Model 710 Receiver Insert Non-DAT Testing
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PURPOSE

The purpose of this test was to examine the robustness of the Remington Model 710 receiver insert during conditions of extreme abuse. The first test evaluated the tendency of the receiver insert to deform when placed in a high-temperature, high-humidity environment. The second test evaluated deformation over 10,000+ cycles of sear loading.

CONCLUSIONS

No significant longevity deficiencies were found. The ANSYS model showed stresses well below the limits of the material used in the receiver insert. The creep test revealed no significant movement of the firing pin head once the fixture reached the temperature of its chamber. The first receiver insert fatigue test showed an unexpected increase in firing pin head protrusion as the number of cycles on the insert increased. This was attributed to error caused by an inconsistent measurement technique. In the second fatigue test, care was taken to align the firing pin head before measuring. During this retest, all measurements fell within a 0.005 inch wide band. When the test was concluded, none of the gun's components showed extreme wear.

PROCEDURE

ANSYS analysis. An analysis was performed in ANSYS to determine stress levels in the receiver insert. In this analysis, it was assumed that the steel side plate and the steel pins in the plate did not deform significantly relative to the plastic receiver insert. Three steps were used in the analysis.

First, a simplified ANSYS model of the receiver insert was created. It was meshed and a stress was placed on one of the holes in the receiver insert that mated with the metal side plate. The result of this analysis was used to determine stiffness, both vertically and horizontally, for that hole. The analysis was then repeated for all the holes in the receiver insert that mated with the side plate.

An ADAMS model of the side plate was created. The holes were attached to springs whose stiffness values had been derived from the ANSYS analysis. The plate was loaded with a force equivalent to the force of the firing pin head on the sear. When the analysis was run, the plate quickly achieved equilibrium. The forces at each hole were taken from this analysis.

The ANSYS model was loaded using the forces from the ADAMS analysis. At each hole where a load was applied, the nodes in the area where loads were applied were constrained to move together. The analysis was solved using the ANSYS PCG solver.

Creep test fixture. The creep test fixture was constructed from a 710 receiver fitted to a barrel that had been cut off just beyond the chamber. The gun was fitted with a standard 710 action in which the firing pin tip had been replaced with a threaded rod long enough to protrude from the barrel. A five inch long die spring with a spring constant of 45 lbs/in was slipped over the threaded rod, and a washer and nut were used to compress the spring to 3.89 inches. The resultant load was 50 pounds, roughly twice the standard load. The complete creep fixture may be seen in Figure 1.

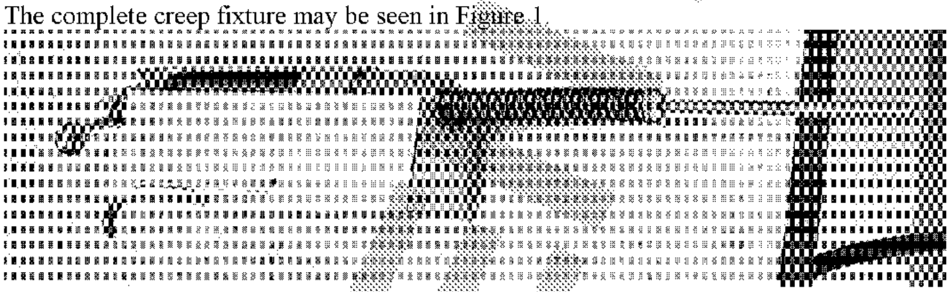

Figure 1. Creep Test Fixture.

The flat front of the receiver was placed upon a granite table and the distance from the back face of the receiver to the back face of the firing pin head was measured. Figure 2 shows the setup used to measure firing pin protrusion. Figure 3 shows the two locations used for measurement.

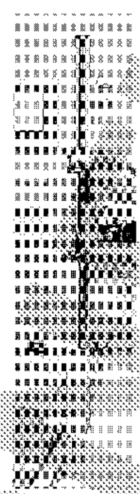

Figure 2. Height gauge used to measure firing pin protrusion (fatigue fixture shown)

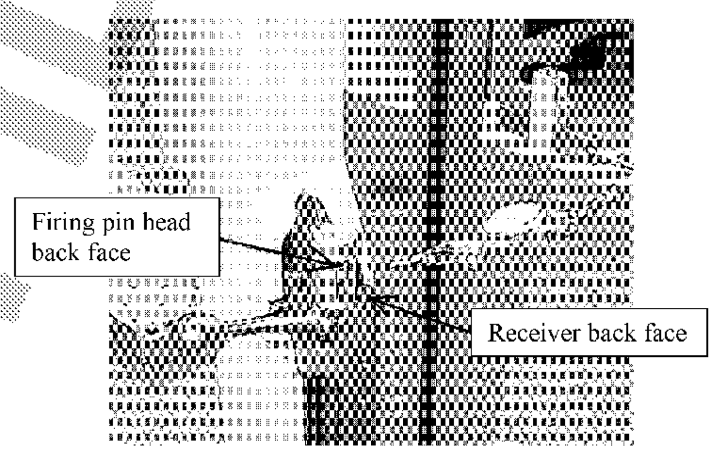

Figure 3. Closeup of measured area.

The entire fixture was placed in a humidity chamber set for 200° F and 90% relative humidity. At that temperature, the chamber was only able to achieve a relative humidity of around 70%. After the fixture had been in the humidity chamber for three hours, the firing pin head protrusion was measured again. It was then measured twice daily for ten days.

Fatigue fixture. The fatigue fixture was similar to the creep test fixture. It also was constructed from a 710 receiver and parts with a shortened barrel. A threaded rod was turned down and screwed in place of the firing pin tip. A 45 lb/in spring was used to apply 50 pounds of preload as in the creep fixture. A 1 ¼" bore air cylinder was used to press cyclically on the threaded rod, lifting the firing pin head off the sear and letting it drop again. The fatigue test fixture may be seen in Figure 4.

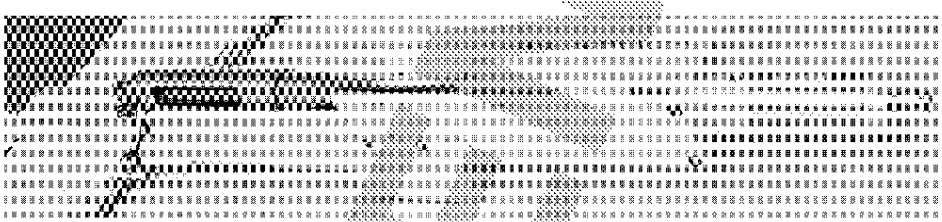

Figure 4. Fatigue Test Fixture.

Like the creep test fixture, the distance from the back face of the receiver to the back face of the firing pin head was measured with a height gauge. The firing pin head protrusion was measured before beginning the fatigue test. It was then measured every 1,000 cycles until 10,000 cycles were performed. The assembly was then disassembled and checked for wear and looseness. The receiver was reassembled with a different action and receiver insert and the test was performed again. This time, care was taken to rotate the firing pin until the firing pin head had seated completely before taking the measurement, something that had not been done during the first test. Seating the firing pin head each time caused the measurements to be more consistent. 10,000 cycles were placed on the new receiver insert, measuring every 1,000 cycles. Then, another 20,000 cycles were placed on the receiver insert and the firing pin head protrusion was measured again. The fixture was disassembled and the receiver insert and fire control parts were checked for wear.

RESULTS

ANSYS analysis. The results from the ANSYS analysis may be seen in Figure 5. The loading in the ANSYS model was based on a constant firing pin spring force of 25.5 pounds. Considerably higher stresses could be expected to occur in the fatigue test from the peak load developed due to the impact between the firing pin and sear when the firing pin was allowed to drop back into place between cycles. Under static loading, peak stress occurred at the back end of the receiver insert and at the sear pin hole. Stresses there were calculated to be around 1,400 psi, with a strain of 0.2%. The failure criteria for the material are 9,000 psi or 2.4%, whichever comes first.

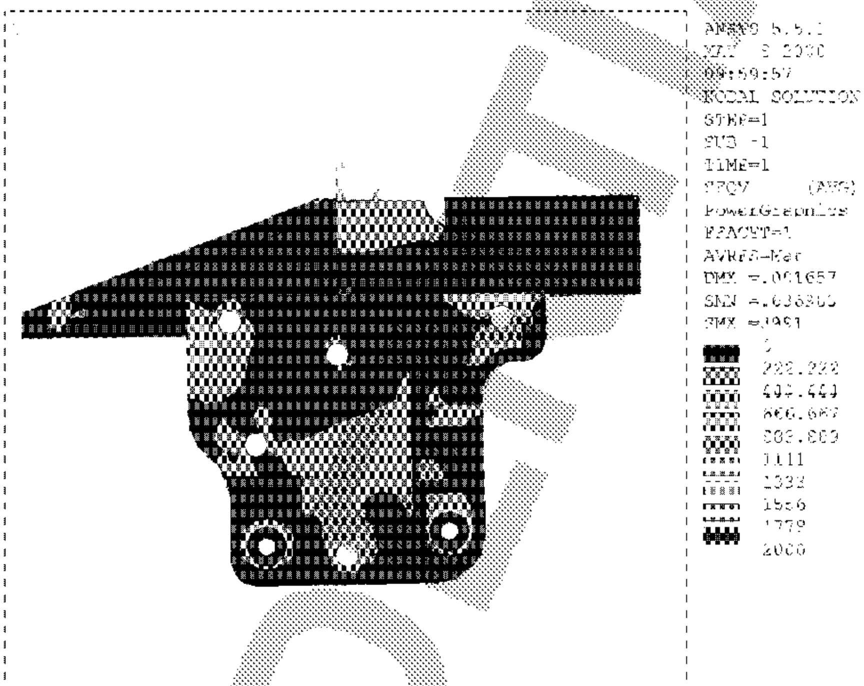

Figure 5. Von Mises stress distribution through receiver insert. (stress in psi)

Creep test. Figure 6 contains a graph of firing pin protrusion measured during the duration of the creep test. The firing pin protrusion dropped from 0.691 inches to 0.682 inches after the fixture had been in the chamber three hours. After that, the measurements fluctuated in a band between 0.684 inches and 0.6815 inches.

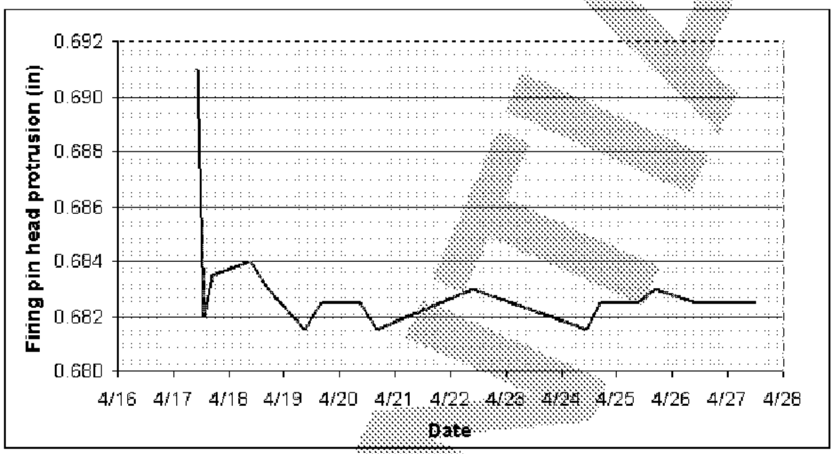

Figure 6. Firing pin protrusion over creep test duration.

Fatigue test. Figure 7 contains a graph of firing pin head protrusion over the duration of the test. In the first test, firing pin head protrusion rose over time. It climbed slowly until 5000 cycles, where it jumped 0.013 inches before leveling off. In the second test, care was taken to rotate the firing pin head back into the same alignment each time the measurement was taken. It turned out to be more consistent, with a low value of 0.693 and a high value of 0.6985 occurring early in the test. After 10,000 cycles had been put on the receiver insert, the fixture was cycled 20,000 more times. The firing pin head protrusion was then measured to be 0.6975 inches.

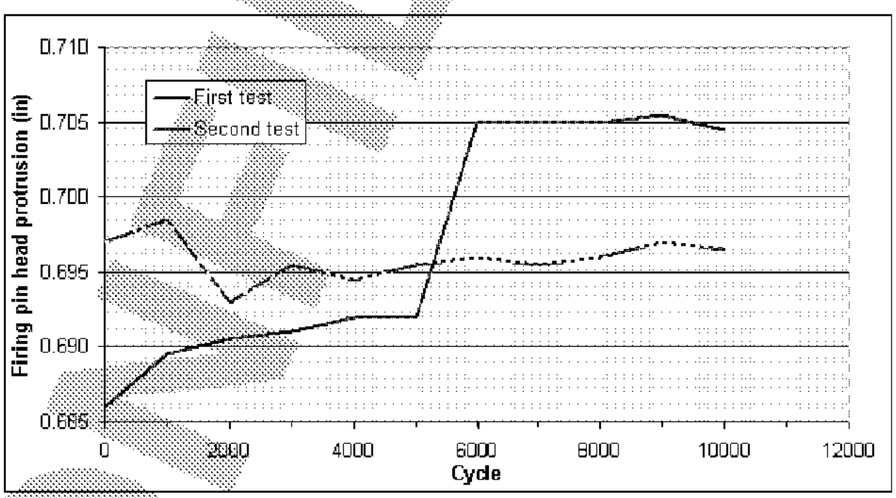

Figure 7. Firing pin protrusion over fatigue test duration.