Chapter 27. Supplemental Miscellaneous Notes by Chapter

As I wrote in the introduction to Chapter 26, Miscellaneous Notes, one of the interesting challenges I had in writing this book was that I continued to receive information after the chapters it fit into had been finalized. Since the book was published on October 1, 2010, I have continued to receive excellent supplemental information and specimens. Now (June 2011), enough new material has been acquired to warrant this first supplemental chapter, which is formatted like chapter 26, with the new supplemental information presented in the order of its appropriate chapter. Because the last numbered page in the book is page 408, this chapter begins with page 409.

The new chapter is possible primarily because of the increased interest in MBA Gyrojets and other ordnance generated by the book. Collectors worldwide searched their collections and files for additional material. Without their help and generosity, this supplement would not have been possible. Jeff Osborne and Will Adye-White made particularly significant contributions and should be added to the Acknowledgments, page v.

Chapter 3. Finjets

On September 22, 1961, MBA engineer Bert Gould filed patent application 140,090 to protect his invention of an antipersonnel microjet—in this case a Finjet—that disappeared about 5 minutes after entering its human target. If the rocket missed its target, it would disappear while laying on the hot, damp jungle floor in Vietnam. A variation of the rocket disappeared in flight if it missed its target. Gould's original application was abandoned after patent examiners questioned some aspects of it, but later, after the application was modified, it was submitted again on September 1, 1965 as application 485,673. Patent 3,326,129 was issued on June 20, 1967.

The purpose of the disappearing rockets was to *"hinder examination of such rockets by an enemy after the rocket has been fired and also to add a psychological factor to the effectiveness of the weapon."* The projectile would be undetectable in a target's body because it would have dissolved in the body's fluids. If it were made of a combustible material, it would burn up. It was hoped that this would create fear among enemy soldiers facing a mysterious weapon that left no trace of itself after being fired. In addition, when used by police, a projectile which destroyed itself in flight if it missed its target could provide a greater level of safety for innocent bystanders.

The two Finjets shown next in Figure 27–1 are Gould's original pencil drawings done for the 1961 patent application. They were discovered while I was going through a large quantity of recently-acquired MBA files, including a group of patent applications.

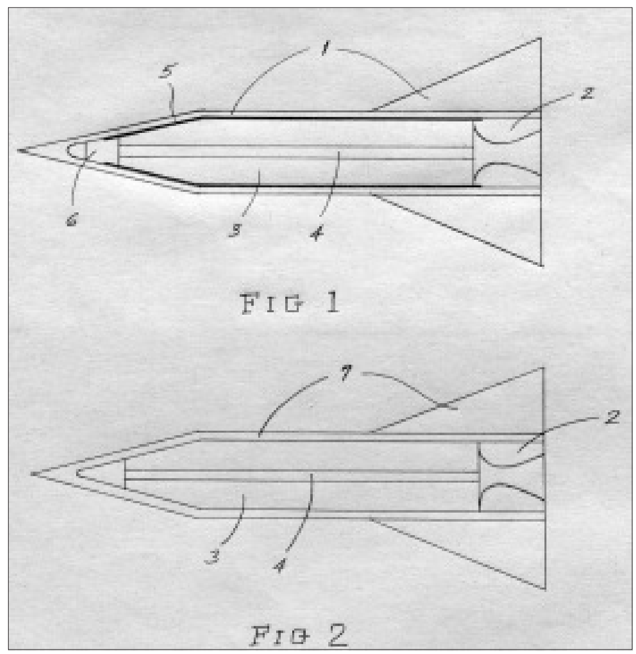

Fig. 27–1. Disappearing Finjets. MBA (Bert Gould) drawing.

The rockets are not drawn to any scale, but they were to have a diameter of about 1.5 to 3.0mm and a length of about 8 to 35mm. The rockets are therefore shown about 4x actual size, assuming a 3mm diameter.

The top rocket has a combustible case and fins (1). The nozzle (2) is partially combustible, and its remnants would be a tiny unrecognizable mass. The case is insulated from the propellant (3) by a clay-like material (5) which would dissolve in body fluids or moisture. The relatively slow-burning fuse plug (6), ignited by the propellant, would ignite the case and fins at the end of the rocket's flight if it missed its target.

The bottom rocket has a soluble case, fins, and nozzle. The nozzle would be made of a harder material and would take somewhat longer to dissolve.

The idea of a disappearing projectile had great appeal to Mainhardt, but the actual manufacture of workable self-powered rockets that disappeared after their propellant had been consumed was possibly too challenging from a technical point of view. I have no record of any actually being made or fired. However, as briefly discussed on page 70 in the last paragraph, 0.030-inch Javettes with soluble plastic tails and tungsten powder points were in fact made and tested.

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The next group of figures was taken from a series of documents MBA used to prove that it developed, at its own expense, a wide range of miniature rockets prior to being awarded any government contracts for them. Proprietary rights to ordnance produced without government financial support was a critical issue for Mainhardt. If MBA received funding under a government contract for a research and development project, the government then owned the rights to the project's results, including hardware. When the government then issued a Request for Proposals (RFP) for large-scale production of the products, it was able to share technical details of ordnance that had been developed by MBA with other firms, including MBA competitors who wanted to bid for a production contract for the ordnance.

In some cases, MBA claimed that certain Microjets had been developed independently by the company, and that the government did not have the right to share the technology with others. These are early drawings, used to support MBA's claims, that do not appear in Chapter 3, Finjets.

Figure 27-2, shown next, is from an MBA patent application (61,017) dated October 6, 1960, just six months after the company had been founded. It depicts two different Finjets inside tube launchers. The top specimen looks fairly typical to me, except that its forward fins (canards) are very wide compared to actual production versions. These would have provided greater strength and stability inside the launch tube, but would have increased drag and weight. In addition, the canards appear to be molded as an integral part of the case, not added later as with typical production 3mm Finjets.

The bottom specimen shows a Finjet with fins so wide they act as canards themselves. This Finjet would have been very stable in its launch tube, but the aerodynamic drag of the huge fins would have been considerable.

Neither of the Finjets is drawn to any scale, but the bottom rocket is about twice the diameter of the top one. No actual specimen has been seen.

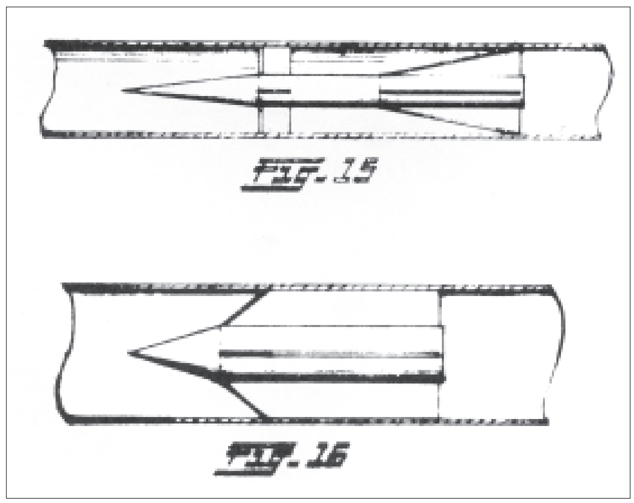


Fig. 27–2. Wide-canard Finjets.

Figure 27-3 shows the first aerodynamic 3mm Finjet with its separate stainless steel "combustion chamber." The concept of using a separate steel combustion chamber insert was soon discarded. Note the absence of a steel needle nose on this early rocket.

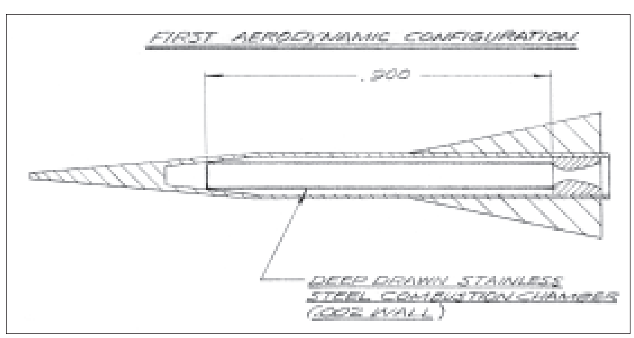


Fig. 27–3. First aerodynamic 3mm Finjet.

The next Finjet, shown in Figure 27-4, is a 3mm, 3-fin rocket with an aluminum case and unusual melamine glass nozzle. Other Finjet nozzle materials considered are discussed on pages 32 and 33.

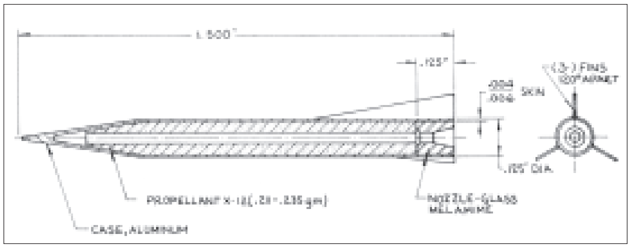


Fig. 27–4. 3mm aluminum Finjet.

The two Finjets shown below in Figure 27-5 are from an undated MBA drawing. A specimen of the top 3mm (1/8 inch) rocket is shown in Figure 3–47 (D) on page 48. Before finding this drawing, I did not realize that it had a "tangent ogive," although its shorter, more rounded nose was obvious.

The bottom 4.5mm (3/16 inch) Finjet has a "secant ogive" and a specimen of it is shown at the top of Figure 3–23 on page 40. Until I saw the drawing, I did not realize that the rocket's nose had a hole for a needle point. Interestingly, although the bottom Finjet is 50 percent larger in size than the top one, they both have the same 0.039-inch diameter needle point hole.

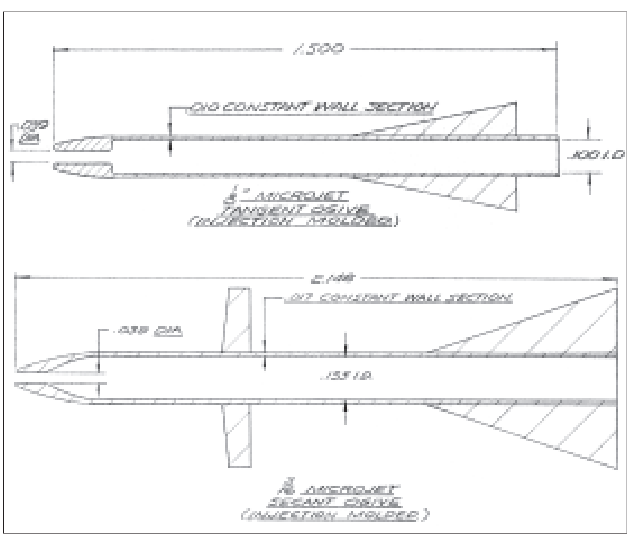


Fig. 27–5. Finjets with tangent and secant ogives.

Figure 27–6 below shows the only MBA drawing I have seen with only what appears to be a typical 3mm Finjet's propellant grain and its dimensions. *Note: The original drawing from which the edited figure below was taken was 11 inches wide, as were other drawings shown in this chapter. Some were 8 inches wide. I realize that by reducing the drawings' sizes to fit these pages, some letters and numbers may be challenging to read, which is why I keep a magnifying glass handy.*

The propellant grain is 0.094 inches (2.39mm) in diameter and 1.0 inches (25mm) long. The central perforation has a diameter of 0.039 inches (0.1mm). Although not listed on the drawing, the grain's weight would be about 120 milligrams.

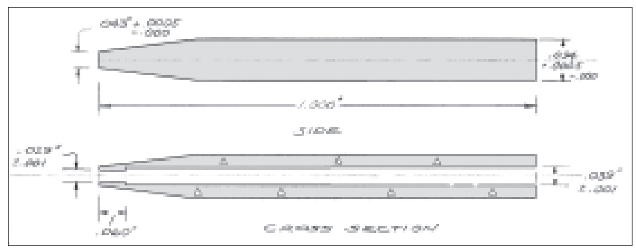


Fig. 27–6. Propellant grain for 3mm Finjet.

The figure below is the only MBA drawing I have seen of just the forward fins (canards) of a 3mm Finjet. Canards are discussed on pages 42 and 43. Note the asymmetric tips of the fins, which would cause spin to increase the rocket's stability. They would have to be installed with the same orientation as the rear fins.

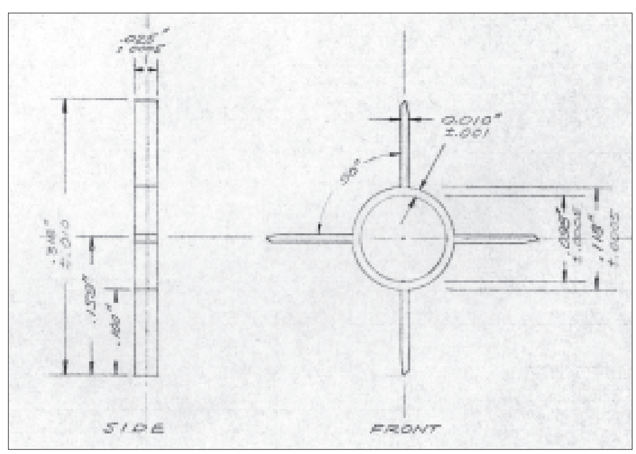


Fig. 27–7. Forward fins (canards) for 3mm Finjet.

Figure 27–8 below shows an unusual Finjet design not seen before. The MBA drawing it was taken from is dated October 9, 1961. The rocket is 3 inches (76mm) long and the plastic body has a diameter of 0.246 inch (6.2mm). The hole in the nose for a needle point is 0.060 inch in diameter, about 30 percent larger than the needle diameter in the 3mm Finjet.

This Finjet is the only one seen so far with canards that have swept (angled) leading and trailing edges. Most canards have straight leading and trailing edges. Also indicated on the drawing are the positions of the C.G.. (Center of Gravity, or balance point) both before (with propellant) and after (without propellant) burn-out. Note that the C.G. shifts forward away from the C.P. (Center of Pressure, during propellant burn), increasing stability. No specimen of this rocket is known.

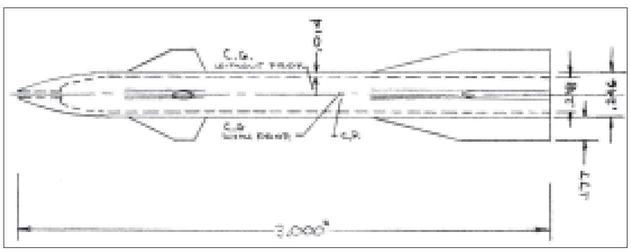


Fig. 27–8. 6mm "Preliminary Concept" Finjet.

Figure 27–9 to the right shows a group of individual drawings of Finjet needle noses. Although production 3mm Finjets generally used steel phonograph needles as points, other types were also considered. (*A*) shows a 3mm Finjet with a 0.375-inch (9.5mm) needle nose inserted 0.09 inch (2.3mm) into the case. (*B*) is a needle also 0.375 inch long and with a diameter of 0.041 inch (1mm).

(*C*) shows a point made of stainless steel with a 0.041-inch cylindrical body and conical nose. (*D*) is dated November 13, 1961, and shows a plastic (Nylon 101) point with a spherical-radius tip and a 0.041-inch diameter. (*E*) is dated September 1, 1961, and shows another, longer 0.5-inch (12.7mm) plastic (Nylon 31) point with a slightly thicker 0.049-inch (1.2mm) diameter. See figures 3–27 and 28 on page 41 for two Nylon-needle Finjets. (*F*) is an experimental point (material not listed) with a spherical-radius tip and 0.237-inch (6mm) length. It is dated November 8, 1961.

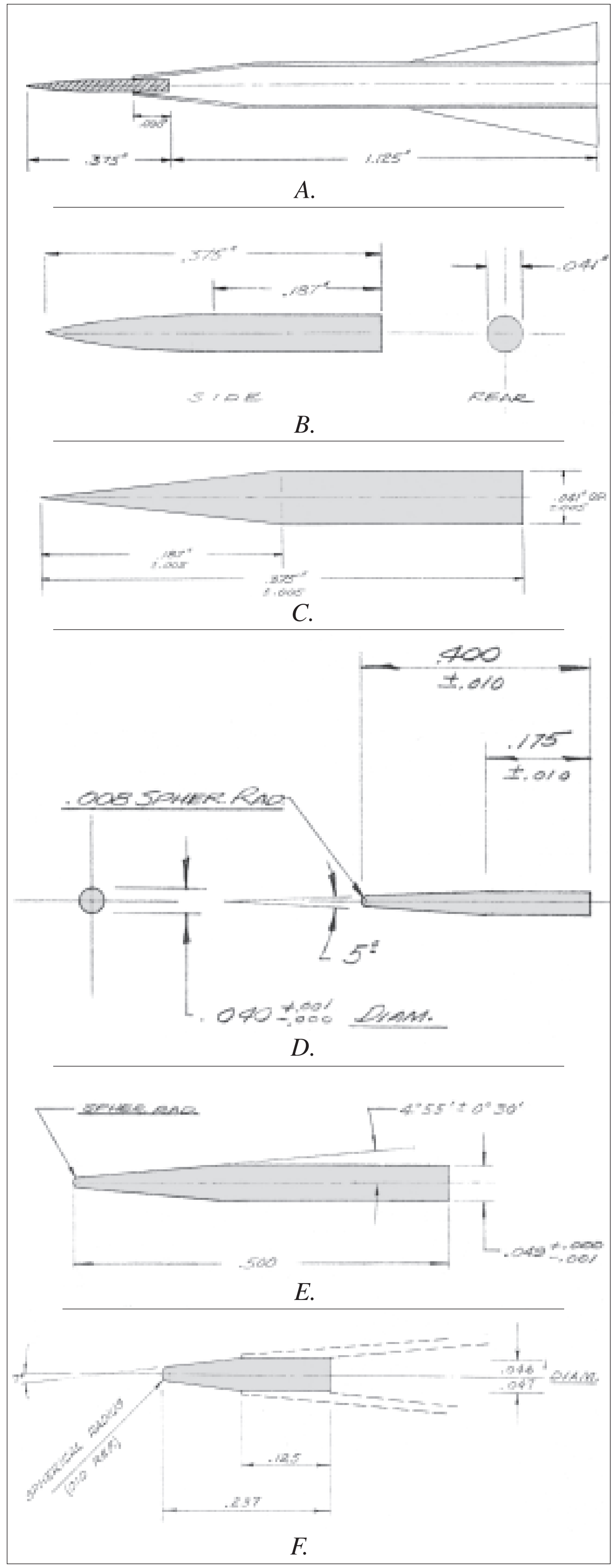


Fig. 27–9. Finjet needle noses.

Figure 3–19 on page 39 shows an electroforming apparatus used to make nickel Finjets by depositing nickel onto a mandrel shaped like a Finjet. Figure 3–20 shows two electroformed Finjets, one off the mandrel and one with its fins formed. Figure 27–10 below shows two additional electroformed nickel Finjets. Note the comment that no cracks are permissible along fin fold lines, a common defect with electroformed Finjets. The top rocket is 1.5 inches long and has a diameter of 0.11 inch (2.8mm). The bottom rocket is 2.7 inches long and has a diameter of 0.194 inch (5mm). Both rockets are tapered slightly inside to aid in their removal from the mandrels.

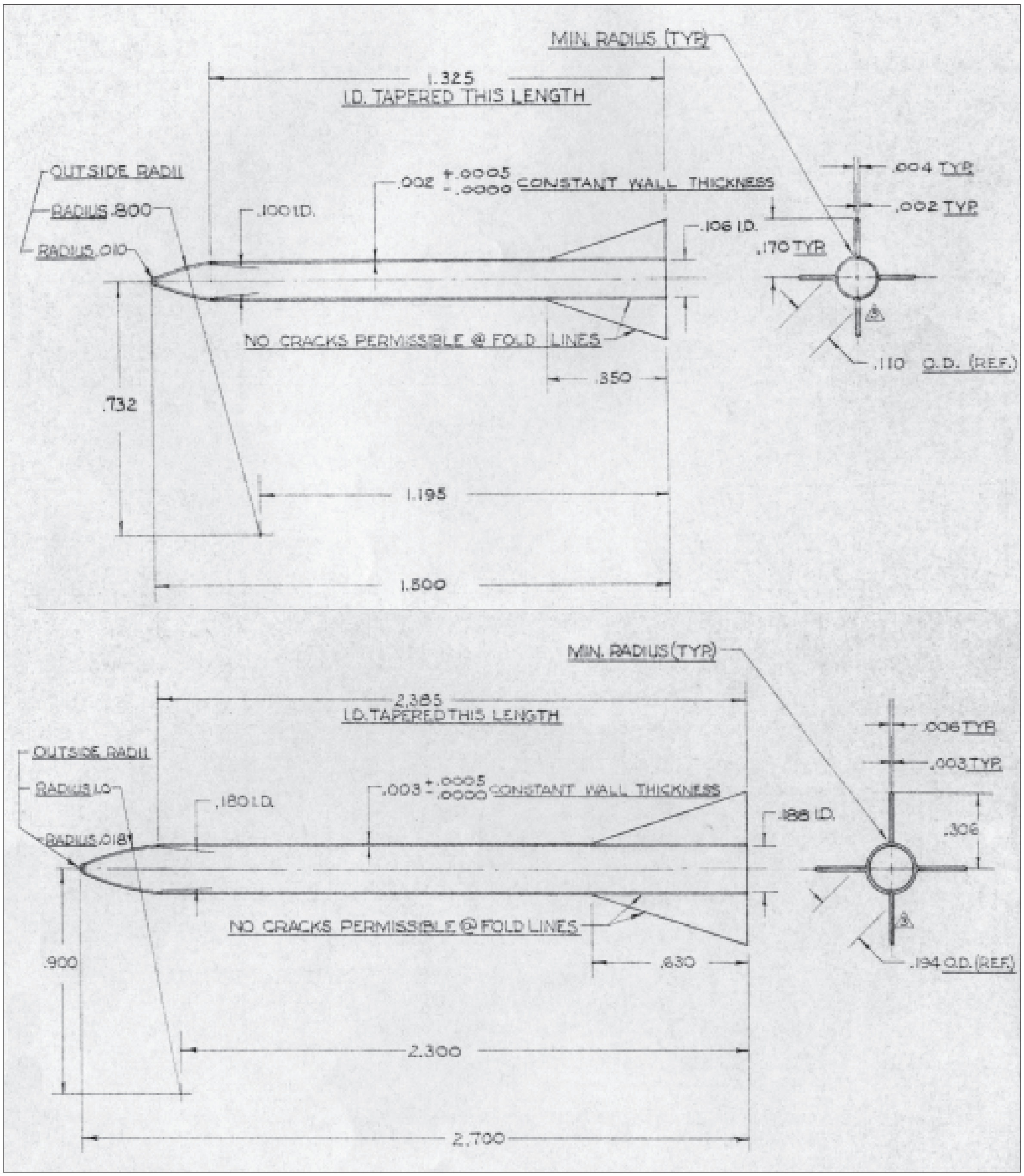


Fig. 27–10. Electroformed nickel Finjets.

During early testing and marketing of Finjets, MBA often used Giant-size, Sweetheart-brand, candy-cane-striped paper soda straws as launch tubes, including firing demonstrations at the Pentagon. See page 42, Figure 3–32. Mainhardt explained to me that the fins of a 3mm Finjet were trimmed to fit inside the straw with just the right amount of friction to provide enough hold-down, but not too much. It is not hard to visualize a shooter, generally Mainhardt or Biehl, trimming each of four fins by hand before inserting the Finjet into its straw launcher. Apparently, after enough straw firings had been completed, MBA determined what amount of trimming gave the best results and prepared the October 4, 1961, drawing seen below in Figure 27–11. The drawing, titled *Trimmed Fin Microjet Case*, shows just the trimmed fin radius, which was the sole point of the drawing, from which any number of trimmed-fin cases could be made in advance for straw launches, all with the same dimensions. I checked the 0.147-inch radius (0.294-inch diameter) against a Sweetheart giant straw, and it matched perfectly.

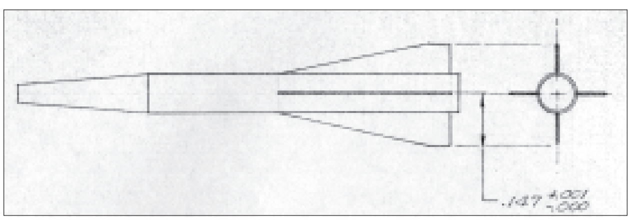


Fig. 27–11. Trimmed-fin Finjet.

The next Finjet is from an MBA drawing dated August 15, 1961. It is an aluminum (7075 T6) rocket 1.5 inches long with a 0.110-inch (2.794 mm) outside diameter and an unusual 0.102-inch (2.59mm) step in its base for a nozzle.

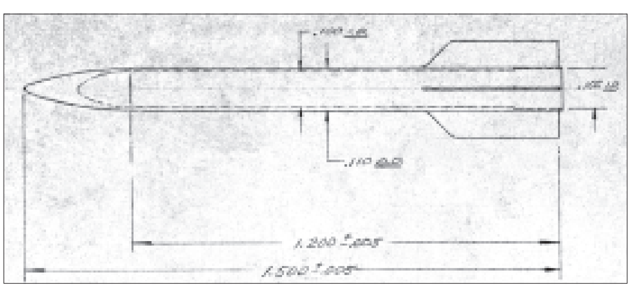


Fig. 27–12. 3mm Aluminum Finjet.

One of MBA's marketing points for the Finjet was the large number of rounds of rocket ammunition a soldier could carry for a given weight compared to conventional cartridges; in this case, the .30-06. The comparison was even more attractive due to the short combat ranges in Vietnam jungles where there was little need for a round of ammunition to be effective out to the .30-06's 3,000 yards.

In 1961 OrdTech, Inc., a wholly-owned subsidiary of MBA with the task of marketing MBA's ordnance products, created the illustration below in Figure 27–13. It shows that at a more-realistic jungle combat range of 125 yards, a soldier could carry a 1-pound load of 12,000 small Finjets instead of just 16 rounds of .30-06. If an effective range of 250 yards was required, 1,500 3mm Finjets, also a 1-pound load, could be used.

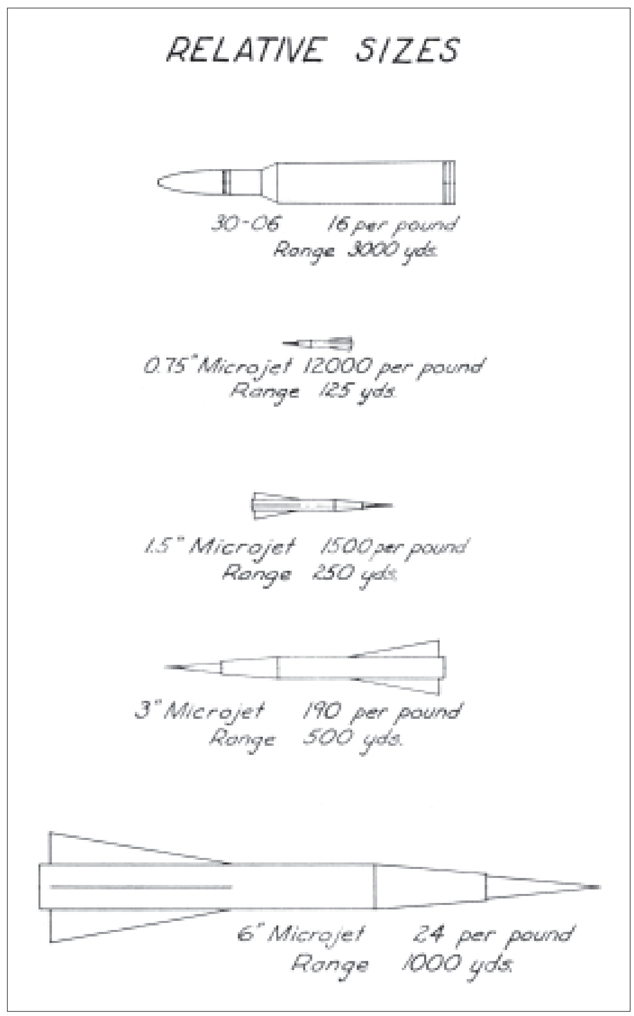


Fig. 27–13. Microjet (Finjet) relative sizes.

The illustration only deals with rounds of ammunition per pound. It did not include a comparison by weight or any other weapon characteristic of an M1 or M14 rifle and a typical Finjet launcher, which weighed almost nothing.

Figure 3–39 on page 45 shows an MBA/OrdTech concept of how the Finjets could be used in combat. A similar illustration just recently discovered, also by OrdTech, shows another planned Finjet delivery method. In this scenario, U.S. helicopters are each equipped with a 1,000-pound load of Finjets in a rack mounted on the helicopter's belly. When ripple-fired in a total of 66 seconds, the 1-million-Finjet load would saturate (1 rocket per 2 square feet) an area 200 feet wide and 10,000 feet (1.9 miles) long. The helicopters would be flying at only 100 mph and at 100 feet above the enemy, a dangerous way to deliver ordnance.

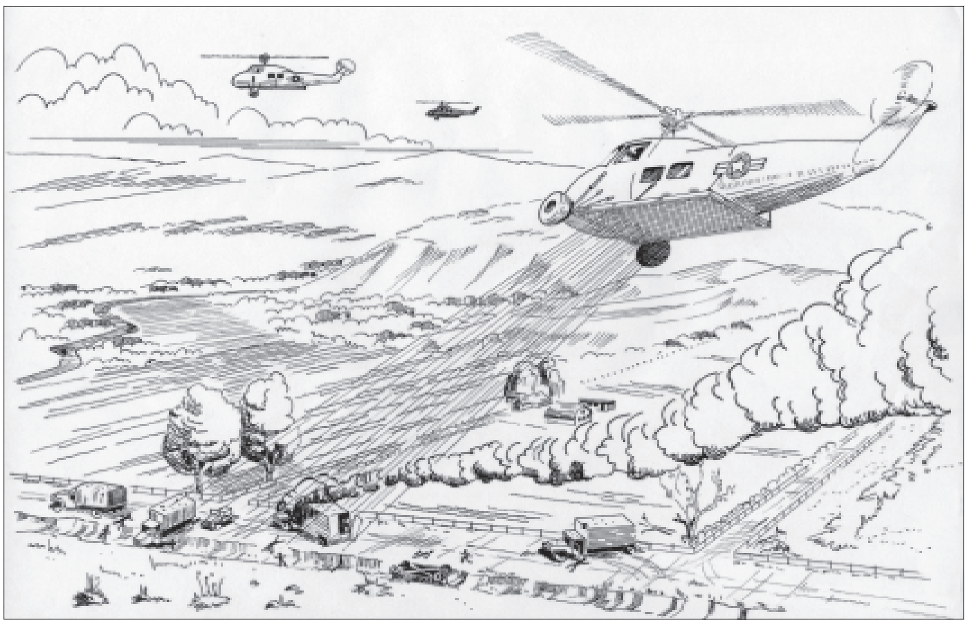


Fig. 27–14. Finjets fired from helicopters.

To close out this section on new supplemental Finjet information, an undated MBA drawing of a 40mm Finjet-launching cartridge from a patent application is included to the right. The cartridge contains an unknown number of 3mm Finjets without canards or steel needle noses. The Finjets are held in alignment inside a frangible capsule by a perforated disc. The round was to be fired from a *smoothbore* M79, or similar launcher, at a velocity of 250 feet per second. As the round's propellant burned, it ignited the Finjets' fuses, positioned through holes in a pusher plate. The burning fuses acted as delay trains to allow the capsule to be projected out ahead of the shooter before the rockets ignited, which pressurized the frangible capsule, causing it to open up and release the Finjets. This design added range and velocity to the salvo of Finjets, and two variations were also shown. One used packing material around the Finjets rather than a capsule.

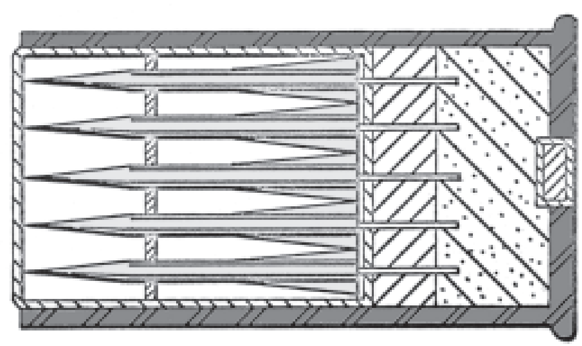


Fig. 27–15. 40mm Finjet-launching cartridge. Actual size.

Chapter 4. Anti-Mine Lancejets

After a brief introduction, I began Chapter 4, Lancejets, with information about MBA's first Lancejet, an anti-mine, .25-caliber rocket developed under contract for the Army. Most of my information was from MB-82, which was published in April 1962, two years before the project's end, and therefore incomplete; Mainhardt interviews; and specimens. Now, thanks to Jeff Osborne, who provided a copy of U.S. Army Engineer Research and Development Laboratories (USAERDL) Report 1828, *Antimine Rocket and Universal Mine Destructor Feasibility Study*, September 1965, we have extremely detailed information about this MBA work done under contracts DA 44-009 ENG 4907, DA 44-009 AMC 80(T), and DA 44-009 AMC 268 (T).

The period covered in the report was from the fall of 1961, when the concept of anti-mine rockets originated during a meeting of USAERDL and MBA personnel, until the spring of 1964, when the final MBA contract was completed.

Thankfully, the new material supports what I said in chapter 4, with one important exception: The nozzle ports drilled in the steel 4-port nozzles used in later anti-mine Lancejets were in fact angled, not straight. I probably missed that when I examined the rocket shown in Figure 4–2 on page 52 because the 0.216-inch-diameter nozzle is small and the four ports are even smaller. In addition, the port angle is a shallow 3 degrees, just enough to cause a relatively slow spin of 18,000 rpm (at burnout) to augment the rocket's javelin-type stabilization. The Lancejets were "javelin stabilized with roll compensation."

When describing the anti-mine Lancejet shown in Figure 4–3 on page 52, I noted that the delay-train fuse was not included. The reason was that the rocket's explosive warhead and its fuse had not been developed when the drawing, which depicts the first anti-mine Lancejet developed, was made. The rocket had three "half-caliber" 0.125-inch fins added which were glued on with an epoxy adhesive. The fins were designed to augment the rocket's javelin stabilization, which was its primary stabilization, and reduce the rocket's dispersion. Unfortunately, more times than not the fins separated from the rocket's case during firing. As a result, the design with fins was soon dropped.

Because the Lancejets appeared to have the capability to clear most types of mines, the system of launcher and rockets was named "Universal Mine Destructor (UMD)." It was designed to clear a path 5 meters (16 feet) wide and 200 meters (656 feet) long with one load of ammunition (28,750 Lancejets in 25 racks) while moving at 15 mph. The system would be capable of being mounted on any M113 armored personnel carrier (APC) in less than 6 man-hours with no modifications to the vehicle.

The Lancejets were capable of penetrating and lodging in both Soviet TMD-B wooden box mines and thinly-encased metal mines such as the US M15 (shown in Figure 4–5 on page 53). The final 1964 design is shown below in Figure 27–16.

The project began because new technology in land mines was capable of defeating existing mine clearing devices. Several new methods of defeating mines were considered and rejected, except for the direct attack of the mine's basic explosive charge, bypassing the mine's fuze. The question was then whether to attack mines individually or to use an area clearance procedure. Because the technology required to individually detect and destroy single mines while moving forward

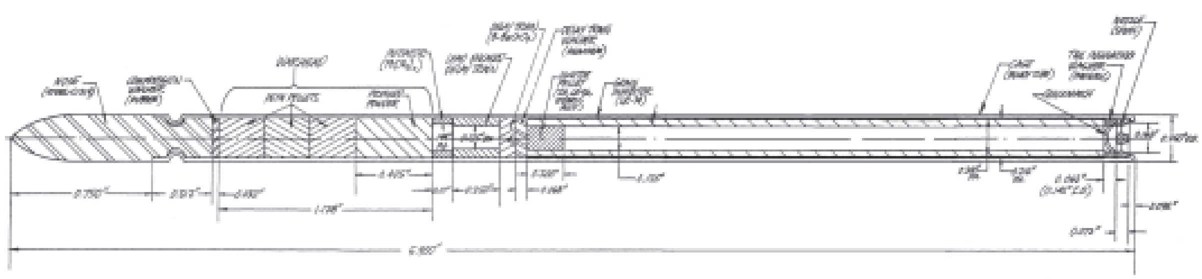


Fig. 27–16. MBA anti-mine rocket, final design.Actual size.

so as to not present a stationary target to the enemy did not exist, and was not anticipated to exist until 1973, area clearance of a minefield by direct attack on mines' explosive charges was required.

In the fall of 1961, an MBA proposal to the U.S. Army for the development of Finjets for use in Vietnam was forwarded to USAERDL. The 3mm plastic Finjets being proposed had no anti-mine application; however, mine clearing research personnel thought that larger metal miniature rockets might have such an application. USAERDL personnel visited MBA in September 1961 and saw Finjet firing demonstrations. MBA personnel were asked for their opinion on whether miniature rockets might be suitable for an anti-mine role. Not surprisingly, this led to an MBA proposal to study the design criteria of a miniature rocket and its delivery system for attacking antitank mines. In December 1961 a three-phase contract, DA 44-009 ENG 4907, was let with MBA for this study. The three phases were:

— Penetration and Stoppage: Development of a basic rocket capable of penetrating and stopping inside the body of a mine on the surface or under 6 inches of soil.

— Delivery and Coverage: A study of various systems to deliver the anti-mine rockets and the number of rockets required.

— Initiation of Explosive: Development of a warhead to neutralize or detonate mines.

A fourth phase (Warhead Refinement and Rocket Optimization) was added in August 1962 to complete the design of a reliable anti-mine rocket. During this last phase, contract DA 44-009 AMC 80(T) was let with MBA to determine quantity production costs of the anti-mine rockets. The costs were subsequently judged to be feasible.

Even though the rockets proved to be technically feasible and practical from a cost standpoint, the UMD system had some serious technical issues that had to be dealt with. Each rocket was made by hand and as a group they were not reliable. Before work on the complete UMD system could be undertaken, rocket reliability had to be improved. In June 1963, a seven-phase contract, DA 44-009 AMC 268(T) was let to MBA for the study of rocket reliability and system parameters. This work was completed in the spring of 1964.

Going back to the project's beginning in 1961, MBA's first step was to determine the energy required to penetrate mines and the soil covering them. This was done by using a 2.375-pound, 0.1875-inch-diameter spike dropped from several different heights onto an inert M15 mine. Because sand was the most difficult soil to penetrate, it was used in the tests. MBA used a series of tests and mathematical calculations to determine that the energy required was 950 foot-pounds per square inch and that either a 0.219-inch diameter or 0.250-inch diameter rocket (as a minimum size) would suffice.

It was also established that an anti-mine rocket must have a very high ballistic density to penetrate 6 inches of sand and a mine case, and this meant that the rocket must have a large L/D (length to diameter ratio), which Lancejets have with their long, slender bodies. MBA concluded that fin-stabilized rockets would be better than high-spin-stabilized rockets because a high-spin rocket must have a small L/D (relatively short and thick, like a Gyrojet) for aerodynamic stability. That is why MBA's anti-mine rockets were Lancejets. Because of high dispersion, fins were first tried to overcome or reduce the various factors (such as nozzle port misalignment) that caused dispersion. When fins were rejected because they failed, 4-port nozzles with slightly (3-degree) canted ports to cause a slow spin to offset thrust misalignment were adopted. With a 4-port nozzle, a quarter revolution (90 degrees of roll) while the rocket was still inside the launch tube was enough to compensate.

MBA made several sizes of rockets and conducted penetration tests to confirm earlier tests and calculations. The 0.25-inch diameter, 6-inch long rocket was selected for development because:

— That L/D gave the best penetration results.

— The tubing for the case could be purchased cheaply in a standard size.

— The rocket had enough space for an explosive warhead of 1 to 2 grams.

These Lancejets (no fins attached) had the following characteristics:

Burn time:	0.050 second
Loaded weight:	12.43 grams
Empty weight:	10.57 grams
Propellant weight:	1.86 grams
Distance to burnout:	17.9 feet
Burnout velocity:	860 fps

There was a fairly large variation in these results which MBA thought was caused by the hand fabrication of small lots with little quality control. It is not clear why there was little quality control. One would think that at the beginning of a project like this, *maximum* quality control would be required at every step in order to obtain the best, most consistent data.

The .25-caliber Finjets were fired through a guide tube to ensure they hit the mine target. Free flight tests were then conducted to determine the aerodynamic stability of the rockets fitted with three fins. They were fired from a triangular cross-section launcher 18 inches long, with a resulting CEP of 200 mils. The term "CEP," often used by MBA when discussing accuracy, and "Mil" are explained in the Glossary. In this case, a 200 mil CEP meant that 50 percent of the rockets fired hit inside a circle with an 480-inch diameter and 50 percent hit outside the circle, at a 100-foot range.

The aluminum-case rocket shown in Figure 4–3 on page 52 is the final design of the first phase of the first contract. Its nozzle was made of phenolic resin and its simulated warhead weighed 2 grams. Note its short, rounded nose.

Twelve of the rockets were tested at USAERDL. They were fired through a horizontal guide tube at inert M15 mines covered with 6 inches of clay. Only one rocket was successful, penetrating 2 inches into the target mine. It was determined that the fins of the other 11 rockets were lost during the flights. The steel fins were attached to the aluminum bodies by an epoxy resin, and there appeared to be a brittle fracture of the epoxy.

The tests also showed that the phenolic resin nozzle ablated unevenly, causing a large thrust misalignment. To better stabilize the rockets, a nonablating steel nozzle was tried. Because the fins proved to be unreliable, a javelin-type stabilization was used with a longer, heavier, pointed steel nose. These changes resulted in a reduced (82±20 mils) dispersion.

However, misaligned thrust was still a problem, and was thought to be caused in part by uneven propellant burning. By giving the rocket a slight spin of at least a quarter turn before it left its launcher, this type of misalignment tended to cancel itself. It was calculated that a 4-port nozzle with ports having a 3-degree cant angle would turn the rocket one-third of a revolution before it left a 6-inch launch tube. Other nozzles were tried, and the one adopted in the final design is shown in Figure 27-16 on page 416. A design shown below in Figure 27–17 was suggested by MBA. However, contract funds were not available to pursue it.

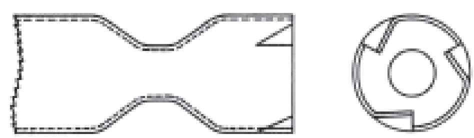


Fig. 27–17. MBA proposed anti-mine Lancejet nozzle. USAERDL Report 1828.

When I first saw this drawing with its spin-producing vanes inside the nozzle's rear expansion chamber, it reminded me of another nozzle in the book. See Figure 6–6 on page 82, an experimental .30-caliber Gyrojet from the Woodin Laboratory collection. The nozzle design produced only 3 percent of the spin required for a Gyrojet, but it might have been ideal for the very slow spin of an anti-mine Lancejet. Apparently, even though the design was not evaluated under the USAERDL contract, MBA decided to do that on its own time and with its own money.

By changing the rocket's design from a finned, 1-port-nozzle rocket to a 4-port Lancejet with spin augmentation, a dispersion of 28.4±9.6 mils was achieved. Another benefit was increased packing density. The finned rockets required triangular launch tubes, while the finless version could use round launch tubes with many more rockets being packed for launch in a smaller space.

During early tests, aluminum cases experienced a loss of strength in the delay train and nozzle areas due to heat, and some ruptured. Tests using temperature-indicating paint revealed that the surface temperature of the rockets exceeded 400 degrees F. The *Alcoa Aluminum Handbook* stated that the tensile strength of the 7075 T6 aluminum alloy used for the rocket cases dropped from 83,000 psi at 75 degrees F to just 14,000 psi at 400 degrees F, which allowed internal pressure to rupture the cases. To prevent this, MBA used an inhibitor labeled LR-39 with some success.

Note: USAERDL Report 1828 notes that LR numbers in the report referred to chemical compounds which MBA claimed were developed at their private expense. MBA claimed proprietary rights to anything it had developed on its own prior to a government contract, and this led to serious disputes between the company and the government over just what the government owned—and could share with other companies bidding on government contracts—and what it did not.

Tests were conducted with other aluminum alloys in the 2024 series, and these worked satisfactorily. Cost studies of aluminum cases indicated that in high production quantities, the lowest price for a case was 5 cents. During this period, USAERDL personnel had been in contact with the Bundy Tubing Company, which made double-wrap, copper-brazed steel tubing used by the automotive industry for hydraulic brake lines and other applications which required multiple bends. Bundy tubing would not kink when it was bent around axles and other automotive components. MBA was directed to make a few rockets using Bundy tubing for cases, in part because the projected cost of Bundy tube cases was half that of aluminum; just 2.5 cents per case. Bundy tubing is also very strong.

It was interesting to learn that Mainhardt was introduced to Bundy tubing by Army personnel supervising his contract. See pages 152 and 153 for a discussion and pictures of Bundy tube 13mm Gyrojet rockets made after the USAERDL contract ended.

Aluminum rockets weighed about 12.5 grams and had a velocity of 700 to 850 fps. They consistently passed through wooden box mines on the ground's surface instead of stopping in them, as desired, and detonating. The Bundy tube rockets weighed about 18.2 grams and had a velocity of 550 to 625 fps. They stopped in the wooden box mines 50 percent of the time, a significant improvement. No case ruptures were experienced with the Bundy tube rockets. Because of their strength, cost, satisfactory 50-mil dispersion, and better stopping characteristics, they were adopted.

Early ignition of the anti-mine rocket's propellant was by the method MBA had used with its Finjets; a pyrotechnic fuse inserted through a nozzle port. This fuse ran down the full length of the propellant grain, through the front washer, and into the delay mix. It provided a relatively slow ignition (about 130 msec) and required complex and expensive manufacturing techniques. It is shown below in Figure 27–18 (A).

The second method (B) replaced the pyrotechnic fuse with a length of quickmatch which had a dab of sensitizer on the end against the nozzle. An ignitor pellet was used at the forward end of the grain. An external aluminum pressure cap with a 20 mil touchhole to transmit flame from a sheet igniter was also used to hold down the rocket with an 8-pound force until sufficient pressure had built up for a normal launch. This system had an ignition time of 20 to 45 msec, a marked improvement toward the desired 10 msec goal.

In method (C), the length of quickmatch was reduced to just a small piece wedged in the rocket's rear insulating washer. This received flame through the external pressure cap, which was retained.

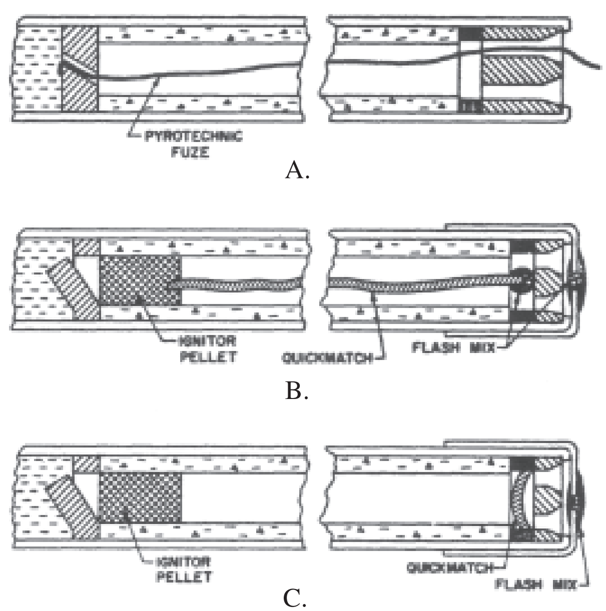


Fig. 27–18. Anti-mine ignition methods. USAERDL Report 1828.

The original propellant used in the anti-mine rockets was a U.S. Navy high-energy, double-base propellant, designated X-12, which had been used by MBA in other types of miniature rockets. X-12 cost $50 a pound in 1961 ($360 in 2010 dollars). During tests, it was learned that the Hercules Powder Company produced a propellent designated ARP that was almost identical to the Navy's X-12 in its performance. ARP cost just $5 a pound, so it was adopted.

One of the early proposals for the rocket's warhead was the use of a thermal material to either deflagrate (burn rapidly, with intense heat) or detonate (explode violently) the mine explosive. The anti-mine rocket would enter the mine, stop, and then destroy the mine explosive. Thermite was the most obvious type of thermal warhead, but it was unreliable in either burning or detonating Composition C-4, TNT, or Composition B explosives. In addition, because the UMD vehicle was moving forward at 15 mph, burning the mine explosive took too long as the vehicle approached the mine, placing it inside the vehicle's safety zone. A fast-acting explosive warhead was therefore required, and pentaerythritol tetranitrate (PETN) was selected.

A warhead with 100 mg of PETN and a 40 mg lead styphnate initiator would detonate Composition C-3 explosive. During tests, lead azide was substituted for lead styphnate to obtain better warhead reliability.

During the design of the delay train, it was determined that the delay element must burn for more than 52 msec and less than 1 second. The propellant required a burn time of at least 50 msec, and mine penetration required 2 msec. The upper limit of 1 second was determined by the forward speed of the UMD vehicle. If the delay time was too long, the vehicle would be too close to the mine explosion. A 50 msec delay was therefore selected. Boron-barium chromate delay mixtures had found wide acceptance in military delay trains and were selected for the anti-mine rockets.

Based on warhead testing results, a new warhead was designed having a 175-mg lead azide initiator and a main charge of 1.72 grams of PETN. In over 300 tests of this design, there were no failures of the delay to detonate the lead azide and in 150 tests of complete rockets, there were no failures of the lead azide to detonate the PETN.

The most difficult problem associated with the development of the anti-mine Lancejet was to maintain the reliability of the delay train and warhead with time (shelf life). Rockets stored for one month had good reliability, but those stored for six months before firing had poor reliability.

During Phase IV, Warhead Refinement and Rocket Optimization, MBA made "minor modifications" to the rockets and achieved the following results:

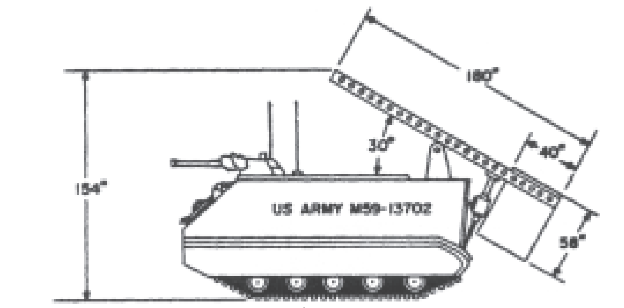
— <u>Propulsion Unit</u> (ignition, thrust, freedom from case burnthrough, nozzle ejection, and backburn). Number tested; 69. Number failing; 3. Percent functioning properly; 95.7

—<u>Delay Train</u> (ignition, burning reliably, freedom from prematurely detonating warhead). Number tested; 142. Number failing; 6. Percent functioning properly; 95.8.

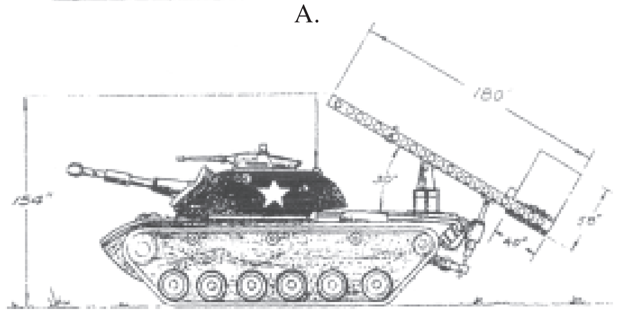
— <u>Warhead</u> (reliability of detonation, ability to detonate cast TNT, Comp. B, etc.). Number tested; 125. Number failing; 0. Percent functioning properly; 100.

After proving that anti-mine Lancejets were feasible in small, handmade lots, MBA began a study to determine the feasibility and cost of mass production. The number of rockets selected was for 1,000 mine-clearing operations—30 million rockets—to be produced at a rate of 10 million per year for 3 years. MBA included the cost of rocket materials, production equipment, buildings, plant site, utilities, personnel, etc. required to support the preparation and loading of the explosives, along with assembly operations of the rocket. The cost per rocket was determined to be 21.62 cents ($6.5 million total). In an independent analysis, USAERDL determined that the unit cost would be 24.75 cents using MBA's rocket design and 30.10 cents using a USAERDL-design delay-initiator.

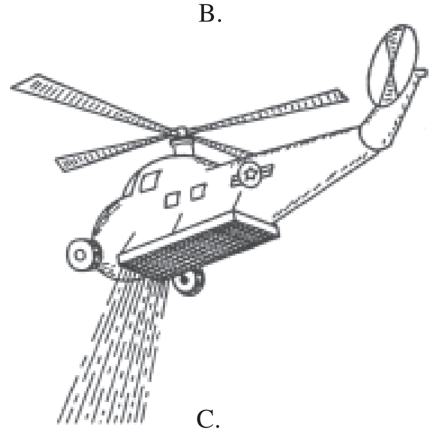
There were several UMD vehicles considered in addition to the M113 Armored Personnel Carrier (APC) mentioned earlier in this chapter. These included an M59 APC, an M48 tank, and an H-34 helicopter identical to the one shown on page 415, with a launching rack on its belly. Apparently, MBA wanted to make the point that most if not all of its miniature rockets could be launched from helicopters, and included them in many of its proposals. These are shown below in Figure 27–19.



A.



B.



C.

Fig. 27–19. Anti-mine/UMD launching vehicles. (A) M59 APC. (B) M48 Tank. (C) H-34 helicopter. USAERDL Report 1828.

Note that the launching racks on the M59 and M48 are elevated at the same 30 degrees and the top of the racks are both 154 inches above the ground. This would allow the individual 1,050-round racks to be projected far enough ahead of the vehicles for their safety and to fire their Finjets the required 20 feet above the ground. This height would allow the Lancejets to be at burnout (and maximum velocity) just before ground impact. It would also allow the rockets' dispersion to open up the salvo to its design width and length. It is not clear how the helicopter-launched rockets would achieve their required 20-foot firing height or impact pattern. In addition to these vehicles with their UMD racks installed, other concepts included projecting canisters out ahead of the vehicle with compressed air and using parachute-retarded canisters of anti-mine rockets projected out ahead of the tracked vehicles.

After MBA had fulfilled the terms of its contracts with USAERDL, the company's involvement with anti-mine Lancejets ended in some controversy. The Army believed that because it paid for MBA's work, all of the designs, data, etc. developed under the contracts were government property. MBA challenged that, claiming that much of the work had been done by the company prior to the contracts, and that MBA still had proprietary rights, including patent applications, for some of the concepts and designs. In addition, during the bidding process for the anti-mine rocket/UMD mass production contract, MBA lost out to another company which submitted a lower bid. During the review and appeal process, some of MBA's claims were upheld but most were not.

The final anti-mine Lancejet of this supplemental chapter is shown below in Figure 27–20 at about one-half actual size. I acquired it from an MBA engineer who worked on the project. The steel Lancejet completely perforated the .60-caliber fired brass cartridge case at its shoulder. It was fired during penetration tests of various metal objects at MBA and kept as a souvenir.

Fig. 27–20. MBA .25-caliber anti-mine Lancejet in a fired .60-caliber cartridge case.

Chapter 4. 1/16-Inch (1.5mm) Lancejets

When the book was published, I did not have a lot of information about MBA's little 1.5mm Lancejets. Now, thanks again to Jeff Osborne, I have a copy of MBA document number MB-63/338, *Feasibility of Employing Miniature Rockets for Special Applications*, dated November 1963. This document was MBA's final comprehensive report of work done under contract number DA 18-108-AMC-105(A), U.S. Army Chemical Research and Development Laboratories, Edgewood Arsenal, Maryland. The document was originally classified Confidential, but has since been downgraded to Unclassified. In addition to the MBA report, I acquired an interesting 1.5mm Lancejet component display of one of the Lancejets covered.

The document's summary states that: *"A miniature rocket has been developed for the U.S. Army Chemical Research and Development Laboratories for use in special applications. The rocket is a 1/16 inch diameter Lancejet. The development of this rocket was based on a design which was generated and tested during previous company-funded research. ..."*

The rocket's performance and physical characteristics are summarized below in Table 27–1.

Length, inches	1.50
Outside Diameter, inches	0.063
Weight loaded, grams	0.159
Weight fired, grams	0.136
Case material	7075 T6 Aluminum
Propellant	ARP
Burn time, milliseconds	13
Burnout velocity, fps	705
Burnout distance, feet	4.2

Table 27–1. 1.5mm MBA Lancejet characteristics. MB-63/338 .

This Lancejet was designed to carry a payload of chemical agent for use in special applications, and MBA stated that it met all of the requirements of the contract. *Note: It was not until November 25, 1969, that President Richard Nixon renounced the United States' use of toxins and ordered that U.S. stocks of them be destroyed.*

According to MBA, the javelin-stabilized Lancejet was chosen for the following reasons:

— Simplicity. The Lancejet does not require fins for stabilization, thus manufacturing complexity and expense are considerably reduced.

—Packing Density. Finless Lancejets have a high packing density and are therefore readily adaptable to canister or bomblet applications.

— Range. Lancejets have a long range as a result of their ballistic density.

MBA's final design, shown below at 2x actual size in Figure 27–21, was obtained in part by applying scaling laws to the existing .25-caliber Lancejet.

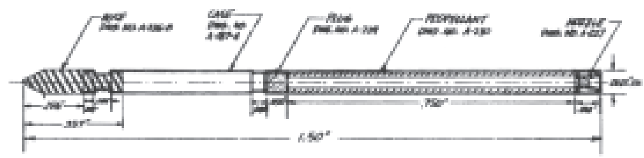


Fig. 27–21. MBA 1.5mm Lancejet, design A-4 (final). MB-63/338.

The 1.5mm Lancejet, sometimes referred to by MBA as a 1/16-inch rocket, had three major components; the ignition system, the propulsion system, and the warhead (payload) section. MBA developed the overall rocket design and the ignition and propulsion systems, while the U.S. Army Chemical Research and Development Laboratory developed the warhead design. MBA's experimental program was divided into three phases:

— The fabrication of inert prototype Lancejets to study manufacturing and assembly techniques.

— The evaluation of the rocket's static performance.

— The study of the Lancejet's aerodynamic performance.

During the first phase, MBA determined the best methods of fabrication and installation of the nozzle and "nose ballast plug" (steel nose). Most if not all of the inert 1.5mm Lancejets seen in collections today are probably from this phase of MBA's work. Methods for loading the tiny propellant grains into the small cases were also considered. As a result of the studies, several tools were developed for fabrication and assembly of live rockets to be used in the next two phases of experimental live firing tests. The drawings of the tools and the descriptions of how they were used answer questions I have had for some time. The first of these, a grain-insertion tool, begins with a fused propellant grain. No tool was required to insert the pyrotechnic fuse into the grain because it was hollow from end to end. A small dab of adhesive was used to secure one end of the fuse in the front (left) end of the grain. Then, the free back end of the fuse was run through the tool's hypodermic needle and out the back of the tool. Next, the grain was positioned against the stop on the front (left) side of the tool. The tool was then used to insert the fused grain into the rocket case, and as it was being inserted (by hand), excess inhibitor material was scraped away. With the grain positioned inside the case and secured by the inhibitor, the tool was removed. This tool is shown below in Figure 27–22, an MBA drawing dated September 11, 1963.

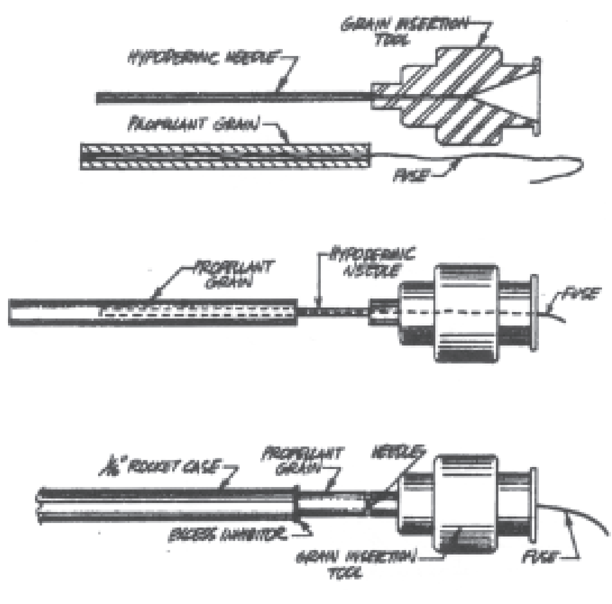


Figure 27–22. 1.5mm Lancejet grain insertion tool. MB-63/338.

The next tool was used to apply the rollover crimp in the back of the rocket's case to secure the steel nozzle behind the propellant grain. The rollover crimp was formed in two steps. First, the loaded case with a nozzle inserted against the back of the propellant grain was inserted in the tool with the fuse run through a central hole and out the right side of the tool. When pressure was applied as the tool was rotating in a lathe, the first 45 degrees of the crimp was formed. Then the rocket was inserted into another tool head and the final 45 degrees of the rollover was formed. This tool is shown below in Figure 27–23, an MBA drawing dated August 12, 1963.

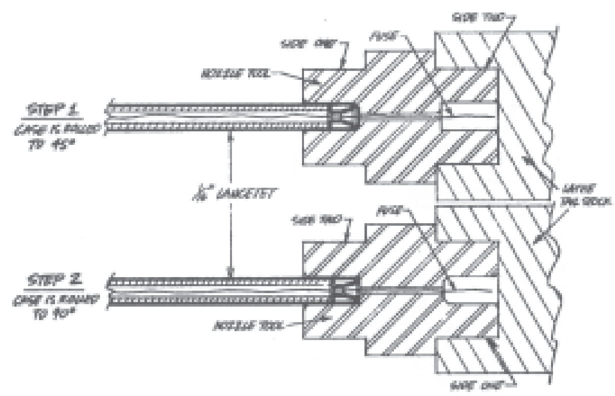


Figure 27–23. 1.5mm Lancejet nozzle crimp tool. MB-63/338 .

The third tool, shown below in Figure 27-24, formed a cannelure to crimp the nose in place and to secure the plug that separated the propellant grain from the rocket's chemical warhead, protecting it against the propellant's heat and pressure. A freely-rotating disc with its edge rounded over was pressed against the rocket's case while it was spun in a lathe. Surprisingly, the September 17, 1963, drawing does not depict a support for the rocket's nose during the operation to prevent the case from being bent. However, examination of specimens reveals that the cannelures are shallow, so probably not much pressure was applied to form them.

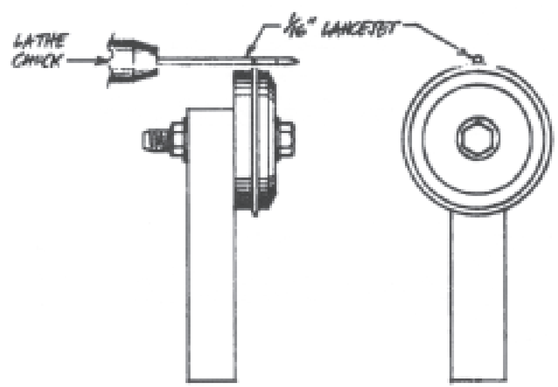


Figure 27–24. 1.5mm Lancejet crimp rolling tool. MB-63/338 .

The second phase of the project was to study the static performance of the Lancejet's rocket motor. To avoid the wasteful use of an entire Lancejet when just the motor was being evaluated, an abbreviated case was developed. It had only the rocket's motor section, which was closed off at the front by a steel plug secured by a rollover crimp. It was designated S1 (static) and is shown below in Figure 27–25.

Figure 27–25. Short case without payload section or nose, for static tests. MB-63/338 .

Static tests using the short cases and then, later, complete rockets, were designed to take three basic measurements; thrust-time profile (how much thrust in what period of time), pressure-time profile (how much pressure in what period of time), and total thrust (impulse) using a ballistic pendulum. The thrust measurements were taken from a thrust stand, shown below in Figure 27–26.

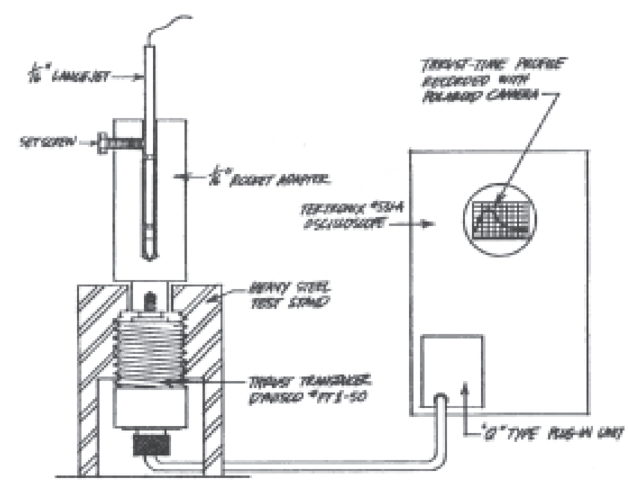


Figure 27–26. Thrust stand. MB-63/338 .

When pressures were being measured, a pressure transducer was piggybacked under the thrust transducer. A typical oscilloscope trace of a thrust (in 100-gram graduations) versus time (in 5 msec graduations) is shown below in Figure 27–27.

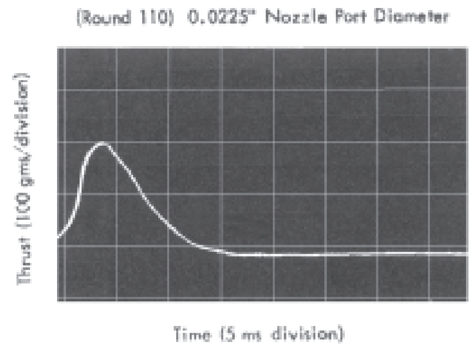


Figure 27–27. Thrust-time trace. MB-63/338 .

Motors with different grain sizes and nozzle port diameters were tested to determine which gave the best performance. The following items were measured:

— Total impulse (momentum caused by thrust).

— Specific impulse (total impulse divided by the mass of the propellant grain).

— Burn time.

— Burn characteristics (regressive, as in the trace above; neutral; or progressive).

— Maximum thrust.

— Average thrust.

— Ignition time.

During pressure testing, information concerning combustion efficiency, chamber pressure, and maximum case stress was obtained. The thrust stand was also used to determine the effects of high and low temperature storage and operation on Lancejet performance. Five Lancejets were placed in a 150-degree F oven for six hours, then individually removed and tested at an estimated temperature of 130 degrees F when fired.

Six Lancejets were placed in a container of dry ice after each had been sealed in plastic. A temperature of -60±10 degrees F was maintained for six hours, then individual rockets were removed and tested at an estimated temperature of -30 degrees F when fired.

In addition to the thrust stand, a ballistic pendulum was also used to verify electronic measurements. A ballistic pendulum is similar to a clock pendulum, with a weight suspended on an arm below a pivot. The weight and the length of the arm are calibrated. A rocket is attached to the weight in a horizontal position, and when the rocket is fired, it moves the pendulum some distance in some time, depending on the thrust it produces and how long it produces it. Generally, a high-speed movie camera is used to record the rocket's performance, from which impulse can the determined.

Payload compartment (warhead) temperature was also determined during phase two testing by coating rockets with temperature-sensitive crayons (Tompilstik).

The final phase of the experimental program included flight testing the aerodynamic performance of the Lancejets. This study generated stability data, velocity versus distance profiles, dispersion data, and limited penetration data.

Stability tests were conducted primarily to determine the minimum amount of "nose ballast" required to stabilize the rocket *prior to ignition*. This statement is significant because it reveals that the chemical-warhead Lancejets were to be launched or dispersed inside a bomblet dropped from an aircraft, allowed to free-fall toward their targets, and then ignite and accelerate while going straight down.

Because stability in a Lancejet is dependent on the center of gravity being ahead of the center of pressure, and because the center of gravity moves forward, ahead of the center of pressure, as the propellant burns, test were initially conducted with unfired rockets. This would be the most challenging scenario. Rockets with varying nose weights were launched toward a "yaw screen" at about 150 fps by a common slingshot with the rockets oriented 90 degrees to their flight path. Distances required for the rockets to stabilize—A "stabilized" rocket was one that penetrated the yaw screen—with different nose weights were measured and the minimum nose weight was determined.

Velocity versus distance profiles were measured by firing rockets in a horizontal launch tube aimed at velocity screens. As the rocket passed down the glass tube, its velocity was measured at seven points. After the rocket left the launch tube, it traveled a given distance and then struck the velocity screens, where a final velocity was measured. Velocity-distance profiles could then be constructed and from these, burnout velocity and distance could be seen.

A vertical test range was used to measure dispersion because the Lancejets would be launched vertically during actual operations and because a vertical launch would eliminate tip-off error. Vertical launches were made through tubes equal to the Lancejet's length and tubes twice the rocket's length. The three test ranges are shown below in Figure 27–28. (A) is the horizontal slingshot yaw test apparatus, (B) is the horizontal velocity apparatus, and (C) is the vertical test apparatus.

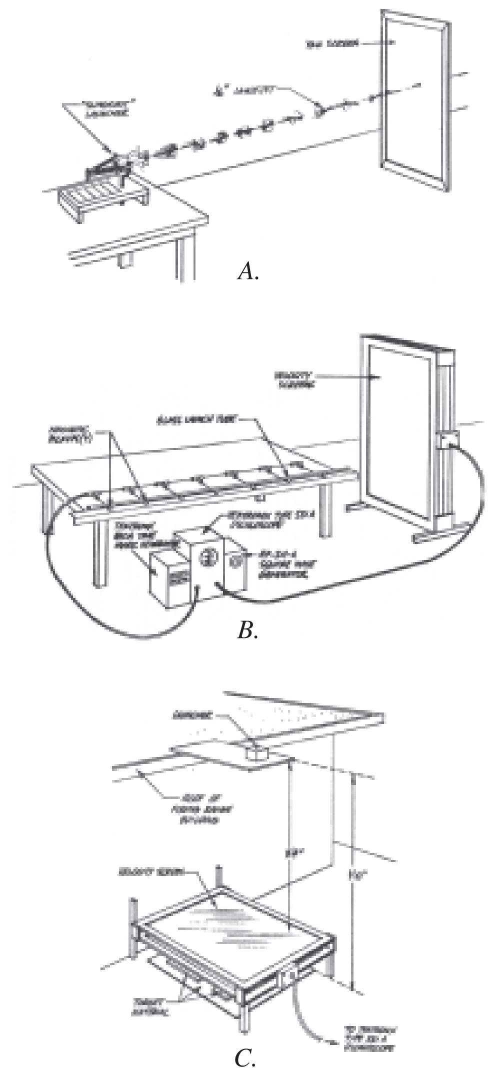
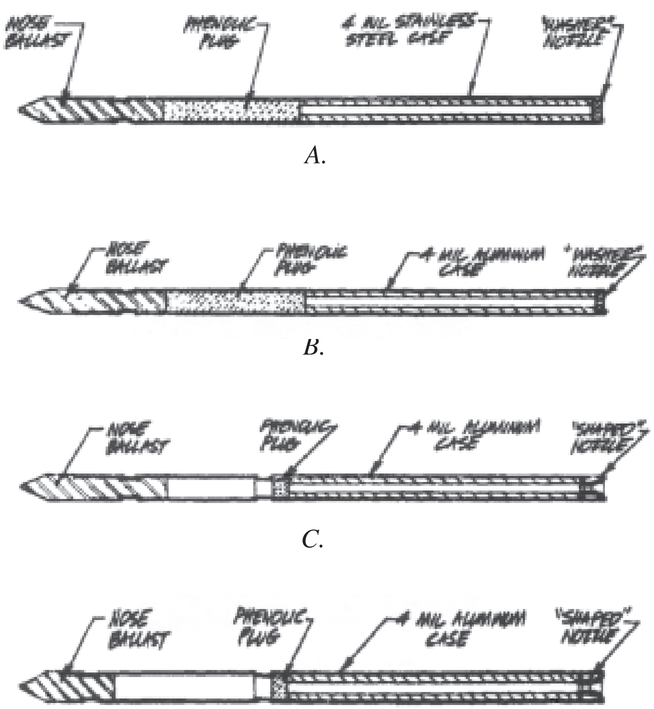


Figure 27–28. Lancejet test ranges. MB-63/338 .

Although not required by the terms of the contract, a limited amount of penetration testing was done in conjunction with other testing by placing various materials in front of the target backstop during velocity and dispersion experiments. The materials included Celotex, white pine, Bakelite, plywood, and various articles of clothing.

During the testing, four Lancejet designs were tried, with design A-4, shown as a measured drawing in Figure 27–21 on page 422, being the design adopted. The designs are shown below in Figure 27–29 at twice actual size. All four designs use a nose cannelure. A-1 (A) has a long phenolic plug ahead of the propellant, no warhead, a stainless steel case, a simple nozzle made from a flat washer, and a weight of 310 mg. A-2 (B) has identical construction to A1, but has an aluminum case and a weight of 205 mg. A-3(C) has space for a chemical payload, a shaped nozzle, an aluminum case with a cannelure to separate the phenolic plug from the chemical payload, and a weight of 200 mg. A-4 (D) is identical in construction to A3 except that it has a shorter nose, a longer payload section, and a weight of just 159 mg.



A.

B.

C.

D.

Figure 27–29. Lancejet designs, 2x actual size. MB-63/338 .

Physical characteristics of the A-4 Lancejet are as follows (± 1-3 percent):

— Weight, loaded, with fuse; 0.159 grams.

— Weight, fired; 0.136 grams.

— Propellent weight; 0.029 grams (Fuse weighs 0.010 grams).

— Length; 1.5 inches.

— Outside diameter; 0.0625 inches (1.59mm).

— Case thickness; 0.004 inches.

— Nozzle throat diameter; 0.0225 inches (Several different throat diameters were tested.)

— Propellant web thickness; 0.011 inches.

— Initial burning surface area; 0.073 square inches.

— Final burning surface area; 0.0125 square inches.

Performance characteristics of the A-4 Lancejet are as follows (± 10 percent):

— Burn time; 0.013 second.

— Thrust; 246 grams.

— Acceleration, maximum g's; 1,920.

— Burnout velocity; 705 feet per second.

— Burnout distance; 4.16 feet.

— Maximum chamber pressure; 1,372 psi.

— Maximum case stress; 9,350 psi.

Reliability of the little rockets was excellent. There were no failures of 20 rockets tested statically, including firings at temperatures of -30 to +130 degrees F. There were just three unsatisfactory firings of 27 rockets fired aerodynamically.

When fired from a 3-inch launcher, dispersion was 100 mils CEP (50 percent of rockets hitting inside a 20-foot diameter circle at 100 feet). With a 1.5-inch launcher, dispersion was four times greater at 405 mils CEP, which MBA saw as an advantage, because that would enhance wide-area coverage of the Lancejets after their bomblet release. Four A-4 component drawings, reduced considerably from their original size, are shown below in Figure 27–30. These were made in June and July 1963. The 7075 T6 aluminum case (A) is 1.344 inches long. It has an outside diameter of 0.0625 inch and an inside diameter of 0.0545 inch.

The nozzle (B) was made of “Ledloy 300 steel,” and had a final throat diameter of 0.0225 inch. The earlier washer design produced too much pressure for too short a time, causing early aluminum cases to burst. The use of the final nozzle design shown produced a much better pressure-time profile, and allowed the return of aluminum as the case material instead of the heavier stainless steel used to contain the high pressure spike caused by the washer-type nozzle.

The rocket’s nose (C) was also made of “Ledloy 300” steel and is shorter than the nose used in other designs. Its reduced weight allowed the Lancejet to achieve its 705 fps burnout velocity without reducing stability.

The propellant grain (D) is 0.750 inch long. It has an outside diameter of 0.052 inch and a central perforation with a 0.031-inch diameter. Although X-12 was initially used as the rocket’s propellant, ARP was quickly adopted for all testing and was selected for the final A-4 design. ARP cost $5 per pound and X-12 cost $50 per pound, and both had the same performance.

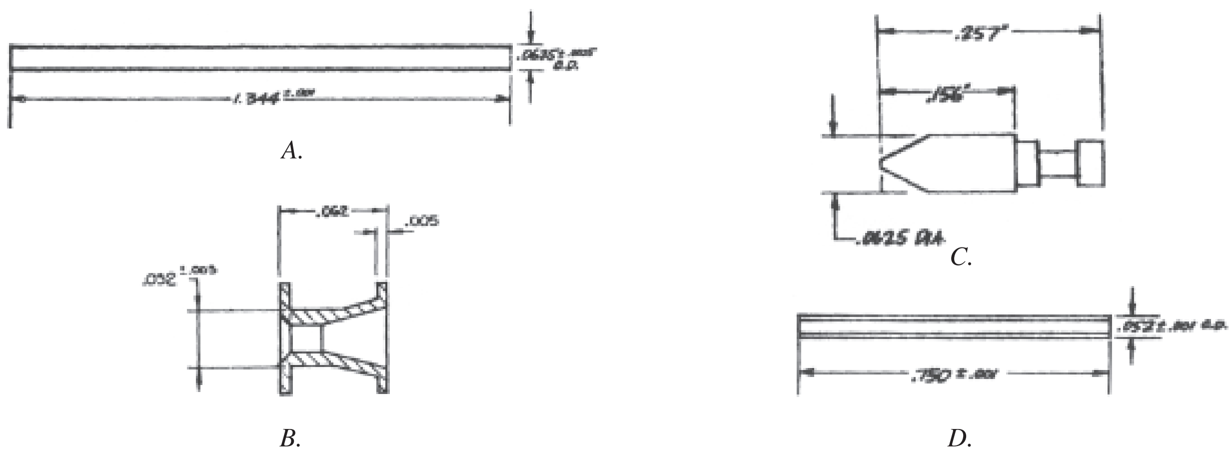


Figure 27–30. Lancejet design A-4 component drawings. MB-63/338 .

In November 1963, with the submission of its final comprehensive report, MB-63/338 *Feasibility of Employing Miniature Rockets for Special Applications*, MBA had completed the terms of its contract with the U.S. Army Chemical Research and Development Laboratories. The company had proven that its little rockets were at least feasible in delivering a chemical payload to a target. Interestingly, one of the report’s conclusions was that the Lancejet’s design was *“flexible in that it may readily be adapted to either* <u>*external or internal*</u> *carriage of the [chemical] payload.”* This brief comment is the only reference seen to the Lancejets possibly carrying payloads externally, which is how MBA’s tiny antipersonnel Javettes, developed during this approximate time period, carried theirs. The report is silent on the subject of the type and characteristics of the payload because development of that part of the project was an Army task. The report is also silent about how the Army payload carried inside the rocket’s warhead was to be released into the target. MBA’s patent application covering its Javettes was originally classified secret, and information about this chemical payload probably had the same classification. As explained before, not all of MBA's sensitive work involving biological and chemical warfare before they were banned in 1969 has been declassified.

Not surprisingly, MBA recommended that *"additional development of the 1/16 inch Lancejet should be undertaken"* and that work should begin to develop a method for *"fabrication and delivery of experimental munitions to CRDL [Chemical Research and Development Laboratories] for evaluation."* No research and development firm worth its salt would ever close out a government contract without a recommendation that more work be accomplished to "optimize" whatever was developed during the first contract.

To close out this section on 1.5mm Lancejets, I have included Figure 27–31, which is a scan of a letter-size page with an A-1 design Lancejet glued on, together with specimens of the rocket's components. I edited the scan to move the elements closer together to save space. The items are shown at actual size.

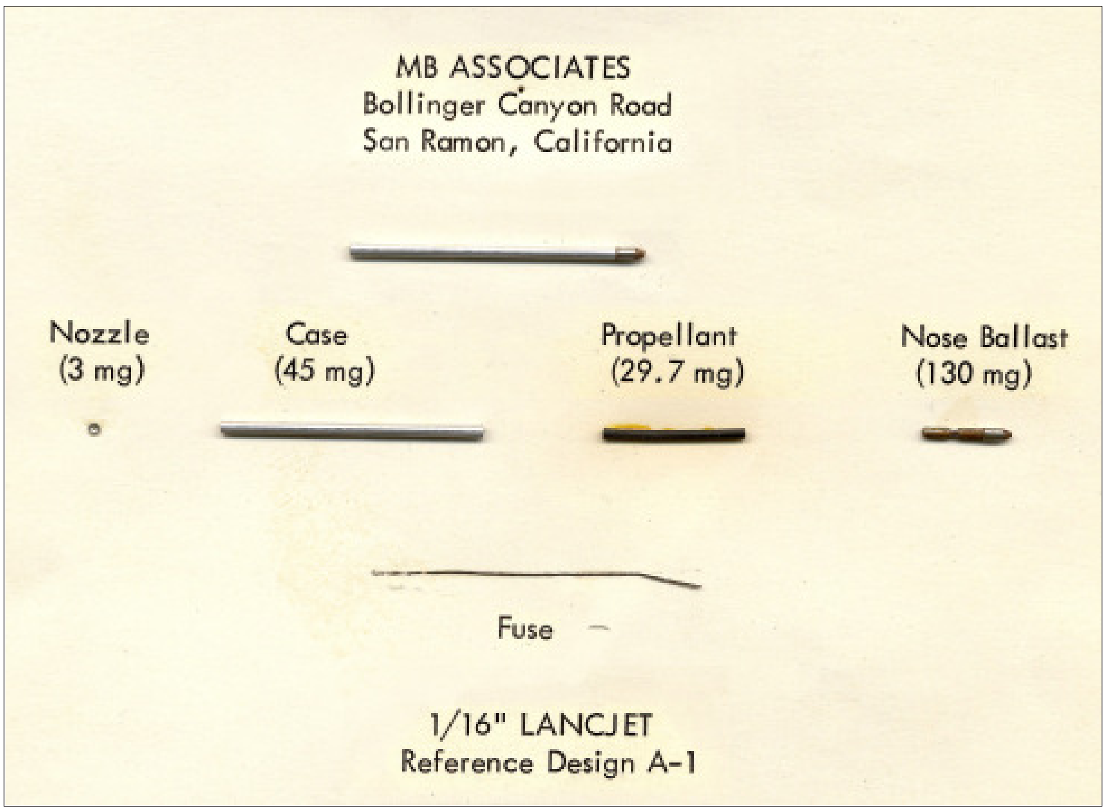


Figure 27–31. A-1 Lancejet and components specimens. Actual size.

Chapter 5. Javettes

An interesting unclassified abstract of a still-classified MBA report titled *"Improved Water Soluble Javette"* has come to light. The report's summary is dated February 1, 1974. This small tidbit of information is of interest because by having an *improved* water soluble Javette being reported on, that verifies that there was an earlier version. It is not clear why MBA would be working on an improved version five years after chemical and biological warfare weapons were banned and ordered destroyed. Hopefully, the report will be downgraded to unclassified soon.

—.—

One type of cartridge that was developed for the MBA E-1/M-1 silent electric pistol to fire 0.030-inch Javettes is shown in Figure 5–4 on page 63. When I acquired that cartridge my source, who worked with Mainhardt on the project, told me there might be another specimen to be found. After the book was published, I was very pleased to learn that the round had in fact been located and that it was available. It is very nearly identical in appearance and dimensions to the quiet round specimen shown in Figure 5-4 and it has also been fired and reloaded several times. However, its outer cartridge body and end cap are made of carbon steel, not stainless, which creates a significant variation. It also reminds us of the value of a good magnet in checking our collectible cartridges. The round is shown below in Figure 27–32 with a typical Javette included for perspective. It’s bore has opened up a little, probably due to multiple firings, and the Javette is only loosely held.

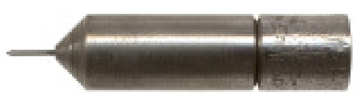


Figure 27–32. Javette quiet round cartridge with carbon steel body and end cap. Actual size.

The final quiet round variation (for now) was made more recently by a Mainhardt contractor who worked with him earlier. He did not discuss its application in any detail except to say that it was for a less-lethal project. It is made entirely of stainless steel and does not attract a magnet in the slightest. Interestingly, unlike the specimen shown above, its bore is very tight; so tight some force must be used to insert a standard Javette. It is in new condition and has not been fired.

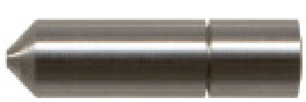


Figure 27–33. Javette quiet round stainless steel cartridge. Actual size.

As I was doing research for the book I was fortunate to acquire specimens of many of the items I was studying, including the MBA “Ammunition Concealment Round shown and described on pages 66-68. Figures 5–10 and 5–11 show the round in detail, but not enough detail. In addition to a handful of complete rounds, I also had an original .223 REM-UMC cartridge case with its head drilled out and stepped for a .25 ACP cartridge case, an extra Javette, an original Teflon gas check, an original box of Olin MG42 primers, and most importantly, an original “barrel #25” stainless insert. Obtaining a correct REM-UMC .25 ACP pistol case was easy, as was a quantity of the correct Bullseye pistol powder.

I kept the Javette, gas check, and powder and gave the rest of the components to Paul Smith, who has done so many wonderful sectioned cartridges and rockets for the book. Paul produced the masterpiece shown below in Figure 27-34 to which I added the javette, Teflon gas check, and propellant.

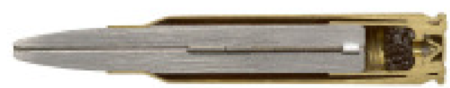


Figure 27–34. Sectioned MBA Ammunition Concealment Round with Javette and Teflon gas check. Actual size.

Figure 5–1 on page 62 shows the first design of a .22 Long Rifle cartridge used to fire MBA Javettes in a standard .22 rifle and a High Standard Model HD-MS, which was a silenced version of the HD made for the OSS in 1944 and 1945. During the quiet round project, one of these silenced pistols was provided to MBA by the CIA for use in developing the .22 Javette round to be fired in the silenced pistol. After the book was published, I acquired a blunt-nose variation of the round shown in Figure 5–1, and it is shown below in Figure 27–35. It has a heavy case cannelure to secure the insert, which is made of carbon steel, not stainless like later versions. The case, which has been struck several times, has a SUPER X headstamp. It is not clear whether the round is a dummy or a misfire.

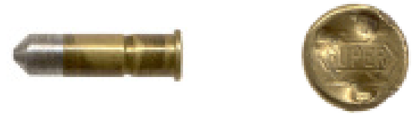


Figure 27–35. MBA .22 Long Rifle Quiet Round, actual size, and headstamp, 2x actual size.

Chapters 13 & 14. 13mm Gyrojet Rockets and Firearms

Figure 14–33 (A) on page 188 shows an unusual long spear cartridge adapter, and Figure 14–34 (C) on page 189 shows the spear loaded in a 13mm MBA survival pistol. The spear point has a hole in its shaft to attach a line so it can be retrieved after firing, hopefully with a fish attached. The spear also has a folding barb, which would function correctly only if the spear were not spinning. In addition, if the spear were spinning, that would prevent the retrieval line from paying out correctly from the pistol.

I recently acquired the cased MBA 13mm Gyrojet survival pistol, spear cartridge adapter, and spare spear variation shown below in Figure 27–36. The two spears are shown at actual size. The pistol has an unusual, almost iridescent green finish not seen on any other Gyrojet firearm. The walnut case does not appear to have been designed expressly for this pistol, but adapted for it. It might have originally been for a Lancejet underwater pistol as shown in Figure 4–7 on page 54. The Lancejet also has long spears which could fit in the grooved walnut strips.

In order to fire the spear, the shooter first loaded a standard 13mm Gyrojet rocket in the pistol with the barrel extended. Then the spear adapter was loaded into the muzzle cap, as shown in Figure 14–34. When the rocket was fired, it moved forward, cocking the hammer for another shot. It then imbedded itself in the base of the spear adapter, which is hollow and sized to receive the 13mm rocket. At this point, the Gyrojet was moving relatively slowly (about 150 fps), and its impact in the adapter base was cushioned by the air it had to compress and squeeze out as it fully seated itself. It appears that there is just enough clearance between the rocket and the spear to allow the rocket to spin inside without causing the spear to spin. The rocket simply pushed it forward out of the muzzle cap as it accelerated. Unfortunately, I have no data about the spear's velocity at rocket burnout, and I'm tempted to find out myself. The complete spear round is shown with a standard 13mm Gyrojet rocket in its base, as it would be at launch.

A.

B.

C.

Figure 27–36. 13mm Survival pistol, serial number B5113S (A); Spear round (B), actual size; and spear variation (C), actual size.

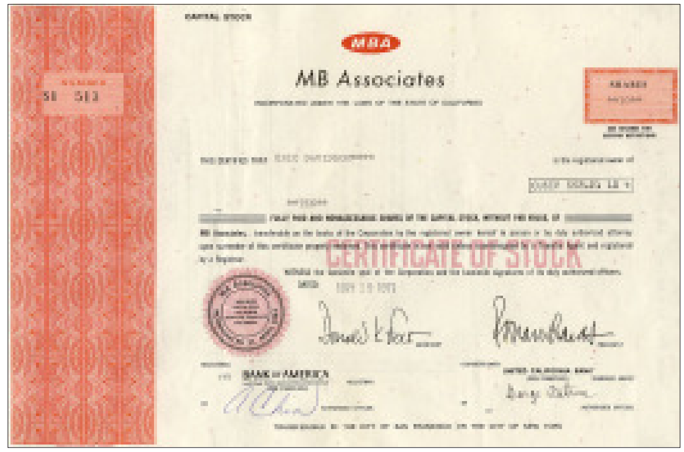
Chapter 14. 13mm Gyrojet Firearms (Certificates)

As part of a discussion about MBA cased presentation Gyrojet pistol sets, four certificates are shown in Figure 14–6 on page 173. Certificates of authenticity signed by Mainhardt were included in the cased presentation sets, and others of the same design (modified from unused MBA stock certificates) were presented to VIPs and guests at the factory who fired Gyrojets, thereby qualifying as "rocketeers."

I acquired the certificates shown below in Figure 27–37 after the book was published. Eric Davidson provided his original 1971 MBA stock certificate with its more modern design, and I included the Trebor stock certificate to round out the group. The first two use the same blank stock certificates as shown earlier.

A.

B.



C.

D.

Figure 27–37. MBA and Trebor certificates. (A) "Stun-gunner" certificate, issued to persons who witnessed MBA's Stun-Gun. (B) Similar Trebor "Stun-gunner" certificate prepared for King Hassan II of Morocco (1929-1999). Signed by Mainhardt, but not presented. Trebor aggressively marketed less-lethal products to Morocco, but the sale was not closed. (C) MBA stock certificate, 1971. (D) Trebor stock certificate.

Chapter 15. 13mm Gyrojet Flares and Launchers

A group of short 1.4-inch Gyrojet flares for use in pistols is shown in Figure 15–2 on page 200, with (I) being a sectioned example of a specimen with a magnesium case. I had not noticed the details of the flare's motor section construction before now. As I mentioned, 13mm Gyrojet pistol rounds were used in these early flares. They were cut off and turned down to allow the flare's pyrotechnic cup to fit. The bulkhead and delay train between the propellant and pyrotechnic mixture were made as a separate piece, with the Gyrojet case rolled over to secure it in place. Later flare motor sections were made as one piece, as shown in Figure 15–10 on page 204-205.

The early 2-piece construction is clearly shown in Paul Smith's new sectioned flare shown below in Figure 27–38. The section was made using a specimen of the flare shown in Figure 15-2 (B), with a short motor section, plain aluminum case (or cup), and 4-port plain steel nozzle. The section also reveals that the pyrotechnic section was made from two pieces; a straight-wall cylindrical body capped by a separate nose piece, a detail I had not seen before. Five of the flares were packaged in a heat-sealed polyethylene bag with five individual sealed compartments. An MBA logo was stapled to the top, and its back was marked "Al [aluminum) Crane [Naval Ammunition Depot Crane, Indiana]." MBA was marketing the company's new flare to the U.S. Navy, and NAD Crane was the facility evaluating proposed Navy signal pyrotechnics (and a lot more). Thankfully, this particular package of flares did not make it to Crane for testing. Instead, it somehow wound up in Tampa, Florida, and was provided by Mike Michaels. To save space, I cropped the bottom four compartments, now empty, from the photo.

Figure 27–38. Sectioned MBA 13mm 1.4-inch pistol flare and poly bag with whole flare and MBA logo. Actual size.

MBA 13mm radar chaff flares are discussed and shown on page 218. One additional dummy variation of the flare, with one small hole in the motor section to identify it as a dummy, surfaced at the International Ammunition Association (IAA) annual live auction held during the St. Louis International Cartridge Show in April 2011. This is the world's largest and best (my opinion) cartridge show, and is held at the Renaissance St. Louis Airport Hotel every year during the week before Easter. Details and schedule of the show may be seen at www.cartridgecollectors.org, the IAA's web site.

I helped produce the auction catalog and therefore had an opportunity to examine the dummy rocket and make the picture shown below in Figure 27–39. However, I did not consign it or bid on it or the other Gyrojets in the auction. It sold for a record $1,200 (for an MBA 13mm Gyrojet rocket) in the no-reserve auction. Like Figure 15–36 (B), it is marked "INERT" in white. The dummy is in excellent condition, and the nickel primer has not been snapped. As is typical, the flare has a polyethylene nose cap and a 2-port copper-plated nozzle.

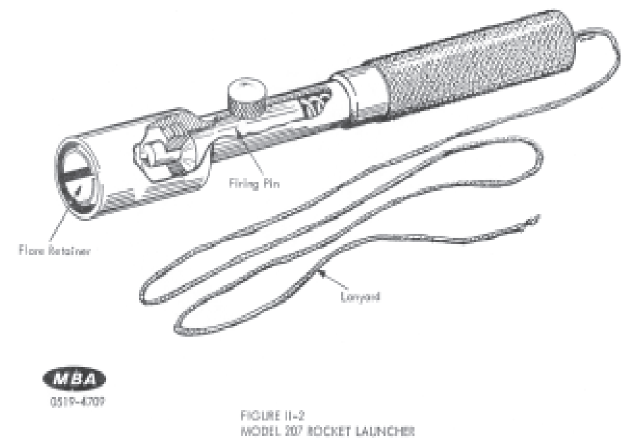
Figure 27–39. MBA 13mm dummy chaff flare with one hole in the motor section. Actual size.

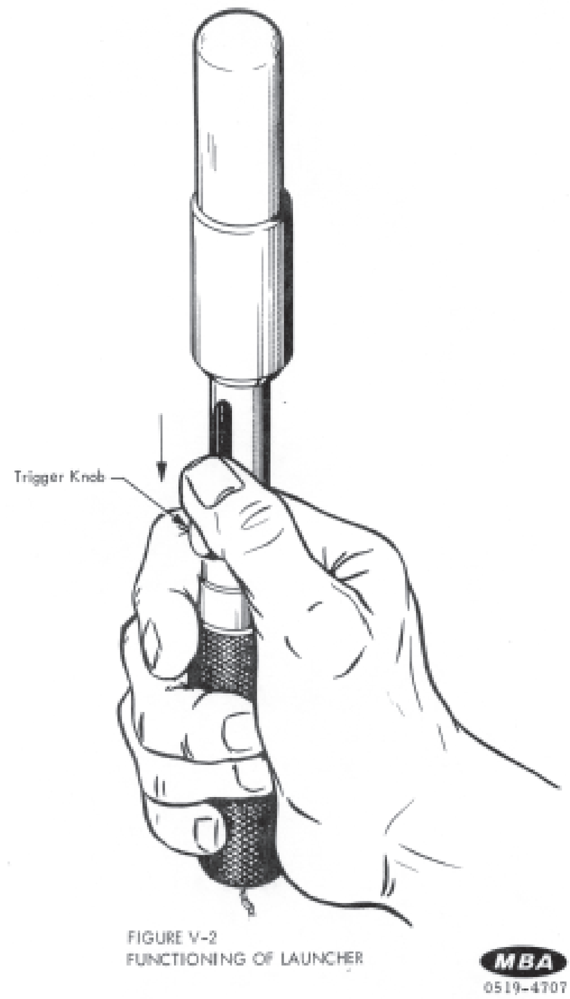
In August 1969, the Pyrotechnics Laboratory, Feltman Research Laboratories, Picatinny Arsenal, Dover, New Jersey published Technical Report 3943, *Evaluation of MBAssociates 201 Global Flares/ Distress Signals (Green, Red, and White)*. The evaluation was conducted from March 1969 through June 1969. The purpose of the evaluation was to determine whether the flares were suitable for inclusion in the Individual Lightweight Survival Kit. The flares functioned with an overall reliability of 92.6 percent at a 90 percent confidence level, which was considered satisfactory. Reliability was not adversely affected by exposure to adverse conditions.

In October 1970, MBA produced report MB-R 70/113, *Preproduction Sample/ Initial Production Item Report* for contract DAAA 21 71 C 0085 in preparation for mass production of the M201G flare. The report spelled out in great detail what MBA would do, generally on a daily basis, to ensure quality control of the flares it was producing under the contract.

On April 2, 1971, MBA published MB-TM-71/8, *Technical Manual for the Personnel Distress Signal Kit, Revision A*, for the United States Air Force in accordance with contract F33657-71-C-0769. The publication of the 15-page manual signaled the introduction of the MBA Model 201G into U.S. Air Force inventory and issue to aircrew personnel.

Three illustrations from the manual are shown below and to the right in Figure 27–40.





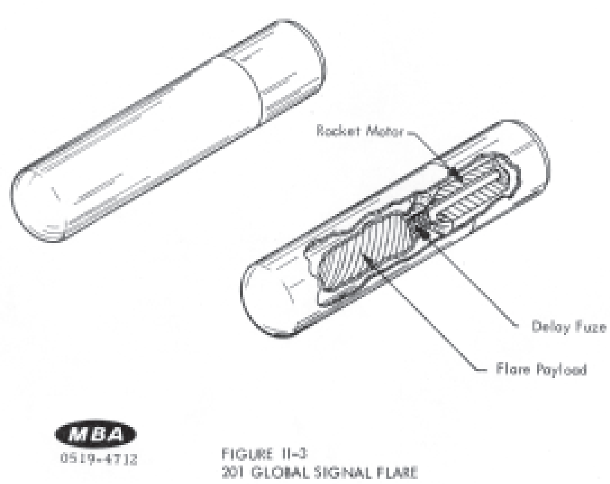


Figure 27–40. Illustrations from MB-TM-71/8.

Chapter 17. Large-Caliber Gyrojets

When I began work on the book, I had very little information about the large-caliber Gyrojets covered in chapter 17. Now, thanks yet again to Jeff Osborne, I have a copy of MB-R-66/85, *Miniature Rocket Delivery System, Phase V - System Capability Analysis and Final Comprehensive Report,* dated October 1966. The report was prepared under contract DA 18-035-AMC-709(A), U.S. Army Edgewood Arsenal, Weapons Development and Engineering Laboratories, Ground Munitions Laboratory. It was unclassified.

The purpose of the project was to determine and demonstrate the feasibility of medium range (500-2,500 meters/1,640-8,202 feet/0.3-1.5 miles) delivery and dissemination of incapacitating agents, e.g., CS, a tear and nauseating agent referred to as an "irritant," by using nonhazardous miniature rockets. For the purposes of the project, "nonhazardous" referred to the impact characteristics of the rocket (less than 55 foot-pounds of kinetic energy at impact). Actual CS was not used during most of the test firings, but was simulated by a pyrotechnic smoke mixture.

During the first phase of the project, a 30mm Gyrojet was determined to best suit contract requirements. During Phase II, the design of rocket components and initial testing were accomplished. Phase III involved the testing of a multi-tube rocket launcher. Phase IV refined various components tested during phase III. The final Phase V was an analysis of system capabilities on targets within its range.

MBA's 20mm Gyrojet, shown below in Figure 27-41, was used as the starting point for the project's preliminary design. It is almost identical to the 20mm Gyrojet drawing shown in Figure 17–7 on page 232. Because it was to be scaled up, no dimensions were listed; however, based on it being a 20mm rocket, I scaled it to approximately actual size. The notations on the drawing refer to mathematical variables.

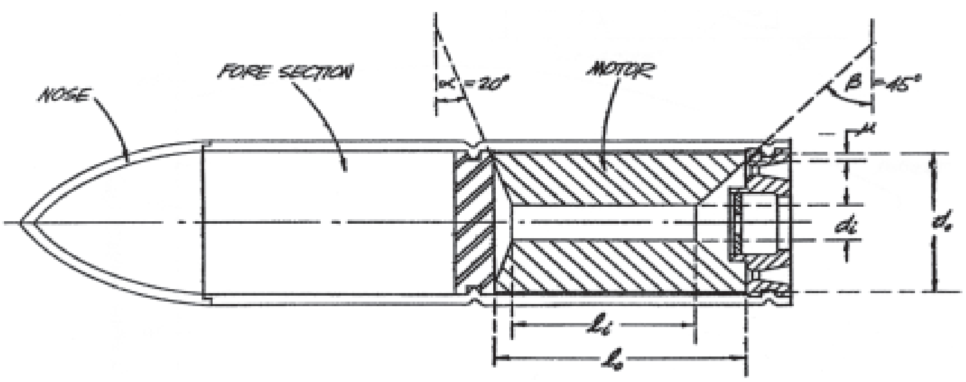


Figure 27–41. MBA 20mm Gyrojet. MB-R-66/85.

The new 30mm rocket's propellant was shaped so that its burning surface was nearly constant with time, resulting in a nearly level internal pressure. The propellant was X-12, although ARP could also have been used with minor modifications. The rocket's four nozzle ports were canted at 13 degrees.

When MBA scaled the 20mm rocket design up to 30mm, the resulting smoke rocket had the following characteristics:

— Diameter; 30mm (1.2 inches)

— Length; 183mm (7.2 inches). The L/D was 6, well below the maximum of 6.5 to stabilize a spinning rocket.

— Burnout velocity; 1,150 feet per second, which kept the rocket subsonic for most of its flight.

— Smoke payload mass; 60 grams

— Total mass; 280 grams

— Propellant mass; 50 grams

The rocket's range was adjusted by varying its launch angle above or below that required for its maximum 8,200-foot range. It was better to increase the launch angle because that reduced the impact kinetic energy. It was determined that 175 rockets having a dispersion of slightly less than 10 mils CEP would be required to achieve the CS agent effectiveness called for in the contract over an area of one hectare (10,000 square meters/ 2.47 acres).

Based on MBA's experience with 13mm and 20mm Gyrojets, it was estimated that there was a 90 percent probability of MBA being able to meet the dispersion requirements.

The recommended dimensions for the new Gyrojet with smoke simulating CS tear gas are shown in Figure 27–42 to the right.

With the basic characteristics of the rocket established during Phase I of the project, the detailed mechanical design was accomplished during Phase II. Rocket components were tested and made to function individually and then the complete rocket was tested. The Gyrojet actually constructed was somewhat different from the proposed design, especially in the nose design with its mechanical impact fuze. The rocket was made from 304 stainless steel tubing with a yield strength of 100,000 psi and an ultimate strength of 115,000 psi. The maximum pressure the rocket motor section was exposed to was 45,200 psi.

The bulkhead separating the motor section from the payload section was made of 2011-T3 aluminum, rolled into the motor section with a cannelure. The nozzle was made of free-machining (easier to machine with less friction, but 20 percent more expensive) steel. The nozzle's four ports were drilled at an angle of 18 degrees.

The X-12 propellant grain weighed 54 grams and was inhibited on its outer surface with thin 3M 8100 tape. It was sealed against moisture by a 0.002-inch thick piece of 3003H 9 aluminum foil cemented over the port inlets. The seal burst at propellant ignition when pressure reached 1,400 psi.

The igniter was an Olin BWP 8-4 bridgewire primer held in the nozzle against a 0.1875-inch flash hole.

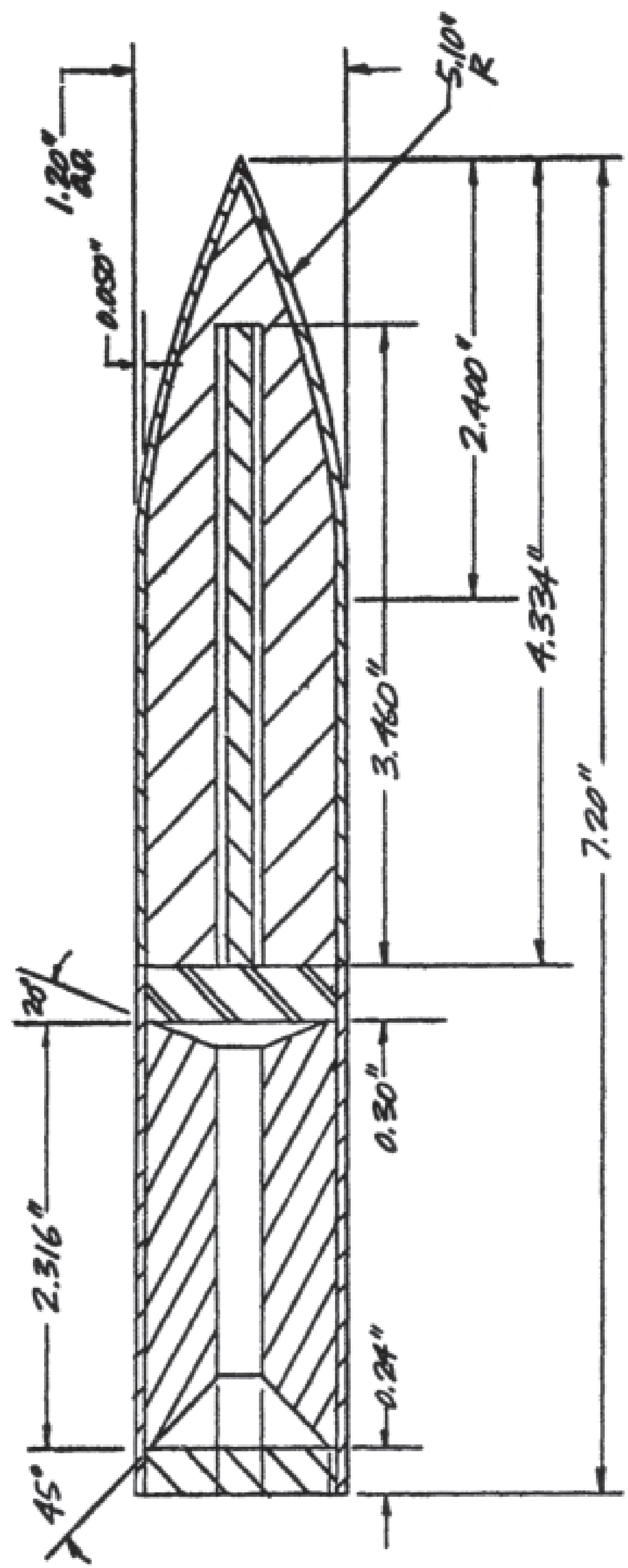


Figure 27–42. MBA 30mm smoke (simulating CS tear gas) rocket. Actual size. MB-R-66/85.

An impact-actuated fuze was required because the rocket's time of flight varied from 25 to 38 seconds as range varied from 500 to 2500 meters. This fuze fired when the rocket's spin decelerated on impact.

Note: One of the concepts discussed in MB-R-66/85 was that of a "trailing" or "non-trailing" rocket. A Gyrojet in flight has a very high (78,000 rpm in this case) spin rate when fully spun up and is in many respects a gyroscope, which is reluctant to change its attitude. During the initial part of its flight, a Gyrojet is said to be "trailing" because its longitudinal (nose to base) axis is parallel to its trajectory. It is like a train on tracks, aligned with the tracks.

However, as the rocket slows down and begins to descend from the top of its trajectory, its nose does not always drop to stay in alignment with its trajectory because, being a gyroscope, its attitude is set and stable. The rocket is then said to be "non-trailing," and will hit the ground flat, not nose down, while still spinning at a fast rate.

If the rocket is fired straight up, it will remain nose up at the peak of its trajectory, descend, and hit the ground base first while still spinning.

The extent to which a rocket is trailing or non-trailing depends, to a large extent, on its launch angle. Because this rocket would be launched at significantly different angles in order to adjust its range to what a particular situation called for, a fuze that fired when the rocket's spin, and therefore centrifugal force, was reduced to a set level regardless of the rocket's attitude at impact was required. A point fuze was not appropriate because the rocket would not always impact point (nose) first.

This trailing/non-trailing phenomenon occurs with any Gyrojet, not just large ones. However, most small-caliber Gyrojets were designed to be fired more or less horizontally (at low launch angles) from handheld weapons, so the rockets were almost always trailing, hitting their targets nose first.

Figure 27–43 depicts the rocket's trajectories and impact attitudes at various launch angles. At launch angles above 78 degrees (nearly straight up), the rocket climbs to 6,700 feet, stops, and descends base down, impacting at a range of 700 meters or less depending on the exact launch angle.

At launch angles between 74 and 76 degrees, the rocket climbs to a slightly lower height and then descends at a nearly flat attitude, impacting the ground in a level attitude at a range of approximately 800 Meters.

At launch angles less than 72 degrees, the rocket remains trailing and impacts the ground nose first at a range of 1,500 meters.

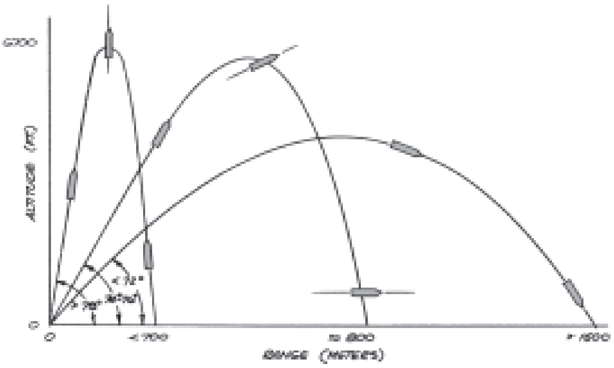


Figure 27–43. Rocket impact attitudes. MB-R-66/85.

The fuze selected for the first 30mm tear gas (CS) rocket is shown below in Figure 27–44, edited by shading for clarity.

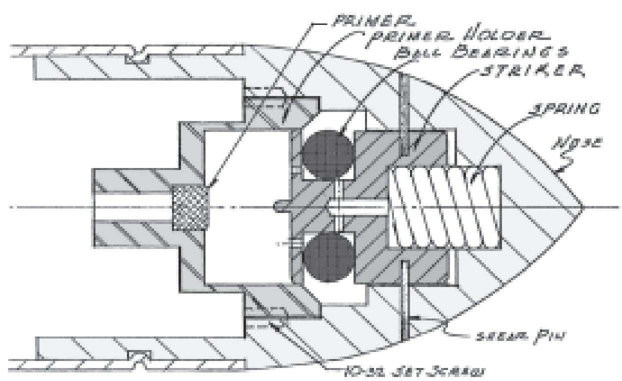


Figure 27–44. MBA 30mm tear gas Gyrojet fuze. MB-R-66/85.

Finally, and thankfully, after years of searching, we now have MBA's explanation of exactly how this fuze worked. *"The fuze mechanism functions as follows: Upon spin acceleration, the six (6) 3/16″ ball bear-*

ings are centrifugally forced outward against the 45° incline plane of the primer holder and exert their inertial forces forward against the striker. When the spin rate has built up to 830 rev/sec [49,800 rpm], the ball force minus the spring force [acting against it] equals 70 lbs and the shear pins break and arm the fuze. This action occurs about 175 ft from the launcher on the way to burnout. The fuze remains armed during the flight while the rocket spin decelerates due to air friction as shown by the calculated spin deceleration curve presented in [MB-R-66/85 Figure]. The ball force continues to overcome the maximum spring force of 37 lbs until the rocket impacts and the spin rate is reduced to 325 rev/sec [19,500 rpm]. At this spin rate the spring overcomes the ball force and the balls are forced inward into the striker. The striker is propelled by the spring into the Olin M42G primer which fires into the payload."

The required energy for M42G primer ignition was 1.25 inch-pounds, and the spring energy was 4.35 inch-pounds, more than enough. The striker and primer holder were anodized to reduce the possibility of the two aluminum parts seizing and a graphite lubricant was applied to sliding surfaces to reduce friction.

The rocket's pyrotechnic smoke warhead (simulating the ultimate CS tear gas payload) weighed 60 grams. Because the smoke mix burns slowly at atmospheric pressure, a radial burn configuration was required to ensure that the mix was completely burned within 12 seconds after the fuze fired. To initiate the radial burn, a strand of quickmatch in the 0.25-inch hole in the mix ran from the fuse along the axis of the smoke mix.

The back end of the payload section was a sieve (open mesh) plate. Because the payload section was just a friction-fit in the motor section case, not secured by a cannelure, when the smoke mix began to burn, it produced enough pressure through the sieve plate to eject the payload from the motor section. Smoke (operationally, CS gas) was emitted through the sieve plate as the payload section lay on the ground.

In a design modification, the payload was a slurry mixture, which was "disseminated" by a standard number 8 blasting cap initiated by the fuze primer. The 30mm rocket is shown to the right in Figure 27–45 at approximately actual size.

It is almost, but not quite, identical to the 30mm rockets shown and described on page 241. It is also similar to the Woodin Laboratory specimens shown in Figure 17–29 on page 243, one of which used a BWP bridgewire electric primer and point-detonating impact fuse while the other used a percussion primer.

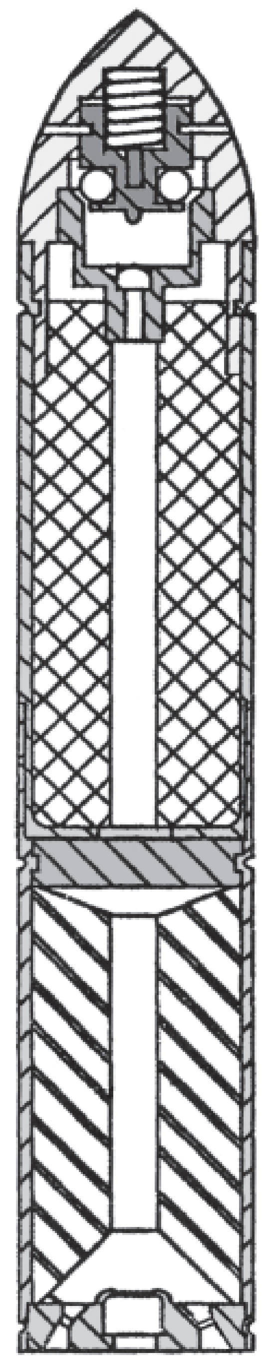


Figure 27–45. 30mm smoke Gyrojet, actual size. MB-R-66/85.

A single-round launcher was designed and built for firing tests. A "foreign make" 50mm mortar was modified with a 1.255-inch (31.9mm) tube 24 inches long. An electrical firing pin and circuit were added, together with a U.S. M4 mortar sight. The launcher was capable of launch angles of 35 to 90 degrees and because the bottom of the launch tube was open, it had almost zero recoil.

Rocket hold down was by a 0.125-inch thick O-ring in the rocket's back cannelure. The rocket was loaded in the launcher with about 0.25 inch of the back end of the motor section protruding from the launch tube. As the rocket fired, the O-ring hold down was stripped off the rocket if its thrust was more than about 10 pounds. This prevented the rocket from leaving the launcher if the primer fired without igniting the propellant.

As explained earlier, the fuzed payload section of the Gyrojet was a friction-fit in the motor section. This required just a 0.0005-inch interference. This design was adopted because during drop tests of warheads, fuzes which were lightly pressed into payload cases would sometimes separate prematurely from the payload on impact before they fired. The preferred method would have been for the opening point for the smoke (CS) to deploy from the payload section to be through the hole left in the payload's front end when the fuze was ejected by pressure from the burning smoke mixture, but this was not practical.

MBA conducted test firings at MBA headquarters in San Ramon, California, in January and February 1966, including 17 motor tests and 23 fuze tests. Because MBA did not have long-range testing facilities, rockets were modified to increase their drag and reduce their range while still providing useful data. Not surprisingly, problems were encountered and addressed.

The first full-scale, long-range system demonstration was conducted at U.S. Army Camp Roberts, California on March 17-18, 1966. The objective was to fire at least five rockets per 500-meter increment through the 500-2,500 meter ranges. Of 34 rockets built for the tests, 19 were actually fired, with mixed results. All of the rockets which deployed smoke and were recovered were launched at an angle of 68.5 degrees, which corresponds to a range of 1,500 meters for a rocket with a burnout velocity of 1,150 fps. The actual range of these rockets was 1,850 meters (6,070 feet or 1.15 miles). Based on firing test data, the rockets' maximum range was calculated to be greater than 2,700 meters (8,858 feet, or 1.7 miles).

At the end of the Phase II firing tests, MBA felt that the feasibility of the "chemical agent carrying" rocket had been established and that only a small amount of development work was required to eliminate the problems which were encountered. During Phase II, a slurry (non-soluble composition suspended in a thin, watery mixture) agent-carrying rocket was developed by modifying the pyrotechnic agent rocket, and work on this rocket continued in Phase IV, which was accomplished out of order before Phase III because of problems which had to be resolved prior to Phase III launcher testing and final Phase V analysis.

It became apparent during firing tests that at ranges of more than about 1,500 meters, the Gyrojet's attitude at impact was "nose on." MBA felt that the deceleration in spin due to nose-on impact could allow the fuze's striker to be let down on the primer slowly enough to not fire it. The fuze was therefore modified to include *both* nose impact firing *and* spin deceleration firing. The combination fuze is shown in Figure 27–46. On nose impact, the nose extension, protruding through the fuze's nose, hit the striker insert, breaking the shear pin and firing the M42G primer. The fuze spring was changed to cause the fuze to fire about 45 seconds (instead of 40) after rocket burnout, and this required a larger spring volume and modified striker.

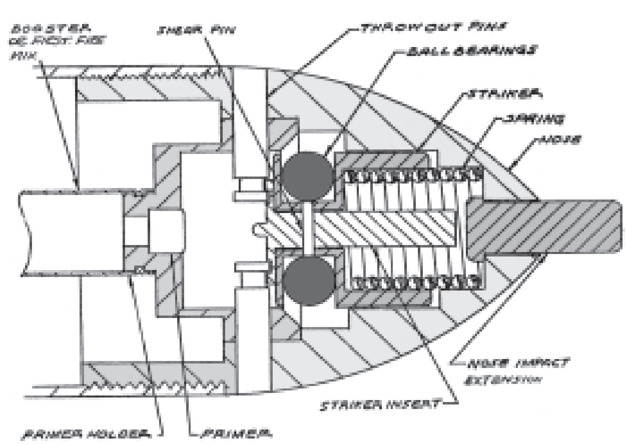


Figure 27–46. Combination 30mm Gyrojet fuze. MB-R-66/85.

The arming shear pins were replaced with two centrifugal throw-out pins so that arming could be accomplished at a lower spin, which reduced the ball forces and denting on the inclined surfaces of the primer holder. The fuze's arming spin was reduced from 49,800 rpm down to 33,000 rpm and its firing spin was reduced from 19,500 rpm down to 16,500 rpm.

The new rocket design is shown below in Figure 27–47. Note the addition of four 0.125-inch smoke holes in the payload section and the "banana plug" used to ignite the BWP 8-4 electric primer. Slurry payload (not pictured) used a Composition C explosive booster cup initiated by a number 8 blasting cap. The slurry payload carried during demonstrations was titanium tetrachloride ($TiCL_4$), which forms white smoke when exposed to the water vapor in ambient air. MBA used this same material as the spotting element in the CXU-2/B cold smoke markers for the BDU-33 B/B practice bomb as described and pictured on page 332. It is likely that this rocket is the one pictured in Figure 17–29 (B) on page 243, where I incorrectly identified it as a HE Gyrojet. The smoke holes on the Woodin Laboratory specimen are just above the upper case cannelure and measure 0.125 inch. The banana plug igniter would have been glued to the rocket's nozzle before firing.

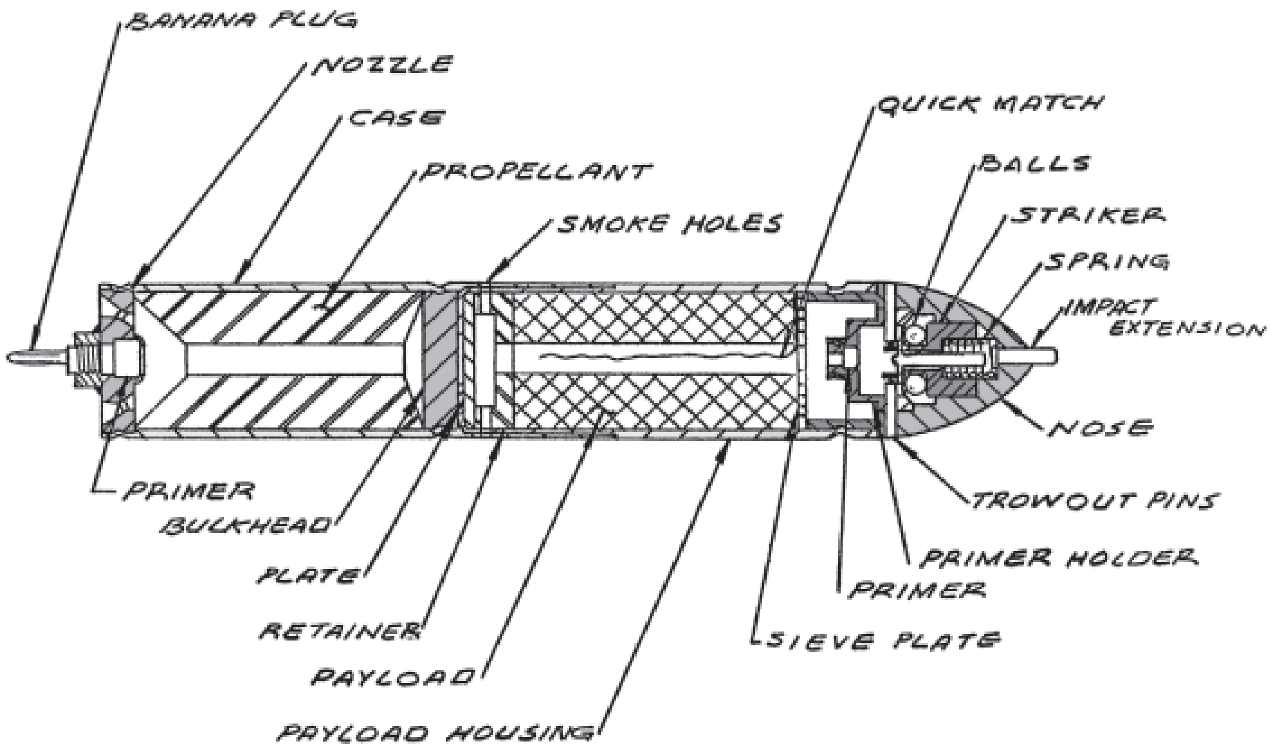


Figure 27–47. Revised 30mm smoke Gyrojet with combination fuze. Not to scale. MB-R-66/85.

The second full-scale, long-range system demonstration was also conducted at Camp Roberts on May 17-18, 1966, with the objective of firing 40 pyrotechnic and slurry rockets through the 500-2,500 meter ranges in 500-meter increments. There were a total of 47 rockets actually fired.

The slurry warhead rockets had a much lower incidence of successful functioning than the pyrotechnic ones, with identical fuzes. This appeared to be due to impact forces breaking the booster cups and blasting caps, allowing the liquid slurry to contact the primers and inside of the blasting caps. MBA believed this problem could be easily overcome by strengthening the booster cups.

At the end of the second demonstration, MBA concluded that the feasibility of both the pyrotechnic and slurry rockets had been well established. The rocket motor design was very reliable, and the problems encountered could be resolved. *Note: The requirement of MBA's contract with the Army was to demonstrate the <u>feasibility</u> of the chemical-agent-carrying Gyrojets, not to fully develop them to an operational level. That level of development would come later with a follow-on contract (MBA hoped).*

During Phase III, launcher design and testing, slight modifications in the rocket's warhead were made, a simulated launcher was tested, and a launcher design concept was produced. MBA's contract required that, *"This launcher should provide for the firing of the maximum number of rounds and still be consistent with ease of handling requirements for personnel. It must be portable and easy to set up with a maximum weight of 60 pounds. The launcher should be a 'shipping crate' disposable type."*

MBA's design concept is shown below in Figure 27–48. It was designed to ripple-fire 180 rockets at a time (the number determined to cover one hectare). Each of the four "shipping crate" modules contained 45 rockets and weighed 40 pounds loaded. The tripod base weighed about 25 pounds. An external firing box was powered by a hand-cranked generator or batteries. The electrical connection to the rockets was by a "banana plug" mechanically bonded to the rocket's BWP 8-4 electric primer. This type of connection, which was tested, also provided the rocket hold down force.

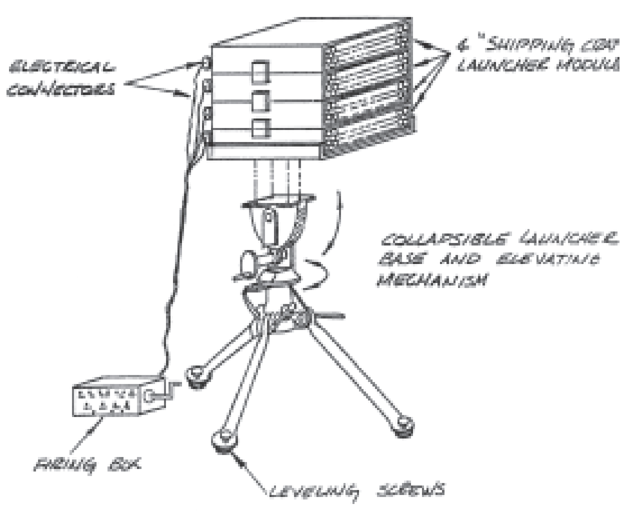


Figure 27–48. 30mm rocket launcher design. MB-R-66/85.

A simulated 46-round launcher built by MBA is shown next in Figure 27–49. It was made from angle iron with a semifixed launch angle. The aluminum launch tubes had electrical jacks on their bottom ends for primer ignition and rocket hold down. The tubes were 22 inches long (the length used in prior testing), but they could have been shorter with no loss of rocket accuracy. An M-4 mortar sight was mounted on the frame, which provided a launch angle of 68 degrees.

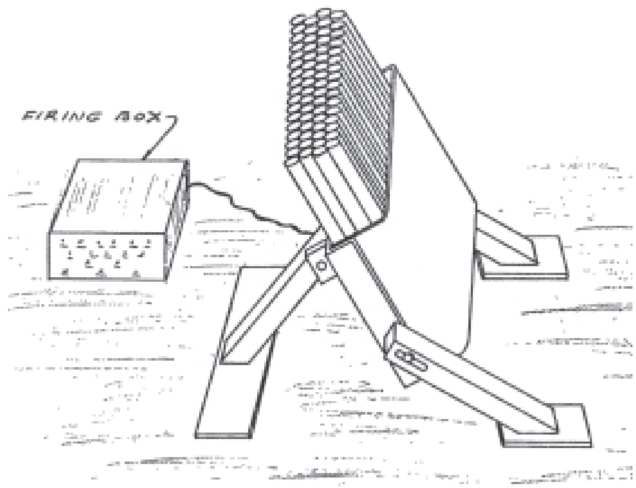


Figure 27–49. Simulated 30mm rocket launcher. MB-R-66/85.

Phase III firing tests demonstrations were conducted at the U.S. Army Edgewood Arsenal on August 10, 1966, by Edgewood Arsenal personnel with guidance provided by MBA. The simulated launcher was used, and was bolted to an aluminum plate which was in turn bolted to a concrete pad. The launch angle was fixed at 69 degrees, so that the rocket range was between 1,500 and 2,000 meters.

Initial firing tests to "sight in' the launcher were 100% successful, but when the first 46-round ripple fire was attempted, only 10 rockets fired. This failure was determined to be due to the dry-cell battery having insufficient storage capacity. Another larger-capacity battery was connected, and subsequent 46-round firings were successful. At the conclusion of Phase III tests, MBA again concluded that the feasibility of ripple firing 30mm rockets for the random dispersion of chemical agents over a 1-hectare area at distances of up to 3,100 meters was established.

During the final Phase V of the contract, MBA analyzed the data from Phases I- IV. Not surprisingly, the company recommended more research and development, including the possible use of a "drag device" on the descending rocket's trajectory and a method by which the rocket's payload section could be separated from the motor section prior to impact. This was seen as a potential benefit because some of the rockets buried themselves deep into the ground on impact. The final comprehensive report was issued in October, 1966, and with that report, MBA had fulfilled its contractual requirements with the Army.

Note: One final reminder; MBA designed, manufactured, and tested these experimental 30mm rockets with pyrotechnic or slurry smoke payloads because using actual chemical agents during this developmental period would have been too dangerous. In addition, MBA had no facilities to handle it. The smoke simulated the planned chemical agents, which were to be provided by the Army. It was not designed to function as a signal, distress or otherwise.

Chapter 17. Large Caliber Gyrojets, 40mm

On pages 250 and 251, MBA 40mm cloud-seeding Gyrojets are discussed and shown in Figure 17–39. After the book was published, Paul Smith completed the section of the MBA Type III cloud-seeding rocket, production lot 3, serial number 266, shown to the right in Figure 27–50. The section was actually in three pieces because the rocket's previous owner decided to cut it up to see what was inside. Fortunately, he saved the pieces, and with Smith's sections in hand, I scanned the three and then combined them in Photoshop to create the image shown.

There were some surprises. I had not known that the Olin BWP 8-4 electric primer had extra primer composition added, perhaps to improve the reliability of the large grain's ignition, or that the grain had a threaded hole inside, which would have increased its burning surface area.

It is also interesting that the delay train uses a high-low pressure system to gently expel the rocket's silver iodide (AgI) payload through the rocket's nose. The irregular line above the silver iodide payload is a piece of aluminum foil to seal the payload against moisture.

Figure 27–50. 40mm cloud-seeding rocket section.

Chapter 18. 40mm Gunpowder-Powered Less-Lethal

Figure 18–29 on page 269 shows a small picture of a Mark 70, Model 0 early Stun-Gun kit with five cartridges. A much better photograph, dated October 16, 1970, of this kit has surfaced that shows two sectioned cartridges, including a 5-piece wood baton round not seen before. The cartridges are plain aluminum, with gold anodized bases and rims.

Figure 27–51. 40mm Mark 70 Stun-Gun kit. MBA photo.

The MBA "Gatling Gun" hand-cranked Mark 72 Model 0 40mm Stun-Bag "Stun-Burst" launcher is shown in Figure 18–36 on page 272. This is a very scarce MBA less-lethal device, with reportedly only three prototypes being produced, and just one completely finished and operational. I have an MBA video of it being fired, and it does not seem to be particularly accurate. Apparently, none were sold in the police and corrections market, or to the military.

The new photo of the device is shown next in Figure 27–52, which shows its left side with its ammo can.

Figure 27–52. 40mm Mark 72 Model 0 Stun-Burst. MBA photograph.

Chapter 20. 12 Gauge Less-Lethal

Figure 20–2 on page 280 shows a group of 12-gauge Stinger-Stiks with (D) being a small pocket-size version of the device. MBA color marketing photos are rare because of their cost, so the one here is unusual. It shows the small Stinger-Stik, a round of 12-gauge less-lethal ammunition, and a 1-inch Stun-Bag.

Figure 27–53. Small 12-gauge Stinger-Stik. MBA photograph.

Chapter 24. Miscellaneous MBA Ordnance

A dilemma sometimes faced by collectors is when they have the opportunity to acquire a group of collectibles as one lot, which they must take intact or not at all. They may not pick and choose, or "cherry pick" from the group for just the items they are seeking. The deal presented is for all or nothing. This happened to me several times during work on the book, and the groups of MBA items offered always contained very scarce specimens I was not likely to encounter again, in addition to more common items that were duplicates of things I already had in my collection. The groups also included unknowns, several of which still remain unknown. However, we sometimes get lucky, and through a happy coincidence I learned about the 40mm MBA flechette rockets discussed here to close out this supplemental chapter, which is about 10 times longer than I thought it would be.

Thanks one more time to Jeff Osborne, I now have a copy of MBA technical report MB-R-72/72, *Preliminary Report on the Feasibility of the Arrow Rocket Multiflechette Weapon System*, dated September 25, 1972. The report describes a bizarre weapon system developed and tested under contract DAAD05-72-C-0152, sponsored by the Advanced Research Projects Agency (ARPA), Order No. 1665, Amendment #1, for the Army Small Arms Systems Agency, Aberdeen Proving Ground, Maryland. The report is the ninth monthly report, but it is not the final comprehensive report.

MB-R-72/72 covers the period between August 26 and September 15, 1972, when *"key features of the small arms rocket multiflechette weapon (MFW) system were successfully demonstrated. The present Phase II program has been aimed at the test weapon development and demonstration of a 40mm diameter version of the MFW. MBAssocistes has applied the acronym ARROW (Advanced Recoilless ROcket Weapon) to the MFW system."* MBA also developed another ARROW over-the-shoulder launcher in 30mm that is shown on page 241 in Figure 17–24.

The 40mm MFW system used an open-breech launcher and a round that burned out *inside the launch tube*. During Phase I of the program, versions of ARROW which launched 50 to 200 flechettes at velocities of 1,300 to 2,000 fps with each trigger pull were analyzed. These doubled the "firefight relative exchange ratio" compared to the best 5.56mm systems contemplated. Phase II of the feasibility and demonstration program had the following major goals:

— Development of a lightweight steel rocket motor that could boost a 54.5 gram flechette payload to a velocity of 1,500 fps with in-tube burn out in a 4-foot tube.

— Development of a payload that consists of 97 eight-grain flechettes producing a circular pattern with a 13-mil CEP or less dispersion.

— Demonstration of the combined rocket and payload.

— Design and fabrication of a prototype single shot launcher.

All of these objectives had been met by September 15, 1972. The round developed and demonstrated had the following characteristics:

— Electric ignition. The final round was anticipated to have percussion ignition.

— Weight of 183 grams (.404 pounds).

— Burnout velocity of 1,373 fps.

— Temperature range of -40 to +125 degrees F.

— Burn out distance of 4 feet (in tube).

— Payload of 97 eight-grain flechettes with a 1.85mm (0.073 inch) diameter and a length of 27.4mm (1.08 inches). Note: It appears that larger flechettes with a 2mm (0.08 inch) diameter and 38.2mm (1.5 inches) length were also tried.

— Motor case made of 300 grade maraging (very high strength) steel.

— Aluminum nozzle.

— Plastic parts made of Lexan.

— 34.1 grams of DTS 7123 propellant.

The feasibility test round configuration demonstrated successfully in September,1972 is shown in Figures 27–54 and 27–55.

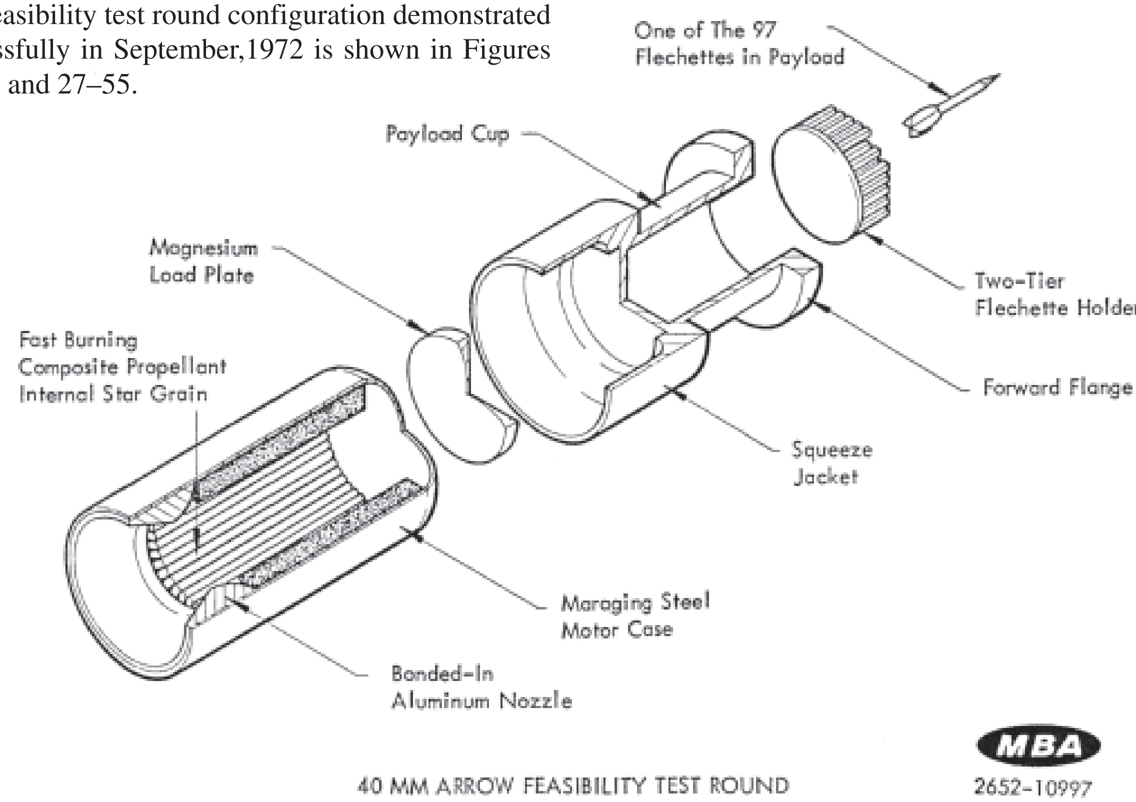


Figure 27–54. Arrow components. MBA drawing fromMB-R-72/72.

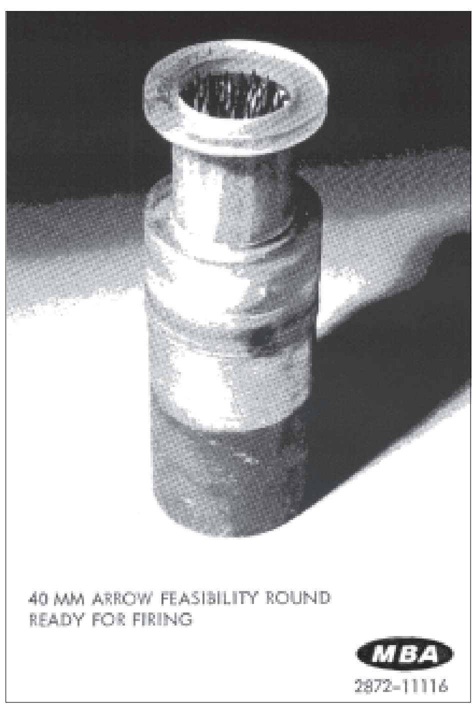


Figure 27–55. Complete ARROW round. MBA photo from MB-R-72/72.

An unfired specimen of the 40 x 126mm rocket is shown below in Figure 27–56 at actual size. It is not a Gyrojet, and it does not spin. It has one large 18mm nozzle port. The propellant is arranged in longitudinal strips inside the case as depicted in Figure 27–54.

Two additional Lexan payload cup variations were included with the rocket and are also shown, as is the Lexan two-tier flechette holder, also depicted in Figure 27–54, which could be used with either of the larger cups. The cups were originally designed to be deformable as the rocket passed through a "retardation taper" at the launcher's muzzle. During testing, this taper was determined to not be necessary to enhance flechette separation from the payload cup, and it was eliminated. The aluminum nozzle was a substitute for the phenolic nozzle used in earlier Phase I tests and rejected.

The complete rocket (A) is shown loaded with flechettes which measure 1.5 inches in length and 0.08 inch in diameter. They each weigh 12.5 grains. These longer flechettes are appropriate for the longer payload cup installed on the rocket. I confirmed that the two payload cup variations (B) and (C), which have shorter, larger diameter cups, will in fact hold 97 shorter, thinner flechettes as shown in the Figure 27–54 drawing. These smaller, 1.08-inch flechettes with 0.07-inch diameters will also fit in the two-tier flechette holder (D), which fits snugly in the larger diameter cups above the first layer of 97 short flechettes, apparently to create a larger payload. The forward flange of the payload cup shown in the Figure 27–54 drawing is somewhat thicker than any of the three specimen cups, indicating that a variety of payload cup designs and payloads were tried.

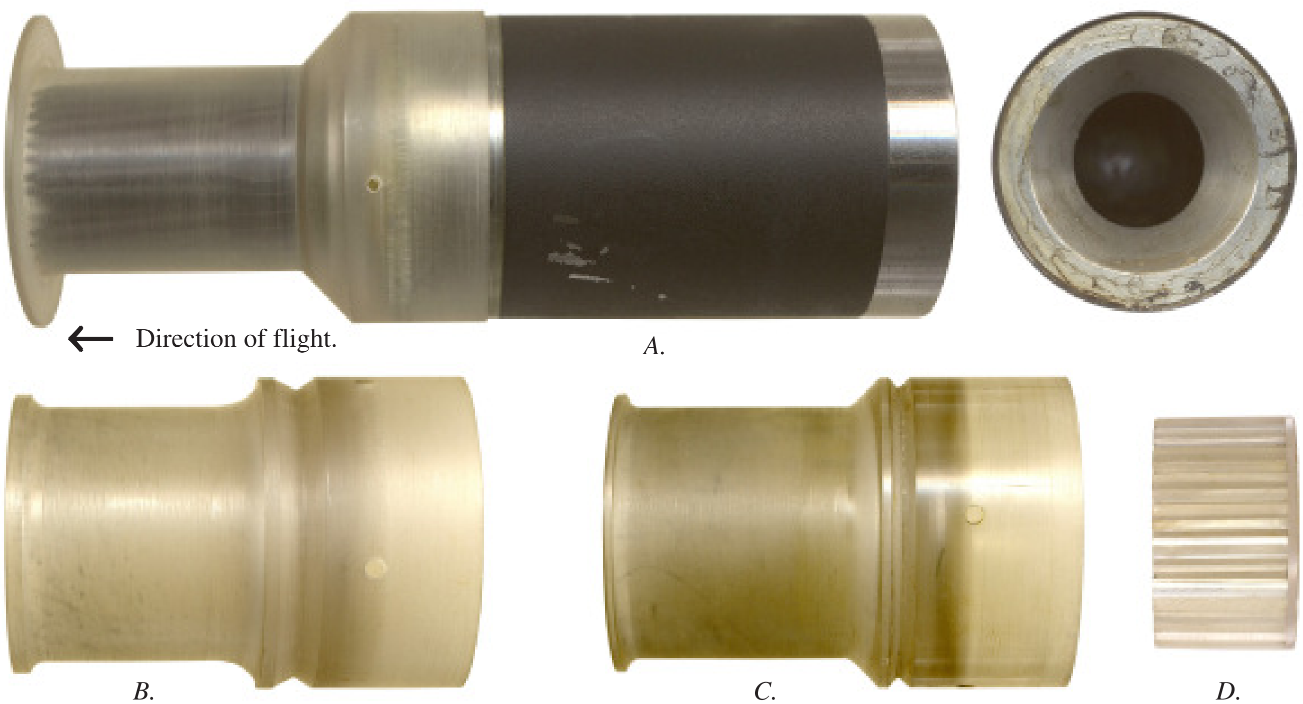


Figure 27–56. (A) MBA 40mm ARROW multiflechette feasibilty rocket and nozzle. (B) Payload cup variation. (C) Payload cup variation. (D) Two-tier flechette holder, side view. All actual size. Direction of flight was from right to left.

The prototype over-the-shoulder launcher, pictured in the white prior to being black anodized, is shown next in Figure 27–57. It weighed 6.9 pounds and was 48 inches long. In the unlikely event that the rocket motor case began to fail, the launcher was strong enough to contain the pressure of the swelling case. The launcher and case combined could contain about 16,000 psi, and the motor was designed to have a maximum pressure of about 5,200 psi. As a result, the launcher had a safety factor of three. In case the nozzle failed, it would be ejected to the rear with no increase in pressure, and in fact a loss of pressure.

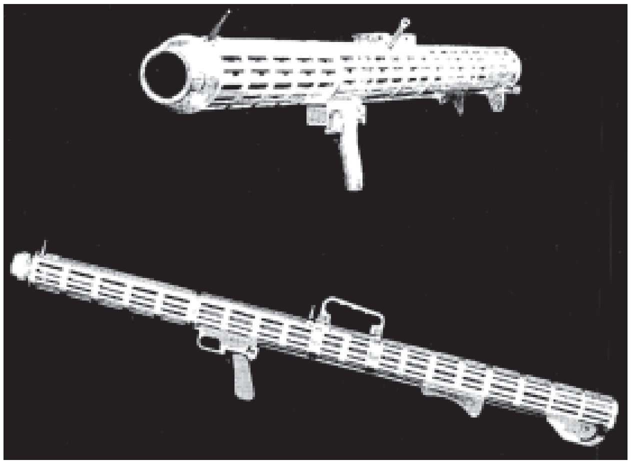


Figure 27–57. 40mm MBA prototype 40mm launcher. MBA photo fromMB-R-72/72.

While I am very grateful for my copy of MB-R-72/72, not all of the questions about this unusual rocket design have been fully answered, and I look forward to finding the Phase I report and the final comprehensive report of this fascinating project with the strangest-looking MBA rocket ever.

One thing that is not totally clear is the actual purpose of the system for combat use. However, we have a strong indication of this by the fact that MB-R-72/72 refers to the multiflechette weapon system doubling the "firefight relative exchange ratio," meaning that for every round of 5.56mm ammunition fired at the enemy during a firefight, two flechettes could be fired with the MBA weapon. The system is clearly designed for ground combat using concepts of flechette salvo fire developed during project SPIW (discussed on page 123-124). The rocket motor was designed to rapidly accelerate the 97-flechette (or more) payload, contained in a flexible Lexan cup, to a supersonic velocity of about 1,400 fps and then slow down abruptly and cause the flechettes to release from the cup and continue en masse toward their target. High speed photos showed that this release occurred about 10 feet ahead of the launcher muzzle where the rocket was slowing down with a force of about 125 negative g's.

One other puzzling 40 x 126mm rocket was included in the group with the one shown on page 445, and MB-R-72/72 does not mention it. It is a black-anodized aluminum dummy rocket with the same general configuration as the other 40mm rocket, and it has identical overall dimensions. An "INERT" sticker on its side, identifies it as a dummy. Some of the design characteristics are slightly different from the first rocket, especially in the nozzle area, but it is clearly a variation, not an entirely different design. It has a separate payload cup in the front and motor section in the back, separated by a solid bulkhead. Hopefully, I will be able to pin it down before the next supplement. In the meantime, it is shown below in Figure 27–58 at actual size.

← Direction of flight.

Figure 27–58. 40mm MBA dummy ARROW multiflechette rocket variation, actual size..

— End of supplemental chapter 27 —