D R A F T
R
A
F
T

MODEL 40X FIRE CONTROL INVESTIGATION

INTRODUCTION

Consistent reports and occasional customer complaints from the field, all voicing trouble with the performance of the 40X fire control prompted this investigation. These complaints have been varied in nature from variation in pull weight to complete failure in firing. Since design testing had revealed no justification of these complaints, there has been considerable doubt as to their validity, and if so, what could be done about it. What about the M/721-722 which is of the same basic design?

OBJECTIVE

1. Does the fire control, if properly made, fail at any time?
2. Does the pull weight vary with extended cycling and how much?
3. Determination of causes, if any, which bring about the above.
4. Propose methods of curing these ills.
5. Take a general look at all the factors in good gun function in this model; i.e. Firing Pin, Bolt Lugs, Cocking Piece, Main Spring, Head Space, etc..

SUMMARY & CONCLUSIONS

1. The fire control as now designed will fail to fire properly under continued use if not lubricated consistently. This, in extreme cold climatic conditions, would present a problem in all our present line of bolt action guns.

2. Under present manufacturing and design standards the load-lubrication variable results in a variation in pull weight (average) from 3 lbs. to 6 lbs..

3. Calculations affirm test data that the coefficient of friction of steel on steel between lubricated and dry surface straddles nicely the loads imparted to the connector from some minus value to a max.of 3 lbs; Actual measurements run 0 to 2 lbs. Added to the above is the connector surface variable and spring weight in the pull adjustment spring. This makes test data and theoretical in close agreement. Two out of three tests started dry eventually failed even to fire. The sear being held in the cocked position with the trigger disengaged.

4. The plating of the sears with a low coefficient material to reduce the Mu variable proved realistic. Electroplate went 9600 cycles very satisfactorily before breaking down and reverting to steel on steel characteristics. Nicol lasted 2,000 cycles. Molysulphide was no better. Chrome plated parts went to 10,000 cycles with no change in wear apparent after 2,000-3,000 cycles. Fired intermittently dry and oiled after 10,000 cycles with less change in overall variation than steel on steel in any one try of 10 cycles.

	Best	Worst
Steel on steel	$<$ 2 oz.	2#10 oz. - 5#3oz.
Chrome on chrome	$<$ 1 oz.	2#0 oz. - 2#15 oz.
Chrome dry to chrome lubricated - 10 cycle Avg.	1½ oz.	
Steel dry to steel lubricated	3#3 oz. - 5# 8 oz.	

5. Firing pin indent was maintained at .022 for 50,000 cycles on one sample and for 30,000 on second where both dropped to 020 (satisfactory). Third sample start 022 - 30,000 018 low.

Headspace developed early when lugs were not lubricated (start o -042; 5000 - .0435; 10,000 - .0475; 15000 - .052) accompanied by galling. Maintains 052 when lubricated to 50,000 cycles. Second sample lubricated every 1,000 cycles changes from .0435 to .0445 at 10,000. Maintained this to 50,000 - no change.

Sear engagement remained at initial setting throughout all testing (production assembly).

Bolt lugs reacted in line with receiver mating surfaces but to a lesser degree. Cocking piece and bolt cam surface were lubricated throughout and were OK.

6. The similarity in design between the 40X and the 721-722 line gives immediate rise to the question of how much of the foregoing is in these bolt action sporters. We believe that these characteristics are very real and under extreme cold-lubrication conditions could fail to fire.

Main spring showed some "set" but not excessive and maintained satisfactory indent to 50,000 cycles.

A longer test would be necessary to established "set rate" beyond the 50,000 cycle period of this test.

FUTURE PROGRAM

1. No further work is anticipated at this time by this department to establish the causes of field complaints.
2. The nature of the plating cycle produces "treeing" and excessive plating on the critical sear surfaces and mating connector, which ruins the parts for further use, resulting in dangerous chipping and pull failure upon assembly. Investigation of this control must be established.
3. No cost picture was considered but a possible reduction in grinding and stoning operations could conceivably be achieved on 40X parts by plating all 40X - 721 - 722 parts in the "as produced" conditions. Tests should verify this before acceptance.
4. Consultation with Electroplate might produce a better, lower cost coating than chrome in its final state. The results on the pilot samples was very discouraging and at this time it is our belief this is the best they have to offer.
5. It is our recommendation that the process be investigated and at least 40X parts be plated satisfactorily on all future guns produced and that this be initiated immediately.
6. For limited firing in 721-722 guns Electroplate could bear this nicely if the cost picture was favorable compared to chrome.

TEST PROCEDURE AND DETAILS

The first 40X dry cycled was set up to investigate the gun in the "as packed" condition. Action and parts oiled with about a 30# load between the bolt and receiver to represent the residual load from the fired case. It was recognized that this load would be applied on the closing stroke as well as the opening stroke of the bolt. Further, this muzzle load was acting in conjunction with the normal mainspring-sear load. The (Firing Pin) sears were lubricated but, as field practice does not dictate lubrication of the Lug areas, this was omitted. The gun was dry cycled 52,200 cycles. At 1,000 cycle intervals headspace, firing pin indent, protrusion, sear engagement, and a ten cycle weight average taken on trigger pull.

Head space	Start .0435		Finish .048	
Indent stayed constant at	.022 - 45,000 cycles		50,000 cycles	.020
Firing Pin protrusion	.035 constant			
Sear engagement	.015 constant			
Pull average 10 cycle	Low 3# 6 oz.		High 5# 3 oz.	
Pull	Lowest Single 2# 10 oz.		Highest 5# 12 oz.	

Several times during this test the gun refused to fire. No apparent mechanical reason could be found when dismantled. The gun always continued to function when inspection was under way. Some scouring of the bolt lugs was observed but at 52,000 (end of cycling) the scoured area had not completely covered the lug surfaces.

To verify the foregoing test another gun was run through the same procedure and conditions. This gun followed closely the reaction of the first.

Head space	Start	.0435	13,000 30,000	.052 .052
Indent	Start	.022	30,000	.0185
Firing Pin protrusion	OK			
Sear engagement	.010 - Stayed			
Pull average	Low 2# 14 oz.		High 3# 10 oz.	
Pull - Single	Low 2# 13 oz.		High 3# 12 oz.	

This gun did <u>not</u> refuse to fire during the 30,000 cycles. The pull was very consistent at all times which was quite the reverse of #1 sample. However, the lugs of receiver and bolt responded early (10,000 cycles) to the lack of lubrication by galling and fast development of headspace - .052 at 13,000 cycles.

Gun #3 was then started on the above routine test to determine how soon it would refuse to fire. We were fortunate in getting early failures to fire. This gun began failing at 2,000 cycles and test was stopped at 8,000. This model could be set up by carefully moving the trigger back and forth on the connector (not firing). This action resulted in setting up the sears so the trigger could then be pulled fully, leaving the firing pin fully cocked supported only by the sear. A slight jar or pressure on the cocking piece, or movement of bolt handle, would release the firing pin. Had the gun been loaded it would have fired the live round.

This would indicate the friction element to be the big variable in all of our difficulties. Handbooks tell us this can vary between .25 and .74 depending on surface lubrication, finish, loads, etc..

A calculation of the Mu in this assembly seemed fitting. Using model drawing dimensions, spring weights of 17 to 19 pounds on the main spring calculations involving the mean dimensions on moments above the pivot pin and the bearing to be applied at the center of the 27° angle on the rear of the sear (63° as the firing pin sees it), the coefficients to equalize all forces would be .289 to .35.

A fire control was set at the specs of approx. 3# pull weight; a run of 10 cycles was weighed. This fire control varied between 2# 15 oz. to 3# 12 oz.; average 3.32 lbs. All sears were now lubricated carefully and weighed for 10 cycles. Average was 5# 5 oz., min. 5# 1 oz., max. 5# 8 oz.. This seemed to confirm the Mu analogy.

The most logical approach economically was to try a coating having a low coefficient of friction high bearing strength. Three seemed possible; Nicol, Chrome and Electroplate.

Under test Nicol started out fine but at around 2,000 cycles began to fail, chipped off badly and was discarded.

Chrome was next tried. Difficulty was experienced in getting a plate free from excessive build up or "treeing" on the sharp sear edges. Of the two samples tried these were exceptionally good. Of a 10 cycle average run at ∠ 1 oz thru 7,000 cycles, no indication of freezing average shifted over the 7,000 cycles from 3# 5 oz. up to 3# 8 oz. This was dry, care being taken to get no oil on the parts. The parts were now oiled and tested pull was then back to 3# 6 oz., and after 6,000 more was still at the 3# 8 oz. setting with no change. The second sample followed in close agreement with the first tolerances and average remained the same as #1. The surprising fact still was the little influence lubrication had on the total pull weight. It would appear there is hope of having the parts such that an adjustment could be made and held for the life of the gun.

Electroplate was next tried. These samples looked very uniform and high hopes for these were entertained, since this would remove the critical aspect of chrome plating. This test was an exact duplicate of the reaction experienced with the tests on chrome plate. Very uniform pulls, no change in the averages as the test progressed. This was the reaction till we reached 9,600 cycles, at which point the results suddenly changed. The weight looked like steel on steel. Under the microscope it was found that this was indeed what had happened. The Electroplate had worn away and we were again getting steel on steel. No further testing was done with Electroplate.

CHMorse:T
12-12-56