CAUTIONARY TALE No 1

First of a series proposed for forthcoming editions of 'Springs'.

The Corrosion Resistant Properties Of Stainless Steel Springs

To avoid problems of corrosion or protection of carbon steel against corrosion, it is common practice in spring industry to utilise an austenistic stainless steel, usually of the AISI 302 type. This type of spring material will not corrode in many everyday circumstances that would cause unacceptable red rust or even failure of carbon spring steel. However, it is well known that stainless steel is not corrosion resistant in all environments in which springs are used, and there are a number of nickel, cobalt and other alloy systems that are corrosion resistant in the more aggressive environments.

The point of this cautionary tale is to highlight three ordinary situations in which stainless steels may corrode, and be an embarrassment to spring manufacturers. After all, stainless steel springs that are visibly rusty are very difficult to sell!

302 type austenitic stainless steel is corrosion resistant thanks to the formation of a tightly adherent oxide coating – a coating that forms readily at room temperature due to reaction of the spring surface with oxygen in the atmosphere. Whilst ever this oxide is present over the whole of the spring surface, the stainless steel will be corrosion resistant.

The pre-condition for stainless steel to corrode is damage to the natural oxide film on its surface. This film can be damaged mechanically during deformation processes, such as coiling, grinding or shot peening. Immediately after these processes, the surface of stainless steel is susceptible to contaminants, especially particles of carbon steel, which adhere to the bare surface of the stainless steel and prevent the protective oxide from forming. Small carbon steel particles can be generated from coiling or grinding machines previously used to process carbon steel, or from shot peening. If such contamination is thought to be possible, the contaminant can be removed by pickling in 5% HNO3 + 1% HCl, followed by acid passivation and/or low temperature heat treatment to increase the natural formation of the protective oxide film.

Springmakers may clean their stainless steel springs prior to stress relieving in order to remove high pressure oil used to aid coiling, or to avoid black marks and uneven discolouration due to the residual soap. Chlorine-containing chemicals are frequently used for this cleaning process. It is very important that all traces of chlorine are rinsed off the springs prior to the stress relieving process, chlorine being the most common contaminant found on corroded stainless steel springs during *IST* investigations of corrosion, undertaken using energy dispersive X-ray analysis methods.

If stainless steel springs are used in an environment which contains no free oxygen (which is necessary for re-forming the oxide film), and if the oxide film is damaged in any way during service, by contact with itself or other components, or by occasional contact with an aggressive chemical, the stainless steel's corrosion resistance performance will only be like that of an unprotected carbon steel. In these

circumstances, rust is very likely, and may appear as it does in the attached photograph of a stainless steel spring that failed due to corrosion fatigue.

Oxygen-free environments encountered by springs are:-

(a) being sealed in plastic bags, or silicon rubber
(b) working in alcohol or other chemicals.

The moral of this cautionary tale is to be careful with your stainless steel springs. Make sure that oxide film remains undamaged or readily repaired, and they will remain as bright and shiny as they were on the day there were formed.