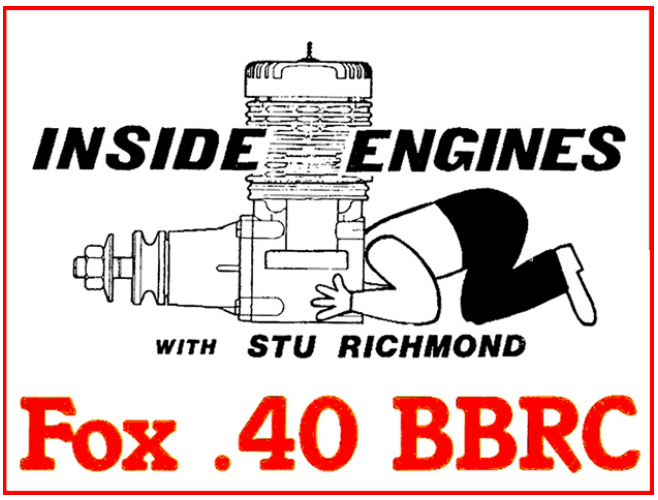
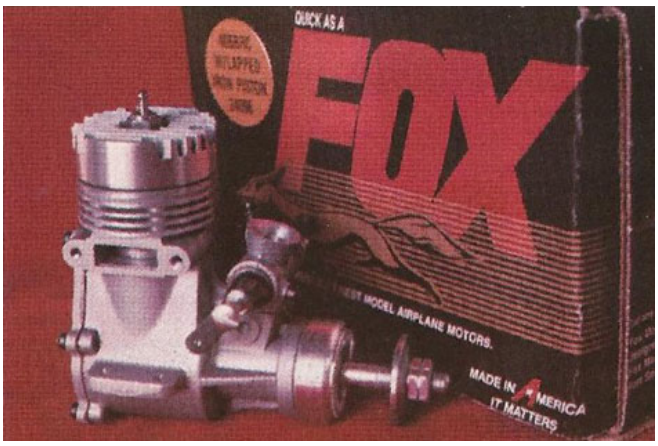
Fox 40 BB R/C





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.

• 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 In-side 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 in-side 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 scratch build from my original

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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,

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.

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.

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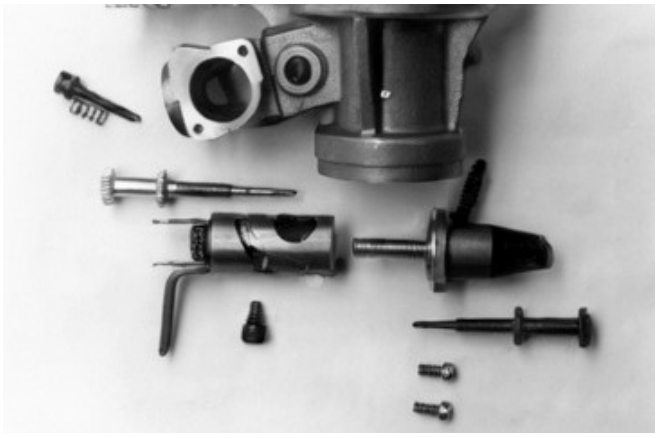
The Fox features the long-wearing economical match of a Meehanite cast iron piston running in a steel cylinder. High back door has one transfer port cast into it.

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 but-ton. 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 bot-tom of the squish band down to the top of the piston (at top dead center) measures .040 inches. The Fox Standard uses no head gasket; the aluminum button forms its seal easily to the steel cylinder.

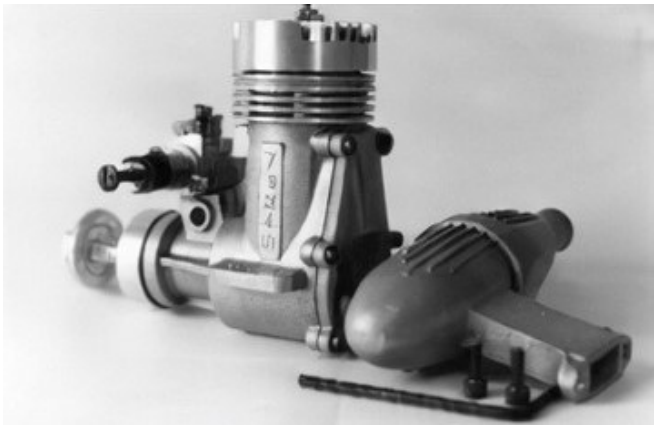
A light upwards push slid out the steel cylinder liner, its top inside diameter measured .835 inches, and the wall thickness is a modest .035 inches. Fox also makes a .36- size engine in this case with a heavier cylinder wall. The small .150 inch diameter hole under the exhaust port is for jigging/positioning 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.



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

The reciprocating weight of the piston, connecting rod, wrist pin and roll pin assembly totals 16-1/2

grams, which is just un-der Iwo-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.



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.

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.

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.

The prop washer and 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 the rough the crankcase casting against the carb's neck provides final locking/clamping action.

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

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

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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 fora pressure line from the muffler to the fuel tank's inlet.

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 only fault I've been able to find with 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

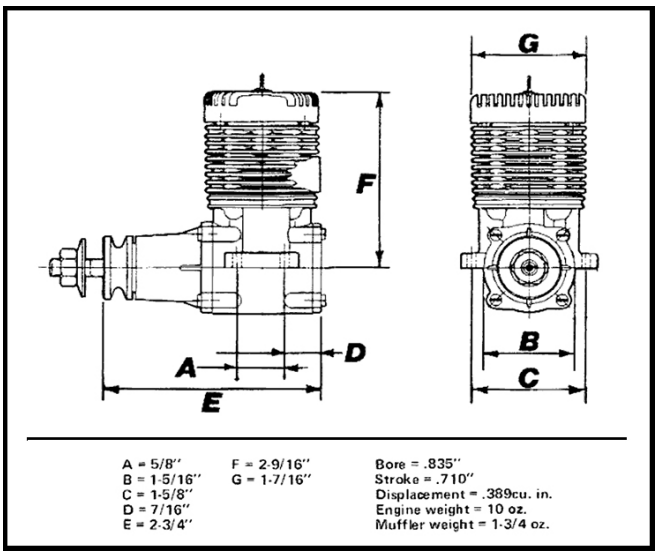
(Readings are after break-in and with Master Air Screw props and 10 percent nitro fuel with one ounce of castor oil added. The supplied muffler is installed for the following readings.)

Prop Size	Low Speed	High Speed	Range
9 - 6	2.300	15.300	6.6:1
9 - 1/2 - 6	2.200*	15.200**	6.9:1
10 - 6	1.850	14.100	7.6:1
11 - 6	1.700	11.900	7.0:1

*without muffler – 2.500
**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. •



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