Scott Cranks ... The Saga !

One evening, I received a phone call from Stan Thomas, asking if I had any long stroke Scott cranks left over from the previous batch made for the club in 1977 /8. I told him that the club had chosen to order only ten pairs of long stroke and ten pairs of short stroke cranks at that time. As the long stroke cranks are significantly more heavily loaded and of a weaker design than the short stroke cranks, then the long stroke items had sold out very quickly. I explained that I was not exactly looking for extra work, as I am oversubscribed with aerospace related contracts. Stan realised that the only way he could have such cranks for himself, was if he could arrange for a commitment for 20 sets that I stipulated as being the minimum batch quantity to be viable. In order that there be absolutely no misunderstanding, it should be clearly understood that Stan Thomas has carried out the advertising for the sole purpose of enabling a batch of special cranks to be made, without any personal gain. This initiative was to enable both Stan and other Scott owners to have the possibility to obtain such cranks. All monies will be paid directly to Moss Engineering .

I decided to set down an outline of my involvement in the manufacture of cranks from 1967 to the present. Some of this has been set down before, but I will repeat some details so as to give a complete picture and hope that those who have read some items before, will be understanding.

In 1967 I purchased the 28 (29 model) TT Replica now owned by Ted Parkin. It soon suffered a crank breakage and this led to me visiting Tom Ward at his Scott Mecca at Wilfred Street Derby. Tom told me that there were no cranks to be had and that he had a waiting list for second hand cranks. He could put my name at the bottom of this list and in due time, it was possible that a crank could be found. He warned that he could not guarantee that such a crank was free of cracks.

I was very fortunate to be involved in a family engineering business and decided to make a batch of cranks, so as to supply my immediate needs and those of several other Scott owners.

I consulted a metallurgist from the specialist steel company Richard W Carr of Sheffield, and the nature of the problem was discussed. The original Scott cranks were made from a non standardised good quality mild steel. This is a steel with low carbon content but without any significant content of nickel, chromium, vanadium etc that would toughen the core. The crank was manufactured with extra metal left where it was subsequently to be ground. It was then cooked in a sealed box containing charcoal. This causes carbon to be infused into the surface of the metal to a depth of 0.025” / 0.035” depending on the duration and temperature of the cooking. A process of heating to remove stresses might have followed and finally it would be heated to a red heat and quenched. The outer section of the crank that has received the infusion of carbon would be hardened to approx Rockwell C scale 60 / 62 and final grinding would then take place. The interior of the crank that had not received extra carbon, was incapable of being made hard and so remained comparatively soft. If you try to bend two items of similar shape, but dissimilar material, it will be noticed that given the same effort, one will bend further than the other. It is also a fact, that stiffer materials are more prone to crack if subjected to bending than softer items. The Scott crank therefore relied heavily on the strength of the hard but brittle thin “hardened case”. After a period, the flexure of the crank will cause cracks to appear in the thin hard outer case. The crank now had only the strength of the soft inner core to sustain it. Any flexure would be concentrated at the weak points where the hard case had cracked and future failure would be imminent. It was decided that it would be better to use a high tensile steel that would be of equal hardness and toughness throughout and less prone to cracking. I was advised to use a nickel chrome high tensile steel recommended for such use where alternating stress fatigue was a problem.

I made a second batch around 1974 but with slight alterations to increase thicknesses where possible.

In pursuing my racing, I was putting my engine under much greater stress than normal, so the failures kept occurring. I was breaking two to three cranks per season, with attendant crankcase damage.

When I started racing in 1970, there were many Scotts racing, perhaps six in each relevant race. Compared with a four stroke, it was easy to tune a Scott for more speed, you just open up the ports to give longer timings. You lost some bottom end torque, but that was an acceptable trade off if you were racing. Year by year, the Scotts disappeared from the track, as frequent crank breakages took their toll.

I revised my main bearing arrangement, not because the Scott design was inadequate, but because I wanted to gain room for a thicker crank. My first mod was to fit Timken taper roller bearings in conjunction with thicker cranks.

My next step was to remove the Scott cups and shroud rings and replaced them with a dural cup housing XLS 1½" ball bearings. The cranks had a 1 ½" boss on the rear to locate in the ball bearings and had no undercuts in the thickened rear face. This arrangement proved quite successful and is still installed in Ted Parkin's UE 7373.

After the carnage I had experienced, I was still nervous of crank failures, so when I finally devised a scheme to incorporate outer bearings, so as to make a four bearing crank assembly, I carried this out in 1977. The inner crank and bearing arrangement was almost identical to the then current design with the addition of the outer components.

This four bearing arrangement was made from modest 55-65 TT nickel chrome steel turned on a lathe. It lasted from 1977 to 2002. My judgement had been that the Scott long stroke crank would inevitably fail and only the life span would vary with several factors. From my observation the LH crank fails 60% to the RH 40% due to differing damping flexure relative to the primary drive sprocket.

In 1997, cranks were again unavailable and I was asked if I would manufacture some "unbreakable" cranks for the club.

I explained that this was a contradiction in terms, but that I would do all I could to make cranks to the strongest standard whilst still being interchangeable with standard cranks. It was not an option to consider variations that would require expensive modifications to the crankcase.

My first action, was to measure many cranks and crankcases to discover if there was any possibility to thicken the cranks. This uncovered many minor variations in the Scott product. It became evident that in late 1928, when the long stroke engine was introduced, they thickened the crank disc by 1/64" and modified the rod as the big end was now no longer central with the cylinder bore.

Several areas were identified where small but significant beneficial changes could be made, especially concerning the undercut machining on the rear face of the crank disc. This feature is a major source of weakness and detracts from the support needed by the crankpin on the opposite face. When all possible uplifts had been considered, it was time to reconsider the material.

I have been fortunate to have learned a reasonable amount about metals from metallurgists, but as you can never know enough,. I decided to ask for advice from the Institute of Metals in London.

I phoned and explained the outline of the problem. They replied that I would need a “Consultation”! I mentally started to ready myself for financial ruin, but they then asked if any of these cranks would be exported. When I replied in the affirmative, they told me that they were part funded by the government, as a service to industry where export was involved, so that the “Consultation” would be free. I replied that I could just about afford this, only to find that the other person had no sense of humour.

It was arranged that a “specialist” would visit the following Friday. When he rang to get directions, I explained the location of my village and the small lane, of which I am at the end. You could hear his voice becoming progressively more unimpressed. On the great day, our “specialist” arrived, resplendently suited and in corresponding transport.

I greeted him in my overalls. As he eyed the exterior of my modestly deceptive workshop, you could see his lip curl! He pulled himself together with that “well let’s get it over with” look and asked me about the problem. I showed him a collection of broken Scott cranks, from my very black museum. He mused for a while and then said that I could either use EN40B and nitride harden, or EN36 and case harden, or EN19 with appropriate heat treatment.

With a monumental effort at self control, I respectfully asked where he acquired such knowledge as enabled him to guide such as I. He replied that he had learned this technology whilst working for BSA at Umberslade Hall.

The origins of the EN series of steel specifications are not universally known. In short it was this:-

In 1939, when Britain was considering what steps should be taken to gear up for the large scale production of munitions and machines of war, it was realised that our steel industries were not standardised. Many small companies existed who made steel to unique recipes, each claiming some advantage and calling it’s products by idiosyncratic names.

The government realised that if we were to successfully make war materials of a controlled and consistent nature, then these companies would have to make the same range of products. All the metallurgists from these companies were assembled in a hotel and told that they would only be let out when they had agreed on a range of common steel specifications. They were told that each of these specifications would be given an “Emergency Number” This is what EN stands for and it was intended to be in operation only for the duration of the war. You might understand my disappointment, that when, in 1997, after I had enlisted the help of the leading learned body in the UK on the subject of metal specifications, I was recommended to use metals that were technically an amalgam of 1930’s steel technology.

I had shown him the Scott I use for vintage racing, so he asked what I had done for this engine. I explained that I had employed significant design alterations to incorporate a four bearing crank and titanium con rods. He was startled and asked why I had used titanium, I told him and he nodded agreement. What spec did you use, he demanded. I again told him. Why that spec?, again agreement. He then said that “he had not expected to come to a place like this and find someone using titanium for con rods. Furthermore he said that the Institute had only just completed a “Commission” for Ferrari, to advise them what metal to use for the con rods of Mr Schumacher’s formula one car for 1998. At the conclusion of their investigations, the Institute had advised Ferrari to manufacture the con rods of their latest formula one engine from titanium of exactly the same specification as I had employed on my Scott vintage racer. He supposed that I had made these titanium items recently. I reached out and took from a shelf, a pile of engineering drawings which showed him the design of the titanium con rods and the date 1977!. I explained that we Scott owners took great pride in caring for our much prized mounts as well as we were each able. The realisation that this Scott vintage racer had titanium con rods twenty years before Mr Schumacher, was visibly unpalatable to our friend, but after a few seconds silence, he asked if I knew that titanium was abrasive? I replied that I was aware of this. What did you do to cope with this problem, he demanded. I told him that rubbing faces were plated with silver. Why silver quoth he? Ye Gods! I thought, where do they find such experts? I explained that silver was used on Norton racing pistons in the 1930's and that it was commonly used on space vehicles where oil was not suitable. He wrote down all this information and told me that he would contact Ferrari the following Monday, to advise them of the Institute's latest recommendations. He told me that if I wanted any further assistance, then I could contact him again. With this kind offer he left.

A brief look at history books will reveal that the British are not inclined to accept defeat readily when challenged.

I decided that some lateral thinking was called for.

Question. Where is the greatest need to achieve the highest strength of metals in relation to size and weight?

Answer. In space vehicles and fighting aircraft.

Question. Where are most of these made?

Answer. USA

Response. Ring USA Embassy in London. Question, is there an Institute of Metals in USA? Yes!, Can I have phone number?

I ring Institute of Metals in the USA. (The inmates had not been trained at Umberslade Hall)

I explain the problem and the need to source the very strongest material available as the design is beyond the capacity of conventional metals to cope.

I bought high purity high strength vacuum arc remelted military spec metal (300 M VAR) as used by Macdonald Douglas for critical aerospace applications.

Clive Waye was living and working in California at this time and was very interested in the project. He agreed that the metal should be delivered to him and then given to a local machine shop for rough machining.

Following this it was heat treated to 110TT approx 52 Rockwell C scale by military heat treatment specialists.

The part finished cranks were then shipped to myself for finish grinding.

The finished product represented a great advance on any previous items in terms of specification.

I will never claim that they are unbreakable, but that they are the very best that present knowledge can provide.

The life of any crank is greatly effected by the alignment of the rod and small end and integrity of the big end bearing. The big end bearing should not be too tight. If the rollers have to be pushed out, it is too tight and will have a short life. There is a widespread misunderstanding regarding "Forging" This technique is mainly used to reduce manufacturing costs in mass production applications. Although some modest advantages accrue from forging if accurate and expensive close forging dies are used, these do not give the materials used in this process the qualities of the materials I used. It is not a process used extensively in critical aerospace applications.

To put everything in perspective, I was born 100% ignorant and it is my ambition to die 99.5% ignorant.

If we maintain an open mind and our thirst for knowledge continues undimmed throughout our lives, then this great goal might just be attainable!

Kindest Regards to all fellow Scott lovers

Roger Moss