Fox 25

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 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 main-shafts 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 main- shaft. 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 1/4" bore restrictor, is equipped with registers for two spray-bar 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

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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.

Running Time Prior to Test 1 hour. Bore .738 Stroke .600 Weight 4 ½ ozs.

Power Prop	**R.P.M.**
10x6	12.000
9x6	12.800
7 x 10 ½	13.500
7x9	14.200
7x8	14.600

Top Flite	**R.P.M.**
10x6	11.100
9x8	11.300
9x6	12.100
8x8	12.250
8x6	12.800

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