VIC'S TIPS

Two stroke or four stroke? Vic Eastwood ponders

ALL OF THE presently competitive moto-cross machinery in the World Championships feature two-stroke engines. The 'stroker' is light in weight, simple in construction and develops a lot of power. Designed especially for moto-cross application, over a number of years of development, they have reached a point where they are just about perfect for moto-cross, with 45 or so brake horse power, good torque at low revs and clean carburation. There are a few four stroke engines used in the Grand Prix, but all of these engines are converted road or trail bike motors and have been modified for the job, rather than being specially designed.

A few years ago, before the advent of the purpose-built two stroke, four strokes were deemed ideal. They pulled a high gear at low engine speeds and revved freely, making for less gear changes per lap, whereas the older two strokes had little power at low revs and needed many gear changes to keep the engines going really fast.

The only way that a four stroke engine will be competitive in modern Grand Prix racing is for a manufacturer to design an engine *especially* for the purpose as they have in the case of the two strokes.

As you probably know, I race a four stroke VE Hagon-Yamaha, so I have a soft spot for the 'old thumpers' and it saddens me to see the two strokes doing so well, but of course it is economics which have dictated the trend. Lightweight two strokes are cheaper to produce because they have a simpler construction, with fewer moving parts. However, if modern legislation has its way then four strokes will return booming their cleaner exhaust emission gases over the countryside. Sorry, whispering over the countryside; if the exhaust is clean it'll be sure be quiet, see legislation No. XYZ . . . etc., etc.

The ideal

There are some signs of this happening with more and more four stroke single cylinder engines being made in trail bike form. Unfortunately, they are still a little too complicated to make an ideal moto-cross motor.

Our ideal motor would be able to put up with any mistake which the rider could heap upon it. Most riders change gear without the clutch (daren't let go of the bar to pull the lever in) or they use the clutch coming out of corners, slipping it unmercifully. Missed gears are often heard by revving engines, silenced only by a grating crunch as the rider's boot slams in a gear. Or following a crash the bike lays on its side with the throttle wide open and the engine flat out just waiting to explode. Apart from taking all this abuse, it must be very small, compact and light.

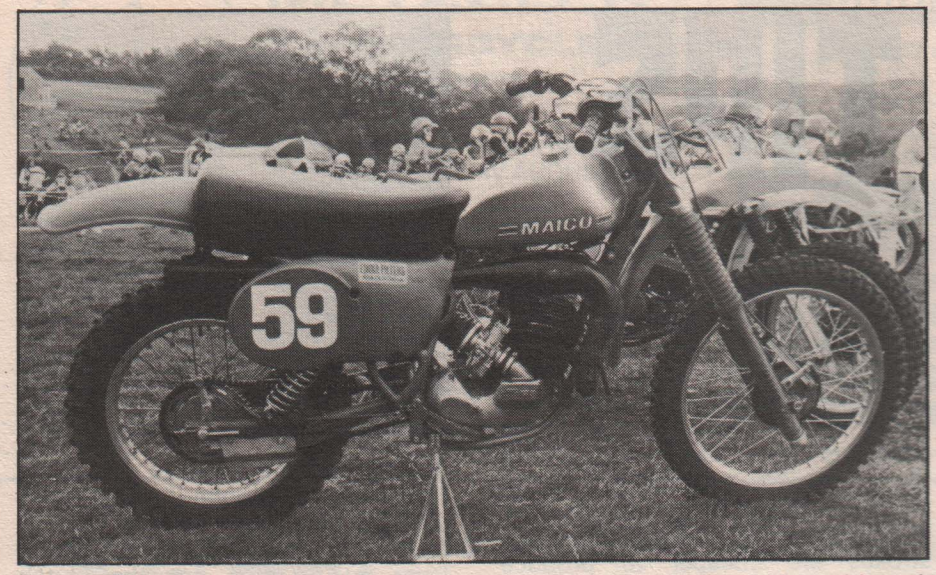
Electronic ignition is a must nowadays; it takes so little checking and adjusting, the owner merely has to keep the rotor/stator free from dust, and the wire connections clean and held together by taping. The points/coil ignition system has a lot in its favour, but takes more maintaining. It gives a very good spark at low revs (whether charged by a generating flywheel or a battery) but nevertheless needs a mechanical auto advance and retard mechanism to make for easy starting.

Alan Clews took the old BSA B50 engine, refined and improved it, and brought the CCM to fruition. Very popular, but expensive. Ironically, his new range of MX bikes will be two strokes.

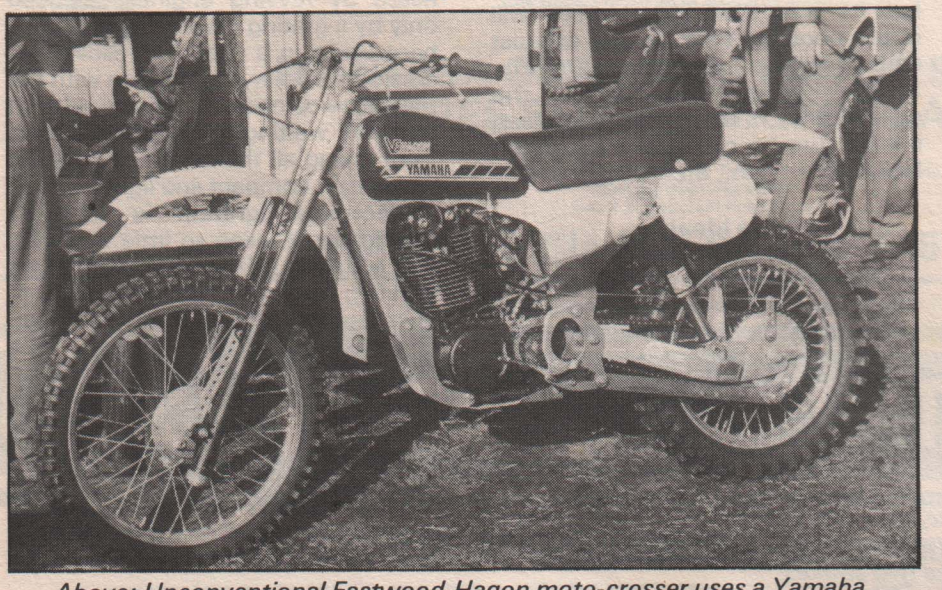
Improvements

Most engines when they are mass produced can be improved upon. The cast cylinder barrel of a two stroke leaves the inlet, exhaust and transfer ports rough. There are *always* rough edges where the ports in the cylinder liner do not exactly line up with the ports in the alloy barrel. Smoothing the ports and removing any sharp edges and steps will improve the power output, but too much filing and polishing can ruin the performance completely. When the manufacturer designs and produces an engine it will have undergone many hours of testing to find the best port timings and port sizes to give optimum output.

If these port timings and sizes are altered from standard it is almost certain that the engine will not have as much power. Yes, it may be *faster* when it is flat out, but it will have lost



Even better than a reed valve for a two stroke is rotary valve induction, although crankcase width is increased. Not a problem with the 125 Maico, but could be with bigger engines.



Above: Unconventional Eastwood-Hagon moto-crosser uses a Yamaha XT500 four stroke single for propulsion.

Mikkola's two-stroke Yamaha breathes through a reed valve.

some acceleration, or the converse may happen. Good power at the bottom, but no power when revving.

If we ignore reed valves for a moment, then the general rule is that increased inlet timing, ie a lower inlet port shortening the inlet side of the piston skirt gives more power at high revs, less at low revs. If the exhaust ports and transfer ports are raised as well, then we have a road racing type engine (a lot of power at very high revs). It follows that by decreasing the inlet timing, lowering the exhaust and transport ports, the engine becomes more docile, and we have a trials-type motor.

Reed valves

The introduction of reed valves has opened up a new dimension for moto-cross two strokes. A reed valve will only open when there is a lower pressure on the piston side of the reed than on the other; if there is an increase, then the reeds close. To get a lot of power we need the inlet port open as long as possible, as we have said at high rpm this engine will really go; at low revs, though, the cylinder will be over-filled and fuel will come back out of the inlet port through the carburation. This is what we call gassing up. If we now put the reed valve in the inlet port, then at low revs any fuel spraying back will close the reed and stop the gassing up. If the reed valve is large enough it will also let enough fuel through at high revs to give us our top end power. There are a number of variations on reeds and port layouts. Yamaha fit the reeds directly in the inlet tract *(Figure 1)* while Suzuki fit their reeds in a port which joins the inlet tract to the crankcase *(Figure 2).*

Having filled the crankcase, the transfer ports play their part in moving the gases to the combustion chamber *(Figure 3).* These must have a large entry at the crankcase throat to get as much gas through as possible. Where this gas is directed as it enters the cylinder, via the transfer ports, is very critical. It must be noted that before the transfer port can open, the exhaust is half open. The gases leaving the transfer ports must be guided away from the exhaust port to keep them inside the cylinder. This is why there are two or more ports each side of the cylinder, one large, the other small. The smaller port gives most of the direction to the gas while the larger passes most of this cooler inlet gas over the piston crown to keep the piston cooler and minimise piston

expansion *(Figure 3)*.

Normal practice with exhaust ports is to make them very wide, with a central bridge to stop the piston rings from entering the port and breaking. Most of the hot burnt gases leave the

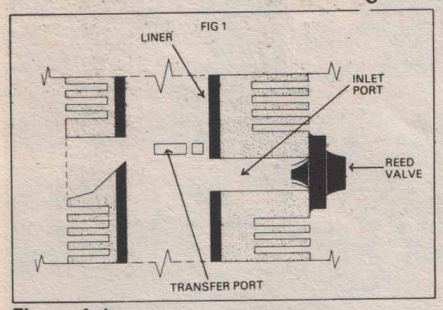


Figure 1 ▲

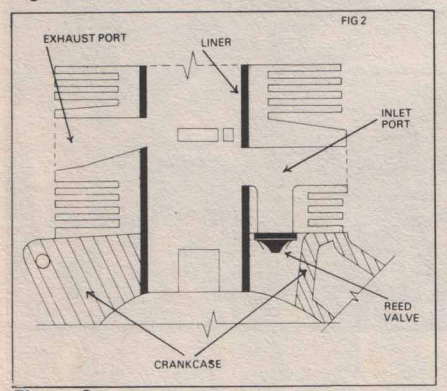


Figure 2 ▲

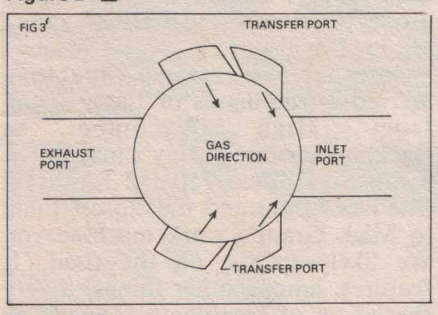


Figure 3 ▲

port as soon as it is open, so the port is wider at the top than the bottom. A problem with using an exhaust port bridge is that it gets very hot, due to the exhaust gases passing either side of it, and expands inwards — sometimes causing seizures. This is so bad on some engines that the bridge is relieved a little by grinding and some very small holes are drilled in the piston for extra oiling. It also helps to give a good long fillet of aluminium behind the bridge to help dissipate some of the heat.

One thing I must stress at this point is that if you are not sure of *exactly* what you are doing, then get your engine tuned and 'cleaned' by an expert.

Right: Two shots from the Bel Ray Sponsored Schoolboy National Championship. Above is Junior rider Jamie Addis, Yamaha mounted, while below is Senior A1 class competitor Gary Hamilton.