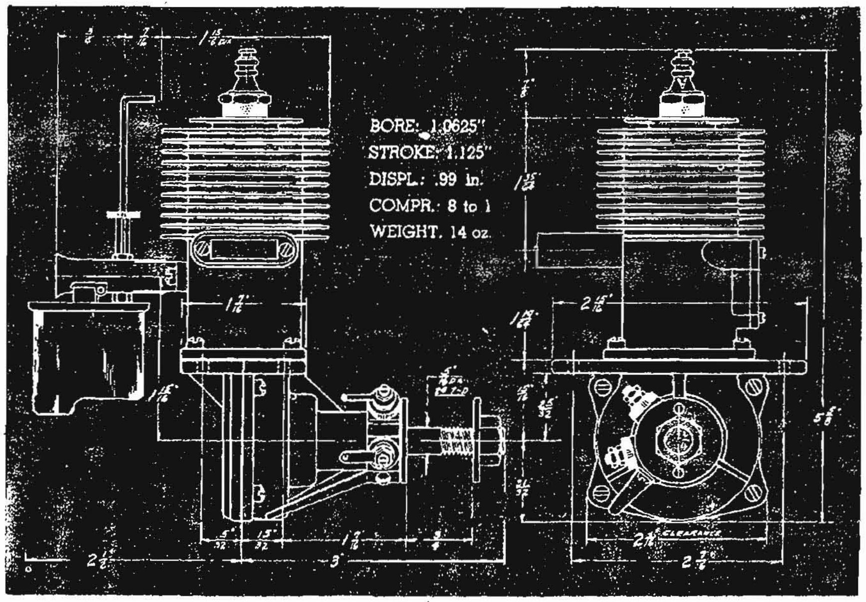
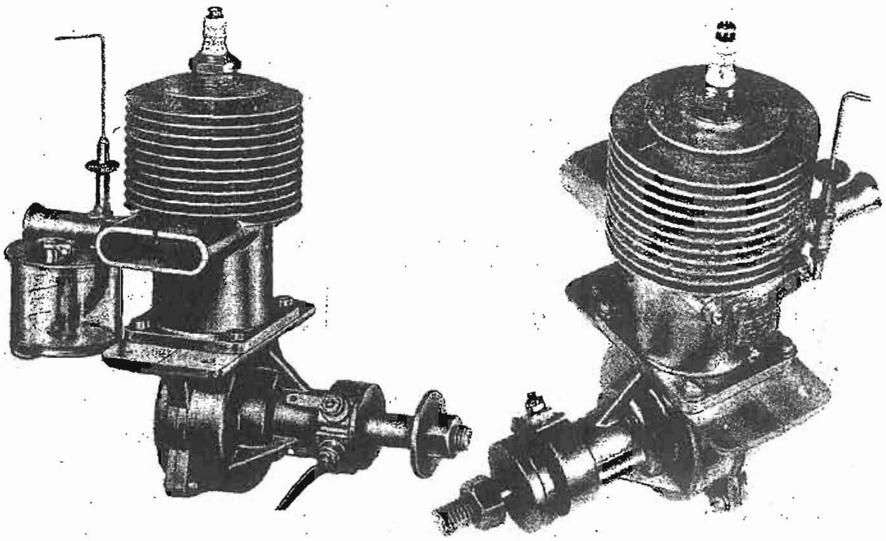
ENGINE REVIEW

In response to RC'ers' demand, Forster revives wonderful two-speed, spark ignition .99, a real thrust maker, that's for sure!

by E. C. MARTIN



Easy starting, precise power control, good cooling distinguish the .99.



The most potent reminder of old times for veteran modelers must surely be the noise and smell of a spark ignition engine, and it is with a feeling of nostalgia that we reintroduce that grand old warhorse, the Forster .99. Henry Ford was turning out the Model A when the Forster .99 made its debut and we can think of no better parallel in explanation of the unique qualities, among present day engines, than to call it the Model A of modeldom. It is not by any means the team of rampaging horses that screams out of a racing .60, and it falls far short of the urge produced by ten busy little .099 Diesels, but it has in great abundance those qualities we have almost forgotten — life almost eternal, trigger starting and reliability, hot or cold, rain or shine, and on plain ordinary gas and engine oil. Above all it is completely controllable from a lazy idle to a solid dignified roar, and it displaces air in quantities that will get 12 lb. of tissue and timber off the ground with remarkable ease. In addition to this it runs clean. With reasonable care there is no need to get a trace of oil on the finish, or even on your hands. You can go flying in your dress suit.

This Model A parallel goes just as aptly with the construction details. Obviously the cylinder is enormous with 1-1/16 in. bore and 1-1/8 in. stroke, but the crankshaft at 3/8 in. diameter would be just right for a hot .15, and when one dwells on the fact that this shaft has a 1/4 in. hole through it, the conclusion must be reached that we are dealing with a very different machine from the modern model engine. This brings us to the differences between spark ignition and the other types and, more particularly, the differences as they affect the Forster .99, for it would be unwise to run this engine consistently by glow plug.

If piston type heat engines were classified in terms of shock loading on the piston, rod and crank, steam engines would come at the bottom of the list and Diesels at the top, with spark ignition gasoline engines somewhere in the middle and glow plug between spark and Diesel. A steam engine sustains a steady push of almost constant pressure throughout the stroke of its piston. A Diesel produces a sudden concentrated blow somewhere near the top of the stroke, and a glow engine a similar shock, but of less violence and longer duration. The spark ignition engine of moderate compression ratio, like the Forster, burns its charge slowly, beginning some 45° before TDC, rising to maximum pressure at TDC, and continuing throughout the majority of the stroke, exhausting at moderate pressure. In other words the thrust on the piston is spread over a large proportion of the crankshaft revolution, and the maximum pressure, transferred to the crank when it is at TDC and taking all stress in bend and shear, is considerably less than in the other

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types of internal combustion engine. Consequently, the crankshaft does not have to be so rugged in bend and shear strength, which, of course, largely governs the shaft dimensions.

It is good engineering to build the same safety factor into all the parts as you establish over-all stability by your weakest part. The .99 is designed for a certain type of performance and it is proportioned throughout in a manner adequate for this performance. As a result it is extremely light in weight for the payload it will move. But here we have another anomaly. Its power/weight ratio in bhp/lb. is strictly old fashioned at about .7 as compared with a racing .60 at 1.5 or more, so why use it when the figures belie everything we have said? The answer lies in the fact that an aero engine is only as good as the prop it drives, and to develop appreciable bhp, an engine has to turn out five figure revs, which usually means light loads at high airspeeds and small props. Eight, nine, and ten foot models weighing as many pounds just don't fit, especially as they are so large that the small prop does little more than blow oil on the windshield. A big model with a fat fuselage has to have a prop large enough to embrace a clear airstream, and such a prop has to have an engine that is efficient at the resulting low speeds to drive it. A hot .60 turns out a fussy, erratic .5 bhp at 7,000 rpm. The Forster .99 turns out a smooth, dead reliable .6 bhp at the same speed, and for the same engine weight. In addition it is capable of idling reliably at under 2,000 rpm by means of its two-speed timer and alternating between the two figures with complete reliability. If your radio control ambitions extend to a big, beautiful, realistic nerve soother, then the Forster is your engine.

This engine is what we have come to regard as an old fashioned and outmoded design, as regards construction. However, it would be more true to say that it is a fairly efficient design for an old fashioned and outmoded type of model aircraft. In recent years we have been swept away by the novelty of small power models and the thrills of U-control, and now that these have found their own level, it seems that there is a revival of interest in big stuff because it can now be reliably controlled by radio. So the old fashioned design becomes a modern need.

Basically, the engine consists of a two-piece pressure die cast crankcase with a one-piece die cast aluminum cylinder with steel liner, the head bolted on the upper face of the crankcase. The now rarely-seen three-port induction system is used with the carburetor air intake attached to the cylinder. The bypass is effected by passing the charge through a port in the piston and a coinciding port in the cylinder into an external passage covered by a bolted-on plate, and thence through the normal bypass ports into the cylinder.

The crankcase has a front and back casting with the paper gasketed joint on the cylinder bore center line. Four bolts with lock washers hold the castings together. The two halves spread out at the top to form a wide platform which provides mounting lugs and a machined surface, to which the flanged cylinder casting is bolted with four screws and lock washers. This results in beam mounting lugs which are well above the usual crank center-line position, and since only the upper surface is machined flat, with a casting draft angle on the under surfaces, it is advisable to use the upper surface as the mounting face. This is a strong case for mounting the engine in the inverted position. Mounting on the under face of the lugs is likely, by virtue of the draft angle, to distort the crankcase and cause leakage of the center joint.

The front casting incorporates the main bearing housing and is bushed with sintered bronze. A 3/8 ID x 7/8 OD ball bearing is provided at the inside end, and stepped machined edges for point housing mounting at the outer end.

A built-up crankshaft is used, consisting of main shaft, crank web and crank pin pressed together and finish machined, heat treated and ground as a unit. The crank pin is 5/16 in. dia. and hollow, and counter-balanced by a cutaway web which accounts for a proportion of the reciprocating weight as well as all the rotating weight. The web is nearly 1/4 in. thick. The outer end of the shaft has a 5/16 thread and is provided with a flat for keying both prop drive washers, and has sufficient length to accommodate props of 3/4 in. hub thickness.

The conrod is a sturdy aluminum die-casting of T-section having sintered bronze bushings of identical dimensions at both ends, thus making the rod reversible. This contributes to long life since the lower bearing will wear first, and reversing will extend the period before wear becomes serious.

A gravity cast aluminum piston with stroke length skirt and two cast iron compression rings is used. The wrist pin bearings are honed to the tubular hardened and ground pin, which is retained by a miniature snap ring at each end. A nicely contoured low compression baffle giving high turbulence completes a beautifully workmanlike job. An indication of the accuracy of fitting and wearing characteristics of rings and bore is the fact that at the conclusion of the tests, some four hours' total running, the rings were worn very evenly and the break-in grooves were still visible, as were the honing marks in the cylinder bore.

The port in the piston skirt which forms part of the bypass system is cored out during casting, and is arranged to open fully at bdc, and to commence opening before the conventional bypass ports.

This arrangement gets the charge moving preparatory to delivery to the cylinder, since there is a slight vacuum in the passage trapped from the upward stroke of the piston.

Twelve very deep tapered fins provide efficient cylinder cooling and the engine appears capable of sustained idling with very little air movement without overheating.

A die-cast exhaust stack mounts to a suitable face on the cylinder and is retained by two screws inside the stack. For scale applications a realistic plumbing system can easily be fitted by constructing it so that the screws come on the outside.

Square multiple cylinder ports are used throughout, and a great deal of the volumetric handicap of three port induction is overcome by making the carburetor port narrow and fairly wide. The corresponding air intake is a bolted-on die casting with a trumpet mouth, a 1/4 in. bore and a narrow diverging passage to the inlet ports. The .29 intake bore is rendered more efficient at high speeds by having a spraybar offset to the very edge so that there is no obstruction to mixture flow. In practice this system works very well with smooth, progressive needle control and smooth instant pick-up from low to high speeds.

The spraybar itself features a very fine thread and locknuts at both ends to permit correct positioning of the jet hole in relation to the intake passage. The needle is ground to a fine point and is soldered into the standard Forster split sleeve nut type of control knob.

The very successful Forster patented point breaker housing is used with twin point sets, providing simple and precise adjustment for gap by means of thumb nuts. The moving point rockers are hardened and tungsten points are used, as a result of which no point adjustment was necessary throughout the tests.

The .99 handles delightfully, as we have said, and we can say without reservation that the most discriminating users will be well satisfied. This is to be expected from a big engine, but is not always found to the same degree. For those who have never before handled an ignition engine, the way in which speed can be controlled by simply moving the advance lever will come as a pleasant surprise.

The system for setting the mixture and spark controls for efficient two-speed operation is simple and straightforward, and if good batteries and clean fuel are used, the settings stay put. The clean take-over from one speed to the other enables the "throttle" to be blipped with the assurance that a known amount of power will be there immediately, and that the engine is not going to splutter and stall. It should be borne in mind, however, that gasoline fuels do not tolerate such a variation in mixture strength as alcohol fuels, and special attention should therefore be paid to tank position if violent maneuvers are anticipated.

When setting the controls, the most simple procedure seems to be to get the engine running at maximum power on the *high* points, then enrich the mixture by half a turn. Switch to the *low* points, and adjust the mixture for maximum speed and retard the ignition control until the minimum speed is obtained at which the engine will two-stroke. Switching to *high* will then give immediate response and close to optimum power, depending on where you set the point assembly for idling. Those familiar with two-speed spark ignition will find that considerable trimming beyond the limits of point angularity can be executed by adjusting the point gaps, but for normal purposes, the speed change ordinarily available is perfectly adequate for a large model.

A locking screw and spring will be found inside the housing, which, in the event of housing creep, can be tightened permanently if desired. Starting can then be effected on the *low* speed points.

TEST: Forster Two-Speed .99

Fuel: Eight parts unleaded gasoline; one part Havoline SAE 70 motor oil; Running Time Prior to Test: Three hours; Bore: 1.0625; Stroke: 1.125; Weight: 13-1/4 oz.; Ignition Equipment: Smith Competitor Coil and Condenser; Champion V 3/8-24 plug; 4-1/2 volt battery.

Props

Although Top Flite and Power Props are normally used for these tests, suitable sizes are not available for an engine so large. Props of various makes, both domestic and foreign, have therefore been used and we cannot vouch for their dimensional accuracy in relation to one another.

SIZE	*RPM*
16 x 4 (wide blades)	6,500
15 x 6	7,100
14 x 8	7,600
14 x 6	8,050
12 x 8	8,200
12 x 6	8,400

NOTE: *It is necessary to add ether to alcohol base fuels in order to get easy starting. Although slightly more power is available, the engine handles better with the cheaper gasoline fuel, and we feel that results with it are most interesting to the most people. Low compression ratio is the reason.* END