PROGRESS REPORT
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MODEL 40X FIRE CONTROL INVESTIGATION

By

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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~~ changes in trigger 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~~ Also the question of 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~~ eliminating these ~~ills~~ problems.
5. Take a general look at all the factors ~~in~~ relating to good gun functioning in this model; i.e. Firing Pin, Bolt Lugs, Cocking Piece, Main Spring, Head Space, etc..

SUMMARY & CONCLUSIONS

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

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2. Under ~~present~~ existing manufacturing and design standards the load-lubrication variable results in a ~~variation~~ change 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~~ These considerations bring the test data and theoretical results into close agreement. Two out of three tests which were started dry, eventually failed even to fire. The sear was 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 ~~[illegible]~~ very effective. "Electroplate" completed 9600 cycles very satisfactorily before breaking down and reverting to steel on steel characteristics. ~~Steel~~ Nickel-plate lasted 2,000 cycles. Molysulphide was no better. Chrome plated parts ~~went to~~ completed 10,000 cycles with no change in wear apparent after 2,000-3,000 cycles. Fired intermittently dry and oiled after 10,000 cycles there was 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 0 -.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~~ cycles, without 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 applicable to these bolt action sporters. We believe that these characteristics are very real and under extreme cold-lubrication conditions could fail to fire.

7. 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.

8. add

FUTURE PROGRAM

1. ~~No further work is anticipated at this time by this department to establish the causes of field complaints.~~

1. The quality of chrome plating on cyanide hardened surfaces is difficult to control and therefore adequate process and controls must be established before this system could be used.

2. No ~~cost picture was~~ economics were considered, but a possible reduction in the grinding and stoning operations could conceivably be achieved on 40X parts by plating all ~~40X 721 722 parts~~ the connectors and sears in the "as produced" condition. Tests should verify this before acceptance.

3. Consultation with "Electroplate" might produce a still better and lower cost coating than chrome ~~in its final state~~ plating. The results on the ~~pilot~~ samples from the "Electro-plate" company were very discouraging, and at this time it is our belief this is the best they have to offer.

4. It is our recommendation that the process be investigated and at least 40X parts be plated satisfactorily on all future ~~guns~~ models produced and that this be initiated immediately.

5. For the limited firing in 721-722 models, ~~guns~~ "Electroplate" may be adequate ~~could cover this need~~ if the cost picture is favorable when compared to chrome plating.

TEST PROCEDURE AND DETAILS

The first 40X dry cycled was set up to investigate the ~~rifle~~ in the "as packed" condition. The Action and parts were oiled and 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 rifle 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 rifle 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 rifle was run through the same procedure and conditions. This gun followed closely the results of the first test.

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.	

In this test

This gun rifle did not 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.

The gun #3 rifle 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.~~ Failure occurred ~~This gun began failing~~ at 2,000 cycles and test was stopped at 8,000. This ~~malfunction~~ U.L. 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~~ rifle been loaded it would have fired the live round.

This would indicate that the influence of friction is ~~the friction element~~ to be the big variable. Significant ~~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 importance of the frictional coefficient as the principal factor in the fire control variables.

The most logical approach economically was to try a coating having a low coefficient of friction and high bearing strength. Three were considered: Nickel, Chrome and Electroplate.

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

Chrome plating 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

Summary & Conclusions

Add (1) Unless the bolt lugs ~~were~~ are "glass" hard~~ened~~ we would always expect a certain amount of galling in absence of any lubrication.

8. ~~Add~~

~~An explanation as to the reasons for the galling of the surface between the sear and the firing pin head are somewhat obscure. However, it was noted during the test that a black coating seemed to form on these surfaces, giving rise to the question as to whether or not the compressed air driven dry cycling device was producing sufficient dirt or foreign matter in the area to cause this coating.~~

~~[illegible]~~ investigation should be conducted to ~~[illegible]~~ bolt & ~~[illegible]~~ thereby ~~[illegible]~~ of ~~[illegible]~~

8. a better heat treat of bolt + receiver [illegible] be found to reduce the [illegible] inadequate [illegible]

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.

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