewhat off the beaten track. With its one-piece crankcase, front housing and fuel tank casting and inclined rear intake, its appearance is quite unlike that of any other engine at present on the market.

The most unexpected feature of the Rocket-09 is in its revival of the 3-port type layout—i.e. piston controlled induction instead of the rotary-valve or reed-valve system that has become standard practice nowadays. Instead of the usual single induction port of the old-type 3-port engine, however, Fox has brought things up to date by using twin opposed induction ports, of generous area, fed from an annular chamber, into which mixture is drawn from an inclined rear-positioned carburettor. This has also facilitated the use of an efficient reverse-flow scavenged cylinder, having twin internal transfer flutes and twin opposed exhaust ports. Other modern features include the use of a ball-joint small-end and a built-in glow filament in a hemispherical pattern cylinder head. Standard beam mounting lugs are disposed symmetrically on the horizontal centre-line of the engine and aft of the cylinder axis. Frontal overhang, however, is kept at a minimum by the short main bearing—made possible by the rear carburettor location. Alternative, four-point, radial mounting is provided for by means of a rectangular flange which normally serves to secure the tank backplate. The engine can be used with or without the integral tank, beam or bulkhead mounted.

Specification

Type : Single-cylinder, air-cooled, reverse-flow-scavenged 3-port 2-stroke cycle.

Bore : 0.527 in. Stroke : 0.450 in.

Swept Volume : 0.0974 cu. in. = 1.596 c.c.

Stroke/Bore Ratio : 0.854 : 1.

Weight : 3.1 oz.

General Structural Data

Pressure die-cast aluminium alloy crankcase and unbushed main bearing unit with integral fuel tank. Tank section separated from crank chamber by screw-in backplate. Rear of tank sealed by stamped aluminium plate, with cork insertion gasket, retained by four screws and nuts. Counterbalanced, hardened crankshaft with ¼ in. dia. journal and ⅛ in. dia. crankpin. A ⅛ in. dia. oil hole leads into the main bearing from below the cylinder skirt. Machined leaded-steel cylinder with integral fins, screwed into crankcase and seating on soft aluminium gasket. Lightweight, flat crown, steel piston, hardened on outer skirt surface and with swaged socket to ball-joint steel connecting-rod. Screw-in aluminium cylinder head with integral glow element. Soft aluminium head gasket. Alloy prop driver, keyed to shaft by three short lands on latter. Pressed-in brass spraybar, with one-piece steel valve needle and control knob.

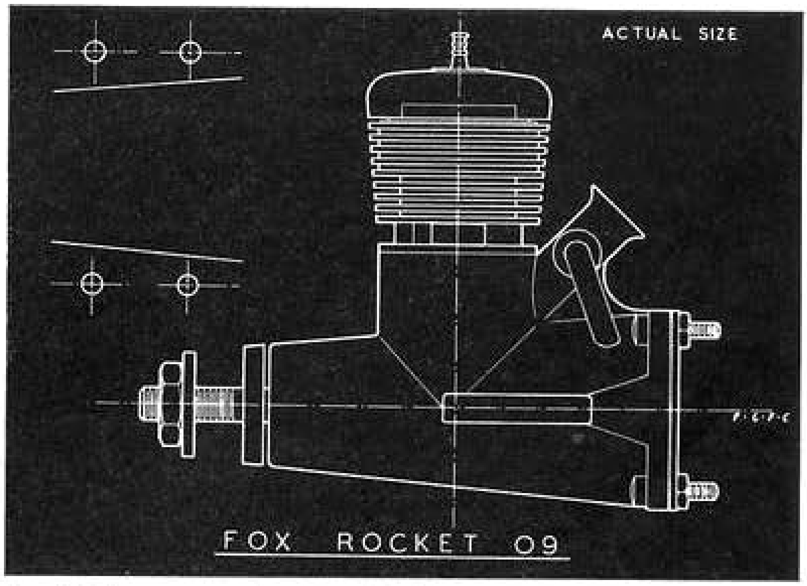
Test Engine Data

Running time prior to test: 1 hour.
Fuel used : mixture of two parts Record Nitrex-15 and one part Record Super-Nitrex.

Performance

The maker's recommended fuel for the Fox Rocket-09 is Fox "Missile Mist." This is a fuel containing approximately 20 per cent. nitromethane but is unobtainable in the U.K. An equivalent was therefore blended by adding one part Record Super-Nitrex (30 per cent. nitro) to two parts Nitro-15 (15 per cent. nitro).

The first clue to the excellent handling of our test sample came with the initial start from cold. The maker's instruction leaflet is clearly worded and was followed exactly.



It calls for a port prime for cold starting. The result was a genuine first flick start, the motor cutting out after a few seconds. A further half-turn of the needle-valve was then sufficient to keep the 09 running continuously and evenly.

With the motor warmed up, restarts were virtually instantaneous after a single, choked, preliminary flick of the prop. This excellent starting continued through a wide variety of props and the engine proved remarkably docile with no tendency to "bite" on props down to 6 × 3 size—allowing r.p.m. well above the peaking speed. On the smaller and lighter props there was a tendency (as with other non-rotary valve type engines) to start in the reverse direction. This, however, was easily dealt with by flicking the prop backwards.

The needle-valve was positive and progressive in operation. Fairly accurate adjustment was necessary to extract the last hundred or so r.p.m., but the 09 would continue to run on an excessively rich mixture, allowing plenty of time to make such adjustment. This latter is particularly welcome in view of the fact that the position of the needle-control, while at a safe distance from the prop, is rather close to exhaust heat.

Torque tests revealed a maximum of 9.2 oz. in., equivalent to a b.m.e.p. of 37 lb./sq. in. For a 3-port type motor, the b.h.p. peaking speed was unusually high—14,000 r.p.m.—where an output of just over 0.11 b.h.p. was realised. The Rocket-09 will, however, rev happily well beyond the peak. The maker's recommended props are 7/3 and 6/4, wood or nylon. With a 7/3 wood, the test engine reached 13,000 r.p.m. static, and, on a 6/4 nylon, exceeded 15,500 r.p.m. At these higher speeds, the engine is particularly smooth running.

In all, a likeable motor and one that was a pleasure to test.

Power/Weight Ratio (as tested) : 0.57 b.h.p./lb.

Specific Output (as tested) : 69 b.h.p./litre.

FOX'S ROCKET 15

2.4 c.c. glo-plug motor

KNOWN simply as the Fox 15 on its introduction in 1958, this American 2.5 c.c. class engine was later re-designated Fox Rocket 15 to identify it as one of the "Rocket" line of low-priced motors—others: Rocket 09 and Rocket 35—thereby distinguishing it from the more expensive "contest" Fox models. (This can, however, be a trifle confusing since the new roller-bearing 1961 model Fox Combat 35 uses a modification of the Rocket 35 main-casting and, in consequence, at present carries the "Rocket" emblem on the side of the transfer passage.)

The Rocket 15 sells, in the U.S., for a modest $6.95 (under 50s. at the current rate of exchange) and, despite the addition of purchase-tax and customs duty, is still (at 65s.) one of the cheapest 2.5's available in the United Kingdom. For this price, one can scarcely expect World Championship class performance and the Fox does, in fact, fall short of top contest 2.5 c.c. standards of power output by about 25 per cent. When one remembers, however, that the Fox sells for half the price of most competition engines of this size, its performance, in terms of power per unit of cost, is quite good.

Like the majority of American engines above "Half-A" size, the Rocket 15 is a shaft rotary-valve, loop-scavenged glowplug ignition engine with plain (bushed) main bearing. Nevertheless, it does contain uncommon features.

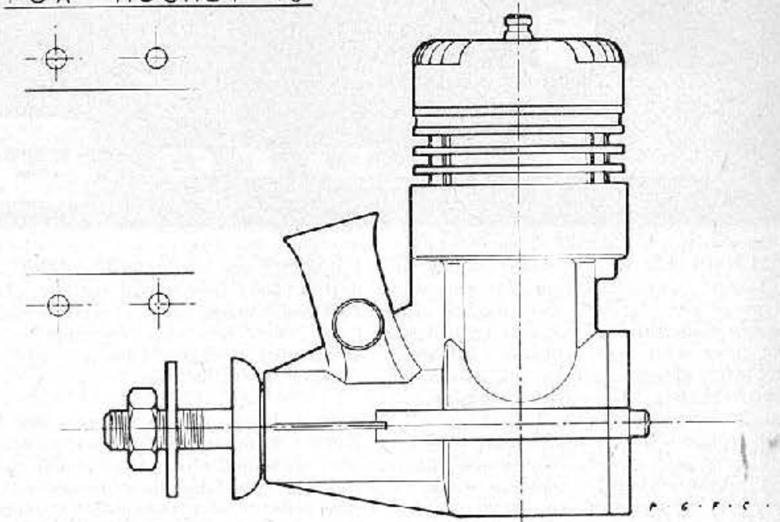
The motor is assembled around a pressure diecast aluminium alloy crank-case and main bearing unit which calls for very little machining. It carries a pressed-in brass spraybar and a bronze main bearing bush. The beam mounting lugs are arranged symmetrically on the centre-line and are tapped to receive the two screws retaining the diecast backplate. These points could, conceivably, be used for bulkhead type mounting in place of the beam mounts. The crankshaft has an above-average journal diameter, is hardened and counterbalanced.

Like all Fox loop-scavenged motors, the Rocket 15 uses a Desaxé cylinder arrangement—i.e. the cylinder is offset to the exhaust side relative to the crank-shaft axis. Unlike these other Fox models, however, the 15 has a one-piece cylinder with integral cooling fins (instead of a drop-in liner in an extended main casting) plus an unusual transfer port arrangement. The cylinder has a very deep base flange, ¼ in. thick, the exhaust port being cut through this on the one side, while the transfer port is cut through the cylinder wall and into the bottom of the flange to register with the transfer passage in the crankcase casting. The cylinder is held down with two long screws, arranged fore and aft, passing through the fins from the cylinder head and two extra screws secure the head to the cylinder.

Fairly extensive use is made of aluminium alloy diecastings. In addition to the crankcase and backplate, the cylinder head, prop driver and connecting-rod are all castings. The threaded valve needle, incidentally, is machined in one piece, with control knob, from mild steel and is not, therefore, subject to the petty failures which sometimes beset soft soldered assemblies.

The whole engine is noticeably compact when laid alongside some 2.5's and is also rather lighter than most engines of this capacity.

FOX ROCKET 15



ACTUAL SIZE

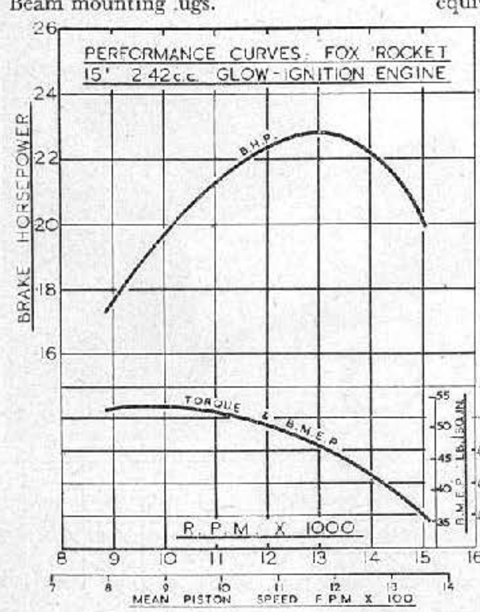
Specification

Type: Single-cylinder, air-cooled, loop scavenged two-stroke cycle, glowplug ignition. Crankshaft rotary valve induction. Baffle piston. Offset ignition plug.

Bore: 0.590 in. Stroke: 0.540 in.
Stroke/Bore Ratio: 0.915 : 1.
Swept Volume: 0.1476 cu. in. = 2.419 c.c.
Weight: 4 oz.

General Structural Data

Pressure diecast aluminium alloy crankcase and main bearing housing with bronze bush. Hardened and ground steel crankshaft with 3/8 in. dia. journal and 5/32 in. dia. crankpin. Unhardened steel cylinder with integral cooling fins. Meehanite piston with fully-floating 1/8 in. dia. solid gudgeon-pin and pressure diecast aluminium alloy unbushed connecting-rod. Pressure die-cast aluminium alloy finned cylinder head with aluminium gasket. Pressed-in brass spraybar with steel needle-valve and compression-spring friction device. Beam mounting lugs.



Test Engine Data

Running time prior to test: 3 hours.

Fuel used: two parts Record Nitrex-15 and one part Record Super-Nitrex to give 20 per cent. nitromethane mixture. Record Methanex used for running-in.

Ignition plug used: Fox short-reach 1.5 volt as supplied.

Performance

A small but sensible instruction leaflet is issued with the Fox 15. In this, the use of Fox "Superfuel," a general purpose, low-nitro content blend is specified. However, designer Duke Fox has more recently recommended Fox "Missile-Mist," a fuel containing approximately 20 per cent. nitromethane. Missile-Mist is, of course, unobtainable in the U.K., and an approximate equivalent was therefore blended by mixing KK Record Nitrex-15 and Super-Nitrex in the proportions given above.

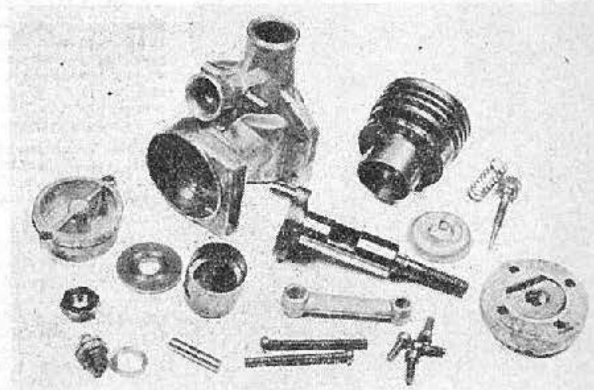
Starting characteristics of the Rocket 15 were uncomplicated. For a start from cold, the engine responded fairly readily after a port prime. Hot restarts could be quickly obtained with either a port prime or (particularly on the larger prop sizes) after two preliminary choked flicks. Some caution is needed in adjusting the needle-valve when the motor is running, due to its close proximity to the prop. We also found a tendency for the coil spring to cause the needle to jump back a few degrees when the fingers were removed and it was sometimes necessary to go past the desired setting to compensate for this.

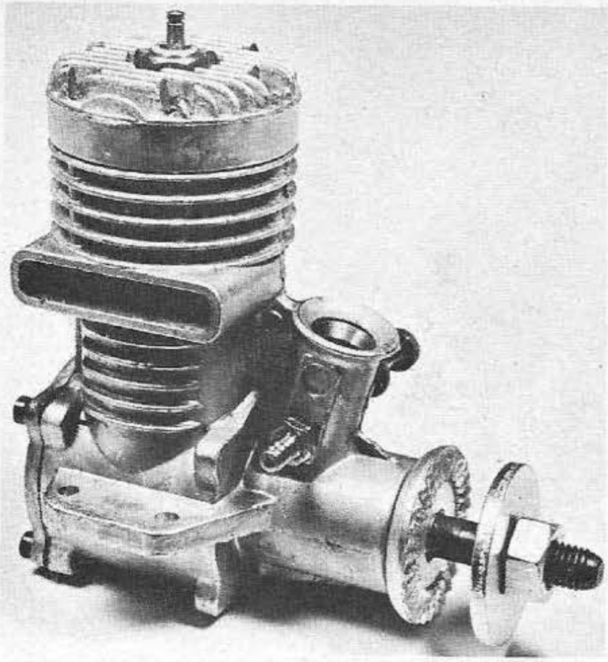
General running qualities were good. Running was particularly even under light loads and the engine ran extremely steadily at speeds far in excess of the b.h.p. peaking speed. Maximum torque was determined at between 9,000 and 10,000 r.p.m. and reached a value of 0.104 lb. ft. or 20 oz. in. Maximum power occurred at 13,000 r.p.m. where a figure of 0.228 b.h.p. was determined.

Power/Weight Ratio (as tested): 0.92 b.h.p./lb.

Specific Output (as tested): 94 b.h.p./litre.

Parts of the Rocket 15, note the square inlet port in the crankshaft and sturdy cylinder assembly.





Externally, new Fox is distinguished by wider beam mounts and no longer carries "Rocket" emblem on side, plain instead of red head.

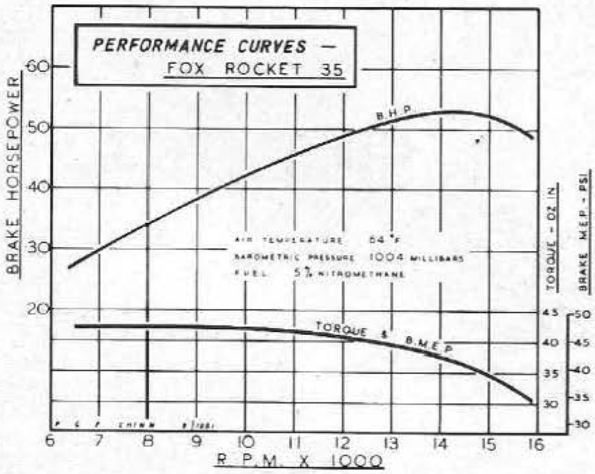
Engine Review
'62 Fox .35

by P. G. F. CHINN

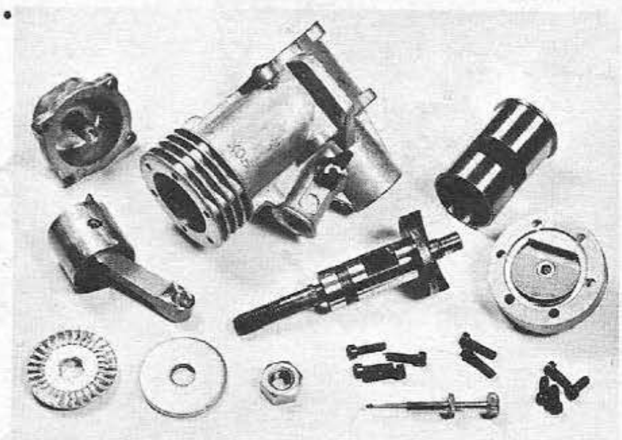
AND AGAIN ANOTHER NEW ENGINE—THIS ONE DESIGNED AND READY FOR INTRODUCTION IN 1962. MODELERS ARE INDEED FORTUNATE. MUST BE THEIR GOOD CLEAN LIVING THAT HAS THE ENGINE MANUFACTURERS CONTINUALLY STRIVING TO PRODUCE THE NEWEST AND THE BEST.

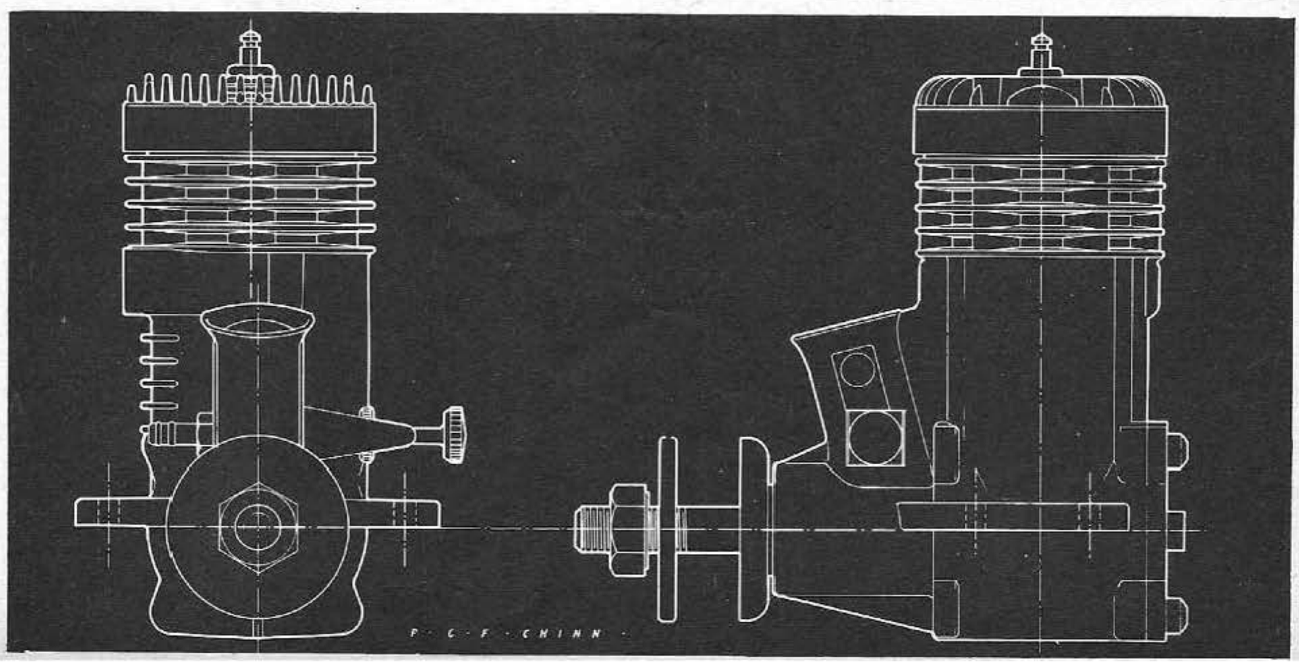
► New crankshaft, new body casting, new cylinder sleeve, modified piston and rod, sleeved venturi, unpainted head, one third of an ounce heavier. Same needle-valve, backplate, prop washers and nut. This summarizes the basic specs of the new 1962 Fox Rocket, as compared with the original model of two years ago. The price of the engine remains the same—a modest $11.95.

The original Rocket .35 used the body casting of the 1957 black-head Combat .35. Later this casting was modified to incorporate four lugs at the front of the crankcase. In this form it was used for the 1961 Combat-Special and .40 models, the integral bearing (*Continued on page* 57)



Inside story is one of many changes compared with '59 Rocket .35. New case, modified shaft, lighter piston and new revised porting.





housing being cut off in the case of the Combat-Special and the lugs used to secure this engine's unique needle-bearing housing. In its latest form, as used by the new Rocket .35, the casting retains these lugs but is also widened across the beam mount lugs by 3/16 in. Lateral mounting hole spacing has also been increased—from 1½ in. to 1⅝ in.—so existing airplanes fitted with the earlier engines will need modification to accommodate the new Rocket .35.

Like all Fox .35's, excepting the Combat-Special, the casting embraces cylinder block, crankcase and main bearing housing, complete with intake, bypass and exhaust ducts, as a single pressure diecast unit. It incorporates a cast-in bronze main bearing which has a shallow longitudinal oil channel to aid lubrication of the front end. Unlike the earlier Rocket, the carburetor intake is drilled out ⅜-in., straight through into the main bearing, and has a separate steel venturi insert. This has permitted a larger intake aperture in the bearing for better "breathing" and, at the same time, a slightly reduced venturi throat for improved fuel suction.

Several important changes are apparent in the crankshaft. Firstly, it is now hardened. Secondly, the gas passage through the shaft has been increased 21 percent in cross-sectional area by enlarging its bore to 11/32 in. Thirdly, although, unlike the .40 and Combat-Special, a full circular type web is retained, counterbalance has been substantially increased. Fourthly, the front of the ½ in. dia. journal, between its outer extremity and the valve port, is relieved, forming an oil channel ⅜ in. wide and dividing the shaft into unequal length front and rear journals. The rectangular valve port is 13/32 in. long and, in conjunction with the enlarged elliptical bearing aperture, extends the intake period by about 12 degrees of crank rotation to a full 180 degrees.

Fox tradition demands a Desaxe type cylinder arrangement (i.e. cylinder offset to the exhaust side relative to the crankshaft axis) so it is no surprise to find this feature continued. A thin walled, leaded steel cylinder is also retained but the former, conservative, porting is replaced by ports closely resembling those of the .40 and Combat-Special. The exhaust port is unaltered in depth but extends further around the cylinder and now has a central vertical dividing bar. The bypass port is the same width as before but its depth has been increased by a full ⅛ in. to nearly 5/16 in. Most of this extra depth is due to the lowering of the bottom edge of the port, but the engine falls into line with a current trend in that the top edge is also raised to give a marked reduction in exhaust lead. In other words, the bypass period is now prolonged to within a very few degrees of the exhaust timing—by our measurement, 4 degrees each side of BDC; exhaust and bypass periods being, respectively, 142 and 134 degrees.

The design of the Meehanite cast-iron piston is essentially the same as that of the earlier Rocket .35 and features an internal annular rib immediately above the wrist pin to resist ovality occurring either during manufacture or use. The piston has, however, been lightened: the skirt thickness is slightly reduced, the annular rib is a little narrower and a little more metal has been milled out between the wristpin bosses. The full floating wrist-pin has a diameter of 5/32 in. and is slightly harder than of old. It has pressed-in brass end pads. The connecting rod, of 24ST aluminum alloy is as before, except for a slight reduction in the width of the big-end bearing. This is on account of the shorter working length of the crankpin (due, in turn, to the wider counterbalance used) and has the advantage of making for easier assembly and dis-assembly of the engine. The complete piston and rod assembly can now be detached from the crankpin after withdrawing the cylinder liner, instead of the wristpin first having to be fished out through an access hole in the back of the casting. Since this access hole is no longer necessary, the new Rocket .35 does not have it.

The diecast aluminum cylinder head is the same as before but does not have the red enamelled outside finish of the original—which, however, is no loss, since the paint did tend to scratch and chip rather easily. The head shape is such as to give a pent-roof type combustion chamber on the exhaust side of the piston baffle. The plug is central and there is a soft aluminum blow-out proof gasket located in a channel in the head. Six Phillips screws secure the head to the cylinder.

On test, we found that the improvements to the Rocket .35 were most evident in better handling characteristics. Power, so far as our particular example was concerned, was not greatly increased and although we were able to record virtually as high a peak output on a 5 percent nitromethane fuel as had previously required 15-20 percent nitro, maximum torque was about the same. Power, on a specific output basis, was not, of course, up to the high level of the .40 or, even less so, to the exceptional figure of the Combat-Special. This is hardly surprising since one does not expect $14.95 or $19.95 performance for $11.95.

A pleasing feature was that only a short break-in was required before the engine was ready to be leaned out. We made rpm checks on various props after a one hour break in, on 5 percent nitro fuel. On a 10x6 Tornado, the Rocket .35 turned up 10,900 rpm, on a 9x6 Top Flite, 11,800 rpm and on a Power-Prop 11x3, 11,700 rpm. Other typical prop speeds were: 12x4 Tornado, 8,700; 11x5 Power, 9,750; 10x3½ Top Flite, 12,900; 9x5 Top Flite, 13,050; 9x4 Tornado, 14,300; 8x6 Power, 15,250.

Starting was very good, especially from cold, when the engine would usually start first or second flick after priming and the only adverse comment we have to make is that we would like to see a bigger control knob on the needle-valve for more comfortable handling. Needle-valve adjustment is very securely held by a double spring tensioner and this makes the small control knob very stiff to operate. Incidentally, as users may be tempted to ease the needle-valve adjustment by bending the spring, we should mention that this should not be done cold, as the spring is of hard spring steel and will break rather easily.

Maximum torque recorded by the Rocket .35 was 42 oz. in. This was maintained fairly steadily between 6,500 and 10,000 rpm, beyond which, torque fell off to result in a horsepower peaking speed of just over 14,000 rpm where an output of 0.53 bhp was realized. This, of course, was on a relatively mild fuel, such as is recommended for general use, and an appreciably higher performance can be obtained by using hotter fuels—such as by adding Fox Hi-Nitro to standard Fox Superfuel.

To sum up, the 1962 Rocket 35 is easy to start, of useful performance and, despite a moderate selling price, is a soundly engineered job that should give long and trouble-free service.

Summary of Data

Type: Loop-scavenged, two-cycle with shaft rotary valve induction.

Weight: 7.85 oz.

Displacement: 0.3519 cu. in.

Bore: 0.800 in. Stroke: 0.700 in.

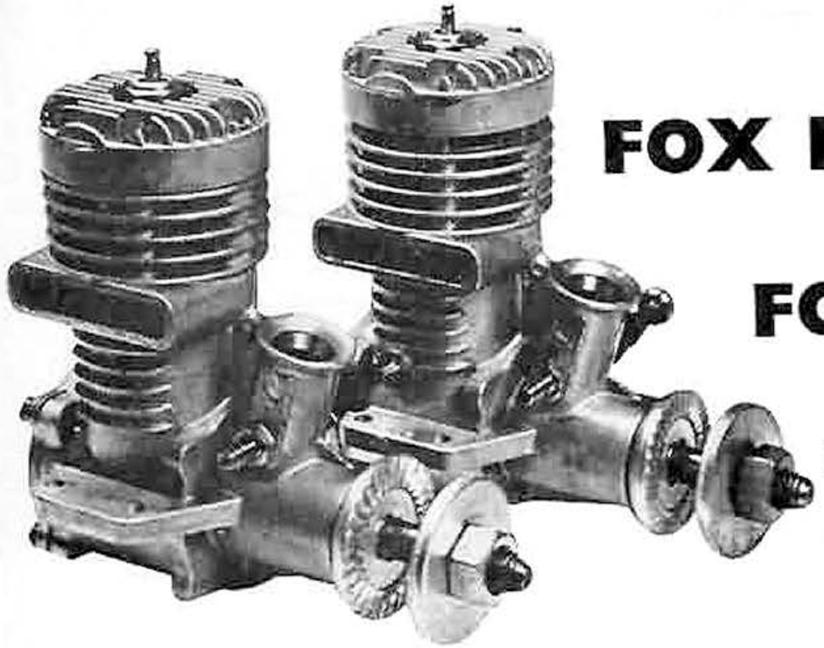
Stroke/Bore Ratio: 0.875:1

Specific Output (as tested): 1.51 bhp/cu. in.

Power/Weight (as tested): 1.08 bhp/lb.

Manufacturer: Fox Manufacturing Co. Inc., 5305 Towson Avenue, Fort Smith, Arkansas.

Price: $11.95.



The FOX Rocket 35 and FOX 40

5.7 c.c. and 6.5 c.c. Glow Plug Motors

THE Fox Rocket 35, originally introduced two years ago as the first low-priced large Fox engine, is now being marketed in an improved 1962 version. Practically identical in appearance and using many common components is the Fox "40" model and it was therefore decided to combine both engines in a single report. The two engines make a rather interesting test comparison since, despite their similarity, there is, at least so far as our test samples are concerned, a most marked difference in performance between them.

Both engines are based on a one-piece pressure diecast cylinder/crankcase/main-bearing unit which has its origin in the "Combat 35" of 1957, being later modified so as to be adaptable also to the current Combat-Special engine. Recently, the casting has been further modified to have larger beam mount lugs with wider lateral bolt hole spacing. Our test Rocket 35 was equipped with this new crankcase which, we assume, is also being used, or will be used, on the Combat-Special and 40.

As can be seen from our heading photograph, the main feature distinguishing the 40 from the 35 is the "lifted" head. This is accounted for by the increased stroke of the 40's 0.790 in., as against the 35's 0.700 in. Cylinder bore of the two engines is the same and respective piston displacements are, therefore, 0.397 and 0.352 cu. in. We should, perhaps, mention here that the Fox company's object in producing a "40" was to take full advantage of present American rules for that popular free-for-all, the "rat-race."

Apart from an increased crank throw to give the required extended piston stroke, the 40 crankshaft differs from the 35 shaft in several respects. The 1962 35 shaft is, itself, an improvement on the original Rocket 35 shaft and is now hardened. The 40 shaft is distinguished by heavier counterbalancing and a reworked valve port. Extra counterbalancing has been achieved by cutting away the web flanks either side of the crankpin. Extra stiffness has been built into the crank web by increasing its thickness. The enlarged valve port of the 40 gives an induction period of approximately 200 deg., 20 deg. more than for the 1962 Rocket 35 and about 32 deg. more than for the previous Rocket 35. Both crankshafts now have a wide oil channel located 3/16 in. back from the front end.

The cylinder liner used by the 40 and new Rocket 35 is similar to that of the Combat Special model (M.A., June, 1961), being quite thin with a centrally divided 180 deg. exhaust port and a very large transfer port. This latter is timed to open only 4-5 deg. after the exhaust, the exhaust period being 140-142 deg. The liner is a good fit in the casting and is flanged at the top where it is locked by the cylinder head. The 40 liner is approximately 5/64 in. taller, above the exhaust port, than the 35. The cylinder heads are identical.

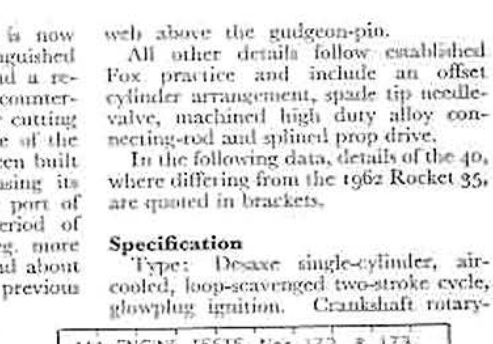
The pistons are of lightweight design, again very similar to the Combat-Special. The 40 piston is longer, both above and below the gudgeon-pin and the skirt is cut-away at the front to clear the crank counterbalance at bottom dead centre. Both pistons have an annular internal stiffening web above the gudgeon-pin.

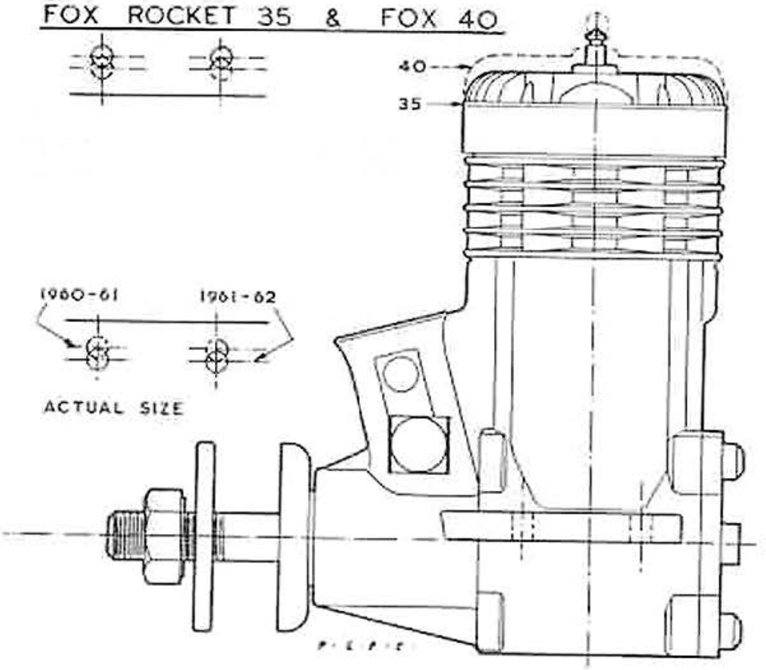
All other details follow established Fox practice and include an offset cylinder arrangement, spade tip needle-valve, machined high duty alloy connecting-rod and splined prop drive.

In the following data, details of the 40, where differing from the 1962 Rocket 35, are quoted in brackets.

Specification

Type: Desaxe single-cylinder, air-cooled, loop-scavenged two-stroke cycle, glowplug ignition. Crankshaft rotary-





valve induction. Baffle piston. Central ignition plug.

Bore: 0.800 in. Stroke: 0.700 in. (0.790 in.).

Swept Volume: 0.3519 cu. in. = 5.767 c.c. (0.3971 cu. in. = 6.507 c.c.).

Stroke/Bore Ratio: 0.875 : 1 (0.9875 : 1).

Weight: 7.85 oz. (7.6 oz.).

General Structural Data

Pressure diecast silicon aluminium alloy crankcase/cylinder/main-bearing unit with cast-in bronze bearing. Counterbalanced, hardened and ground crankshaft with ½ in. dia. main journal, 7/32 in. dia. solid crankpin and 11/32 in. bore gas passage. Lightweight Mechanite piston with fully-floating 5/32 in. dia. tubular gudgeon-pin fitted with brass eyelet end pads. Connecting-rod of 20-24ST alloy with plain unbushed eyes. Leaded-steel cylinder, flanged at top and secured via pressure diecast silicon aluminium alloy cylinder head and six head screws. Recessed 0.010 in. soft aluminium head gasket. Pressure diecast aluminium alloy backplate with centre boss suitable for tapping crankcase pressure and secured with four screws. Steel drive washer. Brass spraybar with one-piece steel needle and double spring ratchet. Detachable steel venturi insert. Beam mounting lugs.

The main casting etc., is common to both the 35 and 40

Test Conditions

Running time prior to test: 2 hours approximately.

Fuel used: 5 per cent. nitromethane, 30 per cent. castor-oil, 65 per cent. methanol.

Ignition plugs used: Maker's 1.5 volt long reach as supplied.

Air temperature: 64 deg. F. (80 deg. F.).

Barometer: 29.6 in. Hg. (29.9 in. Hg.).

Performance

Both our test samples were sent to us direct from the U.S.A., the 40 by Duke Fox himself and the Rocket 35 via the Fox Manufacturing Company's advertising agents, Messrs. Humphrey, Williamson, & Gibson, Inc., of Oklahoma City. From internal examination, the 40 appeared to have had a slight amount of running but the 35 had obviously had no more than the normal brief factory check. Neither engine, we found, required the excessively long running-in period which, in the past, has been a frequent criticism levelled at the larger types of glowplug engines.

When submitting the 40 for test, Duke Fox commented that we should find this engine superior in power to the outstanding needle-bearing Combat-Special on moderate sized props.

This was, in fact, confirmed by our initial r.p.m. tests. On only mild fuel the 40 turned an 11 × 6 Tornado Nylon a little over 10,000 r.p.m., and an 11 × 4 Top Flite at 11,600 r.p.m. Higher up the scale, a steady 13,950 was reached on a Top-Flite wood 10 × 3½ and on the popular 10 × 6 stunt props the 40 was found to better 12,000.

Mention of stunt props, incidentally, prompts us to suggest that, while the 40 may not be of great interest to British modellers for the purpose for which it was primarily designed (i.e. rat-racing), it should make a good stunt motor—particularly in large or overweight models, for which the power of some 35's may be marginal. When used with the standard venturi insert, the 40 is extremely non-critical on the needle-valve and will absorb wide variations of fuel pressure without protest.

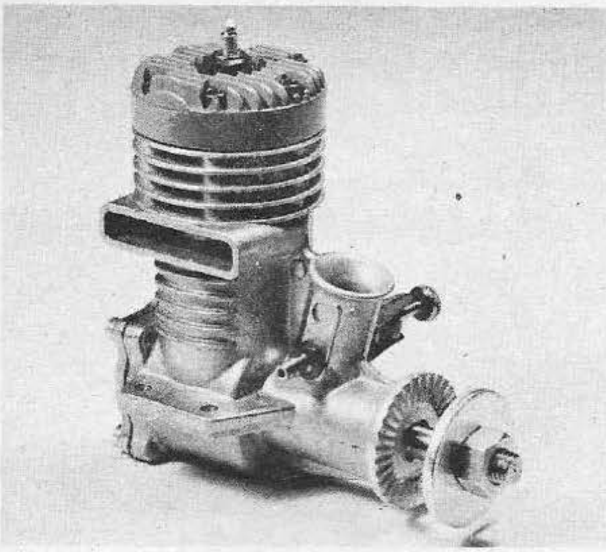
The unusually high power of the 40 which, on 5 per cent. nitromethane fuel, included a peak output of 0.72 b.h.p. at 15,000 r.p.m., rather tended to overshadow the performance of the Rocket 35. Maximum torque reached by the 35 was a full 30 per cent. lower than for the 40, although, since the torque curve is differently shaped, the drop in power output at the peak is not so serious—0.53 b.h.p. at 14,000 r.p.m. Actually, the Fox company claim 0.85 b.h.p. at 18,000 for the Rocket 35, probably on a high nitro content fuel, but, although our figures could, undoubtedly, be substantially improved with more nitromethane, we feel that 0.85, which is comparable with the output we obtained on 30 per cent. nitromethane with the Combat-Special, is a little on the optimistic side for the Rocket 35.

Handling qualities of both engines were quite satisfactory, with the possible exception of the needle-valve knob, which, apart from its close proximity to the prop (due to the short frontal overhang) is rather awkward to operate because of its small size and stiff spring. Starting characteristics were good, with an edge in favour of the 40 on hot restarts. Running qualities were also good. Under light loads and speeds above 13,000 r.p.m., the needle adjustment became a little more critical on the 35 and careful adjustment was necessary to achieve optimum performance. With the 40 it was noticed that there was a marked increase in power as the engine warmed up. On props allowing speeds approaching peak r.p.m. the 40 took 15-20 sec. from cold to reach maximum power.

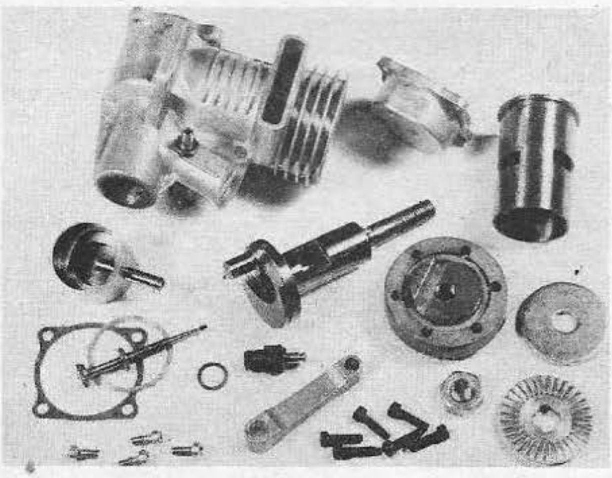
In the U.S., the Rocket 35 is priced at $11.95 and the 40 at $14.95—i.e. approximately £4. 5s. 4d. and £5 6s. 9d. respectively.

Power/Weight Ratio (as tested): *Rocket* 35: 1.08 b.h.p./lb. 40: 1.52 b.h.p./lb.

Specific Output (as tested): *Rocket* 35: 91.9 b.h.p./litre. 40: 110.6 b.h.p./litre.



Almost identical externally with the Combat 35, the Rocket is distinguished by its Red Head. One difference is small bore carburetor.



Rocket .35 parts. Features include ½" shaft, special needle valve and special piston designed to resist ovality in manufacture.

ENGINE REVIEW

ROCKET 35

by P. G. F. CHINN

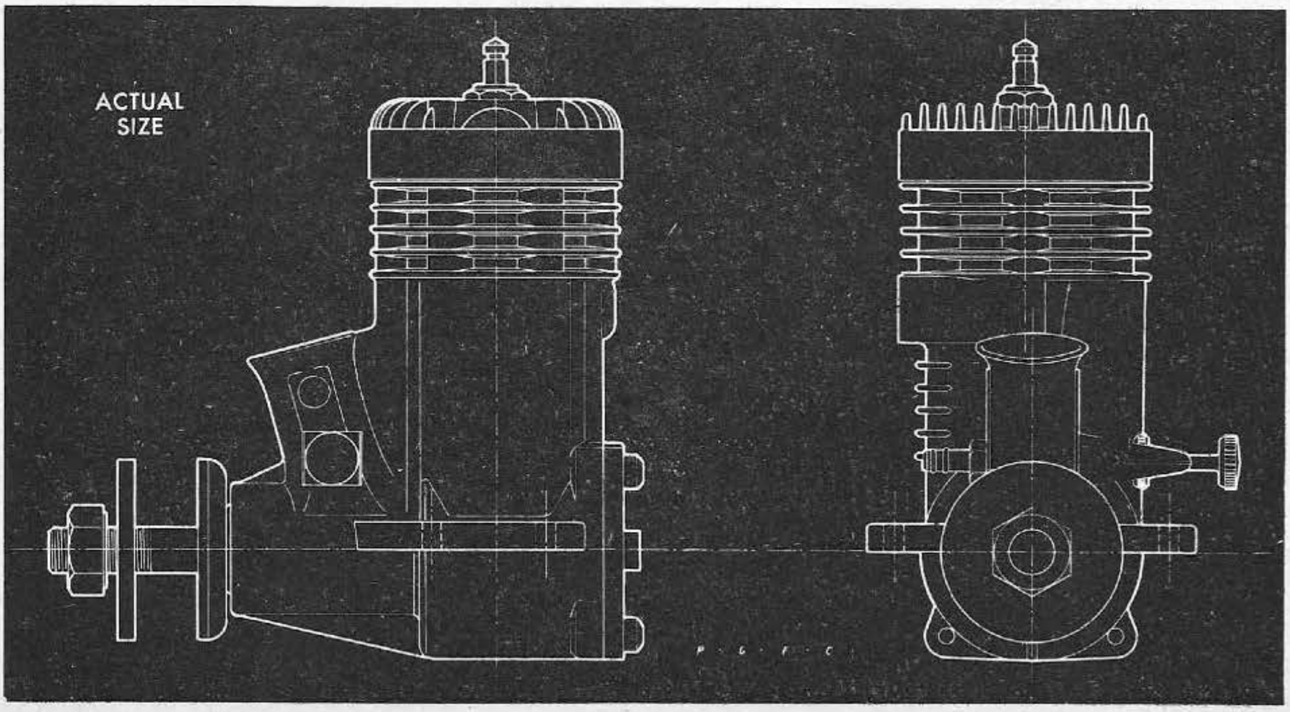
Fox first to popularize the .35 size for stunt and combat work; continue progressive design effort in this popular series..

► Think of Fox 35 and you cannot help but think of control-line stunt. Duke Fox can be said to have started the present trend of stunt design when he introduced the first Fox 35 in January 1949. Up to that time, top stunt fliers almost invariably favored a .60 size power plant. The smaller, lighter Fox was the first of the modern stunt 35's, quickly became the choice of stunt experts and has remained one of the most popular 35's to this day.

Until the introduction of the Rocket series (19, 15 and 35) however, Fox motors were not numbered among the industry's low-priced products. The Rocket 35, $4 cheaper than the Stunt 35 and $8 less than the Combat 35, brings a Fox 35 within the reach of still more would-be Fox users.

The Fox Stunt 35 has gone through several minor design changes over the years, but the first major re-design of this basic layout came with the black-head Combat-Special announced in January 1957. It is on this model that the Rocket 35 is based.

Side-by-side examination of the two models reveals that the main differences are to be found in the crankshaft, cylinder-head and valve timing. The same main casting is used, but the Rocket has a smaller bore carburetor and no separate restrictor. The induction (*Continued on page 51*)



aperture through the main bearing is correspondingly smaller, reducing the intake period by about 10 degrees of crank rotation. The crankshaft, unlike that of the Combat 35, is not hardened and is of the disk web, crescent counterbalance type. The gas passage through the shaft is reduced in area by approximately 35 per cent to 5/16 in. dia., although the journal diameter remains a full ½ inch. The cylinder-head has modified internal contours, giving a lower compression ratio than that of the Combat 35 and, instead of the black finish, is painted red.

The basic design of the Rocket 35 is, of course, traditional Fox: shaft induction, Desaxe type (offset) loop-scavenged cylinder, short frontal overhang and one-piece crankcase / main-bearing / cylinder-block

Engine Review

(*Continued from page* 51)

construction. The body of the engine is a well-produced pressure casting with a long carburetor intake and strong beam mounting lugs. Noteworthy is the manner in which efforts have been made to provide added resistance to crack-up damage. The bearing housing, for example, features a full length lower web, while the intake is strongly webbed to the lower cylinder block section to increase stiffness.

The crankshaft, ground on the working surfaces, has a 7/32 in. dia. crankpin and, as already mentioned, a generous ½-in. dia. journal. It is stepped down to ¼ in. dia. for the propshaft section. Prop drive is conveyed through four short splines which engage a 1-in. dia. hardened steel drive disk with the usual serrated face. The shaft runs in a bronze bushed bearing 1-3/32 in. long. A shallow, longitudinal oil groove extends to within ⅜ in. of the front end of the bearing, to ensure adequate lubrication ahead of the valve port.

A drop-in cylinder sleeve of leaded steel is used. This is quite light, with a wall thickness of only .037 in. and is flanged at the top where it is locked against vertical and rotational movement by the cylinder head. An aluminum blow-out-proof head gasket, recessed into a channel in the head, is used and six Phillips screws tie the head to the main casting, screwing into vertical ribs formed between the cooling fins. The pressure die-cast head is generously finned and has a centrally located long-reach O.K. plug.

The piston is of Meehanite, machined from bar stock with normal flat crown and straight baffle. It has a narrow annular rib inside, immediately above the wristpin bosses. This is an additional complication for the manufacturer but one which should pay dividends in helping to maintain piston roundness—piston ovality being frequently encountered in engines of this size and type, especially where the piston skirt is machined to minimum thickness in the interests of reduced reciprocating weight. A hardened steel 5/32 in. dia. full-floating wrist-pin, with brass eyelet end pads, is used and a 24ST aluminum alloy connecting-rod couples the piston to the shaft. To facilitate fitting and removal of the piston assembly from the engine, a 3/16 in. dia. hole is bored through the back of the main casting to line up with the wrist-pin at bottom dead center. Removing the cylinder sleeve then allows a thin stick of soft balsa to be forced into the wrist-pin end to withdraw it and release piston and rod.

The needle-valve is of the current Fox improved pattern in which the needle is supported at both ends. In this, the needle, instead of being tapered off to a point, has a small knob on the end which fits into the small bored section of the spraybar. The knob is flattened on two sides to allow the passage of fuel which is regulated, in the normal way, by the tapered section of the needle. The backplate is also different from orthodox practice in that the upper two retaining screws are wider spaced than the bottom pair, thus ensuring that the backplate cannot be replaced incorrectly.

On test, our Rocket 35 delivered a maximum horsepower of just over .53 at a shade under 14,000 rpm, following a total logged time of five hours. Fuel was in accordance with the maker's recommendation. Although this figure of .53 is below the maker's claims, it is nevertheless a satisfactory level and could doubtless be bettered under ideal weather conditions permitting the further addition of Fox Hi-Nitro to the fuel. Maximum torque was 46 oz. in. at 8000-9000. Plotted course of the power curve was as follows:

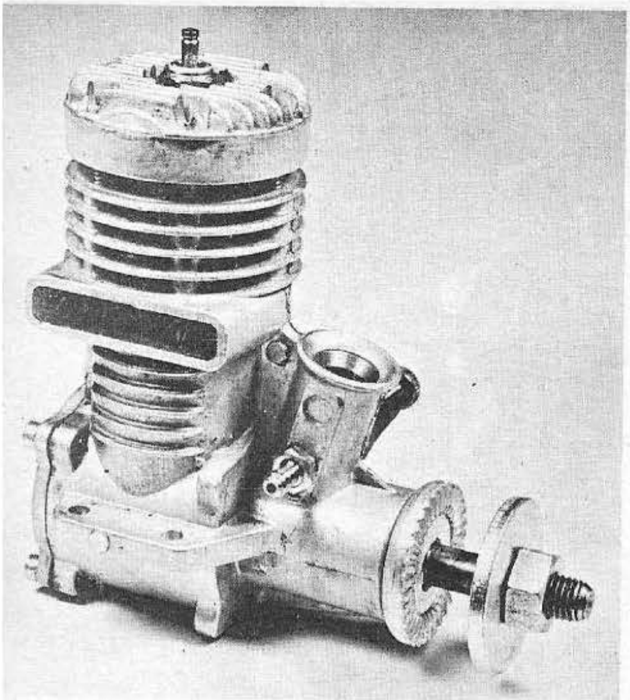
At	8,000 rpm	— .365	bhp.
	9,000 "	— .410	"
	10,000 "	— .450	"
	11,000 "	— .482	"
	12,000 "	— .510	"
	13,000 "	— .527	"
	14,000 "	— .532	"
	15,000 "	— .523	"

Typical prop speeds represented by these figures include 10,500 on all 11 x 4, 11,900 on a 10 x 6 and 12,400 on a 10 x 5. For starting, the Rocket seems to like to be reasonably wet, although care should be taken not to flood the motor. When restarting the motor warm, our Rocket responded best to a port prime—as for cold starting—rather than choking the intake. In this respect starting was not, perhaps, quite so foolproof as with the Stunt 35 engine.

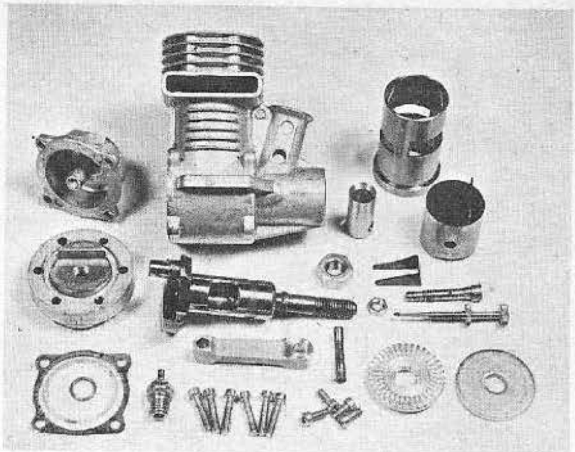
Running on all props was even and free from excessive vibration and response to the needle valve adjustment was positive and progressive. The only criticism here is that the short frontal overhang and small control knob did tend to make needle adjustments a trifle uncomfortable when the motor was running, but this would be less critical with the engine installed in a model, where one's hand can be steadied against the fuselage while the needle is operated betwen forefinger and thumb.

Summary of Data

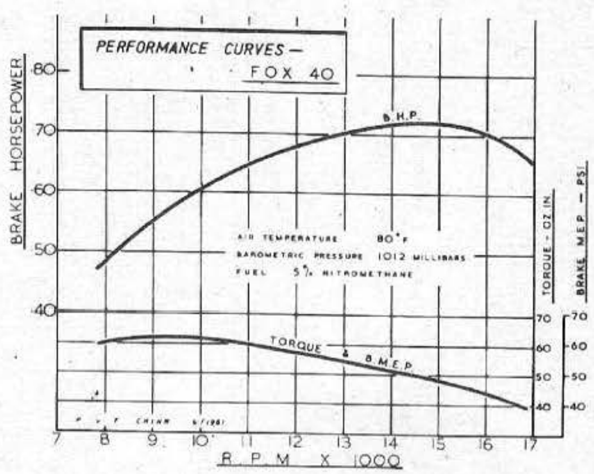
Type: Loop-scavenged two-cycle with shaft rotary valve induction.
Weight: 7.5 oz.
Displacement: 0.3519 cu. in.
Bore: 0.800 in. Stroke: 0.700 in.
Stroke/Bore Ratio: 0.875:1
Specific Output (as tested): 1.54 bhp/cu. in.
Power/Weight Ratio (as tested): 1.13 bhp/lb.
Manufacturer: Fox Manufacturing Company Inc., 5305 Towson Avenue, Fort Smith, Arkansas.
Price: $11.95.



The Rocket .40 in all other respects exactly same in appearance as the Rocket .35 model, new .40 can be identified by lifted head.



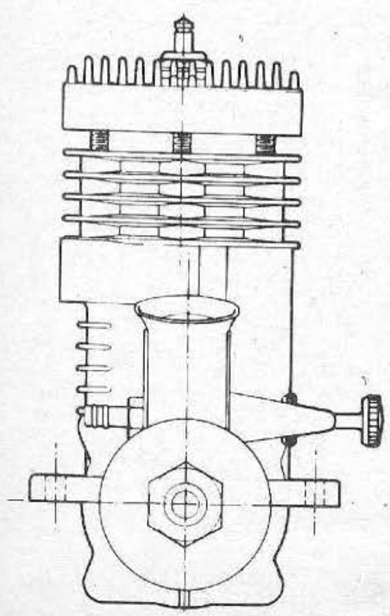
Component parts of Fox .40 include ultra light piston, heavily counter-balanced hardened shaft. Excellent power/weight characteristics.



► Like the Fox .07 (M.A.N. July issue), Fox's .40 is an in-between size. Designed to take advantage of the maximum displacement allowed under rat-racing rules, this new Fox model has a swept cylinder volume of .397 cu. in.

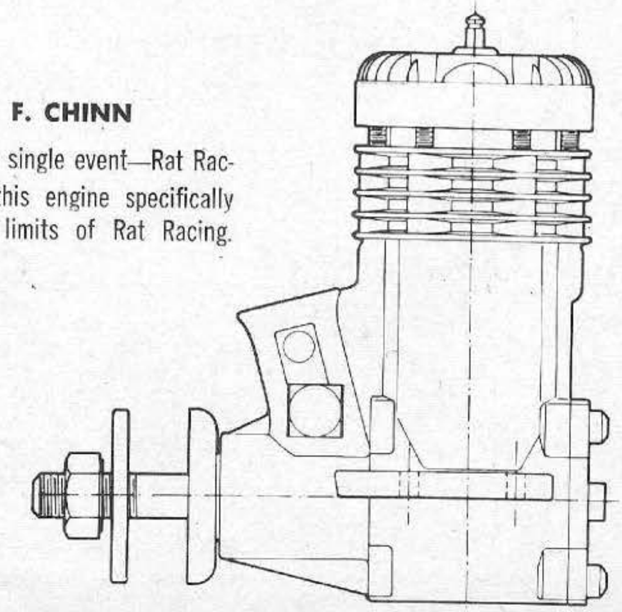
Externally, the engine closely resembles the Fox Rocket .35. It is based on the same body casting and uses the same cylinder head, plus such incidentals as prop washers and nut, needle-valve assembly, etc. Internally, however, the .40 is quite a bit different. (*Continued on page* 38)

ENGINE REVIEW • FOX .40



by P. G. F. CHINN

A special engine for a single event—Rat Racing—Fox developed this engine specifically to meet the upper limits of Rat Racing.



Increasing the displacement of a basic design can be done in one of three ways: (a) enlarging the bore, (b) lengthening the stroke or (c) a combination of both. Fox has chosen the second method for the .40. All Fox 35's to date have featured a common bore and stroke of .800 x .700 in. In the .40, the stroke has been increased to .790. An alternative would have been to increase the bore to .850 in. to give precisely the same displacement. This, however, would have meant a stroke/bore ratio bordering on the practical minimum and a piston weight that would have been excessively difficult to balance with a .350 throw shaft. It is also doubtful whether it would have been feasible to bore out the existing casting to take a .50 thou. increase.

It is, of course, a well-known fact that the practice of increasing the displacement of an established basic design, without an all-round scaling up in size and weight, often brings with it complications, such as serious vibration, overheating, increased rate of wear or a deterioration in handling qualities. On the basis of our findings, however, the Fox .40 would appear to be one of the more successful examples of this technique. Although the engine is practically the same weight as the Rocket .35, it does not suffer from excessive vibration, is easy to start and, while it gets fairly hot, shows no sign of distress or loss of performance on this account.

The .40 has a little under 13 percent more piston displacement than the .35's and the question naturally arises: "How much more performance?" Here, the .40, for which the designers obviously drew on their experience with the very powerful needle-bearing Combat-Special, measures up very favorably. The increase in performance compared with last year's Rocket .35, is considerably better than the 13 percent increase in displacement would indicate. In fact, on a mild fuel containing not more than 5 percent nitro-methane, the .40 gives more power than most .35's running on more expensive competition and racing fuels. Alternatively, running on an equivalent 'hot' fuel, the .40 gets surprisingly close to the needle-bearing Combat-Special on the bigger prop sizes and will actually equal or slightly better it at the lower end of the rpm range.

Although designated a "rat-racing special" by the makers, the Fox .40 should prove useful for many other applications. For example, with large or overweight stunt CL models where the power of a .35 may prove marginal, the weight and mounting dimensions of the .40 are such that it can take the place of a .35 with little or no modification to the model. (The .40 comes equipped, incidentally, with a standard stunt size venturi insert for normal suction feed, although it can, if desired, be converted to pressurized delivery via a backplate tapping).

General design and construction of the .40 follows typical Fox practice. The main casting, a silicon-aluminum pressure die-casting embodies the crankcase, complete cylinder barrel and main bearing with carburetor intake. The bearing has a cast-in bronze bushing which has a shallow longitudinal oil groove extending to within ⅛ in. of the front end. The carburetor has a ⅜ in. dia. parallel bore and leads into a circular valve aperture in the main bearing. A removable 9/32 in. bore steel venturi insert is fitted, retained by the brass spraybar assembly.

The crankshaft is of hardened steel and is heavily counterbalanced by means of cutaway web flanks either side of the crankpin, plus a large crescent counterweight. As on the Combat-Special, more than the entire weight of the conrod is balanced out. The shaft has a 7/32 in. dia. crankpin and a ½ in. dia. journal which is relieved for a short distance between the square valve port and the front end. The shaft is bored for an 11/32 in. gas passage —larger than the Rocket .35 but smaller than the Combat Special. The intake duration is generous and occupies approximately 200 degrees of shaft rotation.

The usual Fox set-up, employing a Desaxe type cylinder arrangement, is retained to gain the benefits of asymmetrical exhaust and bypass timing with reduced loading on stressed parts during the firing stroke. The cylinder sleeve is similar to that of the Combat .35 and has practically identical port dimensions but very slightly reduced bypass and exhaust periods. To accommodate the lengthened stroke, the sleeve extends nearly 5/32 in. above the top of the casting and the diecast head, with its recessed .010 in. aluminum gasket, seats on this with a ⅛ in. gap between its base and the top fin of the cylinder barrel.

The piston is notable for its lightness. It is identical in design with the Rocket and Combat pistons, but has been lightened internally and, as a result, is lighter than the Rocket piston, despite a slightly longer skirt. As on the other models, the wrist-pin is tubular, full-floating, has brass eyelet end-pads and a diameter of 5/32 in.

Incidentally, to save confusion, we should, perhaps, mention that the .40, like the Combat Special, carries the name "Fox Rocket" cast on the side of the bypass passage. This stems from the fact that all three engines are built around the original Rocket .35 main casting. This is probably going to cause argument among engine collectors of a decade or two hence! However, the new improved '61-62 model Rocket .35 is just appearing *without* the "Rocket" emblem, so we can expect that production of 40's and Combats will now also appear similarly unadorned.

Fox engines are stated to receive approximately five minutes running before dispatch from the factory. Examination of our test sample indicated that it had been given little or no more than this nominal period and we were prepared to be resigned to the lengthy break-in period that is all too often necessary with motors of the larger type. In fact, our fears proved groundless and a one-hour break-in, accummulated in rich runs, each of no more than one minute duration, was sufficient to bring the .40 to a point where, with the needle set for a maximum performance, it would run out a full tank of fuel. A further 40 minutes running was then given before actual performance tests were begun.

Starting qualities of the Fox .40 were found to be good. Priming through the exhaust port was used when the engine was cold. When hot it would start with intake choking only. The needle-valve adjustment was extremely non-critical—perhaps a little too much so. Several turns of the needle separate the "4-cycle" position from the "lean run" position and as the needle-valve knob is a trifle stiff and awkward to use, adjustment does tend to be rather slow at times.

Our performance tests were undertaken during a rather warm spell of weather and a mild fuel was therefore chosen in order to avoid any risk of overheating. With this, the .40 reached a maximum torque of just over 61 oz. in. at around 9,000 rpm; a very satisfactory figure, which is reflected in the engine's ability to turn a 12 x 4 Tornado Nylon prop at nearly 10,000 rpm and an 11 x 5 Power Prop at 11,400. 11,500 rpm were reached on a 10 x 6 Top Flite and over 12,000 on a Tornado 10 x 6. A reading of 13,850 rpm was clocked on a Top Flite Nylon 10 x 3½. Peak horsepower was realized at approximately 15,000 rpm where the level reached was .72 bhp, an excellent performance.

Summary of Data.

Type: Loop scavenged two cycle with shaft rotary valve induction.

Weight: 7.6 oz.

Displacement: 0.397 cu. in.

Bore: 0.800 in. Stroke: 0.790 in.

Stroke/Bore Ratio: 0.9875:1

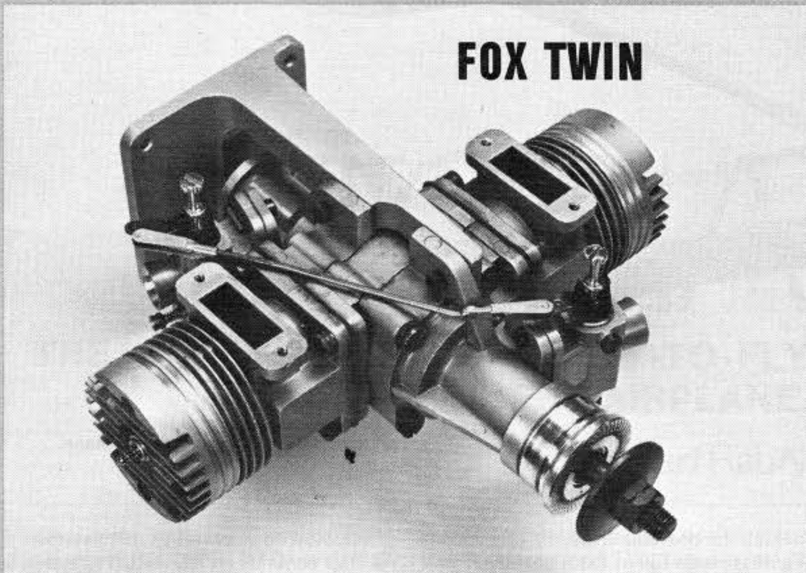
Specific Output (as tested): 1.81 bhp/cu. in.

Power/Weight Ratio (as tested): 1.52 bhp/lb.

Manufacturer: Fox Manufacturing Company Inc., 5305 Towson Avenue, Fort Smith, Arkansas.

Price: $14.95.

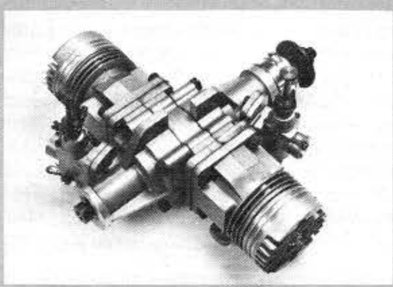
ENGINE REVIEW



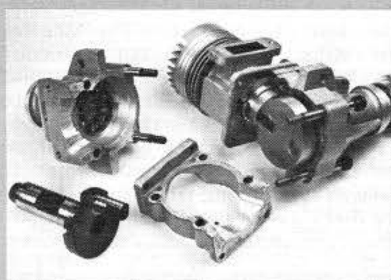
Over thirty years' experience has gone into Duke Fox's new twin design.

SPECIFICATIONS

Type: Air-cooled, horizontally-opposed, simultaneous-firing, twin-cylinder, two-stroke cycle with dual shaft rotary-valve induction and Schnuerle scavenging.
Bore: 0.907 in. (23.04 mm)
Stroke: 0.937 in. (23.80 mm)
Displacement: 1.2108 cu in. (19.84cc)
Measured Compression Ratio: Approx. 9.5:1
Speed Control: Twin Fox MK.X carburetors with coupled throttles.
Checked Weight: 1,236 grams (43.6 oz) including firewall mount.
Manufacturer's claimed power output: 3.0 bhp at 14,000 rpm.
Manufacturer: Fox Manufacturing Company, 5305 Towson Avenue, Fort Smith, AR 72901.



Fox Twin with mount removed. Engine is now fitted with new Fox MK.X carbs.



Unusual crankcase and shaft design helps separate chambers for improved charging.

Schnuerle-ported cylinders are used with two-part heads having conical chambers.

• The Fox Twin, the largest and most powerful Fox model aircraft engine produced to date, is also the first two-cylinder motor from the Fox factory. Duke Fox began work on its design more than two years ago at the time when the Schnuerle-scavenged Series II Eagle 60 was under development. Not surprisingly, it shares many of the Eagle-II's features.

Basically, the Twin could, in fact, be regarded as two 60s placed back to back, each with its own carburetor and rotary-valve and *almost* with its own crank chamber. This is a good concept, since it helps to overcome the problem that has long bedeviled the designers of flat-twin, simultaneous-firing, two-cycle engines: the difficulty of delivering the optimum charge to each cylinder, at all times, so as to prevent one cylinder from starving and cutting out prematurely when the throttle is closed.

Ideally, in a crankcase charged two-cycle engine, each cylinder should have its own sealed crank chamber, fed from its own carburetor. The Fox Twin comes near to this by using a full-circle center web in the crankshaft. This runs with a clearance between its periphery and the surrounding crankcase wall of only about .020", and although there is some additional leakage through the rear crankpin drive slot, it is reasonable to suppose that charge separation is sufficient to render each cylinder responsive to fine-tuning of mixture strength via its individual carburetor.

With a twin-cylinder engine, the designer has the choice either of using a one-piece crankshaft, in which case connecting rods with split lower end bearings will be necessary, or of employing a two- or three-piece shaft, permitting the use of ordinary conrods without detachable caps. Duke Fox has opted for the latter approach. The crankshaft is made in three parts. The front component has a large (17 mm) diameter main journal and a 10.3 mm bore gas passage fed from a rectangular valve port, 15.5 mm long, that opens at 45 degrees ABDC and closes at 52 degrees ATDC (our measurements). It has a 7.6 mm thick crankweb with an integral crankpin which is firmly pressed into the 8 mm thick center web. This means that the front conrod has to be in position before the two parts are pressed together and, consequently, the two shaft parts, plus the conrod, are a permanent subassembly.

The front section of the shaft runs in

(Continued on page 106)

two ball journal bearings; a 17 x 30 mm 10-ball steel-caged inner, and a 1/2" x 7/8" 12-ball steel-caged outer. The rear section of the shaft has a smaller (but still substantial) journal diameter of 15 mm and runs in a single 15 x 28 mm 9-ball steel-caged bearing, supplemented by a plain bearing that is bronze bushed at its outer end. The rear shaft has the same diameter gas passage (10.2 mm), and is fed by a rectangular valve port 16 mm long, but has slightly different timing—opening at 39 degrees ABDC and closing at 50 degrees ATDC (our measurements). The hefty integral crankpin has a diameter of 0.341" (nominally 11/32" or 8.7 mm) and is extended to form a 1/4" wide tongue that engages the slot in the center web.

The crankcase is made in three sections from aluminum pressure castings. The front and rear sections containing the main bearings are externally similar. Sand-

FOX TWIN

(Continued from page 106)

wiched between them is a 9/16" wide center section, the three components being aligned and held together by four special 3/16" diameter steel through-bolts with 6-32 threaded ends.

Each cylinder comprises a hardened steel liner in a pressure cast aluminum case that is tied to the crankcase with four 8-32 socket-head cap screws. Cylinder porting consists of a centrally bridged exhaust port, flanked by two deep bypass ports angled away from the exhaust and fed from sharply angled bypass passages in the surrounding casting. In place of the usual single upwardly-inclined third port there are two such ports. Port opening periods are fairly long. According to our measurements, the exhaust ports are open for 150 degrees of crank angle, the flanking bypass ports for 132 degrees, and the inclined third ports for 130 degrees.

The pistons have single, pegged compression rings and skirt windows to assist gas flow to the bypass passages. The tubular 1/4" o.d. wristpins are placed high in the piston, enabling long conrods to be used which cancel out the increased rod angularity that would otherwise result from the engine's longer than usual stroke.

The conrods are bronze bushed at both ends.

Cylinder heads are uncommon and are made in two parts. The inserted inner part, or "button" as Fox calls it, is machined from bar stock and has a conical combustion chamber surrounded by a vestigial (approximately 1/16" wide) squishband. The outer component is pressure cast with deep tapered cooling fins. Eight 6-32 socket-head cap screws are used to tie the complete assembly to the cylinder. Glowplugs are Fox 1.5 volt long-reach bar type. Combustion chamber volumes of the two cylinders were well matched on the engine examined and gave a nominal geometric compression ratio of approximately 9.5:1.

One or two changes have been made to the Fox Twin since it was first announced last year and the engine is now fitted with the new Fox MK.X carburetor. This breaks with a Fox tradition in that it uses a conventional barrel throttle, rotating in a helical movement around a fixed spraybar and containing a secondary needle for adjusting the idling mixture. In other words, it works on the same principle as a number of other adjustable automatic-mixture-control carburetors. This will undoubtedly please those who are used to conventional carburetors and who may have been confused by the old type Fox carb adjustment procedures, although we would like to say, in passing, that the older Fox carb is, in principle, a very good carburetor and is not the least bit tricky to set up if one follows the correct sequence of adjustments.

The Fox Twin comes complete with an adjustable link coupling the two throttles together and a "Y" fitting for connecting the two carburetors to a common fuel line. It is also supplied ready-installed on a firewall type aluminum mount and this accounts for just over 5 oz of its total weight of nearly 2 3/4 lb. Also available for use with the engine are pairs of chromed exhaust header pipes in a choice of straight, swept-back or curve patterns. A pair of 6" straight pipes with screws weighs just over 5 oz.

The Fox Twin is of rugged construction throughout and is obviously powerful. The manufacturer rates the engine at around 3 bhp at 14,000 rpm, which does not seem to be an unreasonable claim and we hope to run full tests to confirm this in due course. Fox emphasizes that the engine should be allowed to rev and should not be loaded down with too large a prop. The instruction sheet suggests a 13" diameter prop for peak performance. However, modelers flying quarter-scale and other large-scale models who want to use a bigger size can use a 15x6 or 16x4.

Will it fit?

Fox Twin mounting dimensions, less muffler:

Overall width (less glowplugs): 185 mm (7 1/4")

Length from prop driver, including firewall mount: 157 mm (6 3/16")

Bolt-hole spacing: 54 x 54 mm (2 1/8" x 2 1/8")

An Autobiography of the Designer and Manufacturer of Fox Engines

BY DUKE FOX

I suppose I should be saying that my earliest memories were flying model airplanes, but truthfully, this is not so. My earliest memory is from moving from a house with an indoor toilet to one that had an outhouse, and my mother being afraid I was going to fall into the “you know what”. I never did, however, and in a few months we moved into town into the “brown house.” I suppose I was about three and one half at the time.

My father then made his living selling Model T Fords, and the town was Ripon, California (at that time with a population of 800 or 900 people). Within a few weeks of moving into the brown house, my father had acquired a goat and a dozen chickens. He also built a chicken pen, a chicken shed, and a roost. I noticed that the chickens would fly across the pen, and I was fascinated at how they were able to fly. In fact, just about everything fascinated me. I was told that the bars on the roost were what the chickens slept on, and I couldn’t understand why they didn’t fall off. So, I found out. I went out one evening and sat on the roost and watched the chickens one by one come in and climb onto the perch. Soon there were a dozen chickens on this roost, and one small boy. Sleep is catching, because I went to sleep. The next thing I remember is my father picking me up off the roost and carrying me into the house.

In those days the biggest problem in selling an automobile was to convince the prospects that they could learn to drive it. Somehow, my father never did seem to have any problem this way. In fact, he even taught me to drive, so it was a great lark for me. He would come home during the day with a different car nearly every time and tell me “go and drive that one around the block and see how you like it.” You can imagine a four or five year old boy driving a car around the block. It’s a good thing that the cars in those days had low hoods, otherwise, I would never have been able to see anything except the dashboards. It was years later before I ever figured out that I was helping my father convince the prospects that he or she could learn to drive easily.

About this same time my father would take me to the shop (which was only two blocks away) whenever they had an automobile that was pulled down for a ring job, valve grind, or whatever. By the time I was four and one half years old, I understood clearly what a valve, crankshaft, piston, coil, timer, transmission did, and how they functioned.

My interest in flying chickens shifted to all birds. Whenever I would see a strange bird, I would run and ask my mother or father what that was, One day a big bird flew over and it was making a loud noise, and I did the usual thing. I ran in and asked my father, who happened to be there, to come see and tell me what kind of bird that was. He explained, "son, that is not a bird, that is a machine, and there is a man in it." What a mind-boggling concept! A machine that a man could ride in! I was hooked for life.

One of the toys that appeared for me to play with about this time was a model windmill with blades that actually turned in the wind. That toy lasted for quite a few weeks, and I experimented with the wind blowing forward, backward, up, down edgewise, and how the vane would turn the fan into the wind, and vice versa. I would spin it and see if it would make a little wind. From playing with that toy I think I developed a fair understanding of how a propeller worked.

Then, wonder of wonders, when I was about five years old, a barnstormer came to town. My proud father came home, swooped me up, and said, "We've got to go see this." In a farmer's field, about a mile away, was this beautiful biplane. I can see it today. It had a radial motor up front. I know I was no older than five, because shortly after I was five we moved to another house. My father proudly pushed me up and told the pilot of the airplane what a smart kid he's got. The pilot pointed to a cylinder and asked me what that was. I can remember saying, "Well, that has to be a cylinder, and there would be a piston in it hat would go up and down, but I have never seen a motor with the cylinders arranged in a circle like that. They have always been in a straight line." The pilot pointed to a push rod, and I said, "I don't know what you call it, but it would make a valve go."

Shortly after, we moved out in the country a bit, where we lived for six or eight months. My father came home with a kite one time. Oh, wonder of wonders! We went out and flew it together and sent messages up the string until my father wound it up and said that it was time to go in. I flew that kite quite a number of times out in the small pasture nearby, until one day it got away from me, and the kite sailed away. I went after it for all I was worth. The kite went down some distance away in an orchard. I don't know what kind of fruit trees those were, but they had thorns. I rescued my kite, and when I was climbing down the tree, my folks and the neighbors both appeared and took me home. Boy I was a bloody mess! I had scratches all over me, but not to worry, my precious kite was safe.

I also learned about this time that I was not really big enough to handle a shotgun. My father thought that I should, but man, when that thing went off, down I went. My shoulder was sore for a week after that.

When I was about six years old, my folks thought that I should go to school. To make things work out right, they moved to a nearby town, Manteca, where I lived until I finished junior college.

When I was about eight years old, my father brought home a kit of a Baby ROG. Actually, it wasn't an ROG, as it didn't have any legs. It had about a 12" wingspan with a 1/8" square motor stock, and it was tissue covered. My father helped me build the model, and for the first time I smelled model airplane cement and banana oil. It took about a day to get it finished, and we flew it indoors. It was great. If I launched it in the kitchen doorway, it would fly through the dining room and into the living room, which was straight on, and it would hit the front wall at about the ceiling point. What a thrill!

I flew that model dozens of times, and one day I flew it for one of my neighbor boys my age and we were talking about the marvel of it. He was tossing his cap up in the air and catching it. Then disaster struck. The cap landed on the model and crushed it. There was no fixing it because we had no more wood for a motor stick. These memories are still in my mind today. There was nothing to do but try to build another one. Out to the woodpile I went, sharpened my pocketknife as sharp as I could, and selected nice pieces of wood to use. I was able to sliver down some redwood to pretty thin pieces to make the wing frame, and I was able to make wing clips out of paper clips. Also, a paper clip made a good rear hook. The thrust washer was a little more of a problem. I finally solved it by hammering on a nail until it was properly flattened, and then with a series of additional nails, would keep pounding onto the place for the hole until I was able to get a hole in it. Then I bent it and clipped it off, and presto, a thrust washer.

I probably built half a dozen kindling wood models using LePages glue, which has to be the worst excuse for glue man ever invented, and covered them with wax paper. You know, it really is hard to get wax paper to stick to wood using LePages glue. Somehow, I was able to get it done. Some of my models actually flew eight or ten feet, especially if I threw them kind of hard.

Model Airplane News appeared on the newsstand in about August, 1929, I am told. A whole new world opened up. I could send away money and get balsa wood, banana oil, good tissue, wire, cement, rubber and all sorts of good things back by mail. Also, I started sending for catalogs, which I devoured. In very short order, I had the house filled with Baby ROG type models, some a little bigger, some a little smaller, some with landing gears, some without. I made pushers and experimented with CG and whatnot on those. I made a tailless plane. I built an ornithopter or two. Anything connected with flying that could be built with a model, I wanted to build.

I remember when I was in the fourth grade, one day the teacher told us to open our book to a certain page and to start reading. I liked reading, and was good at it. I went through about three stories and half of the fourth, when she said to quit. Then she asked us to start counting backward to see how many words we had read. I remember the number to this day. I had read 430 words in a minutes time. I don't think the teacher believed me at first, because she started asking me questions about different characters. I can remember saying, "Well which story are you talking about? In the first story they did this, and in the second story they did that, and in the third story there was nobody by that name." I never had to sit through reading classes after that.

One day the school principal asked me to show him my models. He asked me to bring the models over and we flew them in the school auditorium. He was quite impressed, and told me that I could fly my models there any time. All I had to do was just ask the janitor to let me in. However, that didn't work so great because the janitor always seemed to want to hide when I came around, as he was always in a hurry to do something else.

We were in the deepest part of the depression by then, and nobody was buying automobiles. In order to feed the family, my father started farming the vacant lots around the area. What little money was made off the produce bought groceries so that we wouldn't be too hungry. As I look back, there was a two or three year period that I never did have enough to eat. Meanwhile, I was growing like a beanpole. My feet had grown so big that I couldn't wear anybody's cast offs. It took real money to get me shoes. Hand me down shirts and overalls I could wear. I can remember the year I graduated from grade school. I graduated in a borrowed suit, a neck tie my school teacher had given me, and a haircut that a friendly neighborhood barber had given me.

The house we had lived in was repossessed. Fortunately, my father had owned a vacant lot and was able to buy a milk shed for $15.00. We moved the milk shed onto the vacant lot. Shortly after this the economy started easing up a little bit. No matter how tight things were, though, I was able to come up with 75 cents or $1.00 a month to send away for model building supplies, and I kept building models after school all of this period.

In those days a thirteen year old boy could get a job, and I was able to get a job during the summer in the cannery paying first 15 cents and hour, and then 25 cents and hour. This financed my school clothes through high school and my model building, and in my junior year, an automobile. I had wheels and could go to model contests.

The Junior Birdmen, sponsored by the San Francisco Examiner, had hired a man who was promoting the Junior Birdmen, and held a series of contests throughout central California, one contest nearly every Sunday. Boy, did I go for those! Their system was that if you won first place in one of their events, you got a silver wristlet, and that made you an ace. Over a couple of years I accumulated several dozen of those silver wristlets. I began to get the feeling that some of the contest regulars weren't too happy to see me when I pulled up to a contest. All of these contests related to either gliders or rubber models, because Mr. Hurst felt that the gasoline powered model was dangerous, and he resisted it.

I dearly wanted a gas powered model, but it wasn't until 1936, I believe, that I was able to mail away and buy a Mighty Midget kit. I remember I assembled the motor and cranked for three days, and I couldn't get that motor to run. I checked and re-checked to make sure that I had done everything right. Finally, in desperation, I decided to turn the needle valve body around, even though the instructions plainly said the hole should be in back. Wonder of wonders, the motor started in the first couple of flips and ran very well. I built a 6' model similar to a Curtis Robin rubber model that I had built earlier. We took it out and it flew great. I flew that model a lot of times. It was always a little disconcerting, because every time it landed, we ran a risk of damaging something.

By this time the summer work was paying better, and I was able to buy a Dennymite motor, which was one of the best ones built at the time. I built several different models around that Dennymite motor, and I placed in quite a few contests, and won one (free flight, I believe). In retrospect, the gas models were more of a challenge, but I learned more from building rubber models because they built easily, and because I was able to try out so many different thoughts. I learned quickly that a triangle fuselage was stiffer than a rectangular one, that diagonal verticals were stiffer than straight ones. Regardless of what Charles Hampson Grant said in his center of lateral area theories, I found that if I put the wing up front on a high pylon, it stayed right side up. I learned that if you wanted a model to catch and stay in a thermal, that you had to cut down the rudder area to the bare minimum. I learned that an all weather airplane, one that you could fly in the rain, won more hardware than a fair weather ship that was a tremendous flyer.

About the time I graduated from high school, June, 1940, I went to quite a number of free flight contests, and started meeting people that were to become famous in the model world. I first met Danner Bunch at a Fresno contest. I met Irwin Olson at the California State Fair contest. I met John Dobshoff and Robert Wherle, I first met John Pond at Sunnyvale when he was testing his beautiful, new 9" Cavalier. It sailed out, not into the sunset, but into the South Bay.

I remember taking an interest in a lot of motors that appeared about this time. Al Hovseppion built a little motor he called a Micro. It was especially attractive because he had two brass tubes sticking out to form an exhaust stack. Jim Brown's engines started appearing, the little Dynamite, then the Thermite. The first Elf I saw was down at Sunnyvale on a biplane, and the owner explained how he had flown it on two lines attached to operate the elevator. Now he came out to the open spaces to see how it would go by free flight. Unfortunately, after two hours he still couldn't get the motor running, and gave up. If he really did fly the motor the way he described, it predated Walker by quite a few years. I remember an indoor towline glider event sponsored by the Junior Birdmen in which I beat Bob Muser by just two seconds.

When I was about thirteen or fourteen years old, I figured out that my best security for the future was to get the best education I could. Of course, I had known from the time I was four or five years old that I wanted to learn how to build airplanes. So all during high school and junior college I took all of the courses that I could that I though would improve my engineering skills. Money was tight, and when I was in high school, I didn't even know that I would get a chance at even two years of college. So I didn't waste any time on study halls. When I was able to go to junior college, I took everything that was available. Consequently, when I graduated from junior college, I was fairly well equipped to start in the engineering department at Hughes Aircraft.

Hughes Aircraft was just developing out of the little group that had built Howard's Racer. I was hired and given badge #32 and found myself shortly doing wiring installation drawings on the D2 airplane, which was Hughes competition to the Northrop

Black Widow, a three man, twin boom type airplane. I was a quick, neat draftsman, and I worked up in the company quickly.

Meanwhile, having moved to the Los Angeles area, I rooted around and started looking up the model clubs, the flying area, and the different manufacturers that I had read about. I remember that I made such a pest of myself around Clyde Austin's place that he had to ask me to leave.

A few months after I had moved from central California to Burbank, California, the Burbank club had a free flight contest. I had done quite a bit with towline models earlier, and I had designed about a 4' wingspan that I thought was pretty good. I built one the day before the contest. I went out to the contest the next day, and in due course made my flight. In these days there were no dethermalizers and there was no weight limit on control line gliders. The day was hot, there was a lot of lift in the sky, and I figured that I would sacrifice the model to win the contest. One launch and it was up in the sky for ten or fifteen minutes, and it was gone forever. I waited around for the end of the contest, fully expecting to get a first place award. What a shock when they told me I was disqualified. I don't remember the reason that they came up with, but I always felt that had I been one of the locals, not a newcomer, it would have been different. Later I started to fly at Western and Rosecrans, which was the center of gas model flying at that time. I became active in the club and became a Sunday regular. I flew in their contests, but never did have outstanding success because my interest tan toward experimentation and designing the unusual and offbeat. When I found out what it would do, I kind of lost interest. I just couldn't seem to get excited about building the same design one after another.

I was out flying at Western and Rosecrans one Sunday around noon, and one of the fellows told me that he had heard on his car radio that the Japanese had attacked Pearl Harbor, and that we were at war. I can remember wondering just what changes in my life would some about because of that.

Because I was working at Hughes, I got deferments up until the spring of 1944, when I was drafted. During this period I continued to work with the club and continued to fly with them, and had started to plan my first engine, which became the Fox .59. This motor, which is now at the AMA museum, was designed by me but was mostly built by whoever I could get to do what. Patterns I had made at a pattern shop, castings were made at a small aluminum foundry in downtown Los Angeles, and a machinist was going to machine up the first motor. The compression was so poor, however, that the motor really wouldn't run satisfactorily.

I became acquainted with a Frank Smith, who later became very famous for his mini-plane design. He invited me over to his apartment basement where he had a small lathe, and it was through his efforts that we really got the first motor to run satisfactorily. In cooperation with Frank, we built three or four motors off of these patterns, and then, when I was called to the service in the Spring or Summer of 1944, modeling pretty well stopped.

I remember I was sent to Camp Buckley, outside of Denver, to basic training. The first week-end that I got a pass, I guess I walked five or six miles out in the country to go to a model contest. I talked to the different people and was able to mooch a ride back with one of the modelers by the name of Joe Nogy.

While I was at Camp Buckley, I could see that if I didn't do something to change it, that I would wind up riveting patches on a bomber somewhere in the South Pacific, and I didn't particularly want to do that. I got permission to prepare a description of some experiments that I had done on the stability of a towed glider. Evidently the article was forwarded through channels, because after going through basic, I was shipped down to Biloxi, Mississippi to go to B24 school. About halfway through this school, I got shipping papers to go to Dayton Ohio, and found myself at Wright Field, assigned to the glider branch. From the glider branch it was a small step to a group created to investigate the flight characteristics of an experimental Cornelius glider that had killed its pilot.

This project was ramrodded by a Captain Stolzenberger, who was a good promoter and had a good imagination. He was convinced that we could learn more about this glider, or any airplane, by building a scale model of it and flying it. He convinced the authorities to give him a free hand to build such a model. At Wright Field he had available to him some very good talent, both in aerodynamics and all its associated fields. Captain Stolzenberger made the decision to build a ¼ scale dynamically similar radio controlled model of the glider. The Aerodynamics Department calculated the moments of inertia, and the weight that would be required of the glider, and it fell my lot to build the glider. I explained that we would need to have a couple of fair size work benches and, it was not to take forever, I would need a helper or two. This was supplied.

I designed the structure of the glider and the various fittings. Since the machine could weigh only so much, it was entirely covered with balsa wood, and had good size fittings throughout. The radio was a Babcock Bang Bang system, taken from the glider target planes that were being used at that time.

The one question that I asked was, "How are we going to launch this thing?" The plan was for a helicopter to pull the glider up dangling from a cable about 50 feet long. In due course of events we finished the model, provided the cable and a quick disconnect (something on the order of ice tongs), and went out to the field area to give it a test. It turned out that helicopters at that time were not capable vertical assent of more than 10 feet or 15 feet, and the helicopter had to move out of its own vortices rather rapidly in order to gain altitude. You can imagine the yank on the glider when the helicopter started accelerating away from the launch site and the cable came to the end. The lift tongs tore the sides of the fuselage out. We took the wounded bird back. I suggested to Captain Stolzenberger that we could repair the model, but that he should start working the system to see if we could go to Lakehurst and drop this from a blimp, since the speed of the air ships was not too great, and the model could be attached to the bottom of the gondola. I think that he did not know what to do next, because a tremendous look of relief came across his face. He got behind the idea very enthusiastically.

In a few days I had the glider all repaired. Fortunately, the damage was just localized to the clamping area, and it didn't take too much repair. In due course the Captain was able to requisition a C-46 (Curtiss-built twin engine transport), and we loaded the glider and all of the tools we thought we would need, and off to Lakehurst we went. Many of the people at Lakehurst cooperated wonderfully, and shortly we had a saddle hung underneath the gondola of one of the M-2 ships. This time the air ship took off with the glider hung right underneath it. A section of the floor of the gondola was removable, and it was my duty to reach down and release the glider at the proper signal. I was very happy for the rides in the blimp, but I was not at all happy with the idea of hanging through the opening in the bottom of a gondola at 3,000 or 4,000 feet. I arranged a rope around my waist and securely tied it. If I should slip and go down, I would only go a few feet and the rope would hold me.

The tests worked great, with no damage to the glider. Six or seven flights were made over a period of three or four days. The tests proved, as we had suspected, that the forward wings on the glider worked fine as long as there was not enough yaw for the rudder to stall. Once the rudder stalled, the thing went into an uncontrollable flat spin, and seemed to have no desire to come out. Normal reversing of the controls did not seem to work. However, just by luck, on the first flight the Captain tried letting the controls return to neutral, and it was found that after about three quick turns, the glider would straighten itself out. With the controls reversed, instead of straightening itself out, the glider would flip over on its back and flat spin upside down. Not only had we proved that the glider design was no good, we had also proved that you did not have to have a wind tunnel in order to learn a lot about the flight stability of a plane. After this, the group went on to experiment with a couple of powered machines, However, at that time both the power plants and the radio were very basic, and seemed very elementary by today's standards.

While I was in B-25 school a year or so earlier, I had made up production drawings of what was to be the long shaft Fox .59. My original sand cast model motor weighed about 14 ounces, which I thought was too heavy. So, I made everything thinner and lighter. This produced, as we later found out, a good running motor, but very frail. My thought at this time was then when I would get out of the service, I would have a motor design and a set of tools made so I could find a machine shop to do the machining. Thus, I would be in the motor business.

I came home on furlough near the end of 1944 or early in 1945. I asked around, and it seemed that Anderson Die Cast Company was the major die cast company in Los Angeles at that time. I went to visit them, and they seemed to know what they were doing. They offered to make a die casting mold for me for $3,2000.00. This mold would make all the cast parts necessary for that .59. I accepted their offer. Since I been frugal with my paycheck while I was working at Hughes, I had just enough money to cover the cost of this tool.

Later, while I was at Wright Field, Anderson finished the tool and sampled it. They then sent me sample parts. I was able to get a machine shop in Dayton to machine up the parts for the first die cast .59. A few weeks later I was discharged from service. I took my newly made motor back to Los Angeles. At that time I didn't have any models or any place to build one.

The .59 motor ran quite well. After talking to some potential motor manufacturers, I chose Mr. Claude Slate, who I had known casually at Hughes Aircraft. During the war he had bought a machine shop in downtown Los Angeles, and was primarily making rings for the oil well industry. Claude was a good engineer and an honorable person. He appeared to me to be the ideal person to handle my business. The deal was struck. Claude would build the motors, sell them, and pay me a royalty in return for the design, the drawings, and the use of the casting die. For the first couple of months I donated my time and labor to help Claude get started. However, after about three months, I got itchy to get back into the aircraft engineering business, and went job hunting in earnest. Douglas, in Santa Monica, offered me almost twice the money that Hughes Aircraft did, so you know where I went to work. It seemed strange to me that after Hughes learned that I had taken a job with Douglas, they more than doubled their ante. However, I told them that I had made a commitment, and I wasn't going to switch.

I was really fortunate at Douglas in being assigned to the mechanical division of their research department. The research department was staffed with the head of the Physics Department, head of the Electrical Department, head of the Hydraulic Department, head of the Sound and Vibration Department, etc. Each of these people were specialists and technically oriented. However, whatever tests they wanted, it fell to the Mechanical Department to design and build whatever test equipment it took.

During the two years at Douglas I worked on several very interesting projects. At first I was assigned just small projects of designing and fitting, making some alterations in some equipment, or something like that. After a couple of months they started feeling confident of my capabilities, and I had some good sized projects assigned to me.

One of the most interesting projects was a telemetering data reading. The Nike Missile was just being developed at that time. When the test shots were made, the various information pickups in the missile were telemetered back to the ground and recorded on some high speed film as just a long string of graphs. Thus, a ten or fifteen second firing might result in a ¼ mile of film. Of course, on any section of film you looked at, the lines would all look the same length. This information had to be condensed. They put a group of women to work reading the lines to make the graph, which was very time consuming. This was not acceptable since they had another shot planned the next day.

They wanted to know what changes should be made, if any. I was coupled up with an optics man and an electronics man, and I was to somehow provide the plotting mechanism. The optics man developed the reader. The electronics man provided the amplified switching systems, and I was able to take a recording and modify it so it would produce a readable graph on any channel (or channels) they might select. The result was the army was very happy to get the reader, and as far as I know, that one reader served the whole series of experiments until more advanced methods of transferring information were developed. Shortly after this, the head of the Electrical Lab engaged me in conversation and asked me, "Duke, do you think that you could build us a test stand so that we could test a whole DC-6 system?" I asked him what was involved, and he said, "Well, the basic problem is that we have a $20,000.00 budget allowance, and that is just not enough money to get power plants and gear boxes to turn four 50 kilowatt generators that are on our systems. Besides, we need a building. We need space on the inside of a building shielded from the sun and rain where we can spread out the equipment to see what happens when an appliance shorts or a defect occurs." I asked what exploratory work had been done, and he said he had priced diesel engines with high speed drives and they were too expensive. I asked about the high speed drive bit. It appeared that the generators had to be turned up as high as 8,000 RPM. This was way above the speed of a gasoline, diesel, or electric motor. At any rate, I thought about it for a little while, and told him that I thought I could come up with something. He said, "Well, I'll get you assigned to the project."

I went on about my business, and a day or two later my own leadman came to me and said that I had evidently been talking to the electrical people. I now had authorization to plan, design, and build this generator test stand. This had to be done under a $21,000.00 budget.

It was pointed out to me that there was a sheet iron building on the lower end of the hill. This building has been used for storage, and would be available. That would be acceptable, and that would get us the building for free. All that would remain would be to build the benches on the inside and provide a way of turning the four large generators at the required speed. I made some phone calls and some trips around Los Angeles, and was able to but four new Chrysler industrial pump engines. These were already mounted up on a base with a radiator and the whole nine yards.

While working at Douglas, I also planned and supervised some huge coils used to shake an airplane, some air explosion protective devices, and I helped in a small way on some high altitude fuel vapor lock studies and some cold chamber studies.

One of the highlights of this period was when my supervisor called me up to his desk and said, "Duke, do you know what you have done?" I almost panicked. I couldn't think of anywhere that I had screwed up. What he said was that in the whole history of Douglas Aircraft, the generator test stand was the first project of this nature to ever come out ahead of schedule and under budget. I guess you can imagine that made me some points. All the while I was working at Douglas, it did not appear that the Slate Project was going well at all. I had bought myself a Sears and Roebuck lathe, a little Benchmaster mill, and a Walker-Turner drill press. After I got home at night, I was building experimental motors. In the two years I was at Douglas, I probably built twenty or twenty-five hand made motors, each one different, exploring different porting configurations, different bore stroke ratios, etc.

In the fall of 1949, Douglas had a big layoff. I suppose they had caught up with the DC-6 orders. It was suggested to me that if I could find a job elsewhere, I had best do so. It appeared unlikely that Douglas was going to get any substantial orders soon, and if they did not, I would probably have to go. I was not too disappointed. Douglas had given me almost a month's severance pay.

I had built my .35 by that time, and I felt that this one was worth producing. Very little was happening down at Slate in regard to the .59's, and yet I was tied up with a contract that he wasn't quite ready to release me from. So, I started building stunt .35's. The first two were actually sand cast from wood patterns, but the cost of the castings in this manner was prohibitive. I knew that I had to get lower cost castings.

One company offered to make a permanent mold and run it for 35 cents a set. They did make the mold, but when I tried to get production, I found that the shop proprietor had a good job offer from a big company, and he just shut his shop down. I had a mold, but nobody to run it. All over Los Angeles I went, and after a lot of time and worry, I did find someone who would run the mold. We produced castings off of that mold for over two years.

In 1949, after I had split from Douglas, I decided to try to make a living off of the stunt . 35. I went to the Veterans Administration and signed up for veteran's supplementary benefits.

Mr. Dale Arnold ran a nearby shop, and I had him make crankshafts and cylinder blanks. The porting and the rest of the work I planned to do myself. I sold the first fifty motors in January, 1949, and the word started coming back that they ran very well, but the crankshafts started breaking. The crankshafts were breaking across the throw between the crank pin and the main. What a dilemma! I was down to my last dollar and the motors were breaking up. There was nothing to do but go back to remaking the crankshafts. I made the web a little thicker and changed form 1113 to 1018 steel. The new cranks didn't break, the good word kept passing around, and people started buying the motor. About this time, Dale Arnold, who had been a good parts supplier for me, said, "Duke, let's go into a partnership. I have a shop with some equipment, and you have a product it looks like people will buy." So, the partnership was formed.

Dale was a good machinist and production minded, and I learned a lot from him rather quickly. By the summer of 1949, our motors did very well in the Nationals, and we had orders lined up and waiting. We were able to get a 1,000 square foot metal building with no down payment on Varna Street, So, we moved out of Dale's and my garages into this nice, new building. Sales continued to grow. I hired first one man, and then another. I thought things were going pretty well.

However, there was one fly in the ointment and kept getting worse. Dale's wife was very difficult and demanding, always wanting more money. Dale wound up taking $100.00 to $125.00 a week out of the company, and I was taking $15.00. If I took an equal amount to Dale, the company would not have survived. Obviously, this sort of thing could not continue. The last straw came when I was trying to arrange financing to buy a new lathe. The banker informed me that not only would I have to sign the mortgage papers, but so would Dale and his wife. We went down to sign the papers. I signed it and Dale signed it, but Dale's wife took the pen and announced in a loud voice that everybody in the bank could hear that she wasn't going to sign it unless she got $150.00 a week (this was like $1,000.00 a week now). I told the banker that we had a problem, excused myself, and went outside. I told Dale that the business couldn't stand that amount of money, and asked him to do something.

We went back to the shop. About three or four days later, Dale came in and announced that if I could raise $5,000.00, he would bow out. Perhaps that would be the solution to his marriage problems. I will be forever grateful to Dale for letting me off the hook so modestly. By any count that I could make, the business was worth about $20,000.00 at that time. I will also be forever grateful to my parents, because they offered to mortgage their house so I could come up with the money to pay Dale off. This was done.

The orders continued to come in, and the need to hire more people continued. After I paid Dale Arnold off, he got a job with one of the larger companies in the area. That left me without a tool maker, setup man, or foreman. By this time I felt that I had learned enough that I could do just about any of the work to be done. However, I really did need help.

I remember how ingenious Tony Naccarato was. He was a regular down at the Rosecrans Flying Field, and he seemed to have a bent for experimenting in the same way that I did. I went to see him and found that he was unemployed at the time except for making a few model things in his garage. His wrench business was not doing very well, and he was looking around for something to bite into. At any rate, I hired him. He moved from South Los Angeles up to the North side where I had my shop, and he became my foreman.

Everything went well for a while. The business was making enough money that I could afford a new car, and I got a big, red, Lincoln Convertible.

A salesman from Ranger Diecast came around trying to drum up business. He made me a proposal to replace the permanent mold castings that we were using with die castings. This offer came at just the right time. That old permanent mold had made a lot of castings, and it was getting pretty tired. Anyway, I gave him the go ahead, and before too long Fox .35's were coming in die castings instead of permanent mold. At the same time we switched from the four screw head to the six screw head. Otherwise, the parts remained the same.

In an effort to try to get the parts coming better and requiring less hand fitting, I had bought an old centerless grinder, and later, a pull broach. We used the pull broach to broach the bearings and to broach the cylinder bores, preparing for honing. The pull broach on the cylinders worked so much better than trying to ream or bore them, that when I started thinking about a .19 size motor, I was planning to broach the casting for the sleeve rather than bore it. This was the primary reason for the unusual design of the first split case .19. Fortunately, when we came to actually broach the castings, we found that the castings themselves just didn't have enough strength to withstand the broaching pressure, and we went back and bored them anyway.

About this time my G.I. bill was beginning to run out, so I went over to sign up to get flying lessons. This had been an ambition of mine since childhood. Two days before my first lesson, Tony, my foreman, complained that his leg really did hurt him. I had him pull up his pants leg and it was the worst looking leg that I had ever seen. Black and blue from the knee down, it looked like gangrene was about to set in.

I cancelled my flying lessons and got Tony to go to a doctor about some medical aid. It seems that he had broken his leg in an airplane crash years before, and it evidently healed, but not properly, and was very weakened. When he stepped down too hard, the bones crushed. Here he was trying to walk around on a leg with bones broken in several pieces. Anyway, Tony was out for almost two months, and that was the end of the G.I. flying lessons because the time did run out on me.

Meanwhile, the .19 that we had been so proud of started coming back with the crankcase broken through the exhaust section. It seemed as though the casting was not only not strong enough to broach, it wasn't strong enough to stand the stretch reversals from running for very long.

It was obvious that I was going to have to do something very quickly. We started a crash program to replace the crankcase with one of conventional design. As soon as the conventional crankcases started coming through, I sent out the word for a recall. Lordy, they sure did start coming back! For a while, it looked like somebody else was making them, because it seemed like we got back a whole lot more than we sold. Actually, I would imagine that there are less than forty or fifty of these split case .19's left floating around.

It was not really a big deal to pull the guts from the split case and put them in the new case and re-sell them. Very few of them had reached the consumers. They just came back from the dealers off of their shelves. It was never very clear to me why our Fox .19 did not run quite as energetic as the K&B .19 at that time. We tried every way that I knew to sort it out and find the magic formula. Actually, in the running of the motors, we did find one miracle motor that ran 1,000 RPM's faster than any other. If we could have made them all like this, I am sure that we would have sold four or five times as many .19's.

I cannot put a finger on any reason why most of our .19's would run from 12,200 to 12,500 RPM with a propeller, and this one single motor ran 13,700 RPM. In those days I didn't have the measuring equipment to check sleeve taper, roundness, and that sort of thing. I do know that I ran that motor a whole lot, replacing pieces one by one. No single piece seemed to count for the performance, but just the fact that every piece in it seemed to be just a little bit better than others apparently identical.

Well, business went on and it smoothed out. I was finally making more money than I would have if I had stayed in aircraft engineering. Of course, most of it went back into the shop, more equipment, more inventory, and building the business.

I had finally achieved a degree of independence and financial success. I was still single, and living with my parents, who were by now retired and becoming quite aged. For the first time I really felt that I could spend time and money looking for a wife. During the next couple of years I did start dating. When you are thirty years old and have lost contact with all of your childhood friends, how do you find eligible females? Well after finding a couple of ways not to, I decided that I was going to tell every friend that I had that I was looking, and now on the eligibility list. I can assure you that when you promise all of your friends if they arrange a date for you, that you will show the girl a good time, there will be no wanting for dates. The way "Miss Right" came along was through the mailman. He fixed me up with a date with a young lady who is now my wife of 37 years. After the first few evenings, I started looking to find where the flaw was. I could find no flaws, and she looked as good as ever. I started being afraid that she was going to get away from me. Very shortly afterwards we were married, and then the business became a team effort.

We were only back from our honeymoon for a couple of weeks when she announced that she wanted to come down and acquaint herself with the business. She had been a bookkeeper at a previous place of employment. All of my bookkeeping had been done by a bookkeeping service a couple of doors away. Her contributions to the business over the next 37 years were many, and she helped keep the business together during a lot of bad times to come.

One day shortly after, I was walking down the street on Van Nuys, and a stranger called out, "Hey Duke." I turned around and he walked up to me and said, "How is the business going?" I told him, "Very good." But I had no idea who in the world he was. He said, "You don't remember me, do you?" I said, "No." He said, "Well, I'll remember you all of my life. About the fourth or fifth time you came in for your G.I. subsidy on a new business start up, you told me that the business seemed to be making a profit now, and you guessed you weren't eligible for this aid anymore. Duke, of all the thousands of G.I.'s that came through my office, you are the only one that ever did not draw the full twelve months that were allowed." I thanked him for his concern, and I still wonder to this day whether I was stupid in being so honest.

In 1954, we had expanded the building as much as the lot would allow. I had bought a G.I. tract house and was living nearby with my wife and stepson. There was always a little tension between my wife and my parents, and a lot of tension with my one sister who lived nearby. I had a lot of problems with the city of Los Angeles inspectors. I remember one inspector who came around and said I would have to paint the inside of the women's toilet (this was a sheet metal building, remember). I painted it aluminum to match the rest of the corrugated aluminum, and he came back and said it had to be white. I painted it a nice glossy white, and then the third time he came back and said, "I'm sorry but you will have to do it again. It is supposed to be a dull white, not a glossy white." Also, I had some problem leaving a few 2 x 4's out in the back yard, which I was informed had to be up on saw horses. They also made me replace a perfectly good 1,000 P.S.I. boiler tank (which I was using with my air compressor) with a much weaker one that did have the right stamp on it. Today, I would know that these inspectors were looking for some sort of payoff, but I was too young and inexperienced then to recognize it.

At any rate, in 1954 I had these problems. Then, on top of that, K&B had introduced the new green head series motor, and it was a very strong running motor. It ran noticeably stronger than our stunt .35, which is still our main income piece.

About the time the K&B motor was introduced, our sales were running about $20,000.00 to $22,000.00 a month, and I was carrying a $10,000.00 plus payroll. It seemed like the pipeline got filled all of a sudden. From $22,000.00 a month, we dropped to an $8,000.00 month, and then a $6,000.00 month. The $8,000.00 month I swallowed, but with the $6,000.00 month I knew that I had to retrench. I cut out all the overtime and invited anybody that wanted to do so to go job hunting. It looked like the gravy train was over, and I started to evaluate how best to survive.

At that time the mail was the only way to get things delivered, and it took parcel post over a week to get from Los Angeles to the East coast. I figured that if I could move somewhere in the middle of the country and get away from the inspectors that were giving me so much trouble, and get away from living so close to my parents and sisters, and at the same time get into a lower overhead situation, that was the thing to do. Also I was really getting tired of living in the high density Los Angels area, waking up to the noise of the highways, and going to sleep to the noise of the highways. I took a map and drew a circle in the middle South area. I didn't want to live far enough North so that we had really cold weather, and I thought that by working in the middle of the country, we might be able to get a three day delivery to both the East coast and the West coast. We sent out about one hundred letters to chambers of commerce along with a questionnaire. We received about forty answers.

About this time I found that some of my employees didn't take so kindly to the retrenchment, and they hustled to a union organizer to try to force me to increase the wages. Anyway, the upshot of it was that all of a sudden I had the problems of a violently depressed business, facing a move, and the union problem, all simultaneously, You can imagine I wasn't feeling too chipper.

I did select Fort Smith, Arkansas as the best place to move. I went about the business of getting the incomplete parts completed and in saleable form. I then loaded everything on three semi-trailers and sent it to Fort smith. I arranged for the sale of the shop property and of our home and away we came, driving our vehicles across the country. I came first, driving my Muntz sports car, to meet the trucks and supervise unloading in our rented quarters. My wife came a few days later, along with my stepson, who was then about ten years old.

Fort Smith was a depressed town then, and we were wanted badly. We gradually settled in, and I kept filling orders through the stock of finished motors that we had built up before we moved. I had the business of finding new sources of material and supplies. I found that it didn't seem to be any more difficult to pick up the phone and call Chicago than it was to call downtown Los Angeles from North Hollywood.

The union problems came to haunt us in the form of a runaway shop charge. This was finally solved through a lot of negotiation and paying some fines and back pay penalties. In about a year I got things well enough under control that I felt I could start another motor project. This time I wanted the prestige of a winning speed motor, and the Fox .29R, with the bathtub intake, was the answer. The Fox 29R was moderately successful and managed to win both B speed and Proto speed in the 1957 Nationals (I believe this was the correct year).

About this time combat model flying started to become a recognized event. It was obvious to me that if I wanted to retain any part of this market, I had to come up with a better motor than our stunt .35. The motor that we settled on was a production version of a hand built motor that I had built back in 1954. The hand built motor was made primarily to explore the idea of making a fuel pump in the crankshaft. The fuel pump idea never did work, but the motor itself ran quite strong. The prototype I still have, and it runs quite strong, even by today's standards. It was a .36 size motor, was a single bypass baffle design, except the baffle was curved in the manner of the Bunch tiger. The crankshaft diameter was increased from 7/16" to 1/2", and the rod was somewhat sturdier.

I made up production drawings and had tools made to make what became our X series of motors. In retrospect, I feel that I made a mistake in not putting the extra effort into making curved baffles for all the pistons, but this was a little more expensive than cutting a straight baffle. On the production motor I went to a straight baffle for economy sake. All of the nice, docile handling characteristics of my prototype went down the drain. The straight baffle version was just plain cranky. I made and sold a few hundred of these, but I could see that this was never going to become popular unless I did something about the crankiness. I did experiment and came up with a higher, different shaped straight baffle that became the black head combat. I still don't understand why I was so hung up on the straight baffle. It still didn't run quite as strong and act as nice as the prototype. However, this motor did sell and became the first of a long series through about 1971 or 1972, when the series was discontinued.

Sometimes you do things right. In 1956, a real estate agent sold me an eight acre plot of ground on the South side of town. It was available for under 10,000.00. It looked good to me, and I bought it. After a little while, the pressure was on us to move out of the rented building, so we started to build the building we are now in. It was quite a bit bigger than I had originally figured, but bankers are funny. I was unable to borrow enough money to build a 20,000 sq. ft. building, but I had no problem in borrowing enough money to build a 40,000 sq. ft. building. I made up my drawings, took them down and got the permit, and went about having the local people put up the structure.

One of the features that I used was 45' long composite roof beams consisting of a plywood web and angle iron cap struts. This was a familiar structure to me because that is the way the wood airplanes that I had worked on were designed. The building was about one half up when trouble same. I guess the architects resented not getting a fee out of this project, and the city inspector didn't know his business at all. He just depended on feedback from the local architects as to what was a stable building. I supplied him my stress calculations, but he didn't know what he was looking at. Finally, I loaded a beam from the floor to show him that it would carry the 15,000 pound distributed load the code called for. What I found interesting was that the deflection was almost exactly what I had calculated. It must have been okay, because the building is still standing, although it is leaking like a sieve. I guess I am going to have to put a new roof on it soon, although thirty three years is not too bad for a sheet iron roof in this climate.

Now, with a lot of room available, I started laying out the shop in a little more sensible arrangement. The automatics went into one corner of the building and were arranged so we could run a fork lift up and down the aisle. The grinders went over in another corner of the building so that the vibration from the automatics wouldn't screw up the close work. Second operation equipment was lined up so that, hopefully, the parts would go down an aisle from machine to machine. Shipping was placed right next to our office, and we went about the business of taking care of our orders in the best possible manner.

In 1957, for my birthday, I felt I had enough security that I could afford to buy an airplane and learn to fly it. When I told my wife that that was what I was going to do for my birthday, we just about had a divorce. I told her not to get too excited because I was going to do this. This had been my goal through all the years for all of this work. After sulking a bit, she announced that if I was going to kill myself, she would come and die with me. We went out and got our student licenses and started studying in ground school and started taking a few flight lessons. When we took the written test, my wife got a 74 score, and I got a 72. I figured that she ought to be doing great. In due time we both soloed, and this seemed to satisfy her. As far as I know, she hasn't taken one solo flight since.

We bought a 172 Cessna that had been used for two or three years, with about three hundred hours on it. I flew this around the central area for about three years, and it became obvious that a 172 Cessna was fine for training and local flying, but it wasn't much of a machine to go anyplace. I started shopping for a faster airplane with more range. I found a Bonanza (modestly priced) that had about five hundred hours on it. I bought that and flew it for the next ten years. Anyway, I am getting ahead of my story.

In 1959, the Berkley Company was in deep financial trouble, In an effort to save something out of an impending bankruptcy, Bill Effinger persuaded me to buy the company out of Chapter 11 bankruptcy. In this situation, the buyer puts money into the kitty and it pays off the creditors a certain portion of their indebtedness. I learned at that point that you don't trust lawyers. My deal with the lawyer was that if I could get the company for $40,000.00, I wanted it. If not, I didn't. He took the $40,000.00, and I came home waiting for the deal to go through. A month or so later he called, wanting another $20,000.00. I said , "No deal." He said, "Well you've got to." It seems like he had already spent the $40,000.00. I guess I never will know who got the money, but I did get the company.

All of the Berkley inventory was loaded up and shipped to Fort Smith, and installed in a nearby building that I had built. I put Bill Effinger on salary to run the business. Bill and I got along quite well, and I think that the thing might have worked had I just put it in storage for a couple of years and then gradually picked it up. But I was persuaded that continuity was important, and I found that the wholesalers were so overloaded with Berkley kits that it would be years before the kits were sold and they would be in a position to buy more. After six months I was beginning to suspect that this wasn't going to work, and after nine months I was sure. Effinger found himself another job, and I went about gradually liquidating the kit business (which took several years).

In 1982, I believe, our government passed what was called the Kennedy Round of Tariff Reductions. At this time any foreign model airplane motor coming into this country had a 38% duty attached to it. For this reason, the imported motors were not considered to be serious competition to the domestic manufacturers. Boy, that Kennedy Tariff Reduction changed all of that! Importers blossomed on every street corner. While most of them were not as advanced technically as our motors, they did have a major price advantage. Shortly, every market niche that I could find quickly had a copy, and on many of these copies they corrected our mistakes and had done a little better.

In 1964, business had dwindled to virtually nothing. We weren't selling enough even to pay our overhead. One day I took my assembly lead man aside and told him that it was going to be up to him to run the model engine business the best he could because I had to go out and find a way to earn a living. I started running around the country trying to hustle job shop business.

I got a job from International Harvester, in Memphis, plus two or three local jobs. The buyer at International Harvester introduced me to a 5% type salesman who really did wonders for us. He invited me to his home in Atlanta, where we could become acquainted and talk over the way he operated his business and the way I operated my business. It looked like we had a real good match. In a year he had filled my shop with work, and we continued to grind out military parts for about five years. These were the Vietnam years, if you remember, and the government was buying ammunition and parts like mad, and the pay was really pretty good. The major unpleasant part was that I had to deal with some real bastards.

We did very well in this kind of business, and because of my engineering background, I was able to understand the traps in the military prints, and designed in process gauging that would ensure that when the parts came off the end of the line, they would pass inspection. Also, when you have a part from the military, you are talking about quite a bit of money. Most of the work we did ran in the order of $100,000.00 to $500,000.00. The result was that when the Vietnam war started to wind down, I had quite a bit of newly acquired machinery and plenty of cash, and several very capable production people. There was enough money that I felt it was expedient to try to protect some of it, which I did by trading off my Bonanza for a Baron.

When the military work evaporated, my attention turned back to model airplanes. It appeared that radio control had matured enough that we should consider a new family of motors. A few new schnuerle motors began to appear in the model market. I did not feel that I had a good enough handle on this new porting to design and tool new motors, and I did not have enough time to really become comfortable with it. Consequently, I designed the Eagle I, the Fox .19 and 25 bushing motors, and modified the crankcase for the .36RC. These motors used the conventional single bypass design. The Eagle I was a pretty good market success, and over the next few years we sold about 35,000 of these. The .25 was also a good seller for quite a few years. However, the .19 didn't seem to sell quite so well, even though it really was a strong performer.

About this time in my life I began getting tired quickly. I can remember waking up in bed one morning and telling my wife that if this is what it was like to get old, I am not sure that I wanted to. However, as it turned out, a flight physical picked up my diabetes. I was quite unhappy because I had gone to three different medical doctors to find out why I felt so lousy, and all three in essence said, "You have some sort of a virus, and some of them are pretty rough." For a year or so I tried to diet and control my diabetes in such a way that I could retain my flight physical. However, it was a lost cause. Without insulin I was always cold, always tired, and felt so lousy that I didn't fell like flying the airplane anyway. So, I started on the insulin and sold the airplane.

The day I sold the airplane it was like a funeral around the house, as you can well imagine. It turned out that not only did I have diabetes, but I was beginning to have rather serious heart pains. Shortly afterward, I went to the hospital for a heart bypass operation (then, it was a relatively new surgery). After the heart bypass operation and with a reasonable amount of insulin, I felt great again. So, I got back to the business of trying to build better model airplane motors.

In an effort to buy into schnuerle porting technology quickly, so to speak, I had bought the assets of the Roselle and Fry venture. I had thought that Jack Fry wanted to be in the model engine business so bad that he would put forth the effort to make it work. I financed a small shop where he could pursue his RAF motor. Unfortunately, he just wanted to play, and I could see nothing forthcoming. I called the shop every day in mid morning and mid afternoon for two consecutive weeks, and never once got an answer. Then I knew I had to close down the operation.

I went up there and we loaded the few pieces of equipment and the parts in a trailer and sent them back to Fort Smith. The thing was little bit messy, because Jack had borrowed some money and charged it against the corporation, even though I had set up a bank account. It was specifically stated that he should not be able to borrow money. At any rate, it cost me a few dollars, but we got that unraveled.

By this time, however, I had experimented enough with other brands of schnuerle motors, and saw that it was too late to make any money off the RAF. This was the second time I talked myself into a business deal with someone who was failing. First with Berkley and Effinger, and now with the RAF promotion. I guess the best advice that I could give anybody thinking of going into business is if you can't build it yourself, don't. Very seldom when you buy a business does it go as well as it appears.

When I was running the military parts, I got a good taste of what a really good production line can do. With relatively short runs of model airplane production parts, it seems that one was never able to get the line refined the way you would want it.

I was dreaming of something where I would have a bigger market than the model airplane motors, and a bicycle motor looked like the end of the rainbow. About 1979, I started working on a bicycle motor design in earnest. It took several years, but I eventually came up with a motor that I felt was far superior to anything on the market. It really worked well.

I started trying to sell the bicycle motor in earnest. I learned that the U.S. Department of Transportation was pushing a set of laws labeled the Anti-Moped Laws. While this was not a federal law, it was pushed by the Department of Transportation, and eventually all fifty states passed this law. Basically, the law stated that powered vehicles under 50CC were no longer exempt from licensing or registration laws, and they were required to have a lot of safety equipment. Basically, this said that my primary market, the kids from nine to fourteen years old, could not use our product on the public streets. They would have to be old enough to get an automobile drivers license. Furthermore, even if the bicycle only had a Cox .020 mounted on the handlebar, the bicycle would have to be equipped with turn signals, roll bars, windshield or face shield, lights, and enough other junk so that the thing would probably weigh another fifty pounds.

Obviously, as state after state accepted these laws, my market evaporated. I had borrowed heavily during the development tooling, and furthermore, had not paid any attention to the model airplane motor business. The model airplane motor business had pretty well dried up. It was a hard decision to make to abandon the bicycle motor, but it had to be done.

I tried to start rebuilding the model airplane motor business. After thoroughly mulling over the various possibilities, it was decided to focus on the .40 size motor. The casting tooling for what is now our .40 standard and Delux had been developed several years before as a combat motor. A series of modifications, such as lengthening the crankshaft, altering the exhaust stack to accept a muffler, building a muffler for it, increasing the bore .040 to bring the displacement up to .40, and providing a carburetor for it was a sizeable chore. But not nearly as much as building a totally new motor from scratch. This motor was first introduced as a single ball bearing main motor. After being on the market a short time, it became obvious that the life of the motor could be improved considerably by adding the front ball bearing again as it had been in the earlier combat, and enlarging the wrist pin. These alterations were made and the resultant motor was very much improved. The boring out process worked so well in bringing the . 36 to a .40 that we decided to apply it to the .45 and bring it up to a .50. Increasing the bore on the.45 to bring it up to a .50 seemed to work quite well also.

The Eagle III motor ran very well. However, it took an awful lot of work to machine the split crankcase and to get the deck of both halves the same height. The special screws required to hold the halves together were also a considerable expense. All in all, it did not appear that we could continue to make Eagle III's profitably, so the next step was to refine the Eagle III and provide it with a new set of castings and a larger crankshaft. The Eagle 4 was the result, and it was quite a project because we had to design a totally new motor and build a new casting mold and all new fixtures, which turned out to be more of a project than we had originally envisioned. However, the results were well worthwhile. While there are still some points in the parts production that don't function as smoothly as I would like, we are getting it worked out, and the finished motors come off consistently good, and the assembly is probably the easiest assembly of any of our motors.

Well, that brings us up to date on the first seventy-one years of my life. I doubt that I will see another seventy-one, but it is quite possible that I will see another thirty or forty. Most of my mother's folks lived to be well into their ninety's and my Great Aunt Libby lived to be one hundred thirteen, So, if heredity has anything to do with it, I should be around for quite a few more years.

To all you Fox fans out there, I say, "Enjoy your hobby!

So how did you get the nickname Duke, Mr. Fox"? "

Well, son, it just happens to be my 100% given name". "Oh"! And Duke Fox had politely answered the time-honored question once more. When he died on February 15, 1991, the FOX MANUFACTURING CO. of 530 Towson Ave., Fort Smith, Arkansas 72901 wrote a gentle and loving commentary on his life in their March 15 "Fox Newsletter", noting he had been a major force in the hobby for over 43 years. And he surely had!

Duke's father was in the automobile business and young Fox became quite familiar with cylinders, pistons and how the engines operated. Around the age of nine he encountered his first model airplane ads in "Popular Mechanics" and "Bill Barnes" who started putting a model plane in each issue. Duke was hooked and at the time in 1928 there were no model shops so magazine ordering was it. The Junior Birdmen stirred things up in the San Francisco area with contests every weekend where the Foxes lived. After high school graduation in 1938 Duke went to Modesto Jr. College (Aircraft engineering) and worked for Hughes.

His service years were spent at Wright Field while keeping up his active modeling. While in the service he worked out the design and production drawings for the long shaft Fox .59 spark ignition and after finding a partner (Arnold) who owned shop facilities, managed to put it into production, only to see failure after a few months of production by the partners business troubles. Duke went to work for Douglas while building some 20 experimental engine types in his home wotkshop. Using the Ohlsson 23 for weight and dimensional guides, but wishing a much more powerful engine, Duke brought out his first 35 with production in his Mother's garage. The first 35s were sold successfully and quickly found a "home" with the new control line stunt fellows!

With production increasing he moved his shop/facilities to North Hollywood and there brought out the 29 stunt and 29R, resurrected the 59 as a glow and basking in the success of his engine sales made an exhaustive search for an area suited to his type of business. Thus in 1955 he chose Fort Smith, Arkansas for central distribution, lower production costs and the ease of getting to model meets around the country. From Ft. Smith he began one of the most prolific design and production efforts in the USA, from the 049s to the huge 1.20 twin R/C and the current l5s, 25s, 40s and 60s, some of the most powerful model engines ever manufactured. But Duke avoided the "new" four-stroke field which he left to others. Looking back on his production in earlier years, Duke noted that one of his very best designs was the .07 cid, developed for and sold exclusively to Comet for their ready-to-fly plastic control-line airplanes.

In later years he published some of the most beautiful product catalogs and also had beautiful red, white and blue engine ads to tout his wares, also packed in his "Made in USA" colorful boxes. The Fox "line" was expanded to include his universally used glow plugs and castor oil based fuels (he started a small revolution in the fuel field when he put the formula of the contents on each can). Duke branched briefly into the making of Kart engines and in later years, spinners, motor mounts, shaft extensions, prop reamers, wrenches, taps, silencers, many "U" control products, pressure fittings, fuel line, 'bulbs, filters and all of the highest quality. Most have come and gone from his catalogs over the years.

In the 70's, rumors of Duke's incarceration for child pornography were whispered around the industry but never discussed in "polite circles." Sadly it was true. Afterwards he delved more strongly than ever into his model business and the 80's brought some of his best work..the "Eagle 60" was low cost to compete with the new imports and the all new Fox 60 "Hawk" gussied up with bright red anodized head and prop driver/bearing cover and the power to meet the competition. The huge "78" was the largest US mfg engine at the time. In 1977-78 Duke had begun work on the totally redesigned and massive "Eagle II" 60, while also planning for his first production twin 1.20 R/C two-cycle model engine.

This air-cooled, horizontally-opposed, simultaneous-firing, twin-cylinder, two-stroke cycle with dual shaft rotary-valve induction and Schnuerle scavenging model airplane engine, was manufactured in a single 2000 engine "batch." It came onto the market in the summer of 1980 at $250 retail and was the most powerful two-stroke for sale rated at 3.0 hp, at 14,000 rpms on a 13/6 propellor. It shared most of the big Eagle II features, could pe regarded as two sixties placed back to back, each with its own carburetor and rotary valve and almost with its own crank chamber. Modelers fell all over themselves to be the first to own one in their area. Most unfortunately this powerful engine had two problems right out of the box. First, it had the "old style" Fox carbs which were difficult to master. A few weeks after the introduction Duke Fox replaced the carbs with his new MK.X with conventional barrel throttle. This helped the second problem of the tendency of one cylinder to die but by no means cured the problem. Modelers had "cooled off" on the big twin because of the problems and sales dropped off. Clarence Lee's full page commentary in RCM put it this way..."shortly after release of the engine, fellows began to experience idle and acceleration problems. As is typical of all glow twins, one cylinder would have a tendency to load up and die." Clarence went on to note the time he spent with little success in trying to adjust the carbs and eliminate the problem, and the interesting solution.

In November 1980, Clarence and Duke were at a U-control contest in the Sepulveda Basin, (Calif.) and struck up a conversation regarding the flameout problem of the twin, and Duke noted "they" had found by blocking off the two boost ports this would eliminate the problem with a minimum power loss. Simply put, blocking off the boost ports directly opposite the exhaust stopped the incoming fuel charge from putting out the glow plug. This was accomplished by rotating 1800 the paper gasket that seals the joining surface of the cylinder to the crankcase. But by then the market for large and powerful engines was growing with new four-strokers and "chainsaw" type engines and the twin's potential was lost. And loud...gosh one can't imagine its vroooommmm!

This incredible twin, American made, limited production, and the only genuine Fox ever manufactured, is just now some 15 years off the market, beginning to catch on with multicylinder engine collectors. Peter Chinn, in the July 1980 MAN has a detailed (as only he could) article on the Fox twin, but treads lightly on the "problems."

In the 1980s Duke Fox began to write a series of advertisements come commentaries called "Duke's Mixture" in MAN and his expertise resulted in two definitive articles of the dozen or so he wrote. In his August, 1989, on model engine fuels, (methanol, nitromethane, temperature ranges, castor oil, and percentages of mixture) he wrote the best information ever published. In a previous column, in June, 1988 also in MAN he wrote on "the merits of ball bearings, vs bronze bushings, vs aluminum for crankshaft main bearings and also on the relative merits of lapped-ring and ABC piston/cylinder combinations"...a genuine treatise. I quote his last paragraph which more than any comments I have found, sum up the Duke Fox lifetime of work.

"Our Fox 19BB, 40BB and 50BB are our top line motors. Materials used are top quality and the best we have found for the purpose. All cylinders and bearing surfaces have been hand fitted for optimum clearance. All_motors have been test run at full power and all needle valves have been adjusted to normal operating adjustment. We pay less attention to cosmetics than our competitors, but nobody takes the care we do to insure that your motor will start readily, run right, and fly your airplane with authority. Buy one-you will be happy that you did"!

A SHORT HISTORY OF THE FOX COMBAT SPECIALS AND OTHER CLOSELY RELATED ENGINES

(as I see it)
by
Bill Ives

1957

It all began in 1957 when Duke Fox introduced the new Fox .35 Combat Special. It had the new crankcase with four srew rear cover, round intake with removable insert, new spade type NVA, plain aluminum head, bushing main bearings, with hole rear of crankcase for wristpin removal. "Fox .35" on the bypass.

1958

In 1958 Duke Fox figured a way to get more power from the combat special. He improved the intake port timing, he improved the piston and baffle, and he painted the cylinder head black so that you could tell the difference from the first combat special since they both look the same except for the above mentioned changes. Also, in 1958 Fox introduced the new .29X Racing Engine. It looks just like the black head .35 except it has a new style cylinder head with machined fins and is aluminum color. This engine has only "Fox" and a circle on the bypass and has a bore of .738.

1959

In 1959 Duke Fox introduced a "low price series" of engines and called these engines "Rockets". The first model Fox .35 "Rocket" had a red head and the name "Rocket" and a rocket design on the bypass. The intake venturi was made smaller than the previous combat engines and it did not have a removable insert. Aside from these minor changes, it looks like the first and second Combat Specials.

1960

In 1960 the new Fox .35 Combat Special Series III was introduced. It had a new two-piece crankcase with detachable front housing held on by four screws, it has twin needle bearings on the crankshaft, a new square intake without insert and a pressure fitting in the four screw rear cover. It also said "Rocket" on the bypass and had the wristpin hole in the rear crankcase. It also had a large "picture window" intake port in the cylinder liner. In 1960 Fox started using the same Series III crankcase casting for the "Rocket" .35 so now the crankcase on the second type Red Head "Rocket" .35 has four lugs on the front of the crankcase, otherwise, the second type Red Head "Rocket" .35 looks the same as

the first type "Rocket" .35.
The Series III Combat Special was also made with a rocket on the bypass end no wristpin hole in the crankcase rear.

1961

In 1961 Fox introduced the new Fox .40 Rat Race engine, 1st type. It used the same crankcase as the 2nd type .35 Red Head "Rocket" with a rocket on the bypass and four lugs on the crankcase front. It had a larger intake with insert, boss for pressure fitting on the rear cover. It had the same .800" bore as the .35 engines, but it had a longer stroke. The .35 engines have a .700" stroke and the .40 has a .790" stroke which means the cylinder liner on the .40 is .090" longer than the .35 liner. Thus the .40 engine has a .090" gap between the head and the cylinder top fin and it has the wristpin hole in the rear of the crankcase. The Fox .40 R/C engine was also introduced in 1961.

1962

1962 was a banner year for Duke Fox. He introduced several new engines and made several changes in the old engines.
First the changes - by making the crankpin shorter and the con rod big and slightly narrower it was now possible to remove the rear cover and slip the con rod off the crankpin and remove the piston and con rod as a unit. No longer was it necessary to try and fish the wrist pin out thru the hole in the rear of the crankcase, which was sometimes impossible if the wrist pin was badly gummed up. Now the smaller round hole in the crankcase was no longer needed.
The crankcase was redesigned, the name "Rocket" was no longer used on the bypass, and the beam mounting lugs were made wider by 3/16". Lateral mounting space was increased from 1 1/2" to 1 5/8". The above changes were made to the Series III Combat Special, the 3rd type "Rocket" .35 and both .40 Rat Race and .40 R/C engines.
The new improved 1962 "Rocket" .35 3rd type no longer has a "red head", it is now plain aluminum. It now has a larger intake venturi with removable insert, no "Rocket" on the bypass, no hole in the rear, and wider beam mounts.
Now for the "ALL New" 1962 engines. The New Fox .40BB Rat Race engine has a new golden color crankcase and head. The new crankcaseis of one-piece design with a square intake like the Series III Combat engine. It has one ball bearing on the rear and one needle bearing on the front of the crankshaft, and no reinforcing webs on the crankcase front. It has no insert in the intake and has a pressure fitting in the rear cover. It has a decal on the bypass that says Fox 40 BB Rat Race. The stroke on the .40 is still .790", and a four screw rear cover.
The .29X Racing engine now looks just like the Series III Combat Special but it only has a .738" bore and Fox only on the bypass. The ALL New .35 "Blue Ribbon" engine was introduced in the fall of 1962.
The new .35 "Blue Ribbon" engine used the same crankcase as the .40BB Rat Race engine but it was not gold color, it was plain aluminum. It used two needle bearings on the crankshaft main, a square intake with insert, no pressure fitting, no webs on the front, "Fox .35" on the bypass, and no hole in the crankcase rear.

1963

In 1963 the .35 "Blue Ribbon" engine was improved and had a name change. It is now called the Fox .35X and looks the same as the old .35 "Blue Ribbon" engine except it now has three webs added to the crankcase nose for strength. It has only one needle bearing main and one bushing on the front. The .35X proved to be such a successful combat engine that the Fox .35 Series III Combat Special was discontinued. Both the Fox .40BB Golden Rat Race engine and the .29X Race Engine stayed the same as they had been since 1962.

<u>1964</u>

In 1964 the Fox .40 Rat Race engine was improved. It now has a new stronger crankshaft and a new stronger solid wrist pin with brass end pads. Combat flyers using the .35X had been blowing up the engine by trying to get too much extra power out of it. They asked Duke Fox to strengthen the crankshaft and conrod. While Duke was redesigning a new stronger crankshaft he decided that, since the combat rules allowed competitors to use up to a .36 size engine, he would increase the size of the . 35X to ..36 cubic inch engines for maximum displacement. He increased the stroke to .715" and called the new engine a Fox .36X. It looked just like the .35X except it now has a bulge at the top of the bypass and has Fox .36X on the bypass. The 1964 Fox .36X had the same head and center plug as the . 35X.

<u>1965</u>

There were more new engines and changes in 1965. The Fox .36X has a new head with an angled plug. A new custom fitted for combat engine is produced, the Fox .36X BB.

The .36X BB looked just like the plain .36X except the outside crankcase was polished, it has a single ball bearing main, no insert in the venturi, a pressure fitting in the back cover, and a wider milled exhaust port. It still has "Fox .36X" on the bypass.

A new racing engine was introduced - the new Fox .29X BB Rear Rotor Race Engine. The engine has a twin ball bearing main and an adjustable rear rotor intake, a new head with a groove around it and a center glow plug. It only has "Fox" on the bypass and webs on the crankcase front.

Fox .40 BB Rat Race remains the same.

<u>1966</u>

The Fox .40BB for 1966 has a new big 19/32" crankshaft, otherwise, it is the same.

<u>1967</u>

All the Fox engines remained the same, nothing was added.

<u>1968</u>

A new .29X racing engine was introduced in 1968. It had a new front rotary valve intake, single needle bearing main, a crankcase like the .36X, a head like the old .29X BB, an insert in the venturi, and "Fox" only on the bypass.

<u>1969-1970</u>

Nothing new was added. No changes were made.

<u>1971</u>

For 1971 the Fox .36X now has a web in the exhaust stack. An all new Fox .40 Stunt Engine was introduced. It was a big, massive, round intake engine with a four screw rear cover, new NVA, "Fox" on the bypass, and a center plug.

<u>1972-1973</u>

Nothing new.

<u>1974</u>

Fox had been experimenting with a new design combat engine. In 1974 Duke Fox released the all new schneurle ported combat engine, the so called Mark 1 Combat Special. It looked something like the old .36X BB but yet it was different. It had a solid finless cylinder head with an angled plug, new shorter front crankcase housing with twin ball bearings on the crankshaft, four screw rear cover, big massive NVA with insert in the venturi, "Fox .36X" on the left bypass, and a web in the exhaust stack.

1975

The 1975 .36X schneurle combat engine is called the Mark II. It differs very little from the Mark 1 Combat Special, yet it does not have the web in the exhaust stack. It has an all new NVA which was designed to hold the pressure of a bladder fuel tank for fast combat. A suction type NVA and insert also came with the engine for use in slow combat. The pressure type NVA has an angled intake pipe and it has a two piece needle valve assy. "Fox .36X" is on the bypass, polished case, redesigned thrust washer.

1976

In 1976 Fox introduced the first "Tall Back Door" schneurle ported combat special and called it the Mark III. The Mark III Combat Special is completely redesigned. It has an all new crankcase of dull finish with a six screw tall back door for ease of machining. It has a new small exhaust stack and opening, an all new button head with finned polished clamp, center plug, twin ball bearing main, square slanted intake with a pressure type NVA. A suction NVA and insert was also supplied with the engine. It has "Fox Combat Special" on the left bypass.

1977-1979

Nothing new.

1980

From 1976 to 1980 slow combat was gaining in popularity. Competitors found that the Fox Mark III combat engine did not perform well when used with the suction NVA and insert for slow combat. Duke Fox designed a new, tall, square intake stack with two needle valve locations available. The lower position for pressure for use in fast combat with no insert, and the upper position for use in slow combat with suction NVA and the insert. At the same time he designed a new thrust washer so that it would cover the front ball nearing beter and keep dirt off the bearing. He anodized the thrust washer a nice bright red color so that you will not lose it in the green grass (Just Kidding). He decided not to polish the cylinder head but he still put "Fox Combat Special" on the left bypass. He called this engine the Mark IV Combat Special. Now both fast and slow combat flyers had a super performing engine.

1981-1982

Nothing new.

1983

In 1983 Fox released the Mark V Compact Engine. The engine was designed for the noncompetitive sport flyer. It has most of the features of the Mark IV Combat Special except it only has a single ball bearing main and is drilled and tapped for a muffler. It also has the button head with clamp. It does not have any markings on the left bypass or anywhere on the engine. It is schneurle ported and is known as the Fox .36BB Control Line Engine.

1986

From 1980 to 1986 the Fox Mark IV Combat Special was the king of both slow and fast. In 1986 Duke Fox decided the combat flyers of the world needed a new engine so he introduced the all New Mark VI Combat Special. It used the ABC piston and cylinder setup plus a slightly longer nose with twin ball bearings. The diameter of the crank was increased to .590 and it used a 7/32 diameter tubular wrist pin retainer. The intake stack is now cut at a nice angle nut still has the holes for high and low needle valve locations. It has a new pressure type NVA, the thrust washer is a nice polished aluminum color, the finned head clamp is also polished, the exhaust stack has two bosses that are drilled and tapped for a muffler. If the front threaded portion of the crankshaft is damaged, it can be replaced by unscrewing it from the crankshaft and installing a new threaded stub only. The left bypass has a long vertical flat area with the name "Fox" and the letter "C" stamped into it.

Dukes Mixture

In case you don't know how to determine the optimum nitro content for your motor—here is how it is done.

Fill the tank with the fuel to be tested. Start your motor and run it up at full throttle at your take-off mixture setting. After 15 seconds warm-up, touch the plug with your battery lead. If the motor slows down, reduce the nitro content. If it remains the same, or speeds up a couple of hundred RPM, you are at optimum. If it speeds up quite a bit, you need more nitro. After the test, check to see if your plug is still good. If the plug is burned out, re-do the test. Your goal is a fuel that speeds up only a trace with additional glow plug heat.

This month's discussion will be on the relative merits of ball bearings vs bronze bushings vs cast aluminum for crankshaft main bearings; and also on the relative merits of lapped - ring - and A.B.C piston cylinder combinations.

First; on crankshaft bearings: Just about everyone in the trade acknowledges that two ball bearings are the most desirable. The advantages of the two ball bearing crankshaft are as follows: low initial friction, which in turn makes starting easy and no break-in requirements. Other advantages of double ball bearings are that the wear and consequent resulting shift of the crank position is virtually non existent in a ball bearing motor, and that the thrust from a starter doesn't cause wear on the front of the case. If it were not for the cost, I think that all model airplane engines would have two ball bearings on the main. However, this is not to say that a bushing main motor cannot be mode to run very well. The simplest form of bearing is for the crankshaft to run in the cast aluminum. This is done with fair success in our low priced .15 RC, and with the low priced K&B motors. This is simple and cheap. However, when the shaft runs in aluminum, it is imperative for it to be well lubricated. And therein, often, is a problem. If you make the fit a little too tight, and the fuel doesn't work its way out around the front, the bearing goes dry. At the best the motor slows down when you try to lean it out. At the worst, the crankshaft can gall and pick up metal, and ruin the crankcase. Also, assuming the motor does get a good start in life, it does wear. As it wears, you get more and more leakage out the front. A badly worn bushing can spray as much fuel out the front as it burns. Of course, this means that instead of flying 12 or 13 minutes on 8 oz. of fuel, you are out in 6 or 7 minutes. Also, carburetors don't work right when a bearing leaks badly, and a reliable idle becomes unreliable. The use of the hypereutectic alloys for main bearings reduce wear somewhat. But, in my opinion, it only alters it slightly.

Now, let's consider bronze bushiness. True bronze is mostly copper with small amounts of alloying agents. #660 is the most widely used and works well. This has the advantage over aluminum in that should the shaft run dry. or when a little dirt gets in it, the galling does not occur like it would with aluminum. The manufacturer can then be less fearful of a dry bearing and fit it closer than he would an aluminum one. Result - Improved fuel mileage and better carburetion. While it is generally considered that the piston and cylinder present the primary break-in problem, this is not necessarily so. Bushing type motors do have the requirement of wearing in and polishing both the crankshaft and the main bearing surface. If the bearing is not honed just right and the crank is not real round, it is quite possible to never get a really free running bearing. Some motors have appeared on the market which had rather yellow looking bearings, which signify high zinc content. These don't seem to work well at all. They tend to deform under the pressure of running, and the bearing gets loose. True bronze has a dark reddish copper looking surface, and not the bright yellow that you associate with brass.

At this point I would also say that many manufacturers, including me, have at one time along the line tried the use of powdered metal type bearings. This type of bearing works poorly in model motors, presumably because the pores allow the oil filn, which the shaft should ride on, to be pushed through the pores. Consequently, instead of floating on a wedge of oil, the crank actually rubs metal to metal. Powdered metal bearings will invariably wear the crank out much faster than a solid bronze bushing. The powdered metal bearings are cheaper.

Whether they are better than the cast aluminum in my mind is questionable. The cast aluminum bearing does hold the oil wedge and the crankshaft will spin freer than it will in a powdered metal bushing. But, the steel crank against aluminum is vulnerable to wear and is very vulnerable to galling if a speck of dirt gets in the bearing or it runs dry.

Now, to the connecting rod. Connecting rods usually fail differently on the bottom end than on the top end. The bottom end is well cooled with the incoming fuel spray and is well lubricated. But the crankpin rotation plus its small size gives a pretty fair load rating, much higher than on a crankshaft. The unit load rating on a crankpin might be ten times as high as on a crank main. Connecting rods lower end are sometimes run on the rod material, and sometimes bushed. And, in rare cases, as in our old 60 and 74. and larger chain saw motors, have needle bearings.

Aluminum rod material seems to run pretty satisfactorily on smaller size engines. In 19's and 25's, you can usually run aluminum with no problem and have the rod last as long as the rest of the motor. A bar stock connecting rod made from one of the stronger bar stack grades of aluminum has pretty fair bearine antifriction qualities, and works well on the pin. When you get into larger size motors, such as 40's and larger, the wear rate on the connecting rod sometimes becomes unacceptable. In this case, most manufacturers have resorted to a bushing.· However, in my opinion, a poor bushing is worse than none at all. Certain imported motors have brass rod bushings, which, of course, last a very short time. Some rods have used the powdered bronze type bearing, but due to the abrasive nature of the bushing, the wear on the pin is very fast. In short order, the crankpin itself is worn out, even though it is hardened very hard. #660 bronze is a good grade general purpose bronze and is sometimes used with very good successes. However, the best material we have found is phosphor bronze material. Phosphor bronze is quite expensive costing several times that of #660, but it is dense and very high strength, and has all the good characteristics of bearing bronze.

Now to the top side of the rod. The top side of a rod is not subjected to the high rotational speeds that the bottom is, since it only oscillates. However the lubrication conditions are much worse. The area is a whole lot hotter, and there is relatively small amount of fuel spray up in this area, and traditionally the size of the wrist pin is smaller than the crankpin. This is basically in an effort to keep the reciprocating parts light. However, the strain on a rod is considerable, especially in A.B.C set-ups when the piston sometimes sticks. In a bad warm-up situation loads can be high enough to pull the rod apart. In our experience, there is about an even choice whether we bush the top end of the con rod and increase its antifriction characteristics, or whether we leave the additional metal around to increase the tension load that a rod can take in the case of a piston sticking. The choice seems to be dictated mostly by the type of failures that we have had, although I will have to admit that we do sometimes put a bushing in where it is not needed because people think that it means quality.

Now, to the piston and cylinder. For years the most popular model airplane piston materials were iron in its various forms, (gray cast, ductile, and Mehanite). The advantage of an iron piston is its low expansion, its dimensional stability. and the fact that it does not soften noticeably with the heat reached in model engines. The primary disadvantage is its weight, which is about 3 times as much per cubic inch as aluminum. This is somewhat offset by the fact that iron does have a higher modulus of elasticity than aluminum, and it is possible to make an iron piston that's thinner than an aluminum one and still maintain its shape. Iron pistons are usually run in soft steel liners. Most of the model engines in the past 50 years have been built in this combination. The iron can be fit very closely in the steel liner. The expansion co-efficient of both are about the same, and should the parts rub too hard, the iron tends to burnish and not gall. To the user, an iron piston/steel liner motor has a freeness and a snap-over compression not readily achieved with any other combination. The primary disadvantage of the iron piston and the soft steel liner is that as you get into larger and larger out-put motors, it becomes more and more difficult to keep the expansion of the cylinder liner and piston matched. At one time we produced the 59 with an iron piston and steel liner, but today our 40 Standard is the largest that we feel is practical.

The second, very popular, piston and cylinder combination is the use of a hardened steel liner and an aluminum piston fitted with 1 or 2 piston rings. A lot of motors of yesteryear used this combination. The McCoy and the Hornet were outstandingly successful. This combination worked very well and had a light piston which was relatively vibration free. However, the success of this combination depends on having a quality piston ring. Unfortunately, only one piston ring company seemed capable of producing an acceptable quality ring, and when they were swallowed by a conglomerate, quality model size rings became unavailable. K&B solved their problem by developing the Dykes ring to an acceptable quality. We solved our problem by developing a new method of shaping conventional design piston rings. Licensing of this patent is now available to interested ring manufacturers. The primary advantages of a steel liner-ring piston motor is its ability to accept abuse - over lean runs, dirt, no warm up. etc.. and the fact that it can be flown out of the box without fear of damaging it or seizing the piston. About the only disadvantage is that the cylinder webs reduce the power output slightly over the other two types.

Now, to A.B.C. or A.A.C. type cylinder/piston combinations. A.B.C is an abbreviation for Aluminum (piston) Brass (Liner) Chrome (plated). The problem of getting a good piston ring was probably a substantial cause for the increased popularity of the so called A.B.C type piston anti cylinder combinations. This amounts to an aluminum piston with no rings, but cast out of one of the modern high silicon, low expansion aluminums which is fitted into a brass liner which has been chrome plated. The chrome plating produces a hard wearing surface to keep the cylinder liner from wearing out. An aluminum piston ran in a brass liner with no plating would be completely worn out in 10 or I5 minutes. However, hard chrome is expensive, difficult to apply evenly, and almost impossible to hone once its on. In order to make a very small shape anti surface improvements, we had to resort to diamond and borizon honing stones to make a few tenths corrections in our A.B.C. lines when they come back from plating. Now not everybody claiming an A.B.C cylinder really has hard chrome on it. Some cylinders have used polished chrome, like that put on auautomobile bumpers. This is much softer and can be honed. but also it wears out quicker. It is cheaper however. AIso, there have been same cases, where manufacturers have used electroplated nickel or electroless nickel. Nickel, compared to chrome, is very soft. Furthermore, nickel has more adhesion problems to the base metal.

Our advice is to stay away from cylinders that are nickel or polished chrome plated. For an A.B.C cylinder and piston to work right, a cylinder should be either a low expansion aluminum of the #390 alloy variety, or brass, and should be hard chrome plated. The piston must be one of the high silicon types, the most usual being the #390 series. The advantage of the A.B.C is that when it is properly fitted, the motor will run slightly faster than the ring motor, primarily because the webs in the cylinder which retain the rings on the ring motor can be removed and leaves a little more porting area. The disadvantages are first, one of cost, and second, that the motor must be handled mare carefully than a ring motor. The warm up period, particularly, is vulnerably. If an A.B.C motor that is cold and still relatively new is started and run at full power immediately, the piston heats up faster than the cylinder and, consequently, expands faster. It is not unusual for the piston to stick in the top of the cylinder with such force that the inertia pulls the rod apart. However, an A.B.C that is carefully handled and is operated properly will last a very Iong time and runs very smooth.

Our Fox 19BB. 40BB. and 50BB are our tap of the line motors. Materials used are top quality and .the best grade we have found for the purpose. All cylinders and bearing surfaces have been hand fitted for optimum clearance. All motors have been test run at full power and the needle valves have been adjusted to a normal operating adjustment. We pay less attention to cosmetics than our competitors but nobody takes the care we do to insure that your motor will start ready, run right, and fly your airplane with authority. Buy one—you will be happy that you did.

Not everything we are told is so: For example: We are often told "It is motor torque, and gyroscopic action, that causes an aircraft to want to turn lift when power is applied."

I suspected these forces were insignificant, and that the spiral propwash pushing on the rudder was the over-riding force at play - so I devised a little test. Take a North Pacific type rubber model. Assemble, and fly. It will fly in lift turn circles. Now cement the stab in with CA. and then extend the rudder slot from top to bottom. Put the rudder on facing down. It will fly in right turn circles. Replace the rudder with a longer parallel sheet that you can slide up or down, and you will be able to find a position where the top forces and bottom forces are balanced, and the model will fly straight. Conclusion—the "authorities" were just plain wrong·

A second popular belief that just isn't so: "Reducing the crankcase volume of a 2 cycle model airplane motor will improve its power." My observations didn't jibe with this theory. so I devised a test. I fitted all unported cylinder and piston into a rear cover so I could pull the piston in or out while the motor was running, thus varying the crankcase volume. Result: A very slight increase in R.P.M. as the crankcase volume was increased. This I didn't expect, so the test was repeated with several other Fox motors - and a couple if brand X motors. In every case maximum R.P.M. was achieved with somewhat greater case volume than stock. Conclusion: The "authorities" on hopping up a motor were just plain wrong.

Take off hesitation can be eliminated and acceleration out of a turn can be improved by simply re-routing your fuel line. No Bull—it really works. This applies to standard tank without pump set-ups. What you do is route your motor's fuel line around the right side of the motor, over the front bearing housing in front of the carburetor, and back, then loop· it up to the fuel nipple. The reason that it works is that during acceleration the fuel wants to move back, creating a pressure reduction or total cavitation at the jet in the usual set-ups. By routing the fuel line around the front of the carburetor, the fuel to the left of the foremost point is pushed toward the carburetor, not toward the tank. It is the small amount of fuel in this section of fuel line that keeps feeding the motor for the two or three seconds of severe acceleration.

You can drive your car anywhere in our country and fill up your gas tank with any brand fuel, and reasonably expect it to perform about the same as any other brand.

This is because gasoline refining companies have voluntarily established standards on viscosity, flash point, octane, etc., so that just about any automobile produced will run okay on various manufacturers' fuel.

Unfortunately. this is not true in the model airplane business. Commercial model fuels are sold with a variety of types and quantities if oils, and some measure nitro by weight, some by volume, and some don't seem to measure it at all. The reluctance if a fuel blender to put his ingredients on the can makes me a bit suspicious that he is trying to hide something - or, perhaps, the absence if something.· I would like to see each blender fuel to voluntarily print on his container just what the ingredients are in his fuel so the modeler know what he is getting. Also, I would like to see the quantities if each ingredient listed by volume.

All model plane fuel uses commercial methanol as its base. It is commonly known as wood alcohol because it was first produced from wood chips. Now, most if it is produced from natural gas, I am told. In any event, methanol, when bought in tank car quantities, is quite reasonable in cost. It is not the alcohol that runs up the cost if model airplane Fuel, it is what you put in it and put it in. While alcohol costs less than $1.00 a gallon, a good oil costs $6.00 to $8.00 a gallon, and nitromethane costs $30.00 to $35.00 a gallon when purchased in quantities. Under the pressure if competitive pricing, any Fuel blender is constantly tempted to use less and less if the high priced ingredients and more and more if the low priced ingredients.

Now, about the ingredients themselves. Methanol is a single chemical, and not a mixture, as gasoline is. The manufacturing plants deliver it 99.9% pure, or better.

About the only thing that can happen to the methanol is if it is sloppily handled, it can be contaminated with water. It only takes a Jew drops if water in a gallon if fuel to produce noticeable flameout tendencies. Likewise, nitromethane is a nearly pure product, and is sold in one grade only. You should note that nitro content by weight will be in the order if 2/3 the quantity as when nitro content is measured by volume. A modern R.C. motor if a 40 size class requires about 22% oil to be well lubricated and to have a good, long life. Larger motors need less oil, percentage wise, than small ones. The reason being that as the size if the motor increases, the displacement goes up as the cube, while the area to be lubricated goes up as the square. Thus, a motor with a 1 1/2" bore would be as well lubricated on a 10% oil mix as one with a 3/4" bore would be with a 20% oil mix. Unfortunately, some manufacturers have been delivering fuel with as little as 12% and 13% oil, and recommending it for 40 size motors. The result if extended use if such a Fuel is as you would expect, an abnormal rate if wear in the motor, and on rare occasions, a catastrophic failure.

Over the years a great many different oils have been used in the search for something that works better and costs less than castor oil. The most usual if these are the glycol r\type synthetic lubricants. The glycols have good lubrication qualities, but they have one major shortcoming, and that is that they vaporize at somewhere around 500° F to 550° F. Lawn mowers, outboard motors, and the like are never run hard enough so that this is if any significance.

But a model airplane motor that is run hard could have a piston and wrist pin temperature in a 700° F range, and because if this, the motor using pure poly-aIcaglycol lubricant is almost certain to have catastrophic ring, wrist pin, and upper rod failure. Castor oil is the only oil I know if that will continue to Junction at 800° E Synthetic oils if the phosphate ester type also have this shortcoming.

Other oils that have been used are soybean oil, fish oil, and modified mineral oils, such as turbine oil. I am sure that there are dozens if other oils that different Fuel blenders have tried, and some are using. I would like to point out that lubrication is not the only requirement if the oil. The rusting if the steel parts, such as crankshafts and bearings, is also a consideration. Motors that were run 30 and 40 years ago on a straight castor oil, alcohol, nitromethane mix show little rust. Some motors that have come back for repair have the bearings rusted until they are ruined. I have to believe that this was caused by some sort if a breakdown in some if the synthetic oils or additives used.

Over the years there have been a lot if different additives used in model airplane Fuels. Propylene oxide mixes well in Fuel, and it only takes 2% or 3% propylene oxide to very materially improve the idling characteristics if a motor. However, the government has determined that propylene oxide is a carcinogen (cancer causing agent).

Any blender who now uses propylene oxide is laying himself open to all sorts if lawsuits. Nitroethane is a sister chemical to nitromethane, and while it is not as effective a power additive as nitromethane is, it is very oily, and a very excellent solvent. Nitroethane is a very useful fuel ingredient for motors with an aluminum piston, because it keeps the inside if the motor nice and clean, as well as providing additional lubrication. A motor with an iron piston should not use a Fuel containing nitroethane or synthetic oils because they tend to wash away the glaze castor oil puts on these surfaces, giving their long wearing characteristics.

In summary, what I am saying is that I would like to see all the Fuel manufacturers list the nitro content by volume, give the oil amount and type in percentages by volume, and identify any other additives used. Smaller motors need larger percentages if oil than large ones.

Good, middle if the road figures would be 22% for 40 size and under, 18% for 60 size, and less for larger motors. In order to understand the importance of a good oil in model airplane Fuel, I would like to report a conversation I had with a research engineer with one if the large oil companies. He said that an automobile engine that would normally run 100,000 miles on conventional gasoline would do well to run 2,000 or 3,000 miles on pure methanol because methanol had no lubrication value whatever. The challenge in exploring alcohol based Fuels for automobiles was to bring up the lubrication value if the alcohol to match gasoline, and it appeared that this could not be done economically. The oil in your Fuel is probably the most important factor in how long your model motor serves you.

Happy Flying,

The words "It went lean on me" has to be one if the most used, least understood phrases in modeling today. It seems that any time a model motor loses power, the accusation is "it went lean on me." There are several reasons why a motor could slow down and, possibly, quit. A properly broken-in model motor, running on the right fuel and plug, and properly cooled, does not sag and heat up when the fuel level is dropped too far or the needle is tweaked in too far. What should happen is that the motor just slows very slightly and then quits firing. In the cases when the motor sags down and cooks, there are three probable causes: (1) the crankshaft bearings are not getting enough cooling fuel and heat up and start dragging, (2) the cylinder and piston don't have enough clearance and start binding, or (3) (and the most usual cause if all) is that the motor starts pre-igniting.

When the motor is leaned in and makes more power, it also makes more heat. When it makes more heat, the plug element gets hotter and the ignition starts occurring sooner. if the motor has a little extra heat added because if being new and creating friction, or because the weather is hot, or because the fuel has too much nitro, or because the glow plug retains too much heat, the motor can come up to a critical point at which the ignition starts too soon, and with the over-advanced ignition, the combustion pressure presses the piston down on part if the up stroke, and this in turn generates more friction and more heat, which again further aggravates the pre-ignition problem. Most model motors are set up so that they will run very close to the pre-ignition point, because that is the way that we get the most power. Once a motor goes over the power peak, the only way to get it back is to throttle back and cool it off. Remember, if you start to lean your motor in to get maximum power, and as the motor warms up it seems to slow down, you are suffering from pre-ignition. A slight bit if pre-ignition on a dead lean setting may not be too bad because that is the way you usually get the most power out if your motor. However, if there is much sagging at a dead lean setting, then you are giving away too much if the rich lean tolerance if the motor and something should be done.

Switching to a cooler running plug helps. Reducing the nitro in your fuel can make a lot if difference. Adding a little more oil to your fuel can help some. And if all if these put together in reasonable quantities isn't enough, then reducing the compression ratio is in order.

Unfortunately, we see a lot if cases of preignition these days. One of the reasons is that nitro is not as expensive as it was a few years back, and people, thinking that more nitro means more power, will order the more expensive fuel. It is not a bad idea to carry around a can if FAI type fuel (4 parts straight alcohol, 1 part straight castor). The next time you or one of your flying buddies experiencs a "leaning out" tendency, try cutting your fuel with the FAI mixture and see if it doesn't help.

Vale Fox

When writing of departed friends or companies, the late Ron Chernich (Australia, editor of Model Engine News) often titled his articles "Vale....". I finally looked this up and found besides "hill and vale", Vale (pronounced va' le *ed.*) means "farewell". Its use is not all that common now and indeed, it doesn't seem to be listed in the latest dictionaries. But now you know how I am using it, I bring you this sad report:

From a Stunt Hanger thread dated Feb. 4, 2014 came this letter from Fox Mfg written earlier in 2014:

"In these tough economic times Fox has had to retrench and focus our limited number of employees on the outside jobs that provide a profit. With the price of motors driven by the Chinese imports, Fox engine profitability is limited. At this time we don't have the ability to dedicate staff to our
Fox engine department. When the economy improves and outside jobs increase, we'll be able to resume engine production.

Thanks for your support,
Fox Mfg"

There had been rumors of Fox leaving the engine business in late 2013, but this really confirmed things. December 4, 2013, I spoke to Sharon at Fox and bought the last Fox 40 Stunt in the shop. At that time she said no engines were being produced. Fox had advertised a booth at this year's Toledo RC show, but never came to open it. This was the first time since 1967 when I started going to Toledo that Fox was absent. Then, September 4 this year (2014) I thought I would buy one of the newest 2 NV throttles. Sharon said they were all gone. I asked if there were any engines in the building; she said no engines of any size or type were left.

And so after 67 years, Fox engines disappear with a whimper, not a bang.

Their factory is still open and making contract jobs that fit the capabilities of their equipment. In fact for years, this has been their major business. Model engines were really a minor line, but they stayed with them. It would be wonderful if they made engines once again, but realistically does any market remain? Their RC engines haven't been popular, control line combat, Duke's first love, is flown by very few, and precision aerobatic (stunt) fliers shun the old Stunt 35 and use foreign .25s and custom made .61s. Of course these situations refer to those still using internal combustion engines; the use of electric motors grows every day further reducing any potential market for IC engines.

For those new to our great hobby, a brief look at Fox follows. A project to catalog and picture the various Foxes led to identifying 306 engine designs produced from 1947-2006. This project was carried in eight issues of the Engine Collectors Journal, #s 161, 162, 163, 164, 170, 172, 174, and 175. (Tim Dannels may still have these back issues available. www.modelenginecollecting.com).

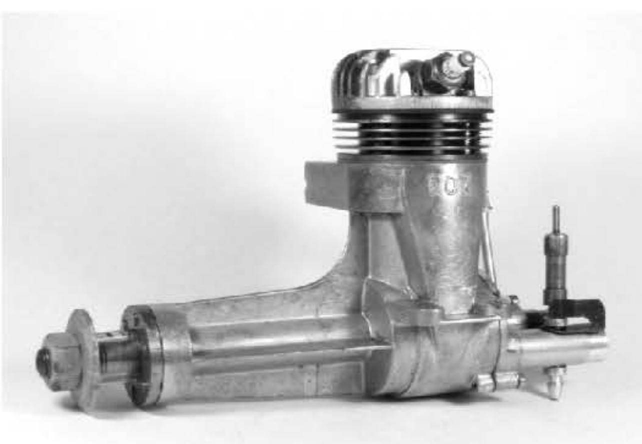
Duke Fox

Only some of the more significant engines are shown here. As a side note, Duke Fox was very particular about naming some things. His products were "Motors", not engines. They could be quieted by using "Silencers", not mufflers. And his marine engines were "Boat Motors".

The Fox .59

In the August 1947 Model Airplane News, a brand new engine was advertised by the Claude C. Slate Company, the Fox .59. This was Duke Fox's first design and as he had no factory at the time, Claude Slate built and sold the .59. The engine was very light and very powerful and ran on spark plug ignition; the glow plug wasn't around when the .59 was designed before WWII. We collectors call this engine the .59 Longshaft and it is highly desired.

1st ad for the Fox 59



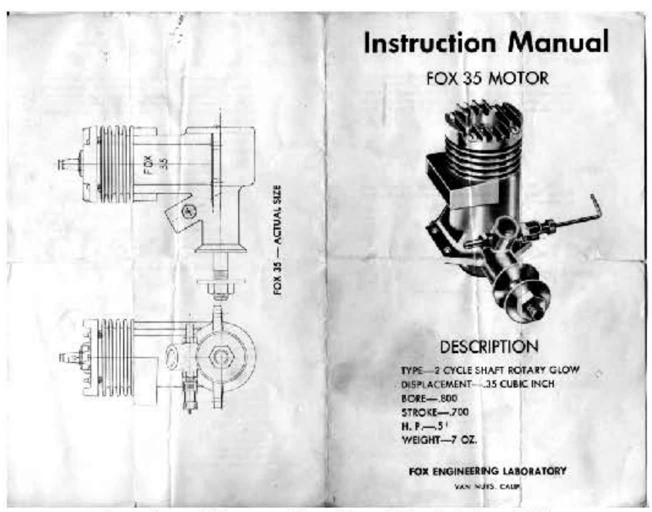
Fox .59 Longshaft

The Glow Plug

Ray Arden commercially introduced the glow plug in November of 1947.

Nov. 1947- 1st ad for the Arden Glow Plug

Fox designed a light, compact, and powerful glow engine engine for control line fliers in 1948; the legendary Fox 35. Control line was becoming more and more popular and stunt fliers eventually adopted this engine, later called the 35 Stunt. I think this was the first engine on the market designed from the start as a glow plug engine. Duke Fox built the first 35s in his mother's garage or basement and distributed them by word of mouth. At that time he was the "Fox Engineering Laboratory"



Instructions for the first Fox 35

The first Fox 35

Fox realized he wasn't a machinist and teamed up with Dale Arnold to form the "Arnold and Fox Engineering Co." first advertising the "Superpower Fox 35" in November of 1949.

The first Arnold and Fox ad Aug. 1949 MAN

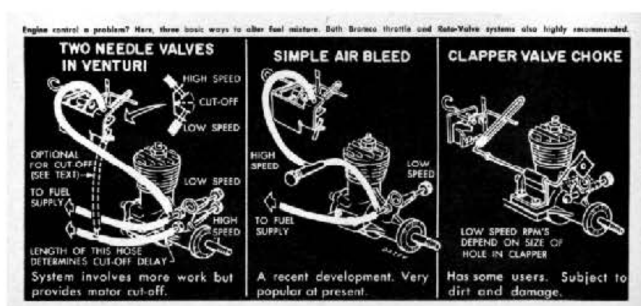
The 35 was continuously modified over the years with the 60th anniversary engine marketed in 2008; this was the last Stunt 35. Most internal parts are interchangeable with the original engine!

The last Stunt 35

In 1953 Fox marketed the "Split case" 19; so called for its 2 piece case. The case was very weak, breaking under the exhaust stack in a crash. Fox asked owners to send him their split case engines and he installed all the old parts in a new 1 piece case; maybe one of the first recalls in the USA in 1954!

1953 Fox .19 "Splitcase"

Control Line Carrier and RC, both requiring speed control were getting popular in 1954 and Fox introduced his 19, 25, 35, and 59 in 2 speed versions. They used 2 needle valve assemblies, one for high and one for low speed. There were many schemes for controlling the fuel flow.



1954 Fox 25 2-speed

In 1953 Fox and Arnold split up and Duke continued on his own as the Fox Manufacturing Co. And in 1955, Fox moved from Varna Ave in North Hollywood, California to Fort Smith, Arkansas where they remain today.

Performance engines always interested Fox and in 1956, he introduced the "Bathtub" 29R, so called for its huge intake. The first version had a unique 2 plug head.

1956 Fox 29R "Bathtub"

Smaller engines were popular and in 1958-1964 Duke produced a .15, an .09, an . 07 for Comet plastic RTFs, a .10, and finally an .049.

1958 Fox .15 Rocket

1959 Fox .09 Rocket

1960/61 Comet (Fox) .07

1962 Fox .10

1964 Fox .049

Duke's other performance loves were combat engines. His first Combat Special was out in 1957 and his last Mark VII in 1994. But possibly his most innovative engines were the 1960-1962 Series 3 Combat Specials (and 29Xs) with their twin needle bearing crankshafts, 2 piece crankcases, and huge 3/8" square intakes for running with pressure fuel systems.

1960 Fox .35 Series 3 Combat Special

In 1962 when the AMA wrote the Rat Race rules to allow up to a .40 cid displacement, Fox stroked his .35 from .700" to .790" to create the world's first .40 cid engines. To account for the extra stroke, the liner had to be lengthened, thus the heads on the .40s sat noticeably high than those on the .35s. The next year Duke began his throttle experiments in earnest, probably putting a new throttle on the market every year or so! The 1962 .40 RC is one of the most bizarre!

1962 .40 RC

In the mid 1960's Fox started work on an ultimate RC engine with twin BB crankshaft, needle bearings on both ends of the conrod, hardened cylinder, twin ring aluminum piston, and a carburetor with 3 adjustable jets. Finally ready for the market in 1967 in .60 (blue head) and .74 (red head) sizes, AMA made the .74 worthless by mandating a .60 maximum engine size. The .60 was a nice engine, but heavy for a .60; the .74 was Fox's real flagship. Duke stroked the .74 and created the Fox .78. It became popular with scale fliers and lasted clear into 1981, but it is doubtful the few sales to scale modelers recouped the development costs.

1967 Fox .60 RC

1967 Fox .74 RC

1981 Fox .78 RC

Schnuerle porting became popular in the 1970's and in 1975 Fox designed his B (Big) case engines with their unusual "Coffin" rear cover to allow for casting rather than expensively machining Duke's interpretation of this porting. These engines all had bolt on carbs, pressure and suction versions for CL, small and large throat for RC, BB and bushed crankshafts, lapped iron/steel, ringed aluminum steel, and ABC piston cylinders; some variety, huh! Improved versions of this engine are (were) still sold as the current 45BB RC.

1975 Fox .45 BB

In 1976 a C (Compact) case was developed using a fixed venturi with drop in carb and the 6 bolt "Coffin" rear cover. Over the years it was made in .29, .36, and .40 cid, bushed and BB cranks, CL and RC, lapped iron/steel, ringed aluminum/steel, ABC, and AAC, sport CL, combat, and RC versions, this engine is (was) currently made in only .40 variations, one of Fox's more successful designs.

1981 Fox .36 MK IV Combat Special

1983 Fox .29 BB Schneurle (Series 5)

1994 Fox .36 MK 7 Combat Special

In 1979, Fox dropped the svelte Eagle .60 and marketed the Eagle II, a brawny thing with a 2 piece crankcase, and large shaft with extra large bearings. By grafting 2 of these together with a special center section and crankshaft, the 1.2 cid Twin was created. An improved Eagle III followed and finally the Eagle 4 with a one piece crankcase was born. Also sold in a .74 size, the Eagle 4 was Fox's last large engine.

1973 Fox Eagle .60 RC

1979 Fox Eagle II

1979 Fox 1.2 Twin

1994 Fox Eagle 4 .74 Ring

Fox also produced large engines for the ¼, 1/3 scale fans using custom made parts with Sachs cylinders. And over the years produced bicycle, marine, heli engines, and RC car engines.

1983 2.98 cid Fox Bicycle Motor

1976 Fox .45 Boat Motor

1991 Fox Eagle 4 .74 Helicopter Motor

About 1992 Fox .15 Car Motor

I hope you have enjoyed this short history of Fox Engines, the last of the original mass market American model engine manufacturers.

Bill Mohrbacher