

1-16-62

PROGRESS REPORTMODEL 700 BOLT ACTION RIFLE

| | |
|----------------------------|---------------------------------|
| Period: | October 1960 - April 1962 |
| Project Number: | AD-700-2 |
| Amount Authorized: | \$110,300 Spent: \$120,822 |
| Previous Progress Reports: | None |
| Notebooks: | None |
| Prepared by: | J. W. Blair |

INTRODUCTION

In April 1962 Remington Arms announced the Model 700 customized high power bolt action center fire rifle. This rifle available in two grades, ADL and BDL, replaced the former Models 721, 722, and 725. The new model is the finest production rifle available today and culminates more than 85 years of successful bolt action manufacturing.

HISTORY AND BACKGROUND

Remington produced the first American designed bolt action rifle for military and sporting purposes. The Remington-Keene rifle was introduced in 1876 and discontinued in 1883 in favor of the Remington-Lee because the locking system was unable to handle the higher chamber pressures of smokeless powders.

The Remington-Lee Military Rifle and Carbine was introduced in 1880 and the Special Sporting Rifle in 1886. The outstanding features of these rifles were the first detachable box magazines and the half-cock safety system. This rifle was the forerunner of the famous Lee-Enfield rifle which was the standard of the British Army for more than fifty years.

The Model 30 was introduced in 1921 and the M/30S shortly after and they became one of the first successful high powered bolt action rifles chambered for military cartridges to be placed on the American sporting market. Until the war most shooters had preferred the lever or slide action. When they returned from service they were trained and proficient with service bolt actions and demanded sporting rifles of similar design. Remington, who had produced over 1.5 million 1917 Enfields at Lion and Eddystone, Pennsylvania, modified the design to a sporter and toolled up from the inventory of parts and machinery which remained from their government contracts. Early models had the Enfield cock on closing type bolt but were shortly replaced with the improved cock on opening cam which gave more positive and easier operation. These models were discontinued in 1940.

The Model 720 was introduced in 1941 but only a few were made available before production was curtailed due to wartime production. The M/720 was a revised version of the discontinued model 30S and was scheduled to resume production after the war. Improvements had been made in the stock design, the bolt handle and the sights; but the 720 failed as a valuable contribution to the Remington line of quality rifles and was not continued after the war.

An exhaustive survey was conducted in 1944 to determine the likes and desires of the shooting public. Coupled with the objectives of better acceptability and lower cost, these public feelings lead to the reactivation of some experimental R&D design concepts previously deferred. Attention was focused on a new high-power bolt-action center-fire rifle. This new rifle was to be light weight, highly accurate, rugged, appealing, easy to handle, and be producible at a cost to compete with the Winchester '94.

The Model 721-722 was announced in 1948 and it offered the strongest actions ever built in a sporting rifle. The bolt incorporated a new concept in strength and safety, the encased or shrouded head. The cartridge case is enclosed in the bolt face and the bolt face is encased in the receiver which completely sealed the gases inside the chamber. This protection to the shooter is possible because there were no cuts made in the bolt head for an extractor as in the Mauser and similar types. The Remington extractor is located entirely in the bolt face and is one of the many patented features of Remington products.

The Model 721-722 accomplished all its goals, expectations and sales forecasts. It put into the hands of the general public a light, safe, and accurate rifle for less than \$80.00. The original forecast was for 13,800 rifles per year based on a normal year of a twelve year span. Actual sales amounted to 32,334 the first year, a total of 421,756 during 1948-'62 and averaged 30,125 annually for this period. The peak year was 1951 when 63,489 rifles were sold.

In 1955 Remington introduced the Model 40-X rim fire rifle to replace the M/37 and compete with the Winchester Model 52. It was the first target rifle Remington produced that would compete with the 52 and today, after only seven years of existence, it accounts for about 50% of all the rifles on the line at small bore matches.

As a result of the development work performed by Remington R&D for the Army Advanced Marksmanship Unit in 1958 and '59 it was proposed to produce the International Match Rifle. Since the volume of these match rifles would not justify the expense involved to produce this custom work, it was proposed to also produce the M/40X in a center fire

action for bench rest shooters. A production of 500 combined units a year was anticipated based on a special single discount sales policy. Shortly after the introduction in 1960 the sales policy was revised to the standard dual discount policy. The resulting increase in price has kept the sales volume down to about 300 annually, but still about 50% of the rifles on the line at bench rest matches are Remington custom built.

Having successfully produced the moderate priced Models 721-722, indications pointed to bringing out a bolt action model with customized characteristics to challenge the field of the Winchester Model 70. The new model, designated the M/725, was to retain all the desirable features of the 721 action but would offer better appearance and handling plus other experimental design developments.

The M/725, introduced in 1958, was not enthusiastically received by the buying public and anticipated sales were never realized. One major reason for the unsuccessful sales was the lack of increased value for the \$40.00 increase in sales price. With the 725 sales failing to meet expectations and 721-722 sales dropping due to outside competition and newer Remington models, it became evident that a new and distinct bolt action rifle was needed. The need for such a design culminated in the design and development of the Model 700, the subject of this report.

OBJECTIVE

Specifications were established to return Remington to as impregnable a competitive position as enjoyed during the late 40's and early 50's with the M/721-2. The specific desire was to competitively surpass the Winchester Model 70, Weatherby Mark V, and others in the deluxe high powered bolt action field. It was felt that this could be done by complying with the following objectives:

1. Appearance: New stock configuration including an improved Monte Carlo cheek piece comb, custom checkering with distinct patterns, distinguished design of the bolt handle and knob plus a streamlined configuration of the barrel, receiver and stock.
2. Cost: Produce this new customized rifle and sell it for the price currently received for the 721 and 725.
3. Weight: Maintain the approximate weights of the 721 and 725, 6-1/2 pounds and up depending on the caliber.
4. Variety of Calibers: Provide a range of calibers from the 222 Rem. to the 458 Win. Magnum

SUMMARY AND CONCLUSIONS

Significant in the overall design and development of the M/700 was the independent development of several major supplementary projects. These outside developments, when coupled with the specific developments of the project, have led to an extremely successful acceptance of the model.

The outstanding characteristic of the new rifle as developed in Part I of this project was the styling of the stock and the improved appearance of the bolt. The two principal features of the stock styling were the more desirable Monte Carlo cheek piece comb and the pistol grip. Features of the bolt were more pleasing lines and checkering on the knob.

Other important developments were initiated during the project as additional advancements. Included in this group were the revision of the extractor, the addition of the BDL model, the adoption of the press checkering and the announcement of the 7mm Rem. Magnum cartridge.

Part I of the project covered the expenditure of \$19,300 for the design and development of the M/700 rifle. The original proposal was to supply one design similar to the present ADL style in regards to stock design and style with hand checkering, the slightly modified action including the new safety, restyling on the bolt handle and checkering on the top of the knob. It was suggested by R&D that the model be presented in five or six most common calibers including the 375 H&H Mag. and 458 Win. Mag. For these two larger calibers it was proposed to supply the same action and receiver as the smaller calibers but supply a larger heavier barrel to help absorb part of the additional recoil and a larger stock to support the larger barrel.

Before Part II started, Sales added the requirement for the deluxe model known originally as the ADL and finally as the BDL. Sales also wanted the new model to be presented in a more complete series of calibers including a new magnum caliber, either a 300 or 350 Magnum. R&D counter-proposed the 7mm Magnum and soon the development of this cartridge was under way. The completion of this cartridge development in time to announce simultaneously with the new model has lent handily in the acceptance of both the rifle and the cartridge.

Ilion R&D had been interested for some time in developing a new method of checkering stocks to give the quality of hand checkering produced in production methods. There was underway at the time two development programs for new methods of checkering. R&D was developing a machine to checker stocks using a multispiindle pantagraph principle to reproduce from a master a hand checkering type design. A second development program was under way by the Machine Development Laboratory Section for reproducing designs by compression in a die utilizing pressure, heat and time. The successful conclusion of the latter method in time to be included in the announcement of the new model helped to present the M/700 as a new and distinct rifle, not just a dressed-up version of the Model 725.

A late development in the M/700 bolt assembly was the modification and improvement of the extractor. Sales and Arms Service had received complaints from customers on the patented type extractor used in the 721, 722, and 725. These complaints were mostly from hand loaders who have a tendency to shoot hot loads or even overloads. A stronger

version of the original 721 extractor was designed and added to the new model. Subsequently an investigation program has been conducted to compare the 700 extractor to the 721 extractor and finally to competitive models. The M/700 extractor was about 9% stronger than the 721 and a minimum of 20% stronger than competitive models.

The proof of the work performed on the development and presentation of the 700 is in the acceptance by the buying public. The 1961 forecast for the M/721-722-725 was 15,000 combined. The third year (1964) proposed forecast of the 700 in replacing its predecessors was to be 25,000. From its announcement in April to the end of December 1962 sales have totaled more than 43,000 rifles. Of this total approximately 12,500 were the new 7mm Magnum and another 12,500 were 30-06 caliber. Roughly 30% of all sales were in the BDL Grade.

The following table lists the available calibers and the current list prices:

ADL Grade

| | |
|--|----------|
| 222 Rem., 222 Rem. Mag., 243 Win., 270 Win., | |
| 280 Rem., 30-06, and 308 Win. | \$114.95 |
| 7mm Rem. Mag. and 264 Win. Mag. (Stainless Steel | |
| Barrel and Recoil Pad) | \$129.95 |

BDL Grade

| | |
|---|----------|
| 222 Rem., 222 Rem. Mag., 243 Win., 270 Win., | |
| 280 Rem., 30-06, and 308 Win. | \$139.95 |
| 7mm Rem. Mag. and 264 Win. Mag. (Stainless Steel | |
| Barrel and Recoil Pad) | \$154.95 |
| 375 H&H Mag. and 458 Win. Mag. (built in Muzzle Brake | |
| and Recoil Pad) | \$310.00 |

JWB:nl
1-9-63

EXPERIMENTAL DETAILSDevelopment of 7 mm Remington Magnum

Remington announced its new 7mm Magnum cartridge with the introduction of the M/700 rifle. The new caliber culminated a program to devise a high velocity center fire cartridge equal to or better than the .264 Win. Mag. brought out several years ago. It was desired by Sales to announce a new magnum caliber with the new rifle and had been considering something in the 300 or 350 Magnum caliber.

Ilion R&D felt that a cartridge as large as those under consideration would cause excessive recoil and stock breakage in a standard weight rifle. Ilion had previously done some work on 7mm Magnums and proposed to Sales the consideration of the 7mm bullet in the 264 Magnum case. The initial work was performed using the 264 Magnum case in a M/721 chambered accordingly. Tests conducted in the first pressure-velocity barrel indicated that 264 Magnum velocities could be exceeded. In a joint effort between Ilion R&D and the Bridgeport plant, the final development of the cartridge was completed from the earlier work performed in Ilion.

Several names were suggested for the new cartridge including 280 Rem. Magnum, 284 Rem. Magnum, and the 7mm Rem. Magnum. Sales chose 7mm Remington Magnum and cartridge production was given a first priority to permit an early 1962 introduction. Customer acceptance has exceeded expectations and has helped stimulate sales of the M/700. Sales records indicate the 7mm sold equal to the 30-06 and the two in combination accounted for about two-thirds of the 43,000 M/700 rifles sold.

Custom Checkering

The two-fold purpose of checkering on a gun stock is to aid the shooter in gripping and enhance the appearance. The introduction of the M/700 incorporated a new method of custom checkering developed by the Machine Development Laboratories Group assigned in Ilion. The development of this unique and novel method of decorating the stock and fore-end of both rifles and shotguns provides a customized condition by a production operation.

The new method used to produce this custom decoration is not checkering in the true interpretation since the design is not cut into the wood with a tool. The new process uses the combination of heat, pressure and time to mold the design into the wood. When the heated die is pressed into the wood for a short duration, the wood fibers are bent and displaced from their natural position by the die configuration. The normal moisture content of the wood provides sufficient plasticizing to "set" the design.

The present method of machine checkering requires an extensive capital investment since each machine is custom built for a particular model and pattern with little interchangeability. Custom or molded checkering can be performed on a common machine by changing dies for each stock or pattern style. This allows changes from model to model and even pattern modifications with less investment and increased versatility.

Development of the BDL Grade

When the Part I study was completed for design and development of the single grade Model 700, Sales requested the design be expanded to a standard and a deluxe (ADL) grade. The following modifications or additions were made to the standard grade in developing the deluxe grade:

1. The M/725 trigger guard and magazine floor plate were modified to fit on the M/700 including the necessary cuts in the stock.
2. A new checkering pattern was developed for the new grade.
3. The black fore-end tip and grip cap with white spaces were designed.
4. The top of the receiver was grit blasted.
5. The attachment of the swivels and sling were made standard equipment.
6. The standard grade was redesignated the ADL and the deluxe grade became the BDL.

A special BDL grade was established for the 375 H&H Magnum and 458 Win. Mag. calibers. To reduce the added recoil and support the added weight the following modifications were developed:

1. A heavier, larger diameter and longer barrel with a built-in muzzle brake was necessary for these larger calibers.
2. A larger and longer stock with two supporting pins in the receiver area was devised to accommodate and support the larger barrel.
3. The stock is hand checkered instead of molded custom checkered and is oil finished instead of standard lacquer.
4. The sights were modified to accommodate the changes made in the diameter and length of the barrel.

Indications to date show the BDL grade not as accurate as the ADL grade.

The two prime reasons for the difference are:

1. The ADL stock is stronger
 - a. The ADL stock is "U" shaped in the magazine area.
 - b. The BDL has only the side walls in the magazine area because of the floor plate.
2. The ADL has three screws mounting the receiver assembly to the stock group.
 - a. The ADL has two screws through the trigger guard to the receiver plus one screw seated in a deep escutcheon in the stock to the receiver.
 - b. The BDL magazine floor plate eliminates one screw entirely and the forward screw is seated in the aluminum frame of the floor plate instead of the escutcheon.

New Extractor

Sales and Arms Service have received complaints from customers about failures of the M/721 type extractor. These complaints have come mainly from hand loaders shooting hot loads. The usual source of these failures was blown primers or ruptured cases caused gas to escape in the bolt head. The net result was that the case was expanded in the bolt head, crushing the extractor claw. Instead of replacing the damaged extractor most shooters continue on firing and when the damaged extractor failed to work properly, a complaint was forthcoming.

Sales requested an investigation into the possibility of supplying the M/700 with a M/760 type riveted extractor. A new design, based on the M/760 extractor, was made up with a thicker cross section in both the spring and claw. Comparative blow-up tests were conducted and the 721 type extractor became inoperative while the 760 type was not deformed. Besides the increased strength, this new style also showed a better ejection pattern. A modified form of the new system was made up for the 7mm, 264 Mag., 375 Mag., and 458 Mag.

Subsequent to the release of the M/700 a study was conducted to determine the comparative extracting quality of the new extractor, the former design and certain competitive models. A test fixture was made up to subject the extractor to the pull of a compressed spring mounted on a threaded rod attached to a chambered cartridge case. The spring was compressed against the muzzle and the spring force was gauged. There was no pull on the extractor until the bolt was opened against the extractor cam and engaged the extractor against the case rim. Three things could happen as the bolt was turned open;

(1) the extractor could hold its engagement in the cartridge rim, (2) the extractor could slide off the case rim, or (3) if the extractor were still engaged at about 350 lbs. or more - the extractor would shear a section from the case rim.

The new extractor was compared to the 721 type and withstood an additional 14% pull and when compared with competitive models withstood a minimum of 20% additional pull. Results of these tests show the following facts:

| Make | Caliber | Pounds of Load | | | General Comment |
|------------------|----------|----------------|------|------|--------------------------|
| | | Min. | Max. | Ave. | |
| Remington M/700 | 7mm | 310 | 385 | 349 | Case rim failed |
| Remington M/700 | 30-06 | 300 | 350 | 323 | Case rim failed |
| B S A | 30-06 | 250 | 275 | 266 | Extractor slipped off |
| Husqvarna | 30-06 | 235 | 360 | 290 | Case failed on Max. |
| Weatherby Mark V | 30-06 | 250 | 250 | 250 | Extractor slipped off |
| Weatherby Mark V | 300 Mag. | 250 | -- | -- | Extractor broke |
| Winchester M/70 | 308 | 100 | 200 | 150 | No resistance to slip |
| Winchester M/70 | 264 Mag. | 175 | 190 | 182 | Extractor slipped easily |
| Winchester M/70 | 458 Mag. | 200 | 300 | 246 | Extractor slipped off |

6mm Remington

A new caliber is to be announced about March 1, 1963 for the M/700, both the ADL and BDL Grades. This new cartridge is the 6mm Remington and it results from an extensive testing program for accuracy by Union R&D. This additional caliber will bring the selection to ten in ADL and twelve in BDL.

A comparative test program was conducted by Union R&D to determine the proper twist to manufacture this new caliber. A series of accuracy tests were fired using M/700's and M/40X's, each chambered for the 6mm and rifles in 8, 9 and 10 inch twist. Various weight bullets from 65 grains to 105 grains were hand-loaded and fired in comparison with the factory loads with 100-grain bullets. These tests were fired in all weights, all twists, and in both style rifles from the bench at 100 yards range.

The results of the tests showed the 9" twist the most desirable. The figures represent averages in inches of nine 5-shot groups, maximum spread:

| Model 700 | | | Ammunition | Model 40X | | |
|-----------|------|------|--------------------------------------|-----------|------|------|
| 8" | 9" | 10" | | 8" | 9" | 10" |
| 1.69 | 1.20 | 2.07 | 60 Gr. Sierra H.P. 45.3 Gr. 4064 | 1.00 | .92 | .99 |
| 1.89 | 1.44 | 1.73 | 75 Gr. Sierra H.P. 42 Gr. 4064 | 1.08 | .95 | .98 |
| 2.05 | 1.75 | 1.72 | 85 Gr. Sierra P.S.P. 40 Gr. 4064 | 1.37 | 1.07 | .95 |
| 2.13 | 1.58 | 2.51 | 105 Gr. Speer S.P. 43 Gr. 4350 | .99 | 1.15 | 1.10 |
| 2.61 | 2.47 | 3.45 | 105 Gr. Speer Spitzer 43 Gr. 4350 | 2.15 | 1.69 | 2.19 |
| 2.95 | 2.53 | 2.57 | Factory Load 100 Gr. Rem. P.S.P. | 1.50 | 1.60 | 1.22 |
| 2.22 | 1.83 | 2.34 | Average | 1.55 | 1.23 | 1.22 |

Revised Safety

A revised version of the M/721 Safety was established for the M/700. The Safety in the M/721 was rather stiff and was difficult at times to get the Safe engaged. Customers had complained that the Safety was located so that it was unhandy to manipulate and that it could be moved from Safe to Fire by brush and other obstructions.

The Safety (lever) was lengthened and formed around the side of the receiver. The radius between the pivot and the detent ball was shortened to improve detenting. The angle on the sear camming surface was modified to improve the mechanical advantage.

There was an additional cut added in the fabrication of the receiver as clearance for the modified Safety. This design change improves the appearance of the pistol grip area and makes the safety button easily operable.

A different bolt stop spring was devised and modifications were made to the receiver to allow lowering the tang and improving the streamlining.

Stock - ADL and BDL Grades

The Stock was designed to combine the symmetry of lines and comfort in handling. The fore-end was made slimmer and shorter than the M/721 and the Monte Carlo cheekpiece comb was added. The trigger was moved 1/4" toward the grip to prevent the hand from contacting the swept-back bolt handle during recoil.

The grip is so designed that when grasping it the trigger finger is in a relaxed position, that is, the lower joint of the fore-finger is in prolongation of the forearm reaching the trigger with ease. The curve of the grip and its height with relation to the bottom line of the stock add a custom feel to the M/700. This is accomplished by having a slight parabolical curve toward the rear of the grip with plenty of finger room just behind the trigger guard. The grip has an almost full oval cross section with a comfortable circumference. Pressed into its sides and top is the complimentary checkering pattern conforming with the comfortable and pleasing shape of the grip.

The Monte Carlo cheek-piece is thick enough and properly sloped so that it fits snugly and it is comfortable even with cartridges having large recoil. Its large flat surface provides a positive and controlled method of canting the head thereby lessening the time required to line up the eye with the sight (iron or telescopic) and providing a firmer and more uniform hold.

The comb is properly placed on the stock so that when the grip is grasped for shooting the base of the thumb is supported. This is done by locating the comb over the center of the grip. The fluted comb is artistically cut so that it runs parallel with the lower edge of the stock - not cut downward at a sharp angle. The rear portion of the undercut blends into the surface of the stock with no perceptible angle.

The Buttstock is full and rounded to about a half circle just behind the grip and narrows in a straight taper toward the toe to conform with the butt plate. The upper edge is thick and full which tapers in the same manner as the cheek-piece toward the front. The pitch and drops are designed so that when the rifle is brought up for a quick shot it is done with ease and speed. When the rifle is fired it will deliver the recoil through the center of its form clinging to the shooter's shoulder and not sliding up or down.

The fore-end is comparatively full and long having lines in balance with the rest of the stock and slightly swelling over the magazine blending into the grip. Pressed into the fore-end is the checkering pattern on the sides and bottom, having its outlines parallel to the edges of the fore-arm. The BDL is capped off with a well proportioned black fore-end tip having a white spacer between it and the walnut stock.

The recoil pad added to the stock on all magnum calibers was developed by experimentation to provide a maximum recoil absorption without bottoming out. The design of the pad and the selection of material were worked out to allow a full cushioning effect of the higher recoil characteristics of magnum loads.

FUTURE PROGRAM

It has been recommended that the M/700 be made available in the C, D and F Grades. These weapons would be custom made by the Custom Rifle Shop of the Ilion R&D Department as the present BDL 375's and 458's are currently made.

The "C" Grade rifle would be similar to the BDL 375 and 458 with hand finished oiled stocks, hand checkering, and a choice of the ADL or BDL magazine. The "D" and "F" grades would have high grade wood, hand finished in oil, hand checkering and a choice of magazines. The barrels and receivers would be hand engraved or hand engraved and gold inlaid depending on the grade.

Another development presently under way is the 30 caliber bullet in the 7mm magnum case. Pressure barrels have been made up for test firing at Bridgeport and some testing has been performed. Several custom rifles have been made for customers chambered in this caliber and more are presently on order.

Calculations for Strength of the Action

Materials Used

Bolt Head - ASE 8640
 Receiver - ASE 4140
 Barrel - 416 Stainless Steel or RA Spec 155

P = Pressure of Proof Load = 70,000 psi
 A = Area of case base (Diameter of case = .513)
 M = Strength of Materials (elastic limit) 150,000 psi
 F = Force of Proof Load = Pa

Stress on the Bolt Lugs

A - In Shear

Area of bolt lugs = $2 \cdot lw$ $l = .01745 r$
 $= 2 \cdot (\text{arc BC}) (\text{length AB}) = .01745 (.349) (80)$
 $= 2 \cdot (.487) (.444) = .487 \text{ in.}$
 $= .433 \text{ in}^2$

Maximum allowable load in shear = $.6MA$
 $= 150,000 (.433) (.6)$
 $= 39,000 \text{ pounds}$

$$\begin{aligned} \text{Area (a) of case base} &= 3.14 \left(\frac{.513^2}{4} \right) \\ &= .207 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Force of Proof Load} &= Pa \\ &= 70,000 \text{ psi} \times .207 \text{ in}^2 \\ &= 14,490 \text{ pounds} \end{aligned}$$

$$\begin{aligned} \text{Factor of Safety} &= \frac{\text{Max. Load}}{\text{Proof force}} \\ &= \frac{39,000 \text{ lbs.}}{14,490 \text{ lbs.}} \\ &= 2.69 \end{aligned}$$

B - In Compression

$$\begin{aligned} \text{Area of bolt lugs} &= 2 (lw) \\ &= 2 (.490) (.143) \\ &= .137 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} l &= \text{mean difference in arc BC \& arc DE} \\ &= (.492 \& .487) \\ w &= 1/2 (\text{dia. lugs} - \text{dia. bolt head}) \\ &= 1/2 (.990 - .703) \end{aligned}$$

$$\begin{aligned} \text{Maximum allowable load in compression} &= MA \\ &= 150,000 (.137) \\ &= 20,800 \text{ pounds} \end{aligned}$$

$$\begin{aligned} \text{Force of Proof Load} &= Pa \text{ (from above)} \\ &= 14,490 \end{aligned}$$

$$\begin{aligned} \text{Factor of Safety} &= \frac{\text{Max. Load}}{\text{Proof force}} = \frac{20,800}{14,490} \\ &= 1.47 \end{aligned}$$

Stress on Receiver Lugs

A. - In shear the bottom lug is weaker than the top because of the loading ramp cut and the bolt lug is narrower than the receiver lug; therefore the bolt lug would tend to tear through the center.

Area sheared out by bolt lug = w of bolt lug x l of receiver lug + 2 x h of bolt lug x l of receiver lug.

$$\begin{aligned} A &= w(.490) \times l(.280) + 2h(.143) \times l(.280) \\ &= .137 + .080 \\ &= .217 \text{ in}^2 \end{aligned}$$

Since one bolt lug has an area of 1/2 (.433) or .217 in² and the upper receiver lug is stronger than the lower, it is assumed the bolt lugs would shear before the receiver lugs.

B. - Stress in tension of Receiver

$$\begin{aligned} \text{Area of cross section} &= 3.14 \text{ (mean diameter) (wall thickness)} \\ &= 3.14 (1.212 \times .147) \\ &= .262 \text{ in}^2 \end{aligned}$$

$$\begin{aligned} \text{Maximum allowable load in tension} &= \text{MA} \\ &= 150,000 \text{ psi } (.262 \text{ in}^2) \\ &= 39,225 \text{ pounds} \end{aligned}$$

$$\begin{aligned} \text{Factor of Safety} &= \frac{\text{Max. Load}}{\text{Proof Load}} \\ &= \frac{39,225}{14,490} \\ &= 2.71 \end{aligned}$$

From Lamé's formula we can determine the ability of the action to withstand the high pressure from within. Since the barrel material is the weaker of the barrel-receiver group, we shall consider the strength of the barrel alone:

- P = Pressure within the chamber (70,000 psi on proof load)
- R = Radius at pitch diameter of threads = 1.020/2 = .510
- r = Radius of chamber = .513/2 = .257
- S = Maximum allowable stress

$$\begin{aligned}
 S &= P \left(\frac{R^2 + r^2}{R^2 - r^2} \right) \\
 &= 70,000 \left(\frac{.510^2 + .257^2}{.510^2 - .257^2} \right) \\
 &= 70,000 \left(\frac{.332}{.200} \right) \\
 &= 116,300 \text{ psi}
 \end{aligned}$$

$$\begin{aligned}
 \text{Factor of Safety} &= \frac{\text{mean tensile}}{\text{max. stress}} \\
 &= \frac{115,000}{116,200} \\
 &= .905
 \end{aligned}$$

When considering the total strength of the action, assume the strength of both the barrel and receiver to be of the weaker material since the stronger material in the receiver will add to the total strength only if the weaker material withstands an overload.

- P = 70,000
- R = Radius of receiver = 1.358/2 or .679
- r = .257
- S = Maximum allowable stress

$$\begin{aligned}
 S &= P \left(\frac{R^2 + r^2}{R^2 - r^2} \right) \\
 &= 70,000 \left(\frac{.679^2 + .257^2}{.679^2 - .257^2} \right) \\
 &= 70,000 \left(\frac{.460}{.396} \right) \\
 &= 93,400 \text{ psi}
 \end{aligned}$$

Ballistic Information on 7mm Rem. Magnum

| Bullet Weight | Muzzle | Velocity - Feet Per Second | | | | |
|---------------|--------|----------------------------|----------|----------|----------|----------|
| | | 100 yds. | 200 yds. | 300 yds. | 400 yds. | 500 yds. |
| 150 grain | 3260 | 3070 | 2880 | 2690 | 2500 | 2320 |
| 175 grain | 3020 | 2660 | 2340 | 2050 | 1790 | 1560 |

| Bullet Weight | Muzzle | Energy - Foot Pounds | | | | |
|---------------|--------|----------------------|----------|----------|----------|----------|
| | | 100 yds. | 200 yds. | 300 yds. | 400 yds. | 500 yds. |
| 150 grain | 3540 | 3140 | 2760 | 2410 | 2080 | 1790 |
| 175 grain | 3540 | 2750 | 2130 | 1630 | 1240 | 945 |

| | Trajectory - Inches | | | | | |
|-----------|---------------------|----------|----------|----------|----------|----------|
| | 100 yds. | 200 yds. | 250 yds. | 300 yds. | 400 yds. | 500 yds. |
| 150 grain | +2 | +2 | 0 | -3 | -14 | -30 |
| 175 grain | +1.8 | 0 | -- | -8.5 | -24.8 | -48.4 |

Bullets are Soft Point Core-Lokt