

More talk about Light 15 crown wheel and pinions by Bernie Hadaway

The teeth on our spiral bevel pinions live in a very stressful environment and anything we can do to make

their life less stressful and long lived is less stressful for everyone. Stressful lifestyles, as we know, lead to *fatigue*. This, I believe, is a cause for spiral bevel pinion failures in Light 15 gearboxes – and many other gear failures, if it comes to that.

*Metal fatigue* takes root from surface imperfections, such as grooves or machining marks, where high stress concentration, above the average operational stress forces takes place. They are particularly of concern when the grooves, or machining marks are in a plane across the applied acting strain forces [bending].

The stressed concentrations, when repetitive, cause local surface cracking sympathetic to the surface defect, and in a short time will generate into a total *fatigue failure*. The progression of *fatigue failure* can be traced across the fracture surface after a gear tooth separates. The surface of the fracture will show the progression of the fatigue crack which can nearly always be traced to a surface irregularity.

An analogy of *selective fatigue* can

be observed when a length of wire – coat-hanger wire would do – is vee notched with a file and then subjected to repetitive bending. It will invariably break at the notch,

whereas wire without notching will not when subjected to the same treatment.

It follows, that if we can avoid areas of stress concentration on the spiral bevel pinion, then the life of our Light 15 gearboxes should improve – and as a consequence, ours as well.

The source of *stress fatigue* is generated from the longitudinal machining marks or grooves, in the pinion tooth root or gullet, left over from the gear hobbing process. In most cases where adequate design safety factors exist, low stress is encountered and the marks would not be a problem. In the case of the

## TECHNICAL TALK

Photo 1: 1/8 inch diameter diamond plated burr driven by a s m a l l 25,000rpm modellers' power head



Light 15 crown wheel and pinion it does not appear to be the case, and it is reasonable to consider the removal of the marks.

It is not a difficult undertaking.

## TECHNICAL TALK

Photo No. 1 shows a pinion where the gullet imperfections are converted into a smooth fillet radius. It will provide the opportunity for uniform stresses in this vital area and should increase operational life.

The correcting tool is shown. This is a relatively inexpensive  $\frac{1}{8}$  inch diameter diamond plated burr driven by a small 25,000rpm modellers' power head. The tool's rotation leaves directional marks in the tooth gullet which will not cause *fatigue*. The longitudinal imperfections have gone.

Photo No. 2 shows typical hobbing marks before removal.

There can be other longitudinal marks on the pinion tooth flanks; these will be on the forward drive pinion face. They usually result from

too much meshing clearance between crown wheel and pinion, and are discovered when we pull down a box for maintenance. These marks are caused by *tip interference* when the pure involute action under power is not achieved. The tips of the crown wheel teeth bear hard into the pinion tooth face due to poor involute action, resulting in surface spalling of the pinion tooth faces. If these marks are not too bad I am inclined to blend them out before returning to service.

Photo No. 3 shows what to look for. I have exaggerated a typical defect for photographic purposes.

Problems associated with *tip interference* are now recognised and computer programming of gear cutting geometry provides precise *tip relief profiles* on the gear teeth and would be great on Light 15 crown wheels!

If we examine the crown wheel – as is the case with my example – we will see evidence of the high-pressure edge at the tips of the teeth, which is a bright, shiny line. Some indication of the contact forces involved can be appreciated by the slight chipping of the teeth on outside corners

Photo No. 4 shows this quite clearly.

One is tempted to ease these edges,

but I am not sure if I can guess a proper profile to overcome this problem – I will think about it!!

In any case, the meshing clearance, which our manual tells us about, is usually about 0.008inches.

This should be observed and certainly not exceeded because it could generate another source for *fatigue* problems.

After all this, I cannot positively qualify my recommendations as being a cure for all ills because I have only in recent times put them into practice. However, as always I *know I am right!!!* [ask my wife, Clare!!!!]

There is one more assembly precaution I take to look after my crown wheel and pinion – but this is another story.

Bernie Hadaway.



*Below left to right.*

*Photo 2: Typical hobbing marks prior to removal.*

*Photo 3: An exaggerated image of what to look for.*

*Photo 4: Slight chipping of the teeth on the outside corners.*

