Jim Ronkainen

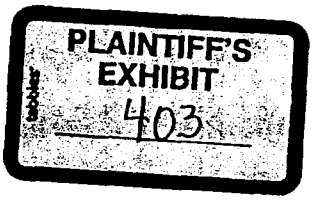
From: Ronkainen, Jim
Sent: 06/07/2004 11:54:46 AM
To: Diaz, Danny
CC:
BCC:
Subject: Revised Draft

Danny,

Attached is a revised draft of the response to Ilion's proposal. Please let me know when you'd like to review it.

Thanks,

Jim



DRAFT

Commentary on Adding the Blocker to the Current Production Trigger Assembly

Background:

The primary design objective of the M/700 Safety Pivoted Link (SPL) trigger assembly is to insure the trigger is returned and maintained under the sear within 75% of full engagement when the safety is moved to the SAFE position. Secondly, the design provides for trigger regain at a trigger pull force of 3.5 pounds. In addition, the design addresses performance and corrosion issues. Finally, the design is retrofitable into current M/700 and Seven bolt action rifles.

While the SPL trigger assembly may look and act like the current production trigger assembly, the resemblance is only a little more than superficial – the parts from the SPL safety/blocking system are not directly portable to the current trigger assembly. Ilion's proposal to simply add the SPL safety/blocker system to the current trigger assembly design without a redesign of the blocker and several other components is not possible. The issues and areas affected defending these positions are outlined below.

Trigger under the sear:

SPL safety and blocker would require complete redesign

The kinematics of the SPL safety/blocker mechanism are optimized for the SPL components and their locations with respect to each other in the SPL trigger assembly. This is a case of where the SPL and current trigger assembly designs are superficially similar – not only are the parts different in size and shape between the SPL and the current system, the relationship of the parts with respect to each other are different as well. To use the SPL safety blocker mechanism on the current trigger assembly would require a complete redesign of the safety/blocker mechanism to work as intended. In summary, while the concept of the SPL safety/blocker system is portable to the current trigger assembly, the SPL parts themselves are not.

Sear bias spring location

The SPL trigger assembly design required moving the sear spring and its support upward, while lowering the top surface of the front spacer block to give the blocker room to operate inside the trigger housing while providing easy access to the blocker adjustment screw. The shape of the sear/safety cam was also modified to facilitate the relocation of the sear spring. While it may be possible to use the current sear/safety cam and move the sear spring support from the top of the front spacer block, the motion requirements of the sear/safety cam to release the firing pin head and the space available for the revised sear spring design make this an extremely difficult problem to solve. Folding a sear spring support shelf from one or both side plates creates asymmetry between the right and left hand side plates (i.e. they are no longer a common part). This in turn defeats one of the primary reasons for going with stamped side plates: both parts are not made in the same die set, thus increasing hole-to-hole position variation between the assembled side plates.

Safety stop surfaces on rear spacer block

One of the less obvious functions of the SPL trigger housing is that the rear spacer block's top surfaces serve as the stop for the safety in the SAFE and FIRE positions. The locations of the stop surfaces on the rear spacer block are integral to the kinematics of the safety/blocker system mechanism. To ensure proper function of the safety/blocker mechanism, the SPL safety, the current trigger assembly's rear spacer block, or both would need to be redesigned.

Conflict between front spacer block rivet and blocker hold down stud

The blocker hold down stud is critical to the proper operation of the blocker system on the SPL. The blocker hold down stud prevents the deflection and twisting of the blocker so that a force applied to the trigger cannot defeat the blocking action of the blocker. To ensure the security of the blocker hold down stud, it is press fit into the front spacer of the trigger housing. On the current trigger housing, two rivets are used in each spacer block to secure the side plates and to prevent rotation of the spacer blocks in the trigger housing once assembled. The top rivet in the front spacer block presents two impediments to implementation of the blocker. First, the upper rivet's head would interfere with the movement of the blocker on the trigger housing. Second, and more importantly, the blocker hold down stud is in the same approximate location as the upper rivet. Removing this rivet to permit the use of the blocker hold down stud would require some type of mating feature between the front spacer block and the side plates to prevent undesired motion (rotation and translation) of the front spacer block in the trigger housing.

Connector removed

The trigger in the SPL is a balanced design, which is important to SAAMI Jar-Off performance. The nominal eccentricity of the center of gravity (CG) with respect to the axis of the SPL trigger pivot hole is 0.00007" (for all practical purposes zero). The eccentricity of the current trigger assembly trigger/connector CG is 0.118" from the axis of the trigger pivot hole.

Tolerancing

At first glance, the positional tolerances for holes in the side plates of the SPL trigger housing appear to be tight. But, when compared to the current side plate design, many of the positional tolerances are actually looser than the current design by up to 50%. The reason for the tight positional tolerances on the pivot holes for the critical components are not arbitrary. The tolerances specified are necessary to ensure that all components that are within their tolerance specifications will assemble and work properly. Misalignment of the holes between the side plates causes the parts mounted inside the trigger housing to twist, which can in turn cause them to contact and bind against the inside of the trigger housing if the twisting is great enough. The positional tolerances applied to the holes in the SPL trigger housing allow all parts that are within specification to be assembled and operate without binding.

Regain

The SPL trigger assembly has been designed and tested to regain at a trigger pull of 3½ lbs. The current trigger assembly will not consistently regain at that trigger pull force level and would require a higher minimum trigger pull force setting than the SPL.

Surface finish

One of the main purposes of the surface finish requirement on the SPL trigger is to ensure regain. The surface roughness and directionality are important parameters as they can create macroscopic ridges that the sear must climb in order to regain engagement if they are improperly specified. The trigger/sear interface of the SPL trigger assembly is designed so that the sear has line contact with the top surface of the trigger. In addition, the surface roughness and direction on the trigger and sear are specified such that they will not interlock with each other – the features left from finishing are not parallel to each other. The surface finish specification on the trigger's sear engagement surface is 4µin. While this may seem to be very fine and difficult to achieve, t[redacted] The surface finish on the SPL sear/safety cam is actually less stringent than the current sear/safety cam (20 versus 16µin).

Plating

Plating on the trigger's sear engagement surface is another important factor in promoting regain. The lubricity (slipperiness) of the electroless nickel plating is much better than that of steel by itself, which lowers the coefficient of friction between the trigger and sear permitting regain at lower restorative forces. The plating process used by the current plating vendor includes a highly aggressive wash to ensure the adhesion of the plating to the part substrate. The aggressiveness of the pre-plating was treatment degrades the surface finish of the trigger by etching it, bringing it out of specification. A vendor with a less aggressive wash and plating process has been identified, but the costs are increased approximately 10X from the current plating vendor. It may be worthwhile to test triggers plated by Ilion's current plating vendor to see what effect the degraded surface finish has on regain.

Corrosion resistance and performance

Plating

Electroless nickel plating the SPL trigger assembly provides better corrosion protection to the trigger assembly components than black oxide. In addition, the plating acts as a lubricant between components that have sliding contact with each other. The corrosion resistance and lubrication effect are both desirable properties of the plating.

Trigger feel

Creep comes from perception of uneven motion of the trigger as sensed by the shooter's finger as it pulls the trigger to fire the gun. Rough surfaces, especially with the surface features aligned to interact with each other can cause a creepy feeling trigger. The stick-slip frictional phenomenon is also a contributor to creepy feeling triggers. The smoothness (surface finish) of the trigger's sear engagement surface provides similar

performance benefits for trigger feel as it does for regain. The lubricity of the electroless nickel plating makes a positive contribution to trigger feel as it helps prevent stick-slip frictional phenomenon that contributes to a creepy trigger.

Other features

Sear retention feature of the SPL given up

One of the novel features provided by the SPL trigger housing is retention of the sear and sear spring without slave pins when the trigger assembly is not in the action. On the current trigger assembly, the sear and sear spring are free to exit the trigger housing and be lost if slave pins are not used. Installation of the trigger assembly into the action is simplified not only in production, but especially in the field where slave pins are generally not available.

Sear shape

The dog-boned cross-sectional shape of the SPL sear is a concession to the MIM manufacturing process to minimize thick sections in the part. The dog-bone shape also has the added benefit in that it does not provide a large area to support a film of congealing lubricant between the side of the sear and the side plates of the trigger housing. In addition, the side cavities in the sear provide relief for debris that could accumulate between the sear and side plate, decreasing the possibility of the debris impeding the function of the sear.

Summary:

In summary, while the concept of the SPL blocker is portable to the current trigger assembly design, the SPL parts themselves are not. To port the safety/blocker design to the current trigger assembly would require a complete redesign of the safety/blocker system as well as a good number of the components of the current trigger assembly to even work, which would likely negate any savings associated with this approach. The improved performance of the SPL trigger assembly (lower permissible trigger pull forces, lower SAAMI Jar Off sensitivity) would also have to be forgone if the SPL safety/blocker concept were to be implemented on the current trigger assembly. Finally, all testing (EET and DAT) would have to be repeated with a likely increase in the risk of failure.