

April 4, 1968

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Dear Les:

Thank you for your recent letter. In the first paragraph you have asked a question which is an important one and not too thoroughly understood by the average gun man, gun nut, or I'm sorry to say, by the so called knowledgeable gun designers. I could write you a volume on this subject but realize that you would become bored before you got half way through it.

This area of strength of guns and the strength of the cartridge case has been one I have followed closely over the past 30 some odd years in gun development, 22 of those years being spent here at Ilion, and the others in the Ordnance Department. There is no gun on the market today that compares with the Remington in strength because they all lack some portion of support to the cartridge case and although they have copied the M/721 basic design to a certain extent, have failed to see through the completeness of the basics for this design.

Actually, the strength of a brass cartridge case in center fire design, and let's confine ourselves first of all to the 30-06 grand-daddy case, is in the neighborhood of around 85,000 psi before the unsupported portion of the head will burst. Naturally, proof loads that are in the areas of 60,000 to 65,000 psi are safe to handle under normal conditions, but when some of the blowups that I have seen get out of control and reach the 85,000 pound areas then there is concern for the strength of the gun. When gases are released they work on every square inch available and you can imagine what 85,000 psi release inside of a Mauser, Enfield, Springfield and the like would do ~~where~~ areas of the locking lugs are exposed directly to this pressure. The materials used in the steels have nothing to do with holding these items together once that much pressure is released.

Therefore, the strength of the cartridge case when exposed to exceptionally high pressures in the areas above proof loads, and in cases that are exposed such as the rimless types, must need additional support. This is obtained

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primarily in the basic M/721 design by providing a shroud in the bolt which completely encloses the cartridge case without any cuts or strength reducing slots in this portion of the shroud. The shroud, without support of the barrel, will give additional support to roughly 120,000 psi before enough gas is released to do damage to the rest of the action. This is about the area where most of the competitive guns lie at the present time. I am referring specifically to those that have copied the basic M/721 idea for additional strength, and in some instances I would say that this is a more dangerous situation to the handloader or the shooter who fires a lot of ammunition, than if he had the type of gun without the shroud, because when 120,000 psi pressure is released a considerable amount of damage can occur; therefore, endangering the shooter to a higher degree.

This, of course, is not the end of the story for the M/700-721 system. Upon careful examination you will find that the shroud in the bolt of our rifles is also supported by a recessed shroud in the barrel. The barrel, in addition, is supported by the receiver. Therefore, under extreme pressures, the only expansion that can take place in a high pressure load in a M/721 design is the expansion of the space between the cartridge case and the shroud, the shroud and the barrel, and the barrel in the receiver. These clearances between the elements mentioned are not enough to allow complete rupture of a cartridge head at its base, but only enough to provide smooth entry of the bolt into the recess in the barrel, and not allowing the case head to expand beyond a few thousandths of expansion in the primer pocket. Naturally, when the primer pocket opens up there will be a rupture that takes place between that pocket across the base of the head of the cartridge. This will occur anywhere from the 85,000 pound level up. We have experienced here in the M/721 basic system, pressures in excess of 300,000 psi with the gun holding everything intact. Enough gas pressure leaks out through the large primer pocket to cock the firing pin, expand the relative parts of the gun such as the bolt shroud into the barrel, and the barrel into the receiver, into one welded homogenous unit.

Examination, then, of such a result can only be made by cutting a cross section of these elements.

I personally have tested, I believe, every known big game rifle made with exceptions of Haskins and Champlin and the other that has been developed down South in that neighboring area. I have explored all of the different types of rifles and locking systems, and results that are obtained through high pressure testing has led us into a considerable amount of design knowledge as to the strength of a gun and how to protect it. I had a famous gun writer telling me how strong such and such a thousand dollar bolt action rifle was; it was the strongest in the world, etc., and I asked him what the pressures the

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gun was tested at. He said 90,000 psi. Naturally, it was unsupported in the cartridge case area and I advised him that he could take an \$85.00 Model 788 and we tested it at well over 200,000 psi without any difficulties. This is the difference between making a statement not based on fact, and one based on fact.

We make a thorough study here of the flow of gas under high pressure that has been released in various types of cartridge cases, and we know exactly where it flows and how much of the gas particles can be accommodated. Without mentioning any names as far as our competition is concerned, I can say that I have traced the flow of gas in progressively loaded ammunition right straight on up through to destruction.

Of all of the cartridge cases and loads examined the 30-06 is perhaps the most potent of all. Naturally, there are numerous cartridges developed on the basic 30-06 case but none can produce pressures or damage to a gun like a 30-06. Therefore, our standard tests now are based on loads on 30-06 cases and they run somewhat like this. In powder weight in grams, using 2198 powder, a proof load is 2.78 grams for the 220 grain bullet. This develops pressures in the neighborhood of 60,000 to 65,000 psi. We start there with our loads and progressively increase them to 3.4 grams, which is a full case. Then beyond to obtain pressures in the areas of close to 300,000 psi we add 220 grain projectiles immediately ahead of the loaded round. The M/721 system withstood pressures that were developed by this load with 5 - 220 grain bullets in front of the heavy proof load. The M/600, which is a basic 721 action, except shortened, is probably even stronger, not because it has any larger lugs but because of the shorter action. However, we haven't subjected it to any strength test beyond that which we have found adequate in the 721. But the shorter bolt makes for a stiffer action and therefore prevents or at least nullifies the bending action of the receiver to a greater degree than the longer receiver.

The M/788 is probably the second strongest action in the world today and follows very closely in the footsteps of the M/721 system, having withstood pressures in the area to include several slugs ahead of a 30-06 proof load.

I covered the strength test system that we have introduced here at Remington with General Hatcher just after announcement of the M/721 system. I reviewed the test procedure and fixtures with him, and showed him the results, which he published in the American Rifleman writeup on the M/721 at that time. Perhaps you can dig up one of the old issues and reread the results. He in turn sent me numerous military weapons which he wanted tested under the same conditions, and of course there were M1 rifles, Japanese guns, Enfields, and the like in the test. After basically starting with the test with handloads just exceeding

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proof loads, they were all blown up and I sent the box back to him full of scrap iron. All of these guns had bolts that did not support the cartridge case and therefore were at the mercy of the strength of the brass. He was quite upset by the results because he had just published his book which involved the strength characteristics of some of the military weapons and made some statements about the tremendous strength of the M1 rifle and some of the rest of them, which was disproved by this test. But it was too late to change the book since it was already in print. Again, this points out the difference between actual measurement and proof by fact as against theory without test results.

To expand further into the belted type case which I favor greatly as far as strength is concerned, there is no stronger case in the world today than the belted magnum. This has been proven by test in some of the heavy pressure loads that I conducted with both the 300 and 375 H&H Magnum. The damage that can be expected in any gun is greatly reduced when using the belted case versus the 30-06, with or without supported shrouded heads.

If I had to use a bolt action rifle with high power loads that had a bolt not designed to support the cartridge case, I would select any of the belted magnums just from a safety point of view.

Again, another area is in considering the design of rimmed cases. There is no question that the strongest system man has developed is a system of rimmed cartridge cases completely supported in the barrel and then held with a very adequate locking mechanism behind it. Here again, support of the cartridge case allows one to reach the upper limits of pressure without damage to the gun, and this of course is accomplished without providing any shroud. But the basic problem is still there and it is being accommodated by another means of supporting the case. Regardless of whether it is a bolt or the barrel, as long as the case is supported so you are not depending upon the strength of the brass, then you have a strong system. Just to give you an example of the extent to which we go into design, I previously mentioned the flow of gas in this letter. In the development of the M/580 - 590 system of rim fire rifles, blotter paper was used in 360 degree arc around the rifle to pick up any escape of powder particles under high pressure loads that might find their way out of the gun. Here, too, even in rimmed cases, where you have an extractor slot, the strength of the cartridge case determines when rupture will occur, such as a blanking press does when you are blanking material out of a blanking die.

This rifle is the only one I have ever seen that will not allow gas to escape back along the bolt through alongside the firing pin. In the disassembly of your M/580 bolt, if you will note, back of the locking lugs are two abutments which block flowing gas, if it gets beyond the locking lugs, the gas would have to bypass these obstructions before

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reaching the bolt plug, which is the third stopping point in the rear of the bolt before it would hit you in the eye.

In all of our high pressure load tests here, for example, the M/580 will not allow expanding gas to escape along the bolt or through the firing pin beyond the first stopping point. This is why I claim it to be the safest rimmed fire bolt action rifle in the world. This is all of course in addition to the superb strength of the locking system which actually, Les, approaches many of the 30-06 type center fire bolt action rifles.

I am afraid the general public does not really realize what we have done in the development of our modern bolt action systems, especially in the M/788 and M/580 series. When most people buy a 22 Caliber rifle they seem to want to pick up the cheapest one they can find. In the new M/580 - 590 Series we have left no stone unturned to provide the finest in center fire design in rim fire rifles. And the statement that we have made in this claim was not just idle chatter. Unfortunately, a lot of these features are hidden features, and cost money; therefore, the price tag is not the lowest. But the gun is the finest. I have seen it withstand pressures that would take apart many of the modern bolt action center fire rifles on the market today.

One of the serious situations with which I think we are faced in this country is the rebarreling of so many of the cheaper, poorly designed center fire actions available to gunsmiths in the world today. And an overflow of these guns from WW-2. Unfortunately, the unsuspecting sportsman has paid enough money to purchase a modern, well designed American-made rifle in getting one of the so-called foreign actions rebarreled. And when I say foreign action, I also should include the Springfield action, too.

You know, Les, of all actions tested, those that do not support the cartridge case, the Model 30 or Enfield is the strongest. Not only does it have a healthy locking system but actually the gun through its clearances allows a tremendous amount of gas to escape externally and does not provide as much working area internally for the gases to work on. The effect on the surrounding stock is disastrous as the stock will fly into millions of pieces of small splinters. Nevertheless, the action will stand up admirably well and exceeds the Springfield, Mauser, Japanese Arisaka, the M1 Rifle and the old Model 70 by a large degree. However, because of lack of strength in supporting the case it does not anywhere nearly approach the M/721 system.

You would do well with your accumulation of bolt action rifles, someday when you have time, to look over the bolt systems very thoroughly. You will note, and I am sure you are familiar with the terms shear and bearing; observe very closely the locking areas both in shear and bearing. You will find, I know, that some will have an exceptionally large amount of shear, and for what good

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reason. You will also note abutments in a lot of the bolts. For example, the safety lug on the Springfield --- what good is it? When escaping gases move rearward, that provides a good spot for the gases to work on. I have seen Springfields shear the safety lug right off. Once the bolt starts moving and rearwardly, ten of those safety lugs would not prevent the bolt from shearing straight through the receiver into the shooter's head.

I wonder sometimes what designers had in mind. Instead of investigating, they drew pictures. Instead of calculating, they drew pictures. A recently designed new rifle selling for around \$1,000 with which you are very familiar has lugs that are claimed to be the strongest in the world, have tremendous shear area, and very little bearing area.

You've heard the old adage: A chain is no stronger than the weakest link. Why have so much strength in one section and nothing in the other section.

The proper balance, the most efficient utilization of weight and material, and thorough study of the gas flow, strength of the cartridge case, how it is to be supported, how the gases are to escape and where, and adherence to deflection of gases and reduction of working areas for the gas, are all very necessary elements to be considered in the design of a new rifle.

I don't know whether this has answered any of your questions, but I could go on and on. As I say, someday I might write a book on this subject. Perhaps you and I can compare notes this summer. I would really enjoy spending a few hours with you to discuss just this one subject. I don't know how you feel about further discussions in this area, but if you are interested I will certainly oblige.

Now another subject you have brought up is the utilization of one bullet for several loads. I will certainly not argue with you on this item as you are absolutely right. In my book, one bullet is not adequate for all speeds and loads. But I think you appreciate the economic point of view involved. Certainly I don't believe there is anyone in the world who has explored the effect of bullet expansion at various velocities in flesh that you have. And our discussions together on this subject have been most enlightening. I have worked on artificial systems which come close to reproducing the actual flesh conditions and intend to do more of this sort of thing as soon as my range is complete, which should be within the next month or two. I intend to work up a material combination which will reproduce very, very closely the effects of flesh and bone. I would like very much to discuss this with you at length sometime. I believe that our Corelokt design is one of the finest in the world as a compromise design for all types of velocities that can be expected in the various loads. However, there are others equally

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as good and I like the idea of a combination design where the one section of the bullet can work on the light resistance while the heavy section carries on through to do the real damage.

Believe this is all for now, Les. Hope this has helped you some. I appreciate your comments on the articles in the Rifleman and others. That gun vise looks fine. I am going to make one for myself. I wish I could see you in Boston, but don't plan to go this year as work here is pretty pressing, but will have items to talk about which will require my presence this time next year at the NRA Show. So will cancel out for this one.

This summer will be an unsettled one for us as we do not know what Dennis is going to do. He may locate in Sheridan, as I mentioned before. On the other hand, he may be in the OCS work in either Navy or Army.

That's all for now. Best to you and Martie. Glad to hear from you at any time.

Regards,

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