can-am

motorcycles

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Looking back fifty years
Chapter four [first production engines]
David McLean 1971 to 1976

The evolution of the Rotax engine from 1970 concept to proven 1973 production. The very first engines were in 125cc form. Starting at the inlet was a 27mm Bing carburetor and a long 27mm curved inlet manifold and when the 175cc engine was introduced this was retained for the first series of fifteen engines. However, it was known that a 250cc engine would be eventually made, and that there would be a common carburetor and manifold size for all three engine sizes, so the carburetor and manifold dimensions were increased to 32mm for the second series of engines. The lubrication of the engine would be provided by a proven Mikuni oil pump. This pump had a long term proven record on Japanese motorcycles and on our prototype and production engines had no recorded failures. It had two equal capacity outlet ports; one to a jet on the inlet manifold [to lubricate the rotary valve and crankcase interior], and one to the crankshaft right hand main bearing [surplus oil would be caught by a slinger plate on the crankshaft and guided to a hollow crank pin and then to the big end of the connecting rod and then to the crankcase interior].There were three different capacity pumps, for the three engine sizes. On the control arm 125, 175, or 250 was stamped. The output of the pump was controlled by engine speed and throttle cable controlled arm. If clean, quality oil,air and fuel were supplied to this under stressed crankshaft ass'y, one could expect many hours of trouble free use.

The rotary valve is made from .6mm stainless steel, and it was originally located by a key way on the crankshaft and shims on both sides to center it in the rotary valve cavity. This shiming is a tedious job for production or for one rebuilding an engine. This was changed to a spline system, where a keyed sleeve was located on the crankshaft and this sleeve had external splines. The rotary valve now had a slip fit internal spline and could now float to a mid position in the rotary valve cavity.

The cylinder and head had enough fin area to provide cooling for almost any competition event, [a mud covered engine with no forward movement would be considered a too extreme event]. The original cylinders sat on a .5mm paper base gasket and were held down with four taper seat nuts torqued to 20 ft/lb. It was found that this torque setting could not be maintained for a long period of time. To verify the torque, the cylinder head had to be removed and a long extension used to verify. One could not expect every customer to check this, so the nuts were changed to a large flat base style and the cylinder base changed to accept this. This improved the time needed to lose some torque but eventually a new more dense .5mm gasket was needed and the torque spec. raised to 22 ft/lb. All of this applies to the 125/175 engines only, the 250 engines have four long studs passing through the cylinder and cylinder head.

The crankcase has a drain plug. This could be used to drain excess gasoline accumulation or in a worst case situation, water if one's enduro bike was left lying in a river. If a longer pointed bolt was used [8 x 1.25mm] the crankshaft could be locked at TDC.

The piston ring condition is one of the most important parts of good engine performance. In a two-cycle engine the rings work under extreme conditions; not always well lubricated, passing over many ports, particularly a wide exhaust port. To assure good performance, the rings must make good contact with the full circumference of the cylinder bore, and have minimal end gap. The condition of the rings is something to verify often in a competition engine. With this engine a controlled circular squish band is used between the piston top and the cylinder head. Each size engine has its own squish gap and it is controlled by shims.

The primary drive gear is located on the crankshaft by a key way, this key is not strong enough to pass the shock loads to the transmission alone. Its holding nut must be torqued to 90 ft/lb and a liquid thread lock used. Most primary drive gear engines use helical [angled] tooth form gears. One of the reasons for this is to reduce gear noise, however these gears are not efficient in transferring power. Rotax chose to use narrow spur [straight] tooth form gears, and to minimize noise the gears were ground to a matching pair. Competition performance had priority over noise.

The large clutch gear originally had a rubber cushion drive to the clutch drum, however after many hours of use, rotational play developed and it was changed to rivet the gear directly to the drum. These matching ground primary gears had to be held in perfect alignment. Eventually, it was found that if good steel was used throughout the drive train it would not be necessary for a clutch or rear wheel hub cushion. The clutch drum and hub are made from relatively soft aluminium and the clutch plates are made of steel. After many hours of hard use, indented grooves develop in the contact surfaces. This results in non progressive clutch engagement and disengagement and also results in hard to find neutral when the engine is running and the engine is in gear.The expensive repair for this problem is replacement of the clutch hub, drum and attached matching primary gears.

The three ramp clutch release design resulted in very heavy clutch lever pull [even with a nylon lined, opened bend clutch cable]. With the first 125 engines with light clutch springs, pull was light and progressive, but as the 175 and 250 engines were introduced with stronger and stronger clutch springs the drag on these ramps increased to the point that progressive clutch engagement and disengagement was elusive. The change from aluminium to a magnesium clutch cover with the 250 GP and MX 2 models did not help the problem. Rotax were committed to the dies of this inferior clutch release design.

The kick starter gears proved to be very reliable once the correct steel and heat treatment was found. The kick starter shaft is an unusual design in this engine, in that it is not a solid shaft but is a thin wall tube with the gear shift shaft passing through its interior. The kick starter shaft is even thinner walled at its outer splined end where the kick starter is attached.

The Rotax torque spec. for the high tensile steel bolt in the kick starter hub is 15 ft/lb. This is needed to securely lock the splines together, and this is easily done with the engine out of the frame. However, once back in the frame there is no access for a torque wrench and one must use a reasonable amount of force with a hand wrench to secure this bolt. What does reasonable feel like? It is probably in the area of 10 ft/lb which is not sufficient. After a period of months or years rotational play will develop between the splines, and if the hub bolt is not re-torqued to eliminate this play, the peaks of the splines will eventually shear off. The kick starter will not function anymore and the engine must be disassembled and expensive parts replaced.

The O-ring that seals the gear shift shaft to the kick starter shaft joint, can be an area of leakage.The chamfer on the end of the kick starter shaft and the machined groove in the gear shift shaft must be in proper alignment and be corrosion and dirt free. However, this is an area where muddy water can collect and could often be cleaned with a high pressure hose. This can interfere with O-ring sealing and water may pass by into the engine and oil leak out. This is a flaw in gear shift shaft seal design, there should be spring loaded oil seal with an outward facing shield lip.

The gearbox cavity is where most of the serious problems were in the prototype engines. The first problem was the difficulty of shifting into the next gear. On our competitors' good shifting gearboxes, the gear dogs were always considerably more narrow than the slots they had to engage with. With the Rotax gearbox, the dogs were almost as wide as the slots they had to engage with. The slots could not be made any wider for structural reasons but a request was made to reduce the dog widths by about one third and the five degree under cut angle ot the engagement surfaces retained. When the new gears arrived, the problem disappeared. The next problem that appeared with many hours of testing, was gears and both gearbox shafts breaking, that could result in a need to replace the crankcases. The gear shifting mechanism pivoted on a steel shaft that was cast into the aluminium sand cast crankcases. On a number of engines this shaft became loose, stopping the shifting, this was not repairable and the crankcases needed to be replaced. When the 1973 production pressure die cast engines became available this problem disappeared. On a competition engine such as this, it is important to be able to shift easily and have no missed shifts. Attention was given to all six gears, in that the shifter mechanism would shift each gear to just under 100% engagement and that the shift drum index cam and plunger would hold the gear in that position. While in this position there still had to be running clearance between the shifter fork and the engagement groove in the gear, to prevent galling of the shifter fork surface. The first engines had the gearbox output sprocket connected to the shaft with a taper and a key way [similar to the ignition flywheel connection to the crankshaft]. This was done to have a strong large diameter output shaft. This required a special puller to be used to remove the sprocket. Once there was a change to better steel, a conventional spline could be used and the sprocket could be removed with standard tools. Once the 1973 production engines arrived, the steel quality in the gearbox improved and all of those detailed measurements needed for a good shifting gearbox were completed. The gearbox was now an easy shifting gearbox [with or without clutch use] and it did not break anymore. All of this knowledge gained from this 125/175 six speed gearbox, now could be transferred to the wider and stronger geared 250 five speed gearbox.

The Bosch CDI [capacitor discharge ignition] was fairly new at this time. Only a few motorcycles were actually being tested during the prototype period of 1972-3. However, the failure rate of the ignition was very high, and it could occur in any of the three electrical components, [the charging or trigger coils on the engine backing plate or the electronic box/ignition coil mounted on the frame]. The most likely failure being the charging coil in the engine. With 1973 production, the failures continued but at a very low % rate and they were covered by warranty. For a vintage can-am that will be many decades old, this ignition failure problem continues on. The trigger coil and the electronic box are sealed with epoxy but the charging coil is not. The insulated copper wires are protected by a wrap of cloth.
With ageing and possible freezing or scorching heat temperatures and humidity, the wire insulation deteriorates and the charging coil fails to produce enough energy for a spark.
A new [if available] coil, a rewound or used coil are the possible fix.

All early can-am's and TNT's have aluminium pressure die cast crankcases and outer cases. Starting with the 250 GP and all MX 2 models the case material was changed to magnesium for a weight savings. When this magnesium is covered with paint or an oil film, it is stable, but when left unprotected in a humid environment severe corrosion can occur.
One of the more likely areas is the unsealed ignition cavity. Wash water, humidity and condensation can cause severe damage inside.

This Rotax engine in all sizes 125/175/250cc would prove to be a very competitive and reliable engine for many years into the future. With the benefit of hindsight, one can see some flaws. If Rotax was provided the opportunity to restart again, they would probably eliminate them.

This year is 100 years since the birth of Rotax. In the past Rotax has been a leader in 2 cycle engine design and and now is a leader in 4 cycle engine design as well. They produce many thousands of quality designed and quality constructed 4 cycle engines each year. This Austrian company Rotax should be proud of all that they have achieved.

This is a draft of chapter four, from one person's perspective. Should others wish to add to this, please come forward.

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