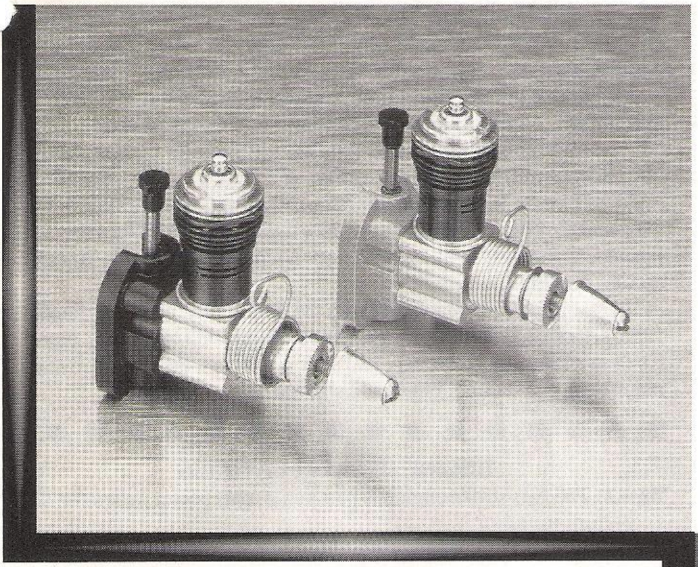

Like the Project Three-Way series, this article resulted from a reader suggestion. Millions of ½A engines have been produced over the years; the lion's share have been produced by Cox for its line of ready-to-fly control line models. Many of these engines are still in garages and attics across the land, and are still usable.

We asked Larry Renger to discuss the evolution of these engines as well as their care and feeding.

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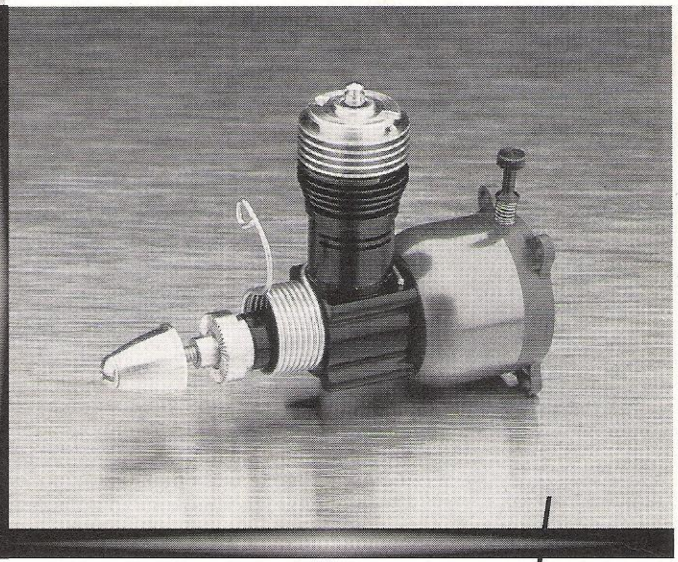
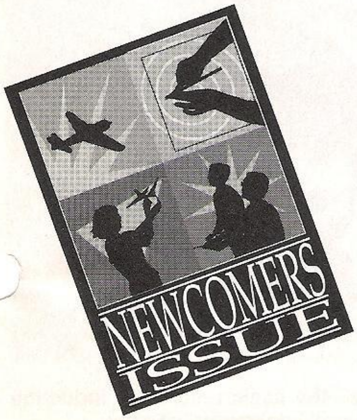


COX ½A ENGINES: background

■ PART I/II ■

■ LARRY RENGER



The purpose of this article is to describe the various Cox .049s, their construction, and appropriate application. Part II (July 1996 issue) will get into engine care, running, and modification.

Cox began in 1945 with a "pop" gun—a toy gun that used a simple piston pump to make a cork go "pop!" for a shooting sound. Simple, cute—it sold great! Since this was just at the end of WW II, the materials were wood and string, since metal was still on limited availability.

As a followup, Roy Cox made a wooden car that was dragged in a circle by a string-and-stick system. It was also successful, and was followed by a deluxe version made from aluminum castings. Tether-car racing was very popular about that time, and Roy's cars were being modified for engine power. Seeing a trend, he arranged with Cameron Brothers to mount engines in his cars and sold a line of powered cars of increasing performance.

Finally, in 1949, the first Cox-designed engine was used in the cars, followed a year or two later by the first Cox-manufactured engines.

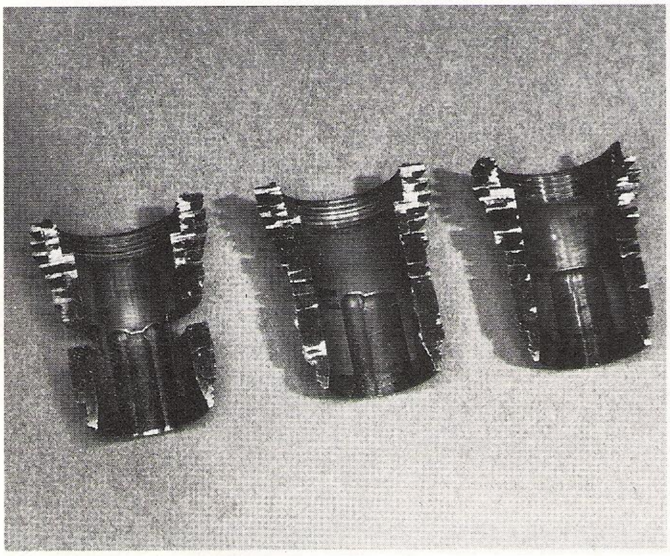
At the peak of popularity, more than one million Cox .049 engines were produced every year. Consider that, at that time, there were two other major manufacturers of nearly the same size! For a couple of decades, total .049 engine sales were about the same as car sales.

Because of the low price, huge volume of production, and ready availability, modelers have always regarded ½A engines as a "throwaway" commodity, rather than the precision jewels they really are. Hideous mistreatment, wrong fuel, and incorrect props are all standard fare for the small engine. (You wouldn't treat a watch that way, and the engine tolerances are a lot tighter.) As a result of the misunderstandings, small engines have a reputation for being "finicky" and short of life.

In reality, an .049 that is run with the proper fuel, prop, and needle-valve setting, and is run in a clean environment, will last a long time. Cox ran a test some years ago, and after 400 hours, the engine would require electric starting, but would still run.

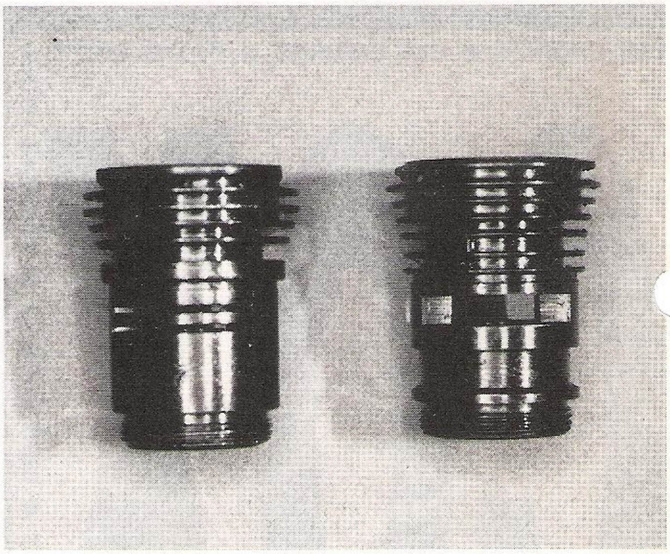
ENGINE DESIGN FEATURES

Basics: The two-stroke engine is part pump, part power generator. The

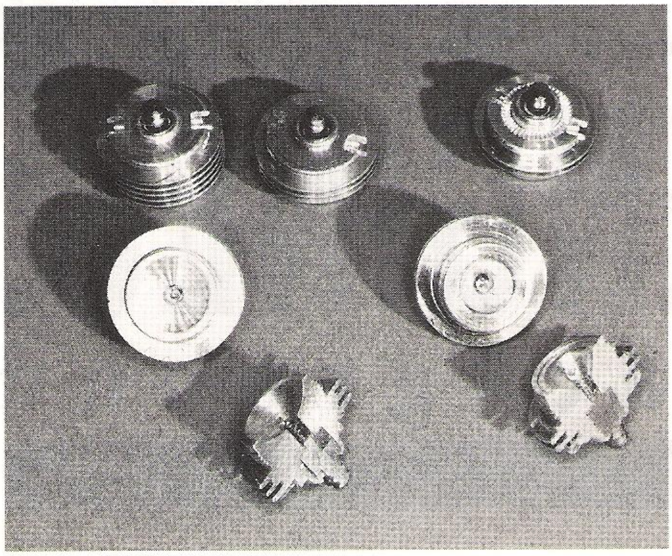


Bypass porting of Cox engines. From left to right: twin booster grooves, single groove, and standard porting.

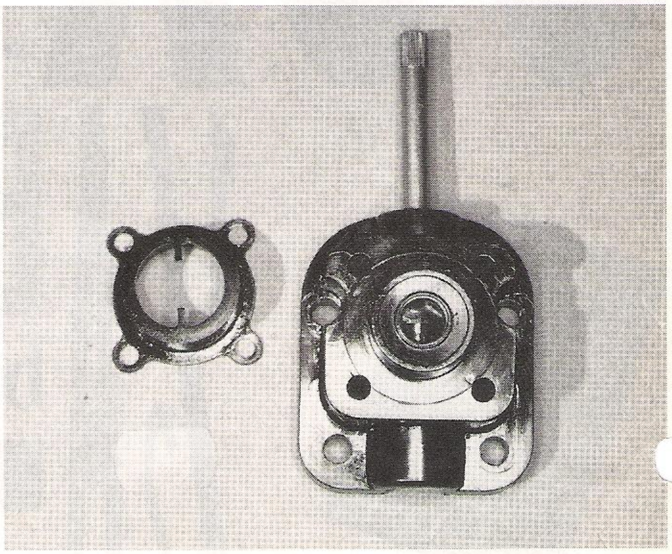
Photos by the author Graphic Design by Heather Erdahl



Slit exhaust (L) prevents fuel ignition on the outside of the engine. Open exhaust (R) yields a smidgen more power.



Texaco (L) and standard head share Hemi shape. High-compression head (R) has squish band. Coil wire sizes differ too.



Ready-to-Fly firewall backplate—the basic reed-valve induction system. Engine pressure seals reed into venturi opening.

ngine has to pump a fuel/air mixture into the cylinder, where it is ignited to produce power.

Most of the design and performance differences come from the pumping and flow design—not the head and combustion design. If you can't get a lot of "mix" into the cylinder, you aren't going to get a lot of power out. The key is to get a smooth flow of mix in, and waste exhaust out, in the minimum time; definitely a case of "more is more!"

Most engine designs use one of three techniques to get fuel/air mix into the engine's combustion chamber. The parts of the pumping action of an engine are split into intake, bypass, and exhaust systems. Intake systems are reasonably independent, but bypass and exhaust systems must work together. This will be clarified (I hope) as we go along.

Intake systems: This is the technique used to suck air into the engine and combine it with the fuel to create a well-vaporized "mix" that will burn smoothly and rapidly.

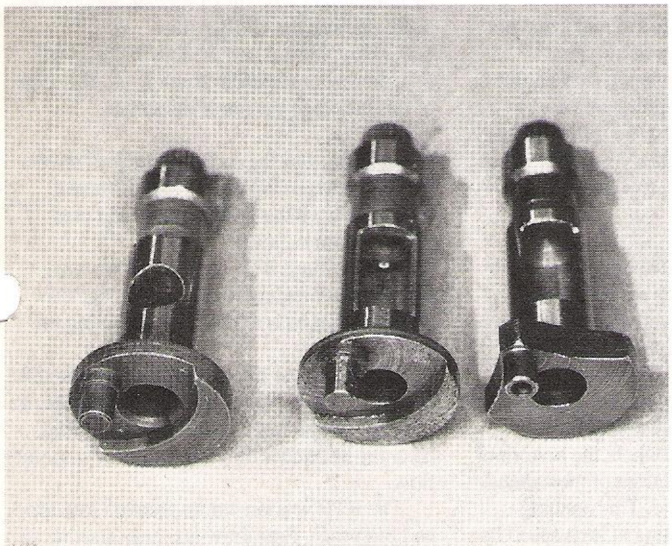
There are three basic systems to control the intake timing of an engine. The simplest is the side-port; second is the reed valve; and most complex is the rotary timed engine.

In almost all engines, there is a "venturi" tube where the fuel is drawn by reduced pressure to spray into the airstream. The intake valving systems are intended to provide maximum fuel and air draw within the constraints of complexity and expense. Other considerations are easy handling, steady needle setting, and fuel draw through high "g" maneuvers.

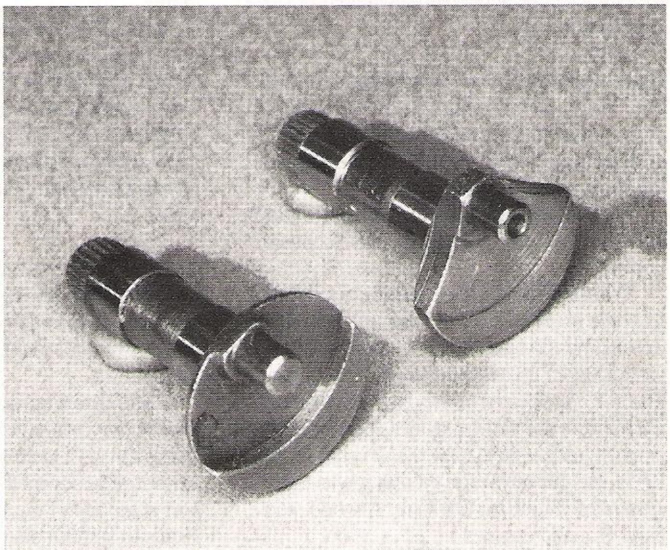
The side-port is a very old system; it is still used on replica engines. The principle is that the bottom of the piston uncovers the intake at the top of the stroke. There is a good vacuum in the crankcase, so there is a strong suction to pull the mixture through the venturi past the needle valve.

This type of induction system is extremely reliable and trouble-free, and leads to easy starting, and solid run characteristics, but is very limited in how much power can be generated by the engine. And since the timing is symmetrical about the top-dead-center position, the engine will run right or left rotation.

The second system, and the most used on Cox engines, is the reed-valve intake. A floating reed made of Mylar is used to seal the venturi whenever there is pressure in the crankcase, and open up when there is



Rotary type crankshafts. L-R: Medallion sport timing, Tee Dee standard, and the special "helicopter" crank.



Reed-valve cranks: stock (L) and competition. Note stronger support for crankpin, drilled pin for lighter weight.

COX ENGINES

Engine	Exhaust Port	Bypass Booster	Sub-Piston Induction	Piston Weight	Taper Grind	Head	Valve Type	Crankshaft Type	Tank Type	Miscellaneous	Purpose
Standard Prod'n	Slit	No	No	Std.	No	Low, Std.	Reed	Std.	External	Screened Venturi	Regular RTF Power
High Perf. Prod'n	Slit	1	No	Std.	No	Low, Std.	Reed	Std.	External	Screened Venturi	RTF CL Stunt, Lazy Bee
Babe Bee	Slit	No	No	Std.	No	Low, Std.	Reed	Std.	Sm., Metal	Free-Flight Vents	Trainer Models
Black Widow	Open	No	Yes	Std.	No	Low, Std.	Reed	Std.	Lg., Metal	CL Stunt Venting	Sport Models
Dragonfly	Slit	1	No	Std.	No	Low, Std	Reed	Std.	XLg., Plastic	Clunk & Vents for RC Throttle/Muffler	RC Sport Models
Texaco	Slit	1	No	Std.	No	Low, 5-Fin	Reed	Std.	Lg., Metal	Free-Flight Vents	FF Comp.
Texaco Jr.	Slit	1	No	Std.	No	Low, 5-Fin	Reed	Std.	Sm., Metal	Free-Flight Vents	FF Comp.
Killer Bee	Slit	1	Yes	Light	Yes	High	Reed	Comp.	External	Special Venturi	Comp.
Venom	Open	1	Yes	Light	Yes	High	Reed	Comp.	Lg., Metal	CL Stunt Venting	Comp.
QRC	Slit	No	No	Std.	No	Low, Std.	Reed	Std.	Lg., Metal	CL Stunt Vents Muffler	Sport Models
Medallion	Slit	1	No	Std.	No	Low, Std.	Rotary	Std.	External	Beam Mounting Throttle/Muffler	RC Sport Models
Tee Dee	Open	2	Yes	Std.	Yes	High	Rotary	Std.	External	Beam Mounting	Comp.
Tee Dee R/C	Open	1	No	Light	Yes	Low, Std.	Rotary	Comp.	External	Beam Mounting Carburetor & Muffler	High Perf. RC

a slight vacuum. Now the engine can pull fuel/air mixture whenever there is demand—not just when the piston is at the top of the stroke.

As with the side-port engine, reed-valved engines may run either direction. Since the crankcase is only drawing when there is demand, the engines work beautifully over a very large speed range and start easily.

The final system is rotary timed intake. There are several configurations that do this, but the most common is the one that has the port in the crankshaft, and the venturi mounted in the front of the crankcase. Timing is achieved when the port in the shaft rotates around to uncover the venturi.

Since the timing may be precisely controlled, the engine may be tuned to be a docile sport engine or a fire breathing racer. Handling, starting, and usable speed range are determined by the engine timing.

For example, the Tee Dee series is set up for racing and the Medallions for sport. The ability to control timing allows much higher rpm than can be achieved with a reed or side-port system.

Bypass porting is the technique used to get fuel/air mix into the cylinder. It is always closely related in its design to the exhaust system, since both must work in and through the same cylinder walls.

Bypass porting falls into three basic forms: 360° porting, loop scavenged, and Schnuerle porting.

With 360° porting, the idea is to smoothly flow the fresh mixture in from all sides while exhausting the burned mix (also from all sides). When it is working right, the intake shoots up the center of the cylinder, pushing the exhaust down the outsides and through the exhaust ports. Only a few diesels such as the PAW use this anymore, though it was the system of choice for OK Cub, Atwood, and early Holland engines.

Loop scavenging is a technique that uses a single bypass and exhaust on separate sides of the engine. A baffle on the piston redirects the intake upward, and it "scavenges" or pushes out the exhaust. Strange head shapes are required to clear the piston baffle, and smooth combustion characteristics require much experimentation on the part of the designer.

This system was the standard for "large" engines such as the K&B, Fox, and McCoy. The smallest engine I can remember that used this technique was the Anderson Royal Spitfire .065.

Finally we get to the Schnuerle system of porting. (The Cox engines use the original system outlined in Schnuerle's patents.) There are two bypasses on opposite sides of the cylinder, and two exhausts at 90°. Later modifications in large engines have resulted in the two main bypasses moving closer together, a small booster with different timing located between, and one exhaust on the opposite wall.

This is the most sophisticated of all the bypass/exhaust schemes, and works so well that it allows an engine design to start easily and still have racing performance. In small engines, only a few imports from East Germany and Russia use the more advanced system.

WHICH ENGINE IS WHICH?

Cox engines have used a bewildering array of components over the years, and most of them can be interchanged to produce an uncountable variety of possible configurations. Because of this, I'll stick to the design of current engines in this article. I will get into mix-and-match modifications along with some hop-up tips in Part II.

Currently there are 21 engines in the hobby line, and two more used in the ready-to-fly airplanes. This variety is necessary because there are so many different applications in modeling. Since there is now only one major ½A manufacturer, Cox makes all types of engines for every type of flying. It isn't like big engines, where you might buy a K&B for ducted fan, a Fox for Stunt, and a Nelson for racing.

Some features cost more to make and not only would be useless, but detrimental in certain applications. As a result, Cox engines vary widely in price depending on how complex they are to make. The selling margin on all Cox products is roughly constant; what you pay is directly related to what it cost to make.

Cylinders: These now have two main bypasses and two exhausts as mentioned above. In addition, however, they may have one or two additional booster grooves per bypass.

The exhaust ports may be open or slits, and may or may not have subpiston induction (SPI). This is a technique where the bottom of the piston uncovers the bottom of the exhaust port at the top of the stroke. This opening seems to smooth out running at high speed by allowing a last little puff of fresh air into the crankcase. Perhaps it cools the piston; perhaps it helps fill the top of the case; I doubt anyone genuinely knows why it works.

The final difference among cylinders relates to how they are finally ground to finish. A device called a hone is used to smooth the walls of the cylinder and achieve the precise dimensions needed. This final grind can be of constant diameter or have a change from bottom to top.

Low-end engines have a straight bore. This makes it easier to assure a perfect seal for easy starting. Higher-performance engines need a taper on the piston and cylinder to compensate for higher heating near the head. This taper reduces the seal at the bottom of the stroke, and makes starting a bit harder. As with most things, you have to pick what you need; you can't have it all.

Pistons: Cox makes three basic types: heavy wall, light-wall, and tapered or untapered. The light-wall pistons were originally developed for the Killer Bee (high-performance reed-valve engine); as we gain experience with them, they will likely be used in more and more engines in the line.

Crankshafts: Again there are several combinations. The shafts may be for reed or rotary engines. If rotary, there are the sport-timed Medallion and race-timed Tee Dees.

There are now also two different balance systems in use: the original "smile" counterweight cut into the back of the shaft, and the new competition balance system originated for the Tee Dee R/C, and now used on the Killer Bee, Venom, and Tee Dee "Helicopter" engine used by Light Machines.

Glow Heads: Three types are in use by Cox. Most common is the standard-compression head found on Babe Bees and Ready-to-Fly (RTF) engines. There is a second head of identical internal configuration with an extra cooling fin for use on the Texaco engines. Finally, there is the high-compression head used on the Tee Dees, Killer Bees, and Venom.

There also are a variety of outside manufacturers who make special-application heads such as the GloBee, the Galbreath/Nelson, and the Davis Diesel and RJL diesel conversions. It is beyond the scope of this article to get into the specials.

Backplates: For the reed engines you have a choice of two backplates or four different tanks. All have the needle valve, and reed-valve system built in.

The standard RTF backplate features a small venturi and a screen over the back to prevent large bits of junk from jamming the reed valve.

The backplate developed for the Killer Bee is a variation that features a beveled intake, no screen, a bigger-bore venturi, and a special chamfer just under the reed valve for smoother flow.

The RTF version works great on low nitro and big props. Fuel draw and easy starting are maximized.

When you are running the engine fast, however, the venturi must be opened up to allow more air flow. The higher velocity of air helps maintain good fuel draw, though on the Killer Bee, the opening was made as large as possible, and the starting and needle sensitivity are somewhat "worse" than the RTF version.

Fuel Tanks: Fuel tanks may be metal or plastic, long or short, and have vents for Stunt or free flight.

The Babe Bee tank is short, metal, and has free-flight venting. The Black Widow tank is long, metal, and has Stunt venting. The Texaco tank is long, metal, and free flight vented. The Dragonfly tank is plastic, very large, Stunt vented, and has a "clunk" fuel pickup for aerobatic RC flying.

Those are the basics. To put them together in a useable format, the chart that gives all the characteristics of each engine is presented here. I hope this background is enough to prepare you for Part II: Running, Ruining, Fixing, and Hopping-Up Cox engines. ✈

CHOOSE YOUR WEAPON

Whether your into speed, sport, duration or scale, Cox has the right engine for you. Built on a tradition of quality, precision, and reliability.

Venom .049

For many years, the Black Widow engine has set the standard for 1/2A racing events. The experts have always "tweaked" the engine one way or another to extract that winning edge over a "stock" engine. Now, Cox has taken all the best ideas from the top racers, and a couple of its own, and combined them to make the Venom.
17,000 RPM avg./30% Nitro
5"x3P Competition Propeller

Texaco .049

Texaco Jr .049

The Cox Texaco .049 has become the standard for 1/2A R/C Duration flying. Now, to meet the competition requirements of both long and short tank events, the engine is available in two different tank sizes and also includes a "zero drag" spring starter. When competing in 1/2A Texaco & Duration events or out for a Sunday afternoon fun fly, smooth steady power and fuel economy is the secret to great performance! The Cox Texaco features a high velocity venturi for improved fuel economy and a 5 fin glow head for extra cooling when swinging a big prop.

Tee Dee R/C .05

The .05 is based on the popular Tee Dee .051 Competition engine. This is the lightest engine available with true carburetor and muffler.

Killer Bee .049

Killer Bee .051

Designed to run ultra fast with high nitro fuel on small props, the Killer Bee engines will clean up in Nostalgia Free-Flight. Available in both .049 and .051 sizes, the Killer Bees are ready for class 1/2A or A competition.

Tee Dee R/C .09

The .09 is a radio ready version of the powerful Tee Dee .09. The Tee Dee R/C .09 features true carburetion and muffler. Small size and weight allow the user to install this engine as a "Turbo-Boost" in most aircraft intended for 1/2A R/C flying.

Dragonfly .049

WITH THROTTLE & MUFFLER

The Dragonfly features an integrated throttle/muffler system, Snap Starter® for easy starting and oversized fuel tank with built in "clunk" system to allow inverted flight.

Black Widow .049

First introduced in 1973, the Black Widow is our most popular .049 reed valve engine! It's great for all types of control line models including 1/2A Stunt, Mouse Racing, Beginner Combat and Powered R/C Sailplanes, too.

COX

MADE IN U.S.A.

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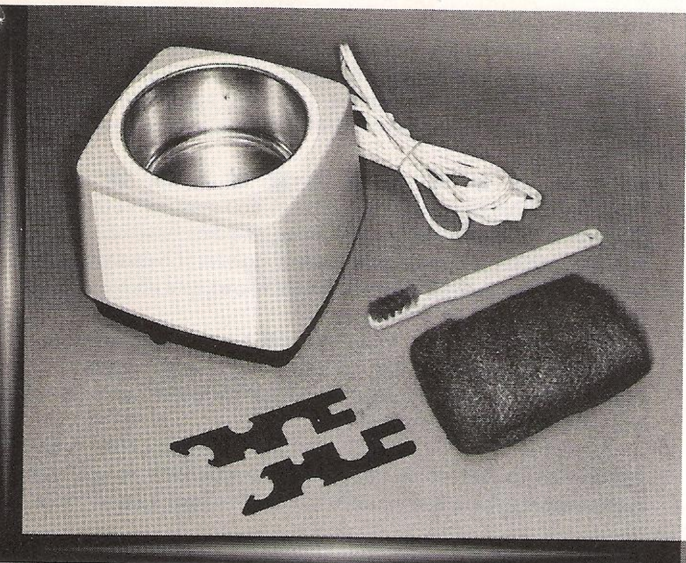
Running Tips, Care, Repair, and Customizing



In Part I (June 1996 issue) the author provided background and history of Cox engines. Now you can learn more about their "care and feeding."

Engine Running Tips: **The essential points to consider in running Cox engines are:**

- Choice of fuel
- Prop balancing
- Starting battery and glow-plug clip system
- Break-in
- Choice of propeller
- Mounting
- Fuel filtration
- Cleanliness

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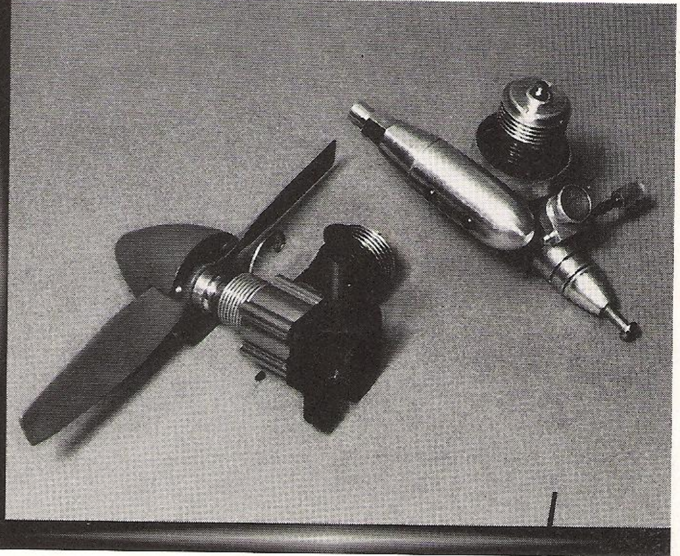
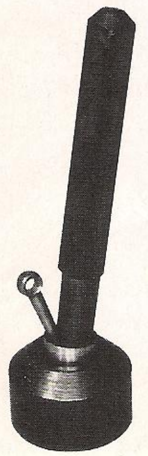


COX 1/2A ENGINES: care & feeding

PART II of II



Piston/rod socket tightener. Work out your aggressions with a hammer!

LARRY RENGER

Fuels: Cox recommends use of a minimum of 15% nitromethane—mixed by volume, not weight. No cheating here!

Cox fuels have 18% oil—all of it castor oil. Cox engines do not seem to like pure synthetic oils; at least half of the oil in the fuel should be castor. Note that Cox fuels are very good, but not magic. There are other equivalent fuels of top quality. I only run Cox fuels because I know *exactly* what is in them.

There does not seem to be an upper limit to how much nitromethane you can run in any Cox engine. I usually run Cox Racing (30%), and when interested in peak performance, will switch to Aerodyne 500+P—a 50%-nitro mix with propylene oxide added. If I were competing, I would probably go all the way up to 65% nitro.

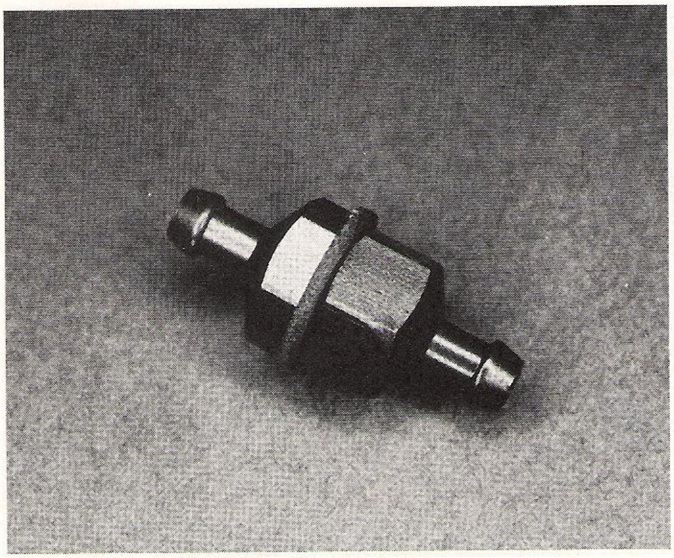
Remember that once you run an engine for a while on high-nitro fuel, it will be heat-cycled to run that way, and will lose power when you drop back to lower-nitro fuels. The ideal is to break an engine in on the fuel you intend to run forever.

There is a balance that must be met for top performance. It is necessary to hit the correct combination of fuel, propeller, compression ratio, weather conditions, and glow plug element heat to get the ultimate performance out of an engine. Only a tachometer is accurate enough for this kind of experimentation.In general, high nitro goes with small props, cold plugs, and low compression. The benefit is maximum power output. Low nitro needs more heat and higher compression; the payoff is more lugging power and greater fuel efficiency.

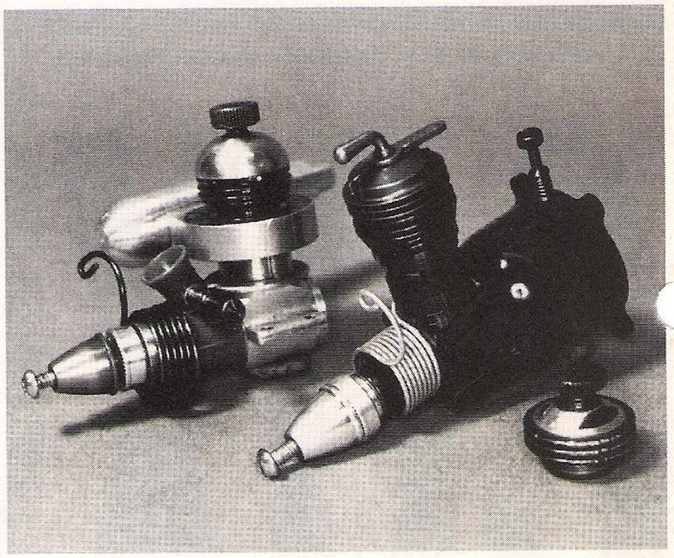
Propellers: This ties in with fuel choice. You must select the correct prop for the type of flying you are doing, and then break the engine in to run on that prop. Choice of brand is up to you; if balanced correctly, no prop will damage the engine unless it allows rpm above the structural "redline" for that engine.

Some engines, like the Killer Bees, are tuned to only run small props and high-nitro fuel. The run will be very erratic on other combinations. Select the correct engine for the airplane and the correct prop and fuel for that combination.

A safe bet in props are the Cox 5 x 3 or 6 x 3 sizes. One or the other will do well for 80% of all situations. For competition, several other choices seem to have been established by consistent winning ways:

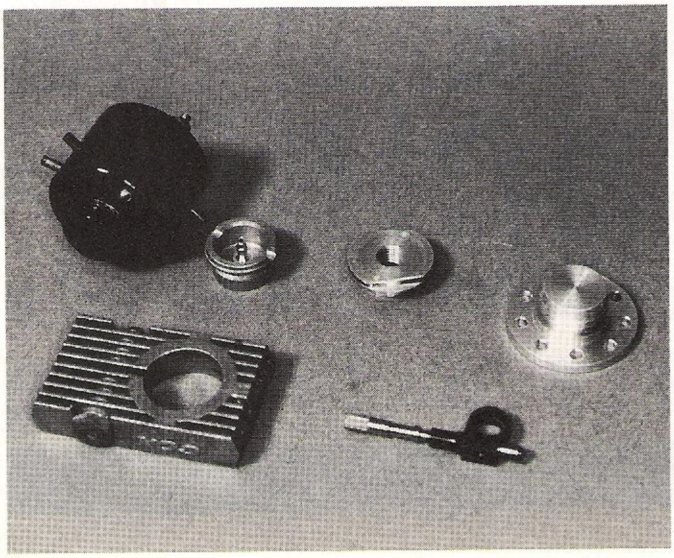


A fuel filter is a must. At least filter the fuel going into your tank. At best, filter it again between tank and engine!

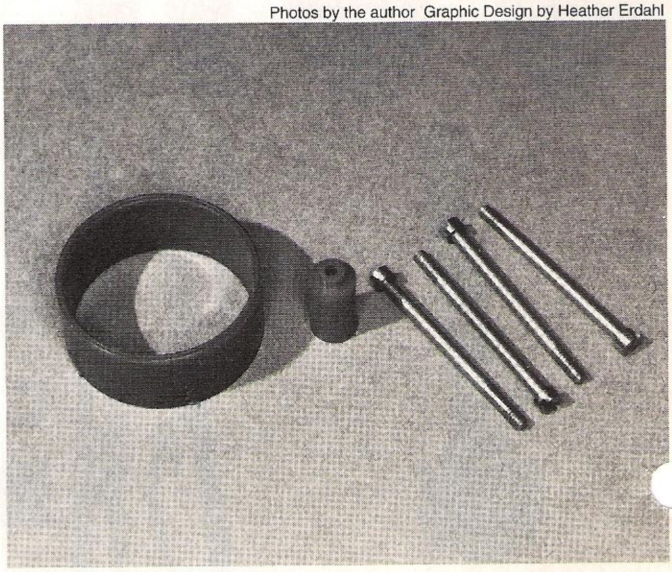


Front: Davis diesel head. Middle: Venom .049 with RJL conversion head. Rear: Medallion with rare Lofquist diesel head.

Photos by the author Graphic Design by Heather Erdahl



A number of custom accessories are available to adapt Cox engines to a variety of installations and uses.



For ultra-long runs: the Kavan tank extender. Available in long- and short-bolt versions for Babe Bee or Black Widow.

The Texaco events typically use props of large size, starting with the 7 x 3.5 and 8 x 4 props. On the other end of the scale, Nostalgia Free Flight fliers seem to prefer the very small props like the Tornado 5 x 3 and APC 5.5 x 2. Mouse Racers and ½A Combat fliers seem to like the Tornado 5 x 4.

Prop Balancing: This is very important in running Cox engines. Small models need all the power they can get, and an engine will put out more *oomph* (technical term) if it is running smoothly. In addition to the extra power, the engine and airplane will last longer!

I prefer the Top Flite magnetic balancer; it is head-and-shoulders better than the rest. Second-best is the large-wheel variety typified by Du-Bro. Generally, anything is better than nothing, though balancing across a knife blade is really close to worse-than-nothing. Balancers will never wear out, and can be used for every engine and prop you own.

Mounting: The more solidly an engine is mounted, the faster it will run. Soft mounts are intended to reduce noise and damage to the airframe. A soft mount always costs rpm, and is unnecessary on a small engine.

Use the correct size screws with as large a head as possible to spread the loads out. *Very important: The mounting surface must be flat!* Any mounting distortion will at least cost you power, and at worst may trash the engine.

Starting Battery and Clips: The starting system you use should provide a medium-orange glow in the glow plug filament at all times. If your plug just has a little visible glow at the bottom of the element, you are guaranteed to have a hard-starting engine. Plugs take a high current flow, and a poor battery, thin wires, and dirty or weakly attached clip will cause lots of grief.

A glow-driver system is the best because it will adapt to weather, battery charge, flooding, etc. and still fire up your engine. A glow driver will even overcome poor wiring or connections to some extent.

The simplest system I find effective is a pair of alkaline D-cells soldered in parallel. The cable to the clip should be lamp cord, and the clip must be clean and provide both friction and spring force to assure high current flow.

Fuel Filtration: Yes, filter your fuel—without qualification. The fuel passages in a Cox engine are tiny. It takes almost nothing to plug up a needle valve, and that will either prevent running or make the run erratic. The ideal is to filter the fuel from can to tank, and again between tank and engine. Cox fuel cans have a built-in filter.

Break-In: Break-in is a process of both polishing the parts to mate with each other, and "stress-relieving" the parts by heat-cycling them. As with prop and fuel, break-in technique depends on the use of the engine. Casual flying requires only a casual break-in; full performance requires closer attention.

For sport flying, you need only run the engine rich (by opening the needle valve to add more fuel to the fuel/air mixture) for a minute, then begin leaning it out (by closing the needle valve somewhat) a bit at a time.

Listen for the engine attempting to "sag off" from overheating. If it is suddenly slowing down, richen it up and let it cool for a few moments before leaning it out again. As soon as it will hold a solid two-cycle peak, it is ready to fly.

You will find that the engine will gain performance over a period of time. You probably sacrifice a small amount of peak performance, but for sport flying, who cares?

To get peak performance out of an engine in competition, you may need to do a bit more careful break-in. The first phase is to let the parts polish themselves a bit to avoid galling or scuffing. I like to do this by using a low-nitro fuel (15%), a slightly smaller prop than planned, and run a bit on the rich side. The plan is to get the rpm close to the final planned range, but with the engine lightly loaded and running cool.

About five minutes of running this way should give all the surfaces an initial polish, and clean out any assembly oil that may have been left in the engine during manufacturing. You are attempting to minimize heat and stress on this initial run.

The reason for running the engine at the speed you finally hope to achieve is to have the inertial vibration levels correct. That is, the rockin'-and-rollin' are happening the same as if you were running flat-out.

At this point, you need to begin to heat-cycle the engine to get the parts to their final "relaxed" shape. I recommend switching to the final nitro and prop for this type of running. This part of the run seems like the sport break-in, but intensified.

Start your engine and lean it out to a scream. Immediately back off to a rich setting. Re-lean the engine, and run it at high speed for a few moments longer. Continue this process of longer and longer peaks until the engine will hold full, steady high rpm with no tendency to sag.

Each time you peak the engine, it builds heat, and the metal moves a bit. The wear factor goes up as the engine repolishes itself and extra heat is generated. This is the reason that an engine will suddenly try to sag-off lean. Too much heat!

The more heating and cooling cycles, and the longer the heat periods you run, the closer the metal will settle into its final shape. It is a continuous re-fitting process that cannot be achieved at the factory. During the break-in process, never let the engine sag off lean! Don't just let the engine run by itself. Break-in is a boring process that requires your constant attention.

Again, when the engine is under maximum stress, you want the rpm to be roughly where you will finally run the engine. A properly broken-in engine will be easier to start, will last longer, and will be less sensitive to needle-valve setting. Basically, the engine has "blueprinted" itself.

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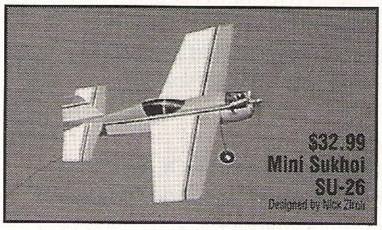

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really good-running, well-broken-in engine had. The result was awful! As soon as the engine was run, it promptly changed shape, and wore in to some other fit that didn't work as well.)

Cleanliness! As with fuel filtration, this is a *must* with small engines. A ½A engine has *half* of a larger engine's clearance between piston and cylinder! That makes the dust and dirt twice as big!

If you hit the dirt with your engine, take it home and clean it properly. The alternative is that you will lose a significant amount of performance (and most of your engine's life) in the first part of the next run!

Engine Care

Cleaning: To clean an engine, remove the backplate, head, cylinder, and piston—*without rotating the crankshaft.* Usually it is not necessary to pull the crankshaft from the case, but if it is a rotary engine, and you crashed in really fine dust, tear the engine down completely. Use a good solvent like denatured alcohol, kerosene, or model fuel. Use brushes and paper towels to physically remove the dirt; just sloshing a part in solvent is only somewhat effective.

If it is necessary to remove the crankshaft, here is the removal and reassembly procedure:

Removal: The screw size for the crankshaft is a 5 x 40. This is not commonly found at hobby shops, but it is a standard hardware size. Purchase some hex-head ½-inch 5 x 40 machine screws and matching hex wrench. After removing the backplate, cylinder, and piston from the engine, insert one of the screws into the shaft as far as it will go.

Place the crankcase rear-end down on a sheet of cardboard on a cement floor (cement for solid backing; cardboard so the crankcase won't be marred). Whup that puppy with a hammer until the shaft slides free of the drive washer. Keep that screw just for removing shafts.

Reinstallation: This is a bit more tricky. After thoroughly cleaning and oiling the parts, slip the shaft into the engine, and gently reassemble the thrust washer (if used) and prop drive plate onto the shaft.

Get the drive plate started into the same grooves as used in the original assembly, then use a stack of washers and one of the hex screws to pull the drive plate all the way down to the stop on the shaft. Recheck that the drive plate runs true (no wobble). Note that I specify a hex-head screw because it requires no pushing to be turned. I got a screwdriver three stitches deep into the palm of my hand while trying this with a standard slotted screw. Be warned!

While the engine is apart, examine all the parts for damage and wear. If needed, use a piston reset tool to tighten up the piston ball socket. This is a good time to consider removing accumulated varnish from the cylinder walls (see below).

Reassemble the engine with a good grade of oil. WD-40, Marvel Mystery, and 3-In-One all seem to work OK. After-run oils should be good. My preference is Break-Free—a gun oil with Teflon particles in it. I won't say for *sure* it is an improvement, but how can a bit of Teflon hurt?

Varnish Removal: As an engine runs, a certain amount of burned oil will accumulate on the cylinder walls. This "varnish" does two things: It reduces the clearance between cylinder and piston, which may generate heat; and it tends to get sticky as it heats up. The result is an engine that suddenly has a difficult time being run up to peak rpm and holding it. It seems exactly as though the engine was *un*broken-in.

To remove the varnish coating, remove the cylinder head, head gasket, and cylinder from the engine. Get a pad of 000-grade steel wool. Wrap a strip of the steel wool around a clean dowel and scour the inside of the cylinder bore until it is completely silvery again. It is very difficult to harm a cylinder bore with this technique; the steel wool is softer than the steel in the cylinder, but it's much harder than the varnish.

Clean the cylinder in solvent. Use a brush to assure that all the residue and wool hairs have been removed. Then reassemble the engine as above.

Piston Resetting: This is a technique that allows you to tighten the fit between the conrod ball and the socket in the piston. Allowing the fit to get too loose can cause vibration, inaccurate timing, and breakage. I find that the socket usually needs only be tightened once (at most, twice) in the life of an engine. The metal eventually wears very smooth and work-hardens itself, so the fit eventually remains constant.

When using the socket-setter, use the hammer gently at first, and keep moving the position of the tool around on the socket. The key is to tighten the socket as evenly as possible. Keep checking the resulting fit, which is achieved when there is no noticeable "slop" between the ball and socket, but there is no bind.

Clean the piston and rod, then oil the socket before reassembling the engine.

Storage: I keep my engines in a sealed metal box. Prior to storage, they get a liberal dousing inside and out with oil (again, my favorite is Break-Free). It would be an excellent idea to throw a bag of desiccant in with the engines to stop rust.

Miscellaneous Thoughts: Keep all the screws tight. Plastic can cold-flow; check that screws remain snugly tight. On Tee Dee and Medallion engines, check that the carburetor body retaining nut (the silver ring behind the prop drive) is snug.

Air leaks in one place or another are the source of most starting problems. Glow heads loosen up by themselves; check the tightness every run. If a gasket looks worn or torn, replace it. Look at any plastic parts for cracks. The rubber Hycar washers on the back of the tank can harden, and should be replaced if they look suspicious. Backplates on the rotary-valve engines can also loosen themselves.

Castor oil gums up when the engine is not used; expect to have to clean out the fuel system, and run a full tank through the engine at slow speed, when you fire it up again.

Fuel absorbs water at an amazing rate; keep your fuel can sealed well even between flights.

Engine Repair: There isn't really much you can repair on any model engine. Generally it is a situation of finding the problem and replacing the parts. If your hobby shop can't get parts from their distributor, tell them that Cox has a no-minimum policy on part purchases for dealers. In addition, you can purchase parts direct from Cox through Customer Service. The toll-free hot line (800) 451-0339.

Some things worth knowing about servicing your engines:

- You can free up an old, gunky engine by warming it with a film-shrinking iron, or by boiling it in water.

- You can clean almost anything off an old engine by boiling it in dishwasher detergent.

- All the screws on Cox engines are standard sizes—2-56, 3-48, 4-40, 5-40, etc. None of the other threads are used by anyone else; we get all-custom taps. Customer Service has a list of those thread definitions if you just have to have them.

- Glow heads can be bad for a variety of reasons. The most obvious is when they don't glow. It is also possible for the upper seals to leak, or for the element to have an aluminum coating fused to it. This will limit the ability to catalyze the combustion process. If in doubt, look at the element under a microscope. If the element is not shiny like jewelry, it is probably shot.

- It is usually a good idea to keep pistons and cylinders as matched pairs. Once the parts have broken in together, why lose that fit? For sport flying you can mix them, but performance will vary wildly.

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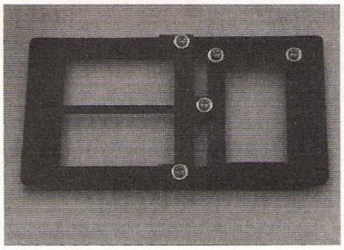

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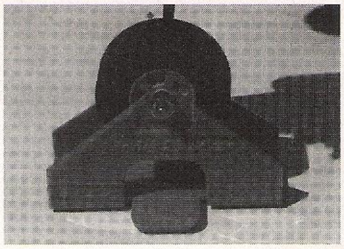

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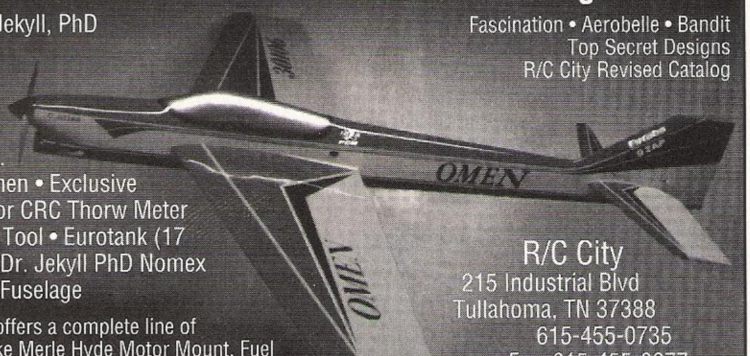

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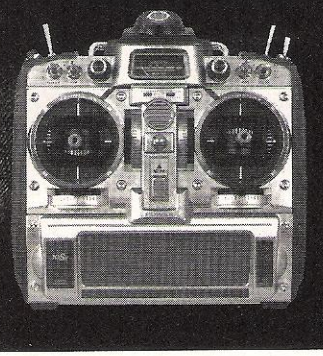

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Customizing

Any modification to a Cox engine voids your warranty! Read this section at your own risk.

Several modifications are mentioned that *can* work if done right, but will always make the engine warranty kaput.

There are two types of engine rework:

The best type is to simply assemble the engine you need for a specific application from the correct set of parts.

The second type is "hop-up" or tuning. I will deal with these topics separately.

Custom Setups: The trick here is to understand what you need for your application, and then to know what parts are available to let you achieve the result. A few standard applications and how to get there are given below.

• Control Line Stunt: Here you need an engine of good power, but the key is to achieve the ultimate in steady running. It is usually necessary to muffle the engine, too. Two examples are shown in a photograph. One is the engine I use in the Me-109 stunter; the other is set up for flying in a fully competitive ½A Stunt model.

Engine one uses the crankcase, crankshaft, cylinder, and piston from the Killer Bee. To smooth out the run and increase ability to run a large prop, the standard ready-to-fly or "product" backplate is substituted for the bored-out one provided with the Killer Bee. Again to achieve steady run under the varied loads, plus provide extra cooling, the head from the Texaco engine is substituted for the high-compression head normally found on a Killer Bee.

The second engine started as a Tee Dee R/C .05. The Control Line venturi was substituted for the RC carburetor, and a Texaco head was substituted for the same reasons as before. In addition, a steadier run can be achieved by tapping the muffler for pressure to the tank. If still more power is needed, drill out the venturi to a bigger diameter, and use the side tap on the engine per the free flight engine instructions.

• Diesel: Several diesel-type conversions are shown in the photo. The two heads that are currently available are from RJL (Box 5, Sierra Madre CA 91025) and Davis Diesel (Box 141, Milford CT 06460). The RJL uses an O-ring seal; the Davis uses Teflon disks as a destructible seal. The RJL has a lock arm to fix the compression lever; the Davis uses a spring system and knob. Both work just fine, and both will instantly void your warranty on the engine.

The keys to successful diesel operation are to pick adequately strong components and to use absolutely fresh fuel with a high ether content. Small diesels need lots of ether—up to 50%! The engines shown are the Venom and the Medallion. The crankshafts on these engines are the least likely to break under the mistreatment dished out by diesel operation.

Since the goal of running a diesel is to get long duration and swing large props, the ideal engine would be the Venom front end and a Texaco tank and backplate. The Venom will punch out the power and be durable; the Texaco tank and backplate have a small venturi for maximum duration and smooth running at low speeds.

A couple of words about using mufflers and exhaust restrictors for RC throttling:

As mentioned in the first engine article, there is a thing we do on our exhaust ports called *sub-piston induction* (SPI). The piston uncovers the bottom of the exhaust port at top-dead-center, and some air is allowed to go under the piston into the crankcase. This is used on open-exhaust engines to get the last little bit of performance.

SPI is instant death when running a muffler or exhaust restriction throttle system. If you are going to use a muffler, be sure to select a cylinder with no SPI. When using a muffler with SPI, the exhaust gas is pumped down into the crankcase. This is good for more than 2,000 to 3,000 lost rpm.

• Longer Runs: In addition to running as a diesel, there are a couple of techniques to get longer engine-run times. The first is to use the tank from the Dragonfly. It has 11cc capacity, compared to the Black Widow/Venom/Texaco capacity of 8cc. In addition, as shown in the photo, there is a tank extender from Kavan (available through Hobby Lobby International, 5614 Franklin Pike Circle, Brentwood TN 37027; Tel.: [615] 373-1444).

• Different Heads: There are at least four manufacturers of heads to allow you to use standard glow plugs or special plugs in Cox engines. These units may be used for economy in sport engines, or higher performance in competition, depending on the unit selected.

The RJL and Charlie's conversions allow use of short, regular plugs. There are GloBee and Galbreath heads that allow use of GloBee inserts or Nelson plugs. You pay your money, get out the tachometer, and start experimenting to find what is best. (GloBee heads are available from a number of distributors; Galbreath heads are available from Doug Galbreath, 3408 Topsail Pl., Davis CA 95616.)

Hop-Ups: The most practical hop-up for the average individual is to carefully tune the combination of head gaskets, nitro content, and prop to match the airplane. This will get you 90% of the way there. The next-most-effective procedure is to set up a pressure fuel system and drill out the venturi to allow more air to enter the engine. That will get you to 98% of maximum possible performance.

Beyond that, you get into the "pro" stuff. Serious engine hop-up involves lots of experimentation and scrapped parts.

Experience, testing, patience, and a deep wallet are the main requirements for success. It is not for the casual modeler or one who doesn't record the results of experiments.

Here is where you really are on your own! Any of this stuff will void your warranty. And more often than not, you will hop-*down* an engine rather than hop it *up*. An entire new article by an expert in ½A engine hop-up would be needed to really cover the subject. All I will do is describe the types of true modifications people do.

Hop-ups usually start with custom fitting of parts by selection or lapping techniques. Then people modify timing of the cylinder ports and crankshaft ports. Shimming the cylinder up or down to achieve timing changes is one way this is done. Another technique for timing changes is to actually machine the dimensions of the parts differently.

Extreme hop-ups involve engine re-design to use such things as full Schnuerle porting or ball bearings. People machine their own cylinders, crankcases, and tuned-pipe systems. It depends on what you want, and how much time, expertise, and money you have.

Conclusions

First: You can have a terrific amount of fun with small engines, and Cox is the leader worldwide. There are currently about a dozen Cox .049 variations to suit most of the possible needs in the hobby. If the exact combination you need isn't available, you can put together what you want.

Second: To get satisfactory performance from small engines, they need *more* care than big engines—not less. They rarely get the kind of careful attention they need. Think of flying a ½A engine after a crash, with just a slosh of fuel to hose off the dirt, as similar to pouring a cup of sand down the Weber carbs on a Ferrari.

Third: For best performance, what you need to do is easy, sensible stuff. Here is 95% of what you need to know, in a nutshell:

- Cleanliness!
- Have a realistic understanding of what the engines can do; don't overprop or over rev them.
- Select the right engine for the airplane.
- Choose your fuel to be high enough in nitro and oil content.

These few items will make you seem to be an instant expert!

The point of the hobby is to have fun! Learning how to get the most out of your engines will make it a lot easier to have that fun.

I hope this pair of articles has provided the basics you need, and piqued your interest in learning more about these fascinating bits of running jewelry. ✈

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Item Description Price
CC____ MO/Check____
Credit Card#:____ Exp____
Signature:____
Subtotal:____
SalesTax:____
Shipping____
TOTAL: $____