SUGGESTIONS SUPPORTING A NEW LINE OF BOLT ACTION RIFLES AND SHOTGUNS.

Introduction.

This program reviews the favorable and undesirable features of the M700 rifle with suggestions to support an improved M700, elevating it to a higher quality level of customer acceptance. The development will not be too expensive or time consuming and would provide a base rifle allowing time to accommodate the more innovative ideas.

A proposed foundation for a new bolt action shotgun follows the rifle program.

Program for the improved rifle.

The M700 action exceeds the strength of every known bolt action CF rifle by a substantial margin. Supporting the exposed head of the cartridge case by reinforcing it with the bolt shroud, barrel recess and receiver, prevents case rupture and a damaging amount of gas from escaping rearward during high pressure firing. The ring extractor used in the M700 eliminated the need for expensive qualification threading and an extractor cut in the barreled receiver assembly so commonly used in previous bolt action rifles. The superior strength was a fortituous spin-off of this design and not known until severe strength testing revealed the secret. Any future development should include the integrity of this principle and must be jealously guarded. This is not to say that the ring extractor is mandatory to protect the strength principle but the support of the cartridge case without rupture under high pressure is extremely important.

The M700 extractor has undergone a series of design changes to guarantee reliability and the latest is believed to be superior to previous attempts. Unfortunately a bad reputation of breakage, malfunctions, and difficult repairs

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has plagued the principle to the point that future customer acceptance is severely questioned.

During an Ordnance development of a tank machine gun by Remington, an improvement to the ring extractor was found in a German WWI machine gun resulting in a successful design for our program. This extractor was a claw type, small but efficient in nature housed in a cut in the bolt shroud. Its main feature, an ever-tightening grip as the load was increased, left little to be desired. The outside surface of this extractor replaced the cut-out portion of the shroud and was thoroughly supported by the barrel recess. Strength tests revealed that this combination provided all the strength of the ring-extractor design. It is suggested that this principle be used in the improved rifle.

In general the accuracy of the M700 is adequate for hunting, varmit, silhouette and target shooting. Special orders for bench-rest type rifles produced by the custom shop have proven accuracy superior to all but the finest match rifles. Modern barrel manufacturing methods such as used in Remington are to be credited for this achievement. Remington, however, is not in the league of competition for the position match shooter, dominated by Anschutz.

There are several areas where accuracy can and should be enhanced by changes in the basic design such as the barrel bracket. The cross-sectional area of the bracket adjacent to the barrel is considered weak by many gunsmiths and has now gained a bad reputation for lack of recoil support especially when using heavy-calibered ammunition. This situation is

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aggravated by improper bedding in the stock, especially if the bedding support contacts the bottom of the bracket.

Any shifting or bending of the bracket can cause accuracy problems. One made of powder metal or other means of greater rigidity as used in the M 788 would be of benefit.

A round surface on the bottom of the receiver as presented by the M700 has always been questioned by many gunsmiths, designers, and match shooters as a possible area of non-stability during the torquing of the receiver during firing. If true, and I believe the torque problem does exist, a conventional flat surface should be provided for proper bedding. The new barrel bracket design could be extended with a mating flat surface to fit the receiver.

Research is needed to explore the areas of bedding actions in an effort to determine the magnitude of advantages in barrel-dampening devices. Although some investigation in the past has shown advantages by using dampening methods inconsistencies have prevailed. I believe the results of past efforts were clouded by barrels which had varied wall thicknesses. Modern manufacture such as practiced by Remington virtually guarantee centralized bores in the barrels. Reliability in the use of bedding devices would be enhanced with these barrels. Such methods as electric bedding, 2-point and 3-point bedding, pre-determined muzzle pressure, free-floating barrels and other means should be explored.

There is some indication that accuracy is improved when accompanied by faster lock time in rimfire rifles and the same should be true in center fire rifles. It is believed that

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the fall of the firing pin sets up pre-vibrations in the barrel prior to ignition which disrupt accuracy. There also may be a more uniform ignition advantage.

Accuracy testing of thousands of production rifles has revealed that the M788 is superior to the M700. This fact was observed during the development of the M788 when compared to the M700. Using the same barrel process, stock bedding principles and the same lots of ammunition have ruled out most of the variables between the two rifles, the exception being the receiver(front vs rear lockup), heavy vs light barrel bracket, and the difference in lock time. M700 lock time is approximately 5.5ms and the M788 is 2.7ms. The shooters are also observing the accuracy advantage of the M788. It is believed that the faster lock time in the M788 gives this model accuracy advantage. Re-design of the M700 should involve reduced lock time to improve its accuracy and give the off hand competitor the advantage of this principle.

There are numerous ideas to achieve faster lock time. Such a design is a flat-type formed pin with rotary swaged nose as used in the M788. Other ideas include the use of lighter weight metals, ie, aluminum, titanium, tubular construction, carbide or allow steel-tipped light weight pins, etc. It will be found that a nose diameter of .060" is necessary when using the lighter weight pin for proper ignition. Faster lock time approaching zero should be our objective.

Reliable accuracy is no more secure than the rigidity of the scope base mounting screws and in the M700 6/48 screws are

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not adequate. The use of 8/40 screws as used in the M788 or a fixed scope base of Ruger design is recommended.

Glass bedding methods are excellent to insure a perfect fit of the action to the stock. Also recent developments in custom designs provide extruded aluminum bedding elements which precisely fit the barreled action and are securely epoxied to the recesses of the stock. Fiber glass and other plastic materials are now appearing on the market, impervious to the elements and strikingly attractive. These items certainly suggest improvements in accuracy.

Accuracy is always enhanced by fine trigger mechanisms. Remington's M700 has a reasonable trigger which when properly adjusted, allowed a spread of pull weight from 1# to 8# with a crisp let off. However one must rely on the factory adjustment which is anchored with loc-tite cement plus staking with a center punch. The latter ruins the threads and side plates of the mechanism and the former fills the screw slots, all of which makes it virtually impossible to adjust by anyone, including gunsmiths. The excuse for this is in the name of safety to prevent the customer from making adjustments. However the shooters are attempting to make adjustments and often ruin the meager adjusting means that has been damaged in assembly.

A more substantial approach is the Canjar design which in essence is a copy of Remington's principle but improved and of course more expensive. This assembly allows more contact area for the screws. The main adjustment of over travel is retained by a nylon pin. Canjar provides instruction for adjustment and a warning statement, which apparently relieves him of responsibility in case of accidental discharge due

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to faulty adjustment. The screws are Allen-headed which eliminates the slot problem. Two-link and three-link systems are available-the latter can be adjusted down to a 2 oz. pull. Most match shooters resort to the Canjar or Kenyon design. It is suggested that before improvement to our trigger mechanism be made that we analyze Canjar, Anschutz, Kenyon and Feinwerkbau designs.

Remington's manual safety blocks the sear mechanism. The manual motion is in the same plane as the trigger movement and allows a dangerous condition to exist. Pulling the trigger at the same time the manual safe is moved to off, fires the rifle! This motion is not unlike taking the hammer off safe in a M94 Winchester or a revolver.

A manual safety should never be allowed to function in the same plane with the trigger unless a disconnector is provided preventing firing if movement of the safety takes place while the trigger is pulled! A safer and more reliable manual safety is a 3-position type located on the cocking piece. it is recommended that these ideas be considered.

The stock design of the M700 is excellent, presenting good balance and symmetry. The RKW finish is appealing to those who desire a glossy shiny finish but has little appeal to the experienced sportsman who is accustomed to European walnut and hand-rubbed oil finishes.

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The effect of pressed checkering has down graded cut checkering and has led some shooters to search for stocks with other decorative designs. One attractive procedure is to use a grained stipling pattern as found on fine German-made firearms. Also there is a slight trend toward hunting scenes cut or impressed or transferred on the stock.

Approximately 15% of the population are left-handed and I believe it is prudent to coninue providing these models for the left-handed shooters.

For many years Remington was very aggressive in developing and promoting new calibers, leading the competition in the market place. Such successful developments as the 7MM Magnum -25-06, 222, 22-250 are examples. Naturally not all of our cartridge developments were a huge success and the inability to analyze a future market such as was done on the military 308 has in some degree hurt our posture. To keep our product alive new developments in cartridge design which provide a substantial improvement over the common place is needed. The 7/308 and the Remington 7MM Express are good examples of a policy to keep new cartridge development in the forefront.

A peen-hammered barrel presents desired effects of something special being done to high grade rifles. This process was used for years on the surface of a sterling silver bell on slide trombones manufactured by the Old's musical instrument company. They claimed exceptional tone qualities from this process due to the relief of surface tensions

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on the bell, and this feature became an appearance of excellence among musicians.

We achieve this appearance in our rotary swaging of barrels and then remove the surface by grinding. The idea of providing a super-grade barrel with this aesthetic effect was meekly presented to the operations committee several years ago. This lacked technical support of what might be desirable mechanical improvements in accuracy. Certainly the aesthetics of something special was there. Since then the fine custom Manlicher rifles display their product with this appearance. I believe the surface condition if left might indeed support improved accuracy performance along with a desirable appearance and certainly would be obtainable at no extra expense.

PROPOSED IDEAS FOR FUTURE DEVELOPMENT.

Several ideas were suggested in my Sept. 81 report that would improve the performance of the match shooter in his quest for perfection in accuracy and these are repeated in this report.

Recoilless principles used in fine match-grade air rifles, (nullifying recoil caused by movement of the compression piston.)

Movement of a large mass prior to release of a bullet or pellet tends to throw the shooter's aim off target before exit of the projectile. This problem exists in such open-bolt centerfire rifles as the BAR, M3 and Thompson Sub machine guns and others. To nullify this unwanted problem in match grade air rifles four approaches have been taken as follows:

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1. Anschutz match air rifle uses an oil-filled hydraulic cylinder, an action similiar to car-type shock absorbers to compensate for the forward motion of the compression piston.

2. Walther's match air rifle uses a single stroke pheumatic system which allows a piston to compress air into a chamber only a few times larger than the pellet. Movement of the trigger sear allows a heavy spring-loaded hammer to hit a striking lever which in turn pushes open an exhaust valve.

3. Beeman's match air rifle involves double-acting pistons which results in a smooth recoilless and vibration-free firing action.

4. Feinwerkbau's match air rifle uses a principle where movement of the compression piston at the moment of firing trips a sear which releases the entire barrelled receiver assembly to ride on a pair of hidden, hardened rails. The necessary "equal and opposite" reaction causes this heavy metal mass to slide back about ¼" on the rails while the shooter holds the motionless stock and trigger. The shooter feels almost nothing and his sighting picture is undisturbed. The mechanism must be returned to its locked-forward position for the next shot.

Eliminating the disturbing recoil sensation caused by the moving piston prior to pellet movement in these excellent match air rifles allows the shooter to concentrate on all the fine points of shooting affecting his performance such as sight picture, hold, trigger pull and follow-through.

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Remington's patented recoilless principle.

Developed during bench rest shooting competition around 1947-1950, this system applied to powder-actuated fire arms. The objective was to eliminate the variable offered by the shooter's shoulder from shot to shot in an effort to improve accuracy. The principle was sound and was instrumental in winning bench rest matches in Johnstown,New York. It was also a factor in the development of the several accuracy devices now in use in gallery testing at the Ilion plant.

Basically the system allowed the barreled action with scope to move 3/4" rearwardly on bearings before being retarded. In other words the bullet would exit before rearward resistance could affect the shifting of the point of impact.

Remington's method is quite similiar and preceeded that used by Feinwerkbau.

A recommendation for consideration in future rimfire match rifle design.

Two variations in accommodating the movement of barreled actions until bullet exit were used in Remington's recoilless design.

1. The preliminary design allowed the action to float on lubricated lead bearings sliding rearwardly in a metal track.

2. In the final design the action was allowed to recoil on a series of cam followers until the bullet had exited.

The principle is sound, and now is being used successfully by Feinwerkbau in their championship winning air rifles. I used this system successfully in winning bench rest matches. Remington accuracy devices have proven successfu

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in millions of rounds fired. Therefore I believe the method could be introduced into a rimfire match rifle where the principl would nullify errors in the major problems associated with follow-through.

SUMMARY

Air rifle shooting has emphasized the need for follow-through in precision off hand shooting making one aware of the need for uniform resistance to recoil.

Olympic class air rifles have built-in designs to nullify any unnecessary movement of mass which would aggravate consistent resistance to recoil.

Remington's patented recoilless system provides a secure method of eliminating this effect in powder-actuated firearms.

It is recommended Remington consider incorporating this principle in future match rifle development.

Recoil reduction is uppermost in every shooter's mind and numerous ideas have been promoted to solve this disturbing element. Some ideas have been moderately successful such as the Cutts Compensator, a protruding device located ahead of the muzzle, where jetting gas following the bullet impinges upon flat metal surfaces pulling the gun forward. In use the result is an ear-splitting but reasonable recoil reduction of about 10% of the total recoil. However, the effect appears late during the recoil cycle and aids some shooters more than others depending upon how tightly they hold the gun to the shoulder. Many innovations to this principle less effective but possibly more attractive have been used such as providing drilled holes or cut slots in the barrel.

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Other ideas such as used in Remington's M1100 wherein a portion of gas energy is stored in a moving mass and then later transferred back into the gun has been successful and acceptable as a recoil reducer to the hunter, skeet and trap shooter.

Moving butt stocks which store energy in a spring or hydraulic absorbing means such as the so-called hydro-coil have been attempted but with questionable success. This principle allows the shooter's grip hand to recoil into his cheek with an umpleasant effect as the stock pull length is decreased. Naturally if used with a scope on a high recoil rifle this would result in eye injury.

The most common lowest cost and least effective method is the provision of rubber recoil pads designed with collapsing internal rubber fins. This device made of rubber stores recoil similiar to a spring allowing an undesirable fast recovery. An analogy is the motion of suspension springs in automobiles which require shock absorbers to subdue the rebound of stored energy.

An ideal butt pad would be the type that resists compression up to a predetermined pre-load level, then absorbs the recoil without a spring-like action recovering gradually back to normal.

Such a device was developed by Remington with the assistance of DuPont-made of polyurethane foam. Tests of this device produced outstanding recoil absorbing characteristics and met the principles previously mentioned.
There were problems of color, matching surface to wood, and if sanded, water absorption. These problems I believe can be solved and if produced correctly would perform superbly far

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beyond any butt pad now produced.

A standard 30'06 caliber requires a 36" barrel to obtain maximum velocity. Therefore it is obvious that a considerable amount of gas energy is being wasted when using barrels of shorter lengths. The escaping gas from a 24" barrel in this caliber generates a muzzle pressure of 10,000#sq" and is escaping at velocities in excess of 2700 ft/sec. This escape produces a rearward jet effect which is approximately 1/3 of the total recoil energy, and is so significant that if prevented from happening would be one of the more important advances in gun design and recoil reduction in history. An adequate solution would stir the very foundation of the sporting and military gun industry and would provide a powerful edge of leadership. When achieved safely the principle has far-reaching implications in the commercial and military areas. For example with fully automatic rifles recoil would become nearly stabilized during firing, a feat long sought by the military. Reducing recoil in this magnitude could provide the hunter with potential big caliber performance and a recoil of a 223.

The idea is not a myth. A laboratory model was constructed by Remington personnel using a M760 in 30'06 caliber with the resulting measured recoil of a 223! It is conceivable that this principle could be used on shotguns as well and combined with the recoil-reducing principle in the M1100 could approach a recoil-free shotgun.

Initially some reliable means must be used to trip a

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valve mechanism closing the escape of gas. The most logical means is the bullet. Therefore it is assumed that the various suggestions of valve mechanisms discussed will be programmed to be activated by the bullet. Inertial problems are a big factor and careful calculations, computer analysis, and measurements are necessary. If the nose of the bullet activates a valve mechanism in sufficient time a difficult problem in timing is overcome. Conversely if more delay is needed earlier programming by the bullet in some selected area of the barrel is needed and careful analysis and design must be instigated to prevent dangerous premature muzzle closure before bullet exit.

The following suggestions are without calculation or measured foundation and are ideas only, to be examined and reviewed by design and laboratory personnel. It is hoped that they may cause an hedonic reaction by the readers to further enlarge the spectrum of thought.

Suggestion I

Utilize a 3-section barrel. The first section is held rigid containing the chamber and is smooth bored. Being the longer of the three lengths allows the bullet to obtain maximum velocity. The second or middle section rotates like a nut in a threaded tube. This portion is relatively short and contains gain twist rifling. The rear portion of the barrel works like a collet closing a sphinter valve when rotated by the bullet trapping the expanding gas. The bullet continues into and thru the third rifled muzzle section

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finalizing its spin and accuracy. This section is held rigid. The middle section when rotated loads a spring which is programmed to open the valve, gradually releasing the stored gas by counter rotation at a later period.

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Suggestion II

Use a bullet design of two diameters.

Fig. 1

The front section, for example, could be .284" in diameter and the rear section .375" in diameter. The first 20" of 24" of the barrel is smooth bore to accommodate the .375" rear cylinder of the bullet and the last 4" a .284" rifled bore. The juncture of the two sections of bullet are sharp, creating an intentional stressed area. The bore provides a sharp shoulder from .375" to .284" to shear off the rear slug which acts as a plug preventing any further forward movement of gas.

Fig. 2

Fig. 3

The sheared .284" diameter forward section is allowed to enter the 4" of rifled barrel, spin stabilize, and exit from the muzzle. The remaining slug must be removed. If the front section of the barrel is allowed to slide forward due to the force generated by the forward motion of the bullet, an escape vent could be provided to discharge the slug and the pent-up lower velocity residual gas. It is believed that because of inertia in actuating the mechanism sufficient time to release the stored gas could be programmed to discharge at a gradual reduced rate with negligible effect on recoil reduction. Fig. 4

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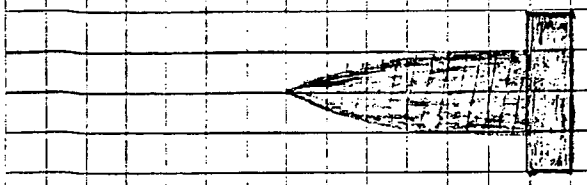
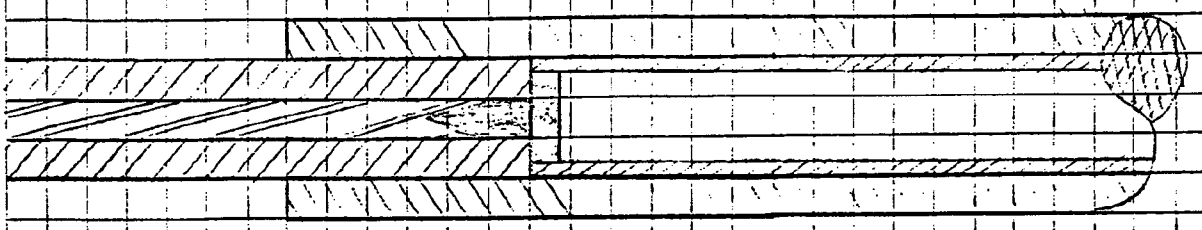


Fig. 1



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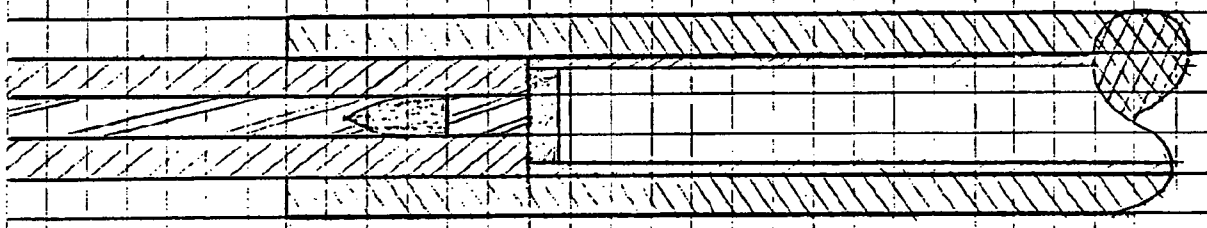

Fig. 3

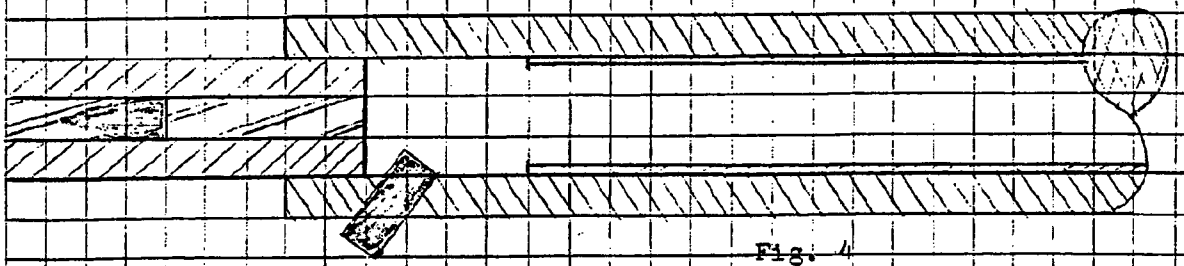

Fig. 4

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Suggestion III

This method has the appearance of petals on a tulip. In this system a series of metal petals surrounded by a very strong spring seals the exit of gas after the projectile forces its way through the petals. The projectile should have a long gradually-tapered section starting just back of the ogive, quite similiar to a tapered heel except having a longer taper.

Fig. 5
Fig. 6
Fig. 7
Fig. 8

The entire action is as follows: The petals, perhaps 8 in number, are closed tightly over the forward section of the muzzle surrounded by a strong circular spring. They must be completely tight, capable of preventing gas from leaking at a pressure of 10,000#sq". As the projectile passes past the muzzle and into the valve area the petals are forced open by the ogive of the bullet and start closing as the rear taper passes through the seals. Trapped residual gas could be allowed to escape through a valve at a later period somewhere in the barrel or by actually using the extraction of the cartridge case as a valve. It is also possible that a delayed blow back unlocking system could be designed wherein the residual gas would thrust the cartridge case rearward using the jet effect in reverse thus forcing the rifle forward. The result would be additional recoil reduction. In this case alteration to the locking mechanism

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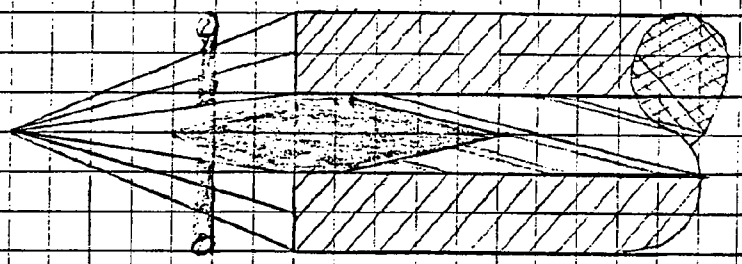
Fig. 5



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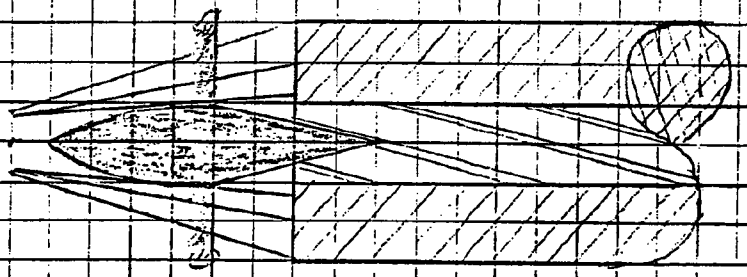

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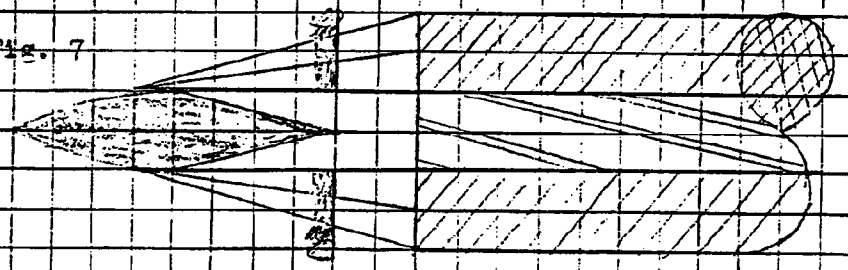
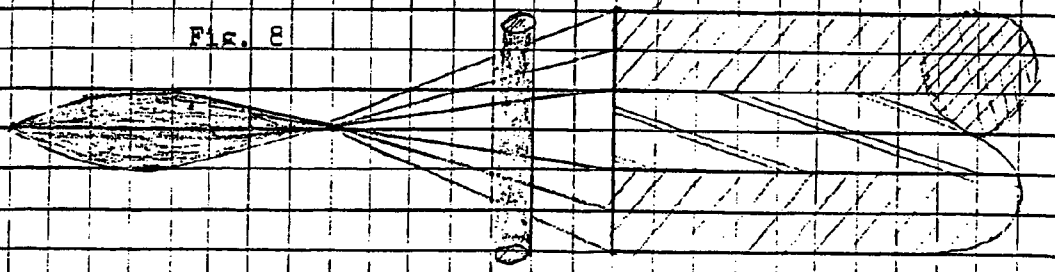


Fig. 8



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and safe handling of the rearward exhaust gas would be in order.

The petal design must be so well engineered that accuracy is not impaired. If the long taper in the rear of the bullet doesn't allow enough working area for the gas, a driving band exposing a sharp shoulder of substantial working area followed by a long taper allows closing of the petals.

Ultra high velocity can be obtained by several means. One of the most successful, the Gerlich principle, was used by the Germans in large bore cannons during WWII. This principle used a tapered bore from breech to near the muzzle. The projectile contained one or more circular fins much larger in diameter than the main body exposing a large working area to the expanding gas.

Fig. 9

As the projectile moved toward the muzzle thru the tapered bore the fins folded into redesses attaining a finished bore dimension. During this movement down the tapered bore an exceedingly high velocity was obtained in the neighborhood

Fig. 10
Fig. 11

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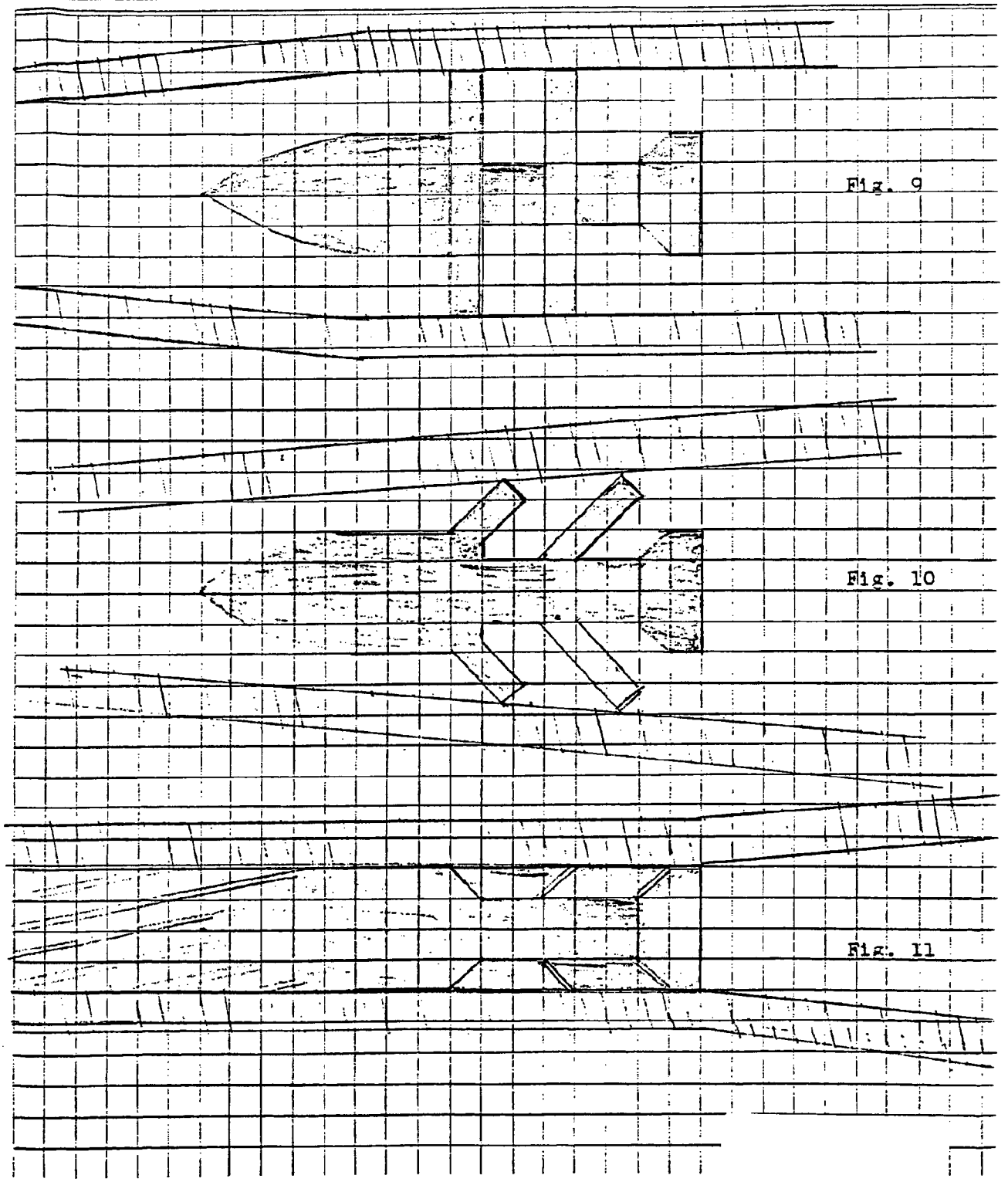

of 5000 ft. per second. Naturally, with this velocity and projectile construction of high hardness and toughness qualities, penetration of armor was achieved with devastating results.

A bullet of 6mm size with two fins of .375" dia. could be used for the initial test of the Gerlich principle. The barrel should be approximately 26" in length with an initial smooth bore diameter of .375" gradually tapering to .240" in 20". The last 6" contains a gain twist rifling to achieve stability.

It seems possible that a projectile, if properly designed, could provide its own power supply. The core would be the actual projectile surrounded by the igniting material safe enough under normal handling to be of no concern. When initiated forward by the thrust of a base percussion type primer the friction caused by contact with the tapered bore would provide combustion. Because of the large working area extra thrust would be attained as the eroding bullet approached muzzle bore dimensions. At a point approximately 6" from the muzzle ignition would be complete and a gain twist would stabilize the projectile. In this design no ejection or extraction is needed and the design of the receiver could be shorter in length, thus lighter in weight, lower cost and would provide a faster lock time.

Fig. 12
Fig. 13
Fig. 14

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Eroding bullet

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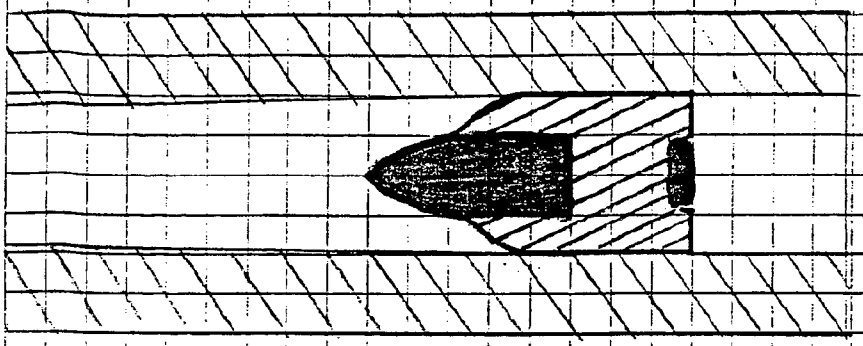

Fig 12

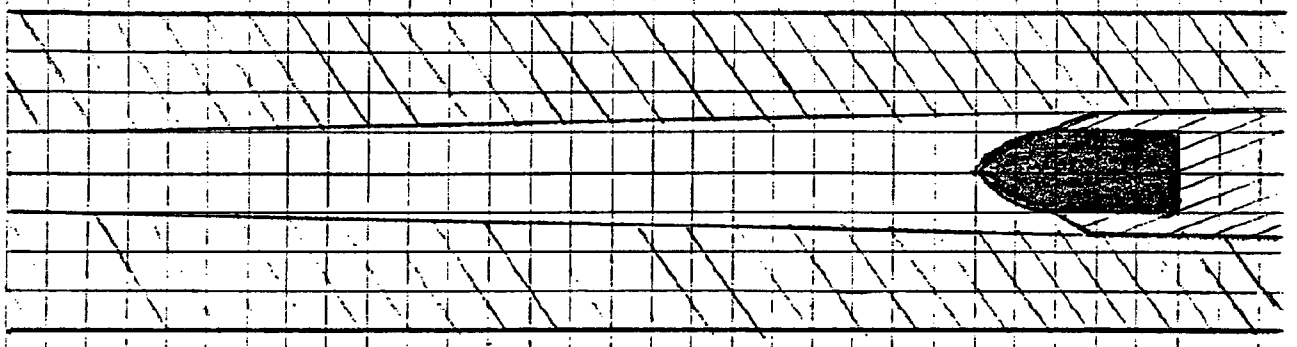

Fig. 13

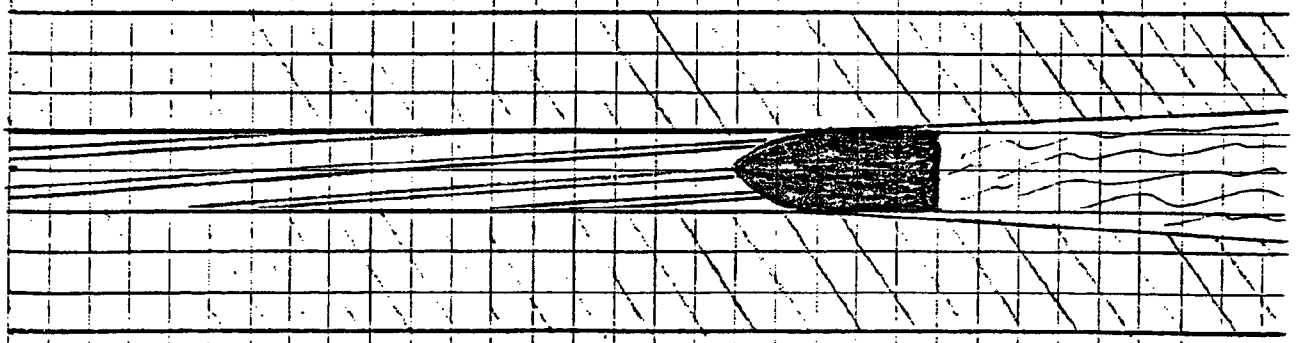

Fig. 14

Proposed foundation for a new bolt action shotgun.

I believe this program can be achieved easily at low development and production cost, because the ground work for such a design was thoroughly covered during the M788 and M540 period.

The effort of simultaneous design to process concept was almost a success in the M788 development, and was attempted to eliminate the costly redesign to process that always occurred in previous attempts. The big problem was to nail down process engineering at the early design stage instead of after the model was tested and accepted for production.

We did achieve a measure of success with this approach by making our layouts of all essential cuts in the receiver the same whether they were for the M788-M540 or the proposed bolt action shotgun. This included the receiver lengths, diameters, ejection ports, feed opening and fire control slots, etc. The drawings of these similiarities were presented to process in this manner.

Thus the bolt action shotgun concept was logical and simple for we needed 3 sizes of receivers for the various M788 cartridges and these sizes were ideal for the shotgun if we were to cover all the gauges from 410-12 ga.

I believe, because of this process design effort, that production machinery as now used for the M788-M540 receivers will accommodate the requirements for the shotgun.

The rear locking system was more than adequate in strength and proper for feeding shot shells. The design did not include a tubular feed system which was adverse to

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the M788 but that doesn't mean it couldn't be accomplished. I do not recall whether a model was made but I remember that strength testing of the competitive bolt action shotguns revealed weaknesses in their bolt handle lock up which would not be acceptable. Therefore our rear multiple lock method was superior. The trigger mechanism of the M788 was a natural for the shotgun and provided a clean crisp let off with very fast lock time of around 2.7 ms.

The reason we did not pursue the program further was because of Mr. Coleman's reluctance in lieu of a bad image for Remington which he thought would lower the status of the M1100.

At that time marketing speculated we would sell 50,000 units a year.