I had an opportunity to visit Special Tool Solutions in Jacksonville, Florida USA, and have a look at their new-version Full-Auto cylinder heads for Norton Commando motorcycles and tour the facility where they're made..

I was amazed at the design and quality of construction of these heads. Visually, they're beautiful and much of this comes from new manufacturing processes that are advantageous in other ways beside visuals. But let's look as the various aspects and discuss important features.

The new heads are cast from #356 aluminum alloy, which is a major advance over the original alloy specification used in Commando heads from the '60s and '70s. The original heads were cast from RR53B alloy, an alloy that was developed by Rolls Royce for pistons in its aero engines during the 1920s. Being designed for pistons, it had good thermal stability and strength but is was also developed to have an amount of surface softness so that if a tight spot developed between piston and cylinder bore, the surface would "smear" slightly and avoid spalling or sticking to the walls of the bore causing seizure. Like other high-tech alloys of the period, it also included iron in the alloying composition. This is not a drawback in a piston (which lives in an internal environment within an engine and is generally exposed to the preservative effects of oil) but when used for an external motorcycle part, the iron tends to oxidize causing porosity and micro-cavities in the metal. Also, the iron content of the alloy made it more viscous when melted at casting temperatures, resulting in difficulties in assuring complete flow and filling of casting voids, particularly in sand-cast operation. This higher viscosity also meant that the casting process was more likely to distort sand cores within a mold or push them out of proper position.

The new-tech #356 alloys have been developed from the well-known 6061 aluminum alloy which is widely used for many purposes. 6061 alloy was specifically designed for production of metal sheets, so its casting properties aren't particularly good. 356 alloy, with T6 heat treatment, is reformulated to enhance its casting properties, making it a much more practical choice for Commando heads which have small and complex internal cavities within the head. But the real advantages of 356 alloy comes from its other characteristics. It's much less likely to oxidize during casting, aging, heat treatment, and use; thus it's more stable in use. It is also stronger, stiffer, and more heat resistant. The heat resistant characteristics are of great benefit, in that alloys that have lower heat-ratings exhibit a metal characteristic called "creep" -- in this case, the metal doesn't break or visibly bend, but under heat and stress, the metal moves under stress. If anyone has had experience of a Commando head that's hard to torque down evenly on a headgasket or which has developed raised conical "dimpling" where studs are threaded into the metal material has likely been seeing the effect of metal creep and can understand how it can be a root cause of head distortion and failure of headgaskets in service. 356 alloy is more resistant to creep at lower and higher temperatures than more conventional alloys.

All of this indicates that the alloy chosen by STS for their new heads is a considerable improvement over the original alloy used in Commando cylinder heads. In addition to the physical characteristics, use of these alloys in conjunction with newer casting equipment and techniques gives a casting which is much improved over those commercially available in the 60's and 70's. This alloy has an advantage that if flows more smoothly in casting, which means that if fills mold cavities better and gives better and

smoother surface appearance; of course, it also provides for accurate shaping of items like fins, less porosity on surface and internal areas, and correct placing for internal cavities in the finished casting. For a final look at a topic that impacts on the quality of castings, we need to consider the issue of casting tools, the forms and molds used in the casting process. Although molds and forms came from the original Australian producer of this new type of head, STS did a small trial run in those molds and found things that they felt needed to be changed. First, the old tools had considerable wear on some areas which resulted in poor castings. Also, STS wanted to modify the base castings to provide more metal in areas that demonstrated a problem on Commandos in service. They re-digitized the factory heads and added metal in the area around hold-down bolts and studs, more thickness in and around the intake and exhaust ports, areas for wider gasket surfaces, and more; also, changes were made to allow more complete and accurate mold filling. Using the more precise digitalization, they ensured that the head is symmetrical side-to-side, giving more strength and uniform cooling and assuring that there was sufficient metal for performance or racing work. Since the old molds were showing wear and deterioration, it was time to make new molds and forms from high-density phenolic to assure that the design improvements were and to provide long-lasting tools for future production. Test castings and the first production run showed that the new molds and forms produced castings to the highest level of quality and incorporated the improvements brought in during the specification process.

After the bare castings are cleaned, heat-treated, and delivered to STS, they receive a thorough inspection. After this, they're moved for installation on a five-axis milling machine. This is the heart of the major update to modern technology for these Norton Commando cylinder heads. After setup in the machine, the upper surface which mating to the head steady is machined as a reference surface and the three fixing points are drilled and threaded, and the head fixing bores (the four bolts, two each adjacent to each spark plug, the center forward hold-down bolt are machined, and the locations to accept cylinder studs between the exhaust valve covers) are bored. (Note - all threads in the head are set by "rolling" the threads in the metal of the casting. This has great benefits - the dimensions for the threading can be more precise, the rolling process prevents stress-raiser cracks and rough spots that can result from "cut" threads, and the process compresses the metal making it more dense and stronger and also aligns the grain within the metal.)
The top surface is checked for smoothness and surface imperfections and then placed upon the milling table with the headgasket side up. The 5-axis milling machine allows full access to all parts of the head not hidden by being fixed to the table. The head gasket face and the faces for the valve covers in the head are machined on a plane to provide good gasket sealing; the 5-axis machine gives an advantage that tools (mills, bits, curved or tapered cutters, etc.) can be changed quickly and easily, allowing the best cutting tool to be used to give the preferred form and surface finish. (Tools are kept in a rotating holder that looks like a revolver chamber; in a matter of seconds, the machine can select a different cutting tool - as directed by the CNC programming - eject the previously-programmed tool, place it in its home position in the revolving holder, and secure the new tool into the mill's cutter mechanism, without any human intervention.)

Thus assured of the most leak-free surface at these points, the combustion chambers are cut with the spark plug holes drilled and threads rolled, cavities for the valve seats recessed, and cups for the spring

collars are cut. At a precise angle, the bores for the valve guides are cut, and locations for the studs - two at front center and one at rear center in the head gasket surface - are bored and threaded. As a part of the external machining, the flat areas on the sides of the heads are milled, the valve spindle bores are cut, the oil drillings are installed, and banjo bolt threads and locations for the spindle end covers are rolled in.
Now comes the "high tech magic"! The ports are machined using the full capabilities of the 5-axis milling machine. The intake ports are machined with circular 32mm openings at the manifolds and are fully contoured into shape with profiles following modern porting principles. All port profiles are fully machined throughout, providing precision complex-curve port shapes and excellent finish characteristics; and - of high importance - the 5-axis computer controlled capabilities mean that the ports are symmetrically matched to be a perfect mirror image for each other. This machining exercise is repeated with the exhaust ports (due to their casting shape, the exhaust ports do not require as much tooled machining as the inlets). As a final step, special STS valve guides, made from a high-tech bronze alloy and high-strength valve seat inserts are installed; also, steel thread inserts for the head gasket fixing studs are installed..
Following the machining and assembly process, the heads are inspected using modern digital measuring equipment to assure a perfect final product.

The STS Full Auto Commando cylinder heads are a modern, high-quality product in every way. They're suitable for direct fitment as an upgraded "standard" component, or as a stronger head for a lightly tuned sporting engine, or they're the suitable base for full, radical porting on an all-out racing engine. The finely finished gasket surfaces and low-porosity castings reduce oil leaks to a minimum and prolong head gasket life and upgraded design and manufacturing gives added strength in all critical parts of the head. There are versions for the 750 and 850 Commando engines. Whatever you need in a Commando head, these heads are the perfect answer. I only wish that we could have had them 50 years ago!

Bruce Henderson