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Ilion, New York
April 24, 1968

TO: G. M. CALHOUN
S. M. ALVIS

FROM: W. E. LEEK

PROPOSED NEW DEVELOPMENT

AUTOMATIC, PUMP AND LEVER CENTER FIRE RIFLES

The attached report is for the purpose of guiding investigation to provide information for the basis of a new line of center fire rifles.

W. E. Leek,
Manager - Firearms Research & Design
Ilion Research Division

WEL:T
Attach.

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REMINGTON ARMS COMPANY, INC.

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Ilion, New York
April 22, 1968

NEW DEVELOPMENT

AUTOMATIC, PUMP AND LEVER CENTER FIRE RIFLES

A new line of automatic, pump and lever center fire rifles must be superior to the presently new BAR. This superiority can and must be achieved in several areas, i.e. (in importance)
(1) strength, (2) appearance, (3) functional performance, (4) endurance, (5) weight reduction, (6) handling, (7) trigger excellence, (8) recoil reduction, (9) elegance in magazine design, insertion and removal from the receiver, (10) and accuracy.

Of these items, strength is the most important factor because this requirement determines to a great extent safety, weight, and appearance limitations.

It is believed that the future of consumable or the so-called caseless cartridge is beset with enough development problems that a new rifle to accommodate this ammunition would seriously delay development of a new center fire auto rifle utilizing standard ammunition. Based on this premise, it is proposed to proceed in

the development of a new design utilizing the standard cased ammunition.

It is most desirable and mandatory, I believe, that all auto system designs of the future should be designed first to withstand endurance-wise the rigors of full automatic fire. Using this technique of testing provides the design the ultimate exposure to functional and endurance weaknesses. Therefore, the designs should be aimed in this direction. In using this approach, although secondary in nature, adaptability to military use could be considered.

Strength of the locked cased system must nearly approach or equal that of the M/700 bolt action system. Evaluation of investigations of numerous other design developments reveals that added strength can be obtained by improvement in extractor design. We have explored this area many times and have in a sense set a policy of arms design; i.e. the center fire actions must support the cartridge case without rupture under any conceivable pressure load.

The multiple lug rotary lock system it appears must be used to keep the rifle within weight and size limitations. The M/742-760 bolt lock is ideally suited for a strong light weight rifle, but has a built in weakness in the extractor design and the imbalance of the bolt support in the barrel extension. Lack of support of the bottom of the bolt by the

extension prevents the multiple lugs being utilized to their fullest in shear and bearing. Full support of all lugs is mandatory. However, this presents problems, too, as it places the feed system further rearwardly from the chamber, aggravating feeding. A longer receiver may be needed to accommodate the needed change. Styling changes will be required to camouflage this extended length. One possibility might be to extend the receiver into the grip section of the stock providing more receiver length and bolt travel without apparent long receiver length.

This area is critical from two points--lacks strength, and if overcome with more lugs creates feeding problem. Even in the M/700 with its superior strength the bottom lug in the receiver fails under load because a portion of the lug in shear was removed to provide a feeding ramp.(1) Extractor design for full support of the cartridge case under load(2) and full support around the periphery of the bolt should be one of the first areas of research investigation.

A rotary bolt has its weaknesses also, especially when rotated at high speed necessary in autoloading mechanisms. The bolt lock (an added device in the M/742 system) nullified the over rotation of the bolt and reduced some of the damage to the receiver, but still is not adequate and needs redesign(3) and evaluation.

Heat transfer from the fired cartridge case to the chamber during obturation has always made the extraction time critical in center fire autoloaders. Recoil operated systems provide added delay during this cycle but they have the added disadvantage (4) of a ~~moving barrel.~~ If a recoil system; i.e. bolt and chamber, could be devised and devoid of a fixed barrel the much needed delay in extraction could be improved. In autoloaders the variation in extraction time during obturation is most critical and I fear one of the important items in the failures of the Armalite rifles used by our military. As the heating and dissipation time cycle changes, varied power requirements aggravate function and limit the usable power time available. (5) Overpowering is generally the designer's approach to a solution. A constant thermal system in the chamber area is most desirable and would eliminate the variables in obturation and improve (6) function. One approach we used in our machine gun development was to use stainless steel in the chamber section. I believe this approach has merit as stainless does not transfer heat readily and, therefore, possibly could be used to maintain a (7) more uniform obturation cycle. During the war, I worked with Mr. Garand on an idea of his to retard the heat flow in a barrel from the 10" point down the barrel from flowing back into the chamber. His idea involved three grooves turned in the barrel

approximately over the neck section in the chamber. His objective was to retard cook-off, and it did this quite effectively. However, it did present accuracy and point of impact problems due to lack of barrel rigidity. This retardation of heat flow would have a tendency to equalize (8) the obturation cycle. Our idea during the machine gun development to provide a joint for a detachable barrel might have some merit in providing a heat barrier at a joint just ahead of the chamber or joint section (9). Plating of external barrel surfaces plus a finned design might help dissipation of heat, although the finned idea has been seen on numerous designs of machine guns, etc. The question arises here as to whether dissipation is fast enough.

There is no doubt that during automatic or full automatic fire the obturation cycle will vary regardless of how many devices we install to retard this variation. Some over powering of the gun is necessary and extra loading of the extractor is expected. Browning's idea of a "T" slot on the machine gun provided the extra grip needed to cope with this problem (10). Perhaps we could devise a double extractor system where the left extractor is cammed out of its gripping position just prior to the ejecting cycle. This would allow added assurance of proper extraction without undue loading of the extractor or damage to the cartridge, but mainly allowing better uniform function during adverse obturation conditions.

If we maintain the multiple lug system and seal it securely I am sure we can approach or equal the desired strength specification and, at the same time, not increase weight of the gun. We have had experience with recoil effects on the M/600 in 308 Caliber without benefit of recoil reducing devices which resulted in severe recoil in this rifle. If we are to achieve light weight and maintain strength, lighter materials must be used. The 5-1/2# to 6# weight for 308 caliber seems most desirable but some recoil reduction must be used. Although aluminum die casting has been used for light weight rifles in small calibers, it appears this would be undesirable in the heavier ones. We have discussed the use of titanium many times, and one model was fabricated in the M/760, and we have always allowed three problems to prevent further development using this material; namely, high material cost, high machining cost, and no known method of coloring except by coating. This material would provide us the ultimate in strength to weight ratio, however. Advances in techniques of alloying, machining, brazing, casting, forming, etc. have been made in this material, and I suggest that titanium be given serious consideration for the manufacture of the receiver. Due consideration as to the size of the receiver should be made here. I suggest four sizes to accommodate ranges of shell lengths and diameters in sizes 223, 30-06, 350 short mag. and 300 H&H mag.

(11)

(12)
In the development of feeding systems for the center fire rifles, detachable boxes are most desirable as they are quicker to load into the receiver, provide additional package loadings for the hunter during fast shooting, and the gun can be unloaded readily and carried in a car without infringing on safety regulations. Yet the hunter can readily get into shooting position with a loaded magazine box at hand.

Assembly of a box magazine into and out of a receiver in any but a vertical manner, prevents appearance problems. Experience in military designs demonstrate that a hinged type box is more reliable. The best magazine latching system seems to be a hinge located at the front section of the box providing a latch in the rear section. However, this requires a little more magazine space in the receiver and sometimes leaves an objectionable opening in the front section of the magazine box in the receiver. But I think this design is most desirable and effort should be made to camouflage the gap left in front of the receiver.

There is one reasonably good box magazine on the market utilized commercially in autoloading rifles and is to be found in the Model 100 Winchester. The only difficulty here is that it can be loaded backwards into the receiver. This particular box is the only one I have ever seen that can be inserted into the receiver vertically with reasonable assurance of proper

insertion and not utilizing a hinge system. These boxes should be of the flush type, relatively easy to grasp. There is no objection to disposable type magazine and perhaps some desirability in their design, but they should be substantial enough that reloading of the individual box could be made.

Low cost of disposable boxes would be most desirable and a combination of molded plastic body with reinforced or substantial metal lips might be considered for such a low cost box.

The basic power systems that have been successfully used in the past for center fire cartridges have mainly been in the area of recoil and gas, and some combinations of both. To my knowledge, all blowback and primer setback power devices for center fire have not been too successful. The desirability of each type has several setbacks but I believe the gas mechanism is the most desirable, with exception of the delay in obturation mentioned previously that can be better accommodated by the recoil method. The M/742 gas principle is probably the most inefficient of those utilized in any of the military or commercially made guns today. However, it is virtually free of interference from adverse buildup of corrosion, powder residue, and the like.

At the time the gas system now utilized in the M/742 was selected it was considered by Rene Studler of the Ordnance Department

to be the most trouble free of the group. However, it must be remembered that he had approved two other means of gas operating mechanisms for rifles used in the military at that time; namely, the White gas expansion system for the M1 rifle and the Williams tappet system on the M1 carbine. I believe that the expansion mechanism is most desirable from standpoint of a cushioned energy force transmitted to the unlocking mechanism. A time delay during the obturation cycle can also be achieved. However, corrosion of the piston elements is ever present. The tappet method has corrosive problems also and depends a great deal upon an inertia block transmitting energy from the gas in the barrel to the operating mechanism through this member. The tappet system was utilized in a 30-06 type rifle developed by Williams of Winchester in hopes of replacing the BAR. This rifle withstood a continuous test of 6,000 rounds of full automatic type firing with no difficulty. A heavy inertia block and a good size tappet system were used by him to achieve this result. It certainly has merit and would outperform the Browning automatic rifle. I don't ever recall need for cleaning or maintenance of the gas system itself.

In tapping off gas earlier ahead of the chamber versus later at the muzzle I believe one would expect cleaner, hotter gases with more efficient impingement through a tappet system to the inertia

block than the expansion type. If the barrel is designed of laminates or of two pieces where the forward section could be disassembled from the rear section it might be desirable to consider a tappet type mechanism, which is ideally suited for gas takeoff just ahead of the chamber.

It is mandatory that the rate of firing not exceed 300 rounds per minute in full automatic type of firing, and I believe would be more successful around 200 rounds per minute. We have experienced problems in keeping rifles and shotguns pointed on target in full automatic fire regardless of recoil at rates exceeding 300 rounds per minute. I feel certain that the M14 would be a more successful military weapon if the rate of fire was at this level. Because of the timing involved in unlocking, storing energy, action springs, etc., a reasonably low rate is difficult to achieve. Delays such as late gas takeoff, gas expansion, absorbing energy by inertia blocks, and cam unlocks seem to be the general area for designers to work in, but to date the low rate of fire has not been achieved. To utilize recoil and blowback as additional forces to extract and eject, and accomplish these during the time allowed, one can see that delays in unlocking cannot be achieved in that area. Therefore, (13)
I suggest that we concentrate on a delay mechanism integrated into the fire control.

The fire control in the M/742 is not adequate for the job at hand. First of all, the trigger pull is poor for either shotgun or rifle. However, we have had some experience with this fire control in full automatic work on the 7188 shotgun. But long extensive endurance firing has not been conducted with these mechanisms. I feel that a hammer type system is possible the better mechanism, such as we use in the M/742, and a good, close look at the M1, Armalite and Fabrique Nationale fire controls would be desirable. The M1 fire control has several advantages. Only one spring is utilized to perform functions with the sear, the hammer and the safety. A double sear type mechanism is provided which, I believe, is safer in full automatic fire than the conventional one notch sear type used in the M/742. Although a disconnect system in the fire control is not provided in the Armalite, I believe it should be, and would consider it an essential element in all gun design to fully guarantee that the mechanisms must be fully locked before the fire control can be actuated.

The M1 has one of the best safety systems for the manual operation of this part I have ever seen. One movement of the safety on the ON position does three things; cams the hammer out of engagement with the sear, locks the hammer back, and blocks the trigger. It is much superior to any other system I have observed and should attract our interest.

Fluted barrels are going to be necessary to meet our general weight requirements and possibly have some advantage in heat dissipation, and should remain rigid during firing, with less weight, providing adequate accruacy. These features, however, have never been investigated (15) and I suggest that we initiate a research program to investigate these features as well as possibility of process development on GFM or Torrington equipment as the machining of such a barrel would be very expensive indeed.

Recoil reduction achieved only by the transfer of recoil energy from the barrel to the operating mechanism and then transferred back into the gun itself at a later period will not be enough to make for comfortable shooting (16). A study should be initiated to determine further if an Adiprene type butt plate would be adequate or if some other mechanical means would be necessary. Devices eliminating or reducing the jet effect at the muzzle should be reinvestigated.

A review again of muzzle devices should be made and due regard given to the effect of the noise level. The following specifications for the individual rifle should be set as a goal at least for the first investigation:

- Overall weight with box magazine empty and no attachments --- 5-1/2 to 6 lbs. in 308 Caliber.
- Barrel length --- 24" max. --- convenient for attachment of scopes and sights.

- Stocks and fore ends to be made of walnut and/or laminated wood with possibility of further reinforcement.
- Fore end area insulated from heat.
- Trigger pull to be in the neighborhood of 5 lbs. with no creep.
- Barrel fluted.
- Receiver size similar to M/742.
- Trigger guard similar to the new BAR.
- Hinged type detachable box magazine.
- Sights rigid and readily adjustable open type for both windage and elevation.
- Recoil reducing mechanism.
- Strength equal to the M/700.
- Functional performance under 1 per cent.
- Accuracy - comparable with M/700.
- Balance and handling - better than BAR or 742.
- Appearance - superior to BAR and 742.
- Manual operation equal or exceeding BAR. Must be superior to 742.

WEL:c
4/22/68

cc: S.M. Alvis
R.J. Service

REMINGTON ARMS COMPANY, INC.

INTER-DEPARTMENTAL CORRESPONDENCE

Remington UMC PETERS UMC

"CONFINE YOUR LETTER TO ONE SUBJECT ONLY"

Ilion, New York
February 6, 1968

MEMORANDUM

TO: W.E. LEEK

FROM: C.W. STEPHAN cs

RECORD OF MEETING - 5MM AUTOLOADER

A meeting was held on January 24, 1968 to discuss the current status of the 5mm Autoloader and to schedule the future program.

The following were present:

W.E. Leek
R.J. Service
C.W. Stephan

1. The design was reported as 85% complete.
2. The cost estimate is to be brought up to date by March.
3. Drawings are to be released to the Plant by January 1, 1969.
4. Announcement date is January 1, 1970.
5. A schedule of necessary model guns is to be developed with the first "Look See" model in March of 1968.
6. Cost of above models is to be estimated.
7. Experimental model numbers to be:
   XRA - Autoloader
   XRP - Pump

CWS:w